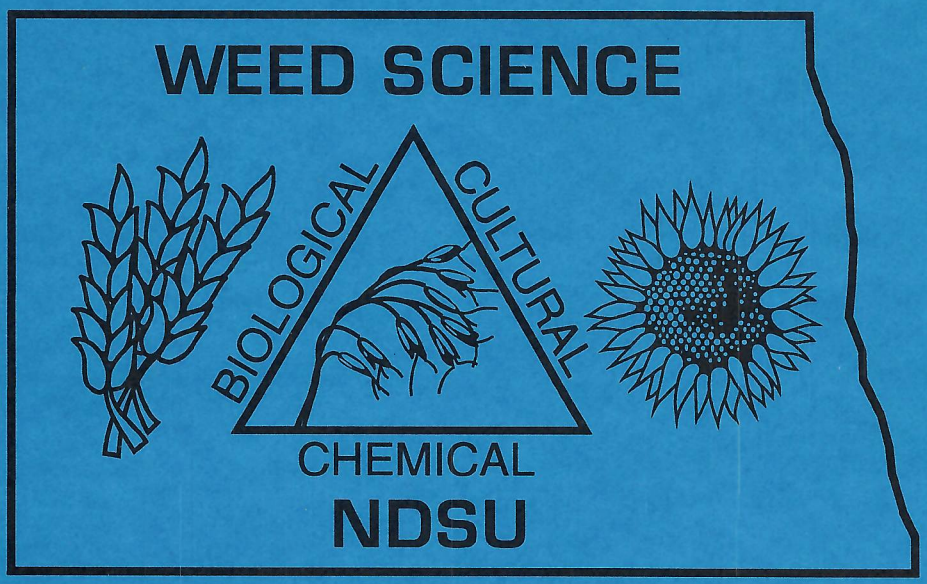
1999
NORTH DAKOTA
Weed Control Research



Weed Research Projects, Department of Plant Sciences
NORTH DAKOTA STATE UNIVERSITY
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NOT FOR PUBLICATION

SUMMARY OF 1999
WEED CONTROL EXPERIMENTS

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Reference to commercial products or trade names is made with no intended endorsement, and failure to mention products or trade names is done with no intended discrimination by North Dakota State University. Experiments with pesticides on non-labeled crops or target species does not imply endorsement of non-labeled uses of pesticides by North Dakota State University.

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CLIMATIC DATA, 1999 CARRINGTON

	Precipitation						April		May		June		July		August		Sept	
Date	April	May	June	July	August	Sept	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
1	NA	0.00	0.27	0.00	0.00	0.04	33	26	75	40	68	50	70	54	74	47	66	57
2	NA	0.00	0.01	0.00	0.04	0.02	29	26	71	49	77	51	77	52	77	57	57	53
3	NA	0.01	0.99	0.14	0.01	0.25	26	23	76	51	78	59	80	62	75	54	55	50
4	NA	0.36	0.00	0.10	0.00	0.49	30	17	75	55	82	61	76	62	81	51	56	49
5	0.45	1.20	0.00	0.05	0.00	0.00	36	19	64	53	77	58	73	58	85	53	66	48
6	0.00	0.44	0.02	0.00	0.00	0.00	39	27	55	42	79	57	81	52	86	56	80	48
7	0.01	0.00	0.00	0.00	0.00	0.00	47	32	53	37	81	53	75	53	70	50	71	52
8	0.00	0.00	0.00	0.63	0.02	0.00	56	30	51	31	83	62	72	56	75	49	58	48
9	0.00	0.45	0.58	0.00	0.23	0.00	55	34	43	37	73	55	69	53	79	60	65	39
10	0.00	1.23	0.00	0.00	0.00	0.00	42	36	54	40	71	48	76	49	84	55	68	39
11	0.00	0.00	0.01	0.00	0.02	0.21	53	33	55	38	70	54	80	53	74	60	59	46
12	0.00	0.00	0.00	0.00	3.16	0.11	59	32	60	36	74	52	85	61	63	50	55	43
13	0.02	0.01	0.00	0.05	0.00	0.00	68	40	52	40	62	47	84	60	72	45	59	43
14	0.00	0.54	0.00	0.11	0.00	0.00	51	35	54	47	66	46	78	64	78	52	60	41
15	0.00	0.06	0.00	0.06	0.68	0.00	40	30	68	51	64	50	78	61	78	57	66	34
16	0.00	0.00	0.00	0.00	0.00	0.00	33	26	64	49	66	40	68	52	75	54	71	40
17	0.00	0.00	0.00	0.00	0.00	0.00	45	23	60	44	72	45	69	50	77	52	79	52
18	0.00	0.00	0.00	1.10	0.00	0.00	65	31	70	39	69	52	70	57	71	50	67	49
19	0.01	0.00	0.00	0.00	0.00	0.00	55	30	78	51	66	56	75	59	78	46	52	42
20	0.00	0.00	0.01	0.00	0.00	0.00	44	39	70	50	78	62	84	61	77	54	61	40
21	0.00	0.00	0.23	0.00	0.00	0.00	54	32	66	47	79	62	89	64	83	53	77	43
22	0.00	0.00	0.16	0.14	0.00	0.00	56	33	68	48	79	63	83	65	85	59	84	44
23	0.00	0.00	0.01	0.00	0.00	0.00	60	28	58	46	77	53	87	61	76	53	67	40
24	0.00	0.01	0.00	0.00	0.00	0.00	67	32	67	44	80	53	86	58	80	51	76	47
25	0.00	0.00	1.10	0.03	0.00	0.20	67	36	69	41	85	58	80	59	86	59	58	42
26	0.01	0.00	0.01	0.00	0.00	0.03	58	46	80	46	70	51	77	52	86	62	52	42
27	0.00	0.00	0.00	0.00	0.00	0.00	64	46	75	49	63	46	84	54	84	58	58	34
28	0.00	0.00	0.03	0.00	0.00	0.00	71	44	86	50	69	53	94	55	78	58	57	32
29	0.00	0.00	0.38	0.00	0.26	0.00	72	40	84	56	73	54	94	56	65	48	60	31
30	0.00	0.20	0.00	0.00	0.00	0.00	76	36	59	47	72	53	79	58	78	58	49	26
31		0.00		0.00	0.00				60	40			69	51	90	65		
Total	0.50	4.51	3.81	2.41	4.42	1.35	52	32	65	45	73	53	79	57	78	54	64	43

CLIMATIC DATA, 1999 CASSELTON																			
	Precipitation						April		May		June		July		August		Sept	
Date	April	May	June	July	August	Sept	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
1	0.11	-	0.02	0.02	0.33	1.42	53	32	78	41	56	50	76	58	75	51	87	66
2	0.56	-	0.1	0.00	0.00	2.6	36	32	77	51	66	49	75	53	82	52	86	56
3	0.001	-	0.00	0.03	0.00	0.7	35	29	76	59	82	49	81	54	79	56	60	54
4	1.3	0.02	0.00	0.00	0.00	0.04	38	31	78	57	84	60	91	69	82	56	59	55
5	0.00	0.8	0.68	1.6	0.00	0.00	44	35	74	55	91	60	82	63	83	57	60	48
6	0.00	0.33	0.2	0.001	0.00	0.02	53	35	74	53	83	63	68	57	87	58	74	56
7	0.11	0.13	0.00	0.00	0.11	0.00	54	39	60	43	81	58	82	58	88	56	78	60
8	0.00	0.16	0.07	0.22	0.00	0.00	60	32	44	35	83	62	76	63	75	49	74	50
9	0.00	0.001	0.02	0.00	0.45	0.00	61	35	54	35	87	64	76	56	75	64	62	44
10	0.00	1.53	0.00	0.001	0.00	0.00	54	35	55	35	81	56	71	53	82	60	65	44
11	0.001	0.24	0.00	0.00	0.09	0.00	48	38	59	45	75	53	78	59	84	64	69	43
12	0.00	0.00	0.00	0.00	1.6	0.6	56	31	59	42	78	55	82	56	82	62	56	47
13	0.00	0.00	0.00	0.00	0.85	0.05	64	34	55	40	65	53	85	61	64	50	58	47
14	0.00	0.00	0.00	0.02	0.00	0.001	66	44	56	46	64	44	88	66	73	50	60	44
15	0.00	0.19	0.00	0.00	0.00	0.00	50	33	64	52	69	45	83	67	78	63	64	41
16	0.001	0.00	0.001	0.08	0.04	0.00	43	28	67	52	68	44	87	61	83	54	66	43
17	0.001	0.00	0.00	0.00	0.00	0.00	36	27	71	47	70	44	74	54	83	52	74	43
18	0.00	0.00	0.00	0.00	0.001	0.00	40	26	70	41	75	51	75	60	84	57	75	51
19	0.00	0.00	0.00	0.00	0.73	0.00	60	30	71	41	75	51	78	58	73	52	73	47
20	0.02	0.00	0.00	0.00	0.001	0.00	54	37	75	55	76	59	83	66	78	55	56	38
21	0.03	0.00	0.00	0.00	0.00	0.00	57	36	77	48	81	65	86	63	78	55	58	38
22	0.00	0.00	0.02	0.31	0.00	0.00	57	38	66	48	83	68	89	67	79	58	78	45
23	0.00	0.00	0.22	0.00	0.00	0.00	59	31	75	44	85	60	92	63	87	56	82	47
24	0.00	0.05	0.00	0.00	0.00	0.00	62	32	61	44	82	54	93	63	74	57	67	40
25	0.00	0.00	0.00	0.00	0.00	0.00	68	36	69	46	84	43	94	63	81	58	75	41
26	0.00	0.00	0.77	0.42	0.00	0.24	69	46	72	43	92	52	88	57	83	64	68	45
27	0.001	0.00	0.00	0.17	0.00	0.08	63	47	78	45	82	52	80	56	92	6	56	38
28	0.00	0.00	0.11	0.00	0.00	0.00	63	45	80	46	69	56	88	58	93	62	62	36
29	0.00	0.00	0.22	0.00	0.00	0.00	74	38	86	58	68	51	93	65	81	51	58	31
30	0.00	0.00	0.12	0.00	0.23	0.00	75	40	89	59	75	54	96	65	69	57	62	31
31		0.04		0.00					78	63			78	59				
Total/Avg	2.14	3.49	2.55	2.87	4.43	5.75	55	35	69	47	78	54	83	60	80	55	67	46

CLIMATIC DATA, 1999 CROOKSTON																		
	Precipitation						April		May		June		July		August		Sept	
Date	April	May	June	July	August	Sept	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
1	0.00	0.00	0.00	0.00	0.00	0.48	33	30	78	52	58	44	72	49	76	52	66	55
2	0.52	0.00	0.01	0.01	0.40	0.68	32	26	77	56	74	50	79	62	71	54	60	52
3	0.01	0.00	0.00	0.00	0.10	0.96	33	28	74	58	75	60	89	64	78	57	60	55
4	0.40	0.00	0.00	0.03	0.00	0.82	40	29	75	59	89	61	80	65	81	58	59	50
5	0.00	0.29	0.32	0.09	0.00	0.00	50	32	66	52	78	62	79	59	88	57	64	44
6	0.00	0.51	0.07	0.03	0.00	0.00	52	33	63	38	85	60	83	57	85	60	78	52
7	0.00	0.02	0.00	0.00	0.00	0.00	56	31	43	31	83	62	76	57	72	57	76	50
8	0.00	0.53	0.03	0.00	0.00	0.00	63	33	48	33	85	64	58	56	74	59	59	44
9	0.00	0.00	0.00	1.10	0.20	0.00	58	34	45	43	78	56	72	54	62	58	63	45
10	0.00	0.63	1.06	0.01	0.00	0.00	50	35	52	43	72	56	80	56	83	59	60	38
11	0.00	0.47	0.00	0.00	0.86	0.32	53	30	59	42	75	58	82	63	74	58	54	43
12	0.00	0.06	0.00	0.00	2.04	0.04	59	34	51	43	77	49	84	60	59	46	59	46
13	0.00	0.02	0.00	0.15	0.00	0.07	67	41	55	43	64	41	83	65	74	48	60	47
14	0.18	0.00	0.00	0.00	0.00	0.00	52	33	66	48	64	43	82	61	76	58	61	38
15	0.00	0.10	0.00	0.01	0.62	0.02	42	27	70	51	65	42	87	62	80	56	65	40
16	0.02	0.07	0.00	0.00	0.00	0.00	36	25	71	47	69	41	71	53	76	55	71	46
17	0.00	0.00	0.00	0.00	0.01	0.00	40	28	64	59	73	56	73	55	75	55	76	53
18	0.02	0.00	0.00	0.02	0.00	0.00	51	32	65	46	75	49	74	55	72	49	68	44
19	0.00	0.00	0.00	0.00	0.00	0.00	52	35	77	54	68	59	82	61	79	56	52	33
20	0.01	0.00	0.08	0.00	0.00	0.00	47	32	76	45	80	65	86	66	80	55	56	34
21	0.00	0.00	0.00	0.00	0.00	0.00	60	36	65	45	80	69	88	69	83	57	77	42
22	0.00	0.05	1.52	1.42	1.60	0.00	57	31	68	42	85	63	84	61	83	58	84	42
23	0.00	0.00	0.01	0.00	0.16	0.00	60	32	61	44	80	55	91	61	75	57	65	38
24	0.00	0.00	0.00	0.00	0.00	0.00	67	40	67	43	83	55	89	69	82	59	73	44
25	0.00	0.00	0.01	0.26	0.00	0.18	70	42	72	39	89	62	85	59	82	65	65	47
26	0.00	0.00	0.64	0.00	0.00	0.39	71	48	78	55	76	53	78	55	88	58	51	35
27	0.00	0.00	0.00	0.03	0.00	0.00	64	43	79	44	68	55	89	55	87	57	63	36
28	0.00	0.00	0.11	0.00	0.00	0.00	73	36	86	57	67	49	90	61	77	46	57	31
29	0.00	0.00	0.10	0.00	0.00	0.00	75	40	90	55	68	55	92	69	73	53	59	34
30	0.00	0.63	0.00	0.00	0.04	0.00	72	50	65	44	75	54	80	56	68	58	50	35
31		0.00		0.00	0.00				57	45			73	50	86	65		
Total	1.16	3.38	3.96	3.16	6.03	3.96	55	34	67	47	75	55	81	60	77	56	64	43

CLIMATIC DATA, 1999 FARGO

	Precipitation						April		May		June		July		August		Sept	
Date	April	May	June	July	August	Sept	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
1	0.17	0.00	0.00	0.00	0.00	1.93	39	33	78	50	63	50	73	58	75	52	74	57
2	0.02	0.00	0.01	0.00	0.00	1.11	34	30	77	52	79	49	80	55	77	59	61	56
3	0.70	0.00	0.05	0.00	0.16	0.94	37	30	78	60	76	60	90	67	78	58	60	56
4	0.08	0.57	0.01	0.77	0.00	1.06	43	31	75	59	89	65	82	62	81	55	62	56
5	0.00	0.62	0.67	0.00	0.00	0.00	50	33	68	57	83	63	79	63	88	59	66	49
6	0.02	0.04	0.20	0.00	0.00	0.00	54	33	59	47	82	62	82	59	89	60	78	51
7	0.12	0.62	0.00	0.00	0.01	0.00	58	40	47	39	83	57	77	57	72	56	75	59
8	0.00	0.00	0.01	0.46	0.00	0.00	62	37	50	34	85	66	72	58	78	51	62	50
9	0.00	0.28	0.00	0.02	0.36	0.00	60	35	54	33	82	62	70	56	82	64	65	45
10	0.00	0.79	0.00	0.00	0.00	0.00	48	38	60	46	75	53	79	50	83	61	66	47
11	0.00	0.01	0.00	0.00	0.68	0.45	53	36	60	46	76	58	82	59	80	65	56	47
12	0.00	0.00	0.00	0.00	1.98	0.02	59	33	53	43	81	54	84	61	69	56	58	48
13	0.00	0.00	0.00	0.00	0.00	0.00	67	53	56	42	68	50	87	66	73	50	59	44
14	0.01	0.07	0.00	0.00	0.00	0.00	55	40	66	49	67	40	83	68	76	54	62	44
15	0.00	0.00	0.00	0.01	0.03	0.00	43	31	70	56	66	45	90	66	83	64	66	42
16	0.00	0.00	0.00	0.00	0.00	0.00	34	27	70	52	67	40	73	57	80	57	73	46
17	0.00	0.00	0.00	0.00	0.01	0.00	37	28	64	45	75	45	73	54	83	54	77	54
18	0.00	0.00	0.00	0.00	0.00	0.00	53	26	69	38	72	57	77	64	73	54	70	54
19	0.00	0.00	0.00	0.00	0.00	0.00	52	32	77	55	69	57	82	58	80	50	56	35
20	0.03	0.00	0.00	0.00	0.00	0.00	52	41	76	55	80	63	86	65	79	61	58	35
21	0.00	0.00	0.02	0.00	0.00	0.00	57	38	66	47	82	67	88	66	83	64	76	42
22	0.00	0.00	0.59	0.08	0.93	0.00	58	38	76	50	84	65	92	69	85	60	82	48
23	0.00	0.00	0.00	0.00	0.00	0.00	61	26	60	45	82	60	94	66	75	56	67	46
24	0.00	0.00	0.00	0.00	0.00	0.00	67	39	66	45	85	58	94	61	83	57	74	46
25	0.00	0.00	0.02	0.52	0.00	0.20	70	41	71	45	91	62	89	63	83	63	67	50
26	0.00	0.00	0.55	0.00	0.00	0.09	66	47	78	43	76	57	78	57	91	66	55	43
27	0.02	0.00	0.02	0.07	0.00	0.00	61	47	80	56	69	53	88	61	93	60	63	37
28	0.00	0.00	0.24	0.00	0.00	0.00	72	48	86	49	66	55	93	57	79	60	59	34
29	0.00	0.00	0.28	0.00	0.00	0.00	73	43	90	63	72	53	95	64	71	52	62	34
30	0.00	0.03	0.05	0.00	0.08	0.00	77	48	76	49	76	57	83	63	66	58	54	36
31		0.00		0.00	0.00				56	46			73	56	87	65		
Total	1.17	3.03	2.72	1.93	4.24	5.80	55	37	68	48	77	56	83	61	80	58	65	46

CLIMATIC DATA, 1999 HETTINGER

	Precipitation						April		May		June		July		August		Sept	
Date	April	May	June	July	August	Sept	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
1	NA	0.00	0.00	0.35	0.00	0.00	27	26	69	46	74	41	74	51	76	59	64	53
2	NA	0.00	0.00	0.01	0.00	0.41	29	23	64	48	80	44	76	54	86	55	54	48
3	NA	0.03	0.28	0.00	0.36	0.17	27	15	68	45	78	53	76	61	80	58	52	48
4	NA	0.11	0.00	0.05	0.00	0.13	32	10	52	45	81	45	77	60	87	51	51	43
5	0.01	0.26	0.00	0.00	0.00	0.01	43	19	49	42	77	56	72	51	89	58	73	34
6	0.00	0.11	1.25	0.00	0.35	0.00	55	30	52	42	65	50	81	44	87	59	84	50
7	0.00	0.00	0.00	1.81	0.00	0.00	62	32	61	33	74	46	84	57	67	59	67	45
8	0.00	0.00	0.08	0.00	0.00	0.00	62	38	63	28	76	57	76	54	86	58	61	39
9	0.00	0.26	0.13	0.00	0.00	0.00	61	36	47	39	69	45	67	52	86	58	66	34
10	0.21	0.38	0.00	0.00	0.06	0.00	45	35	40	32	62	42	74	45	93	52	73	33
11	0.00	0.00	0.24	0.00	0.98	0.00	51	30	48	31	65	51	82	51	91	61	64	49
12	0.00	0.00	0.00	0.00	0.99	0.00	63	27	67	35	68	46	90	53	62	52	53	37
13	0.00	0.01	0.00	0.00	0.00	0.00	67	30	54	41	73	45	88	55	71	44	62	32
14	0.00	0.19	0.00	0.00	0.07	0.00	50	29	61	41	66	47	80	58	84	54	62	28
15	0.00	0.42	0.10	0.07	0.00	0.00	44	28	65	38	67	41	78	60	81	52	69	28
16	0.00	0.00	0.01	0.00	0.00	0.00	45	21	54	38	65	43	71	44	78	48	80	39
17	0.00	0.00	0.00	0.08	0.00	0.00	57	16	64	34	72	47	70	53	82	48	88	48
18	0.00	0.00	0.00	0.00	0.00	0.00	67	29	71	42	71	52	86	58	79	46	62	47
19	0.00	0.00	0.00	0.02	0.00	0.00	67	24	74	51	72	55	71	62	83	55	58	33
20	0.00	0.00	0.00	0.00	0.00	0.00	64	38	72	44	82	55	84	58	85	57	69	26
21	0.39	0.01	0.00	0.05	0.00	0.00	41	38	73	46	89	65	91	59	86	57	80	39
22	0.09	0.00	0.01	0.00	0.00	0.00	54	32	69	45	77	53	89	65	88	55	87	40
23	0.00	0.00	0.00	0.00	0.00	0.00	56	22	76	35	77	49	93	69	78	48	79	40
24	0.00	0.00	0.00	0.00	0.00	0.00	60	34	72	46	84	47	98	61	85	48	81	45
25	0.04	0.00	0.41	0.00	0.00	0.04	51	40	70	39	93	54	85	59	91	59	71	44
26	0.04	0.00	0.00	0.00	0.00	0.00	48	43	81	49	73	53	82	49	92	54	59	35
27	0.00	0.00	0.50	0.00	0.00	0.00	61	46	71	42	54	48	93	61	95	54	54	31
28	0.00	0.00	0.05	0.00	0.26	0.01	52	39	82	49	71	48	104	61	70	60	55	26
29	0.00	0.24	0.00	0.00	0.09	0.00	59	43	85	50	74	50	103	56	61	55	71	30
30	0.00	0.03	0.30	0.00	0.00	0.00	67	46	53	45	73	47	89	63	82	58	54	30
31		0.00		0.00	0.00				51	40			67	53	88	60		
Total	0.78	2.05	3.36	2.44	3.16	0.77	52	31	64	41	73	49	82	56	82	55	67	38

CLIMATIC DATA, 1999 MINOT																		
	Precipitation						April		May		June		July		August		Sept	
Date	April	May	June	July	August	Sept	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
1	NA	0.00	0.05	0.00	0.00	0.02	30	26	76	48	73	49	71	51	74	47	62	48
2	NA	0.00	0.01	0.07	0.34	0.20	33	25	72	54	76	48	76	51	71	56	55	47
3	NA	0.24	0.07	0.00	0.00	0.39	29	22	72	50	78	60	77	58	76	51	53	48
4	NA	0.62	0.00	0.03	0.00	0.08	33	19	62	47	78	57	75	59	80	56	56	49
5	0.00	1.92	0.00	0.00	0.00	0.00	39	19	50	46	76	56	74	58	84	57	68	46
6	0.00	0.85	0.56	0.00	0.09	0.00	47	30	47	42	67	55	84	52	86	55	85	48
7	0.00	0.00	0.00	0.09	0.00	0.24	62	36	59	39	77	55	75	52	69	52	70	52
8	0.00	0.00	0.01	0.76	0.10	0.00	61	33	58	32	82	56	74	54	76	49	58	44
9	0.00	0.03	0.00	0.00	0.00	0.00	62	40	47	40	72	53	72	56	80	60	66	39
10	0.02	1.23	0.00	0.00	0.00	0.00	51	38	45	38	72	50	79	54	83	56	67	38
11	0.00	0.02	0.00	0.00	0.29	0.20	43	33	49	36	68	54	83	57	71	58	63	47
12	0.00	0.01	0.00	0.00	0.39	0.24	61	32	66	38	71	51	86	59	66	49	51	45
13	0.00	0.00	0.11	1.57	0.00	0.00	69	41	59	40	62	48	84	58	72	48	59	42
14	0.00	0.64	0.00	0.00	0.00	0.00	52	35	65	49	69	44	77	59	82	54	59	40
15	0.00	0.09	0.01	0.15	0.46	0.00	46	33	64	49	65	50	74	60	80	56	67	39
16	0.00	0.08	0.00	0.00	0.00	0.00	43	25	60	49	68	46	66	48	76	53	73	46
17	0.00	0.00	0.00	0.00	0.00	0.00	52	22	60	45	72	49	70	55	76	55	83	46
18	0.00	0.00	0.00	0.01	0.00	0.00	65	37	74	42	76	55	68	55	74	53	60	47
19	0.05	0.00	0.00	0.00	0.00	0.00	60	29	76	55	72	55	79	60	81	56	52	41
20	0.00	0.00	0.07	0.00	0.03	0.00	46	35	65	48	78	60	88	62	80	56	65	42
21	0.00	0.60	0.00	0.00	0.00	0.00	52	33	64	45	84	62	88	62	86	56	80	46
22	0.00	0.00	0.15	0.21	0.02	0.00	56	30	58	48	78	60	85	62	83	55	86	46
23	0.00	0.00	0.00	0.00	0.00	0.00	61	29	72	42	76	55	88	64	78	53	70	44
24	0.00	0.00	0.00	0.00	0.00	0.00	68	36	67	49	79	54	87	60	84	53	80	48
25	0.00	0.00	0.03	0.00	0.00	0.25	64	40	71	45	81	56	82	58	88	63	56	39
26	0.03	0.00	0.00	0.00	0.00	0.12	60	46	80	52	68	51	75	54	86	62	51	40
27	0.00	0.00	0.00	0.00	0.00	0.01	61	46	74	48	63	45	80	54	83	62	53	34
28	0.00	0.00	0.00	0.00	0.00	0.00	71	42	88	56	72	49	95	64	78	56	58	33
29	0.00	0.12	0.10	0.00	0.28	0.00	74	41	75	49	71	55	96	61	63	53	58	36
30	0.00	0.33	0.14	0.00	0.00	0.00	76	48	52	44	76	51	80	58	80	58	47	28
31		0.00		0.00	0.00				55	39			68	51	90	60		
Total	0.10	6.78	1.31	2.89	2.00	1.75	54	33	64	45	73	53	79	57	79	55	64	43

CLIMATIC DATA, 1999 PROSPER																			
	Precipitation						April		May		June		July		August		Sept	
Date	April	May	June	July	August	Sept	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
1	NA	0.00	0.00	0.00	0.00	1.16	37	32	77	41	65	50	76	55	74	50	72	56
2	NA	0.00	0.02	0.00	0.00	1.30	32	30	76	48	82	49	80	51	76	54	60	55
3	NA	0.00	0.01	0.42	0.18	0.81	33	29	77	57	76	58	89	64	76	55	60	54
4	NA	0.60	0.05	1.01	0.00	0.45	41	30	74	59	93	63	79	63	81	54	61	54
5	0.00	0.51	0.39	0.00	0.00	0.00	49	33	68	56	82	63	77	60	85	55	68	46
6	0.00	0.19	0.15	0.00	0.19	0.00	51	32	59	46	83	58	81	57	86	57	78	46
7	0.03	0.23	0.00	0.00	0.02	0.00	57	38	46	38	84	56	77	57	72	53	76	57
8	0.00	0.00	0.08	0.22	0.00	0.00	61	33	51	34	87	64	72	57	76	48	63	49
9	0.00	0.29	0.00	0.02	0.60	0.00	57	34	52	34	82	59	69	54	80	63	67	43
10	0.00	0.99	0.00	0.00	0.00	0.00	47	37	60	43	76	54	80	51	84	59	68	45
11	0.00	0.00	0.00	0.00	0.11	0.55	53	36	59	45	77	52	82	55	79	64	56	39
12	0.00	0.00	0.00	0.00	1.05	0.00	58	32	54	41	81	52	84	56	65	54	60	44
13	0.02	0.00	0.00	0.00	0.00	0.00	66	39	56	41	69	52	87	64	72	50	61	43
14	0.01	0.00	0.00	0.00	0.00	0.00	52	37	62	48	70	41	81	66	76	49	64	45
15	0.00	0.10	0.00	0.17	0.01	0.00	41	30	70	55	67	44	87	64	81	63	67	40
16	0.00	0.00	0.00	0.00	0.00	0.00	34	28	70	52	69	43	72	55	78	54	74	40
17	0.00	0.00	0.00	0.00	0.00	0.00	39	28	64	48	76	42	72	53	82	50	78	50
18	0.00	0.00	0.00	0.00	0.01	0.00	54	28	68	40	73	53	75	56	72	52	72	50
19	0.00	0.00	0.00	0.00	0.00	0.00	52	33	74	51	68	57	81	55	79	49	58	37
20	0.04	0.00	0.00	0.00	0.00	0.00	49	40	78	54	80	62	85	59	78	53	60	34
21	0.00	0.00	0.00	0.00	0.00	0.00	56	35	65	48	83	66	87	63	82	53	80	36
22	0.00	0.03	0.24	0.30	0.54	0.00	54	37	76	50	84	65	88	66	85	57	85	44
23	0.00	0.00	0.01	0.00	0.00	0.00	60	31	62	44	82	57	89	62	76	55	68	47
24	0.00	0.00	0.00	0.00	0.00	0.00	66	32	69	45	85	54	91	60	81	57	76	38
25	0.00	0.00	0.36	0.47	0.00	0.19	68	34	73	47	90	58	85	61	82	57	69	49
26	0.00	0.00	0.26	0.00	0.00	0.05	64	46	80	43	76	55	77	56	91	61	55	42
27	0.00	0.00	0.02	0.34	0.00	0.00	61	47	81	51	67	51	86	56	92	56	64	34
28	0.00	0.00	0.20	0.00	0.00	0.00	71	44	88	44	68	51	91	55	78	58	59	33
29	0.00	0.00	0.58	0.00	0.00	0.00	72	37	92	57	70	49	92	62	69	48	63	29
30	0.00	0.00	0.01	0.00	0.12	0.00	76	36	68	50	77	54	75	62	67	57	54	35
31		0.00		0.00	0.00				58	46			71	54	86	62		
Total	0.10	2.94	2.38	2.95	2.83	4.51	54	35	68	47	77	54	81	58	79	55	67	44

CLIMATIC DATA, 1999 ST THOMAS																		
	Precipitation						April		May		June		July		August		Sept	
Date	April	May	June	July	August	Sept	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
1	N/A	0.00	0.00	0.00	0.00	0.00	35	29	79	45	58	47	69	50	74	48	72	56
2	N/A	0.00	0.00	0.00	0.00	0.20	30	27	79	49	72	47	75	45	77	53	59	53
3	N/A	0.01	0.19	0.03	0.00	0.23	32	25	78	57	74	55	80	57	77	49	58	51
4	N/A	0.07	0.41	0.10	0.00	0.25	32	22	75	59	83	60	77	62	78	58	57	53
5	0.37	0.52	0.00	0.02	0.00	0.01	40	18	65	56	79	58	77	58	85	54	61	42
6	0.00	0.09	0.43	0.00	0.20	0.00	40	32	61	42	85	58	82	59	84	54	77	40
7	0.00	0.04	0.00	0.00	0.00	0.01	54	32	46	34	80	55	74	51	70	49	74	54
8	0.00	0.03	0.00	0.34	0.00	0.01	61	33	50	33	83	60	65	56	73	42	56	47
9	0.00	0.02	0.09	0.04	0.13	0.00	57	35	53	34	72	56	72	55	79	60	63	45
10	0.00	0.03	0.00	0.00	0.00	0.00	50	33	45	42	73	50	79	54	81	58	61	41
11	0.00	0.03	0.00	0.00	0.31	0.05	53	33	58	42	77	51	81	56	70	56	55	37
12	0.00	0.02	0.00	0.01	0.32	0.10	58	34	54	41	75	53	84	60	62	53	59	41
13	0.12	0.01	0.00	0.09	0.00	0.02	65	39	54	46	64	42	83	60	74	49	57	48
14	0.00	0.01	0.01	0.16	0.00	0.01	54	38	60	47	60	38	80	62	76	46	60	45
15	0.00	0.04	0.00	0.08	0.50	0.01	41	29	69	51	67	41	78	60	71	58	65	35
16	0.00	0.01	0.00	0.00	0.02	0.00	36	26	68	49	69	38	70	54	72	56	71	38
17	0.00	0.00	0.00	0.00	0.00	0.00	44	27	61	43	74	41	70	53	74	54	78	49
18	0.00	0.01	0.00	0.00	0.00	0.00	55	31	64	38	76	52	74	57	74	54	68	48
19	0.00	0.00	0.00	0.00	0.00	0.00	56	32	75	49	66	49	82	59	79	50	53	35
20	0.00	0.00	0.12	0.00	0.00	0.00	53	37	73	49	76	61	86	61	77	53	60	28
21	0.00	0.00	0.00	0.22	0.00	0.00	61	34	60	46	83	62	87	66	83	53	80	40
22	0.00	0.00	0.62	0.10	0.03	0.00	58	31	54	45	87	64	85	68	83	60	85	43
23	0.00	0.00	0.01	0.00	0.00	0.00	61	28	58	44	78	56	87	62	75	56	66	41
24	0.00	0.00	0.00	0.00	0.00	0.00	69	30	65	46	80	54	88	59	82	57	75	41
25	0.00	0.00	0.55	0.00	0.00	0.01	71	35	72	45	79	51	85	61	84	57	65	46
26	0.00	0.00	0.18	0.00	0.00	0.16	71	42	80	44	74	52	76	53	85	57	52	43
27	0.00	0.00	0.00	0.03	0.00	0.00	63	50	80	54	66	50	84	50	82	54	62	38
28	0.00	0.0	0.00	0.00	0.00	0.00	73	49	89	48	69	54	92	57	73	49	59	34
29	0.00	0.00	0.36	0.00	0.00	0.00	74	39	80	58	70	51	92	61	72	43	58	30
30	0.00	0.33	0.00	0.00	0.00	0.00	78	38	58	47	72	52	80	65	69	56	50	37
31		0.00		0.00	0.00				63	41			69	52	89	60		
Total	0.49	1.27	2.97	1.22	1.51	1.07	54	33	65	46	74	52	79	58	77	53	64	43

CLIMATIC DATA, 1999 WILLISTON																		
	Precipitation						April		May		June		July		August		Sept	
Date	April	May	June	July	August	Sept	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
1	N/A	0.00	0.05	0.10	0.04	0.00	35	27	77	51	73	48	72	49	74	47	68	51
2	N/A	0.00	0.00	0.07	0.38	0.57	40	22	76	52	78	50	77	52	73	55	58	50
3	N/A	0.03	0.23	0.15	0.00	0.10	31	19	61	46	78	59	75	57	80	50	51	48
4	N/A	0.19	0.00	0.11	0.00	0.07	36	17	56	45	74	54	72	57	84	54	54	49
5	0.00	0.22	0.00	0.00	0.00	0.00	53	25	52	43	77	53	74	52	87	56	73	45
6	0.01	0.01	0.01	0.00	0.00	0.00	61	29	58	40	75	56	84	52	88	62	82	51
7	0.00	0.00	0.00	0.28	0.03	0.00	63	34	64	33	76	48	79	56	72	58	70	48
8	0.00	0.02	0.59	0.26	0.04	0.00	62	42	63	37	73	54	74	58	89	58	62	42
9	0.00	0.32	0.00	0.00	0.00	0.00	65	38	50	39	67	49	71	54	86	61	68	39
10	0.06	0.95	0.00	0.00	0.00	0.00	48	35	40	32	71	43	78	50	92	59	75	38
11	0.00	0.35	0.28	0.00	0.04	0.04	41	34	40	32	72	52	84	56	78	59	66	47
12	0.00	0.01	0.01	0.00	0.13	0.12	66	27	66	34	71	46	88	58	66	54	53	39
13	0.00	0.17	0.01	0.00	0.00	0.00	64	33	61	45	72	51	93	58	75	48	62	38
14	0.00	0.05	0.00	0.04	0.00	0.00	51	26	65	45	70	46	83	52	90	56	62	35
15	0.00	0.03	0.00	0.42	0.25	0.00	47	28	63	46	68	48	78	50	73	52	71	34
16	0.00	0.01	0.00	0.00	0.00	0.00	46	24	55	41	71	44	64	44	79	51	80	44
17	0.00	0.00	0.00	0.00	0.00	0.00	60	20	65	38	77	50	74	51	78	58	85	49
18	0.00	0.00	0.00	0.00	0.00	0.15	63	38	76	44	79	56	72	60	81	51	60	42
19	0.01	0.00	0.02	0.02	0.00	0.00	61	32	75	49	78	55	85	58	88	56	52	37
20	0.00	0.00	0.01	0.01	0.09	0.00	57	35	68	44	78	63	91	60	89	62	67	36
21	0.00	0.16	0.00	0.28	0.00	0.00	50	36	67	48	85	61	92	60	94	63	81	44
22	0.00	0.01	0.10	0.35	0.00	0.00	57	36	60	43	77	56	90	61	80	59	86	45
23	0.00	0.00	0.03	0.00	0.00	0.00	62	28	75	39	77	54	89	61	81	52	82	47
24	0.00	0.00	0.00	0.00	0.00	0.00	67	34	74	48	81	50	93	63	93	58	78	44
25	0.00	0.00	0.00	0.00	0.00	0.05	65	39	77	50	85	56	80	61	96	62	56	41
26	0.00	0.00	0.00	0.00	0.00	0.00	59	49	74	49	65	44	79	52	92	59	60	38
27	0.00	0.00	0.03	0.00	0.00	0.00	66	46	78	40	60	39	89	52	88	59	55	30
28	0.00	0.00	0.01	0.00	0.00	0.00	68	46	87	53	73	43	98	57	82	63	58	29
29	0.00	0.04	0.00	0.00	0.00	0.00	70	43	72	47	73	52	100	60	67	57	63	32
30	0.00	0.15	0.00	0.00	0.00	0.00	74	47	58	46	76	46	83	57	93	59	49	32
31		0.00		0.00	0.00				57	46			71	48	81	52		
Total	0.08	2.72	1.38	2.09	1.00	1.10	56	33	65	43	74	51	82	55	83	56	66	41

Soil Test Results at Various Weed Experiment Locations						
		Organic			PPM	
	Soil Texture	Matter	pH	lb/A N	P	K
A. K. Ekre Grassland Preserve (ND)	Loamy sand	2.9	6.8	3	3	70
Buxton, ND	Loam	3.9	8.1			
Camp Grafton, ND	Loamy sand	2.8	7.0	3	3	98
Carrington, ND	Loam	3.2	6.9	Fertilized by test		
Casselton, ND	Silty clay	4.4	8.1	Fertilized by test		
Crookston, MN	Silt loam	3.4	8.3	148	7	105
Colfax, ND	Sandy loam	3.1	6.5	Fertilized by test		
Cuba, ND	Sandy loam	7.0	8.2	3	4	100
Fargo, ND (section 22)	Silty clay	4.5-6.0	7.5	190	26	1095
Fargo, ND (campus)	Silty clay	6.8	7.2	Fertilized by test		
Fargo, ND (Dexter)	Silty clay	5.5	7.5	111	12	310
Glyndon, MN (Zollinger)	Loam	2.6	7.3	Fertilized by test		
Glyndon, MN (Dexter)	Silt loam	2.9	8.4	106	15	110
Grand Forks, ND (English coulee)	Loam	5.1	8.3	17	14	225
Hatton, ND	Sandy loam	2.2	5.9	Fertilized by test		
Hawley, MN	Loam	2.2	8.5	3	4	105
Jamestown, ND (Pipestem Dam)	Loam	6.8	6.8	28	5	290
Minot, ND	Loam	2.7	7.0	Fertilized by test		
Minto, ND	Silty clay	4.2	7.9	337	18	480
Mooreton, ND	Silt loam	3.1	7.5	79	12	210
Oakes, ND	Sandy loam	2.1	7.1	24	Very high	Very high
Oriska, ND	Silty clay	4.1	7.4	Fertilized by test		
Prosper, ND	Silty clay loam	3.2	7.0	90	23	315
Prosper, ND (Zollinger)	Loam	4.0	7.2	Fertilized by test		
Sheyennne ND, Grasslands (Insect)	Loamy sand	2.5	6.9	3	7	125
St. Thomas, ND	Silt loam	3.6	8.3	31	20	160
Wahpeton, ND	Silty clay	5.7	6.2	Fertilized by test		
Wendell, MN (Dexter)	Loam	4.7	8.1	141	29	300
Wendell, MN	Silty clay	5.4	7.8	Fertilized by test		
West Fargo, ND	Silty clay	3.6	7.2	8	42	1460
Williston, ND	Loam	2.3	6.8	Fertilized by test		
Wyndmere	Loamy sand	1.9	6.5	Fertilized by test		

KEY TO ABBREVIATIONS AND EVALUATIONS

Crop injury, crop stand and weed control ratings are based on a visual estimate using a scale of 0 = no effect to 100 = complete kill.

Alfa = Alfalfa	Mesa = Meadow salsify
Amaz = Amaranth	Nabe = Navy bean
Barl, Bar = Barley	Nfcf = Nightflowering catchfly
Bdlf = Broadleaf	Oats = Tame oats
Biww = Biennial wormwood	Pest = Perennial sowthistle
Bubu = Buffalobur	Pesw = Pennsylvania smartweed
Bygr = Barnyardgrass	Pibe = Pinto bean
Cath = Canada thistle	Pota = Potato
Cano = Canola	Powe = Pondweed
Cocb = Common cocklebur	Prle = Prickly lettuce
Colq = Common lambsquarters	Prmi = Proso millet (tame)
Coma = Common mallow	Prpw = Prostrate pigweed
Copu = Common purslane	Qugr = Quackgras
Corw = Common Ragweed	Rrpw = Redroot pigweed
Cram = Crambe	Ruth = Russian thistle
Dali = Dandelion	Safl, Saff = Safflower
Dobr = Downy brome	Shpu = Shepherd's-purse
Drbe = Dry bean	Smwe = Annual smartweed
Duru = Durum wheat	Soyb, Sobe = Soybean
Ebns = Eastern black nightshade	Spsp = Spotted spurge
Fach = False chamomile	Sugb, Sgbt = Sugarbeet
Fibw = Field bindweed	Snfl,Sufl = Sunflower
Fipc = Field pennycress	Swcl = Sweet clover
Fisb = Field sandbur	Tabw = Tame buckwheat
Flwe = Flixweed	Tamu = Tansy mustard
Foba = Foxtail barley	Tumu = Tumble mustard
Fomi, Ftmi = Foxtail millet	Tymu = Tame yellow mustard
Fota, Fxtl = Foxtail species	Vowh = Volunteer wheat
Grft = Green foxtail	Vele = Velvetleaf
Girw = Giant ragweed	Vema = Venice mallow
HNS, Hans = Hairy nightshade	Wht = Volunteer wheat
Howe = Horseweed	Wibw = Wild buckwheat
HRSW = Hard red spring wheat	Wimu = Wild mustard
KOCZ = Kochia	Wioa = Wild oat
Lath = Ladysthumb	Wipm = Wild-proso millet
Lent = Lentils	Yeft = Yellow foxtail
Llsa = Lanceleaf sage	
Mael = Marshelder	

METHODS

PPI = Preplant incorporated
PEI = Preemergence incorporated
PRE, PE = Preemergence
EPOST = Early postemergence
MPOST = Mid postemergence
LPOST = Late postemergence
LLPOST = Late-late postemergence
P, PO, POST = Postemergence
POSTDIR = Postemergence directed

MISCELLANEOUS

DF = Dry flowable

EC = Emulsifiable concentrate

F = Fall

FL = F = Flowable

S = Spring

L = Liquid flowable

WP = Wettable powder

WDG = Water dispersible granules

G = Granules or gallon/A

SG = Soluble granules

Inc = I = Incorporation

%ir = inju = Percent injury rating

%sr = %std, strd = Percent stand reduction

HT = Plant height

SPK = Spike stage

Tswt = TW = Test weight

Yld = Yield

alk = alkanolamine salt

AMN = ammonium nitrate

AMS = ammonium sulfate

bee = butoxyethyl ester

dea = diethanolamine salt

dga = diphycolamine

dma = dimethylamine salt

ioe = isooctyl ester

MS, MVO = methylated vegetable oil

NIS = nonionic surfactant

PO, OC = Petroleum oil concentrate (17% emulsifier)

SURF = S = Surfactant

tms = trimethylsulfonium salt

28N, UAN = 28% liquid nitrogen fertilizer

ADJUVANT	COMPANY
Esterified vegetable oils/fatty acid	
Class Destiny	Cenex
Dash	BASF
Destiny	Cenex
Hasten	WilFarm
MethOil	Terra
MSO	Loveland
Scoil	AGSCO
Sundance II	Rosens
Sun-It II3	AGSCO
W-4971	WilFarm
Esterified vegetable oils & organosilicone surfactant	
Dyne-Amic	Helena
Phase	Loveland
Rivet	Terra
W-1961	WilFarm
Fertilizer & drift retardant	
Array	Rosens
Corral AMS	Cenex
SurfPlus	AGSCO
Nonionic surfactants	
Activate Plus	Terra
Activator 90	Loveland
AGPRO	AGPRO Systems
Agra-Wet	Loveland
Alfonic 12-14-80	Vista Chemical
Amway 80	Amway
Induce	Helena
Kinetic	Helena
L1-700	Loveland
Optima	Helena
Preference	Cenex
R-11	Wilbur-Ellis
R-900	WilFarm
Silwet L-77	Loveland
Spray Booster S	Cenex

TF-8036	Zeneca
Tergitol 15-S-9	Union Carbide
X-77	Loveland
MSO + water conditioning agent	
Vortex	Loveland
Petroleum oil concentrates	
CL-9715	Cenex
Herbimax	Loveland
Mor-Act	Wilbur-Ellis
Ortech	Rosens
17% COC	Cenex
Prime Oil	Terra
Surfactant & fertilizer blends	
AMS Plus	Terra
Breakout	Loveland
Class Act	Cenex
Class Act II	Cenex
Class Act II DB	Cenex
Dispatch AMS	Loveland
Dispatch 2N	Loveland
Impressive HV	Rosen
Newtone	Cenex
Sensation	Rosens
Surfate	AGSCO
Quad 7	AGSCO
Water conditioning agent	
Choice	Loveland
Cayuse	Wilbur-Ellis
MSO/PO+fertilizer blends	
CL-9706	Cenex
CL-9711	Cenex
Eth-N-Gard	WilFarm
FirstMate	Terra

Unknown

Agri-Stay	Ag Dymanics
L1-105	Loveland
ND-4	NDSU
ND-72	NDSU
React	Loveland
Score	Novartis
Supercharge, T1=8035	Zeneca

Drift retardants

Placement

AMS + drift retardant + deposition aid + anti-foam agent

Dryve	Loveland

Drift retardant + anti-foam+water conditioning agent

UltraGard	Loveland

LIST OF HERBICIDES TESTED IN 1999				
Common Name	**Abbreviation**	**Company**	**Formulation**	**Trade Name**
AC 263,222 (imazapic)		American Cyanamid	2 lb/gal EC	Plateau
AC 299,263 Imazamox	Imam	American Cyanamid	1 lb/gal EC	Raptor
Acetochlor&Atrazine	Acet&Atra	Zeneca	2.4&1.6 L	FulTime
Acetochlor&Dichlormid	Acet&Dcmd	Zeneca	6.4 lb/gal EC 3.2 lb/gal ME	Surpass TopNotch
Acethochlor&Mesotrione		Zeneca	3.5 SC	WF 2705
Acetochlor&MON EPTC	Acet&EPTC	Zeneca	1.4&5.6 E	Doubleplay
Acetochlor&MON 4660	Acet&4660	Monsanto	7 lb/gal EC	Harness
Acetochlor&Safener&Atrazine		Monsanto	3.1 & 2.5 L	Harness Xtra
Acetochlor&Safener&glyphosate		Monsanto	5.52 EC	MON 78126
Acifluorfen	Acif, Blzr	BASF, American Cyanamid	2 lb/gal E,S	Blazer, Status
Acifluorfen&Bentazon	Acif&Bent	BASF	0.67+3 lb/gal EC, 1.33+2.67 S	Galaxy, Storm
Alachlor	Alac	Monsanto	4 lb/gal MT	Several
Atrazine	Atra	Various	90% DF	Numerous
Atrazine+2,4-D		UAP	3.25 F	Shotgun
Atrazine+2,4-D+fluroxypyr		UAP	3.25 ESC	PCC-196
Azafenidin	Azaf	DuPont	80% DF	Milestone, R6447
BAS 635	BAS 635	BASF	71.4 DF	BS 635
Bay MKH 6562		Bayer	70% WG	
Bentazon	Bent, Bsgn	BASF	4 lb/gal S	Basagran
Bentazon&Acifluorfen		BASF	3.0+0.67 SL	Galaxy
Bentazon&Atrazine		BASF	5 SC	Laddok S-12
Bromoxynil	Brox	Rhône-Poulenc	2 lb/gal EC	Buctril/Broclean
Carfentrazone		FMC, Novartis	50% DG, 40% WG	Aim
CGA 248757 Fluthiacet	Actn,Flut	Novartis	75% SG	Action
CGA 277476, Oxasulfuron	Oxas, Expt	Novartis	75% SG	Expert
Chlorsulfuron		DuPont	75% WG	Telar
Clethodim	Clet,Slct	Valent	2 lb/gal, 0.94 lb/gal	Select, Prism
Clodinafop	Clod	Novartis		Discover
Clopyralid	Clpy	DowAgro Sciences	3 lb/gal S	Stinger
Clopyralid&2,4-D	Clpy&2,4-D	DowAgro Sciences	0.38+2 lb/gal S	Curtail
Cloransulam	Clor,FrstRt	DowAgro Sciences	84% DF	FirstRate
Cyanazine	Cyan	DuPont	90% DF	Bladex
Cycloate	Cycl	Zeneca	6 lb/gal EC	Ro-Neet
Desmedipham	Desm	AgrEvo	1.3 lb/gal EC	Betanex
Desmedipham & Phenmedipham	Desm&Phen	AgrEvo	0.65+0.65 lb/gal E	Betamix
Desmedipham & Phenmedipham & Ethofumesate	Desm&Phen&Etho	AgrEvo	0.6+0.6+0.6 lb/gal E	Betamix Progress
Diflufenzoypyr	BAS 664	BASF	70% WG	None
Dicamba	Dica	BASF, Gharda USA	4 lb/gal S	Banvel,Clarity,Gharda dicamba
Dicamba&Atrazine		BASF	1.1&2.1 L	Marksman
Dicamba&nicosulfuron	Dica&Nico	BASF	67.3&7.5 DF	Celebrity
Dicamba&primsulfuron		Novartis	43.9&7.5 WDG	Northstar

Dimethenamid	Dime,Frtr	BASF	6 lb/gal EC	Frontier
a-Dimethanamid	a-Dime	BASF	6 lb/gal EC	Frontier or isomer
Dimethanamid&Atrazine		DuPont		Lead-off
Diclofop	Dcfp	AgrEvo	3 lb/gal EC	Hoelon
Difenzoquat	Dife	American Cyanamid	2 lb/gal S	Avenge
Diflufenzopyr Dicamba	BAS 662	BASF	2 lb/gal dicamba, 2.5:1 (dic:d:stu)	Distinct
Diquat	Diqu	Zeneca	2 lb/gal S	Diquat
Endothall	Endo	Elf Atochem	3 lb/gal S	Herbicide 273/Desicate II
EPTC	EPTC	Zeneca	7 lb/gal EC 25% G	Eptam
EPTC&Dichlormid	EPTC&Dcmd	Zeneca	6.7 lb/gal EC 25% G	Eradicane
EPTC&Dichlormid& Acetochlor	EPTC&Dcmd& Acet	Zeneca	6.8 EC	DoublePlay
ET-751	Pyraflufen		0.02 EC	
Ethalfluralin	Etha	DowAgro Sciences	3 lb/gal EC, 10%G	Sonalan
Ethofumesate	Etho	AgrEvo	4 lb/gal F	Nortron
Exp 31809 B			4 SC	
F8426 carfentrazone		FMC	50%	Aim/Affinity
Fenoxaprop-P, Fenoxaprop-S	Fenx-P, Fenx-S	AgrEvo	1 EC	Puma
Fenx-P&2,4-D&MCPA		AgrEvo	0.44+0.58+1.75 lb/gal EC	Tiller
Fenx-P&MCPA		AgrEvo	0.67+4 lb/gal EC	Dakota
Fenx-P&MCPA& Thifensulfuron& Tribenuron		AgrEvo	1.6:7.6:0.187:0.092	Cheyenne
Fluazifop-P	Flfp-P	Zeneca	2 lb/gal EC	Fusilade DX
Fluazifop-P& Fenoxaprop-P	Flfp&Fenx	Zeneca	2+0.66 lb/gal EC	Fusion
Flufenacet		Bayer	60 WG	FOE 5043
Flufenacet&Isoxaflutole	Fluf&Isox	Bayer	48&10% DF	Epic/USA 1999
Flufenacet&Metribuzin		Bayer	54.4&13.6% DF	Axiom/ Domain
Flumetsulam	Flms	DowAgro Sciences	80 WG	Python
Flumetsulam& Clopyralid	Flms&Clpy	DowAgro Sciences	23.1+62.3% DF	Hornet
Flumetsulam& Clpy&2,4-D	Flms&Clpy &2,4-D	DowAgro Sciences	84.3% DF	Scorpion III
Flumetsulam& Metolachlor	Flms&Meto	DowAgro Sciences	0.2+7.47 lb/gal	Broadstrike+Dual
Flumetsulam& Trifluralin	Flms&Trif	DowAgro Sciences	0.25+3.4 lb/gal	Broadstrike+Treflan
Flumiclorac	Flmc,Rsrc	Valent	0.86 lb/gal EC	Resource
Flumioxazin	V-53482	Valent	50%WP	Valor
Flurochloridane		Zeneca	2 EC	Racer
Fluroxypyr	Flur	UAP	1 lb/gal EC	Starane, PCC-140
Flurtamene&Aclonifen		Rhône-Poulenc	3 EC	Nyki
Fomesafen		Zeneca	2 EC	Reflex
Fomesafen&Adjuvant		Zeneca	1.88 EC	Flexstar
Fosamine		DuPont	4 lb/gal SL	Krenite
Glufosinate	Gluf, Lbrty	AgrEvo	1 lb/gal EC	Liberty/Rely

Glufosinate&Atrazine	Gluf&Atra	AgrEvo	1+3.3 L	Liberty ATZ
Glyphosate-ipa	Glyt	Monsanto	3 lb ae/gal S	Roundup Ultra/RT, Glyphos
Glyphosate-tms	Glyt	Zeneca	6 lb ai/gal S	Touchdown
Glyphosate&2,4-D		Monsanto	0.9+1.5 lb/gal	Landmaster BW
Halosulfuron	Halo,Prmt	Monsanto	75% DF	Permit
Hexazinone	Hexa	DuPont	75% DF 90% SP	Velpar
Imazamox	Imam	American Cyanamid	1 lb/gal S	Raptor
Imazaquin	Imqn	American Cyanamid	1.5 lb/gal S	Scepter
Imazethapyr	Imep, Prst	American Cyanamid	2 lb/gal S	Pursuit
Imazethapyr&Imazapyr	Imep&Impr	American Cyanamid	70 WDG	Lightning
Imazethapyr& Pendimethalin	Imep&Pend	American Cyanamid	2.9 EC	Pursuit Plus
Imazamethabenz	Immb	American Cyanamid	2.5 lb/gal EC	Assert
Isoxaflutole	RP 201772	Rhône-Poulenc	75 DF	Balance
Isoxaflutole Tech		Rhône-Poulenc	4 SC	Exp 31809B
Lactofen	Lact	Valent	2 lb/gal S	Cobra
MCPA	MCPA	Rhône-Poulenc	4 lb/gal EC,S	Several, Chiptox
Mesotrione		Zeneca	4 SC	ZA1296
Metolachlor&Atrazine		Norvartis	2.4+3.1L	Biup II Magnum
Metolachlor& Benoxacor (active isomer)		Norvatis	7.6 lb/gal E	Dual II Magnum
Metolachlor&Metribuzin	Meto&Metr	Bayer	6.55&1.45 F	Turbo
Metribuzin	Metr	Bayer, DuPont	4 lb/gal F, 75% DF 4 lb/gal F, 75 %	Sencor Lexone
Metsulfuron	Mets	DuPont	60% DF	Ally/Escort
Nicosulfuron	Nico	DuPont	75% DF	Accent
Nicosulfuron+ rimsulfuron+ atrazine		DuPont	89.46	Basis Gold
Nicosulfuron+rimsulfuron+ Clopyralid+flumetsulam		DuPont	6.2+6.2+51.7 +19.3%	Accent Gold
Oxadiargyl		Rhône-Poulenc	80 WG	Raft
Oxadiazon		Rhône-Poulenc	2 G	Ronstar
Oxyfluorfen	Oxyf	Rohm & Haas	1.6 lb/gal EC	Goal
Paraquat	Para	Zeneca	2.5 lb/gal S 2 lb/gal S; 1.5 SL	Gramoxone Extra Cyclone; Starfire
Pendimethalin	Pend	American Cyanamid	3.3 lb/gal EC	Prowl
Picloram		DowAgro Sciences	2 lb/gal S	Tordon 22K
Primisulfuron		Novartis	64.6% DF	Beacon
Promytryne		Various		Caparol
Propanil	Prnl	Rohm & Haas	80% DF	Stampede 80 EDF
Prosulfuron	Pros	Novartis	75 DF	Peak
Pyrazon	Pyzn	BASF	4.2 lb/gal F	Pyramin
Quinclorac		BASF	75% WP	Paramount
Quizalofop-P	Qufp-P	DuPont	0.88 lb/gal EC	Assure II
Rimsulfuron		DuPont	25% DF	Matrix
Rimsulfuron&Thifensulfuron	Rims&Thif,Bsis	DuPont	75% DF	Basis
Sethoxydim	Seth	BASF American Cyanamid	1.5 lb/gal EC	Poast, Prestige
Sulfentrazone	Snen	DuPont/FMC	75% DF	Authority/Spartan
Sulfometuron	Sume	DuPont	75% DF	Oust

Thifensulfuron	Thif,Pinn,Pncl	DuPont	25% DF	Pinnacle
Thifensulfuron&Tribenuron	Thif&Trib	DuPont	50%+25%DF	Harmony Extra
Tralkoxydim	Tral	Zeneca	80% DF	Achieve
Tribenuron	Trib	DuPont	75% DF	Express
Triflusulfuron	Tfsu	DuPont	50% DF	UpBeet
Triclopyr	Trcp	DowAgro Sciences	4 lb/gal EC	Garlon
Trifluralin	Trif	DowAgro Sciences	4 lb/gal EC 10% G	Several
2,4-D	2,4-D	Various	Various EC, S, WSP	Numerous
2,4-DB	2,4-DB	Various	2 lb/gal	Numerous

[a] Abbreviations in the tables may consist of only the first one, two, or three listed letters when space was limited. Abbreviations of numbered compounds vary with available space, but usually use the first letters and numbers.

LIST OF HERBICIDES TESTED IN 1999				
Common Name	**Abbreviation**	**Company**	**Formulation**	**Trade Name**
AC 263,222 (imazapic)		American Cyanamid	2 lb/gal EC	Plateau
AC 299,263 Imazamox	Imam	American Cyanamid	1 lb/gal EC	Raptor
Acetochlor&Atrazine	Acet&Atra	Zeneca	2.4&1.6 L	FulTime
Acetochlor&Dichlormid	Acet&Dcmd	Zeneca	6.4 lb/gal EC 3.2 lb/gal ME	Surpass TopNotch
Acethochlor&Mesotrione		Zeneca	3.5 SC	WF 2705
Acetochlor&MON EPTC	Acet&EPTC	Zeneca	1.4&5.6 E	Doubleplay
Acetochlor&MON 4660	Acet&4660	Monsanto	7 lb/gal EC	Harness
Acetochlor&Safener&Atrazine		Monsanto	3.1 & 2.5 L	Harness Xtra
Acetochlor&Safener&glyphosate		Monsanto	5.52 EC	MON 78126
Acifluorfen	Acif, Blzr	BASF, American Cyanamid	2 lb/gal E,S	Blazer, Status
Acifluorfen&Bentazon	Acif&Bent	BASF	0.67+3 lb/gal EC, 1.33+2.67 S	Galaxy, Storm
Alachlor	Alac	Monsanto	4 lb/gal MT	Several
Atrazine	Atra	Various	90% DF	Numerous
Atrazine+2,4-D		UAP	3.25 F	Shotgun
Atrazine+2,4-D+fluroxypyr		UAP	3.25 ESC	PCC-196
Azafenidin	Azaf	DuPont	80% DF	Milestone, R6447
BAS 635	BAS 635	BASF	71.4 DF	BS 635
Bay MKH 6562		Bayer	70% WG	
Bentazon	Bent, Bsgn	BASF	4 lb/gal S	Basagran
Bentazon&Acifluorfen		BASF	3.0+0.67 SL	Galaxy
Bentazon&Atrazine		BASF	5 SC	Laddok S-12
Bromoxynil	Brox	Rhône-Poulenc	2 lb/gal EC	Buctril/Broclean
Carfentrazone		FMC, Novartis	50% DG, 40% WG	Aim
CGA 248757 Fluthiacet	Actn,Flut	Novartis	75% SG	Action
CGA 277476, Oxasulfuron	Oxas, Expt	Novartis	75% SG	Expert
Chlorsulfuron		DuPont	75% WG	Telar
Clethodim	Clet,Slct	Valent	2 lb/gal, 0.94 lb/gal	Select, Prism
Clodinafop	Clod	Novartis		Discover
Clopyralid	Clpy	DowAgro Sciences	3 lb/gal S	Stinger
Clopyralid&2,4-D	Clpy&2,4-D	DowAgro Sciences	0.38+2 lb/gal S	Curtail
Cloransulam	Clor,FrstRt	DowAgro Sciences	84% DF	FirstRate
Cyanazine	Cyan	DuPont	90% DF	Bladex
Cycloate	Cycl	Zeneca	6 lb/gal EC	Ro-Neet
Desmedipham	Desm	AgrEvo	1.3 lb/gal EC	Betanex
Desmedipham & Phenmedipham	Desm&Phen	AgrEvo	0.65+0.65 lb/gal E	Betamix
Desmedipham & Phenmedipham & Ethofumesate	Desm&Phen&Etho	AgrEvo	0.6+0.6+0.6 lb/gal E	Betamix Progress
Diflufenzoypyr	BAS 664	BASF	70% WG	None
Dicamba	Dica	BASF, Gharda USA	4 lb/gal S	Banvel,Clarity,Gharda dicamba
Dicamba&Atrazine		BASF	1.1&2.1 L	Marksman
Dicamba&nicosulfuron	Dica&Nico	BASF	67.3&7.5 DF	Celebrity
Dicamba&primsulfuron		Novartis	43.9&7.5 WDG	Northstar

Dimethenamid	Dime,Frtr	BASF	6 lb/gal EC	Frontier
a-Dimethanamid	a-Dime	BASF	6 lb/gal EC	Frontier or isomer
Dimethanamid&Atrazine		DuPont		Lead-off
Diclofop	Dcfp	AgrEvo	3 lb/gal EC	Hoelon
Difenzoquat	Dife	American Cyanamid	2 lb/gal S	Avenge
Diflufenzopyr Dicamba	BAS 662	BASF	2 lb/gal dicamba, 2.5:1 (dic:d:stu)	Distinct
Diquat	Diqu	Zeneca	2 lb/gal S	Diquat
Endothall	Endo	Elf Atochem	3 lb/gal S	Herbicide 273/Desicate II
EPTC	EPTC	Zeneca	7 lb/gal EC 25% G	Eptam
EPTC&Dichlormid	EPTC&Dcmd	Zeneca	6.7 lb/gal EC 25% G	Eradicane
EPTC&Dichlormid& Acetochlor	EPTC&Dcmd& Acet	Zeneca	6.8 EC	DoublePlay
ET-751	Pyraflufen		0.02 EC	
Ethalfluralin	Etha	DowAgro Sciences	3 lb/gal EC, 10%G	Sonalan
Ethofumesate	Etho	AgrEvo	4 lb/gal F	Nortron
Exp 31809 B			4 SC	
F8426 carfentrazone		FMC	50%	Aim/Affinity
Fenoxaprop-P, Fenoxaprop-S	Fenx-P, Fenx-S	AgrEvo	1 EC	Puma
Fenx-P&2,4-D&MCPA		AgrEvo	0.44+0.58+1.75 lb/gal EC	Tiller
Fenx-P&MCPA		AgrEvo	0.67+4 lb/gal EC	Dakota
Fenx-P&MCPA& Thifensulfuron& Tribenuron		AgrEvo	1.6:7.6:0.187:0.092	Cheyenne
Fluazifop-P	Flfp-P	Zeneca	2 lb/gal EC	Fusilade DX
Fluazifop-P& Fenoxaprop-P	Flfp&Fenx	Zeneca	2+0.66 lb/gal EC	Fusion
Flufenacet		Bayer	60 WG	FOE 5043
Flufenacet&Isoxaflutole	Fluf&Isox	Bayer	48&10% DF	Epic/USA 1999
Flufenacet&Metribuzin		Bayer	54.4&13.6% DF	Axiom/ Domain
Flumetsulam	Flms	DowAgro Sciences	80 WG	Python
Flumetsulam& Clopyralid	Flms&Clpy	DowAgro Sciences	23.1+62.3% DF	Hornet
Flumetsulam& Clpy&2,4-D	Flms&Clpy &2,4-D	DowAgro Sciences	84.3% DF	Scorpion III
Flumetsulam& Metolachlor	Flms&Meto	DowAgro Sciences	0.2+7.47 lb/gal	Broadstrike+Dual
Flumetsulam& Trifluralin	Flms&Trif	DowAgro Sciences	0.25+3.4 lb/gal	Broadstrike+Treflan
Flumiclorac	Flmc,Rsrc	Valent	0.86 lb/gal EC	Resource
Flumioxazin	V-53482	Valent	50%WP	Valor
Flurochloridane		Zeneca	2 EC	Racer
Fluroxypyr	Flur	UAP	1 lb/gal EC	Starane, PCC-140
Flurtamene&Aclonifen		Rhône-Poulenc	3 EC	Nyki
Fomesafen		Zeneca	2 EC	Reflex
Fomesafen&Adjuvant		Zeneca	1.88 EC	Flexstar
Fosamine		DuPont	4 lb/gal SL	Krenite
Glufosinate	Gluf, Lbrty	AgrEvo	1 lb/gal EC	Liberty/Rely

Glufosinate&Atrazine	Gluf&Atra	AgrEvo	1+3.3 L	Liberty ATZ
Glyphosate-ipa	Glyt	Monsanto	3 lb ae/gal S	Roundup Ultra/RT, Glyphos
Glyphosate-tms	Glyt	Zeneca	6 lb ai/gal S	Touchdown
Glyphosate&2,4-D		Monsanto	0.9+1.5 lb/gal	Landmaster BW
Halosulfuron	Halo,Prmt	Monsanto	75% DF	Permit
Hexazinone	Hexa	DuPont	75% DF 90% SP	Velpar
Imazamox	Imam	American Cyanamid	1 lb/gal S	Raptor
Imazaquin	Imqn	American Cyanamid	1.5 lb/gal S	Scepter
Imazethapyr	Imep, Prst	American Cyanamid	2 lb/gal S	Pursuit
Imazethapyr&Imazapyr	Imep&Impr	American Cyanamid	70 WDG	Lightning
Imazethapyr& Pendimethalin	Imep&Pend	American Cyanamid	2.9 EC	Pursuit Plus
Imazamethabenz	Immb	American Cyanamid	2.5 lb/gal EC	Assert
Isoxaflutole	RP 201772	Rhône-Poulenc	75 DF	Balance
Isoxaflutole Tech		Rhône-Poulenc	4 SC	Exp 31809B
Lactofen	Lact	Valent	2 lb/gal S	Cobra
MCPA	MCPA	Rhône-Poulenc	4 lb/gal EC,S	Several, Chiptox
Mesotrione		Zeneca	4 SC	ZA1296
Metolachlor&Atrazine		Norvartis	2.4+3.1L	Biup II Magnum
Metolachlor& Benoxacor (active isomer)		Norvatis	7.6 lb/gal E	Dual II Magnum
Metolachlor&Metribuzin	Meto&Metr	Bayer	6.55&1.45 F	Turbo
Metribuzin	Metr	Bayer, DuPont	4 lb/gal F, 75% DF 4 lb/gal F, 75 %	Sencor Lexone
Metsulfuron	Mets	DuPont	60% DF	Ally/Escort
Nicosulfuron	Nico	DuPont	75% DF	Accent
Nicosulfuron+ rimsulfuron+ atrazine		DuPont	89.46	Basis Gold
Nicosulfuron+rimsulfuron+ Clopyralid+flumetsulam		DuPont	6.2+6.2+51.7 +19.3%	Accent Gold
Oxadiargyl		Rhône-Poulenc	80 WG	Raft
Oxadiazon		Rhône-Poulenc	2 G	Ronstar
Oxyfluorfen	Oxyf	Rohm & Haas	1.6 lb/gal EC	Goal
Paraquat	Para	Zeneca	2.5 lb/gal S 2 lb/gal S; 1.5 SL	Gramoxone Extra Cyclone; Starfire
Pendimethalin	Pend	American Cyanamid	3.3 lb/gal EC	Prowl
Picloram		DowAgro Sciences	2 lb/gal S	Tordon 22K
Primisulfuron		Novartis	64.6% DF	Beacon
Promytryne		Various		Caparol
Propanil	Prnl	Rohm & Haas	80% DF	Stampede 80 EDF
Prosulfuron	Pros	Novartis	75 DF	Peak
Pyrazon	Pyzn	BASF	4.2 lb/gal F	Pyramin
Quinclorac		BASF	75% WP	Paramount
Quizalofop-P	Qufp-P	DuPont	0.88 lb/gal EC	Assure II
Rimsulfuron		DuPont	25% DF	Matrix
Rimsulfuron&Thifensulfuron	Rims&Thif,Bsis	DuPont	75% DF	Basis
Sethoxydim	Seth	BASF American Cyanamid	1.5 lb/gal EC	Poast, Prestige
Sulfentrazone	Snen	DuPont/FMC	75% DF	Authority/Spartan
Sulfometuron	Sume	DuPont	75% DF	Oust

Thifensulfuron	Thif,Pinn,Pncl	DuPont	25% DF	Pinnacle
Thifensulfuron&Tribenuron	Thif&Trib	DuPont	50%+25%DF	Harmony Extra
Tralkoxydim	Tral	Zeneca	80% DF	Achieve
Tribenuron	Trib	DuPont	75% DF	Express
Triflusulfuron	Tfsu	DuPont	50% DF	UpBeet
Triclopyr	Trcp	DowAgro Sciences	4 lb/gal EC	Garlon
Trifluralin	Trif	DowAgro Sciences	4 lb/gal EC 10% G	Several
2,4-D	2,4-D	Various	Various EC, S, WSP	Numerous
2,4-DB	2,4-DB	Various	2 lb/gal	Numerous

[a] Abbreviations in the tables may consist of only the first one, two, or three listed letters when space was limited. Abbreviations of numbered compounds vary with available space, but usually use the first letters and numbers.

Micro-rate and Roundup plus Dual and Frontier, Crookston, 1999. (Dexter) 'Empire Roundup Ready' sugarbeet was seeded 1.25 inches deep in 22 inch rows May 17. Counter 15G insecticide at 12 pounds product per acre was applied modified in-furrow at planting. Herbicide treatments were applied in 8.5 gpa water at 40 psi through 8001 nozzles to the center four rows of six row plots May 29, June 7, June 14, June 21 and June 30. Sugarbeet injury and redroot pigweed control were evaluated June 27 and July 20. Sugarbeet was hand thinned to an eight inch spacing June 25. Sugarbeet from the center two rows of 32 foot long plots was counted and harvested September 29.

Date	May 29	June 7	June 14	June 21	June 30
Time of Day	12:30 pm	1:00 pm	1:00 pm	7:30 pm	11:00 am
Air Temp. (°F)	88	79	68	77	77
6" Soil Temp. (°F)	69	72	61	62	62
Rel. Humidity (%)	32	53	34	69	53
Wind Velocity (mph)	6	10	5-8	15	10
Cloud Cover (%)	10	10	20	100	50
Soil Moisture	good	good	good	good	good
Sugarbeet Stage	cotyledon	v2.0-v3.5	v4.0-v5.5	v7.2-v7.8	v10.0-12.0
Redroot Pigweed	cot-2 leaf	2-6 leaf	cot-3 inch	4lf-6 inch	2-9 inches

Summary

Desmedipham + triflusulfuron + clopyralid + clethodim + methylated seed oil adjuvant at the micro - rate gave less redroot pigweed control when applied twice than when applied three times and less control when applied three times rather than four. The micro-rate plus p-dimethenamid or m-metolachlor in the first application gave improved redroot pigweed control and greater sugarbeet injury when the micro-rate was applied two or three times compared to the micro-rate alone. Three applications of the micro-rate plus p-dimethenamid or m-metolachlor gave redroot pigweed control similar to four applications of the micro-rate. Three applications of glyphosate gave less control of redroot pigweed than two applications on June 27 but the third application was not applied on June 27 so a flush of pigweed must have emerged between June 7 and June 27. The final glyphosate treatment on June 30 controlled all remaining redroot pigweed. p-Dimethenamid and m-metolachlor did not increase sugarbeet injury when applied with glyphosate but did increase sugarbeet injury when applied with the micro-rate.

The highest yielding plots were treated three times with glyphosate alone and the yield was significantly greater than all treatments except glyphosate applied twice and glyphosate + m-metolachlor followed by glyphosate. The micro-rate applied two or three times plus p-dimethenamid or m-metolachlor resulted in higher yields than when the micro-rate was applied without p-dimethenamid or m-metolachlor. Yields were similar when the micro-rate was applied four times with or without p-dimethenamid or m-metolachlor. Plots treated with glyphosate + p-dimethenamid followed by glyphosate yielded less than plots treated with glyphosate twice on the same dates. Glyphosate + m-metolachlor followed by glyphosate did not reduce yield compared to glyphosate alone.

Experiment continued on next page.

Micro-rate and Roundup plus Dual and Frontier, Crookston, 1999. (continued)

Treatment	(Date of Application)	Rate	June 27 Sgbt inj	June 27 Rrpw cntl	July 20 Sgbt inj	July 20 Rrpw cntl
		lb/A	%	%	%	%
Desm+Tfsu+Clpy+Clet+MethOil	(May 29, June 7)	0.08+0.004+0.03+0.03+1.5%	28	80	0	51
Desm+Tfsu+Clpy+Clet+MethOil+p-Dime	(May 29)	0.08+0.004+0.03+0.03+1.5%+0.83				
Desm+Tfsu+Clpy+Clet+MethOil	(June 7)	0.08+0.004+0.03+0.03+1.5%	66	100	19	89
Desm+Tfsu+Clpy+Clet+MO	(May 29, June 7, 14)	0.08+0.004+0.03+0.03+1.5%	38	95	3	73
Desm+Tfsu+Clpy+Clet+MethOil+p-Dime	(May 29)	0.08+0.004+0.03+0.03+1.5%+0.64				
Desm+Tfsu+Clpy+Clet+MethOil	(June 7, 14)	0.08+0.004+0.03+0.03+1.5%	65	100	18	95
Desm+Tfsu+Clpy+Clet+MethOil+p-Dime	(May 29)	0.08+0.004+0.03+0.03+1.5%+0.83				
Desm+Tfsu+Clpy+Clet+MethOil	(June 7, 14)	0.08+0.004+0.03+0.03+1.5%	64	100	25	97
Desm+Tfsu+Clpy+Clet+MO	(May 29, June 7, 14, 21)	0.08+0.004+0.03+0.03+1.5%	48	100	18	97
Desm+Tfsu+Clpy+Clet+MethOil+p-Dime	(May 29)	0.08+0.004+0.03+0.03+1.5%+0.83				
Desm+Tfsu+Clpy+Clet+MethOil	(June 7, 14, 21)	0.08+0.004+0.03+0.03+1.5%	66	100	26	99
Glyphosate	(June 7, 21)	0.75	4	100	0	99
Glyt+p-Dimethenamid	(June 7)	0.75+0.83				
Glyphosate	(June 21)	0.75	0	100	3	99
Glyphosate	(May 29, June 7, 30)	0.75	0	81	0	100
Glyt+m-Metolachlor	(June 7)	0.75+1.6				
Glyphosate	(June 21)	0.75	6	100	5	99
Desm+Tfsu+Clpy+Clet+MethOil+m-Meto	(May 29)	0.08+0.004+0.03+0.03+1.5%+1.6				
Desm+Tfsu+Clpy+Clet+MethOil	(June 7, 14)	0.08+0.004+0.03+0.03+1.5%	51	100	18	99
Desm+Tfsu+Clpy+Clet+MethOil+m-Meto	(May 29)	0.08+0.004+0.03+0.03+1.5%+1.6				
Desm+Tfsu+Clpy+Clet+MethOil	(June 7, 14, 21)	0.08+0.004+0.03+0.03+1.5%	63	100	28	100
EXP MEAN			38	96	12	92
C.V. %			27	3	67	5
LSD 5%			15	5	12	6
LSD 1%			20	6	16	8
# OF REPS			4	4	4	4

*MethOil=methylated seed oil from Terra; p-Dime=active isomer of dimethenamid; m-Meto=active isomer of metolachlor.

Experiment continued on next page.

Micro-rate and Roundup plus Dual and Frontier, Crookston, 1999. (continued)

Treatment	Date of (Application)	Rate	Sept.29 Sgbt Popl	Sucr	Root Yield	Impur Index	Extr Sucr
		lb/A	plt/64'	%	ton/A		lb/A
Desm+Tfsu+Clpy+Clet+MethOil (May 29, June 7)							
	0.08+0.004+0.03+0.03+1.5%	68	15.0	7.2	759	1917
Desm+Tfsu+Clpy+Clet+MethOil+p-Dime (May 29)							
	0.08+0.004+0.03+0.03+1.5%+0.83						
Desm+Tfsu+Clpy+Clet+MethOil (June 7)							
	0.08+0.004+0.03+0.03+1.5%	84	14.8	17.8	882	4576
Desm+Tfsu+Clpy+Clet+MethOil (May 29, June 7, 14)							
	0.08+0.004+0.03+0.03+1.5%	84	15.0	13.6	804	3579
Desm+Tfsu+Clpy+Clet+MethOil+p-Dime (May 29)							
	0.08+0.004+0.03+0.03+1.5%+0.64						
Desm+Tfsu+Clpy+Clet+MethOil (June 7, 14)							
	0.08+0.004+0.03+0.03+1.5%	81	15.3	18.0	755	4884
Desm+Tfsu+Clpy+Clet+MethOil+p-Dime (May 29)							
	0.08+0.004+0.03+0.03+1.5%+0.83						
Desm+Tfsu+Clpy+Clet+MethOil (June 7, 14)							
	0.08+0.004+0.03+0.03+1.5%	79	14.9	19.0	856	4946
Desm+Tfsu+Clpy+Clet+MO (May 29, June 7, 14, 21)							
	0.08+0.004+0.03+0.03+1.5%	78	15.2	19.2	791	5148
Desm+Tfsu+Clpy+Clet+MethOil+p-Dime (May 29)							
	0.08+0.004+0.03+0.03+1.5%+0.83						
Desm+Tfsu+Clpy+Clet+MethOil (June 7, 14, 21)							
	0.08+0.004+0.03+0.03+1.5%	84	14.9	19.6	830	5113
Glyphosate (June 7, 21)	0.75	83	15.3	23.8	801	6387
Glyphosate+p-Dimethenamid (June 7)	0.75+0.83					
Glyphosate (June 21)	0.75	85	14.8	22.2	856	5705
Glyphosate (May 29, June 7, 30)	0.75	82	15.4	24.2	757	6622
Glyphosate+m-Metolachlor (June 7)	0.75+1.6					
Glyphosate (June 21)	0.75	81	15.1	23.5	769	6263
Desm+Tfsu+Clpy+Clet+MethOil+m-Meto (May 29)							
	0.08+0.004+0.03+0.03+1.5%+1.6						
Desm+Tfsu+Clpy+Clet+MethOil (June 7, 14)							
	0.08+0.004+0.03+0.03+1.5%	82	15.1	19.4	796	5156
Desm+Tfsu+Clpy+Clet+MethOil+m-Meto (May 29)							
	0.08+0.004+0.03+0.03+1.5%+1.6						
Desm+Tfsu+Clpy+Clet+MethOil (June 7, 14, 21)							
	0.08+0.004+0.03+0.03+1.5%	77	15.2	20.4	820	5433
EXP MEAN		81	15.1	19.1	806	5056
C.V. %		7	2.6	8.1	10	9
LSD 5%		8	NS	2.2	NS	663
LSD 1%		10	NS	3.0	NS	889
# OF REPS		4	4	4	4	4

*MethOil=methylated seed oil from Terra; p-Dime=active isomer of dimethenamid; m-Meto=active isomer of metolachlor.

Micro-rate and Roundup plus Dual and Frontier, Fargo, 1999. (Dexter) 'Empire Roundup Ready' sugarbeet was seeded 1.25 inches deep in 22 inch rows May 3. Counter 15G insecticide at 12 pounds product per acre was applied modified in-furrow at planting. Herbicide treatments were applied in 8.5 gpa water at 40 psi through 8001 nozzles to the center four rows of six row plots June 1, June 7, June 14, June 24 and July 1. Sugarbeet injury and biennial wormwood, redroot pigweed, green and yellow foxtail and kochia control were evaluated June 30 and July 26.

Date	June 1	June 7	June 14	June 24	July 1
Time of Day	1:00 pm	1:30 pm	1:00 pm	8:00 am	10:00 am
Air Temp. (°F)	59	81	63	73	70
6" Soil Temp. (°F)	59	62	62	63	75
Rel. Humidity (%)	66	51	38	65	30
Wind Velocity (mph)	8	5-10	4	2	2
Cloud Cover (%)	95	10	20	30	40
Soil Moisture	good	good	good	good	good
Sugarbeet Stage	cotyledon	v1.5-v3.5	v4.0-v6.0	v8.0	v8.0-v10.0
Biennial Wormwood	2-4 leaf	0.5-2"diam	2-4 leaf	3-7" tall	5-9" tall
Redroot Pigweed	cot-2 leaf	2-4 leaf	4lf(2"tall)	6lf-4"tall	2-6" tall
Green&Yellow Foxtail	emerg-0.5"	1-3" tall	2-4" tall	1-6" tall	3-8" tall
Kochia	cot-2 leaf	0.5"ros diam	1"ros. diam.	1-2" tall	2-4" tall

Summary

Desmedipham + triflusulfuron + clopyralid + clethodim + methylated seed oil adjuvant at the micro-rate gave less weed control when applied twice than when applied three times and less control when applied three times rather than four. The micro-rate plus p-dimethenamid or m-metolachlor in the first application gave improved control of some weed species when the micro-rate was applied two or three times compared to the micro-rate alone. However, the micro-rate applied four times gave similar or better control than the micro-rate applied three times in combination with p-dimethenamid or m-metolachlor. Glyphosate applied two or three times gave nearly total weed control. Weed control was improved but not significantly improved on July 26 by p-dimethenamid or m-metolachlor in combination with glyphosate when glyphosate was applied twice.

Experiment continued on next page.

Micro-rate and Roundup plus Dual and Frontier, Fargo, 1999. (continued)

Treatment	Date of (Application)	Rate	June 30					July 26				
			Sgbt inj	Biww cntl	Rrpw cntl	Gr&Ye Fxtl cntl	Kocz cntl	Sgbt inj	Biww cntl	Rrpw cntl	Gr&Ye Fxtl cntl	Kocz cntl
		lb/A	%	%	%	%	%	%	%	%	%	%
Desm+Tfsu+Clpy+Clet+MO (June 1, 7)		0.08+0.004+0.03+0.03+1.5%	10	90	70	73	84	0	63	48	50	34
Desm+Tfsu+Clpy+Clet+MO+p-Dime (June 1)/ Desm+Tfsu+Clpy+Clet+MO (June 7)		0.08+0.004+0.03+0.03+1.5%+0.83 / 0.08+0.004+0.03+0.03+1.5%	6	87	91	96	82	0	65	71	83	48
Desm+Tfsu+Clpy+Clet+MO (June 1, 7, 14)		0.08+0.004+0.03+0.03+1.5%	11	99	100	99	99	0	91	97	85	81
Desm+Tfsu+Clpy+Clet+MO+p-Dime (June 1)/ Desm+Tfsu+Clpy+Clet+MO (June 7, 14)		0.08+0.004+0.03+0.03+1.5%+0.64 / 0.08+0.004+0.03+0.03+1.5%	20	99	100	100	100	0	91	86	95	89
Desm+Tfsu+Clpy+Clet+MO+p-Dime (June 1)/ Desm+Tfsu+Clpy+Clet+MO (June 7, 14)		0.08+0.004+0.03+0.03+1.5%+0.83 / 0.08+0.004+0.03+0.03+1.5%	23	100	100	100	100	0	91	87	91	71
Desm+Tfsu+Clpy+Clet+MO (June 1,7,14,24)		0.08+0.004+0.03+0.03+1.5%	18	100	100	100	98	0	98	98	100	96
Desm+Tfsu+Clpy+Clet+MO+p-Dime (June 1)/ Desm+Tfsu+Clpy+Clet+MO (June7,14,24)/		0.08+0.004+0.03+0.03+1.5%+0.83 / 0.08+0.004+0.03+0.03+1.5%	26	100	100	100	99	0	98	93	100	91
Glyphosate (June 7, 24)		0.75	0	100	100	100	100	0	100	96	94	100
Glyt+p-Dimethenamid (June 7)/ Glyphosate (June 24)		0.75+0.83 / 0.75	5	100	100	100	100	0	100	100	100	100
Glyphosate (June 1, 14, July 1)		0.75	0	100	100	100	100	0	100	100	100	100
Glyt+m-Metolachlor (June 7)/ Glyphosate (June 24)		0.75+1.6 / 0.75	8	100	100	100	100	0	100	100	100	100
Desm+Tfsu+Clpy+Clet+MO+m-Meto (June 1)/ Desm+Tfsu+Clpy+Clet+MO (June 7, 14)		0.08+0.004+0.03+0.03+1.5%+1.6 / 0.08+0.004+0.03+0.03+1.5%	19	98	100	100	99	0	86	84	95	64
Desm+Tfsu+Clpy+Clet+MO+m-Meto (June 1)/ Desm+Tfsu+Clpy+Clet+MO (June7,14,24)		0.08+0.004+0.03+0.03+1.5%+1.6 / 0.08+0.004+0.03+0.03+1.5%	24	100	100	100	99	0	99	97	100	99
EXP MEAN			13	98	97	97	97	0	91	89	92	82
C.V. %			80	2	5	4	8	0	5	11	5	13
LSD 5%			15	3	8	5	12	NS	7	14	7	15
LSD 1%			20	5	10	7	NS	NS	10	19	9	20
# OF REPS			4	4	4	4	4	4	4	4	4	4

*MethOil=methylated seed oil from Terra; p-Dime=active isomer of dimethenamid; m-Meto=active isomer of metolachlor.

Frontier on Roundup Ready sugarbeet, Fargo, 1999. (Dexter) Preplant incorporated herbicide treatments were applied in 8.5 gpa water at 40 psi through 8001 nozzles to the center four rows of six row plots May 24 and incorporated with a roto-tiller set 2 inches deep. 'Empire Roundup Ready' sugarbeet was seeded 1.25 inches deep in 22 inch rows May 24. Counter 15G insecticide at 12 pounds product per acre was applied modified in-furrow at planting. Postemergence herbicide treatments were applied in 8.5 gpa water at 40 psi through 8001 nozzles to the center four rows of six row plots June 7, June 14, June 24 and July 1. Glyphosate at 1 quart/A was applied to all plots July 7. Sugarbeet injury was evaluated June 30 and July 26. Redroot pigweed and green and yellow foxtail control were evaluated June 30. Sugarbeet was hand thinned to an eight inch spacing July 13. Sugarbeet in the center two rows of 32 foot long plots was counted and harvested October 1.

Date	May 24	June 7	June 14	June 24	July 1
Time of Day	11:45 pm	1:30 pm	1:00 pm	8:00 am	10:00 am
Air Temp. (°F)	64	81	63	73	70
6" Soil Temp. (°F)	54	62	62	63	75
Rel. Humidity (%)	80	51	38	65	30
Wind Velocity (mph)	6	5-10	4	2	2
Cloud Cover (%)	90	10	20	30	40
Soil Moisture	good	good	good	good	good
Sugarbeet Stage	---	v1.0	v1.0-v2.0	v3.8-v6.5	v8.0
Redroot Pigweed	---	cot-2 leaf	2-4 leaf	2-6 leaf	4lf-2"tall
Green&Yellow Foxtail	---	emerg-0.5"	1" tall	0.5-2"tall	1-4" tall

Summary

Dimethenamid and p-dimethenamid applied PPI gave better weed control but more sugarbeet injury than dimethenamid applied postemergence. POST dimethenamid caused no sugarbeet injury. p-Dimethenamid at 0.83 lb/A gave better or similar weed control compared to dimethenamid at 1.5 lb/A. Treatments had no significant effect on sugarbeet population or yield but variability in the experiment was relatively great due to imazethapyr carryover. Plots treated PPI with p-dimethenamid at 1.65 lb/A or dimethenamid at 1.5 lb/A tended to have lower sugarbeet populations and lower yield than plots treated POST.

Experiment continued on next page.

Frontier on Roundup Ready sugarbeet, Fargo, 1999. (continued)

Treatment*	Time of Application	Rate	June 30 Sgbt inj	June 30 Rrpw cntl	June 30 Gr&Ye Fxtl cntl	7-26 Sgbt inj	10-1 Sgbt Popl	Sucr	Root Yield	Impur Index	Extr Sucr
		lb/A	%	%	%	%	plt/64'	%	ton/A		lb/A
p-Dimethenamid-PPI	May 24	0.83	15	98	97	9	91	15.8	20.1	609	5781
p-Dimethenamid-PPI	May 24	1.65	38	100	100	19	86	15.7	18.2	613	5181
Dimethenamid-PPI	May 24	1.5	30	100	100	16	87	15.3	18.9	655	5216
p-Dimethenamid	June 7	0.83	0	53	64	0	107	15.5	21.3	621	5990
p-Dimethenamid	June 7	1.65	0	91	80	0	94	15.5	19.2	613	5421
Dimethenamid	June 7	1.5	0	58	53	0	99	15.6	21.0	617	5943
p-Dimethenamid	June 14	0.64	0	75	48	0	102	15.5	21.5	631	6028
p-Dimethenamid	June 14	0.83	0	87	64	0	114	15.7	23.4	583	6689
p-Dimethenamid	June 14	1.28	0	91	48	0	107	15.4	20.3	649	5636
p-Dimethenamid	June 14	1.65	0	91	60	0	103	16.0	20.3	568	5948
p-Dimethenamid	June 14	2.56	0	81	69	0	101	15.7	20.0	620	5668
Dimethenamid	June 14	1.5	0	61	63	0	105	15.7	19.6	602	5603
Dimethenamid	June 14	2.34	0	73	66	0	102	16.0	18.9	589	5537
p-Dimethenamid	June 24	0.83	0	88	50	0	100	15.5	21.1	623	5914
p-Dimethenamid	June 24	1.65	0	84	54	0	104	15.9	21.9	606	6366
Dimethenamid	June 24	1.5	0	49	29	0	105	15.6	20.5	635	5803
p-Dimethenamid	July 1	0.83	0	0	0	0	102	15.6	21.6	637	6073
p-Dimethenamid	July 1	1.65	0	4	0	0	96	15.7	21.0	597	5992
Dimethenamid	July 1	1.5	0	0	0	0	96	15.7	22.1	616	6320
Untreated Check		0	0	0	0	0	92	15.7	20.3	624	5786
EXP MEAN			4	64	52	2	100	15.6	20.6	615	5845
C.V. %			98	27	30	105	13	2.3	11.6	9	12
LSD 5%			6	25	22	3	NS	NS	NS	NS	NS
LSD 1%			8	33	30	4	NS	NS	NS	NS	NS
# OF REPS			4	4	4	4	4	4	4	4	4

*MethOil=methylated seed oil from Terra; p-Dime=active isomer of dimethenamid

Frontier on Roundup Ready sugarbeet, St. Thomas, 1999. (Dexter) Preplant incorporated herbicide treatments were applied in 8.5 gpa water at 40 psi through 8001 nozzles to the center four rows of six row plots May 13 and incorporated with a roto-tiller set 2 inches deep. 'Empire Roundup Ready' sugarbeet was seeded 1.25 inches deep in 22 inch rows May 13. Counter 15G insecticide at 12 pounds product per acre was applied modified in-furrow at planting. Postemergence herbicide treatments were applied in 8.5 gpa water at 40 psi through 8001 nozzles to the center four rows of six row plots June 1, June 8, June 15 and June 22. Lorsban 4E insecticide at 1 lb ai/A was applied to all plots June 5. Glyphosate at 1 quart/A was applied to all plots June 29. Sugarbeet injury was evaluated June 17 and June 27. Green foxtail control was evaluated June 27. Sugarbeet was hand thinned to an eight inch spacing June 21. Sugarbeet from the center two rows of 32 foot long plots was counted and harvested September 27.

Date	May 13	June 1	June 8	June 15	June 22
Time of Day	8:00 pm	1:00 pm	10:00 am	3:30 pm	3:00 pm
Air Temp. (°F)	54	59	81	68	93
6" Soil Temp. (°F)	52	61	68	62	70
Rel. Humidity (%)	63	67	22	33	52
Wind Velocity (mph)	6	2-4	1-2	10	10
Cloud Cover (%)	100	100	40	80	80
Soil Moisture	good	good	good	good	fair
Sugarbeet Stage	---	v1.0-v2.0	v2.0-v4.5	v4.8-v7.3	v8.5-v10.8
Redroot Pigweed	---	cot-4 leaf	2lf-3"tall	2lf-4"tall	4lf-5"tall
Green Foxtail	---	emerg-1"(2-3lf)	1-2.5" tall	1-5" tall	2-8" tall

Summary

Dimethenamid and p-dimethenamid applied PPI gave more sugarbeet injury than when applied POST. p-Dimethenamid at 1.65 lb/A applied POST on June 1 or June 8 caused significant sugarbeet injury while dimethenamid at 1.5 lb/A applied June 1 or June 8 caused no injury. The PPI treatments gave excellent control of green foxtail. p-Dimethenamid at 0.83 or 1.65 lb/A applied June 1 were the only postemergence treatments that gave over 70% green foxtail control.

The variability in yield was high in this experiment for unknown reasons. Plots treated with p-dimethenamid at 1.65 lb/A on June 1 yielded significantly more than all other treatments except PPI p-dimethenamid at 0.83 lb/A, PPI dimethenamid at 1.5 lb/A and p-dimethenamid at 0.83 lb/A applied June 1. These four treatments plus PPI p-dimethenamid at 1.65 lb/A gave the greatest green foxtail control so that may explain the high yields of the top four treatments. The PPI p-dimethenamid at 1.65 lb/A gave more sugarbeet injury than other treatments and reduced sugarbeet populations more than any other treatment so sugarbeet injury probably was more important than weed control for that treatment. All PPI treatments resulted in significant reductions in sugarbeet plant population. Glyphosate was applied to all plots on June 29 so late season weeds were not a factor. The untreated check yielded similar to all plots except p-dimethenamid at 1.65 lb/A applied June 1. Plots treated with p-dimethenamid at 1.65 lb/A on June 1 had the lowest evaluated sugarbeet injury of all treatments that gave nearly total green foxtail control. This treatment probably gave the highest yield because it provided excellent weed control with an acceptable level of injury.

Experiment continued on next page.

Frontier on Roundup Ready sugarbeet, St. Thomas, 1999. (continued)

Treatment	Time of Application	Rate	June17 Sgbt inj	June 27 Sgbt inj	June 27 Grft cntl	9-27 Sgbt Popl	Sucr	Root Yield	Impur Index	Extr Sucr
		lb/A	%	%	%	plt/64'	%	ton/A		lb/A
p-Dimethenamid-PPI	May 13	0.83	45	45	98	54	16.3	19.4	693	5679
p-Dimethenamid-PPI	May 13	1.65	76	80	100	32	16.1	15.1	735	4302
Dimethenamid-PPI	May 13	1.5	51	51	100	55	16.3	19.1	660	5625
p-Dimethenamid	June 1	0.83	0	5	73	80	15.7	19.3	757	5390
p-Dimethenamid	June 1	1.65	31	20	99	86	15.8	22.2	719	6264
Dimethenamid	June 1	1.5	0	0	0	79	15.8	13.6	670	3901
p-Dimethenamid	June 8	0.64	6	0	0	72	15.7	15.1	709	4235
p-Dimethenamid	June 8	0.83	5	0	0	79	15.9	15.6	713	4415
p-Dimethenamid	June 8	1.28	6	5	0	77	15.7	15.5	688	4364
p-Dimethenamid	June 8	1.65	18	3	15	77	15.5	14.2	721	3917
p-Dimethenamid	June 8	2.56	21	0	13	73	15.5	17.1	720	4717
Dimethenamid	June 8	1.5	4	4	23	72	15.6	15.7	735	4370
Dimethenamid	June 8	2.34	18	5	0	76	15.9	14.8	665	4190
p-Dimethenamid	June 15	0.83	1	0	0	74	15.8	13.7	690	3851
p-Dimethenamid	June 15	1.65	0	0	0	73	16.0	15.9	675	4581
Dimethenamid	June 15	1.5	1	3	0	74	15.6	16.3	747	4509
p-Dimethenamid	June 22	0.83	0	0	0	77	15.5	16.0	790	4337
p-Dimethenamid	June 22	1.65	0	3	0	67	15.1	13.6	789	3614
Dimethenamid	June 22	1.5	0	3	0	64	15.9	12.8	670	3670
Untreated Check		0	0	0	0	75	15.6	16.1	689	4499
EXP MEAN			14	11	26	71	15.8	16.1	712	4521
C.V. %			43	58	44	10	3.0	19.1	10	19
LSD 5%			9	9	16	10	NS	4.3	NS	1187
LSD 1%			12	12	21	14	NS	5.8	NS	1578
# OF REPS			4	4	4	4	4	4	4	4

*MethOil=methylated seed oil from Terra; p-Dime=active isomer of dimethenamid

Frontier and Dual on Roundup Ready sugarbeet, Fargo, 1999. (Dexter) 'Empire Roundup Ready' sugarbeet was seeded 1.25 inches deep in 22 inch rows May 3. Counter 15G insecticide at 12 pounds product per acre was applied modified in-furrow at planting. Herbicide treatments were applied in 8.5 gpa water at 40 psi through 8001 nozzles to the center four rows of six row plots June 1, June 7, June 14 and June 21. Sugarbeet injury and biennial wormwood, redroot pigweed, green and yellow foxtail and wild oats control were evaluated June 30 and July 26. Sugarbeet was hand thinned to an eight inch spacing July 13. Sugarbeet in the center two rows of 32 foot long plots was counted and harvested October 1.

Date	June 1	June 7	June 14	June 21
Time of Day	1:00 pm	1:30 pm	1:00 pm	6:00 pm
Air Temp. (°F)	59	81	63	84
6" Soil Temp. (°F)	59	62	62	68
Rel. Humidity (%)	66	51	38	62
Wind Velocity (mph)	8	5-10	4	18
Cloud Cover (%)	95	10	20	90
Soil Moisture	good	good	good	fair
Sugarbeet Stage	v1.0	v1.5-v3.5	v4.0-v6.0	v6.8-v7.2
Biennial Wormwood	2-4 leaf	0.5-2"diam.	2-4" tall	2-6" tall
Redroot Pigweed	cot-2 leaf	2-4 leaf	4lf(2"tall)	6 lf-4" tall
Wild Oats	2-5" tall	5-8" tall	8-12" tall	12-15" tall
Green&Yellow Foxtail	emerg-0.5"	1-3" tall	2-4" tall	1-6" tall

Summary

All treatments gave excellent control of all weed species evaluated. All the micro-rate combinations with p-dimethenamid or m-metolachlor caused significant sugarbeet injury. The micro-rate plus m-metolachlor at 1.3 lb/A on June 1 followed by three more applications of the micro-rate gave less sugarbeet injury than when m-metolachlor at 2.6 lb/A, p-dimethenamid at 0.64 lb/A or p-dimethenamid at 1.28 lb/A were substituted for m-metolachlor at 1.3 lb/A. Treatments had no significant effect on sugarbeet population or yield. However, plots treated with p-dimethenamid at 1.28 lb/A were the lowest yielding plots in the experiment.

Experiment continued on next page.

Frontier and Dual on Roundup Ready sugarbeet, Fargo, 1999. (continued)

Treatment	(Date of Application)	Rate	June 30					July 26				
			Sgbt inj	Biww cntl	Rrpw cntl	Wioa cntl	Gr&Y Fxtl cntl	Sgbt inj	Biww cntl	Rrpw cntl	Gr&Yel Fxtl cntl	Wioa cntl
		lb/A	%	%	%	%	%	%	%	%	%	%
Glyt+p-Dime (June 7)		0.75+0.64										
Glyphosate (June 21)		0.75	3	100	100	100	100	0	100	100	100	100
Glyt+p-Dime (June 7)		0.75+1.28										
Glyphosate (June 21)		0.75	4	100	100	100	100	0	100	100	100	100
Glyphosate (June 7, June 21)		0.75	1	100	100	100	100	0	100	100	100	100
Glyt+m-Metolachlor (June 7)		0.75+1.3										
Glyphosate (June 21)		0.75	4	100	100	100	100	0	100	100	100	100
Glyphosate+m-Meto (June 7)		0.75+2.6										
Glyphosate (June 21)		0.75	4	100	100	100	100	0	100	100	100	100
Desm+Tfsu+Clpy+Clet+MO+p-Dime (June 1)		0.08+0.004+0.03+0.03+1.5%+0.64										
Desm+Tfsu+Clpy+Clet+MO (June 7, 14, 21)		0.08+0.004+0.03+0.03+1.5%	28	100	100	100	100	0	100	100	100	100
Desm+Tfsu+Clpy+Clet+MO+p-Dime (June 1)		0.08+0.004+0.03+0.03+1.5%+1.28										
Desm+Tfsu+Clpy+Clet+MO (June 7, 14, 21)		0.08+0.004+0.03+0.03+1.5%	34	100	100	100	100	0	100	100	100	100
Desm+Tfsu+Clpy+Clet+MO+m-Meto (June 1)		0.08+0.004+0.03+0.03+1.5%+1.3										
Desm+Tfsu+Clpy+Clet+MO (June 7, 14, 21)		0.08+0.004+0.03+0.03+1.5%	14	100	100	100	100	0	100	100	100	100
Desm+Tfsu+Clpy+Clet+MO+m-Meto (June 1)		0.08+0.004+0.03+0.03+1.5%+2.6										
Desm+Tfsu+Clpy+Clet+MO (June 7, 14, 21)		0.08+0.004+0.03+0.03+1.5%	36	100	100	100	100	0	100	100	100	100
EXP MEAN			14	100	100	100	100	0	100	100	100	100
C.V. %			40	0	0	0	0	0	0	0	0	0
LSD 5%			8	0	0	0	0	0	0	0	0	0
LSD 1%			11	0	0	0	0	0	0	0	0	0
# OF REPS			4	4	4	4	4	4	4	4	4	4

*MethOil=methylated seed oil from Terra; p-Dime=active isomer of dimethenamid; m-Meto=active isomer of metolachlor.

Experiment continued on next page.

Frontier and Dual on Roundup Ready sugarbeet, Fargo, 1999. (continued)

Treatment (Date of Application)	Rate	10-1 Sgbt Popul	Sucrose	Root Yield	Impur Index	Extract Sucrose
	lb/A	plt/64ft	%	ton/A		lb/A
Glyt+p-Dime (June 7)	0.75+0.64					
Glyphosate (June 21)	0.75	92	15.1	22.8	758	6148
Glyt+p-Dime (June 7)	0.75+1.28					
Glyphosate (June 21)	0.75	80	15.3	20.2	749	5504
Glyphosate (June 7, June 21)	0.75	92	15.1	24.8	786	6605
Glyt+m-Metolachlor (June 7)	0.75+1.3					
Glyphosate (June 21)	0.75	89	15.0	23.5	789	6224
Glyphosate+m-Meto (June 7)	0.75+2.6					
Glyphosate (June 21)	0.75	86	15.0	22.6	784	6009
Desm+Tfsu+Clpy+Clet+MO+p-Dime (June 1)	0.08+0.004+0.03+0.03+1.5%+0.64					
Desm+Tfsu+Clpy+Clet+MO (June 7, 14, 21)	0.08+0.004+0.03+0.03+1.5%	90	15.6	20.8	719	5785
Desm+Tfsu+Clpy+Clet+MO+p-Dime (June 1)	0.08+0.004+0.03+0.03+1.5%+1.28					
Desm+Tfsu+Clpy+Clet+MO (June 7, 14, 21)	0.08+0.004+0.03+0.03+1.5%	86	15.1	20.1	758	5388
Desm+Tfsu+Clpy+Clet+MO+m-Meto (June 1)	0.08+0.004+0.03+0.03+1.5%+1.3					
Desm+Tfsu+Clpy+Clet+MO (June 7, 14, 21)	0.08+0.004+0.03+0.03+1.5%	91	15.2	21.4	765	5751
Desm+Tfsu+Clpy+Clet+MO+m-Meto (June 1)	0.08+0.004+0.03+0.03+1.5%+2.6					
Desm+Tfsu+Clpy+Clet+MO (June 7, 14, 21)	0.08+0.004+0.03+0.03+1.5%	89	14.8	22.1	797	5776
EXP MEAN		88	15.1	22.0	767	5910
C.V. %		9	3.8	12.3	11	13
LSD 5%		NS	NS	NS	NS	NS
LSD 1%		NS	NS	NS	NS	NS
# OF REPS		4	4	4	4	4

*MethOil=methylated seed oil from Terra; p-Dime=active isomer of dimethenamid; m-Meto=active isomer of metolachlor.

Frontier and Dual on Roundup Ready sugarbeet, St. Thomas, 1999. (Dexter) 'Empire Roundup Ready' sugarbeet was seeded 1.25 inches deep in 22 inch rows May 13. Counter 15G insecticide at 12 pounds product per acre was applied modified in-furrow at planting. Herbicide treatments were applied in 8.5 gpa water at 40 psi through 8001 nozzles to the center four rows of six row plots June 1, June 8, June 15 and June 22. Lorsban 4E at 1 lb ai/A was applied to all plots June 5. Sugarbeet injury was evaluated June 17 and June 27. Green foxtail control was evaluated June 27. Sugarbeet was hand thinned to an eight inch spacing June 21. Sugarbeet from the center two rows of 32 foot long plots was counted and harvested September 27.

Date	June 1	June 8	June 15	June 22
Time of Day	1:00 pm	10:00 am	3:30 pm	3:00 pm
Air Temp. (°F)	59	81	68	93
6" Soil Temp. (°F)	61	68	62	70
Rel. Humidity (%)	67	22	33	52
Wind Velocity (mph)	2-4	1-2	10	10
Cloud Cover (%)	100	40	80	80
Soil Moisture	good	good	good	fair
Sugarbeet Stage	v1.0-v2.0	v2.0-v4.5	v4.8-v7.3	v8.5-v10.8
Green Foxtail	emerg-1"(2-3lf)	1-2.5" tall	1-5" tall	2-8" tall

Summary

All treatments gave total control of green foxtail. Glyphosate + p-dimethenamid and glyphosate + m-metolachlor applied on June 8 gave more sugarbeet injury than glyphosate applied on June 8. M-metolachlor at 2.6 lb/A gave more sugarbeet injury than m-metolachlor at 1.3 lb/A or p-dimethenamid at 0.64 or 1.28 lb/A. The micro-rate plus m-metolachlor or p-dimethenamid caused 30% or greater sugarbeet injury. Plots treated with the high rate of m-metolachlor or p-dimethenamid were injured more than plots treated with the low rate. However, all plots treated with m-metolachlor or p-dimethenamid yielded more than plots treated with glyphosate twice. Weed control was excellent in all plots on June 27 but perhaps weeds germinating between June 8 and June 22 caused yield loss due to competition. Plots treated with the micro-rate plus m-metolachlor at 2.6 lb/A yielded significantly more than all plots except plots treated with the micro-rate plus p-dimethenamid at 1.28 lb/A. These are the two treatments with the greatest sugarbeet injury on June 17. Perhaps improved weed control after the June 27 weed control evaluation offset the sugarbeet injury.

Experiment continued on next page.

Frontier and Dual on Roundup Ready sugarbeet, St. Thomas, 1999. (continued)

Treatment	(Date of Application)	Rate	6-17 Sgbt inj	June 27 Sgbt inj	June 27 Grft cntl
		lb/A	%	%	%
Glyt+p-Dimethenamid (June 8)		0.75+0.64			
Glyphosate (June 22)		0.75	10	6	100
Glyt+p-Dimethenamid (June 8)		0.75+1.28			
Glyphosate (June 22)		0.75	11	14	100
Glyphosate (June 8, June 22)		0.75	0	1	100
Glyt+m-Metolachlor (June 8)		0.75+1.3			
Glyphosate (June 22)		0.75	9	4	100
Glyphosate+m-Metolachlor (June 8)		0.75+2.6			
Glyphosate (June 22)		0.75	26	29	100
Desm+Tfsu+Clpy+Clet+MO+p-Dime (June 1)		0.08+0.004+0.03+0.03+1.5%+0.64			
Desm+Tfsu+Clpy+Clet+MO (June 8, 15, 22)		0.08+0.004+0.03+0.03+1.5%	31	28	100
Desm+Tfsu+Clpy+Clet+MO+p-Dime (June 1)		0.08+0.004+0.03+0.03+1.5%+1.28			
Desm+Tfsu+Clpy+Clet+MO (June 8, 15, 22)		0.08+0.004+0.03+0.03+1.5%	43	29	100
Desm+Tfsu+Clpy+Clet+MO+m-Meto (June 1)		0.08+0.004+0.03+0.03+1.5%+1.3			
Desm+Tfsu+Clpy+Clet+MO (June 8, 15, 22)		0.08+0.004+0.03+0.03+1.5%	30	31	100
Desm+Tfsu+Clpy+Clet+MO+m-Meto (June 1)		0.08+0.004+0.03+0.03+1.5%+2.6			
Desm+Tfsu+Clpy+Clet+MO (June 8, 15, 22)		0.08+0.004+0.03+0.03+1.5%	50	48	100
EXP MEAN			23	21	100
C.V. %			28	54	0
LSD 5%			9	17	NS
LSD 1%			13	22	NS
# OF REPS			4	4	4

*MethOil=methylated seed oil from Terra; p-Dime=active isomer of dimethenamid; m-Meto=active isomer of metolachlor.

Experiment continued on next page.

Frontier and Dual on Roundup Ready sugarbeet, St. Thomas, 1999. (continued)

Treatment*	(Date of Application)	Rate	9-17 Sgbt Popl	Sucrose	Root Yield	Impur Index	Extr Sucr
		lb/A	plt/64'	%	ton/A		lb/A
Glyphosate+p-Dimethenamid (June 8)		0.75+0.64					
Glyphosate (June 22)		0.75	79	16.3	17.5	649	5124
Glyphosate+p-Dimethenamid (June 8)		0.75+1.28					
Glyphosate (June 22)		0.75	76	16.3	18.7	633	5519
Glyphosate (June 8, June 22)		0.75	80	15.8	13.4	672	3817
Glyt+m-Metolachlor (June 8)		0.75+1.3					
Glyphosate (June 22)		0.75	75	15.9	18.6	701	5299
Glyphosate+m-Metolachlor (June 8)		0.75+2.6					
Glyphosate (June 22)		0.75	78	16.5	17.0	640	5080
Desm+Tfsu+Clpy+Clet+MethOil+p-Dime (June 1)		0.08+0.004+0.03+0.03+1.5%+0.64					
Desm+Tfsu+Clpy+Clet+MethOil (June 8, 15, 22)		0.08+0.004+0.03+0.03+1.5%	81	16.2	18.2	676	5302
Desm+Tfsu+Clpy+Clet+MethOil+p-Dime (June 1)		0.08+0.004+0.03+0.03+1.5%+1.28					
Desm+Tfsu+Clpy+Clet+MethOil (June 8, 15, 22)		0.08+0.004+0.03+0.03+1.5%	86	16.2	20.8	696	6003
Desm+Tfsu+Clpy+Clet+MethOil+m-Meto (June 1)		0.08+0.004+0.03+0.03+1.5%+1.3					
Desm+Tfsu+Clpy+Clet+MethOil (June 8, 15, 22)		0.08+0.004+0.03+0.03+1.5%	80	15.9	18.3	702	5213
Desm+Tfsu+Clpy+Clet+MethOil+m-Meto (June 1)		0.08+0.004+0.03+0.03+1.5%+2.6					
Desm+Tfsu+Clpy+Clet+MethOil (June 8, 15, 22)		0.08+0.004+0.03+0.03+1.5%	89	16.2	21.9	699	6361
EXP MEAN			80	16.1	18.3	674	5302
C.V. %			7	2.3	11.5	10	12
LSD 5%			NS	NS	3.1	NS	908
LSD 1%			NS	NS	4.2	NS	1230
# OF REPS			4	4	4	4	4

*MethOil=methylated seed oil from Terra; p-Dime=active isomer of dimethenamid; m-Meto=active isomer of metolachlor.

Timing of Roundup application on sugarbeet, Crookston, 1999. (Dexter) Preplant incorporated herbicide treatments were applied in 8.5 gpa water at 40 psi through 8001 nozzles to the center four rows of six row plots 2:30 pm May 17 when the air temperature was 67F, six inch soil temperature was 58F, relative humidity was 44%, wind was northwest at 7 mph, cloud cover was 25% and soil moisture was good. Incorporation was with a roto-tiller set two inches deep. 'Empire Roundup Ready' sugarbeet was seeded 1.25 inches deep in 22 inch rows May 17. Counter 15G insecticide at 12 pounds product per acre was applied modified in-furrow at planting. Postemergence herbicide treatments were applied in 8.5 gpa water at 40 psi through 8001 nozzles to the center four rows of six row plots May 29, June 7, June 14, June 21, June 30, July 6, July 12 and July 21. Sugarbeet injury was evaluated June 27 and July 27. Redroot pigweed control was evaluated July 27. Sugarbeet was hand thinned to an eight inch spacing June 25. Sugarbeet from the center two rows of 32 foot long plots was counted and harvested September 29, 1999.

Date	May 29	June 7	June 14	June 21	June 30	July 6	July 12	July 21
Time of Day	1:30 pm	1:00 pm	1:00 pm	7:30 pm	11:00am	10:30am	10:00am	10:00am
Air Temp. (°F)	90	79	68	77	77	70	79	79
6" Soil Temp.(°F)	70	72	61	62	62	68	70	73
Rel. Humidity (%)	32	53	34	69	53	69	20	78
Wind Vel. (mph)	10	10	5-8	15	10	6	7	8
Cloud Cover (%)	30	10	20	100	50	0	10	20
Soil Moisture	good	good	good	good	good	good	good	fair
Sugarbeet Stage	v1.0	v2.0-3.5	v4.0-5.5	v7.2-7.8	8-10lf	10-12lf	12-14lf	canopy
Redroot Pigweed	cot-2lf	2-6 lf	cot-3"	4lf-7"	--	--	--	--

Summary

m-Metolachlor applied PPI gave more sugarbeet injury on June 27 than when applied POST. The micro-rate applied four times caused severe sugarbeet injury on June 27 but injury was no longer visible on July 27. However, plots treated with the micro-rate yielded less than all other treatments. Plots treated with PPI m-metolachlor were injured but yield was similar to yield from the highest yielding plots. All treatments gave excellent redroot pigweed control.

Experiment continued on next page.

Timing of Roundup application on sugarbeet, Crookston, 1999. (continued)

Treatment*	(Date of Application)	Rate	6-27 Sgbt inj	July 27 Sgbt inj	July 27 Rrpw cntl	9-29 Sgbt Popl	Sucrose	Root Yield	Impur Index	Extr Sucr
		lb/A	%	%	%	plt/64'	%	ton/A		lb/A
Glyphosate	(June 7, 21, 30)	0.75	0	0	100	86	15.2	24.0	818	6383
Glyphosate	(June 7, 30)	0.75	0	0	100	96	15.2	23.7	798	6350
Glyphosate	(June 7, July 6)	0.75	1	0	100	91	15.6	22.7	765	6291
Glyphosate	(June 7, 30, July 21)	0.75	0	0	100	92	14.9	23.3	867	6038
Glyphosate	(June 7, July 21)	0.75	0	0	100	87	15.1	22.0	847	5808
Glyphosate	(June 14, 30, July 6)	0.75	0	0	100	91	15.0	23.3	866	6079
Glyphosate	(June 14, July 6)	0.75	3	0	100	91	15.0	24.2	851	6329
Glyphosate	(June 14, July 6, 21)	0.75	0	0	100	93	15.1	24.2	829	6390
Glyphosate	(June 14, July 12)	0.75	4	0	100	87	15.1	23.9	855	6270
m-Metolachlor (PPI)		1.9								
Glyphosate	(July 6)	0.75	25	0	100	87	15.0	23.3	854	6102
m-Metolachlor+Glyt	(June 7)	1.9+0.75								
Glyphosate	(July 21)	0.75	9	0	100	97	15.2	22.6	842	5990
Desm+Tfsu+Clpy+Clet+MethOil	(May 29, June 7, 14, 21)	0.08+0.004+0.03+0.03+1.5%	38	0	97	100	15.0	20.3	879	5309
m-Metolachlor (PPI)		1.9								
Glyphosate	(June 7, 30)	0.75	26	0	100	85	14.9	23.2	868	5992
EXP MEAN			8	0	100	91	15.1	23.1	842	6103
C.V. %			51	0	0	9	2.4	6.2	7	7
LSD 5%			6	0	0	NS	NS	2.1	NS	590
LSD 1%			8	0	1	NS	NS	NS	NS	NS
# OF REPS			4	4	4	4	4	4	4	4

*MethOil=methylated seed oil from Terra; m-Metolachlor=active isomer of metolachlor

Timing of Roundup application on sugarbeet, Fargo, 1999. (Dexter) Preplant incorporated herbicide treatments were applied in 8.5 gpa water at 40 psi through 8001 nozzles to the center four rows of six row plots 11:00 May 3 when the air temperature was 73F, six inch soil temperature was 55F, relative humidity was 41%, wind was south at 28 mph, cloud cover was 75% and soil moisture was good. Incorporation was with a roto-tiller set two inches deep. 'Empire Roundup Ready' sugarbeet was seeded 1.25 inches deep in 22 inch rows May 3. Counter 15G insecticide at 12 pounds product per acre was applied modified in-furrow at planting. Postemergence herbicide treatments were applied in 8.5 gpa water at 40 psi through 8001 nozzles to the center four rows of six row plots June 1, June 7, June 14, June 24, July 1, July 6, July 12 and July 21. Sugarbeet injury and biennial wormwood, redroot pigweed and green and yellow foxtail were evaluated June 30 and July 26. Common lambsquarters control was evaluated June 30.

Date	June 1	June 7	June 14	June 24	July 1	July 6	July 12	July 21
Time of Day	1:00 pm	1:30 pm	1:00 pm	8:00 am	10:00am	1:10 pm	1:00 pm	12:30pm
Air Temp. (°F)	59	81	63	73	70	77	86	90
6" Soil Temp. (°F)	59	62	62	63	75	71	80	76
Rel. Humidity (%)	66	51	38	65	30	47	47	44
Wind Vel. (mph)	8	5-10	4	2	2	11	8	7
Cloud Cover (%)	95	10	20	30	40	0	25	10
Soil Moisture	good	good	good	good	good	good	good	fair
Sugarbeet Stage	v1.0	v1.5-3.5	v4.0-6.0	v8.0	8 leaf	8-10 lf	10-12lf	canopy
Biennial Wormwood	2-4 lf	.5-2"dia	2-4"	3-7"	--	--	--	--
Redroot Pigweed	cot-2lf	2-4 lf	4lf-2"	6lf-4"	--	--	--	--
C. Lambsquarters	2-4 lf	4-8 lf	1-2"	2-6"	--	--	--	--
Gr.&Yel. Foxtail	emer-.5"	1-3"	2-4"	1-6"	--	--	--	--

Summary

The June 30 evaluation was prior to the completion of the postemergence treatments. Weeds emerged after the June 1 and June 7 glyphosate treatments. Metolachlor + glyphosate (June 1) gave better control of redroot pigweed and foxtail than glyphosate (June 1) or PPI metolachlor. All treatments gave excellent weed control on July 26 after all treatments were completed.

Experiment continued on next page.

Timing of Roundup application on sugarbeet, Fargo, 1999. (continued)

Treatment*	(Date of Application)	Rate	June 30					July 26				
			Sgbt inj	Biww cntl	Rrpw cntl	Colq cntl	G&Ye Fxtl cntl	Sgbt inj	Biww cntl	Rrpw cntl	G&Ye Fxtl cntl	
		lb/A	%	%	%	%	%	%	%	%	%	
Glyphosate	(June 1, 14, 24)	0.75	0	100	100	100	100	0	100	97	96	
Glyphosate	(June 1, 24)	0.75	0	100	100	100	100	0	100	96	97	
Glyphosate	(June 1, July 1)	0.75	0	100	90	100	88	0	100	100	100	
Glyphosate	(June 1,24, July 12)	0.75	0	100	100	100	100	0	100	100	100	
Glyphosate	(June 1, July 12)	0.75	0	100	69	98	14	0	100	100	100	
Glyphosate	(June 7, 24, July 1)	0.75	0	100	100	100	83	0	100	100	100	
Glyphosate	(June 7, July 1)	0.75	0	100	69	100	81	0	100	100	100	
Glyphosate	(June 7, July 1, 21)	0.75	0	100	80	100	88	0	100	100	100	
Glyphosate	(June 7, July 6)	0.75	0	100	90	95	91	0	100	100	100	
m-Metolachlor	(PPI)	1.9										
Glyphosate	(July 1)	0.75	0	73	90	85	94	0	100	100	100	
m-Metolachlor+Glyt	(June 1)	1.9+0.75										
Glyphosate	(July 12)	0.75	0	100	93	100	93	0	100	100	100	
Desm+Tfsu+Clpy+Clet+MethOil	(June1,7,14,24)	0.08+0.004+0.03+0.03+1.5%	6	100	100	100	100	0	100	96	100	
m-Metolachlor	(PPI)	1.9										
Glyphosate	(June 1, 24)	0.75	0	100	100	100	100	0	100	99	100	
EXP MEAN			0	98	91	98	87	0	100	99	99	
C.V. %			433	5	12	7	10	0	0	3	1	
LSD 5%			3	7	16	NS	13	0	0	NS	2	
LSD 1%			4	9	21	NS	17	0	0	NS	2	
# OF REPS			4	4	4	4	4	4	4	4	4	

*MethOil=methylated seed oil from Terra; m-Metolachlor=active isomer of metolachlor

Comparison of two Roundup Ready sugarbeet lines, Crookston, 1999. (Dexter) Two lines of Roundup Ready sugarbeet were seeded 1.25 inches deep in 22 inch rows May 20. Counter 15G insecticide at 12 pounds product per acre was applied modified in-furrow at planting. Postemergence herbicide treatments were applied in 8.5 gpa water at 40 psi through 8001 nozzles to the center four rows of six row plots May 29, June 7, June 14, June 21, July 6, and July 12. Sugarbeet injury and redroot pigweed control were evaluated June 27 and July 20. Sugarbeet was hand thinned to an eight inch spacing June 25. Sugarbeet from the center two rows of 32 foot long plots was counted and harvested September 29.

Date	May 29	June 7	June 14	June 21	July 6	July 12
Time of Day	1:30 pm	1:00 pm	1:00 pm	7:30 pm	10:30am	10:00 am
Air Temp. (°F)	90	79	68	77	70	79
6" Soil Temp.(°F)	70	72	61	62	68	70
Rel. Humidity (%)	32	53	34	69	69	20
Wind Vel. (mph)	10	10	5-8	15	6	7
Cloud Cover (%)	30	10	20	100	0	10
Soil Moisture	good	good	good	good	good	good
Sugarbeet Stage	v1.0	v2.0-3.5	v4.0-5.5	v7.2-7.8	10-12lf	12-14 lf
Redroot Pigweed	cot-2lf	2-6 lf	cot-3"	4lf-7"	--	--

Sgbt Line	Treatment*	(Date of Application)	Rate	June 27 Sgbt inj	June 27 Rrpw cntl	July 20 Sgbt inj	July 20 Rrpw cntl
			lb/A	%	%	%	%
Line 77	Glyphosate	(June 7, 21, July 6)	0.75	1	100	0	100
Line 77	Glyphosate	(June 7, 21, July 6)	1.5	0	100	5	100
Line 77	Glyphosate	(June 14, July 12)	1.125	3	100	5	100
Line 77	Glyphosate	(June 14, July 12)	2.25	0	100	3	100
Line 77	Desm+Tfsu+Clpy+Clet+MO	(May29,June7,14,21) 0.08+.004+.03+1.5%		29	100	8	99
Line 78	Glyphosate	(June 7, 21, July 6)	0.75	3	100	0	100
Line 78	Glyphosate	(June 7, 21, July 6)	1.5	4	100	0	99
Line 78	Glyphosate	(June 14, July 12)	1.125	5	100	3	100
Line 78	Glyphosate	(June 14, July 12)	2.25	4	100	0	100
Line 78	Desm+Tfsu+Clpy+Clet+MO	(May29,June7,14,21) 0.08+.004+.03+1.5%		40	100	0	99
EXP MEAN				9	100	2	100
C.V. %				36	0	203	1
LSD 5%				5	0	NS	1
LSD 1%				6	0	NS	NS
# OF REPS				4	4	4	4

*MethOil=methylated seed oil from Terra

Experiment continued on next page.

Comparison of two Roundup Ready sugarbeet lines, Crookston, 1999. (continued)

Date	May 29	June 7	June 14	June 21	July 6	July 12
Time of Day	1:30 pm	1:00 pm	1:00 pm	7:30 pm	10:30am	10:00 am
Air Temp. (°F)	90	79	68	77	70	79
6" Soil Temp.(°F)	70	72	61	62	68	70
Rel. Humidity (%)	32	53	34	69	69	20
Wind Vel. (mph)	10	10	5-8	15	6	7
Cloud Cover (%)	30	10	20	100	0	10
Soil Moisture	good	good	good	good	good	good
Sugarbeet Stage	v1.0	v2.0-3.5	v4.0-5.5	v7.2-7.8	10-12lf	12-14 lf
Redroot Pigweed	cot-2lf	2-6 lf	cot-3"	4lf-7"	--	--

Sgbt Line	Treatment*	(Date of Application)	Rate	9-29 Sgbt Popl	Sucr	Root Yield	Impur Index	Extr Sucr
			lb/A	plt/64'	%	ton/A		lb/A
Line 77	Glyphosate	(June 7, 21, July 6)	0.75	79	14.8	23.6	884	6038
Line 77	Glyphosate	(June 7, 21, July 6)	1.5	84	14.9	23.9	854	6217
Line 77	Glyphosate	(June 14, July 12)	1.125	76	14.9	22.7	896	5821
Line 77	Glyphosate	(June 14, July 12)	2.25	83	14.8	23.9	893	6100
Line 77	Desm+Tfsu+Clpy+Clet+MO	(May29,June7,14,21) 0.08+.004+.03+1.5%		87	14.8	20.6	904	5257
Line 78	Glyphosate	(June 7, 21, July 6)	0.75	71	15.7	25.5	757	7074
Line 78	Glyphosate	(June 7, 21, July 6)	1.5	71	15.7	23.1	762	6417
Line 78	Glyphosate	(June 14, July 12)	1.125	75	15.7	24.6	725	6872
Line 78	Glyphosate	(June 14, July 12)	2.25	76	16.0	23.5	701	6734
Line 78	Desm+Tfsu+Clpy+Clet+MO	(May29,June7,14,21) 0.08+.004+.03+1.5%		74	15.6	23.3	747	6490
EXP MEAN				77	15.3	23.5	812	6302
C.V. %				12	2.5	6.2	10	7
LSD 5%				NS	0.6	2.1	118	639
LSD 1%				NS	0.7	NS	159	863
# OF REPS				4	4	4	4	4

*MethOil=methylated seed oil from Terra

Summary

The sucrose yield from glyphosate treated Line 77 averaged 730 lb/A less than from glyphosate treated Line 78. Desmedipham + triflusulfuron + clopyralid + clethodim + methylated seed oil injured Line 77 more than Line 78 and the yield of Line 77 was 1233 lb/A of sucrose less than from Line 78. All treatments gave excellent weed control.

Comparison of two Roundup Ready sugarbeet lines, Fargo, 1999. (Dexter) Two lines of Roundup Ready sugarbeet were seeded 1.25 inches deep in 22 inch rows May 24. Counter 15G insecticide at 12 pounds product per acre was applied modified in-furrow at planting. Postemergence herbicide treatments were applied in 8.5 gpa water at 40 psi through 8001 nozzles to the center four rows of six row plots June 7, June 14, June 24, July 1, July 12 and July 21. Sugarbeet injury and redroot pigweed and green and yellow foxtail control were evaluated June 30 and July 26. Biennial wormwood control was evaluated June 30.

Date	June 7	June 14	June 24	July 1	July 12	July 21
Time of Day	1:30 pm	1:00 pm	8:00 am	10:00 am	1:00 pm	12:30 pm
Air Temp. (°F)	81	63	73	70	86	90
6" Soil Temp. (°F)	62	62	63	75	80	76
Rel. Humidity (%)	51	38	65	30	47	44
Wind Vel. (mph)	5-10	4	2	2	8	7
Cloud Cover (%)	10	20	30	40	25	10
Soil Moisture	good	good	good	good	good	fair
Sugarbeet Stage	v1.0	v1.0-2.0	v3.8-6.5	v8.0	10 leaf	12-14 lf
Biennial Wormwood	cotyledon	cot-2 lf	2-4 leaf	1-2" tall	2-4" tall	--
Redroot Pigweed	cot-2 lf	2-4 leaf	2-6 leaf	4lf-2"	4-6" tall	--
Gr.&Yellow Foxtail	emer-0.5"	1" tall	0.5-2"	1-4" tall	4-8" tall	--

				June 30				July 26		
Sgbt Line	Treatment*	(Date of Application)	Rate	Sgbt inj	Biww cntl	Gr&Y Fxtl cntl	Rrpw cntl	Sgbt inj	Rrpw cntl	Gr&Y Fxtl cntl
			lb/A	%	%	%	%	%	%	%
Line 77	Glyphosate	(June 14, July 1, 12)	0.75	0	100	100	100	0	100	100
Line 77	Glyphosate	(June 14, July 1, 12)	1.5	0	100	100	100	0	100	100
Line 77	Glyphosate	(June 24, July 21)	1.125	0	100	100	100	0	100	100
Line 77	Glyphosate	(June 24, July 21)	2.25	0	100	100	100	0	100	100
Line 77	Des+Tfs+Clp+Clet+MO	(June7,14,24,July1)	0.08+.004+.03+.03+1.5%	18	100	100	100	0	100	100
Line 78	Glyphosate	(June 14, July 1, 12)	0.75	0	100	100	100	0	100	100
Line 78	Glyphosate	(June 14, July 1, 12)	1.5	0	100	100	100	0	100	100
Line 78	Glyphosate	(June 24, July 21)	1.125	0	100	100	100	0	100	100
Line 78	Glyphosate	(June 24, July 21)	2.25	0	100	100	100	0	100	100
Line 78	Des+Tfs+Clp+Clet+MO	(June7,14,24,July1)	0.08+.004+.03+.03+1.5%	11	100	100	100	0	100	100
EXP MEAN				3	100	100	100	0	100	100
C.V. %				108	0	0	0	0	0	0
LSD 5%				5	0	0	0	0	0	0
LSD 1%				6	0	0	0	0	0	0
# OF REPS				4	4	4	4	4	4	4

*MethOil=methylated seed oil from Terra

Summary

Weed control was excellent with all treatments. Glyphosate caused less sugarbeet injury than desmedipham + triflusulfuron + clopyralid + clethodim + methylated seed oil. Line 77 was injured more than line 78.

Combinations of Roundup with fungicides and insecticides, Fargo, 1999. (Dexter) 'Empire Roundup Ready' sugarbeet was seeded 1.25 inches deep in 22 inch rows May 3. Counter 15G insecticide at 12 pounds product per acre was applied modified in-furrow at planting. Postemergence herbicide treatments were applied in 8.5 gpa water at 40 psi through 8001 nozzles to the center four rows of six row plots June 7, June 24 and July 13. Sugarbeet injury and biennial wormwood, redroot pigweed, and green and yellow foxtail control were evaluated July 26.

Date	June 7	June 24	July 13
Time of Day	1:30 pm	8:00 am	10:30am
Air Temp. (°F)	81	73	79
6" Soil Temp.(°F)	62	63	71
Rel. Humidity (%)	51	65	68
Wind Vel. (mph)	5-10	2	3
Cloud Cover (%)	10	30	35%
Soil Moisture	good	good	fair
Sugarbeet Stage	v1.5-3.5	8 leaf	closed canopy
Biennial Wormwood	0.5-2" diameter	3-7" tall	---
Redroot Pigweed	2-4 lf	6lf-4" tall	---
Gr.&Yel. Foxtail	1-3" tall	1-6" tall	---
Kochia	0.5" ros. diam.	1-2" tall	---
Wild Oats	5-8" tall	12-15" tall	---

Treatment*	(Date of Application)	Rate	Sgbt inj	Biww cntl	Rrpw cntl	Gr&Ye Fxtl cntl
		lb/A	%	%	%	%
Glyphosate (June 7, 24, July 13)		0.75	0	100	100	100
Glyphosate (June 7)		0.75				
Glyphosate+Lorsban (June 24)		0.75+1				
Glyphosate (July 13)		0.75	0	100	100	100
Glyphosate (June 7)		0.75				
Glyphosate+Asana (June 24)		0.75+0.05				
Glyphosate (July 13)		0.75	0	100	100	100
Glyphosate (June 7, 24)		0.75				
Glyphosate+Eminent (July 13)		0.75+0.1	0	100	100	100
Glyphosate (June 7, 24)		0.75				
Glyphosate+SuperTin (July 13)		0.75+0.25	0	100	100	100
Glyphosate (June 7, 24)		0.75				
Glyphosate+Mancozeb (July 13)		0.75+1.6	0	100	100	100
Glyphosate (June 7, 24)		0.75				
Glyphosate+Stratego (July 13)		0.75+0.16	0	100	100	100
Glyphosate (June 7, 24)		0.75				
Gluf+AMS+BAS500F+OC (July 13)		0.75+0.15+1%	0	100	100	100
Glyphosate (June 7, 24)		0.75				
Glyphosate+28%N (July 13)		0.75+7G	0	100	100	100
Glyphosate (June 7, 24)		0.75				
Sethoxydim+MO+Eminent (July 13)		0.19+1.5%+0.1	0	100	100	100
EXP MEAN			0	100	100	100
C.V. %			0	0	0	0
LSD 5%			0	0	0	0
LSD 1%			0	0	0	0
# OF REPS			4	4	4	4

*MO=MethOil, methylated seed oil from Terra; OC=Herbimax, petroleum oil from Loveland.

Summary

All treatments gave excellent weed control and none of the treatments injured sugarbeet.

Herbicides on Roundup Ready Sugarbeet, Glyndon, 1999. (Dexter) 'Hilleshog Empire Roundup Ready' sugarbeet was seeded 1.25 inches deep in 22 inch rows April 29. Counter 15G insecticide at 12 pounds product per acre was applied modified in-furrow at planting. Herbicide treatments were applied in 8.5 gpa water at 40 psi through 8001 nozzles to the center four rows of six row plots May 18, May 25, June 1, June 7 and June 16. Sugarbeet injury and common lambsquarters, redroot pigweed, prostrate pigweed, biennial wormwood and wild oats control were evaluated June 21.

Date	May 18	May 25	June 1	June 7	June 16
Time of Day	5:00 PM	5:00 PM	10:00 AM	5:30 PM	2:00 PM
Air Temp. (°F)	68	73	50	82	73
6" Soil Temp. (°F)	62	68	52	77	66
Rel. Humidity (%)	39	25	21	42	28
Wind Velocity (mph)	5	14	7	4	11
Cloud Cover (%)	0	0	100	0	30
Soil Moisture	good	good	good	good	good
Sugarbeet Stage	cotyledon	v2.0-v3.5	v3.5-v4.1	v6.0-v8.0	v8.0-v10.0
Common Lambsquarters	cotyledon	cot-4 leaf	2-8 leaf	2-4 inches	4-6 inches
Redroot Pigweed	cotyledon	cot-3 leaf	2-8 leaf	2-3 inches	4 inches
Prostrate Pigweed	cotyledon	cot-4 leaf	1-2" diam.	2-3" diam.	4-6" diam.
Biennial Wormwood	cotyledon	2 leaf	4 leaf	2-3 inches	4 inches
Wild Oats	em-2lf(2")	4 inches	6 inches	8 inches	10-12 in.

Summary

All treatments gave excellent weed control. Conventional herbicides caused more sugarbeet injury than glyphosate. The standard rate of conventional herbicides caused more sugarbeet injury than the micro-rate. Desmedipham and desm&phen caused more sugarbeet injury than desm&phen&etho in the micro-rate.

Experiment continued on next page.

Herbicides on Roundup Ready Sugarbeet, Glyndon, 1999. (continued)

Treatment*	(Date of Application)	Rate	Sgbt inj	Colq cntl	Rrpw cntl	Prpw cntl	Biww cntl	Wioa cntl
		lb/A	%	%	%	%	%	%
Desm+Tfsu+Clpy+Clet	(May 18, 25, June 1, 7)	0.25+0.0156+0.09+0.03	38	100	100	100	100	100
Desm+Tfsu+Clpy+Clet+MethOil	(May 18, 25, June 1, 7)	0.08+0.004+0.03+0.03+1.5%	21	100	100	100	100	100
Desm+Tfsu+Clpy+Clet+MethOil	(May 18, 25, June 1, 7)	0.08+0.008+0.03+0.03+1.5%	31	100	100	100	100	100
Desm+Tfsu+Clpy+Clet+Quad 7	(May 18, 25, June 1, 7)	0.08+0.004+0.03+0.03+1.5%	25	100	100	100	100	100
Desm&Phen+Tfsu+Clpy+Clet+MethOil	(May 18, 25, June 1, 7)	0.08+0.004+0.03+0.03+1.5%	21	100	100	100	100	100
De&Ph&Et+Tfsu+Clpy+Clet+MethOil	(May 18, 25, June 1, 7)	0.08+0.004+0.03+0.03+1.5%	9	100	100	100	100	100
Untreated Check		0	0	0	0	0	0	0
Glyphosate	(May 18, 25, June 1, 7)	0.5	1	100	100	100	100	100
Glyphosate	(May 25, June 7)	0.75	0	100	100	100	100	100
Glyphosate	(June 1, June 16)	0.75	0	100	100	100	100	100
Glyphosate+p-Dime	(May 25)	0.75+0.64						
Glyphosate (June 7)		0.75	3	100	100	100	100	100
Glyphosate+m-Meto	(May 25)	0.75+1.9						
Glyphosate (June 7)		0.75	4	100	100	100	100	100
EXP MEAN			13	92	92	92	92	92
C.V. %			38	0	0	0	0	0
LSD 5%			7	0	0	0	0	0
LSD 1%			9	0	0	0	0	0
# OF REPS			4	4	4	4	4	4

*MethOil=methylated seed oil from Terra; AMS=ammonium sulfate; Quad 7=basic blend adjuvant from AGSCO; p-Dime=active isomer of dimethenamid; m-Meto=active isomer of metolachlor.

Herbicides on Roundup Ready Sugarbeet, Mooreton, 1999. (Dexter) 'Hilleshog 8277 Roundup Ready' sugarbeet was seeded 1.25 inches deep in 22 inch rows April 29. Counter 15G insecticide at 12 pounds product per acre was applied modified in-furrow at planting. Herbicide treatments were applied in 8.5 gpa water at 40 psi through 8001 nozzles to the center four rows of six row plots May 18, May 25, June 1, June 9 and June 16. Sugarbeet injury and redroot pigweed, common lambsquarters, marshelder, eastern black nightshade, ladysthumb, biennial wormwood and yellow foxtail control were evaluated June 22. Sugarbeet injury and redroot pigweed and wild proso millet control were evaluated July 16.

Date	May 18	May 25	June 1	June 9	June 16
Time of Day	11:00 AM	11:00 AM	1:00 PM	12:00 PM	11:30 AM
Air Temp. (°F)	66	63	59	88	66
6" Soil Temp. (°F)	55	55	60	72	64
Rel. Humidity (%)	47	38	66	54	32
Wind Velocity (mph)	2	10	5-10	0	8
Cloud Cover (%)	0	0	100	100	5
Soil Moisture	good	good	good	good	good
Sugarbeet Stage	cotyledon	v2.0-v3.5	v4.0-v6.0	---	---
Redroot Pigweed	cotyledon	cot-2 leaf	cot-6 leaf	---	---
Common Lambsquarters	cot-2 leaf	cot-6 leaf	2 lf-1.5"	---	---
Marshelder	cot-2 leaf	cot-4 leaf	2-6 leaf	---	---
E. Black Nightshade	cotyledon	cot-3 leaf	cot-4 leaf	---	---
Ladysthumb	cot-1 leaf	cot-2 leaf	1-3 leaf	---	---
Biennial Wormwood	cot	cot-2 leaf	cot-4 leaf	---	---
Gr.&Yel. Foxtail	emerging	emerg-1 in	emerg-2 in	---	---

Summary

Conventional herbicides caused excessive sugarbeet injury while glyphosate caused no significant injury. Sugarbeet treated with conventional herbicides had not recovered by July 16. Injury to this Roundup Ready variety was much greater than injury to the Liberty Link variety in an adjacent experiment. Desmedipham & phenmedipham in the micro-rate gave less control of redroot pigweed and wild proso millet than desmedipham & phenmedipham & ethofumesate in the micro-rate on July 16.

Experiment continued on next page.

Herbicides on Roundup Ready Sugarbeet, Mooreton, 1999. (continued)

Treatment*	(Date of Application)	Rate	June 22								July 16		
			Sgbt inj	Rrpw cntl	Colq cntl	Mael cntl	Ebns cntl	Lath cntl	Biww cntl	Yeft cntl	Sgbt inj	Rrpw cntl	Wipm cntl
		lb/A	%	%	%	%	%	%	%	%	%	%	%
Desm+Tfsu+Clpy+Clet	(May 18, 25, June 1, 9)	0.25+0.0156+0.09+0.03	58	100	100	100	100	100	100	100	30	99	87
Desm+Tfsu+Clpy+Clet+MethOil	(May 18, 25, June 1, 9)	0.08+0.004+0.03+0.03+1.5%	44	100	100	100	100	100	100	100	23	95	93
Desm+Tfsu+Clpy+Clet+MethOil	(May 18, 25, June 1, 9)	0.08+0.008+0.03+0.03+1.5%	53	100	100	100	100	100	100	100	24	96	93
Desm+Tfsu+Clpy+Clet+Quad 7	(May 18, 25, June 1, 9)	0.08+0.004+0.03+0.03+1.5%	50	100	100	100	100	100	100	100	34	95	90
Desm&Phen+Tfsu+Clpy+Clet+MOil	(May 18, 25, June 1, 9)	0.08+0.004+0.03+0.03+1.5%	44	100	100	100	100	100	100	100	23	91	87
De&Ph&Et+Tfsu+Clpy+Clet+MOil	(May 18, 25, June 1, 9)	0.08+0.004+0.03+0.03+1.5%	33	100	100	100	100	100	100	100	5	97	97
Untreated Check		0	0	0	0	0	0	0	0	0	0	0	0
Glyphosate	(May 18, 25, June 1, 9)	0.5	0	100	100	100	100	100	100	100	0	96	98
Glyphosate	(May 25, June 9)	0.75	0	100	100	100	100	100	100	100	5	98	97
Glyphosate	(June 4, June 16)	0.75	0	100	100	100	100	100	100	100	0	100	98
Glyphosate+p-Dime	(May 25)	0.75+0.64											
Glyphosate	(June 9)	0.75	0	100	100	100	100	100	100	100	0	100	100
Glyphosate+m-Meto	(May 25)	0.75+1.9											
Glyphosate	(June 9)	0.75	0	100	100	100	100	100	100	100	3	99	99
EXP MEAN			23	92	92	92	92	92	92	92	12	89	86
C.V. %			46	0	0	0	0	0	0	0	115	4	6
LSD 5%			16	0	0	0	0	0	0	0	20	5	7
LSD 1%			21	0	0	0	0	0	0	0	27	6	10
# OF REPS			4	4	4	4	4	4	4	4	4	4	4

*MethOil=methylated seed oil from Terra; AMS=ammonium sulfate; Quad 7=basic blend adjuvant from AGSCO; p-Dime=active isomer of dimethenamid; m-Meto=active isomer of metolachlor

Herbicides on Roundup Ready Sugarbeet, Wendell, 1999. (Dexter) 'Hilleshog Empire Roundup Ready' sugarbeet was seeded 1.25 inches deep in 22 inch rows April 27. Counter 15G insecticide at 12 pounds product per acre was applied modified in-furrow at planting. Herbicide treatments were applied in 8.5 gpa water at 40 psi through 8001 nozzles to the center four rows of six row plots May 18, May 25, June 4, June 11 and June 16. Sugarbeet injury and lanceleaf sage, green and yellow foxtail, redroot pigweed, common lambsquarters and common cocklebur control were evaluated June 22 and July 16.

Date	May 18	May 25	June 4	June 11	June 16
Time of Day	1:45 PM	11:00 AM	1:00 PM	10:15 AM	9:55 AM
Air Temp. (°F)	73	68	85	70	64
6" Soil Temp. (°F)	59	58	66	61	62
Rel. Humidity (%)	34	26	44	59	39
Wind Velocity (mph)	9	15	14	10	3
Cloud Cover (%)	5	0	50	0	5
Soil Moisture	good	good	good	good	good
Sugarbeet Stage	coty-v1.2	v2.0-v2.5	v4.0-v6.0	v8.0-v10.0	v10.0-12.0
Lanceleaf sage	cotyledon	2 leaf	4-6 leaf	2-4 inch	3-5 inch
Gr. and Yel. Fxtl	emerg-0.5"	0.5-1 inch	v4.0-v6.0	4-8 inch	6-10 inch
Redroot Pigweed	cotyledon	2-4 lf	6-8 leaf	2-5 inch	4-6 inch
Com. Lambsquarters	cot-2 lf	2-6 lf	2-4 inch	4-8 inch	6-10 inch
Common Cocklebur	cotyledon	2 leaf	4 leaf	2-6 inch	4-8 inch

Summary

Conventional herbicides at the standard rate caused more sugarbeet injury than the micro-rate or glyphosate on June 22. The standard rate of conventional herbicides gave much better control of lanceleaf sage than the micro-rate. Glyphosate gave excellent control of lanceleaf sage. Conventional herbicides at the standard rate with no oil adjuvant gave less grass control than the micro-rate with oil adjuvant. The sugarbeet leaves were affected by bacterial leaf spot and the leaf canopy was not complete during much of the growing season. The open canopy allowed considerable late season emergence of redroot pigweed. The emergence was not uniform over the experiment which caused the relatively high LSD for redroot pigweed control on July 16. Dimethenamid and metolachlor applied POST on May 25 improved redroot pigweed control on July 16.

Experiment continued on next page.

Herbicides on Roundup Ready Sugarbeet, Wendell, 1999. (continued)

Treatment*	(Date of Application)	Rate	June 22						July 16					
			Sgbt inj	Lasa cntl	Gr&Ye Fxtl cntl	Rrpw cntl	Colq cntl	Cocb cntl	Sgbt inj	Lasa cntl	Rrpw cntl	Gr&Ye Fxtl cntl	Colq cntl	Cocb cntl
		lb/A	%	%	%	%	%	%	%	%	%	%	%	%
Desm+Tfsu+Clpy+Clet	(May 18, 25, June 4, 11)	0.25+0.0156+0.09+0.03	31	97	100	100	100	100	0	100	60	88	97	100
Desm+Tfsu+Clpy+Clet+MethOil	(May 18, 25, June 4, 11)	0.08+0.004+0.03+0.03+1.5%	5	80	100	100	100	100	0	33	62	94	96	100
Desm+Tfsu+Clpy+Clet+MethOil	(May 18, 25, June 4, 11)	0.08+0.008+0.03+0.03+1.5%	9	86	100	100	100	100	0	40	82	95	98	97
Desm+Tfsu+Clpy+Clet+Quad7	(May 18, 25, June 4, 11)	0.08+0.004+0.03+0.03+1.5%	6	88	100	100	100	100	0	43	80	95	98	100
Desm&Phen+Tfsu+Clpy+Clet+MOil	(May 18, 25, June 4, 11)	0.08+0.004+0.03+0.03+1.5%	8	81	100	100	100	100	0	33	50	93	99	100
De&Ph&Et+Tfsu+Clpy+Clet+MethOil	(May 18, 25, June 4, 11)	0.08+0.004+0.03+0.03+1.5%	3	86	100	100	100	100	0	45	72	96	99	100
Untreated Check		0	0	0	0	0	0	0	0	0	0	0	0	0
Glyphosate	(May 18, 25, June 4, 11)	0.5	0	100	100	100	100	100	0	100	81	97	100	90
Glyphosate	(May 25, June 11)	0.75	0	100	100	100	100	100	0	100	71	94	100	99
Glyphosate	(June 4, June 16)	0.75	0	100	100	100	100	100	0	100	85	93	97	100
Glyphosate+p-Dime	(May 25)	0.75+0.64												
	Glyphosate (June 11)	0.75	0	100	100	100	100	100	0	100	99	92	99	99
Glyphosate+m-Meto	(May 25)	0.75+1.9												
	Glyphosate (June 11)	0.75	0	100	100	100	100	100	0	100	100	96	100	91
EXP MEAN			5	85	92	92	92	92	0	66	70	86	90	90
C.V. %			73	5	0	0	0	0	0	14	27	6	2	6
LSD 5%			5	6	0	0	0	0	NS	13	27	8	3	8
LSD 1%			7	8	1	0	0	0	NS	18	36	11	4	11
# OF REPS			4	4	4	4	4	4	4	4	4	4	4	4

*MethOil=methylated seed oil from Terra; AMS=ammonium sulfate; Quad 7=basic blend adjuvant from AGSCO; p-Dime=active isomer of dimethenamid; m-Meto=active isomer of metolachlor.

Roundup Ready sugarbeet and cultivation, Crookston, 1999. (Dexter) 'Empire Roundup Ready' sugarbeet was seeded 1.25 inches deep in 22 inch rows May 17. Counter 15G insecticide at 12 pounds product per acre was applied modified in-furrow at planting. Glyphosate at 1 quart per acre was applied to all plots June 7 and July 2. Plots receiving two cultivations were cultivated June 15 and July 7. Plots receiving five cultivations were cultivated June 15, July 1, July 7, July 14 and July 27. Sugarbeet was hand thinned to an eight inch spacing June 25. Sugarbeet from the center two rows of 40 foot long plots was counted and harvested September 28.

Date of Cultivation	September 28 Sugarbeet Population	Sucrose	Root Yield	Impurity Index	Extractable Sucrose
	plants/80ft	%	ton/A		lb/A
No Cultivation	103	16.2	23.1	543	6880
Two Cultivations	91	16.0	22.0	565	6454
Five Cultivations	94	16.4	21.0	547	6307
EXP MEAN	96	16.2	22.0	552	6547
C.V. %	4	3.1	4.9	8	5
LSD 5%	6	NS	1.4	NS	453
LSD 1%	8	NS	NS	NS	NS
# OF REPS	6	6	6	6	6

Summary

Plots cultivated five times yielded less than plots that were not cultivated.

Liberty Link sugarbeet and cultivation, Crookston, 1999. (Dexter) 'Beta 2012 Liberty Link' sugarbeet was seeded 1.25 inches deep in 22 inch rows May 17. Counter 15G insecticide at 12 pounds product per acre was applied modified in-furrow at planting. Liberty at 28 oz product per acre was applied to all plots June 3 and July 2. Plots receiving two cultivations were cultivated June 15 and July 7. Plots receiving five cultivations were cultivated June 15, July 1, July 7, July 14 and July 27. Sugarbeet was hand thinned to an eight inch spacing June 25. Sugarbeet from the center two rows of 40 foot long plots was counted and harvested September 28.

Date of Cultivation	September 28 Sugarbeet Population	Sucrose	Root Yield	Impurity Index	Extractable Sucrose
	plants/80ft	%	ton/A		lb/A
No Cultivation	103	17.2	20.3	489	6481
Two Cultivations	103	17.4	21.3	462	6902
Five Cultivations	104	17.4	20.4	458	6635
EXP MEAN	103	17.3	20.7	470	6673
C.V. %	4	2.5	4.3	9	6
LSD 5%	NS	NS	NS	NS	NS
LSD 1%	NS	NS	NS	NS	NS
# OF REPS	6	6	6	6	6

Summary

Cultivation had no significant influence on sugarbeet yield.

Kochia control with sugarbeet herbicides, Thompson, 1999. (Dexter) Plots 40 feet long and 10 feet wide were established in a natural stand of kochia. The first portion of split applied treatments was applied 2:30 PM July 1 when the air temperature was 82F, relative humidity was 33%, wind velocity was 13 mph, cloud cover was 50%, soil temperature at six inches was 70F, soil moisture was good and kochia was in the cotyledon stage to six inches tall. The second portion of split applied treatments was applied 11:00 AM July 7 when the air temperature was 77F, relative humidity was 34%, wind velocity was 5 mph, cloud cover was 60%, soil temperature at six inches was 66F, soil moisture was good and kochia was 0.5 inch rosette diameter to 8 inches tall. The third portion of split applied treatments was applied 12:30 PM June 12 when the air temperature was 84F, relative humidity was 55%, wind velocity was 10 mph, cloud cover was 80%, soil temperature at six inches was 74F, soil moisture was good and kochia was 1 inch rosette diameter to 9 inches tall. All treatments were applied in 8.5 gpa water at 40 psi through 8001 nozzles to the center 6.67 feet of 10 foot plots. Kochia control was evaluated July 22 and August 3.

Treatment*	(Date of Application)	Rate	July 22 Kocz cntl	Aug. 3 Kocz cntl
		lb/A	%	%
Desm+Tfsu+Clpy+Clethodim	(July 1, 7, 12)	0.25+0.0156+0.09+0.03	55	31
Desm+Tfsu+Clpy+Clet+MethOil	(July 1, 7, 12)	0.08+0.004+0.03+0.03+1.5%	44	23
Desm+Tfsu+Clpy+Clet+MethOil	(July 1, 7, 12)	0.08+0.008+0.03+0.03+1.5%	31	23
Desm+Tfsu+Clpy+Clet+Quad 7	(July 1, 7, 12)	0.08+0.004+0.03+0.03+1.5%	38	19
Desm&Phen+Tfsu+Clpy+Clet+MethOil	(July 1,7,12)	0.08+0.004+0.03+0.03+1.5%	46	28
De&Ph&Et+Tfsu+Clpy+Clet+MOil	(July 1, 7, 12)	0.08+0.004+0.03+0.03+1.5%	43	25
Untreated Check		0	0	0
Glufosinate+AMS	(July 1, 7, 12)	0.268+3	100	100
Glufosinate+AMS	(July 1, 12)	0.357+3	100	100
Glufosinate+AMS	(July 7, 12)	0.357+3	100	100
Gluf+AMS+p-Dimethenamid	(July 1)/Gluf+AMS(July 12)	0.357+3+0.64/0.357+3	100	100
Gluf+AMS+m-Metolachlor	(July 1)/Gluf+AMS(July 12)	0.357+3+1.9/0.357+3	100	100
Glyphosate	(July 1, 7, 12)	0.5	100	100
Glyphosate	(July 1, 12)	0.75	100	100
Glyphosate	(July 7, 12)	0.75	100	100
Glyphosate+p-Dimethenamid	(July 1)/Glyphosate(July 12)	0.75+0.64/0.75	100	100
Glyphosate+m-Metolachlor	(July 1)/Glyphosate(July 12)	0.75+1.9/0.75	100	100
Des&Phen&Etho+Tfsu+Clpy+Clet+MOil	(July 1,7,12)	0.16+0.008+0.03+0.03+1.5%	61	45
Desm&Phen&Etho+Clpy+Clet+MOil	(July 1, 7, 12)	0.16+0.03+0.03+1.5%	71	58
Desm&Phen&Etho+Tfsu+Clpy+Clet	(July 1, 7, 12)	0.25+0.0156+0.09+0.03	66	54
Desm&Phen&Etho+Tfsu+Clpy+Clet	(July 1, 7, 12)	0.5+0.0156+0.09+0.03	87	76
Desm&Phen&Etho+Clpy+Clet	(July 1, 7, 12)	0.25+0.09+0.03	54	45
Desmedipham&Phenmedipham&Ethofumesate	(July 1, 7, 12)	0.5	81	75
Desmedipham&Phenmedipham	(July 1, 7, 12)	0.5	81	76
EXP MEAN			73	66
C.V. %			13	11
LSD 5%			14	10
LSD 1%			18	14
# OF REPS			4	4

*m-Metolachlor=Dual II Magnum (active isomer); p-dimethenamid=BAS65607 (active isomer); AMS=ammonium sulfate; MethOil=methylated seed oil from Terra; Quad 7=basic blend adjuvant from AGSCO.

Experiment continued on next page.

Summary

Some of the kochia was up to 6 inches tall on July 1 when the first herbicide treatments were applied so control with conventional herbicides may be less than if all kochia were small when treated. On August 3, the micro-rate of conventional herbicides only gave from 19 to 28% kochia control. A standard rate of the same herbicides (no oil) gave 31% control. Substituting desmedipham & phenmedipham & ethofumesate at 0.25 lb/A for desmedipham at 0.25 lb/A in the standard rate treatment increased kochia control from 31 to 54%. Desmedipham & phenmedipham & ethofumesate at 0.5 lb/A applied three times gave 75% kochia control. Desm&phen&etho + triflusulfuron + clopyralid + clethodim at 0.5 + 0.0156 + 0.09 + 0.03 lb/A applied three times gave 76% kochia control. This suggests that triflusulfuron contributed nothing to kochia control and that this kochia population was nearly totally resistant to ALS inhibitor herbicides. Treatments that included desm&phen&etho at 0.5 lb/A gave better kochia control than treatments with desm&phen&etho at 0.25 lb/A.

Grass control in sugarbeet, Crookston, 1999. (Dexter) 'Beta 2012 Liberty Link' sugarbeet was seeded 1.25 inches deep in 22 inch rows across the herbicide plots May 17. 'Crusher' canola, 'Manta' Siberian foxtail millet at 40 lb/A, 'Jud' oats at 57 lb/A, 'Stander' barley at 69 lb/A, 'IS Hybrid 5757' sunflower and 'Upland' navy bean at 192 lb/A were seeded in 4-foot strips across the herbicide plots May 17. The first portion of split applied treatments was applied 1:30 PM May 29 when the air temperature was 90F, relative humidity was 32%, wind velocity was 10 mph, cloud cover was 30%, soil temperature at six inches was 70F, soil moisture was good, sugarbeet was in the cotyledon stage, canola was in the cotyledon stage, oats was 2 inches tall, barley was 2 inches tall, navy bean was in the cotyledon stage, sunflower was in the cotyledon stage, foxtail millet was 0.5 inches tall, wild buckwheat was in the cotyledon to 1 leaf stage, and green and yellow foxtail was emerging to 0.5 inches tall. The second portion of split applied treatments and all single application treatments were applied 1:00 PM June 7 when the air temperature was 79F, relative humidity was 53%, wind velocity was 10 mph, cloud cover was 10%, soil temperature at six inches was 72F, soil moisture was good, sugarbeet was in the v2.0 to v3.5 stage, canola was in the 2 to 4 leaf stage, oats was 4 inches tall, barley was 4 inches tall, navy bean was in the 2 leaf to first trifoliolate stage, sunflower was in the 2 to 4 leaf stage, foxtail millet was 1 to 2 inches tall, wild buckwheat was in the 2 to 3 leaf stage, and green and yellow foxtail was 0.5 to 1 inch tall. The third portion of split applied treatments was applied 1:00 PM June 14 when the air temperature was 68F, relative humidity was 34%, wind velocity was 5-8 mph, cloud cover was 20%, soil temperature at six inches was 61F, soil moisture was good, sugarbeet was in the v3.5 to v4.8 stage, canola was 4 inches tall, oats was 6 to 8 inches tall, barley was 8 inches tall, navy bean was in the 2 trifoliolate stage, sunflower was in the 6 to 8 leaf stage, foxtail millet was 2 to 4 inches tall, wild buckwheat was in the cotyledon to 5 leaf stage, and green and yellow foxtail was 0.5 to 3 inches tall. All treatments were applied in 8.5 gpa water at 40 psi through 8001 nozzles to the center 6.67 feet of 11 foot plots. Sugarbeet injury and foxtail millet, canola, oats, barley, navy bean, sunflower, wild buckwheat and yellow foxtail control were evaluated June 19. Oats, barley, green and yellow foxtail and foxtail millet control were evaluated July 20. A second evaluation of green and yellow foxtail was taken on July 20 within the sugarbeet rows where there was more competition for light compared to the first evaluation where foxtail was growing without competition from sugarbeet.

Summary

All treatments gave over 90% grass control on June 19 except glufosinate at 0.26 lb/A applied twice. Oats and barley control from glufosinate at 0.26 lb/A was improved by applying glufosinate three times rather than twice or by adding clethodim, sethoxydim or quizalofop. Green and yellow foxtail control declined from June 19 to July 20. The decline was greater in the absence of competition than in the sugarbeet rows. In the absence of competition, the grass herbicides alone gave the best foxtail control. Combinations of glufosinate + grass herbicides were better than glufosinate alone but less effective than grass herbicide alone. With competition, glufosinate at 0.26 lb/A applied three times gave grass control similar to the grass herbicides applied once. Clethodim plus conventional herbicides at the micro-rate gave similar grass control whether clethodim at 0.03 lb/A was applied three times, 0.047 lb/A was applied twice or 0.094 lb/A was applied once.

Experiment continued on next page.

Grass control in sugarbeet, Crookston, 1999. (continued)

Treatment* (Appl. Date) Rate	June 19									July 20				
	Sgbt inj	Fomi cntl	Cano cntl	Oats cntl	Barl cntl	Nabe cntl	Sufl cntl	Wibw cntl	Yeft cntl	Oats cntl	Barl cntl	Gr&Ye Fxtl[1] cntl	Fomi cntl	Gr&Ye Fxtl[2] cntl
lb/A	%	%	%	%	%	%	%	%	%	%	%	%	%	%
Clethodim+MO (June 7) 0.094+1.5%	0	100	0	100	100	0	0	0	100	99	99	98	94	96
Clethodim+MO (June 7) 0.125+1.5%	0	100	0	100	100	0	0	0	100	99	98	96	96	98
Clethodim+MO (June 7) 0.188+1.5%	0	100	0	100	100	0	0	0	100	98	99	96	97	97
Sethoxydim+MO (June 7) 0.19+1.5%	0	100	0	100	100	0	0	0	100	99	99	97	94	94
Quizalofop+MO (June 7) 0.055+1.5%	0	100	0	100	100	0	0	0	100	100	100	95	92	95
Glufosinate (May 29,June 7) 0.26	0	95	93	89	79	95	99	98	92	25	23	26	53	76
Glufosinate(May29,June7,14) 0.26	0	99	100	99	99	100	100	99	98	99	98	63	91	97
Gluf+Clet+MO (May29,June7) 0.26+0.03+1.5%	0	100	94	99	99	97	100	98	99	96	97	45	92	86
Gluf+Clet (May29,June7,14) 0.26+0.03	0	100	100	100	100	100	100	100	100	99	99	73	97	93
Gluf+Clet+MO(May29,June7,14) 0.26+0.03+1.5%	0	100	100	100	100	100	100	100	100	100	100	79	95	99
Gluf+Sethoxydim(May29,June7) 0.26+0.062	0	99	96	98	97	98	100	98	99	78	80	55	84	83
Gluf+Seth+MO(May29,June7) 0.26+0.062+1.5%	0	100	95	97	96	98	100	98	99	71	70	40	78	79
Gluf+Quizalofop(May29,June7) 0.26+0.028	0	99	97	99	100	98	100	100	98	91	97	51	84	73
Gluf+Qufp+MO(May29,June 7) 0.26+0.028+1.5%	0	99	95	99	99	98	100	98	97	83	90	45	85	81
Desm+Tfsu+Clpy+Clet+MO (May 29, June 7, 14) 0.08+.004+.03+.03+1.5%	15	100	100	100	100	99	99	100	100	99	100	86	97	95
Desm+Tfsu+Clpy+MO (May 29) 0.08+0.004+0.03+1.5% Desm+Tfsu+Clpy+MO+Clet (June 7, 14) 0.08+.004+.03+1.5%+.047	15	100	100	99	100	99	100	99	100	100	100	83	95	96
Desm+Tfsu+Clpy+MO (May 29, June 7) 0.08+0.004+0.03+1.5% Desm+Tfsu+Clpy+MO+Clet (June 14) 0.08+.004+.03+1.5%+.094	15	100	100	91	99	99	100	99	99	100	100	85	98	97
Desm+Tfsu+Clpy+Seth+MO (May 29, June 7, 14) 0.08+.004+.03+.047+1.5%	15	100	99	95	98	98	100	99	99	86	83	66	88	94
Desm+Tfsu+Clpy+Seth+MO (May 29, June 7, 14) .08+.004+.03+0.062+1.5%	15	100	99	100	99	99	100	99	100	94	93	74	96	85
Desm+Tfsu+Clpy+Qufp+MO (May 29, June 7, 14) 0.08+.004+.03+.028+1.5%	15	100	99	99	100	99	100	99	100	97	99	71	94	98
EXP MEAN	5	99	73	98	98	74	75	74	99	90	91	71	90	90
C.V. %	0	1	2	3	2	1	1	1	1	7	5	14	9	8
LSD 5%	NS	1	2	4	2	1	1	1	2	9	6	14	11	10
LSD 1%	NS	2	3	6	3	2	1	2	2	12	8	19	15	13
# OF REPS	4	4	4	4	4	4	4	4	4	4	4	4	4	4

[1] Green and yellow foxtail without competition from sugarbeet.
[2] Green and yellow foxtail in sugarbeet rows.

Grass control in sugarbeet, Fargo, 1999. (Dexter) 'Crusher' canola, 'Manta' Siberian foxtail millet at 40 lb/A, 'Jud' oats at 57 lb/A, 'Stander' barley at 69 lb/A, 'IS Hybrid 5757' sunflower and 'Upland' navy bean at 192 lb/A were seeded in 4-foot strips across the herbicide plots May 24. The first portion of split applied treatments was applied 1:30 PM June 7 when the air temperature was 81F, relative humidity was 51%, wind velocity was 5-10 mph, cloud cover was 10%, soil temp. at six inches was 62F, soil moisture was good, canola was in the cotyledon to 2 leaf stage, oats was in the 1 leaf stage (4 inches tall), barley was in the 1 leaf stage (3 inches tall), navy bean was in the 2 leaf stage, sunflower was in the 2 leaf stage, and foxtail millet was in the 2 leaf stage (1 inch tall). The second portion of split applied treatments and all single application treatments were applied 1:00 PM June 14 when the air temperature was 63F, relative humidity was 38%, wind velocity was 4 mph, cloud cover was 20%, soil temperature at six inches was 62F, soil moisture was good, canola was in the 2 to 4 leaf stage, oats was 5 to 7 inches tall, barley was 4 to 5 inches tall, navy bean was in the 1 trifoliolate stage, sunflower was in the 2 to 4 leaf stage and foxtail millet was 2 to 4 inches tall. The third portion of split applied treatments was applied 10:00 AM June 21 when the air temperature was 77F, relative humidity was 79%, wind velocity was 20 mph, cloud cover was 90%, soil temperature at six inches was 68F, soil moisture was good, canola was in the 4 to 5 leaf stage (4 inches tall), oats was 7 to 9 inches tall, barley was 5 to 7 inches tall, navy bean was in the 1 to 2 trifoliolate stage, sunflower was in the 4 to 6 leaf stage and foxtail millet was 3 to 6 inches tall. All treatments were applied in 8.5 gpa water at 40 psi through 8001 nozzles to the center 6.67 feet of 11 foot plots. Canola, foxtail millet, oats, barley, sunflower and navy bean were evaluated July 3.

Summary

Grass control was over 90% with all treatments. Glufosinate alone gave less barley control than glufosinate + clethodim, sethoxydim or quizalofop. Glufosinate applied three times gave better grass control than glufosinate applied twice. Clethodim combined with conventional herbicides at the micro-rate gave excellent grass control whether applied three times at 0.03 lb/A, twice at 0.047 lb/A or once at 0.094 lb/A.

Experiment continued on next page.

Grass control in sugarbeet, Fargo, 1999. (continued)

Treatment*	(Date of Application)	Rate	Canola cntl	Fomi cntl	Oats cntl	Barley cntl	Sufl cntl	Nabe cntl
		lb/A	%	%	%	%	%	%
Clethodim+MethOil	(June 14)	0.094+1.5%	0	100	100	100	0	0
Clethodim+MethOil	(June 14)	0.125+1.5%	0	100	100	100	0	0
Clethodim+MethOil	(June 14)	0.188+1.5%	0	100	100	100	0	0
Sethoxydim+MethOil	(June 14)	0.19+1.5%	0	100	100	100	0	0
Quizalofop+MethOil	(June 14)	0.055+1.5%	0	100	100	100	0	0
Glufosinate	(June 7, 14)	0.26	95	98	94	91	99	100
Glufosinate	(June 7, 14, 21)	0.26	100	100	98	93	100	98
Gluf+Clethodim	(June 7, 14)	0.26+0.03	99	99	100	100	99	99
Gluf+Clet+MethOil	(June 7, 14)	0.26+0.03+1.5%	100	100	100	100	99	100
Gluf+Clethodim	(June 7, 14, 21)	0.26+0.03	100	100	100	100	100	100
Gluf+Clet+MethOil	(June 7, 14, 21)	0.26+0.03+1.5%	98	100	100	100	100	100
Gluf+Sethoxydim	(June 7, 14)	0.26+0.062	99	99	97	97	100	100
Gluf+Seth+MethOil	(June 7, 14)	0.26+0.062+1.5%	98	100	98	97	99	100
Gluf+Quizalofop	(June 7, 14)	0.26+0.028	99	100	100	100	100	99
Gluf+Qufp+MethOil	(June 7, 14)	0.26+0.028+1.5%	99	100	99	100	100	99
Desm+Tfsu+Clpy+Clet+MO	(June 7, 14, 21)	0.08+.004+.03+.03+1.5%	98	100	100	100	100	100
Desm+Tfsu+Clpy+MO	(June 7)	0.08+0.004+0.03+1.5%						
Desm+Tfsu+Clpy+MO+Clet	(June 14, 21)	0.08+0.004+0.03+1.5%+0.047	97	100	100	100	100	100
Desm+Tfsu+Clpy+MO	(June 7, 14)	0.08+0.004+0.03+1.5%						
Desm+Tfsu+Clpy+MO+Clet	(June 21)	0.08+0.004+0.03+1.5%+0.094	97	100	97	98	100	99
Desm+Tfsu+Clpy+Seth+MO	(June 7, 14, 21)	0.08+0.004+0.03+0.047+1.5%	97	100	100	99	100	100
Desm+Tfsu+Clpy+Seth+MO	(June 7, 14, 21)	0.08+0.004+0.03+0.062+1.5%	98	100	100	99	100	100
Desm+Tfsu+Clpy+Qufp+MO	(June 7, 14, 21)	0.08+0.004+0.03+0.028+1.5%	97	100	99	100	100	99
EXP MEAN			75	100	99	99	76	76
C.V. %			3	1	1	1	1	2
LSD 5%			4	1	1	1	1	2
LSD 1%			5	1	1	2	1	2
# OF REPS			4	4	4	4	4	4

Herbicides on Liberty Link Sugarbeet, Glyndon, 1999. (Dexter) 'Beta 2012 Liberty Link' sugarbeet was seeded 1.25 inches deep in 22 inch rows April 29. Counter 15G insecticide at 12 pounds product per acre was applied modified in-furrow at planting. Herbicide treatments were applied in 8.5 gpa water at 40 psi through 8001 nozzles to the center four rows of six row plots May 18, May 25, June 1, June 7 and June 16. Sugarbeet injury and common lambsquarters, redroot pigweed, prostrate pigweed, biennial wormwood and wild oats control were evaluated June 21.

Date	May 18	May 25	June 1	June 7	June 16
Time of Day	5:00 PM	5:00 PM	10:00 AM	5:30 PM	2:00 PM
Air Temp. (°F)	68	73	50	82	73
6" Soil Temp. (°F)	62	68	52	77	66
Rel. Humidity (%)	39	25	21	42	28
Wind Velocity (mph)	5	14	7	4	11
Cloud Cover (%)	0	0	100	0	30
Soil Moisture	good	good	good	good	good
Sugarbeet Stage	cotyledon	v2.0-v3.5	v3.5-v4.1	v6.0-v8.0	v8.0-v10.0
Common Lambsquarters	cotyledon	cot-4 leaf	2-8 leaf	2-4 inches	4-6 inches
Redroot Pigweed	cotyledon	cot-3 leaf	2-8 leaf	2-3 inches	4 inches
Prostrate Pigweed	cotyledon	cot-4 leaf	1-2" diam.	2-3" diam.	4-6" diam.
Biennial Wormwood	cotyledon	2 leaf	4 leaf	2-3 inches	4 inches
Wild Oats	em-2lf(2")	4 inches	6 inches	8 inches	10-12 in.

Summary

All treatments gave excellent weed control. Conventional herbicides caused more sugarbeet injury than glufosinate. The standard rate of conventional herbicides caused more sugarbeet injury than the micro-rate treatments.

Experiment continued on next page.

Herbicides on Liberty Link Sugarbeet, Glyndon, 1999. (continued)

Treatment*	(Date of Application)	Rate	Sgbt inj	Colq cntl	Rrpw cntl	Prpw cntl	Biww cntl	Wioa cntl
		lb/A	%	%	%	%	%	%
Desm+Tfsu+Clpy+Clethodim	(May 18, 25, June 1, 7)	0.25+0.0156+0.09+0.03	24	100	100	100	100	100
Desm+Tfsu+Clpy+Clet+MethOil	(May 18, 25, June 1, 7)	0.08+0.004+0.03+0.03+1.5%	16	100	100	100	100	100
Desm+Tfsu+Clpy+Clet+MethOil	(May 18, 25, June 1, 7)	0.08+0.008+0.03+0.03+1.5%	16	100	100	100	100	100
Desm+Tfsu+Clpy+Clet+Quad 7	(May 18, 25, June 1, 7)	0.08+0.004+0.03+0.03+1.5%	16	100	100	100	100	100
Desm&Phen+Tfsu+Clpy+Clet+MethOil	(May 18, 25, June 1, 7)	0.08+0.004+0.03+0.03+1.5%	14	100	100	100	100	100
De&Ph&Et+Tfsu+Clpy+Clet+MethOil	(May 18, 25, June 1, 7)	0.08+0.004+0.03+0.03+1.5%	14	100	100	100	100	100
Untreated Check		0	0	0	0	0	0	0
Glufosinate+AMS	(May 18, 25, June 1, 7)	0.268+3	0	100	100	100	100	100
Glufosinate+AMS	(May 25, June 7)	0.357+3	3	99	100	100	100	97
Glufosinate+AMS	(June 1, June 16)	0.357+3	4	100	100	100	100	100
Gluf+AMS+p-Dime	(May 25)	0.357+3+0.64						
Gluf+AMS	(June 7)	0.357+3	5	100	100	100	100	100
Gluf+AMS+m-Meto	(May 25)	0.357+3+1.9						
Gluf+AMS	(June 7)	0.357+3	9	100	100	100	100	100
EXP MEAN			10	92	92	92	92	91
C.V. %			50	0	0	0	0	2
LSD 5%			7	0	0	0	0	2
LSD 1%			10	1	0	0	0	3
# OF REPS			4	4	4	4	4	4

*MethOil=methylated seed oil from Terra; AMS=ammonium sulfate; Quad 7=basic blend adjuvant from AGSCO; p-Dime=active isomer of dimethenamid; m-Meto=active isomer of metolachlor.

Herbicides on Liberty Link Sugarbeet, Mooreton, 1999. (Dexter) 'Beta 2012 Liberty Link' sugarbeet was seeded 1.25 inches deep in 22 inch rows April 29. Counter 15G insecticide at 12 pounds product per acre was applied modified in-furrow at planting. Herbicide treatments were applied in 8.5 gpa water at 40 psi through 8001 nozzles to the center four rows of six row plots May 18, May 25, June 1, June 9 and June 16. Sugarbeet injury and redroot pigweed, common lambsquarters, marshelder, eastern black nightshade, ladysthumb, biennial wormwood and yellow foxtail control were evaluated June 22. Sugarbeet injury and redroot pigweed and wild proso millet control were evaluated July 16.

Date	May 18	May 25	June 1	June 9	June 16
Time of Day	11:00 AM	11:00 AM	1:00 PM	12:00 PM	11:30 AM
Air Temp. (°F)	66	63	59	88	66
6" Soil Temp. (°F)	55	55	60	72	64
Rel. Humidity (%)	47	38	66	54	32
Wind Velocity (mph)	2	10	5-10	0	8
Cloud Cover (%)	0	0	100	100	5
Soil Moisture	good	good	good	good	good
Sugarbeet Stage	cotyledon	v2.0-v3.5	v4.0-v6.0	---	---
Redroot Pigweed	cotyledon	cot-2 leaf	cot-6 leaf	---	---
Common Lambsquarters	cot-2 leaf	cot-6 leaf	2 lf-1.5"	---	---
Marshelder	cot-2 leaf	cot-4 leaf	2-6 leaf	---	---
E. Black Nightshade	cotyledon	cot-3 leaf	cot-4 leaf	---	---
Ladysthumb	cot-1 leaf	cot-2 leaf	1-3 leaf	---	---
Biennial Wormwood	cot	cot-2 leaf	cot-4 leaf	---	---
Gr.&Yel. Foxtail	emerging	emerg-1 in	emerg-2 in	---	---

Summary

The combinations of conventional herbicides caused more sugarbeet injury than glufosinate. Recovery from injury was good by July 16 but plots treated with desmedipham + triflusulfuron + clopyralid + clethodim at the standard rate still had 18% injury. All treatments gave excellent weed control.

Experiment continued on next page.

Herbicides on Liberty Link Sugarbeet, Mooreton, 1999. (continued)

Treatment*	(Date of Application)	Rate	June 22 Sgbt inj	Rrpw cntl	Colq cntl	Mael cntl	Ebns cntl	Lath cntl	Biww cntl	Yeft cntl	July 16 Sgbt cntl	Rrpw cntl	Wipm cntl
		lb/A	%	%	%	%	%	%	%	%	%	%	%
Desm+Tfsu+Clpy+Clet	(May 18, 25, June 1, 9)	0.25+0.0156+0.09+0.03	39	100	100	100	100	100	100	99	18	98	96
Desm+Tfsu+Clpy+Clet+MethOil	(May 18, 25, June 1, 9)	0.08+0.004+0.03+0.03+1.5%	30	100	100	100	100	100	100	100	5	95	95
Desm+Tfsu+Clpy+Clet+MethOil	(May 18, 25, June 1, 9)	0.08+0.008+0.03+0.03+1.5%	25	100	100	100	100	100	100	100	3	98	96
Desm+Tfsu+Clpy+Clet+Quad7	(May 18, 25, June 1, 9)	0.08+0.004+0.03+0.03+1.5%	28	100	100	100	100	100	100	100	3	99	97
Desm&Phen+Tfsu+Clpy+Clet+MOil	(May 18, 25, June 1, 9)	0.08+0.004+0.03+0.03+1.5%	35	100	100	100	100	100	100	100	11	95	99
De&Ph&Et+Tfsu+Clpy+Clet+MOil	(May 18, 25, June 1, 9)	0.08+0.004+0.03+0.03+1.5%	30	100	100	100	100	100	100	100	11	95	96
Untreated Check		0	0	0	0	0	0	0	0	0	0	0	0
Glufosinate+AMS	(May 18, 25, June 1, 9)	0.268+3	0	100	100	100	100	100	100	100	1	97	97
Glufosinate+AMS	(May 25, June 9)	0.357+3	0	100	100	100	100	100	100	100	0	95	95
Glufosinate+AMS	(June 4, June 16)	0.357+3	16	100	100	100	100	100	100	100	3	100	97
Gluf+AMS+p-Dime	(May 25)	0.357+3+0.64											
Gluf+AMS (June 9)		0.357+3	10	100	100	100	100	100	100	100	3	100	99
Gluf+AMS+m-Meto	(May 25)	0.357+3+1.9											
Gluf+AMS (June 9)		0.357+3	6	100	100	100	100	100	100	100	5	99	99
EXP MEAN			18	92	92	92	92	92	92	92	5	89	89
C.V. %			43	0	0	0	0	0	0	0	137	4	4
LSD 5%			11	0	0	0	0	0	0	0	10	5	5
LSD 1%			15	1	0	0	0	0	0	1	NS	7	7
# OF REPS			4	4	4	4	4	4	4	4	4	4	4

*MethOil=methylated seed oil from Terra; AMS=ammonium sulfate; Quad 7=basic blend adjuvant from AGSCO; p-Dime=active isomer of dimethenamid; m-Meto=active isomer of metolachlor

Herbicides on Liberty Link Sugarbeet, Wendell, 1999. (Dexter) 'Beta 2012 Liberty Link' sugarbeet was seeded 1.25 inches deep in 22 inch rows April 27. Counter 15G insecticide at 12 pounds product per acre was applied modified in-furrow at planting. Herbicide treatments were applied in 8.5 gpa water at 40 psi through 8001 nozzles to the center four rows of six row plots May 18, May 25, June 4, June 11 and June 16. Sugarbeet injury and lanceleaf sage, green and yellow foxtail, redroot pigweed, common lambsquarters and common cocklebur control were evaluated June 22 and July 16.

Date	May 18	May 25	June 4	June 11	June 16
Time of Day	1:45 PM	11:00 AM	1:00 PM	10:15 AM	9:55 AM
Air Temp. (°F)	73	68	85	70	64
6" Soil Temp. (°F)	59	58	66	61	62
Rel. Humidity (%)	34	26	44	59	39
Wind Velocity (mph)	9	15	14	10	3
Cloud Cover (%)	5	0	50	0	5
Soil Moisture	good	good	good	good	good
Sugarbeet Stage	coty-v1.2	v2.0-v2.5	v4.0-v6.0	v8.0-v10.0	v10.0-12.0
Lanceleaf sage	cotyledon	2 leaf	4-6 leaf	2-4 inch	3-5 inch
Gr. and Yel. Fxtl	emerg-0.5"	0.5-1 inch	v4.0-v6.0	4-8 inch	6-10 inch
Redroot Pigweed	cotyledon	2-4 lf	6-8 leaf	2-5 inch	4-6 inch
Com. Lambsquarters	cot-2 lf	2-6 lf	2-4 inch	4-8 inch	6-10 inch
Common Cocklebur	cotyledon	2 leaf	4 leaf	2-6 inch	4-8 inch

Summary

Only conventional herbicides at the standard rate caused significant sugarbeet injury on June 22. The standard rate of conventional herbicides gave much better control of lanceleaf sage than the micro-rate. Glufosinate gave excellent control of all weeds. The micro-rate gave excellent control of all weeds except lanceleaf sage. Conventional herbicides at the standard rate with no oil adjuvant gave less grass control than the micro-rate with oil adjuvant.

Experiment continued on the next page.

Herbicides on Liberty Link Sugarbeet, Wendell, 1999. (continued)

Treatment*	(Date of Application)	Rate	June 22						July 16					
			Sgbt inj	Lasa cntl	G&Ye Fxtl cntl	Rrpw cntl	Colq cntl	Cocb cntl	Sgbt inj	Lasa cntl	Rrpw cntl	G&Ye Fxtl cntl	Colq cntl	Cocb cntl
		lb/A	%	%	%	%	%	%	%	%	%	%	%	%
Desm+Tfsu+Clpy+Clet	(May 18, 25, June 4, 11)	0.25+0.0156+0.09+0.03	10	93	100	100	100	100	4	95	99	86	100	100
Desm+Tfsu+Clpy+Clet+MOil	(May 18, 25, June 4, 11)	0.08+0.004+0.03+0.03+1.5%	1	79	100	100	100	100	0	55	100	97	100	100
Desm+Tfsu+Clpy+Clet+MOil	(May 18, 25, June 4, 11)	0.08+0.008+0.03+0.03+1.5%	4	83	100	100	100	100	0	45	100	97	99	100
Desm+Tfsu+Clpy+Clet+Quad7	(May 18, 25, June 4, 11)	0.08+0.004+0.03+0.03+1.5%	3	84	100	100	100	100	0	53	99	98	100	100
Desm&Phen+Tfsu+Clpy+Clet+MOil	(May 18, 25, June 4, 11)	0.08+0.004+0.03+0.03+1.5%	0	88	100	100	100	100	0	60	98	99	99	100
De&Ph&Et+Tfsu+Clpy+Clet+MOil	(May 18, 25, June 4, 11)	0.08+0.004+0.03+0.03+1.5%	3	84	100	100	100	100	3	63	97	97	100	100
Untreated Check		0	0	0	0	0	0	0	0	0	0	0	0	0
Glufosinate+AMS	(May 18, 25, June 4, 11)	0.268+3	0	100	100	100	100	100	0	100	99	98	100	99
Glufosinate+AMS	(May 25, June 11)	0.357+3	0	100	100	100	100	100	0	100	99	95	98	99
Glufosinate+AMS	(June 4, June 16)	0.357+3	0	100	99	100	100	100	0	100	99	98	100	100
Gluf+AMS+p-Dime	(May 25)	0.357+3+0.64												
Gluf+AMS	(June 11)	0.357+3	0	100	100	100	100	100	3	100	100	99	100	100
Gluf+AMS+m-Meto	(May 25)	0.357+3+1.9												
Gluf+AMS	(June 11)	0.357+3	0	100	100	100	100	100	0	100	99	100	100	100
EXP MEAN			2	84	92	92	92	92	1	72	91	89	91	91
C.V. %			214	5	0	0	0	0	402	18	1	4	2	1
LSD 5%			5	6	0	0	0	0	NS	18	2	6	3	1
LSD 1%			NS	9	0	0	0	0	NS	25	2	7	3	1
# OF REPS			4	4	4	4	4	4	4	4	4	4	4	4

*MethOil=methylated seed oil from Terra; AMS=ammonium sulfate; Quad 7=basic blend adjuvant from AGSCO; p-Dime=active isomer of dimethenamid; m-Meto=active isomer of metolachlor

Combinations of Liberty with fungicides and insecticides, Fargo, 1999. (Dexter) 'Beta 2012 Liberty Link' sugarbeet was seeded 1.25 inches deep in 22 inch rows May 3. Counter 15G insecticide at 12 pounds product per acre was applied modified in-furrow at planting. Postemergence herbicide treatments were applied in 8.5 gpa water at 40 psi through 8001 nozzles to the center four rows of six row plots June 7, June 24 and July 13. Sugarbeet injury and biennial wormwood, redroot pigweed, green and yellow foxtail, kochia and wild oat control were evaluated July 26.

Date	June 7	June 24	July 13
Time of Day	1:30 pm	8:00 am	10:30am
Air Temp. (°F)	81	73	79
6" Soil Temp.(°F)	62	63	71
Rel. Humidity (%)	51	65	68
Wind Vel. (mph)	5-10	2	3
Cloud Cover (%)	10	30	35%
Soil Moisture	good	good	fair
Sugarbeet Stage	v1.5-3.5	8 leaf	closed canopy
Biennial Wormwood	0.5-2" diameter	3-7" tall	---
Redroot Pigweed	2-4 lf	6lf-4" tall	---
Gr.&Yel. Foxtail	1-3" tall	1-6" tall	---
Kochia	0.5" ros. diam.	1-2" tall	---
Wild Oats	5-8" tall	12-15" tall	---

Treatment*	(Date of Application)	Rate	Sgbt inj	Biww cntl	Rrpw cntl	G&Ye Fxtl cntl	Kocz cntl	Wioa cntl
		lb/A	%	%	%	%	%	%
Glufosinate+AMS	(June 7, 24, July 13)	0.357+3	0	100	100	100	100	100
Glufosinate+AMS	(June 7)	0.357+3						
Glufosinate+AMS+Lorsban	(June 24)	0.357+3+1						
Glufosinate+AMS	(July 13)	0.357+3	0	100	100	100	100	100
Glufosinate+AMS	(June 7)	0.357+3						
Glufosinate+AMS+Asana	(June 24)	0.357+3+0.05						
Glufosinate+AMS	(July 13)	0.357+3	0	100	100	100	100	100
Glufosinate+AMS	(June 7, 24)	0.357+3						
Glufosinate+AMS+Eminent	(July 13)	0.357+3+0.1	0	100	100	100	100	100
Glufosinate+AMS	(June 7, 24)	0.357+3						
Glufosinate+AMS+SuperTin	(July 13)	0.357+3+0.25	0	100	100	100	100	100
Glufosinate+AMS	(June 7, 24)	0.357+3						
Glufosinate+AMS+Mancozeb	(July 13)	0.357+3+1.6	0	100	100	100	100	100
Glufosinate+AMS	(June 7, 24)	0.357+3						
Glufosinate+AMS+Stratego	(July 13)	0.357+3+0.16	0	100	100	100	100	100
Glufosinate+AMS	(June 7, 24)	0.357+3						
Gluf+AMS+BAS500F+OC	(July 13)	0.357+3+0.15+1%	0	100	100	100	100	100
Glufosinate+AMS	(June 7, 24)	0.357+3						
Glufosinate+AMS+28%N	(July 13)	0.357+3+7G	0	100	100	100	100	100
Glufosinate+AMS	(June 7, 24)	0.357+3						
Sethoxydim+MO+Eminent	(July 13)	0.19+1.5%+0.1	0	100	100	100	100	100
EXP MEAN			0	100	100	100	100	100
C.V. %			0	0	0	0	0	0
LSD 5%			0	0	0	0	0	0
LSD 1%			0	0	0	0	0	0
# OF REPS			4	4	4	4	4	4

*MO=MethOil, methylated seed oil from Terra; OC=Herbimax, petroleum oil from Loveland; AMS=ammonium sulfate.

Summary

All treatments gave excellent weed control and none of the treatments injured sugarbeet.

Weed control in Liberty Link sugarbeet, Crookston, 1999. (Dexter) 'Beta 2012 Liberty Link' sugarbeet was seeded 1.25 inches deep in 22 inch rows May 17. Counter 15G insecticide at 12 pounds product per acre was applied modified in-furrow at planting. Postemergence herbicide treatments were applied in 8.5 gpa water at 40 psi through 8001 nozzles to the center four rows of six row plots May 29, June 7, June 14, June 21 and July 6. Sugarbeet injury and redroot pigweed control were evaluated June 27 and July 20. Sugarbeet was hand thinned to an eight inch spacing July 14. Sugarbeet from the center two rows of 32 foot long plots was counted and harvested September 29.

Date	May 29	June 7	June 14	June 21	July 6
Time of Day	1:30 pm	1:00 pm	1:00 pm	7:30 pm	10:30am
Air Temp. (°F)	90	79	68	77	70
6" Soil Temp.(°F)	70	72	61	62	68
Rel. Humidity (%)	32	53	34	69	69
Wind Vel. (mph)	10	10	5-8	15	6
Cloud Cover (%)	30	10	20	100	0
Soil Moisture	good	good	good	good	good
Sugarbeet Stage	v1.0	v2.0-v3.5	v4.0-v5.5	v7.2-v7.8	10-12 leaf
Redroot Pigweed	cot-2 leaf	2-6 leaf	cot-3" tall	4 lf-6" tall	--

Summary

Desmedipham & phenmedipham & ethofumesate at 0.33 lb/A applied four times gave more sugarbeet injury on June 27 than desmedipham + triflusulfuron + clopyralid + sethoxydim + methylated seed oil adjuvant at the micro-rate applied four times. Adding m-metolachlor to the micro-rate resulted in increased sugarbeet injury. Injury was less when the m-metolachlor was added on June 7 rather than May 29. Sugarbeet injury from glufosinate + AMS was similar to injury from glufosinate + AMS + m-metolachlor. Desmedipham & phenmedipham & ethofumesate gave less control of redroot pigweed than other treatments.

Experiment continued on next page.

Weed control in Liberty Link sugarbeet, Crookston, 1999. (continued)

Treatment*	(Date of Application)	Rate	June 27 Sgbt inj	June 27 Rrpw cntl	July 20 Sgbt inj	July 20 Rrpw cntl
		lb/A	%	%	%	%
Glufosinate+AMS	(June 7, 14, July 6)	0.268+3	1	100	0	100
Glufosinate+AMS	(June 7, 14, July 6)	0.312+3	3	100	0	100
Glufosinate+AMS	(June 7, 14, July 6)	0.357+3	10	100	0	100
Desm&Phen&Etho	(May 29, June 7, 14)	0.33				
Desm&Phen&Etho+Seth+MO	(June 21)	0.33+0.3+1.5%	40	95	0	80
Desm+Tfsu+Clpy+Seth+MO	(May 29, June 7, 14, 21)	0.08+0.004+0.03+0.063+1.5%	30	100	3	99
Desm+Tfsu+Clpy+Seth+MethOil+m-Meto	(May 29)	0.08+0.004+0.03+0.063+1.5%+1.6				
Desm+Tfsu+Clpy+Seth+MO	(June 7, 14, 21)	0.08+0.004+0.03+0.063+1.5%	44	100	5	100
Desm+Tfsu+Clpy+Seth+MethOil	(May 29)	0.08+0.004+0.03+0.063+1.5%				
Desm+Tfsu+Clpy+Seth+MO+m-Meto	(June 7)	0.08+0.004+0.03+0.063+1.5%+1.3				
Desm+Tfsu+Clpy+Seth+MO	(June 14, 21)	0.08+0.004+0.03+0.063+1.5%	35	100	3	100
Gluf+AMS+m-Metolachlor	(June 7)	0.312+3+1.6				
Glufosinate+AMS	(June 21)	0.312+3	6	100	0	99
Glufosinate+AMS	(June 7)	0.312+3				
Gluf+AMS+m-Metolachlor	(June 21)	0.312+3+1.6	8	100	0	100
Glufosinate+AMS	(June 7)	0.312+3				
Gluf+AMS+m-Metolachlor	(June 21)	0.312+3+1.3	6	100	0	99
Glufosinate+AMS	(June 7, 21)	0.312+3				
Gluf+AMS+m-Metolachlor	(July 6)	0.312+3+1.3	5	100	0	100
EXP MEAN			17	100	1	98
C.V. %			31	3	294	4
LSD 5%			8	NS	NS	6
LSD 1%			10	NS	NS	8
# OF REPS			4	4	4	4

*AMS=ammonium sulfate; MO=methylated seed oil from Terra; m-Meto=active isomer of Metolachlor.

Experiment continued on next page.

Weed control in Liberty Link sugarbeet, Crookston, 1999. (continued)

Treatment*	(Date of Application)	Rate	Sept.29 Sgbt Popl	Sucr	Root Yield	Impur Index	Extract Sucrose
		lb/A	plt/64'	%	ton/A		lb/A
Glufosinate+AMS	(June 7, 14, July 6)	0.268+3	97	16.4	24.9	649	7356
Glufosinate+AMS	(June 7, 14, July 6)	0.312+3	92	16.0	24.0	692	6861
Glufosinate+AMS	(June 7, 14, July 6)	0.357+3	99	16.1	22.7	670	6576
Desm&Phen&Etho	(May 29, June 7, 14)	0.33					
Desm&Phen&Etho+Seth+MO	(June 21)	0.33+0.3+1.5%	95	16.3	17.1	669	5033
Desm+Tfsu+Clpy+Seth+MO	(May 29, June 7, 14, 21)	0.08+0.004+0.03+0.063+1.5%	90	15.8	21.1	741	5937
Desm+Tfsu+Clpy+Seth+MethOil+m-Meto	(May 29)	0.08+0.004+0.03+0.063+1.5%+1.6					
Desm+Tfsu+Clpy+Seth+MO	(June 7, 14, 21)	0.08+0.004+0.03+0.063+1.5%	103	16.1	21.6	697	6238
Desm+Tfsu+Clpy+Seth+MethOil	(May 29)	0.08+0.004+0.03+0.063+1.5%					
Desm+Tfsu+Clpy+Seth+MO+m-Meto	(June 7)	0.08+0.004+0.03+0.063+1.5%+1.3					
Desm+Tfsu+Clpy+Seth+MO	(June 14, 21)	0.08+0.004+0.03+0.063+1.5%	94	15.9	22.0	706	6263
Gluf+AMS+m-Metolachlor	(June 7)	0.312+3+1.6					
Glufosinate+AMS	(June 21)	0.312+3	106	16.1	22.0	716	6294
Glufosinate+AMS	(June 7)	0.312+3					
Gluf+AMS+m-Metolachlor	(June 21)	0.312+3+1.6	84	16.3	22.9	696	6686
Glufosinate+AMS	(June 7)	0.312+3					
Gluf+AMS+m-Metolachlor	(June 21)	0.312+3+1.3	89	16.0	23.1	713	6602
Glufosinate+AMS	(June 7, 21)	0.312+3					
Gluf+AMS+m-Metolachlor	(July 6)	0.312+3+1.3	97	16.0	23.4	688	6708
EXP MEAN			95	16.1	22.3	694	6414
C.V. %			11	1.6	8.4	6	9
LSD 5%			NS	NS	2.7	NS	831
LSD 1%			NS	NS	3.6	NS	1119
# OF REPS			4	4	4	4	4

*AMS=ammonium sulfate; MO=methylated seed oil from Terra; m-Meto=active isomer of Metolachlor.

Summary

Plots treated with desmedipham & phenmedipham & ethofumesate four times at 0.33 lb/A yielded less than all other plots. The best yielding plots were treated three times with glufosinate at 0.268 lb/A. Plots treated with the micro-rate and plots treated with glufosinate + m-metolachlor on June 7 yielded significantly less than the best treatment. Adding m-metolachlor increased sugarbeet injury from the micro-rate but did not cause increased yield loss.

Weed control in Liberty Link sugarbeet, Fargo, 1999. (Dexter) 'Beta 2012 Liberty Link' sugarbeet was seeded 1.25 inches deep in 22 inch rows May 3. Counter 15G insecticide at 12 pounds product per acre was applied modified in-furrow at planting. Postemergence herbicide treatments were applied in 8.5 gpa water at 40 psi through 8001 nozzles to the center four rows of six row plots June 1, June 7, June 14, June 24 and July 1. Sugarbeet injury and biennial wormwood, redroot pigweed, green and yellow foxtail and kochia control were evaluated June 30 and July 26.

Date	June 1	June 7	June 14	June 24	July 1
Time of Day	1:00 pm	1:30 pm	1:00 pm	8:00 am	10:00am
Air Temp. (°F)	59	81	63	73	70
6" Soil Temp.(°F)	59	62	62	63	75
Rel. Humidity (%)	66	51	38	65	30
Wind Vel. (mph)	8	5-10	4	2	2
Cloud Cover (%)	95	10	20	30	40
Soil Moisture	good	good	good	good	good
Sugarbeet Stage	v1.0	v1.5-3.5	v4.0-6.0	8 leaf	8-10 leaf
Biennial Wormwood	2-4 lf	.5-2"dia	2-4" tall	3-7" tall	5-9" tall
Redroot Pigweed	cot-2lf	2-4 lf	4lf-2" tall	6lf-4" tall	2-6" tall
Gr.&Yel. Foxtail	emerg-0.5"	1-3" tall	2-4" tall	1-6" tall	3-8" tall
Kochia	cot-2 leaf	0.5"ros. diam.	1"ros. daim.	1-2" tall	2-4" tall

Summary

Desmedipham&phenmedipham&ethofumesate at 0.33 lb/A applied four times gave more sugarbeet injury and less control of biennial wormwood and redroot pigweed than other treatments. Adding m-metolachlor to the micro-rate or to glufosinate + AMS did not result in a significant increase in sugarbeet injury.

Experiment continued on next page.

Weed control in Liberty Link sugarbeet, Fargo, 1999. (continued)

Treatment*	(Date of Application)	Rate	June 30					July 26				
			Sgbt inj	Biww cntl	Rrpw cntl	G&Ye Fxtl cntl	Kocz cntl	Sgbt inj	Biww cntl	Rrpw cntl	G&Ye Fxtl cntl	Kocz cntl
		lb/A	%	%	%	%	%	%	%	%	%	%
Glufosinate+AMS	(June 1, 14)	0.268+3	0	99	100	99	100	0	100	100	99	100
Glufosinate+AMS	(June 1, 14)	0.312+3	5	100	100	100	100	0	100	100	100	100
Glufosinate+AMS	(June 1, 14)	0.357+3	0	100	100	99	99	0	100	100	100	100
Desm&Phen&Etho	(June 1, 7, 14)	0.33										
De&Ph&Et+Seth+MO	(June24)	0.33+0.3+1.5%	41	75	95	100	99	0	56	95	100	96
Desm+Tfsu+Clpy+Seth+MO	(June 1,7,14,21)	0.08+0.004+0.03+0.063+1.5%	14	100	100	100	99	0	99	100	100	100
Desm+Tfsu+Clpy+Seth+MO+m-Meto	(June 1)	0.08+0.004+0.03+0.063+1.5%+1.6										
Desm+Tfsu+Clpy+Seth+MO	(June 7,14,24)	0.08+0.004+0.03+0.063+1.5%	21	100	100	100	100	0	100	100	100	99
Desm+Tfsu+Clpy+Seth+MethOil	(June 1)	0.08+0.004+0.03+0.063+1.5%										
Desm+Tfsu+Clpy+Seth+MO+m-Meto	(June 7)	0.08+0.004+0.03+0.063+1.5%+1.3										
Desm+Tfsu+Clpy+Seth+MO	(June 14, 24)	0.08+0.004+0.03+0.063+1.5%	20	100	100	100	99	0	99	100	100	95
Gluf+AMS+m-Meto	(June 1)	0.312+3+1.6										
Glufosinate+AMS	(June 14)	0.312+3	4	100	99	99	100	0	100	99	97	100
Glufosinate+AMS	(June 1)	0.312+3										
Gluf+AMS+m-Meto	(June 14)	0.312+3+1.6	3	100	100	99	100	0	100	100	93	100
Glufosinate+AMS	(June 1)	0.312+3										
Gluf+AMS+m-Meto	(June 14)	0.312+3+1.3	1	100	100	99	100	0	100	99	95	100
Glufosinate+AMS	(June 1, 14)	0.312+3										
Gluf+AMS+m-Meto	(July 1)	0.312+3+1.3	9	100	100	100	100	0	100	100	100	100
EXP MEAN			11	98	99	100	100	0	96	99	98	99
C.V. %			55	2	2	1	1	0	4	1	3	4
LSD 5%			8	3	3	NS	NS	0	5	2	5	NS
LSD 1%			11	4	NS	NS	NS	0	7	3	NS	NS
# OF REPS			4	4	4	4	4	4	4	4	4	4

*AMS=ammonium sulfate; MO=methylated seed oil from Terra; m-Meto=active isomer of Metolachlor.

Lorsban formulations tank-mixed with conventional sugarbeet herbicides, Fargo, 1999. (Dexter) 'Van der Have 66168' sugarbeet was seeded 1.25 inches deep in 22 inch rows May 3. Counter 15G insecticide at 12 pounds product per acre was applied modified in-furrow at planting. Herbicide treatments were applied in 8.5 gpa water at 40 psi through 8001 nozzles to the center four rows of six row plots June 1, June 7 and June 14. Select + MethOil at 0.09 lb ai/A + 1.5% was applied to the Lorsban alone plots and the untreated check plots June 14. Sugarbeet injury was evaluated June 16, June 30 and July 26. Biennial wormwood, kochia, redroot pigweed and green and yellow foxtail control were evaluated June 16 and July 26.

Date	June 1	June 7	June 14
Time of Day	1:00 pm	1:30 pm	1:00 pm
Air Temp. (°F)	59	81	63
6" Soil Temp. (°F)	59	62	62
Rel. Humidity (%)	66	51	38
Wind Velocity (mph)	8	5-10	4
Cloud Cover (%)	95	10	20
Soil Moisture	good	good	good
Sugarbeet Stage	v1.0	v1.5-v3.5	v4.0-v6.0
Kochia	cot-2 leaf	0.5" ros. diam.	1" ros. diam.
Green and Yellow Foxtail	emerg-0.5" tall	1-3 inches tall	2-4 inches tall
Redroot Pigweed	cot-2 leaf	2-4 leaf	4 leaf-2" tall
Biennial Wormwood	2-4 leaf	0.5-2" diam.	2-4 inches tall

Summary

Weed control was excellent with all treatments except Lorsban alone. The Lorsban alone and check plots were treated with Select on June 14 so the grass control in those plots was from the Select. Use of Lorsban 4E or WG in combination with the micro-rate of desmedipham + triflusulfuron + clopyralid + clethodim + methylated seed oil gave sugarbeet injury similar to the micro-rate alone. Use of Lorsban 4E in combination with a standard rate of desmedipham + triflusulfuron + clopyralid + clethodim (no oil) gave more sugarbeet injury than the herbicides alone. Adding Lorsban WG to the same herbicides at a standard rate did not increase sugarbeet injury.

Experiment continued on next page.

Lorsban formulations tank-mixed with conventional sugarbeet herbicides, Fargo, 1999.
(continued)

Treatment*	(Date of Application)	Rate	June 16					6-30	July 26				
			Sgbt inj	Kocz cntl	Biww cntl	Rrpw cntl	Gr&Ye Fxtl cntl	Sgbt inj	Sgbt inj	Biww cntl	Rrpw cntl	Kocz cntl	Gr&Ye Fxtl cntl
		lb/A	%	%	%	%	%	%	%	%	%	%	%
LorsbanWG	(June 1)	3	0	0	0	0	0	0	0	0	0	0	99
LorsbanWG	(June 7)	3	0	0	0	0	0	0	0	0	0	0	100
Lorsban4E	(June 1)	3	0	0	0	0	0	0	0	0	0	0	100
Lorsban4E	(June 7)	3	0	0	0	0	0	0	0	0	0	0	99
Des+Tfs+Clpy+Clet+MO+LorsWG	(June1) 0.08+0.004+0.03+0.03+1.5%+3 Desm+Tfsu+Clpy+Clet+MO (June7,14) 0.08+0.004+0.03+0.03+1.5%		21	100	100	100	100	9	0	98	87	56	95
Des+Tfs+Clpy+Clet+MO+Lors4E	(June1) 0.08+0.004+0.03+0.03+1.5%+3 Desm+Tfsu+Clpy+Clet+MO (June7,14) 0.08+0.004+0.03+0.03+1.5%		14	100	100	100	100	15	1	99	94	86	98
Desm+Tfsu+Clpy+Clet+LorsWG	(June 1) 0.33+0.0156+0.09+0.09+3 Desm+Tfsu+Clpy+Clet (June 7, 14) 0.33+0.0156+0.09+0.09		48	100	100	100	100	25	3	100	100	99	99
Untreated Check			0	0	0	0	0	0	0	0	0	0	100
Desm+Tfsu+Clpy+Clet+Lors4E	(June 1) 0.33+0.0156+0.09+0.09+3 Desm+Tfsu+Clpy+Clet (June 7, 14) 0.33+0.0156+0.09+0.09		70	100	100	100	100	41	14	100	99	100	98
Desm+Tfsu+Clpy+Clet+MO	(June 1) 0.08+0.004+0.03+0.03+1.5% Des+Tfs+Clp+Clet+MO+LorWG (June7) 0.08+0.004+0.03+0.03+1.5%+3 Desm+Tfsu+Clpy+Clet+MO (June 14) 0.08+0.004+0.03+0.03+1.5%		21	100	100	100	100	10	5	100	87	100	97
Desm+Tfsu+Clpy+Clet+MO	(June 1) 0.08+0.004+0.03+0.03+1.5% Des+Tfs+Clp+Clet+MO+Lor4E (June7) 0.08+0.004+0.03+0.03+1.5%+3 Desm+Tfsu+Clpy+Clet+MO (June 14) 0.08+0.004+0.03+0.03+1.5%		24	100	100	100	100	15	3	97	88	96	96
Desm+Tfsu+Clpy+Clet	(June 1) 0.33+0.0156+0.09+0.09 Des+Tfsu+Clpy+Clet+LorsWG (June7) 0.33+0.0156+0.09+0.09+3 Desm+Tfsu+Clpy+Clet (June 14) 0.33+0.0156+0.09+0.09		45	100	100	100	100	26	8	100	100	100	98
Desm+Tfsu+Clpy+Clet	(June 1) 0.33+0.0156+0.09+0.09 Des+Tfs+Clpy+Clet+Lors4E (June 7) 0.33+0.0156+0.09+0.09+3 Desm+Tfsu+Clpy+Clet (June 14) 0.33+0.0156+0.09+0.09		70	100	100	100	100	36	13	100	99	100	99
Desm+Tfsu+Clpy+Clet+MO	(June1,7,14) 0.08+0.004+0.03+0.03+1.5%		20	100	100	100	100	4	4	99	81	86	95
Desm+Tfsu+Clpy+Clet	(June 1, 7, 14) 0.33+0.0156+0.09+0.09		43	100	100	100	100	29	8	100	100	73	99
EXP MEAN			25	67	67	67	67	14	4	66	62	60	98
C.V. %			44	0	0	0	0	54	148	3	14	20	2
LSD 5%			16	0	0	0	0	11	8	3	13	17	3
LSD 1%			21	0	0	0	0	14	11	3	17	22	4
# OF REPS			4	4	4	4	4	4	4	4	4	4	4

*MethOil=methylated seed oil from Terra.

Herbicide carryover, Fargo, 1996-1999. (Dexter) Preplant incorporated herbicides were applied 11:00 am May 23, 1996 when the air temperature was 59F, relative humidity was 60%, soil temperature at six inches was 50F, wind velocity was 10-16 mph, cloud cover was 100% and soil moisture was good. PPI treatments were incorporated with a rototiller set 3 to 4 inches deep. 'Ozzie' soybean was solid seeded in seven inch rows at 60 pounds per acre May 23. Postemergence treatments were applied 11:00 am June 26, 1996 when the air temperature was 86F, relative humidity was 74%, soil temperature at six inches was 67F, wind velocity was 8 mph, cloud cover was 50%, soil moisture was good and soybean was in the 1 to 2 trifoliolate stage. All herbicides were applied in 8.5 gpa water at 40 psi through 8001 nozzles to the center 13 feet of 20 foot wide by 60 foot long plots. Basagran + Ultima + Dash HC at 1 + 0.5 lb ai/A + 1 pint/A was applied to all plots July 1, 1996. Soybean was chopped in September of 1996. Fall 1996 and 1997 tillage was one pass with a 'Conser-Till' chisel plow at a slow speed and parallel with the direction herbicides were applied. Spring tillage in 1997 and 1998 was one pass with a 'Kongskilde Triple K' field cultivator operated parallel with the herbicide application direction. '2371' wheat at 90 lb/A, 'Foster' barley at 90 lb/A, 'Beta 3712' sugarbeet, 'Westar' canola at 8 lb/A, 'Interstate 6111' sunflower, 'Agri 1' navy bean at 50 lb/A, and 'NK 2555' corn were seeded in 4 foot wide drill strips across herbicide plots June 9, 1997. Wheat, barley, sugarbeet, canola, sunflower, navy bean, and corn injury was evaluated July 5 and July 23, 1997. 'Maribo 9581' sugarbeet was seeded 1.25 inches deep in 22 inch rows April 30, 1998. 'Hilleshog 8277 Roundup Ready' sugarbeet was seeded 1.25 inches deep in 22 inch rows May 27, 1999. Counter 15G insecticide at 12 pounds product per acre was applied modified in-furrow at planting in 1998 and 1999. Desmedipham + triflusulfuron + clopyralid + clethodim + MethOil at 0.08 + 0.004 + 0.03 + 0.03 lb ai/A + 1.5% v/v was applied to all plots May 20, 1998. The same herbicide treatment was applied June 10 with sethoxydim at 0.063 lb ai/A instead of clethodim. Desmedipham + triflusulfuron + clopyralid + sethoxydim + MethOil at 0.16 + 0.008 + 0.06 + 0.126 lb ai/A + 1.5% v/v was applied to all plots July 15, 1998. Glyphosate at 1 quart product per acre was applied to all plots June 17, 1999. Sugarbeet injury was evaluated June 23 and July 3, 1998 and June 30, 1999.

Treatment (trade name)	Method of Applic	Rate	July 5, 1997						
			Wht	Barl	Sgbt	Cano	Sufl	Nabe	Corn
		lb/A	% injury						
CGA-277476 (Expert)	POST	0.0705	0	0	0	0	0	6	0
CGA-277476 (Expert)	POST	0.141	0	0	8	5	13	0	0
Picloram (Tordon)	POST	0.0234	0	0	3	0	0	36	3
Cloransulam (First Rate)	PPI	0.03125	29	39	90	89	79	18	33
Sulfentrazone (Authority)	PPI	0.375	0	0	95	0	6	6	0
Isoxaflutole RPA201772 (Balance)	PPI	0.14	0	0	96	36	18	70	0
MON-37500	POST	0.022	9	18	90	15	91	9	31
Rimsulfuron (Matrix)	POST	0.0156	3	3	3	0	0	8	0
Rimsulfuron (Matrix)	POST	0.0234	0	0	3	0	0	3	3
Rimsulfuron (Matrix)	POST	0.0469	3	0	8	4	0	10	0
EXP MEAN			4	6	39	15	21	17	7
C.V. %			118	105	19	92	56	60	112
LSD 5%			7	9	11	20	17	14	11
LSD 1%			10	12	15	27	23	20	15
# OF REPS			4	4	4	4	4	4	4

Experiment continued on next page.

Herbicide carryover, Fargo, 1996-1999. (continued)

Treatment (trade name)	Method of Applic	Rate	July 23, 1997							1998		1999
			Wht	Barl	Sgbt	Cano	Sufl	Nabe	Corn	June 23 Sgbt	July 3 Sgbt	June30 Sgbt
		lb/A	% injury									
CGA-277476 (Expert)	POST	0.0705	0	0	0	0	0	5	5	5	8	0
CGA-277476 (Expert)	POST	0.141	3	6	10	10	0	5	0	10	0	0
Picloram (Tordon)	POST	0.0234	0	0	16	8	0	68	0	8	0	0
Cloransulam (First Rate)	PPI	0.03125	30	56	95	93	93	33	36	33	31	0
Sulfentrazone (Authority)	PPI	0.375	3	4	98	19	0	0	0	48	38	0
Isoxaflutole RPA201772 (Balance)	PPI	0.14	0	0	97	30	33	88	0	8	3	0
MON-37500	POST	0.022	6	15	80	28	88	3	11	35	29	0
Rimsulfuron (Matrix)	POST	0.0156	0	0	5	0	0	0	0	18	0	0
Rimsulfuron (Matrix)	POST	0.0234	4	3	20	0	0	0	0	15	8	0
Rimsulfuron (Matrix)	POST	0.0469	1	6	10	3	0	0	0	0	3	0
EXP MEAN			5	9	43	19	21	20	5	18	12	0
C.V. %			139	104	33	88	44	47	151	113	131	0
LSD 5%			9	14	20	24	14	14	12	29	22	0
LSD 1%			13	18	28	32	19	19	16	NS	30	0
# OF REPS			4	4	4	4	4	4	4	4	4	4

Summary

Picloram, cloransulam, sulfentrazone, isoxaflutole and MON-37500 applied in 1996 injured one or more species seeded in 1997. CGA-277476 and rimsulfuron caused no significant injury. On July 23, picloram only injured navy bean, cloransulam injured all crops, sulfentrazone only injured sugarbeet, isoxaflutole injured all broadleaf crops and MON-37500 injured all crops except wheat, navy bean and corn.

Chloransulam, sulfentrazone and MON-37500 applied in 1996 caused significant sugarbeet injury in 1998 but none of the treatments injured sugarbeet in 1999.

Carryover of corn herbicides, Fargo, 1998-1999. (Dexter) Preplant incorporated herbicides were applied 11:30 am May 5, 1998 when the air temperature was 70F, relative humidity was 30%, soil temperature at six inches was 56F, wind velocity was 7 mph, sky was clear and soil moisture was poor. PPI treatments were incorporated with a rototiller set 3 inches deep. 'Liberty Link' corn was solid seeded in seven inch rows May 5. Postemergence treatments were applied 12:00 pm July 2, 1998 when the air temperature was 80F, relative humidity was 61%, soil temperature at six inches was 70F, wind velocity was 5 mph, cloud cover was 100%, soil moisture was good and corn was 5 to 9 inches tall. All herbicides were applied in 8.5 gpa water at 40 psi through 8001 nozzles to the center 13 feet of 20 foot wide by 50 foot long plots. Corn stand was poor so all plots were tilled once with a 'Kongskilde Triple K' field cultivator and corn was replanted June 4. Liberty herbicide at 28 fluid ounces per acre was applied to all plots July 13, 1998. Corn was flail shredded August 25, 1998. The plot area was tilled twice with a tandem disk and once with an 'Alloway Seed Better' field cultivator August 25. Tillage was parallel with the direction herbicides were applied. 'Beta 3712' sugarbeet was seeded 1.25 inches deep in 22 inch rows August 25. Sugarbeet injury was evaluated October 2. Spring tillage in 1999 was one pass with an 'Alloway Seed Better' field cultivator. 'SDF0402' wheat at 90 lb/A, 'Stander' barley at 66 lb/A, 'Neche' flax at 31 lb/A, 'Crusher' and 'Hyola 401' canola, 'Van der Have 66168' sugarbeet, 'IS Hybrid 5757' sunflower, 'Interstate Payco 3X417' corn, 'Upland' Navy bean at 116 lb/A, and 'Garst BPR23456' soybean at 116 lb/A were seeded in four foot wide drill strips across each herbicide plot May 27, 1999. Wheat, barley, soybean, navy bean, corn, sunflower, canola, sugarbeet and flax injury were evaluated June 21, 1999.

Treatment*	(Trade Name)	Time of Application	Rate	10-2-98 Sgbt inj	June 21, 1999 Wht inj	Barl inj	Soyb inj	Nabe inj	Corn inj	Sufl inj	Cano inj	Sgbt inj	Flax inj
			lb/A	%	%	%	%	%	%	%	%	%	%
Isoxaflutole	(Balance)	PPI	0.047	13	0	0	0	0	0	0	0	0	0
Isoxaflutole	(Balance)	PPI	0.094	38	0	0	0	0	0	0	0	0	0
Isoxaflutole	(Balance)	PPI	0.186	89	0	0	0	0	0	0	0	0	0
Isoxaflutole	(Balance)	PRE	0.047	18	0	0	0	0	0	0	0	0	0
Isoxaflutole	(Balance)	PRE	0.094	35	0	0	0	0	0	0	0	0	0
Isoxaflutole	(Balance)	PRE	0.186	83	0	0	0	0	0	0	0	0	0
BAS635+X-77		POST	0.027+0.25%	38	0	0	0	0	0	0	0	0	0
BAS635+X-77		POST	0.045+0.25%	68	0	0	0	0	0	0	0	0	0
Azafenidin	(Milestone)	POST	0.067	45	0	0	0	0	0	0	0	0	0
Azafenidin	(Milestone)	POST	0.134	35	0	0	0	0	0	0	0	0	0
Azafenidin	(Milestone)	POST	0.268	28	0	0	0	0	0	0	0	0	0
EXP MEAN				44	0	0	0	0	0	0	0	0	0
C.V. %				69	0	0	0	0	0	0	0	0	0
LSD 5%				44	0	0	0	0	0	0	0	0	0
LSD 1%				NS	0	0	0	0	0	0	0	0	0
# OF REPS				4	4	4	4	4	4	4	4	4	4

*X-77=non-ionic surfactant from Loveland.

Summary

Herbicides were applied in the spring of 1998 and sugarbeet was seeded in August of 1998. Isoxaflutole at 0.186 lb/A and BAS635 at 0.045 lb/A gave significant sugarbeet injury on October 2, 1998. Several crops were seeded across the plots on May 27, 1999 but none of the herbicides caused crop injury on June 21, 1999.

Carryover of soybean herbicides, Fargo, 1998-1999. (Dexter) Preplant incorporated herbicides were applied 11:30 am May 5, 1998 when the air temperature was 70F, relative humidity was 30%, soil temperature at six inches was 56F, wind velocity was 7 mph, sky was clear and soil moisture was poor. PPI treatments were incorporated with a rototiller set 3 inches deep. 'Roundup Ready' soybean was solid seeded in seven inch rows at 70 pounds per acre May 5. Postemergence treatments were applied 12:00 pm July 2, 1998 when the air temperature was 80F, relative humidity was 61%, soil temperature at six inches was 70F, wind velocity was 5 mph, cloud cover was 100%, soil moisture was good and soybean was in the 3 to 4 trifoliolate stage. All herbicides were applied in 8.5 gpa water at 40 psi through 8001 nozzles to the center 13 feet of 20 foot wide by 50 foot long plots. Roundup Ultra at 1 quart per acre was applied to all plots June 4 and July 13, 1998. Soybean was flail shredded August 25, 1998. The plot area was tilled twice with a tandem disk and once with an 'Alloway Seed Better' field cultivator August 25. Tillage was parallel with the direction herbicides were applied. 'Beta 3712' sugarbeet was seeded 1.25 inches deep in 22 inch rows August 25. Sugarbeet injury was evaluated October 2. Spring tillage in 1999 was one pass with an 'Alloway Seed Better' field cultivator. 'SDF0402' wheat at 90 lb/A, 'Stander' barley at 66 lb/A, 'Neche' flax at 31 lb/A, 'Crusher' and 'Hyola 401' canola, 'Van der Have 66168' sugarbeet, 'IS Hybrid 5757' sunflower, 'Interstate Payco 3X417' corn, 'Upland' Navy bean at 116 lb/A, and 'Garst BPR23456' soybean at 116 lb/A were seeded in four foot wide drill strips across each herbicide plot May 27, 1999. Wheat, barley, soybean, navy bean, corn, sunflower, canola, sugarbeet and flax injury were evaluated June 21, 1999.

Treatment*	(Trade Name)	Time of Application	Rate	10-2-98 Sgbt inj	June 21, 1999 Wht inj	Barl inj	Soyb inj	Nabe inj	Corn inj	Sufl inj	Cano inj	Sgbt inj	Flax inj
			lb/A	%	%	%	%	%	%	%	%	%	%
CGA-277476+X-77	(Expert)	POST	0.036+0.25%	38	0	0	0	0	0	0	0	0	0
CGA-277476+X-77	(Expert)	POST	0.071+0.25%	13	0	0	0	0	0	0	0	0	0
CGA-277476+X-77	(Expert)	POST	0.142+0.25%	3	0	0	0	0	0	0	0	0	0
Cloransulam	(FirstRate)	PPI	0.031	69	0	0	0	0	0	3	0	8	5
Cloransulam	(FirstRate)	PRE	0.031	89	0	0	0	0	0	0	0	3	3
Cloransulam+X-77	(FirstRate)	POST	0.016+.25%	100	0	28	0	0	38	89	81	98	85
Imazethapyr+X-77	(Pursuit)	POST	0.063+0.25%	100	0	0	0	0	0	9	39	100	59
Sulfentrazone	(Authority)	PPI	0.375	88	0	0	0	0	0	0	0	4	0
Isoxaflutole	(Balance)	PPI	0.094	85	0	0	0	0	0	0	0	0	0
EXP MEAN				65	0	3	0	0	4	11	13	23	17
C.V. %				27	0	207	0	0	151	48	84	26	33
LSD 5%				26	0	9	0	0	9	8	16	9	8
LSD 1%				35	0	12	0	0	12	11	22	12	11
# OF REPS				4	4	4	4	4	4	4	4	4	4

*X-77=non-ionic surfactant from Loveland.

Summary

Herbicides were applied in the spring of 1998 and sugarbeet was seeded in August of 1998. All herbicides except CGA-277476 caused severe sugarbeet injury October 2, 1998. Several crops were seeded across the plots on May 27, 1999. Cloransulam POST and imazethapy POST caused significant injury to some crops while none of the other treatments caused significant crop injury on June 21, 1999. PPI and PRE cloransulam at 0.031 lb/A did not cause injury while cloransulam POST at 0.016 lb/A injured barley, corn, sunflower, canola, sugarbeet and flax.

Fomesafen on sugarbeet and alfalfa, Fargo (NW section 22), 1999. (Dexter)
Fomesafen was applied in 8.5 gpa water at 40 psi through 8001 nozzles to the center 13 feet of each 20 foot wide plot May 26, 1999 when the air temperature was 73F, relative humidity was 24%, six inch soil temperature was 55F, wind was 11 mph, sky was clear, and soil moisture was good. Incorporation was 2 passes with a 'Kongskilde Triple K' field cultivator. 'Van der Have 66168', 'Hilleshog Horizon' and 'Beta 2084' sugarbeet were each seeded 1.25 inches deep in four 22 inch rows across the herbicide plots May 26. Counter 15G insecticide at 12 pounds product per acre was applied modified in-furrow at planting. 'Avalanche' and 'Imperial' alfalfa at 38 lb/A were seeded in 7.5 inch rows and four foot strips across the herbicide plots May 26. Sugarbeet and alfalfa injury were visually evaluated June 16 and July 1. Sugarbeet was counted in 20 feet of treated row and alfalfa was counted in 3 feet of treated row June 18.

		June 16		July 1		June 18				
Treatment	Rate	Sgbt inj	Alfa inj	Sgbt inj	Alfa inj	Sgbt[1] Popul	Sgbt[2] Popul	Sgbt[3] Popul	Alfa[4] Popul	Alfa[5] Popul
	lb/A	%	%	%	%	---plants/20feet---			--plt/3 ft--	
Control	0	0	0	0	0	58	67	46	152	177
Fomesafen (PPI)	0.05	3	0	5	5	47	50	46	182	186
Fomesafen (PPI)	0.075	26	9	25	9	31	31	29	212	160
Fomesafen (PPI)	0.1	28	10	36	8	38	36	30	108	146
Fomesafen (PPI)	0.15	40	19	53	28	22	26	27	132	118
Fomesafen (PPI)	0.2	60	29	60	34	31	34	25	140	164
Fomesafen (PPI)	0.25	83	48	78	48	20	18	17	70	72
EXP MEAN		34	16	37	19	35	37	31	142	146
C.V. %		35	46	27	44	18	32	26	45	36
LSD 5%		18	11	15	12	9	18	12	NS	NS
LSD 1%		24	15	20	17	13	24	17	NS	NS
# OF REPS		4	4	4	4	4	4	4	4	4

[1]Van der Have 66168 sugarbeet
[2]Hilleshog Horizon sugarbeet
[3]Beta 2084 sugarbeet
[4]Avalanche alfalfa
[5]Imperial alfalfa

Summary

Significant injury to sugarbeet occurred at 0.075 lb/A or higher. Significant injury to alfalfa started at 0.15 lb/A. The tested sugarbeet and alfalfa varieties responded similarly to fomesafen carryover.

HRSW variety tolerance to difenzoquat herbicide at Hettinger. (Erick Eriksmoen)

Injury: +=susceptible, 1=moderate tolerance, 0=tolerant

HRSW	1993	1994	1995	1996	1997	1998	1999
Keene	0	1	0	1	1	1	0
Sharp	0	1	1	1	0	1	0
Butte 86	0	1	+	1	1	1	1
Grandin	+	+	+	+	+	1	1
2371	0	1	1	+	0	1	0
2375	0	1	1	1	0	1	0
2398	0	1	1	+	0	0	0
Kulm	0	1	1	1	0	+	+
Amidon	0	+	0	1	1	0	1
Ernest	0	1	0	1	0	0	0
Trenton	+	+	+	+	+	+	1
Hamer		1	0	1	0	1	0
Lars		1	1	1	0	1	0
Verde		+	+	+	+	+	+
Russ		+	1	1	1	1	0
AC Barrie			0	1	0	1	0
Oxen			0	1	0	1	0
Argent HWSW			+	+	+	1	0
Gunner				+	+	+	+
Forge				1	1	1	0
Nora				+	+	+	+
Reeder				+	+	+	1
Parshall				+	+	+	0
AC Cadillac					0	1	0
Sharpshooter					0	1	0
HJ98					0	0	0
Hager					0	1	0
Ingot						1	0
Ivan						0	0
Ember						1	0
McVey							0
Scholar							0
Norpro							0
Majestic							0
Dandy							0
McKenzie							0
Mercury							0
Aurora							0
McNeal	0	+	1	1	1	0	
AC Eatonia		+	0	1	0	1	
AC Elsa					0	1	
Splendor					0	1	
BacUP					0	1	
AC Crystal						1	
Norlander		1	1	1	0		
Gus	0	1	+	+			
Gulpro			1	1			
AC Cora			1	1			
Len	+	+	+				

Date of Application: 5/13/93; 5/20/94/; 5/29/95; 6/11/96; 6/02/97; 5/20/99

Rate of Application: 4 pts/A, (1999=3.5 pts/A)

VARITAL TOLERANCE TO FAR-GO HERBICIDE AT HETTINGER (Eriksmoen)

Stand reduction: + = susceptible, ? = questionable, 0 = tolerant

Variety	6/9/99	5/26/98	6/18/97	6/20/96	6/9/95
AC Barrie	0	?	0	+	+
Butte 86	0	0	0	0	0
Kulm	0	0	0	+	+
2371	0	0	0	0	0
2375	0	0	0	0	0
2398	0	0	0	0	0
Grandin	0	0	0	0	0
Argent HWSW	0	0	0	0	0
Amidon	0	+	+	+	+
Keene	0	+	0	+	0
Trenton	0	0	0	0	0
Ernest	0	?	0	+	0
Hammer	0	+	0	+	+
Lars	0	0	0	0	0
Sharp	0	0	0	0	0
Russ	0	?	0	0	0
Oxen	0	0	0	0	0
Verde	0	0	0	0	0
Nora	0	0	0	0	
Forge	0	0	0	+	
Gunner	0	0	0	+	
Reeder	0	0	0	0	
Parshall	0	0	0	0	
AC Cadillac	0	0	0		
Sharpshooter	0	0	0		
HJ98	0	0	0		
Hager	0	+	0		
Ingot	0	0			
Ivan	0	+			
Ember	0	0			
Norpro	0				
McVey	0				
Scholar	0				
Majestic	0				
Dandy	0				
McKenzie	0				
Mercury	0				
Aurora	0				
AC Eatonia		0	0	0	+
McNeal		0	0	0	0
AC Elsa		0	0		
Splendor		0	0		
BacUp		0	0		
AC Crystal		+			
Gus				+	0
Glupro				0	+
Norlander				0	0
AC Cora				0	+

Planting date: 4/13/99, 4/8/98, 4/29/97, 4/18/96, 4/7/95

Date of Application: 4/12/99, 4/3/98, 4/3/97, 4/19/96, 4/24/95

Rate of Application: 1997-99 = 3 pts/A, 1995/6 = 2 pts/A

DURUM VARIETY TOLERANCE TO AVENGE HERBICIDE AT HETTINGER (Eriksmoen)

Injury: + = susceptible, 1 = moderate tolerance, 0 = tolerant

Durum	1993	1994	1995	1996	1997	1998	1999
Rugby	0	1	0	1	0	1	0
Vic	+	+	+	+	+	+	1
Ben	0	1	0	1	0	1	0
Monroe	0	1	0	1	0	1	0
Renville	1	+	1	+	1	1	0
Plenty	0	1	1	1	0	1	0
Munich	0	1	1	1	0	1	1
Belzer	+	+	+	+	+	+	+
Maier	0	1	0	1	0	1	0
Mountrail		+	+	1	1	+	0
Lebsock		+	1	+	+	+	0
Lloyd	0		0	1	1	1	0
AC Melita			0	1	0	1	0
Plaza			1	1	1	1	0
Dressler				1	1	1	0
Kari				+		+	1
Ward	0	1	1	1	0	1	
Medora	0	1	1	1	+	1	
Sceptre	0	1	1	1	1	1	
Laker	1	+	+	+	+	+	
Regold	1	+	+	+	1	+	
Voss	0	1	+	+	0	1	

Date of Application: 5/13/93, 5/20/94, 5/29/95, 6/11/96, 6/2/97, 5/25/98, 5/20/99

Rate of Application: 4 pts/A (1999=3.5 pts/A)

Response of durum and spring wheat cultivars to imazamethabenze, Prosper ND, 1999. Peel, Michael D., J. Pederson, and Richard K. Zollinger. Released and experimental varieties of hard red spring wheat and durum were evaluated for their response to imazamethabenze (Avenge) and imazamethabenze plus difenzoquat (Assert). The trial, planted on May 18, was a split plot design. Treatments were whole plots and varieties sub plots. Heading date, height and yield were measured on all plots. No visible injury was observed on any varieties.

Treatments were applied on June 11 when the crop was in the 4 to 5 leaf stage. Treatments included imazamethabenze 1.0 lb ai/A (Avenge 4 pt/A), imazamethabenze 1.5 lb ai/A (Avenge 6 pt/A) and imazamethabenze 0.5 lb ai/A (Avenge 2 pt/A) plus difenzoquat 0.25 lb ai/A (Assert 0.75 pt/A). Average wind speed was 6 mph, and air temp was 72° F. The ten days following the treatment were typified by daily high temperatures of 76° to 92° F and daily low temperatures of 49° to 64° F. At the time treatments were applied plant stands averaged 1.1 million plants/A and all varieties were healthy.

Significance variation due to treatments was determined using an approximate *F* test and least significant differences (α=0.05) were used to separate means. Treatment by variety mean yields were not significantly different for either wheat or durum (Tables 1 and 2). Treatment mean yields were significant for durum but not for wheat. Assert at 6 pt/A resulted in a 12% yield reduction, other treatments were not different (Table. 2). Subtle differences in height and heading date were observed, but were not consistent with treatments.

High levels of bacterial leaf blight, septoria, tan spot and leaf rust were present on several varieties. No differences between treatments for level of these diseases were observed. Barley yellow dwarf was also present and as is typical for the disease occurred in patches, randomly affecting some plots.

Following treatments plots were check at seven day intervals until the crop reached the soft dough stage. No visible injury was observed on any variety (Tables 1 and 2). This is in contrast with 1998, where sever injury that included leaf burn, stunting and reduced tillering was observed. Particularly on the wheat varieties 2375, Hamer, Trenton, Verde, Argent, Ingot, Gunner, and Grandin and the durum varieties Renville, Munich, Belzer and Mountrail. Some differences in environmental conditions were observed between the two years. In 1999 measurable rain fall did not occur for 12 days following the treatments, compared to 1.22 inches four days following the treatments in 1998. Average night time temperatures ranged from 41 to 54 F in 1999 compared with 37 to 54 degrees F in 1998. The variation in day time temperature was 69 to 81 degrees F in 1999 compared with 60 to 80 degrees F in 1998.

Table 1. Response of HRSW to imazamethabenze and imazamethabenze plus difenzoquat, Prosper, ND 1998-1999.

Variety	Treatment*	Heading date		Height		Visual injury		Yield	
		1999	1998	1999	1998	1999	1998	1999	1998
		(June 1)	(June 1)	(cm)	(cm)	%	%	bu/A	bu/A
2375	1	8	27	85	80	0	0	49.3	44.8
	2	8	30	84	78	0	32	44.5	46.0
	3	9	29	82	73	0	23	53.8	34.1
	4	9	30	82	77	0	15	48.7	54.2
AC_Barrie	1	8	30	95	86	0	0	38.0	38.2
	2	8	31	93	83	0	13	34.9	38.2
	3	9	30	96	83	0	7	35.8	45.1
	4	9	31	95	84	0	7	30.2	43.9
Argent	1	7	28	86	82	0	0	37.8	47.7
	2	7	32	82	85	0	22	37.9	36.0
	3	7	34	89	83	0	28	38.2	31.1
	4	7	30	89	86	0	17	37.6	43.6
Dandy	1	5	--	82	--	0	--	47.2	--
	2	5	--	79	--	0	--	49.4	--
	3	5	--	82	--	0	--	49.1	--
	4	6	--	84	--	0	--	53.8	--
Grandin	1	6	28	85	80	0	0	37.5	47.9
	2	7	31	84	83	0	27	35.5	38.6
	3	7	30	89	82	0	23	42.7	27.7
	4	7	30	86	84	0	14	42.1	32.7
Gunner	1	10	30	85	82	0	0	37.0	48.1
	2	10	36	86	88	0	42	33.7	38.2
	3	11	40	88	77	0	60	31.1	25.1
	4	11	35	90	84	0	30	28.6	36.3
Hagar (N92-0434)	1	10	31	82	78	0	0	36.6	44.5
	2	10	31	83	81	0	27	31.7	33.8
	3	11	32	80	75	0	37	37.5	29.8
	4	11	32	84	82	0	13	35.6	40.0
HJ98	1	8	29	86	81	0	0	44.9	46.7
	2	9	31	83	77	0	15	39.2	44.1
	3	9	31	85	76	0	19	38.4	41.1
	4	9	29	82	75	0	8	36.3	50.1
Ingot A26	1	4	24	93	85	0	0	55.7	58.8
	2	5	25	87	85	0	11	43.7	54.5
	3	5	26	90	86	0	13	51.0	47.1
	4	5	26	90	88	0	12	48.2	51.2
Ivan (N93-0136)	1	11	--	83	--	0	--	49.0	--
	2	11	--	82	--	0	--	53.2	--
	3	11	--	84	--	0	--	48.9	--
	4	11	--	84	--	0	--	50.2	--
Keene	1	9	29	98	90	0	0	45.5	47.9
	2	11	30	99	93	0	17	47.0	54.4
	3	10	31	104	87	0	15	50.6	46.2
	4	10	30	101	90	0	9	48.4	47.3
McKenzie	1	6	--	89	--	0	--	41.4	--
	2	7	--	95	--	0	--	37.1	--
	3	6	--	91	--	0	--	40.6	--
	4	6	--	90	--	0	--	41.3	--

Table 1. Continued.

Variety	Treatment*	Heading date		Height		Visual injury		Yield	
		1999	1998	1999	1998	1999	1998	1999	1998
		(June 1)	(June 1)	(cm)	(cm)	%	%	bu/A	bu/A
McVey(MN93413)	1	14	31	95	79	0	0	36.8	51.3
	2	13	32	94	79	0	20	39.4	51.0
	3	15	32	93	78	0	23	38.1	44.1
	4	13	31	95	80	0	10	37.0	51.7
Parshall (ND694)	1	8	27	92	88	0	0	49.1	59.6
	2	8	29	94	88	0	19	46.3	45.8
	3	8	29	95	88	0	22	51.6	38.3
	4	8	28	95	91	0	11	47.6	54.4
Reeder (ND695)	1	7	28	90	81	0	0	50.4	51.1
	2	8	36	88	74	0	31	47.8	24.0
	3	8	40	88	76	0	45	45.8	19.7
	4	9	38	92	79	0	27	49.4	30.1
Russ	1	6	28	88	80	0	0	51.0	46.1
	2	6	29	78	82	0	20	51.9	42.1
	3	7	33	90	80	0	28	43.3	38.0
	4	7	29	81	81	0	12	44.2	47.6
Verde	1	9	29	84	79	0	0	50.0	56.2
	2	10	37	83	77	0	37	50.3	30.6
	3	11	42	86	72	0	50	44.0	20.8
	4	10	36	85	77	0	30	50.6	37.2
ND709-9	1	7	--	86	--	0	--	48.5	--
	2	7	--	85	--	0	--	49.9	--
	3	7	--	87	--	0	--	41.5	--
	4	7	--	87	--	0	--	42.2	--
ND710	1	7	--	89	--	0	--	47.3	--
	2	7	--	86	--	0	--	49.2	--
	3	7	--	88	--	0	--	50.1	--
	4	7	--	87	--	0	--	45.0	--
ND716	1	7	--	83	--	0	--	45.5	--
	2	7	--	80	--	0	--	43.7	--
	3	7	--	86	--	0	--	37.0	--
	4	7	--	83	--	0	--	41.3	--
Ember (SD3219)	1	6	--	86	--	0	--	37.9	--
	2	7	--	88	--	0	--	35.9	--
	3	7	--	87	--	0	--	39.8	--
	4	6	--	86	--	0	--	44.7	--
Entry LSD (0.05)		NS	3.5	4	6	--	15	NS	11.2
Treatment Means	1	7.8	28	89	82	--	0	44.6	39.3
	2	8.1	30	87	82	--	20	43.0	33.5
	3	8.4	32	90	82	--	24	43.3	29.3
	4	8.3	30	89	80	--	12	43.0	35.4
Treatment LSD (0.05)		1.0	1.8	1.6	4	--	12	NS	6.6
R square		0.94	0.86	0.83	1	--	0.90	0.68	0.72

* Treatmnts: 1=Untreated check, 2=imazamethabenze 1.0 lb ai/A, 3=imazamethabenze 1.5 lb ai/A, 4=imazamethabenze 0.5 lb ai/A + difenzoquat 0.25 lb ai/A.

Table 2. Response of durum to imazamethabenze and imazamethabenze plus difenzoquat, Prosper, ND 1998-1999.

Variety	Treatment*	Heading date		Height		Visual injury		Yield	
		1999	1998	1999	1998	1999	1998	1999	1998
		(June 1)	(June 1)	(cm)	(cm)	%	%	bu/A	bu/A
Belzer	1	17	31	111	94	0	0	26.8	40.0
	2	15	42	112	76	0	27	17.2	22.6
	3	16	43	114	74	0	30	16.0	10.8
	4	16	40	111	85	0	13	24.6	20.7
Ben	1	13	30	109	94	0	0	36.0	36.5
	2	13	31	111	93	0	8	35.1	42.5
	3	13	32	110	90	0	8	38.2	30.1
	4	14	31	114	93	0	3	39.1	38.1
Kari (D911551)	1	12	--	105	--	0	--	38.8	--
	2	13	--	106	--	0	--	36.2	--
	3	12	--	107	--	0	--	24.3	--
	4	12	--	107	--	0	--	40.7	--
Maier	1	12	30	106	87	0	0	41.0	31.2
	2	12	31	107	87	0	25	35.0	30.4
	3	12	31	110	87	0	5	38.3	24.6
	4	13	31	108	88	0	3	39.3	27.6
Mountrail	1	12	31	108	91	0	0	38.6	32.4
	2	13	33	109	88	0	22	36.7	28.5
	3	13	33	112	89	0	27	37.5	20.1
	4	13	31	110	95	0	10	47.9	35.0
Munich	1	12	29	103	81	0	0	42.8	35.8
	2	12	29	102	82	0	8	45.2	30.7
	3	12	29	101	81	0	7	48.8	18.6
	4	12	30	102	80	0	3	54.1	35.3
Renville	1	12	30	117	97	0	0	33.2	38.7
	2	13	31	120	98	0	13	29.5	32.6
	3	13	31	119	97	0	13	27.7	26.1
	4	13	31	118	97	0	5	33.3	35.0
Lebsock (D901442)	1	12	--	104	--	0	--	54.2	--
	2	12	--	104	--	0	--	47.8	--
	3	12	--	108	--	0	--	49.9	--
	4	12	--	108	--	0	--	52.6	--
Plaza (D91080)	1	16	--	85	--	0	--	27.5	--
	2	16	--	87	--	0	--	24.4	--
	3	16	--	86	--	0	--	23.4	--
	4	17	--	82	--	0	--	27.1	--
Entry LSD (0.05)		NS	3.0	NS	6.8	--	18	NS	10.1
Treatment Means	1	13	30	105	91	--	0	37.7	28.2
	2	13	33	106	87	--	17	34.1	24.6
	3	13	33	107	86	--	15	33.8	17.1
	4	14	32	107	87	--	6	39.8	25.1
Treatment LSD (0.05)		0.4	2.4	2.7	3.8	--	15	3.8	7.4
R Square		0.91	0.86	0.96	0.85	--	0.82	0.80	0.77

* Treatmnts: 1=Untreated check, 2=imazamethabenze 1.0 lb ai/A, 3=imazamethabenze 1.5 lb ai/A, 4=imazamethabenze 0.5 lb ai/A + difenzoquat 0.25 lb ai/A.

Imazamox application (multiple) at varying growth stages, Fargo. (Roach and Davidson-Harrington) 'Imi tolerant' hard red spring wheat was planted May 24. 2 to 3 leaf treatments were applied to 1.5 to 2 leaf wheat and cotyledon to 4 leaf redroot pigweed and wild mustard on June 8 with 76° F and 10 to 15 mph wind. Tillering treatments were applied to 4.5 to 5 leaf wheat and cotyledon to 6 leaf redroot pigweed on June 15 with 55° F and partly cloudy sky. Jointing treatments were applied to late jointing wheat, 10 to 14 inch redroot pigweed, and 12 inch wild mustard on July 1 with 64° F, partly cloudy sky and 0-5 mph wind. All treatments were applied with a bicycle wheel type plot sprayer delivering 8.5 gpa at 35 psi through 8001 flat fan nozzles to a 7 ft wide area the length of 10 by 30 ft plots. The experiment was a randomized complete block design with four replicates. Machine harvest for yield was on August 27.

		Jun 14	Jun 24	Jul 1	Jul 12	Jul 30		Aug 27
Treatment[a]	Rate	Wht	Wht	Wht	Wht	Wht	Rrpw	Yield
	oz ai/A				%			bu/A
2 to 3 leaf								
Imam+Act90+28N	0.5+0.25%+0.25G	39	58	63	30	11	92	10
Imam+Act90+28N(2X)*	0.5+0.25%+0.25G	36	83	75	46	31	63	9
Imam+Act90+28N(4X)*	0.5+0.25%+0.25G	59	94	88	81	56	83	7
Tillering								
Imam+Act90+28N	0.5+0.25%+0.25G	--	20	11	7	3	99	12
Imam+Act90+28N(2X)*	0.5+0.25%+0.25G	--	61	73	49	45	99	9
Imam+Act90+28N(4X)*	0.5+0.25%+0.25G	--	73	91	83	74	99	5
Jointing								
Imam+Act90+28N	0.5+0.25%+0.25G	--	--	--	1	9	99	10
Imam+Act90+28N(2X)*	0.5+0.25%+0.25G	--	--	--	3	8	99	5
Imam+Act90+28N(4X)*	0.5+0.25%+0.25G	--	--	--	13	80	99	1
Untreated	0	0	0	--	0	0	0	16
C.V. %		12	25	5	15	21	7	17
LSD 5%		6	21	4	7	10	9	2
# OF REPS		4	4	4	4	4	4	4

[a]*(2X)=mix two bottles and make two passes over plot; (4x)=mix four bottles and make four passes over plot!

Efficacy of imazamox alone and with broadleaf herbicides, Fargo. (Roach and Davidson-Harrington). 'Imi tolerant' hard red spring wheat was seeded May 24. 1.5 to 2 leaf stage treatments were applied to cotyledon to 4 leaf redroot pigweed and wild mustard on June 8 with 76° F, partly cloudy sky, and 5 to 10 mph wind. 3 to 5 inch stage treatments were applied to 4.5 to 5 leaf wheat and cotyledon to 6 leaf redroot pigweed on June 15 with 56° F, partly cloudy sky, and 0 to 5 mph wind. All treatments were applied with a bicycle wheel type plot sprayer delivering 8.5 gpa at 35 psi through 8001 flat fan nozzles to a 7 ft wide area the length of 10 by 30 ft plots. The experiment was a randomized complete block design with four replicates. Machine harvest for yield was on August 27.

Treatment	Rate	Jun 14	Jun 24		Jul 1	Jul 12	Jul 30		Aug 27
		Wht	Wht	Rrpw	Wht	Wht	Wht	Rrpw	Yield
	oz ai/A				%				bu/A
1.5 to 2 LEAF STAGE									
Imam+Activator 90+28N	0.5+0.25%+0.25G	40	81	93	76	35	25	68	10
Imam+Activator 90+28N	0.64+0.25%+0.25G	36	74	88	73	31	25	50	10
Imam+Activator 90+28N	0.77+0.25%+0.25G	29	23	89	15	7	8	85	9
Imam+2,4-Ddma+ Activator 90+28N	0.5+5+ 0.25%+0.25G	39	86	72	76	34	27	80	12
Imam+2,4-Ddma+ Activator 90+28N	0.64+6.4+ 0.25%+0.25G	31	63	91	41	17	26	80	11
Imam+2,4-Ddma+ Activator 90+28N	0.77+7.7 +0.25%+0.25G	30	55	88	18	15	13	82	10
Imam+Brox&MCPA+ Activator 90+28N	0.5+8+ 0.25%+0.25G	49	88	96	69	36	27	77	10
Imam+Brox&MCPA+ Activator 90+28N	0.64+8+ 0.25%+0.25G	49	91	95	79	48	41	49	9
Brox&MCPA	8	0	1	73	2	0	0	96	16
4.5 to 5.5 LEAF STAGE									
Imam+Activator 90+28N	0.5+0.25%+0.25G	0	48	97	29	14	10	99	12
Imam+Activator 90+28N	0.65+0.25%+0.25G	0	38	97	33	8	8	99	13
Imam+Activator 90+28N	0.77+0.25%+0.25G	0	59	97	50	18	31	99	11
Imam+2,4-Ddma+ Activator 90+28N	0.5+5+ 0.25%+0.25G	0	8	94	9	0	5	99	13
Imam+2,4-Ddma+ Activator 90+28N	0.5+5+ 0.25%+0.25G	0	6	95	6	0	3	99	15
Imam+2,4-Ddma+ Activator 90+28N	0.64+6.4+ 0.25%+0.25G	0	18	95	9	0	1	99	14
Imam+Brox&MCPA+ Activator 90+28N	0.5+8+ 0.25%+0.25G	0	64	98	73	29	46	99	9
Imam+Brox&MCPA+ Activator 90+28N	0.64+8+ 0.25%+0.25G	0	81	98	87	63	65	99	7
Brox&MCPA	8	0	1	59	4	0	1	99	15
Untreated	0	0	0	0	0	0	4	0	17
C.V. %		23	16	17	9	50	44	15	12
LSD 5%		11	10	21	5	13	12	17	2
# OF REPS		4	4	4	4	4	4	4	4

Imazamox injured the imi wheat and injury was greater from the early application. At the tillering application, imazamox injury to wheat was minimized when applied with 2,4-D and what yield was similar to wheat treated with bromoxynil&MCPA or the untreated. The safening affect from 2,4-Ddma was not as evident at the early application probably because 2,4-D is injurious to what at the 1.5- to 2-leaf stage.

General wild oat control, Fargo. (Roach and Davidson-Harrington) 'Oxen' hard red spring wheat was planted April 29. Treatments were applied to 3.5 to 4 leaf wheat, 1.5 to 2.5 leaf wild oat, cotyledon to 2 leaf wild mustard and wild buckwheat and cotyledon to 1 leaf Venice mallow on May 25 with 61° F, 46% RH, clear sky and 11 mph wind. Split treatments (/) were applied to 5 to 6 leaf wheat, 5 to 6 leaf wild oat, 2 to 6 leaf wild mustard, cotyledon to 4 leaf Venice and common mallow, and rosette Canada thistle on June 1 with 55° F, 45% RH, and 4 to 6 mph wind. Treatments were applied with a bicycle wheel type plot sprayer delivering 8.5 gpa at 35 psi through 8001 flat fan nozzles to a 7 ft wide area the length of 10 by 30 ft plots. The experiment was a randomized complete block design with four replicates. Machine harvest for yield was on August 4.

Treatment[a]	Rate	Jun 14		Jul 19		Aug4
		Wht	Wioa	Wht	Wioa	Yield
	oz/A		%			bu/A
Diclofop+bromoxynil+PO	16+4+0.12G	1	81	0	87	28
Difezoquat+PO/dife+brox+PO	8+0.12G/8+4+0.12G	2	92	1	98	22
Immb+thif&trib+Activator 90	5+0.22+0.25%	3	82	0	81	26
Immb+Activator 90/immb+thif&trib+ Activator 90	2.5+0.25%/2.5+0.22+ 0.25%	0	89	1	90	31
Difenzoquat+thif&trib	12+0.22	3	86	0	81	27
Dife/dife+thif&trib	6/6+0.22	5	91	4	97	23
Tralkoxydim+TF8035+brox&MCPA	2.9+0.5%+8	3	91	0	90	30
Tral+TF8035/tral+TF8035+brox&MCPA	1.25+0.5%/1.25+0.5%+8	2	85	0	84	26
Clodinafop+brox&MCPA+Score	0.8+8+0.8%	0	94	0	96	32
Clfp+Score/clfp+brox&MCPA+Score	0.3+0.8%/0.3+8+0.8%	1	96	1	99	38
Fenoxaprop-P&S+thif&trib	1.7+0.22	1	94	0	97	34
Fenx&S/fenx&S+thif&trib	0.6/0.6+0.22	4	95	1	98	27
Bay MKH 6562+2,4-Dioe+Activator90	0.25+4+0.25%	6	98	6	99	28
Bay MKH 6562+2,4-Dioe+Activator 90	0.42+4+0.25%	3	98	6	99	26
Bay MKH 6562+Activator 90/ Bay MKH 6562+2,4-Dioe+ Activator 90	0.12+0.25% 0.12+4+ 0.25%	1	98	1	99	31
Bay MKH 6562+2,4-Dioe+ND72	0.25+4+1%	3	99	4	99	30
Fenoxaprop-P&MCPA&2,4-D	9.3	1	65	0	82	28
Fenx&MCPA&thif&trib+thif&trib	7.3+0.22	4	60	0	67	23
Untreated	0	0	0	0	0	15
C.V. %		125	6	126	6	21
LSD 5%		NS	7	2	7	8
# OF REPS		4	4	4	4	4

[a]Fenx&S is fenoxaprop-P with safener (Puma).

In general split applications of herbicide tended to provide better wild oat control than single applications. The exception is tralkoxydim, which tended to provide higher control as a single full-rate application. Bay MKH 6562 and clodinafop appear to be very effective and consistent herbicides given the conditions of this split-application experiment. These results indicated that wild oat response to herbicides applied as split treatments depended upon specific conditions and the herbicide involved. Wheat yield was increased up to four times by effective wild oat control.

General wild oat control, Carrington. (Endres) 'Verde' hard red spring wheat was planted May 18. Treatments were applied to 4 leaf wheat, 0.5 to 2 inch redroot pigweed, 1.5 to 3 inch wild mustard, 1 to 2 inch common lambsquarters, 2.5 to 4 leaf yellow foxtail, 1.5 to 2 leaf green foxtail and 1 inch eastern black nightshade on June 11 with 61°F, 61% RH, 3 mph wind and cloudy sky. Split treatments (/) were applied to 5 leaf wheat, 1.5 to 3 inch wild mustard, 2 inch common lambsquarters, and 1 inch eastern black nightshade on June 18 with 57° F, 79% RH, 9 mph wind and mostly sunny. Treatments were applied with a bicycle wheel type plot sprayer delivering 10.3 gpa at 35 psi through 8001 flat fan nozzles to a 7 ft wide area the length of 10 by 30 ft plots. The experiment was a randomized complete block design with four replicates.

Treatment[a]	Rate	Jul 10
		Wht
	oz/A	%
Diclofop+bromoxynil+PO	16+4+0.12G	0
Difezoquat+PO/dife+brox+PO	8+0.12G/8+4+0.12G	22
Immb+thif&trib+Activator 90	5+0.22+0.25%	17
Immb+Activator 90/immb+thif&trib+ Activator 90	2.5+0.25%/2.5+0.22+ 0.25%	3
Difenzoquat+thif&trib	12+0.22	19
Dife/dife+thif&trib	6/6+0.22	4
Tralkoxydim+TF8035+brox&MCPA	2.9+0.5%+8	0
Tral+TF8035/tral+TF8035+brox&MCPA	1.25+0.5%/1.25+0.5%+8	0
Clodinafop+brox&MCPA+Score	0.8+8+0.8%	0
Clfp+Score/Clfpd+brox&MCPA+Score	0.3+0.8%/0.3+8+0.8%	11
Fenoxaprop-P&S+thif&trib	1.7+0.22	2
Fenx&S/Fenx&S+thif&trib	0.6/0.6+0.22	0
Bay MKH 6562+2,4-Dioe+Activator90	0.25+4+0.25%	7
Bay MKH 6562+2,4-Dioe+Activator 90	0.42+4+0.25%	2
Bay MKH 6562+Activator 90/ Bay MKH 6562+2,4-Dioe+Activator 90	0.12+0.25%/ 0.12+4+0.25%	2
Bay MKH 6562+2,4-Dioe+ND72	0.25+4+1%	2
Fenoxaprop-P&MCPA&2,4-D	9.3	9
Fenx&MCPA&thif&trib+thif&trib	7.3+0.22	0
Untreated	0	0
C.V. %		205
LSD 5%		NS
# OF REPS		4

[a]Fenx&S is fenoxapro-P with safener (Puma).

Replication variance of individual treatments prevented the separation of treatment means for wheat injury. There were, however, treatments which resulted in substantial crop injury. These treatment effects were independent of a particular herbicide or application effect. Imazamethabenz and difenzoquat were more injurious as a single application than split application, while split applications of difenzoquat and clodinafop.

Wild oat and downy brome control in wheat, Hettinger. (Erik Eriksmoen). 'Butte 86' hard red spring wheat was seeded on May 12. Treatments wee applied to 4 leaf wheat and to 3 to 5 leaf wild oats on June 4 with 79° F, 27% RH, clear sky and 4 mph wind. A second split application was applied to 5 leaf wheat and to4 to 6 leaf wild oats on June 10 with 51° F, 80% RH, partly sunny sky and 3 mph wind. Treatments were applied with a tractor mounted CO_2 propelled plot sprayer delivering 17 gpa at 40 psi through 8001 flat fan nozzles to a 5 ft wide area the length of 10 by 28 ft plots. The experiment was a randomized complete block design with four replicates. Wild oat populations were 6 plants/ft^2. Evaluations were on June 22 for crop injury and weed control and on July 6 and August 8 for weed control. A hailstorm on June 26 caused moderate to severe crop injury. The trial was not harvested due to a poor crop stand at maturity.

Treatment[a]	Rate	Jun 22		Jun 6		Aug 8	
		Wioa	Dobr	Wioa	Dobr	Wioa	Dobr
	oz ai/A	%					
Difp+brox+PO	16+4+0.12 gpa	87	0	93	18	88	5
Dife+PO/dife+ brox+PO	8+0.12G/8+ 4+0.12 gpa	91	0	87	1	68	0
Immb+thif&trib+Activator 90	5+0.22+0.25%	99	0	99	23	94	0
Immb+Activator 90/immb+ thif&trib+Activator 90	2.5+0.25%/2.5+ 0.22+0.25%	99	6	99	8	91	0
Dife+thif&trib	12+0.22	92	8	99	10	66	32
Dife/dife+thif&trib	6/6+0.22	94	22	85	38	55	15
Tral+TF8035+brox&MCPA	2.9+0.5%+8	98	20	97	5	86	0
Tral+TF8035/tral+ TF8035+brox&MCPA	1.25+0.5%/1.25+ 0.5%+8	81	6	90	2	80	0
Clfp+brox&MCPA+Score	0.8+8+0.8%	99	0	99	5	92	0
Clfp+Score/clod+ brox&MCPA+Score	0.3+0.8%/0.3+ 8+0.8%	99	0	99	0	95	8
Fenx&S+thif&trib	1.7+0.22	99	1	99	5	96	5
Fenx&S/fenx&S+thif&trib	0.6/0.6+0.22	99	0	99	6	92	2
Bay MKH 6562+2,4-Dioe+ Activator 90	0.25+4+ 0.25%	98	63	99	52	94	50
Bay MKH 6562+2,4-Dioe+ Activator 90	0.42+4+ 0.25%	99	68	99	77	97	99
Bay MKH 6562+Activator 90/ Bay MKH 6562+2,4-Dioe+ Activator 90	0.12+0.25%/ 0.12+4+ 0.25%	99	64	99	91	98	97
Bay MKH 6562+2,4-Dioe+ND72	0.25+4+1%	99	87	99	70	96	72
Fenoxaprop-P&MCPA&2,4-D	9.3	98	12	96	29	94	25
Fenx&MCPA&thif&trib+thif&trib	7.3+0.22	97	6	92	2	92	0
Untreated	0	0	0	0	0	0	0
C.V. %		8.3	131	8.5	105	19	115
LSD 0.05		11	33	12	35	22	35
# OF REPS		4	4	4	4	4	4

[a]Fenx&S is a pre-mix of fenoxaprop-P with safener (Puma).

Crop injury was not observed (data not shown). Season long wild oat control was good on all treatments except for the difenzoquat split application, the late application of difenzoquat and the split application of tralkoxydim (trt 8) which tended to diminish through the growing season. Split applications did not enhance wild oat control over the single application of the same product. The Bay MKH 6562 treatments were the only treatments that provided significantly higher season long control of downy brome from the untreated check. The higher rate of Bay MKH 6562 and the Bay MKH 6562 split application provided greater than 90% season long downy brome control.

General wild oat control, Williston. (Riveland) 'Reeder' hard red spring wheat was planted on recrop (land cropped to hard red spring wheat in 1998) in 7-inch rows at 80 lbs/A on April 27. Treatments were applied on May 26 to 3 to 3.5 leaf wheat and 1 to 3 leaf wild oat with 76° F, 32% RH, mostly clear sky, and 5 to 10 mph wind. The second application of split treatments was on June 4 to 4.5 to 5 leaf wheat and 3 to 4 leaf wild oat with 71° F, 53% RH, mostly cloudy sky, and 5 to 10 mph winds. Treatments were applied with a small plot sprayer with wind cones, mounted on a G-Allis Chalmers tractor and delivering 8.6 gpa at 30 psi through 8001 flat fan nozzles to a 6.7 ft wide area the length of 10 by 25 ft plots. The experiment was a randomized complete block design with four replicates. Wild oat populations were greater than 20 plants/ft^2. Plots were evaluated on June 18 and August 24. Wheat was machine harvested on August 25.

Treatment[a]	Rate	Jun 18	Aug 24	Test	Aug 25
		Wioa	Wioa	weight	Yield
	oz/A		%	lbs/bu	bu/A
Diclofop+bromoxynil+PO	16+4+0.12G	53	89	62	14
Difezoquat+PO/dife+brox+PO	8+0.12G/8+4+0.12G	43	81	61	11
Immb+thif&trib+Activator 90	5+0.22+0.25%	65	68	60	13
Immb+Act90/immb+thif&trib+ Activator 90	2.5+0.25%/2.5+0.22+ 0.25%	74	95	62	18
Difenzoquat+thif&trib	12+0.22	30	14	59	9
Dife/dife+thif&trib	6/6+0.22	33	54	62	10
Tralkoxydim+TF8035+brox&MCPA	2.9+0.5%+8	76	81	61	19
Tral+TF8035/tral+TF8035+ brox&MCPA	1.25+0.5%/1.25+0.5%+ 8	60	58	61	17
Clodinafop+brox&MCPA+Score	0.8+8+0.8%	89	95	61	22
Clfp+Score/clfp+ brox&MCPA+Score	0.3+0.8%/0.3+ 8+0.8%	91	96	61	20
fenoxaprop-P&S+thif&trib	1.7+0.22	94	98	61	24
Fenx&S/fenx&S+thif&trib	0.6/0.6+0.22	85	96	61	21
Bay MKH 6562+2,4-Dioe+ Activator90	0.25+4+ 0.25%	68	70	61	12
Bay MKH 6562+2,4-Dioe+ Activator 90	0.42+4+ 0.25%	81	90	61	19
Bay MKH 6562+Activator 90/ Bay MKH 6562+2,4-Dioe+ Activator 90	0.12+0.25%/ 0.12+4+ 0.25%	78	86	62	13
Bay MKH 6562+2,4-Dioe+ND72	0.25+4+1%	73	90	61	14
Fenoxaprop-P&MCPA&2,4-D	9.3	81	87	61	19
Fenx&MCPA&thif&trib+thif&trib	7.3+0.22	74	86	61	18
Untreated	0	0	0	61	5
C.V. %		15	10	1	16
LSD (0.05)		14	11	1	4
# OF REPS		4	4	4	4

[a]FenxS is fenoxaprop-P with safener (Puma).

Bay MKH 6562 rate had to be raised to 0.42 oz/A or ND72 added to the 0.25 oz/A rate to achieve effective wild oat control (90%). Clodinafop and fenoxaprop-P provided effective season-long wild oat control regardless of single or split application. Results indicated that wild oat response to other herbicides applied as single or split treatments depended upon specific conditions and the herbicide involved. Wheat yield was increased up to six fold by effective wild oat control.

1999 Wild Oat Control with clodinafop herbicide in wheat at Hettinger. (Erik Eriksmoen) 'Butte 86' hard red spring wheat was seeded on May 12. Treatments were applied to 4 leaf what and to 3 to 5 leaf wild oats on June 4 with 79 F, 28% RH, clear sky, and 6 mph wind. Treatments were applied with a tractor mounted CO_2 propelled plot sprayer delivering 10 gpa at 40 psi through 8001 flat fan nozzles to a 5 foot wide area the length of 10 by 28 ft plots. The experiment was a randomized complete block design with four replications. Wild oat population was 6 plants/ft^2. Crop injury and wild oat control were evaluated on June 22, July 6, and on August 7. A hailstorm on June 26 caused moderate to severe crop injury. The trial was not harvested.

Treatment	Rate	Wild oat control		
		Jun 22	Jul 6	Aug 7
	oz ai/A		%	
Untreated	0	0	0	0
Clodinafop+Score	0.8+0.8%	99	99	94
Clodinafop+brox&MCPA+Score	0.8+8+0.8%	99	98	98
Clfp+prosulfuron+MCPA+Score	0.8+0.14+6+0.8%	99	99	97
Clfp+fluroxypyr+MCPA+Score	0.8+3+8+0.8%	99	99	94
Fenoxaprop-P&S+brox&MCPA	1.31+8	97	92	85
Tral+brox&MCPA+Supercharge+AMS	2.8+8+0.5%+24	99	96	89
C.V. %		2	4	5
LSD (0.05)		3	5	7
# of Reps		4	4	4

Crop injury caused by treatments was not observed (data not shown). All herbicide treatments provided acceptable wild oat control throughout the growing season. Tank mixing bromoxynil&MCPA, prosulfuron, or fluroxypyr with clodinafop did not decrease wild oat control.

Wild oat control with clodinafop applied with broadleaf herbicides, Fargo. (Roach, Ronald F. and Janet D. Davidson-Harrington). The experiment was conducted to determine wild oat control with clodinafop as influenced by broadleaf herbicides. 'Oxen' hard red spring wheat was planted on April 29. Treatments were applied to 3.5 to 4 leaf wheat, 1.5 to 2.5 leaf wild oat, cotyledon to 2 leaf wild mustard and wild buckwheat, and cotyledon to 1 leaf Venice mallow on May 25 with 61° F, 46% relative humidity, clear sky, and 11 mph wind. The treatments were applied with a bicycle-wheel-type plot sprayer delivering 8.5 gpa at 35 psi through 8001 flat fan nozzles to a 7 ft wide area the length of 10 by 30 ft plots. About 10 days after experiment treatments, bromoxynil&MCPA was applied in the control and clodinafop alone plots to remove interference from broadleaf weeds on wheat response to clodinafop treatments. Wild oat infestation exceeded 200 plants/yd^2. The experiment was a randomized complete block design with four replicates.

Treatment[a]	Rate	May 31					Jun 6		Jun 26		Aug 4
		Wht	Wimu	Wibw	Grft	Wioa	Wht	Wioa	Wht	Wioa	Yield
	oz ai/A					%					(bu/A)
Clodinafop+Score	0.8+0.8%	1	0	0	81	85	0	98	0	92	37
Clfp+bromoxynil&MCPA+Score	0.8+8&0.8%	0	99	99	92	88	0	94	0	84	38
Clfp+thif&trib+MCPA-dma+Score	0.8+0.22+6+0.8%	1	99	97	83	85	0	76	0	55	27
Clfp+thif&trib+Score	0.8+0.22+0.8%	1	99	99	84	86	1	96	0	90	37
Clfp+carf+2,4-Dioe+Score	0.8+0.13+4+0.8%	13	99	97	94	91	5	96	0	89	36
Clfp+carf+MCPA-ioe+Score	0.8+0.13+6+0.8%	14	99	99	91	88	6	97	0	92	35
Untreated	0	0	0	0	0	0	0	0	0	0	13
C.V.		62	0	2	9	8	196	6	0	6	14
LSD 5%		4	NS	2	10	9	NS	7	NS	7	7
# OF REPS		4	4	4	4	4	4	4	4	4	4

[a]Score is an adjuvant from Novartis, Greensboro, NC; ioe is isooctyl ester; dma is dimethylamine.

Clodinafop applied with carfentrazone caused contact burn injury to wheat leaf tips, but plants recovered from injury with time. Observation indicated severe contact burn to wild oat from carfentrazone treatments, but this contact injury did not reduce the effectiveness of clodinafop for wild oat control. Clodinafop control of wild oat was reduced when applied with MCPA-dma+ thifensulfuron&tribenuron. Thifensulfuron&tribenuron with clodinafop did not reduce wild oat control; however, the addition of MCPA-dma to this tank mix resulted in lower wild oat control at mid- and late-season evalutions. Bromoxynil&MCPA applied with clodinafop only slightly reduced wild oat control at the late evaluation. These results indicated that several broadleaf control herbicides have potential for use with clodinafop without greatly reducing wild oat control. Wheat yield was three fold higher in plots with effective wild oat control.

Discover for Wild Oat Control (Terry D. Gregoire, 1999) Durum wheat was sprayed June 11th near Devils Lake, North Dakota. The temperature during application was 70°, relative humidity near 55% with full sunshine. The leaf stages of the wheat and weeds were: wheat 3-4 leaf, wild oat 2-4 leaf, wild mustard 2-4 leaf. Treatments were applied with a CO_2 pressurized back pack sprayer using 8.5 gpa at 40 psi and 8001 nozzles. Treatments were arranged in RCBD and replicated 4 times. Treatment evaluation dates were June 23rd and July 23rd 1999.

Trt No.	Trt. Name	Rate Unit	Growth Stage	June 23 Wild Oat	June 23 Broadleaf	July 23 Wild Oat
				% control		
1	untreated			0.0	0.0	0.0
2	Discover	3.2 oz/a	3-4 lf	92.5	0.0	97.5
2	Score	.8% v/v				
3	Discover	3.2 oz/a	3-4 lf	91.3	100.0	98.8
3	Bronate	16 oz/a	3-4 lf			
3	Score	.8% v/v				
4	Discover	3.2 oz/a	3-4 lf	87.5	100.0	92.5
4	Peak	.25 oz/a	3-4 lf			
4	Score	.8% v/v				
4	MCPA ester	12 fl oz/a	3-4 lf			
5	Discover	3.2 oz/a	3-4 lf	81.3	100.0	95.0
5	Starane	1 oz/a	3-4 lf			
5	MCPA ester	23 fl oz/a	3-4 lf			
5	Score	.8% v/v				
6	Puma	10.4 oz/a	3-4 lf	88.8	100.0	90.0
6	Bronate	16 oz/a	3-4 lf			
7	Achieve	7.2 oz/a	3-4 lf	91.3	100.0	96.3
7	Bronate	16 oz/a	3-4 lf			
7	Supercharge	.5% v/v				
7	Ams	1.5 lb/a	3-4 lf			
LDS (P=.05)				18.24	0.00	8.59
Standard Deviation				12.28	0.00	5.78
CV				16.14	0.0	7.1

Summary

Puma-Bronate had significantly less wild oat control by the July 23rd evaluation date than Discover-Bronate. Early evaluation results indicated a tendency for reduced control when Starane and MCPA Ester were mixed with Discover.

The Durum plant population was good and competitive. No Durum injury was observed with any treatment

Fenoxaprop-P&S for wild oat control, Fargo. (Roach and Davidson-Harrington) 'Oxen hard red spring wheat was planted April 29. Treatments were applied to 3.5 to 4 leaf wheat, cotyledon to 2 leaf wild mustard and wild buckwheat and cotyledon to 1 leaf Venice mallow on May 25 with 61° F, 46% RH, clear sky and 11 mph wind. Split Treatment (/) were applied to 5 to 6 leaf wheat and wild oat, 2 to 6 leaf wild mustard, cotyldedon to 4 leaf Venice and common mallow and Rosette to 6 inch Canada thistle on June 1 with 55° F, 45% RH, cloudy sky and 4 to 6 mph wind. All treatments were applied with a bicycle wheel type plot sprayer delivering 8.5 gpa at 35 psi through 8001 flat fan nozzles to a 7 ft wide area the length of 10 by 30 ft plots. The experiment was a randomized complete block design with four replicates.

Treatment[a]	Rate	5/31/99					6/06/99		7/12/99		8/04/99
		Wht	Wimu	Grft	Wioa	Vema	Wht	Wioa	Wht	Wioa	Yield
	oz ai/A					%					bu/A
Fenx&S/brox&MCPA	1.7+8	1	13	74	78	0	3	97	4	94	27
Fenx&S+thif&trib	1.7+0.3	5	99	78	84	95	4	97	5	92	27
Fenx&S+brox&MCPA	1.7+8	2	99	91	84	40	3	91	1	82	27
Fenx&S+brox	1.7+4	9	97	91	89	70	3	96	1	96	27
Fenx&S+MCPA-ester	1.7+6	4	97	83	81	0	1	96	1	95	29
Fenx&S+flur	1.7+2	4	87	83	83	0	3	99	11	98	26
Fenx&S+flur+ MCPA-ester	1.7+2+ 6	4	99	82	87	0	4	98	4	91	31
Fenx&MCPA&2,4-D+ brox	9.3+ 4	3	98	89	80	40	0	81	0	74	22
Fenx&S+flur+ thif&trib	1.7+2+ 0.14	4	99	88	84	90	0	94	0	94	33
Fenx&S+carf+ thif&trib	1.7+0.13+ 0.14	4	99	78	78	95	4	95	1	90	20
Tral+brox&MCPA+ TF8035	2.9+8+ 0.5%	3	99	89	74	50	0	92	1	85	21
Untreated	0	0	0	0	0	0	0	0	0	0	11
C.V. %		91	7	13	12	--	147	5	190	7	25
LSD 5%		6	9	14	13	--	NS	6	NS	8	11
# OF REPS		4	4	4	4	1	4	4	4	4	3

[a]Fenx&S is a tank mix of fenoxaprop-P plus safener (Puma).

Fenoxaprop treatment did not cause important injury to wheat. Wild oat control was not reduced by tank mixing fenoxaprop with most broadleaf herbicides. At the July 10 evaluation, fenoxaprop treatments (except with bromoxynil&MCPA) were more effective than fenoxaprop-P&MCPA+2,4-D+bromoxynil and tralkoxydim+bromoxynil& MCPA+TF8035 in controlling wild oat. All treatments gave adequate green foxtail control, because the density was sparse. Venice mallow which occurred in one replicate was only controlled by thifensulfuron&tribenuron. Wheat yield was increased nearly three fold by effective wild oat control.

Bayer MKH 6562 for weed control in wheat, Fargo. (Roach, Ronald F. and Janet D. Davidson-Harrington) 'Oxen' hard red spring wheat was planted April 29. Treatments were applied to 3.5 to 4 leaf wheat, 1.5 to 4 leaf wild oat, cotyledon to 2 leaf wild mustard and wild buckwheat, and cotyledon to 1 leaf Venice mallow on May 15 with 61° F, 46% RH, clear sky, and 11 mph wind. Treatments were applied with a bicycle wheel type plot sprayer delivering 8.5 gpa at 35 psi through 8001 flat fan nozzles to a 7 ft wide area the length of 10 by 30 ft plots. The experiment was a randomized complete block design with four replicates.

		Jun 2					Jul 13	
Treatment	Rate	Wht	Wimu	Wibu	Grft	Wioa	Wht	Wioa
	oz ai/A				%			
Bay MKH 6562+Activator 90	0.1+0.25%	0	99	26	70	65	0	68
Bay MKH 6562+Activator 90	0.2+0.25%	2	99	49	79	84	0	87
Bay MKH 6562+Activator 90	0.4+0.25%	3	99	59	82	81	0	78
Bay MKH 6562+ND72	0.1+1%	10	99	56	88	92	3	86
Bay MKH 6562+ND72	0.2+1%	16	99	68	90	98	6	90
Bay MKH 6562+Quad7	0.1+1%	11	99	51	90	95	0	84
Bay MKH 6562+Quad7	0.2+1%	10	99	55	89	94	4	90
Bay MKH 6562+2,4-Ddma+ Activator 90	0.2+4+ 0.25%	2	99	45	73	74	0	86
Bay MKH 6562+2,4-Dioe+ Activator 90	0.2+4+ 0.25%	6	99	70	87	88	3	90
Bay MKH 6562+dica-dga+ Activator 90	0.2+2+ 0.25%	1	99	80	70	74	0	67
Bay MKH 6562+carfentrazone+ Activator 90	0.2+0.13+ 0.25%	7	99	70	87	81	0	79
Bay MKH 6562+brox&MCPA+ Activator 90	0.2+8+ 0.25%	10	99	99	91	90	5	89
Bay MKH 6562+2,4-Ddma+ND72	0.2+4+1%	0	99	29	73	65	0	68
Bay MKH 6562+2,4-Dioe+ND72	0.2+4+1%	9	99	65	88	93	3	91
Fenx+thif&trib	0.8+0.22	0	99	99	86	76	0	65
Untreated	0	0	0	0	0	0	0	0
C.V. %		46	0	25	7	8	122	10
LSD 5%		3	0	20	8	9	2	11
# OF REPS		4	4	4	4	4	4	4

None of the treatments caused important injury to wheat. Injury that occurred was slight chlorosis from which plants recovered. Bay MKH 6562 gave complete control of wild mustard regardless of rate, adjuvant, or other herbicide. Wild buckwheat was only controlled when Bay MKH 6562 was applied with bromoxynil&MCPA or when fenoxaprop was applied with thifensulfuron&tribenuron. Quad 7 and ND72 adjuvants enhanced Bay MKH 6562. Wild oat control from 0.006 lb/A Bay MKH 6562 with Quad 7 or ND72 was equal to control from 0.012 lb/A Bay MHK 6562 with Activator 90. ND72 and 2,4-D dimethyl amine (dma) applied in combination with Bay MKH 6562, however, generally provided less control than when Activator 90 was the adjuvant. 2,4-D isooctyl ester (ioe) generally increased wild oat control regardless of adjuvant. Bay MKH 6562 control of wild oat was also antagonized by dicamba diglycolamine (dga) but not by carfentrazone or bromoxynil&MCPA. These results indicated that Bay MKH 6562 control of wild oat varies with adjuvants and presence of certain broadleaf control herbicides.

Foxtail control in wheat, Fargo. (Roach and Davidson-Harrington) 'Oxen' hard red spring wheat was planted May 24. Treatments were applied to 4.5 to 5.5 leaf wheat, 2 to 4 leaf green and yellow foxtail, and cotyledon to 4 leaf redroot pigweed on June 16 with 55° F, partly cloudy sky, and 0 to 5 mph wind. Treatments were applied with a bicycle wheel type plot sprayer delivering 8.5 gpa at 35 psi through 8001 flat fan nozzles to a 7 ft wide area the length of 10 by 30 ft plots. The experiment was a randomized complete block design with four replicates.

Treatment[a]	Rate	Jun 24		Jul 31	
		Wht	Yeft	Rrpw	Fota
	oz ai/A		%		
Bay MKH 6562+ND72	0.12+1%	5	76	88	63
Bay MKH 6562+ND72	0.25+1%	11	75	90	69
Bay MKH 6562+Fenx&S	0.12+0.4	0	76	79	84
Bay MKH 6562+Fenx&S+ND72	0.12+0.4+1%	2	83	85	82
Bay MKH 6562+Fenx&S+ND72	0.25+0.2+1%	3	79	86	81
Bay MKH 6562+Fenx&S+ND72	0.25+0.4+1%	2	72	87	84
Imazamethabenz+Scoil	2.5+0.18G	0	24	0	10
Imazamethabenz+Scoil	5+0.18G	0	3	0	15
Imazamethabenz+Fenx&S+Scoil	2.5+0.2+0.18G	0	78	0	67
Imazamethabenz+Fenx&S+Scoil	2.5+0.4+0.18G	0	89	13	87
Imazamethabenz+Fenx&S+Scoil	5+0.2+0.18G	0	71	5	72
Tralkoxydim+TF8035	2+0.5%	0	84	1	73
Tralkoxydim+Fenx&S+Scoil	5+0.2+0.18G	0	91	0	99
Fenoxaprop-P&S	0.2	0	79	0	82
Fenoxaprop-P&S+Scoil	0.2+0.18G	0	85	0	94
Fenoxaprop-P&S+TF8035	0.2+0.5%	0	84	0	91
Fenoxaprop-P&S	0.4	0	90	0	98
Fenoxaprop-P&S	0.8	0	91	0	98
Propanil+MCPA+PO	16+4+0.25G	10	73	88	78
Untreated	0	0	0	0	0
C.V. %		98	12	22	16
LSD 5%		2	12	10	17
# OF REPS		4	4	4	4

[a]Fenx&S is fenoxaprop-P plus safener sold under the trade name Puma from Agrevo.

The foxtail (Fota) was mainly a light infestation of yellow foxtail. Yellow foxtail control (July 31) from Bay MKH 6562 was not influenced by rate, but was increased when mixed with fenoxaprop-P&S. However, the increase was similar for all rates of fenoxaprop-P&S and control was no greater than for fenoxaprop-P&S alone at the same rates. The application of imazamethabenz with fenoxaprop-P&S along with Scoil reduced foxtail control compared to fenoxaprop-P alone with Scoil. The results generally indicate that the inclusion of fenoxaprop-P&S with Bayer MKH 6562 or imazamethabenz would provide satisfactory yellow foxtail control, but would not equal that from fenoxaprop-P&S alone

Foxtail control in spring wheat with clodinafop. Brian Jenks and Gary Willoughby. We evaluated clodinafop for foxtail control compared to other products. Grandin hard red spring wheat was seeded May 20. Seedbed preparation was conventional with 6-inch row spacing and wheat seeded at 1 million pls/A. Individual plots were 10 x 30 ft arranged in a RCBD with three replications. All treatments were applied June 7 with XR8001 flat fan nozzles delivering 10 gpa at 40 psi. The crop was not harvested due to hail damage.

Clodinafop alone provided excellent control of foxtails, but control was reduced 10-20% when combined with broadleaf herbicides. Tralkoxydim caused moderate wheat stunting soon after application, but appeared to recover as the season progressed. Soil moisture and relative humidity were high at the time of application. We received one-half inch of rain the day before application.

Application date	June 7
Application timing	POST
Temperature (°F)	
Air	75
Soil	70
Relative humidity (%)	53
Wheat stage	4 to 5-leaf
Foxtail	1" tall / 60 per sq ft
Rrpw	1" tall / 43 per sq ft
Wibw	1" tall / 1-2 per sq ft
Colq	1-2" tall / 1-2 per sq ft

Table. Foxtail control in spring wheat with clodinafop.

		June 18					August 18				
Treatment[a]	Rate	Injury	Fxtl[b]	Wibw	Rrpw	Colq	Injury	Fxtl[b]	Wibw	Rrpw	Colq
	lb/A	%	----------Control (%)----------				%	----------Control (%)----------			
Untreated		0	0	0	0	0	0	0	0	0	0
Clodinafop +	0.063	0	95	0	0	0	0	94	0	0	0
Score	1%										
Clodinafop +	0.063	0	90	100	98	100	0	85	88	98	98
Bromoxynil + MCPA +	0.50										
Score	1%										
Thif + trib[c] +	0.014	0	83	100	100	100	0	70	94	100	98
Clodinafop +	0.063										
MCPA ester +	0.38										
Score	1%										
Clodinafop +	0.063	0	94	97	97	100	0	87	87	92	95
Prosulfuron +	0.009										
Score	1%										
Tralkoxydim +	0.18	16	96	100	99	100	2	78	85	93	93
Supercharge+	0.5%										
AMS +	1.8%										
Bromoxynil + MCPA	0.50										
Fenoxaprop +	0.042	1	95	100	97	100	0	79	90	98	98
Bromoxynil + MCPA	0.50										
LSD		5	6	2	5	0	2	11	6	6	6
CV		69	4	1	4	0	154	8	5	4	5

[a] Thif + trib and bromoxynil + MCPA applied as commercial premixes.
[b] Fxtl=green and yellow foxtail
[c] Thif + trib = thifensulfuron + tribenuron

Discover for Foxtail Control (Terry D. Gregoire, 1999) Durum wheat was sprayed June 11th near Devils Lake, North Dakota. The temperature during application was 70°, relative humidity near 55%, with full sunshine. The leaf stages of the wheat and weeds were: wheat 3-4 leaf, wild oat 3 leaf, wild mustard, wild buckwheat 2 leaf and a mixture of yellow and green foxtail 2-4 lf. Treatments were applied with a CO_2 pressurized back pack sprayer using 8.5 gpa at 40 psi and 8001 nozzles. Treatments were arranged in RCBD and replicated 4 times. Treatment evaluation dates were June 23rd and July 23rd, 1999.

Trt No.	Trt Name	Rate Unit	Growth Stage	June 23			July 23	
				Wild Oat	Foxtail spp	Broadleaf	Wild Oat	Foxtail spp
				% control				
1	Untreated			0.0	0.0	0.0	0.0	0.0
2	Discover	4.0 oz/a	3-4 lf	97.5	95.0	0.0	100.0	98.8
2	Score	1 % v/v						
3	Discover	4.0 oz/a	3-4 lf	97.5	98.8	100.0	97.5	96.3
3	Bronate	16 oz/a	3-4 lf					
3	Score	1% v/v						
4	Discover	4.0 oz/a	3-4 lf	96.3	88.8	100.0	100.0	92.5
4	Peak	.25 oz/a	3-4 lf					
4	Score	1% v/v						
4	MCPA ester	12 fl oz/a	3-4 lf					
5	Discover	4.0 oz/a	3-4 lf	90.0	88.8	100.0	98.8	92.5
5	Starane	1 oz/a	3-4 lf					
5	MCPA ester	23 fl oz/a	3-4 lf					
5	Score	1% v/v						
6	Puma	6.4 oz/a	3-4 lf	73.8	62.5	100.0	87.5	58.8
6	Bronate	16 oz/a	3-4 lf					
7	Achieve	7.7 oz/a	3-4 lf	93.8	83.8	100.0	95.0	87.5
7	Bronate	16 oz/a	3-4 lf					
7	Supercharge	.5% v/v						
7	AMS	1.5 lb/a	3-4 lf					
LDS (P=.05)				14.15	13.05	28.08	9.51	10.17
Standard Deviation				9.52	8.08	18.90	6.40	6.84
CV				12.15	11.9	25.2	7.74	9.1

Summary

The Durum variety was tall and competitive. Puma at 6.4 oz gave significantly less wild oat and foxtail control than Discover treatments. It was also lower than Achieve for foxtail control. There was no obvious reason for the poor foxtail control with puma. No injury to Durum was observed with any treatment.

Kochia and other broadleaf weed control, Fargo. (Roach and Davidson-Harrington). 'Oxen' hard red spring wheat was seeded May 24. Treatments were applied to 4.5 to 5.5 leaf wheat, cotyledon to 6 leaf redroot pigweed and 4 leaf common cocklebur on June 15 with 55 F, partly cloudy sky, and 0 to 5 mph wind. Treatments were applied with a bicycle wheel type plot sprayer delivering 8.5 gpa at 35 psi through 8001 flat fan nozzles to a 7 ft wide area the length of 10 by 30 ft plots. The experiment was a randomized complete block design with four replicates. Machine harvest was on August 25.

		Jun 33		Aug 6		Aug 25
Treatment	Rate	Wht	Rrpw	Wht	Rrpw	Yield
	oz ai/A			%		(bu/A)
Fluroxypyr	0.25	0	0	0	25	37
Fluroxypyr	0.5	0	20	0	38	39
Fluroxypyr+Activator 90	0.5+0.25%	0	20	0	50	37
Fluroxypyr+Quad7	0.5+1%	0	41	0	73	38
Fluroxypyr	1	0	40	0	78	37
Fluroxypyr	1.5	0	43	0	76	37
Fluroxypyr	2	0	71	0	84	38
Fluroxypyr+2,4-Dioe	1.5+6	3	97	0	99	37
Carf+2,4-Ddma+Activator 90+28N	0.13+4+0.25%+4%	8	99	0	99	39
Carf+2,4-Ddma+Activator 90	0.13+4+0.25%	2	91	0	99	37
Carf+2,4-Ddma+Quad7	0.13+4+1%	13	99	3	99	37
Dica-dga+MCPA-dma	1.5+4	5	98	0	99	38
Thif&trib+2,4-Dioe+dica-dga	0.22+4+1	9	99	6	99	35
Brox&MCPA	8	1	88	0	99	37
Untreated	0	0	0	0	0	37
C.V. %		59	19	431	26	
LSD (0.05)		2	16	NS	27	NS
# OF REPS		4	4	4	4	4

Wheat injury was observed at the first evaluation from several treatments but diminished over time. None of the treatments were associated with important long-term injury to wheat and yield was not affected by any treatment. Kochia was too sparse to evaluate, but several kochia plants occurred in the plot boarders and in plots treated with fluroxypyr at 0.25 oz/A. No kochia was observed in other treatments. This indicated hat a minimum fluroxypyr rate of 0.5 oz/A was required for kochia control. Fluroxypyr only provided adequate redroot pigweed control when applied with 5 oz/A 2,4-D isooctyl ester (ioe). Other herbicide treatments provided excellent redroot pigweed control.

Kochia and other broadleaf weed control, Carrington. (Endres). 'Verde' hard red spring wheat was planted May 18. Treatments were applied to 4 leaf wheat, 2 to 3 inch wild mustard, 1.5 inch redroot pigweed, and 2 inch common lambsquarters on June 11 with 62° F, 79% RH, 4 mph wind, and mostly cloudy sky. Treatments were applied with a bicycle-wheel-type plot sprayer delivering 10.3 gpa at 35 psi through 8001 flat fan nozzles to a 7 ft wide area the length of 10 by 30 ft plots. The experiment was a randomized complete block design with four replicates. Machine harvest for yield was on August 27.

Treatment	Rate	Jun 26				Aug 23			Aug 27
		Wht	Wimu	Rrpw	Colq	Wht	Rrpw	Colq	Yield
	oz ai/A				%				(bu/A)
Fluroxypyr	0.25	0	38	0	0	0	0	0	47
Fluroxypyr	0.5	0	48	0	0	0	0	0	51
Fluroxypyr+Activator 90	0.5+0.25%	0	55	0	0	0	0	0	55
Fluroxypyr+Quad7	0.5+1%	0	35	0	0	0	0	0	51
Fluroxypyr	1	0	65	0	0	0	0	0	51
Fluroxypyr	1.5	0	92	0	10	0	0	0	51
Fluroxypyr	2	0	77	48	15	0	50	49	48
Fluroxypyr+2,4-Dioe	1.5+6	0	99	80	93	0	99	99	51
Carf+2,4-Ddma+ Activator 90+28N	0.13+4+ 0.25%+4%	14	98	96	98	0	99	99	51
Carf+2,4-Ddma+ Activator 90	0.13+4+ 0.25%	11	99	97	99	0	99	99	51
Carf+2,4-Ddma+Quad7	0.13+4+1%	10	99	95	99	0	99	99	45
Dica-dga+MCPA-dma	1.5+4	2	96	84	95	0	99	99	44
Thif&Trib+24-Dioe+ Dica-dga	0.22+4+ 1	1	99	93	99	0	99	99	47
Brox&MCPA	8	0	99	97	99	0	99	99	52
Untreated	0	0	0	0	0	0	0	0	54
C.V. %		63	8	14	19	0	23	17	8
LSD (0.05)		2	10	9	13	NS	19	12	6
# OF REPS		4	3	4	4	4	3	4	4

Carfentrazone treatments caused slight (10 to 14%) wheat injury but plants recovered. One objective was to determine the lowest rate of fluroxypyr for kochia control; however, kochia was not consistent at this location. Of the plots that contained kochia, results were variable. 2,4-D isooctyl ester (ioe) at 6 oz/A was required with fluroxypyr for adequate redroot pigweed and common lambsquarters control. Treatments containing carfentrazone, 2,4-D, dicamba, thifensulfuron& tribenuron, bromoxynil, or MCPA generally controlled all weeds evaluated. Dicamba and thifensulfuron&tribenuron were associated with yields lower that the untreated check.

Kochia and other broadleaf weed control, Hettinger. (Erick Ericksmoen). 'Butte 86' hard red spring wheat was seeded on May 12. Treatments were applied to 4 leaf wheat and to 0.5 to 3 inch kochia, 1 to 2 inch Russian thistle, 1 to 1.5 inch wild buckwheat and to 2 to 10 inch field bindweed on June 4 with 80°F, 27% RH, clear sky and 4 mph wind. Treatments were applied with a tractor mounted CO_2 propelled plot sprayer delivering 17 gpa at 40 psi through 8001 flat fan nozzles to a 5 ft wide area the length of 10 by 28 ft plots. The experiment was a randomized complete block design with four replicates. Kochia, Russian thistle, wild buckwheat and field bindweed populations were 18, 0.75, 0.5 and 3.25 plants/ft^2, respectively. Evaluations were on June 22 for crop injury and weed control and on July 6 and August 10 for weed control. A hailstorm on June 26 caused moderate to severe crop injury. The trial was not harvested due to a poor crop stand at maturity.

		Jun 22					Jul 6				Aug 10			
Treatment	Rate	Wht	Fibw	Ruth	KOCZ	Wibw	Fibw	Ruth	KOCZ	Wibw	Fibw	Ruth	KOCZ	Wibw
	oz/A							%						
Fluroxypyr	0.25	0	50	1	10	5	50	36	81	2	45	28	33	25
Fluroxypyr	0.5	0	17	4	63	8	12	12	83	37	0	25	58	37
Fluroxypyr+ Activator 90	0.5+ 0.25%	0	25	20	48	1	33	0	88	37	25	22	71	44
Fluroxypyr+Quad7	0.5+1%	5	26	34	87	36	12	45	91	50	0	34	58	75
Fluroxypyr	1	0	11	0	92	28	20	35	93	38	39	35	77	36
Fluroxypyr	1.5	1	21	50	91	36	45	48	90	38	12	6	88	90
Fluroxypyr	2	2	48	48	91	40	65	50	98	72	65	30	77	55
Fluroxypyr+2,4-Dioe	1.5+6	0	90	94	94	62	92	92	94	91	55	90	89	35
Carf+2,4-Ddma+ Activator 90+28N	0.13+4+ 0.25%+4%	0	98	99	92	80	69	98	90	78	72	98	80	44
Carf+2,4-Ddma+ Activator 90	0.13+4+ 0.25%	0	94	96	88	62	94	91	90	69	55	88	88	42
Carf+2,4-Ddma+ Quad7	0.13+4+ 1%	0	92	97	92	81	94	98	88	32	77	77	90	20
Dica-dga+MCPA-dma	1.5+4	0	94	92	92	66	94	92	89	86	88	58	71	60
Thif&Trib+24-Dioe+ Dica-dga	0.22+4+ 1	0	99	99	97	80	99	99	94	82	95	99	90	80
Brox&MCPA	8	0	99	99	83	80	92	99	90	66	66	95	92	64
Untreated	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C.V. %		500	43	30	18	47	56	46	9	56	83	61	38	75
LSD 5%		NS	31	23	19	31	39	39	11	41	46	46	39	NS
# OF REPS		4	4	4	4	4	4	4	4	4	4	4	4	4

Minor crop injury was observed on the higher rates of fluroxypyr (trts 6 & 7) and on the fluroxypyr+Quad 7 treatment. Broadleaf weed control tended to increase with increasing rates of fluroxypyr. The addition of Activator 90 to fluroxypyr did not enhance weed control. The addition of either Quad 7 or 2,4-Dioe to fluroxypyr tended to enhance weed control. The 1.5 rate of fluroxypyr provided very good season long kochia control. The 1.5 rate of fluroxypyr provided very good season long kochia control. Carfentrazone treatments (trts 9, 10 & 11) provided very good season long control of Russian thistle and kochia, and did a good job at holding back field bindweed until late in the growing season. The addition of 28%N (trt 9) to carfentrazone+Activator 90 did not significantly enhance weed control. The adjuvants Activator 980 and Quad 7 performed equally well when used with carfentrazone treatments (trts 10 & 11). the Dicamba+McPA treatment (trt 12) had excellent season long control of field bindweed and excellent kochia and Russian thistle control through the first two evaluations. The thifensulfuron&tribenuron+2,4-D+dicamba treatment (trt 13) had the highest season long control ratings for field bindweed, kochia and Russian thistle. The bromoxynil+MCPA treatment (trt 14) had excellent season long kochia and Russian thistle control and excellent field bindweed control through the first two evaluations. higher weed control ratings would have been expected with a normal crop stand.

Kochia and other broadleaf weed control, Minot. (Brian Jenks) 'Judd' oat was planted June 8. Treatments were applied on July 9 with 70°F and 58% RH, oat plants were at the 5-leaf stage and kochia was 2 to 4 inches tall in a population of 1 to 2 plants per square ft. Treatments were applied with a bicycle wheel type plot sprayer delivering 10 gpa at 40 psi through 8001 flat fan nozzles to a 7 ft wide area the length of 10 by 30 ft plots. The experiment was a randomized complete block design with four replicates.

Treatment[a]	Rate	Jul 21	Aug 31
	oz/A	%	
Fluroxypyr	0.25	83	84
Fluroxypyr	0.5	80	77
Fluroxypyr+Activator 90	0.5+0.25%	85	86
Fluroxypyr+Quad7	0.5+1%	85	79
Fluroxypyr	1	93	92
Fluroxypyr	1.5	92	93
Fluroxypyr	2	94	97
Fluroxypyr+2,4-Dioe	1.5+6	95	89
Dicamba-dga+MCPA	1.5+4	87	84
Thif&trib+2,4-Dioe+dica-dga	0.22+4+1	92	96
Brox&MCPA	8	99	99
Brox&MCPAe(Bison)	12	99	99
Dica-dma(Sterling)+MCPA ester	2+6	92	95
Brox&MCPAe(Bison)+Dica-dma(Sterling)	8+1	99	100
Untreated	0	0	0
C.V. %		12.5	27.3
LSD (0.05)		4.8	5.8
# OF REPS		4	4

[a]Bromoxynil&MCPAe is a tank mixture sold under the trade name Bison and Dicamba-dma is sold as Sterling both from Terra International Inc. located in Sioux City, Iowa.

Kochia control with fluroxypyr tended to increase with increased fluroxypyr rate. While some kochia plants survived the 0.25 oz/A treatment. The plants did not get more than 6 inches tall. Excellent crop vigor tended to increase the efficacy of all herbicide treatments and improve late season weed control. Treatments containing bromoxynil provided the highest kochia control.

Kochia and other broadleaf weed control, Williston. (Neil Riveland) The experiment was conducted to evaluate weed control and wheat response to broadleaf herbicides. 'Reeder' hard red spring wheat was planted on fallow in 7 inch rows at 80 lb/A on April 27. Treatments were applied on May 26 to 3 to 3.5 leaf wheat, 2 to 4 leaf wild mustard and 1 inch or less Russian thistle and common lambsquarters with 75°F, 40% RH, partly cloudy sky, and 5 to 10 mph wind. Treatments were applied with a small plot sprayer with wind cones, mounted on a G-Allis Chalmers tractor and delivering 8.6 gpa at 30 psi through 8001 flat fan nozzles to a 6.67 ft wide area the length of 10 by 25 ft plots. The experiment was a randomized complete block design with four replicates. Weed populations were 5 to 8, 5 to 10, and 15 to 20 plants/ft^2 for wild mustard, Russian thistle and common lambsquarters, respectively. Plots were evaluated on July 1. Wheat was machine harvested on August 25.

Treatment[a]	Rate	Jul 1				Test Aug 25	
		Wht	Wimu	Ruth	Colq	weight	Yield
	oz ai/A	%					(bu/A)
Fluroxypyr	0.25	0	0	0	0	61	35
Fluroxypyr	0.5	1	16	16	0	61	37
Fluroxypyr+Activator 90	0.5+0.25%	1	23	29	5	62	42
Fluroxypyr+Quad7	0.5+1%	1	18	26	0	61	41
Fluroxypyr	1	0	44	48	5	61	43
Fluroxypyr	1.5	1	70	61	18	61	42
Fluroxypyr	2	1	81	63	33	62	45
Fluroxypyr+2,4-Dioe	1.5+6	1	98	96	98	61	49
Carf+2,4-Ddma+Activator 90+28N	0.13+4+0.25%+4%	3	95	97	99	61	50
Carf+2,4-Ddma+Activator 90	0.13+4+0.25%	2	98	96	99	61	47
Carf+2,4-Ddma+Quad7	0.13+4+1%	3	99	95	98	61	48
Dica-dga+MCPA-dma	1.5+4	1	97	90	97	61	55
Thif&trib+24-Dioe+dica-dga	0.22+4+1	1	99	98	99	61	51
Brox&MCPA	8	2	99	99	99	61	52
Untreated	0	0	0	0	0	61	31
C.V. %		132	14	22	24	1	11
LSD (0.05)		NS	13	19	17	NS	7
# OF REPS		4	4	4	4	4	4

No herbicide treatment produced significant what injury. While increasing the rate of fluroxypyr increased control of wild mustard, Russian thistle and common lambsquarters were not adequately controlled by any rate of fluroxypyr alone. Treatments containing 2,4-D, carfentrazone, dicamba, MCPA, thifensulfuron& tribenuron, or bromoxynil provided excellent control of all weed species present. Treatments providing weed control resulted in higher yields.

Fluroxypyr for kochia control in wheat. (Ronald F. Roach and Janet D. Davidson-Harrington). 'Oxen' hard red spring wheat was seeded May 24. Treatments were applied to 5 to 6 leaf wheat, cotyledon to 6 leaf redroot pigweed, and 4 to 6 leaf common cocklebur on June 16 with 55 F, partly cloudy sky, and 0-5 mph wind. Treatments were applied with a bicycle wheel type plot sprayer delivering 8.5 gpa at 35 psi through 8001 flat fan nozzle to a 7 ft wide area the length of 10 by 30 ft plots. The experiment was a randomized complete block design with four replicates.

Treatment	Rate	Jun 22		Aug 6	
		Wht	Rrpw	Wht	Rrpw
	oz ai/A	%			
Fluroxypyr	0.25	0	25	0	33
Fluroxypyr	0.5	0	42	0	52
Fluroxypyr+Activator 90	0.5+0.25%	0	45	0	70
Fluroxypyr+Quad 7	0.5+1%	0	51	2	60
Fluroxypyr	1	0	66	0	79
Fluroxypyr	1.5	0	72	0	87
Fluroxypyr	2	0	78	0	78
Fluroxypyr+$CaCl_2$	1+0.13%	0	55	0	55
Fluroxypyr+$CaCl_2$+Quad 7	1+0.13%+1%	0	72	1	92
Fluroxypyr+$CaCl_2$+Surfate	1+0.13%+1%	0	71	0	95
Fluroxypyr+2,4-Dioe	0.5+6	3	97	0	99
Fluroxypyr+2,4-Dioe	1.5+6	5	96	1	99
Fluroxypyr+2,4-Dioe	2+8	5	98	0	99
Thif&Trib+2,4-Dioe+Dica-dga	0.22+4+1	7	99	0	99
Untreated	0	0	0	0	0
C.V. %		66	16	350	18
LSD 5%		1	15	NS	22
# OF REPS		4	4	4	3

None of the herbicide treatments caused important injury to wheat. Redroot pigweed was the only weed present, but population was dense. Calcium chloride in the spray solution reduced or tended to reduce fluroxypyr redroot pigweed control. However, the inclusion of Quad 7 or Surfate overcame calcium chloride antagonism and tended to further enhance efficacy. Redroot pigweed was completely controlled when the treatment contained 2,4-D or 2,4-D +thifensulfuron&tribenuron+dicamba diglycolamine (dga).

Fluroxypyr and 2,4-D-Salvo for Wild buckwheat control. (Ronald F. Roach and Janet D. Davidson-Harrington) 'Oxen' hard red spring wheat was seeded April 29. Treatments were applied to 5 to 6 leaf wheat, 2 to 6 leaf wild mustard, cotyledon to 4 leaf Venice mallow and common mallow, rosette Canada thistle, and 5 to 6 leaf wild oat on June 1 with 55 F, 45% RH,.cloudy sky, and 4 to 6 mph wind. Treatments were applied with a bicycle wheel type plot sprayer delivering 8.5 gpa at 35 psi through 8001 flat fan nozzles to a 7 ft wide area the length of 10 by 30 ft plots. The experiment was a randomized complete block design with four replicates. Weed density was wild mustard 10 plants/ft^2 and wild buckwheat 1 plant /yd^2.

Treatment[a]	Rate	Jun 9			Jul 30
		Wht	Wimu	Wibw	Wibw
	oz/A		%		
Fluroxypyr	1.5	0	87	68	94
Fluroxypyr	2	0	81	83	98
Flur&2,4-Dsalvo	10	3	99	78	99
Flur&2,4-Dsalvo	7.5	3	99	93	88
Flur&2,4-Dsalvo	5	1	98	68	93
Flur&2,4-DSalvo+Thif&Trib	5+0.22	5	99	94	95
Flur&2,4-DSalvo+Thifensulfuron	5+0.19	3	99	99	93
Carfentrazone+2,4-D-Salvo+Quad7	0.13+6+1%	6	99	95	88
Carf+24-D-Salvo+Thif+Quad7	0.13+6+0.19+1%	6	99	97	97
Bromoxynil&MCPA	8	0	99	93	98
Thif&Trib+2,4-D-Salvo+NIS	0.22+4+0.25%	3	99	90	73
2,4-D-Salvo	6	4	99	40	78
Untreated	0	0	0	0	0
C.V. %		74	4	10	10
LSD 5%		3	5	16	12
# OF REPS		4	4	2	4

[a]Salvo-isooctyl (2-ethylhexyl ester); fluroxypyr&2,4-D is 1.5:6 and bromoxynil&MCPA is 1:1; thifensulfuron&tribenuron is 2:1.

None of the treatments caused important injury to wheat. Wild mustard was controlled with all treatments that contained 2,4-D. All fluroxypyr treatments gave 88% or more late season wild buckwheat control. At the early rating the pre sence of 2,4-D enhanced wild buckwheat control from fluroxypyr.

Control of common mallow. Brian Jenks and Gary Willoughby. We evaluated several herbicides for control of common mallow. The plot area had was not seeded to a crop in 1999. The cooperator had sprayed glyphosate on the mallow, but the mallow remained relatively healthy. Each herbicide was applied August 15 in one strip (10 x 30 ft). All herbicides were applied with XR8001 flat fan nozzles delivering 10 gpa at 40 psi.

The mallow was almost mature at application time. Glufosinate was clearly more effective than the other treatments. The addition of thifensulfuron and tribenuron to fluroxypyr + 2,4-D enhanced mallow control.

Table. Control of common mallow.

Treatment[1]	Rate	August 25 Coma
	lb/A	Control (%)
Fluroxypyr	0.063	50
Fluroxypyr	0.125	60
Fluroxypyr + 2,4-D ester	0.125 + 0.5	68
Fluroxypyr + 2,4-D ester + Thif&Trib	0.063 + 0.5 + 0.014	80
Glufosinate + AMS	0.44 + 3	95
Imazamox + NIS + 28% N	0.031+ 0.25% + 1 qt	30
Bromoxynil + MCPA	0.50	60

[1] Thif + trib and bromoxynil + MCPA applied as commercial premixes.

Banvel weed control and tolerance in wheat. Zollinger and Fitterer. An experiment was conducted at NW-22 near Fargo to evaluate weed control from POST herbicides. 'Gus' wheat was planted on June 3, 1999. POST treatments were applied on June 19, 1999 at 2:00 pm with 63 F air, 65 F soil surface, 86% relative humidity, 100% clouds, 2 to 5 SE mph wind, dry soil surface, moist subsoil, good crop vigor, dew present, to 3 to 4 lf wheat. Weed species present were: 1 to 2 inch, (1 to 5/ft^2) foxtail; 2 inch, (5 to 10/ft^2) wild mustard; 1 to 3 inch, (1 to 3/ft^2) common lambsquarters; 1 to 4 inch, (2 to 20/ft^2) redroot pigweed; 1 to 2 inch, (2 to 5/ft^2) wild buckwheat; 1 to 3 inch, (7 to 10/ft^2) Venice mallow; and 1 to 3 inch, (2 to 8/ft^2) kochia. Treatments were applied to the center 6.67 feet of the 10 by 40 ft plots with a bicycle-wheel-type plot sprayer using a wind shield delivering 8.5 gpa at 40 psi through 8001 flat fan nozzles. The experiment had a randomized complete block design with three replicates per treatment.

		Wheat			July 1			July 16		
Treatment	Rate	June 24	July 1	July 16	Rrpw	Wimu	Wibw	Rrpw	Colq	Vema
	Product/A	% injury			% control					
Gharda dicamba	0.25pt	12	5	0	78	99	33	83	96	96
Gharda dicamba	0.5pt	13	5	0	80	99	47	83	96	96
Clarity	0.25pt	13	5	0	83	99	25	77	98	96
Clarity	0.5pt	15	5	0	92	99	55	77	98	96
Gharda dicamba+ MCPA-ester	0.25+ 0.5pt	20	10	0	87	99	60	88	99	99
Untreated		0	0	0	0	0	0	0	0	0
LSD (0.05)		7	6	0	15	0	23	18	4	5

Gharda dicamba caused no more wheat injury than Clarity. Injury increased when MCPA-ester was added to Gharda dicamba. No injury was found on or after July 16. Respective rates of Gharda dicamba and Clarity gave similar weed control. On July 16, all treatments gave complete control of wild mustard and kochia.

Valor as a burndown in wheat. Zollinger and Fitterer. An experiment was conducted at NW-22 near Fargo to evaluate weed control from herbicides applied at early preplant and at-planting stages. Early preplant treatments were applied on May 20, 1999 at 11:00 am with 71 F air, 65 F soil at a 2 to 4 inch depth, 61% relative humidity, 80% clouds, 14 to 23 N mph wind, dry soil surface, and moist subsoil. Weed species present were cotyledon to 6 lf (5 plants/ft^2) common lambsquarters; cotyledon (2 plants/ft^2) Venice mallow; 1 to 2 lf (2 plants/ft^2) wild buckwheat; blooming (1 to 2 plants/ft^2) field pennycress; blooming (2 to 3 plants/ft^2) dandelion; and 6 lf (5 plants/ft^2) Canada thistle. 'Gus' wheat was planted and treatments were applied June 3, 1999 at 4:30 pm with 72 F air, 67 F soil at a 2 to 4 inch depth, 51% relative humidity, 100% clouds, 18 to 30 S mph wind, dry soil surface, and moist subsoil. Treatments were applied to the center 6.67 feet of the 10 by 40 ft plots with a bicycle-wheel-type plot sprayer using a wind shield delivering 8.5 gpa at 40 psi through 8001 flat fan nozzles. The experiment had a randomized complete block design with three replicates per treatment.

Treatment[a]	Rate	June 24, 1999				July 1, 1999			
		Fxtl[b]	Rrpw	Vema	Wibw	Fxtl[b]	Rrpw	Vema	Colq
	(Product/A)	(% control)				(% control)			
14 days prior to planting									
Roundup Ultra+AMS	1 qt+3 lb	30	50	73	40	93	33	73	93
Valor+Roundup Ultra+AMS	2 oz+1 qt+3 lb	67	72	66	50	93	60	60	99
Valor+Roundup Ultra+AMS	4 oz+1 qt+3 lb	73	83	93	88	93	70	80	99
At-planting									
Roundup Ultra+AMS	1 qt+3 lb	50	30	40	15	77	37	50	79
Valor+Roundup Ultra+AMS	2 oz+1 qt+3 lb	67	73	80	50	99	67	60	99
Valor+Roundup Ultra+AMS	4 oz+1 qt+3 lb	75	88	95	70	93	73	63	99
Untreated		0	0	0	0	0	0	0	0
LSD (0.05)		11	11	17	16	18	13	10	9

[a]AMS = ammonium sulfate.
[b]Fxtl = Grft and Yeft.

No wheat injury was observed throughout the season. Poor weed control ratings from the early-preplant application resulted from additional weed flushes from no-till conditions. No rainfall occurred between early-preplant and at-planting applications. At July 1, both early preplant and at-planting treatments of Valor and Roundup Ultra gave over 90% foxtail and common lambsquarters control.

Preharvest burndown effects on Durum. Zollinger and Fitterer. An experiment will be conducted at NW-22 near Fargo to evaluate preharvest burndown effects on durum quality. 'Ben' durum was planted on May 25, 1999. Soft dough (50% moisture) treatments were applied August 17 at 1:00 to 2:30 pm with 80 F air, 84 F soil at a 2 to 4 inch depth, 54% relative humidity, 20% clouds, 3 to 5 mph N wind, dry soil surface, and moist subsoil and no dew present. Hard dough (30% moisture or 7-9 days before harvest) treatments were applied August 22 at 11:00 to 12:30 pm with 78 F air, 77 F soil at a 2 to 4 inch depth, 73% relative humidity, 70% clouds, 5 to 10 mph N wind, dry soil surface, and moist subsoil and no dew present. Three to 5 days before harvest treatments were applied August 28 at 10:00 to 10:30 pm with 74 F air, 73 F soil at a 2 to 4 inch depth, 53% relative humidity, 20% clouds, 3 to 7 mph N wind, dry soil surface, and moist subsoil and no dew present. The treatments were applied to the center 6.67 feet of the 10 by 40 ft plots with a CO2 backpack sprayer delivering 8.5 gpa at 40 psi through 8001 flat fan nozzles. The experiment has a randomized complete block design with three replications per treatment.

Treatment	Rate	Yield
	Product/A	bu/A
Hard dough (50% moisture)		
Roundup Ultra	2pt	26
Touchdown+NIS	1.6pt+0.25%	23
Landmaster BW	5.25pt	26
Roundup Ultra+Banvel	2pt+0.5pt	28
Ally+2,4-D Ester	0.1oz+2.25pt	28
Starfire+NIS	2pt+0.25%	25
7-9 days before harvest		
Starfire+NIS	1.33pt+0.25%	25
Starfire+NIS	2pt+0.25%	25
Starfire+NIS	2.66pt+0.25%	26
Soft dough (30% moisture)		
Ally+2,4-D Ester	0.1oz+2.25pt	29
Roundup Ultra	2pt	25
Touchdown+NIS	1.6pt+0.25%	26
Landmaster BW	5.25pt	26
Roundup Ultra+Banvel	2pt+0.5pt	29
3-5 days before harvest		
Starfire+NIS	1.33pt+0.25%	25
Starfire+NIS	2pt+0.25%	25
Starfire+NIS	2.66pt+0.25%	24
Untreated		27
LSD (0.05)		NS

No significant differences in yield. Quality data not available at time of printing.

Durum variety tolerance to preharvest burndown. Zollinger and Fitterer. An experiment was conducted at NW-22 near Fargo to evaluate preharvest burndown effects on durum quality. Four durum varieties ('Ben', 'Lebsock', 'Renville', and 'Maier') were planted on June 3, 1999. Soft dough (50% moisture) treatments were applied August 17 at 1:00 to 2:30 pm with 80 F air, 84 F soil at a 2 to 4 inch depth, 54% relative humidity, 20% clouds, 3 to 5 mph N wind, dry soil surface, and moist subsoil and no dew present. Hard dough (30% moisture) treatments were applied August 22 at 11:00 to 12:30 pm with 78 F air, 77 F soil at a 2 to 4 inch depth, 73% relative humidity, 70% clouds, 5 to 10 mph N wind, dry soil surface, and moist subsoil and no dew present. The treatments were applied to the center 6.67 feet of the 10 by 40 ft plots with a CO2 backpack sprayer delivering 8.5 gpa at 40 psi through 8001 flat fan nozzles. The experiment had a randomized complete block design with four replications per treatment.

Treatment	Rate	Durum yield			
		Ben	Lebsock	Renville	Maier
	Product/A	bu/A			
50% moisture					
Roundup Ultra	2pt	25	28	27	32
Starfire+NIS	2pt+0.25%	25	28	26	29
Ally+2,4-D Ester	0.1oz+2.25pt	26	28	29	34
30% moisture					
Roundup Ultra	2pt	26	29	26	31
Starfire+NIS	2pt+0.25%	23	28	24	31
Ally+2,4-D Ester	0.1oz+2.25pt	29	32	27	28
Untreated		27	32	27	30
LSD (0.05)		3	6	5	4

No significant differences in yield. Quality data not available at time of printing.

2,4-D amine: spray volume and adjuvants, Fargo, 1999. (Ramsdale and Nalewaja) 'Omega' flax, and birdseed sunflower were seeded as strips side-by-side on June 2. Plots 11.5 ft wide were laid out perpendicular to the strips so that each plot contained all three assay species. Treatments were applied at 9:00 am on June 29 with an all-terrain vehicle equipped with a four-nozzle boom (20-in spacing) offset to one side. Conditions at treatment were 65 F, 60% RH, wind S at 6-8 mph, and sky cloudy. Flax was 6- to 8-inch and sunflower 6- to 8-leaf (8- to 10-inch). Experimental design was a randomized complete block with four replicates.

Treatment	Rate	Volume	Speed	Tip[a]	Flax	Sunflower
	oz ai/A	gpa	mph		—— % ——	
2,4-Ddma	3	2.5	10	8001	25	74
2,4-Ddma + Act90	3 + 0.25%	2.5	10	8001	29	76
2,4-Ddma + Quad7	3 + 1%	2.5	10	8001	10	65
2,4-Ddma	3	10	2.5	8001	6	66
2,4-Ddma + Act90	3 + 0.25%	10	2.5	8001	21	71
2,4-Ddma + Quad7	3 + 1%	10	2.5	8001	33	81
2,4-Ddma	3	10	10	8004	11	60
2,4-Ddma + Act90	3 + 0.25%	10	10	8004	36	79
2,4-Ddma + Quad7	3 + 1%	10	10	8004	24	70
CV					51	12
LSD (0.05)					16	13

[a] XR tips applied at 28 psi.

Flax is considered hard to wet by sprays so injury was expected to be least with large droplets without surfactants. Results were variable but injury to flax was generally greater with small droplets in 2.5 gpa without adjuvants as expected. The reduced injury at 10 gpa with small droplets was not expected as 10 gpa should not have exceeded the leaf holding capacity. Adjuvants did not greatly enhance 2,4-D phytotoxicity to sunflower. Growing condition at treatment was moist so 2,4-D amine absorption could occur without adjuvants.

Bayer MKH6562: spray volume and adjuvants, Fargo, 1999. (Ramsdale and Nalewaja) 'Valley' oat, 'Red Siberian' foxtail millet, and 'White' proso millet were planted as strips side-by-side on May 27. Plots 11.5 ft wide were laid out perpendicular to the strips so that each plot contained all three assay species. Treatments were applied on July 2 with an all-terrain vehicle equipped with a four-nozzle boom (20-in spacing) offset to one side. Conditions at treatment were 75 F, 50% RH, wind S at 5 mph, and sky partly cloudy. Oat was 10- to 12-inch, proso millet 8- to 10-inch, and foxtail millet 12- to 14-inch and species were tillering. Experimental design was a randomized complete block with four replicates.

Treatment	Rate	Volume	Speed	Oat	Fomi
	oz ai/A	gpa	mph	%	
Bayer MKH6562 + Act90	0.1 + 0.25%	2.5	10	87	25
Bayer MKH6562 + Act90	0.1 + 1%	2.5	10	93	51
Bayer MKH6562 + Quad7	0.1 + 1%	2.5	10	81	33
Bayer MKH6562 + ND72	0.1 + 1%	2.5	10	90	41
Bayer MKH6562 + 1412-60	0.1 + 1%	2.5	10	92	45
Bayer MKH6562 + Quad7	0.1 + 4%	2.5	10	91	40
Bayer MKH6562 + 1412-60	0.1 + 4%	2.5	10	93	49
Bayer MKH6562 + Act90	0.1 + 0.25%	10	2.5	93	43
Bayer MKH6562 + ND72	0.1 + 1%	10	2.5	90	46
Bayer MKH6562 + Quad7	0.1 + 1%	10	2.5	94	46
Bayer MKH6562 + 1412-60	0.1 + 1%	10	2.5	93	44
CV				6	23
LSD (0.05)				NS	14

All treatments at 28 psi and with an XR8001 tip

Bayer MKH6562 was applied at only 0.1 oz/A, which is one fourth the proposed use rate, yet oat control was too high to allow statistical differentiation among treatments. However, when considering both oat and foxtail millet control, Bay MKH6562 applied in 2.5 gpa was equally as effective as in 10 gpa provided the amount of adjuvant was equal on an area basis. For example, Bayer MKH6562 applied in 2.5 gpa with X-77 at 0.25% generally was less effective than with 1% and similarly with Quad 7 at 1 and 4% respectively. The efficacy with the higher percentage adjuvant in 2.5 gpa equaled that in 10 gpa. These data indicate that Bayer MKH6562 is as equally efficacious in 2.5 or 10 gpa provided the same amount of adjuvant is used on an area basis.

Bentazon: spray volume and adjuvants, Fargo, 1999. (Ramsdale and Nalewaja) 'Omega' flax, and birdseed sunflower were seeded as strips side-by-side on June 2. Plots 11.5 ft wide were laid out perpendicular to the strips so that each plot contained all three assay species. Treatments were applied at 8:30 am on June 29 with an all-terrain vehicle equipped with a four-nozzle boom (20-in spacing) offset to one side. Conditions at treatment were 65 F, 60% RH, wind S at 6-8 mph, and sky cloudy. Flax was 6- to 8-inch and sunflower 6- to 8-leaf (8- to 10-inch). Experimental design was a randomized complete block with four replicates.

Treatment	Rate	Volume	Speed	Tip[a]	Sunflower
	oz ai/A	gpa	mph		% control
Bentazon + Scoil	8 + 1.5 pt	2.5	10	8001	92
Bentazon + Act90	8 + 0.25%	2.5	10	8001	94
Bentazon + SilwetL77	8 + 0.25%	2.5	10	8001	92
Bentazon + Quad7	8 + 1%	2.5	10	8001	94
Bentazon + Quad7	8 + 2%	2.5	10	8001	83
Bentazon + Scoil	8 + 1.5 pt	10	10	8004	90
Bentazon + Act90	8 + 0.25%	10	10	8004	83
Bentazon + SilwetL77	8 + 0.25%	10	10	8004	89
Bentazon + Quad7	8 + 1%	10	10	8004	84
Bentazon + Quad7	8 + 2%	10	10	8004	88
CV					7
LSD (0.05)					NS

[a] XR tips applied at 28 psi.

Bentazon was equally as effective applied in 2.5 or 10 gpa and similar with all adjuvants. The 2.5 gpa application tended to be more effective than 10 gpa application of bentazon. This is interesting since in 1998 10 gpa was more effective than 2.5 for control of sunflower.

Carfentrazone + 2,4-D amine: spray volume and adjuvants, Fargo, 1999. (Ramsdale and Nalewaja) 'Oxen' hard red spring wheat was planted on May 24. Treatments were applied at 8:00 pm on June 23 with an all-terrain vehicle equipped with a four-nozzle boom (20-in spacing) offset to one side. Conditions at treatment were 75 F, 50% RH, wind W at 5 mph, and sky clear. Wheat was tillering (8- to 10-inch) and redroot pigweed 6- to 8-inch. The canopy was dense. Experimental design was a randomized complete block with four replicates.

Treatment	Rate	Volume[a]	July 7	
			Wheat	Rrpw
	oz ai/A	gpa	% injury	% control
Carf + 2,4-Ddma + Act90	0.13 + 4 + 0.25%	2.5	1	90
Carf + 2,4-Ddma + Act90	0.13 + 4 + 1%	2.5	2	93
Carf + 2,4-Ddma + Quad7	0.13 + 4 + 0.25%	2.5	0	92
Carf + 2,4-Ddma + Quad7	0.13 + 4 + 1%	2.5	1	86
Carf + 2,4-Ddma + Act90	0.13 + 4 + 0.25%	5	1	90
Carf + 2,4-Ddma + Quad7	0.13 + 4 + 0.25%	5	0	89
Carf + 2,4-Ddma + Act90	0.13 + 4 + 0.25%	10	0	94
Carf + 2,4-Ddma + Quad7	0.13 + 4 + 0.25%	10	0	88
CV			249	5
LSD (0.05)			NS	NS

[a] Treatments applied with XR8001 tip at 28 psi and volume changed by altering application speed.

Wheat was not injured by carfentrazone plus 2,4-D amine (dma), regardless of adjuvant or spray volume. Carfentrazone plus 2,4-D was equally effective at all spray volumes and both adjuvants.

Clethodim: spray volume and adjuvants, Fargo, 1999. (Ramsdale and Nalewaja) 'Valley' oat, 'Red Siberian' foxtail millet, and 'White' proso millet were planted as strips side-by-side on May 27. Plots 11.5 ft wide were laid out perpendicular to the strips so that each plot contained all three assay species. Treatments were applied on July 1 with an all-terrain vehicle equipped with a four-nozzle boom (20-in spacing) offset to one side. Conditions at treatment were 68 F, 40% RH, wind N at 5 mph, and sky mostly cloudy. Oat was 10- to 12-inch, proso millet 8- to 10-inch, and foxtail millet 12- to 14-inch and species were tillering. Experimental design was a randomized complete block with four replicates.

Treatment	Rate	Volume	Speed	July 13			July 27	
				Oat	Prmi	Fomi	Oat	Yeft
	oz ai/A	gpa	mph	%				
Clet + Scoil	0.3 + 1.5 pt	2.5	10	90	87	84	99	85
Clet + Herbimax	0.3 + 1.5 pt	2.5	10	85	84	81	94	83
Clet + Scoil	0.3 + 1.5 pt	5	5	87	85	86	98	92
Clet + Herbimax	0.3 + 1.5 pt	5	5	80	78	75	86	74
Clet + Scoil	0.3 + 1.5 pt	10	2.5	87	85	84	91	87
Clet + Herbimax	0.3 + 1.5 pt	10	2.5	82	80	78	77	70
CV				4	5	6	3	4
LSD (0.05)				4	NS	NS	4	5

All treatments at 28 psi and with an XR8001 tip.

Clethodim was generally more phytotoxic to all species when applied with the methylated vegetable oil, Scoil, than the petroleum oil, Herbimax. Efficacy generally increased as spray volume decreased especially when the spray contained petroleum oil adjuvant. However, the high level of control with the methylated vegetable oil adjuvant may have prevented expression of any response to spray volume. The increased efficacy with low volume is in response to higher herbicide and adjuvant concentration as all treatments were with an XR8001 nozzle and adjuvants were included on an area basis.

Clodinafop: spray volume and adjuvants, Fargo, 1999. (Ramsdale and Nalewaja) 'Valley' oat, 'Red Siberian' foxtail millet, and 'White' proso millet were planted as strips side-by-side on May 27. Plots 11.5 ft wide were laid out perpendicular to the strips so that each plot contained all three assay species. Treatments were applied on July 1 with an all-terrain vehicle equipped with a four-nozzle boom (20-in spacing) offset to one side. Conditions at treatment were 68 F, 40% RH, wind N at 5 mph, and sky mostly cloudy. Oat was 10- to 12-inch, proso millet 8- to 10-inch, and foxtail millet 12- to 14-inch and species were tillering. Experimental design was a randomized complete block with four replicates.

Treatment	Rate	Volume	Speed	Oat	Prmi	Fomi
	oz ai/A	gpa	mph		%	
Clodinafop + Score	0.6 + 0.6%	2.5	10	90	81	70
Clodinafop + Score	0.6 + 2.4%	2.5	10	92	87	77
Clodinafop + Score	0.6 + 1.5 pt	2.5	10	92	88	80
Clodinafop + Score	0.6 + 0.6%	5	5	93	90	77
Clodinafop + Score	0.6 + 1.5 pt	5	5	94	89	79
Clodinafop + Score	0.6 + 0.6%	10	2.5	92	83	76
Clodinafop + Score	0.6 + 1.5 pt	10	2.5	93	85	77
CV				3	4	7
LSD (0.05)				NS	5	NS

All treatments at 28 psi and with an XR8001 tip

Clodinafop phytotoxicity was not greatly influenced by spray volume or adjuvant (Score) concentration. However, control of all species tended to be lower with 0.6% Score in 2.5 gpa than any other that contained a greater amount of Score. For example, Score at 0.6% was effective in 5 or 10 gpa which contain twice and four times the amount of Score per area than in 2.5 gpa. Clodinafop applied in 2.5 gpa was as effective as in 5 or 10 gpa provided Score was at 2.4% or at 1.5 pt/A (7.5%). These results indicate that keeping the herbicide to adjuvant ratio constant does not take spray volume into account.

Dicamba plus diflufenzopyr: Nozzles, spray volume and adjuvants, Fargo, 1999.
(Ramsdale and Messersmith) 'Omega' flax, and birdseed sunflower were seeded as strips side-by-side on June 2. Plots 11.5 ft wide were laid out perpendicular to the strips so that each plot contained both assay species. A natural infestation of redroot pigweed was also present. Treatments were applied at 8:30 pm on June 26 with an all-terrain vehicle equipped with a four-nozzle boom (20-in spacing) offset to one side. Conditions at treatment were 70 F, 65% RH, wind calm, and sky clear. Flax was 5- to 7-inch and sunflower 6- to 8-leaf (6- to 8-inch). Experimental design was a randomized complete block with four replicates. Dicamba + diflufenzopyr was applied at 3 + 0.6 oz ai/A.

Variable	July 12			July 24	
	Flax	Sunfl	Rrpw	Flax	Sunfl
	% control				
Nozzle (over spray volume and adjuvant)					
Conventional (40 psi)	54	57	57	42	82
Turbo TeeJet (20 psi)	56	56	59	37	88
AI TeeJet (60 psi)	66	67	72	53	83
LSD (5%)	4	4	7	7	3
Volume (over spray nozzle and adjuvant)					
5 gpa	55	59	63	37	84
15 gpa	63	61	62	51	85
LSD (5%)	3	NS	NS	5	NS
Adjuvant (over spray nozzle and volume)					
0.25% v/v NIS + 2.5% v/v UAN	59	62	66	45	86
1% v/v Quad7	58	57	58	44	83
LSD (5%)	NS	3	6	NS	2

All nozzles were 11002's by Spraying Systems Co. and spray volume was changed by altering ground speed.

Dicamba + diflufenzopyr applied with the AI TeeJet nozzle provided greater control of flax, sunflower, and redroot pigweed at the July 12 evaluation and flax at the July 24 evaluation. Sunflower control was greatest when dicamba + diflufenzopyr was applied with the Turbo TeeJet nozzle at the July 24 evaluation. Flax control was greater when dicamba + diflufenzopyr was applied at 15 gpa, while sunflower and redroot pigweed control was not affected by application volume. The higher spray volume would provide better spray coverage and canopy penetration, which may explain the improved flax control with increased spray volume. Species control by dicamba + diflufenzopyr was generally greater when applied with 0.25% nonionic surfactant plus 2.5% urea ammonium nitrate.

Difenzoquat: spray volume and adjuvants, Fargo, 1999. (Ramsdale and Nalewaja) 'Valley' oat, 'Red Siberian' foxtail millet, and 'White' proso millet were planted as strips side-by-side on May 27. Plots 11.5 ft wide were laid out perpendicular to the strips so that each plot contained all three assay species. Treatments were applied on July 2 with an all-terrain vehicle equipped with a four-nozzle boom (20-in spacing) offset to one side. Conditions at treatment were 75 F, 50% RH, wind S at 5 mph, and sky partly cloudy. Oat was 10- to 12-inch, proso millet 8- to 10-inch, and foxtail millet 12- to 14-inch and species were tillering. Experimental design was a randomized complete block with four replicates.

Treatment	Rate	Volume	Speed	Oat control	
				July 20	July 27
	oz ai/A	gpa	mph	%	
Dife	10	2.5	10	82	84
Dife + Terg 15-S-9	10 + 0.25%	2.5	10	87	91
Dife + Terg 15-S-9	10 + 1%	2.5	10	80	87
Dife	10	5	5	89	95
Dife + Terg 15-S-9	10 + 0.25%	5	5	90	97
Dife + Terg 15-S-9	10 + 0.5%	5	5	88	97
Dife	10	10	2.5	91	96
Dife + Terg 15-S-9	10 + 0.25%	10	2.5	92	98
CV				5	3
LSD (0.05)				6	5

All treatments at 28 psi and with an XR8001 tip.

Difenzoquat only controls oat so no data was collected on proso millet or foxtail millet. The inclusion of Tergitol 15-S-9 in the spray tended to enhance difenzoquat phytotoxicity to oat, especially at 2.5 gpa. Difenzoquat efficacy generally increased as spray volume increased from 2.5 to 10 gpa, regardless if alone or with the surfactant. Increasing the surfactant concentration from 0.25 to 1% in the 2.5 gpa spray volume did not increase efficacy. Differences among treatments were small because control was nearly complete. These results strongly indicate that difenzoquat requires high spray volumes to optimize efficacy. However, the high spray volume was obtained using only an 8001 nozzle so high volume were with slow travel giving more droplets per unit area.

Fenoxaprop-P&S: spray volume and adjuvants in wheat, Fargo, 1999. (Ramsdale and Nalewaja) 'Oxen' hard red spring wheat was planted on April 29. Treatments were applied at 12:30 pm on May 26 with an all-terrain vehicle equipped with a four-nozzle boom (20-in spacing) offset to one side. Conditions at treatment were 75 F, 30% RH, wind SW at 8-12 mph, and sky cloudy. Wheat was 3- to 4-leaf (3- to 5-inch) and wild oat 1- to 4-leaf (2- to 5-inch). Experimental design was a randomized complete block with three replicates.

Treatment[a]	Rate	Volume[b]	June 9		July 7
			Grft	Wioa	Wioa
	oz ai/A	gpa	% control		
Fenoxaprop-P&S	0.8	2.5	66	66	56
Fenx&S+Herbimax	0.8 + 1.5 pt	2.5	60	60	58
Fenoxaprop-P&S	0.8	5	67	66	66
Fenx&S+Herbimax	0.8 + 1.5 pt	5	66	68	67
Fenoxaprop-P&S	0.8	10	65	63	67
Fenx&S+Herbimax	0.8 + 1.5 pt	10	69	70	69
CV			9	7	10
LSD (0.05)			NS	NS	10

[a]Fenoxaprop-P&S (Fenx&S) is a mix of fenoxaprop-P plus safener (Puma).
[b] Treatments applied with XR8001 tip at 28 psi and volume changed by altering application speed.

Adjuvant or spray volume did not influence fenoxaprop efficacy at the early evaluation. At the July 7 evaluation adjuvants again did not influence fenoxaprop efficacy. However, wild oat control was generally less from fenoxaprop applied in 2.5 gpa than 5 or 10 gpa.

Fomesafen: Nozzles, spray volume and adjuvants, Fargo, 1999. (Ramsdale and Messersmith) 'Omega' flax, and birdseed sunflower were seeded as strips side-by-side on June 2. Plots 11.5 ft wide were laid out perpendicular to the strips so that each plot contained both assay species. Treatments were applied at 7:30 pm on June 26 with an all-terrain vehicle equipped with a four-nozzle boom (20-in spacing) offset to one side. Conditions at treatment were 75 F, 65% RH, wind NW at 6-8 mph, and sky clear. Flax was 5- to 7-inch and sunflower 6- to 8-leaf (6- to 8-inch). Experimental design was a randomized complete block with four replicates. Fomesafen (Reflex formulation) was applied at 1.5 oz ai/A.

Variable	July 6		July 20	
	Flax	Sunfl	Flax	Sunfl
	% control			
Nozzle (over spray volume and adjuvant)				
Conventional (40 psi)	93	75	85	67
Turbo TeeJet (20 psi)	90	68	76	52
AI TeeJet (60 psi)	90	64	78	44
LSD (5%)	2	3	5	7
Volume (over spray nozzle and adjuvant)				
5 gpa	89	66	74	46
15 gpa	93	72	85	62
LSD (5%)	1	2	4	6
Adjuvant (over spray nozzle and volume)				
0.25% v/v NIS + 2.5% v/v UAN	89	73	78	64
1% v/v Quad7	92	69	78	53
1% v/v Scoil	93	65	83	45
LSD (5%)	2	3	NS	7

All nozzles were 11002's by Spraying Systems Co. and spray volume was changed by altering ground speed.

Flax and sunflower control was greatest when fomesafen was applied with a conventional nozzle at 15 gpa. The improved spray coverage by application with smaller spray droplets and higher spray volume was likely important for efficacy of this contact herbicide. Flax control by fomesafen was generally not affected by adjuvant type. However, control of sunflower was best when fomesafen was applied with 0.25% nonionic surfactant plus 2.5% urea ammonium nitrate.

Glyphosate IPA: spray volume and adjuvants, Fargo, 1999. (Ramsdale and Nalewaja) 'Valley' oat, 'Red Siberian' foxtail millet, and 'White' proso millet were planted as strips side-by-side on May 27. Plots 11.5 ft wide were laid out perpendicular to the strips so that each plot contained all three assay species. Treatments were applied on July 1 with an all-terrain vehicle equipped with a four-nozzle boom (20-in spacing) offset to one side. Conditions at treatment were 68 F, 40% RH, wind N at 5 mph, and sky mostly cloudy. Oat was 10- to 12-inch, proso millet 8- to 10-inch, and foxtail millet 12- to 14-inch and species were tillering. Experimental design was a randomized complete block with four replicates.

Treatment	Rate	Volume	Tip[a]	Speed	July 13			July 20	
					Oat	Prmi	Fomi	Oat	Fomi
	oz ai/A	gpa		mph			%		
Glyphosate IPA	0.5	2.5	XR8001	10	90	85	74	90	89
Glyt + 1214-80	0.5 + 0.5%	2.5	XR8001	10	92	90	86	92	95
Glyphosate IPA	0.5	2.5	LP8001	12	89	89	78	89	90
Glyt + 1214-80	0.5 + 0.5%	2.5	LP8001	12	90	86	84	88	91
Glyphosate IPA	0.5	5	XR8001	5	85	75	68	86	84
Glyt + 1214-80	0.5 + 0.5%	5	XR8001	5	95	91	82	96	95
Glyphosate IPA	0.5	5	XR8002	10	82	75	62	82	82
Glyt + 1214-80	0.5 + 0.5%	5	XR8002	10	91	86	78	94	93
Glyphosate IPA	0.5	10	XR8004	10	54	50	43	49	55
Glyt + 1214-80	0.5 + 0.5%	10	XR8004	10	91	86	78	91	91
CV					4	6	5	4	4
LSD (0.05)					5	6	7	5	5

[a] XR tips applied at 28 psi and LP tips applied at 15 psi.

Glyphosate IPA efficacy was enhanced by nonionic surfactant 1214-80 and the increase was greatest when applied in 10 gpa. Glyphosate IPA was most efficacious when applied in 2.5 gpa and was similar from XR 8001 or LP 8001. The LP 8001 nozzles produce larger droplets that would reduce drift and still optimize efficacy. However at 5 gpa, Glyphosate IPA tended to be slightly more effective when applied with XR 8001 than XR 8002. The smaller droplets would have better spray retention, but also more droplets per acre. These results further indicate increased Glyphosate IPA efficacy with low volume and the addition of surfactant.

Imazamethabenz: spray volume and adjuvants, Fargo, 1999. (Ramsdale and Nalewaja) 'Valley' oat, 'Red Siberian' foxtail millet, and 'White' proso millet were planted as strips side-by-side on August 5. Plots 11.5 ft wide were laid out perpendicular to the strips so that each plot contained all three assay species. Treatments were applied on September 10 with an all-terrain vehicle equipped with a four-nozzle boom (20-in spacing) offset to one side. Conditions at treatment were 70 F, 60% RH, wind S at 10 mph, and sky partly cloudy. Oat was 8- to 10-inch, proso millet 6- to 8-inch, and foxtail millet 8- to 10-inch and species were tillering. Experimental design was a randomized complete block with four replicates.

Treatment	Rate	Volume	Speed	Oat
	oz ai/A	gpa	mph	%
Imazamethabenz + X77	1 + 0.25%	2.5	10	15
Imazamethabenz + X77	2.5 + 0.25%	2.5	10	31
Imazamethabenz + X77	5 + 0.25%	2.5	10	49
Imazamethabenz + Sunit-II	1 + 1.5 pt	2.5	10	43
Imazamethabenz + Sunit-II	2.5 + 1.5 pt	2.5	10	47
Imazamethabenz + Sunit-II	5 + 1.5 pt	2.5	10	60
Imazamethabenz + X77	1 + 0.25%	5	5	19
Imazamethabenz + X77	2.5 + 0.25%	5	5	34
Imazamethabenz + X77	5 + 0.25%	5	5	56
Imazamethabenz + Sunit-II	1 + 1.5 pt	5	5	31
Imazamethabenz + Sunit-II	2.5 + 1.5 pt	5	5	49
Imazamethabenz + Sunit-II	5 + 1.5 pt	5	5	51
Imazamethabenz + X77	1 + 0.25%	10	2.5	13
Imazamethabenz + X77	2.5 + 0.25%	10	2.5	26
Imazamethabenz + X77	5 + 0.25%	10	2.5	46
Imazamethabenz + Sunit-II	1 + 1.5 pt	10	2.5	26
Imazamethabenz + Sunit-II	2.5 + 1.5 pt	10	2.5	40
Imazamethabenz + Sunit-II	5 + 1.5 pt	10	2.5	55
CV				15
LSD (0.05)				9

All treatments at 28 psi and with an XR8001 tip

Spray volume did not influence imazamethabenz control of oat when applied with X-77 at 0.25%. For imazamethabenz at 1 oz/A, control of oat increased as spray volume decreased from 10 gpa to 2.5 gpa and tended to increase for the 2.5 and 5 oz/A rates, when applied with Sun-it II. In general, imazamethabenz at 1 oz/A equaled 2.5 and 2.5 equaled 5 oz/A in oat control as spray volume decreased from 10 to 5 and 5 to 2.5 gpa, when with Sun-it II at 1 pt/A. The results indicate that the benefit from Sun-it II at 1.5 pt/A was most pronounced at low spray volumes and the lower imazamethabenz rates. These results were with oat as a bioassay species and suggest that further research is needed to determine the response to spray volume and adjuvants for wild oat growing in wheat. Control was low probably because of tame oat tolerance and cool conditions with their fall experiment.

Imazamethabenz: spray volume and adjuvants, Fargo, 1999. (Ramsdale and Nalewaja) 'Valley' oat, 'Red Siberian' foxtail millet, and 'White' proso millet were planted as strips side-by-side on May 27. Plots 11.5 ft wide were laid out perpendicular to the strips so that each plot contained all three assay species. Treatments were applied on July 30 with an all-terrain vehicle equipped with a four-nozzle boom (20-in spacing) offset to one side. Conditions at treatment were 73 F, 60% RH, wind W at 6-8 mph, and sky partly cloudy. Oat was 10- to 12-inch, proso millet 8- to 10-inch, and foxtail millet 12- to 14-inch and species were tillering. Experimental design was a randomized complete block with four replicates.

Treatment	Rate	Volume	Speed	Oat
	oz ai/A	gpa	mph	%
Immb + X77	1 + 0.25%	2.5	10	9
Immb + X77	2.5 + 0.25%	2.5	10	26
Immb + X77	5 + 0.25%	2.5	10	64
Immb + Sunit-II	1 + 1.5 pt	2.5	10	29
Immb + Sunit-II	2.5 + 1.5 pt	2.5	10	56
Immb + Sunit-II	5 + 1.5 pt	2.5	10	75
Immb + X77	1 + 0.25%	5	5	20
Immb + X77	2.5 + 0.25%	5	5	34
Immb + X77	5 + 0.25%	5	5	50
Immb + Sunit-II	1 + 1.5 pt	5	5	45
Immb + Sunit-II	2.5 + 1.5 pt	5	5	63
Immb + Sunit-II	5 + 1.5 pt	5	5	80
Immb + X77	1 + 0.25%	10	2.5	18
Immb + X77	2.5 + 0.25%	10	2.5	41
Immb + X77	5 + 0.25%	10	2.5	45
Immb + Sunit-II	1 + 1.5 pt	10	2.5	56
Immb + Sunit-II	2.5 + 1.5 pt	10	2.5	66
Immb + Sunit-II	5 + 1.5 pt	10	2.5	77
CV				17
LSD (0.05)				11

All treatments at 28 psi and with an XR8001 tip

Oat was only evaluated as the other species were not injured by imazamethabenz. Sun-it II was more effective than X-77 in enhancement of imazamethabenz. Oat control was equal or greater from imazamethabenz at 2.5 oz/A with Sun-it II as 5 oz/A with X-77. Spray volume did not greatly influence imazamethabenz phytotoxicity to oat regardless of the adjuvant. However, imazamethabenz at 1 oz/A with Sun-it II applied in 2.5 gpa was less effective than in the other volumes. Further, imazamethabenz at 5 oz/A applied with X-77 generally decreased in efficacy as spray volume increased. These results indicate that imazamethabenz applied in 2.5 gpa is equally as effective as when in 10 gpa and that efficacy is enhanced more by Sun-it II at 1.5 pt/A than X-77 at 0.25%. Oat was used in the experiment to simulate wild oat but tame oat is considered more tolerant than wild oat to imazamethabenz.

Imazamox: spray volume and adjuvants, Fargo, 1999. (Ramsdale and Nalewaja) 'Valley' oat, 'Red Siberian' foxtail millet, and 'White' proso millet were planted as strips side-by-side on May 27. Plots 11.5 ft wide were laid out perpendicular to the strips so that each plot contained all three assay species. Treatments were applied on June 29 with an all-terrain vehicle equipped with a four-nozzle boom (20-in spacing) offset to one side. Conditions at treatment were 69 F, 62% RH, wind S at 10 mph, and sky cloudy. Oat was 10- to 12-inch, proso millet 6- to 8-inch, and foxtail millet 12- to 14-inch and species were tillering. Experimental design was a randomized complete block with four replicates.

Treatment	Rate	Volume	Speed	July 14			July 26			$\bar{x}$
				Oat	Prmi	Fomi	Oat	Prmi	Fomi	
	oz ai/A	gpa	mph	%						
Immx + Scoil	0.25 + 1.5 pt	2.5	10	91	89	93	98	90	95	93
Immx + Scoil	0.25 + 1%	2.5	10	82	79	85	89	74	89	83
Immx + Scoil	0.25 + 1.5 pt	5	5	89	85	88	97	80	92	89
Immx + Scoil	0.25 + 1%	5	5	80	68	86	84	64	91	79
Immx + Scoil	0.25 + 1.5 pt	10	2.5	82	77	81	85	68	86	80
Immx + Scoil	0.25 + 1%	10	2.5	76	69	83	77	53	85	74
Immx + Quad7	0.25 + 1%	2.5	10	84	77	83	89	70	89	82
Immx + Quad7	0.25 + 2%	2.5	10	85	77	81	88	67	85	81
Immx + Quad7	0.25 + 1%	5	5	87	82	88	91	73	91	85
Immx + Quad7	0.25 + 2%	5	5	86	79	86	90	71	88	83
Immx + Quad7	0.25 + 1%	10	2.5	83	72	83	86	64	84	79
Immx + Quad7	0.25 + 2%	10	2.5	82	71	76	88	65	84	78
Immx + Activator 90	0.25 + 0.25%	2.5	10	62	59	76	64	46	80	65
Immx + Activator 90	0.25 + 1%	2.5	10	75	69	76	76	61	83	73
Immx + Activator 90	0.25 + 0.25%	5	5	70	67	80	74	62	83	73
Immx + Activator 90	0.25 + 0.5%	5	5	75	73	80	77	63	85	76
Immx + Activator 90	0.25 + 0.25%	10	2.5	58	59	69	61	49	80	63
CV				4	8	6	4	10	5	
LSD (0.05)				5	8	7	5	9	6	

[a] All treatments were applied with XR8001 tips at 28 psi.

The discussion will be based upon the average over species and evaluations as all species responded similarly to treatments. Imazamox efficacy was greater with 1.5 pt/A than 1% Scoil at all spray volumes. Imazamox efficacy was similar when applied with Quad 7 at either 1 or 2%, and generally greater when applied at 2.5 or 5 gpa than 10 gpa. Imazamox when applied with NIS (Activator 90) at 0.25% was most effective in 5 gpa, but equally as effective at 2.5 gpa when the NIS was increased to 1%. These results indicate that to maximize imazamox efficacy application should be in low spray volume containing Scoil at 1.5 pt/A. Spray volume did not greatly influence imazamox efficacy when applied with Quad 7.

Imazamox: spray volume and adjuvants, Fargo, 1999. (Ramsdale and Nalewaja) 'Valley' oat, 'Red Siberian' foxtail millet, and 'White' proso millet were planted as strips side-by-side on May 27. Plots 11.5 ft wide were laid out perpendicular to the strips so that each plot contained all three assay species. Treatments were applied on July 2 with an all-terrain vehicle equipped with a four-nozzle boom (20-in spacing) offset to one side. Conditions at treatment were 75 F, 50% RH, wind S at 5 mph, and sky partly cloudy. Oat was 10- to 12-inch, proso millet 8- to 10-inch, and foxtail millet 12- to 14-inch and species were tillering. Experimental design was a randomized complete block with four replicates.

					July 17			July 27	
Treatment	Rate	Volume	Tip[a]	Speed	Oat	Prmi	Fomi	Prmi	Fomi
	oz ai/A	gpa		mph			%		
Immx + Act90 + UAN	0.25 + 0.25%+2%	2.5	8001	10	76	76	77	64	69
Immx + Sunit	0.25 + 1.5 pt	2.5	8001	10	81	85	85	85	88
Immx + Quad7	0.25 + 1%	2.5	8001	10	78	79	81	78	81
Immx + Quad7	0.25 + 2%	2.5	8001	10	79	81	81	76	78
Immx + Act90 + UAN	0.25 + 0.25%+2%	5	8001	5	84	80	81	66	77
Immx + Sunit	0.25 + 1.5 pt	5	8001	5	85	86	86	82	86
Immx + Quad7	0.25 + 1%	5	8001	5	79	81	78	78	80
Immx + Act90 + UAN	0.25 + 0.25%+2%	5	8002	10	78	77	80	70	76
Immx + Sunit	0.25 + 1.5 pt	5	8002	10	79	80	81	75	81
Immx + Quad7	0.25 + 1%	5	8002	10	83	82	85	75	79
Immx + Act90 + UAN	0.25 + 0.25%+2%	10	8004	10	78	73	80	58	79
Immx + Sunit	0.25 + 1.5 pt	10	8004	10	79	81	83	69	76
Immx + Quad7	0.25 + 1%	10	8004	10	77	80	80	78	79
CV					5	5	7	8	8
LSD (0.05)					5	6	NS	8	9

[a] XR tips applied at 28 psi and LP tip at 15 psi.

Imazamox control of al species at various times was not greatly influenced by spray volume, nozzle (droplet size), or adjuvant. However, efficacy generally was greater with Sun-it II or Quad 7 than Activator 90 +28%N, especially for proso millet. At 5 gpa, Sun-it II tended to be more effective when in small droplets (8001), but Quad 7 was similarly effective with both droplet sizes (8001 and 8002). The data clearly demonstrate that imazamox is equally effective applied in 2.5 to 10 gpa. Further, efficacy was generally greatest when with Sun-it II applied through 8001 nozzles in 2.5 or 5 gpa. These results support the concept that many herbicides are most efficacious when applied with oil adjuvants on an area basis in low spray volumes.

Nicosulfuron: spray volume and adjuvants, Fargo, 1999. (Ramsdale and Nalewaja) 'Valley' oat, 'Red Siberian' foxtail millet, and 'White' proso millet were planted as strips side-by-side on May 27. Plots 11.5 ft wide were laid out perpendicular to the strips so that each plot contained all three assay species. Treatments were applied on July 1 with an all-terrain vehicle equipped with a four-nozzle boom (20-in spacing) offset to one side. Conditions at treatment were 68 F, 40% RH, wind N at 5 mph, and sky mostly cloudy. Oat was 10- to 12-inch, proso millet 8- to 10-inch, and foxtail millet 12- to 14-inch and species were tillering. Experimental design was a randomized complete block with four replicates.

Treatment	Rate	Volume	Tip[a]	Speed	July 13			July 20	
					Oat	Prmi	Fomi	Prmi	$\bar{x}$
	oz ai/A	gpa		mph			%		
Nico + Act90	0.25+0.25%	2.5	8001	10	77	69	64	59	67
Nico + Quad7	0.25+1%	2.5	8001	10	78	79	80	76	78
Nico + Quad7	0.25+2%	2.5	8001	10	83	86	84	89	86
Nico + Scoil	0.25+1%	2.5	8001	10	78	77	76	82	78
Nico + Scoil	0.25+1.5 pt	2.5	8001	10	85	93	87	95	90
Nico+Act90+AMS	0.25+0.25%+32	2.5	8001	10	70	69	57	58	64
Nico + Scoil	0.25+1.5 pt	10	8001	2.5	85	89	86	96	89
Nico+Act90+AMS	0.25+0.25%+32	10	8001	2.5	80	79	79	79	79
Nico+Act90	0.25+0.25%	10	8004	10	77	77	78	68	75
Nico + Quad7	0.25+1%	10	8004	10	86	84	82	88	85
Nico + Quad7	0.25+2%	10	8004	10	85	91	84	96	89
Nico + Scoil	0.25+1%	10	8004	10	83	84	84	86	84
Nico + Scoil	0.25+1.5 pt	10	8004	10	83	89	86	93	88
Nico+Act90+AMS	0.25+0.25%+32	10	8004	10	84	86	83	82	84
CV					5	5	4	5	
LSD (0.05)					6	6	5	6	

[a] XR tips applied at 28 psi.

The discussion will consider data averaged over species and rating dates as no obvious interaction were evident. Nicosulfuron was more effective when applied in 10 than 2.5 gpa, except efficacy was similar with both volumes when applied with methylated vegetable oil (Scoil) at 1.5 pt/A or Quad 7 at 2% (2.5 gpa). Nicosulfuron was equally as effective when applied at 10 gpa using either 8001 or 8004 nozzles. Thus, the greater coverage or spray retention from the large number of droplets with 8001 nozzles did not relate to increased efficacy (possibly a reduction with Activator 90 +AMS). The application of adjuvants on an area basis apparently is important to nicosulfuron efficacy when using different spray volumes. Methylated vegetable oil at 1.5 pt/A was equally effective at 2.5 or 10 gpa, but was less effective when at 1% less effective in 2.5 gpa (0.2 pt/A) than 10 gpa (0.8 pt/A). Further, Quad 7 at 2% was more effective than 1% when in 2.5 gpa. These results clearly demonstrate that nicosulfuron efficacy at various spray volumes is adjuvant dependant.

Thifensulfuron&Tribenuron: spray volume and adjuvants, Fargo, 1999. (Ramsdale and Nalewaja) 'Omega' flax, and birdseed sunflower were seeded as strips side-by-side on June 2. Plots 11.5 ft wide were laid out perpendicular to the strips so that each plot contained all three assay species. Treatments were applied at 10:00 am on June 29 with an all-terrain vehicle equipped with a four-nozzle boom (20-in spacing) offset to one side. Conditions at treatment were 65 F, 60% RH, wind S at 6-8 mph, and sky cloudy. Flax was 6- to 8-inch and sunflower 6- to 8-leaf (8- to 10-inch). Experimental design was a randomized complete block with four replicates.

Treatment	Rate	Volume	Speed	Tip[a]	Flax	Sunflower
	oz ai/A	gpa	mph		%	
Thif&Trib + X77	0.05 + 0.25%	2.5	10	8001	20	84
Thif&Trib + X77	0.1 + 0.25%	2.5	10	8001	36	92
Thif&Trib + Quad7	0.05 + 1%	2.5	10	8001	31	95
Thif&Trib + Quad7	0.1 + 1%	2.5	10	8001	39	98
Thif&Trib + X77	0.05 + 0.25%	5	5	8001	33	91
Thif&Trib + X77	0.1 + 0.25%	5	5	8001	33	96
Thif&Trib + Quad7	0.05 + 1%	5	5	8001	45	98
Thif&Trib + Quad7	0.1 + 1%	5	5	8001	40	98
Thif&Trib + X77	0.05 + 0.25%	5	10	8002	23	85
Thif&Trib + X77	0.1 + 0.25%	5	10	8002	36	93
Thif&Trib + Quad7	0.05 + 1%	5	10	8002	34	96
Thif&Trib + Quad7	0.1 + 1%	5	10	8002	53	99
CV					19	3
LSD (0.05)					10	3

[a] XR tips applied at 28 psi.

Thifensulfuron&tribenuron is used in wheat for broadleaf weed control. Treatments were only applied in 2.5 and 5 gpa because herbicide applications usually do not exceed 5 gpa in wheat. Thifensulfuron&tribenuron was equally effective in 2.5 or 5 gpa. Quad 7 was more effective than X-77 when applied with thifensulfuron&tribenuron. Sunflower control was quite high even when thifensulfuron&tribenuron was only at 0.05 oz/A. However, when thifensulfuron&tribenuron at 0.05 oz/A was with Quad 7 sunflower control usually equaled that from 0.1 oz/A applied with X-77. Spray volume of 2.5 gpa apparently is adequate for application of thifensulfuron&tribenuron. Quad 7 was an effective adjuvant for thifensulfuron&tribenuron and when at 1% of 2.5 gpa spray application it would probably be economically beneficial.

Tralkoxydim: spray volume and adjuvants in wheat, Fargo, 1999. (Ramsdale and Nalewaja) 'Oxen' hard red spring wheat was planted on April 29. Treatments were applied at 11:30 am on May 26 with an all-terrain vehicle equipped with a four-nozzle boom (20-in spacing) offset to one side. Conditions at treatment were 75 F, 30% RH, wind SW at 8-12 mph, and sky cloudy. Wheat was 3- to 4-leaf (3- to 5-inch) and wild oat 1- to 4-leaf (2- to 5-inch). Experimental design was a randomized complete block with four replicates.

Treatment	Rate	Tip	Volume[a]	Speed	Wild oat control		
					June 9	July 7	$\bar{x}$
	oz ai/A		gpa	mph	——— % ———		
Tral + Supercharge	2 + 0.5%	8001	2.5	10	16	14	15
Tral + Scoil	2 + 1%	8001	2.5	10	26	18	22
Tral + Scoil	2 + 1.5 pt	8001	2.5	10	91	86	88
Tral + ND191C5	2 + 1.5 pt	8001	2.5	10	88	80	84
Tral + Supercharge	2 + 0.5%	8001	5	5	70	38	54
Tral + Scoil	2 + 1%	8001	5	5	39	26	32
Tral + Scoil	2 + 1.5 pt	8001	5	5	88	87	87
Tral + ND191C5	2 + 1.5 pt	8001	5	5	88	82	85
Tral + Supercharge	2 + 0.5%	8002	5	10	51	32	41
Tral + Scoil	2 + 1%	8002	5	10	50	24	37
Tral + Scoil	2 + 1.5 pt	8002	5	10	88	86	87
Tral + Supercharge	2 + 0.5%	8004	10	10	59	34	46
Tral + Scoil	2 + 1%	8004	10	10	69	59	64
Tral + Scoil	2 + 1.5 pt	8004	10	10	63	50	56
Tral + ND191C5	2 + 1.5 pt	8004	10	10	88	83	85
CV					12	15	
LSD (0.05)					11	11	

[a]All treatmens applied with XR tips at 28 psi.

Data will be discussed based upon the wild oat control averaged over the two evaluations. Tralkoxydim was at only 2 oz/A so that wild oat control would not be complete and allow differentiation among treatments. Tralkoxydim applied with Supercharge at 0.5% was more effective when in 5 or 10 gpa versus 2.5 gpa. Tralkoxydim efficacy increased as spray volume increased when with Scoil at 1%. This indicated that the greater amount of adjuvant on an area basis as with high volume was positive to efficacy. However, when Scoil was at 1.5 pt/A, tralkoxydim efficacy increased as spray volume was reduced from 10 to 5 or 2.5 gpa spray volume. The high concentration of oils in the lower spray volume apparently was important to efficacy (3.75% for 1.5 pt/A in 5 gpa). Tralkoxydim efficacy when applied in 5 gpa using 8001 nozzles was similar to using 8002 nozzles regardless of adjuvant. ND191C5 was effective at all spray volumes. These results indicate that to optimize tralkoxydim efficacy use spray volumes of 2.5 or 5 gpa including Scoil at 1.5 pt/A

Quizalofop-P: spray volume and adjuvants, Fargo, 1999. (Ramsdale and Nalewaja) 'Valley' oat, 'Red Siberian' foxtail millet, and 'White' proso millet were planted as strips side-by-side on May 27. Plots 11.5 ft wide were laid out perpendicular to the strips so that each plot contained all three assay species. Treatments were applied on June 30 with an all-terrain vehicle equipped with a four-nozzle boom (20-in spacing) offset to one side. Conditions at treatment were 73 F, 60% RH, wind W at 6-8 mph, and sky partly cloudy. Oat was 10- to 12-inch, proso millet 8- to 10-inch, and foxtail millet 12- to 14-inch and species were tillering. Experimental design was a randomized complete block with four replicates.

Treatment	Rate	Volume	Tip[a]	Speed	Oat	Prmi	Fomi
	oz ai/A	gpa		mph		%	
Quiz + Herbimax	0.4 + 1%	2.5	XR8001	10	89	84	83
Quiz + Herbimax	0.4 + 1.5 pt	2.5	XR8001	10	91	86	89
Quiz + Quad7	0.4 + 1%	2.5	XR8001	10	95	88	90
Quiz + Quad7	0.4 + 1%	2.5	LP8001	10	91	87	90
Quiz + Herbimax	0.4 + 1%	10	XR8001	2.5	90	87	88
Quiz + Herbimax	0.4 + 1.5 pt	10	XR8001	2.5	91	88	89
Quiz + Quad7	0.4 + 1%	10	XR8001	2.5	96	93	91
Quiz + Herbimax	0.4 + 1%	5	XR8002	10	90	87	88
Quiz + Herbimax	0.4 + 1.5 pt	5	XR8002	10	92	87	89
Quiz + Quad7	0.4 + 1%	5	XR8002	10	95	91	90
Quiz + Herbimax	0.4 + 1%	10	XR8004	10	85	83	88
Quiz + Herbimax	0.4 + 1.5 pt	10	XR8004	10	90	85	87
Quiz + Quad7	0.4 + 1%	10	XR8004	10	97	89	89
CV					4	3	5
LSD (0.05)					5	NS	NS

[a] XR tips applied at 28 psi and LP tip at 15 psi.

Quizalofop was highly active with the moist conditons so differentiation among treatments was difficult. However, quizalofop control of species tended to be greatest when applied with Quad 7 at 1%, regardless of spray volume.

Split application of tralkoxydim for wild oat control, Fargo. (Ramsdale and Messersmith) 'Oxen' hard red spring wheat was seeded on April 29. Treatments were a single application at standard timing and two applications at one-half the single application rate. Experimental design was a randomized complete block with 4 replicates, and plot size was 10 by 30 ft. All treatments were applied at 8.5 gpa with a bicycle-wheel-type plot sprayer equipped with four 8001 flat-fan nozzles at 20-inch spacing.

Date	May 18	May 27	June 2
Treatment	1st Split	Single	2nd Split
Air temperature (F)	72	66	75
Relative humidity (%)	55	35	65
Wind (mph)	8-14	10-12	3-5
Sky	cloudy	partly cloudy	partly cloudy
Wheat	1.5 lf	3-4 lf	5-6 lf
Wild oat	1-1.5 lf	1-4 lf	variable

Treatment[a]	Rate	Wild oat		Yield
		June 16	July 9	
	oz ai/A	% control		bu/A
Tralkoxydim + Supercharge	2.9 + 0.5%	74	59	16
Tralkoxydim + Scoil	2.9 + 1.5 pt	90	83	21
Tralkoxydim + Supercharge	2 + 0.5%	60	44	13
Tralkoxydim + Scoil	2 + 1.5 pt	85	76	17
Tralkoxydim + Supercharge	1.5 + 0.5%	65	45	12
Tralkoxydim + Scoil	1.5 + 1.5 pt	83	64	18
Tral + Super / tral + Super	1 + 0.5% / 1 + 0.5%	91	89	24
Tral + Scoil / tral + Scoil	1 + 1.5 pt / 1 + 1.5 pt	95	95	23
Tral + Super / tral + Super	0.75 + 0.5% / 0.75 + 0.5%	84	81	20
Tral + Scoil / tral + Scoil	0.75 + 1.5 pt / 0.75 + 1.5 pt	91	91	32
Untreated		-	-	6
CV		10	11	21
LSD (5%)		12	11	7

[a] Supercharge = methylated vegetable oil plus buffers, Scoil = methylated vegetable oil

Both evaluations were similar, so discussion is based only on the July 9 evaluation. Tralkoxydim applied once with Scoil provided 19 to 32% greater wild oat control than tralkoxydim applied once with Supercharge. Reducing tralkoxydim rate to 1.5 oz/A and applying in two 0.75 oz/A applications increased wild oat control by 22% with Supercharge, but only 8% with Scoil. Tralkoxydim at 2 oz/A in two 1 oz/A applications increased wild oat control by 30% with Supercharge and 12% with Scoil compared to single full-rate applications. Wheat yields were similar following treatment with tralkoxydim at 1.5 oz/A with Supercharge in two 0.75 oz/A applications and a single application of tralkoxydim at 2.9 oz/A with Supercharge. However, wheat yields increased by 11 bu/A when tralkoxydim at 1.5 oz/A with Scoil was applied in two 0.75 oz/A applications compared to a single application at 2.9 oz/A with Scoil. Conditions for wild oat control were very favorable. The experiment needs to be repeated under less favorable conditions to better access reduced rate and split applications of tralkoxydim for wild oat control.

Split application of imazamethabenz for wild oat control, Fargo. (Ramsdale and Messersmith) 'Oxen' hard red spring wheat was seeded on April 29. Treatments were a single application at standard timing and two applications at one-half the single application rate. Experimental design was a randomized complete block with 4 replicates, and plot size was 10 by 30 ft. All treatments were applied at 8.5 gpa with a bicycle-wheel-type plot sprayer equipped with four 8001 flat-fan nozzles at 20-inch spacing.

Date	May 18	May 27	June 2
Treatment	1st Split	Single	2nd Split
Air temperature (F)	72	66	75
Relative humidity (%)	55	35	65
Wind (mph)	8-14	10-12	3-5
Sky	cloudy	partly cloudy	partly cloudy
Wheat	1.5 lf	3-4 lf	5-6 lf
Wild oat	1-1.5 lf	1-4 lf	variable

Treatment[a]	Rate	Wild oat		Yield
		June 16	July 9	
	oz ai/A	% control		bu/A
Immb + Activator 90	5 + 0.25%	75	76	23
Immb + Scoil	5 + 1.5 pt	88	92	25
Immb + Activator 90	2.5 + 0.25%	69	59	20
Immb + Scoil	2.5 + 1.5 pt	85	85	23
Immb + Act 90 / immb + Act 90	2.5 + 0.25% / 2.5 + 0.25%	88	86	29
Immb + Scoil / immb + Scoil	2.5 + 1.5 pt / 2.5 + 1.5 pt	94	94	32
Immb + Act 90 / immb + Act 90	1.25 + 0.25% / 1.25 + 0.25%	80	81	26
Immb + Scoil / immb + Scoil	1.25 + 1.5 pt / 1.25 + 1.5 pt	87	88	32
Untreated		-	-	9
CV		7	7	19
LSD (5%)		8	8	7

[a] Activator 90 = nonionic surfactant, Scoil = methylated vegetable oil

Both evaluations were similar, so discussion is based only on the July 9 evaluation. Imazamethabenz at 2.5 oz/A with Scoil as single and split applications provided >85% control of wild oat and was similar to imazamethabenz at 5 oz/A plus Scoil. Imazamethabenz at 2.5 oz/A plus nonionic surfactant (NIS) applied once provided 59% control of wild oat. However, imazamethabenz at 2.5 oz/A plus NIS in two 1.25 oz/A applications increased wild oat control by 22% over a single 2.5 oz/A application. These results suggest that imazamethabenz rate can be reduced from 5 to 2.5 oz/A and efficacy maintained by including Scoil in the spray mixture and applying once. Wheat yields were similar when imazamethabenz plus Scoil was applied once at 2.5 or 5 oz/A. However, wheat yields increased by 7 bu/A when imazamethabenz at 2.5 oz/A with Scoil was applied in two 1.25 oz/A applications compared to a single full-rate application. Perhaps the split application reduced early wild oat competition, which increased wheat yield. Conditions for wild oat control were very favorable. The experiment needs to be repeated under less favorable conditions to better access reduced rate and split applications of imazamethabenz for wild oat control.

Split application of difenzoquat for wild oat control, Fargo. (Ramsdale and Messersmith) 'Oxen' hard red spring wheat was seeded on April 29. Treatments were a single application at standard timing and two applications at one-half the single application rate. Experimental design was a randomized complete block with 4 replicates, and plot size was 10 by 30 ft. All treatments were applied at 8.5 gpa with a bicycle-wheel-type plot sprayer equipped with four 8001 flat-fan nozzles at 20-inch spacing. Wheat stand was poor due to crusting, and consequently was not harvested.

Date	May 27	June 2	June 9
Treatment	1st Split	Single	2nd Split
Air temperature (F)	66	75	80
Relative humidity (%)	35	65	60
Wind (mph)	10-12	3-5	3-5
Sky	partly cloudy	partly cloudy	partly cloudy
Wheat	3-4 lf	5-6 lf	6-8 lf
Wild oat	1-4 lf	3-6 lf	variable

Treatment[a]	Rate	Wild oat	
		June 22	July 9
	oz ai/A	% control	
Difenzoquat	12	85	89
Difenzoquat	10	83	86
Difenzoquat + Activator 90	10 + 0.25%	84	89
Difenzoquat	8	75	83
Difenzoquat + Activator 90	8 + 0.25%	81	86
Dife / dife	5 / 5	54	89
Dife + Act 90 / dife + Act 90	5 + 0.25% / 5 + 0.25%	70	89
Dife / dife	4 / 4	48	86
Dife + Act 90 / dife + Act 90	4 + 0.25% / 4 + 0.25%	63	86
CV		11	4
LSD (5%)		12	NS

[a] Activator 90 = nonionic surfactant

Reduced rate / split applications of difenzoquat provided less wild oat control compared to single applications at the June 22 evaluation. The addition of nonionic surfactant to difenzoquat increased wild oat control when applied in split applications (June 22 evaluation). The June 22 evaluation was 13 days after the second split application and was based on visible leaf injury. This may explain the low ratings for the split treatments for the June 22 evaluation as the wild oat were large and consequently the visible injury was not indicative of the final control. No differences were observed between treatments at the July 9 evaluation, which was after the wild oat had headed out. Conditions for wild oat control were very favorable. The experiment needs to be repeated under less favorable conditions to better access reduced rate and split applications of difenzoquat for wild oat control.

Split application of clodinafop for wild oat control, Fargo. (Ramsdale and Messersmith) 'Oxen' hard red spring wheat was seeded on April 29. Treatments were a single application at standard timing and two applications at one-half the single application rate. Experimental design was a randomized complete block with 4 replicates, and plot size was 10 by 30 ft. All treatments were applied at 8.5 gpa with a bicycle-wheel-type plot sprayer equipped with four 8001 flat-fan nozzles at 20-inch spacing. Wheat stand was poor due to crusting, and consequently was not harvested.

Date	May 18	May 27	June 2
Treatment	1st Split	Single	2nd Split
Air temperature (F)	72	66	75
Relative humidity (%)	55	35	65
Wind (mph)	8-14	10-12	3-5
Sky	cloudy	partly cloudy	partly cloudy
Wheat	1.5 lf	3-4 lf	5-6 lf
Wild oat	1-1.5 lf	1-4 lf	variable

Treatment[a]	Rate	Wild oat	
		June 16	July 9
	oz ai/A	% control	
Clodinafop + Score	0.8 + 0.8%	95	94
Clodinafop + Score	0.5 + 0.5%	93	91
Clodinafop + Scoil	0.5 + 1.5 pt	94	96
Clod + Score / clod + Score	0.25 + 0.25% / 0.25 + 0.25%	94	97
Clod + Score / clod + Score	0.25 + 0.5% / 0.25 + 0.5%	94	96
Clod + Scoil / clod + Scoil	0.25 + 1.5 pt / 0.25 + 1.5 pr	95	95
CV		1	2
LSD (5%)		NS	2

[a] Score = petroleum oil concentrate, Scoil = methylated vegetable oil

Wild oat control was similar for all treatments at the June 16 evaluation. Clodinafop at 0.5 oz/A applied with Scoil provided greater wild oat control than clodinafop applied with Score. Wild oat control was generally similar when clodinafop was applied in a single 0.5 oz/A application compared to two 0.25 oz/A applications. Conditions for wild oat control were very favorable. The experiment needs to be repeated under less favorable conditions to better access reduced rate and split applications of clodinafop for wild oat control.

Split application of fenoxaprop-P plus safener for wild oat control, Fargo.
(Ramsdale and Messersmith) 'Oxen' hard red spring wheat was seeded on April 29. Treatments were a single application at standard timing and two applications at one-half the single application rate. Experimental design was a randomized complete block with 4 replicates, and plot size was 10 by 30 ft. All treatments were applied at 8.5 gpa with a bicycle-wheel-type plot sprayer equipped with four 8001 flat-fan nozzles at 20-inch spacing. Wheat stand was poor due to crusting, and consequently was not harvested.

Date Treatment	May 18 1st Split	May 27 Single	June 2 2nd Split
Air temperature (F)	72	66	75
Relative humidity (%)	55	35	65
Wind (mph)	8-14	10-12	3-5
Sky	cloudy	partly cloudy	partly cloudy
Wheat	1.5 lf	3-4 lf	5-6 lf
Wild oat	1-1.5 lf	1-4 lf	variable

Treatment[a]	Rate	Wild oat	
		June 16	July 9
	oz ai/A	% control	
Fenoxaprop-P&S	1.7	96	96
Fenoxaprop-P&S	0.8	93	88
Fenx-P + Herbimax	0.8 + 1.5 pt	95	93
Fenx-P + Activator 90	0.8 + 0.25%	94	88
Fenx-P / fenx-P	0.4 / 0.4	94	86
Fenx-P + Herb. / fenx-P + Herb.	0.4 + 1.5 pt/ 0.4 + 1.5 pt	95	96
Fenx-P + Act90 / fenx-P + Act90	0.4 + 0.25% / 0.4 + 0.25%	94	93
CV		2	3
LSD (5%)		NS	4

[a] Herbimax = petroleum oil concentrate, Activator 90 = nonionic surfactant

Wild oat control was similar for all treatments at the June 16 evaluation. Fenoxaprop-P at 0.8 oz/A plus petroleum oil provided greater wild oat control than fenoxaprop-P alone or fenoxaprop-P plus nonionic surfactant at the July 9 evaluation. Wild oat control was generally similar when fenoxaprop-P was applied in a single 0.8 oz/A application compared to two 0.4 oz/A applications. Conditions for wild oat control were very favorable. The experiment needs to be repeated under less favorable conditions to better access reduced rate and split applications of fenoxaprop-P for wild oat control.

Split application of Bay MKH 6562 for wild oat control, Fargo. (Ramsdale and Messersmith) 'Oxen' hard red spring wheat was seeded on April 29. Treatments were a single application at standard timing and two applications at one-half the single application rate. Experimental design was a randomized complete block with 4 replicates, and plot size was 10 by 30 ft. All treatments were applied at 8.5 gpa with a bicycle-wheel-type plot sprayer equipped with four 8001 flat-fan nozzles at 20-inch spacing. Wheat stand was poor due to crusting, and consequently was not harvested.

Date	May 18	May 27	June 2
Treatment	1st Split	Single	2nd Split
Air temperature (F)	72	66	75
Relative humidity (%)	55	35	65
Wind (mph)	8-14	10-12	3-5
Sky	cloudy	partly cloudy	partly cloudy
Wheat	1.5 lf	3-4 lf	5-6 lf
Wild oat	1-1.5 lf	1-4 lf	variable

		Wild oat	
Treatment[a]	Rate	June 16	July 9
	oz ai/A	% control	
MKH 6562 + Activator 90	0.3 + 0.25%	85	86
MKH 6562 + Activator 90	0.15 + 0.25%	84	81
MKH 6562 + Quad 7	0.15 + 1%	91	91
MKH 6562 + Activator 90	0.1 + 0.25%	82	81
MKH 6562 + Quad 7	0.1 + 1%	92	91
MKH 6562 + Act90 / MKH 6562 + Act90	0.075 + 0.25% / 0.075 + 0.25%	86	94
MKH 6562 + Quad7 / MKH 6562 + Quad7	0.075 + 1% / 0.075 + 1%	93	95
MKH 6562 + Act90 / MKH 6562 + Act90	0.05 + 0.25% / 0.05 + 0.25%	88	93
MKH 6562 + Quad7 / MKH 6562 + Quad7	0.05 + 1% / 0.05 + 1%	93	94
CV		5	3
LSD (5%)		7	4

[a] Activator 90 = nonionic surfactant, Quad 7 = basic blend

Both evaluations were similar, so discussion is based only on the July 9 evaluation. MKH 6562 applied once at 0.1 or 0.15 oz/A with Quad 7 provided equal or superior control of wild oat compared to MKH 6562 applied once at 0.3 oz/A with nonionic surfactant. MKH 6562 at 0.1 or 0.15 oz/A with nonionic surfactant in two half-rate applications provided similar wild oat control compared to MKH 6562 applied once at 0.3 oz/A with nonionic surfactant. Conditions for wild oat control were very favorable. The experiment needs to be repeated under less favorable conditions to better access reduced rate and split applications of MKH 6562 for wild oat control.

Distinct with adjuvants. Zollinger and Fitterer. An experiment was conducted near Casselton, ND to evaluate weed control from Distinct. Interstate PayCo '4X85' corn was planted on May 27, 1999. The POST treatments were applied June 18, 1999 at 11:30 am with 72 F air, 86 F soil surface, 48% relative humidity, 30% clouds, 5 to 15 SE mph wind, dry soil surface, dry subsoil, fair crop vigor (yellowing), no dew present, to 8 inch corn. Weed species present were: 2 to 5 inch, (5 to 20/ft^2) foxtail; 1 inch, cotyledon to 2 lf, (5 to 20/ft^2) wild mustard; and 4 to 6 inch, 4 to 6 lf, (2 to 15/ft^2) common cocklebur. Treatments were applied to the center 6.67 feet of the 10 by 40 ft plots with a bicycle-wheel-type plot sprayer using a wind shield delivering 8.5 gpa at 40 psi through 8001 flat fan nozzles. The experiment had a randomized complete block design with three replicates per treatment.

Treatment	Rate	July 2	July 16	
		Fxtl	Fxtl	Cocb
	Product/A	% control		
Distinct+NIS+28% UAN	6oz+0.25%+1.25qt	67	70	73
Distinct+PO	6oz+1qt	67	77	80
Distinct+Scoil	6oz+1pt	77	87	90
Distinct+Quad 7	6oz+1%	75	87	87
Distinct+Agri-Stay	6oz+1.5pt	60	80	80
Untreated		0	0	0
LSD (0.05)		9	6	6

All treatments controlled wild mustard, redroot pigweed, and common lambsquarters at July 16. Scoil and Quad 7 enhanced weed control from Distinct as compared to other adjuvants used. General ranking of adjuvants from most to least were: Scoil=Quad 7>PO>Agri-Stay>NIS+28%UAN.

Accent Gold with adjuvants. Zollinger and Fitterer. An experiment was conducted near Wyndmere, ND to evaluate weed control Accent Gold with adjuvants. Pioneer '37M81' corn was planted on April 28, 1999. POST treatments were applied June 3, 1999 at 10:30 to 11:30 am with 67 F air, 70 F soil surface, 65% relative humidity, 100% clouds, and 5 to 15 mph SE wind, dry soil surface, moist subsoil, poor crop vigor (chlorotic, stunted), no dew present, to 6 inch corn. Weed species present were: 1 to 5 inch, (50 to 300 plants/ft^2) foxtail; 1 to 5 inch, (1 to 2 plants/ft^2) common lambsquarters; 1 to 3 inch, (1 to 2 plants/ft^2) eastern black nightshade; 1 to 5 inch, (5 to 10 plants/ft^2) common ragweed; 1 to 4 inch, (1 to 10 plants/ft^2) curly dock; and 1 to 5 inch, (1 to 5 plants/ft^2) common cocklebur. Treatments were applied to the center 6.67 feet of the 10 by 40 ft plots with a bicycle-wheel-type plot sprayer delivering 8.5 gpa at 40 psi through 8001 flat fan nozzles. The experiment had a randomized complete block design with three replicates per treatment.

Table. Accent Gold with adjuvants (Zollinger and Fitterer).

Treatment [a]	Rate	June 16					June 30			
		Fxtl[b]	Colq	Corw	Cocb	Cudo[b]	Fxtl[b]	Colq	Corw	Ebns
	(oz prod/A)	(% control)								
Accent Gold+Destiny+28% UAN	2.9+1% v/v+1 qt	90	38	70	92	95	92	88	88	60
Accent Gold+Destiny+28% UAN	1.6+1% v/v+1 qt	80	35	75	90	92	78	80	73	35
Accent Gold+PO+28% UAN	1.6+1% v/v+1 qt	72	45	60	92	95	60	50	53	0
Accent Gold+CL9605+28% UAN	1.6+0.5% v/v+1 qt	65	33	55	87	72	68	63	57	60
Accent Gold+Newtone	1.6+1% v/v	88	33	75	90	77	80	73	80	40
Accent Gold+CL9607+28% UAN	1.6+0.5% v/v1 qt	83	20	70	90	90	50	63	75	0
Accent Gold+CL9908+28% UAN	1.6+0.5% v/v+1 qt	73	20	68	90	90	53	53	43	0
Accent Gold+CL9920+28% UAN	1.6+1% v/v+1 qt	73	25	73	90	93	63	57	53	35
Accent Gold+CL9920+28% UAN	2.9+1% v/v+1 qt	77	30	70	93	95	90	82	83	55
Accent Gold+Dispatch 2N	1.6+2.5 qt	85	20	50	90	93	57	43	37	38
Accent Gold+LI-111	1.6+1% v/v	80	50	73	93	95	60	57	50	35
Accent Gold+Breakout	1.6+1% v/v	67	30	75	90	95	47	37	40	15
Accent Gold+FirstMate	1.6+1% v/v	85	35	75	90	85	77	73	70	50
Accent Gold+Agri-Stay	1.6+1.5 pt	73	37	72	90	93	58	43	43	38
Accent Gold+Scoil	1.6+1.5 pt	85	50	80	90	95	87	85	87	50
Untreated		0	0	0	0	0	0	0	0	0
LSD (0.05)		9	5	11	4	11	10	7	7	9

[a]Destiny and Scoil = methylated seed oil; UAN = urea ammonium nitrate; PO = petroleum oil = Herbimax; CL9605 and CL9908 = high concentrate crop oil; Newtone, Breakout and LI-111 = basic blend; CL9607 = drift retardant + ammonium sulfate; CL9920 = modified vegetable oil; Dispatch 2N = surfactant + fertilizer; FirstMate = basic blend + methylated seed oil; Agri-Stay = unclassified.
[b]Fxtl = Grft and Yeft, Cudo = curly dock.

Eastern black nightshade was not evaluated on June 16. All treatments gave complete curly dock and common cocklebur control on June 30. Field conditions preceding and after application were hot and dry. Weeds were drought stressed at application. The low rate of the premix with Destiny+28% nitrogen resulted in reduced foxtail and common ragweed control on June 16 and June 30 and reduced eastern black nightshade control on June 30 as compared to the high rate. The premix with Scoil, a methylated seed oil, gave greater common lambsquarters and curly dock control on June 16 and greater foxtail, common lambsquarters, and eastern black nightshade control on June 30. The premix at the high and low rates with CL9920+28% nitrogen resulted in little difference in weed control on June 16 but the high rate gave greater weed control on June 30 than other treatments at the same rate. The premix with Dispatch 2N generally had the lowest weed control ratings.

Celebrity Plus (Accent&Distinct) with adjuvants-Carrington, ND. Zollinger and Fitterer. An experiment was conducted near Carrington, ND to evaluate weed control from Celebrity with adjuvants. Cargill '1877' corn was planted on May 17, 1999. POST treatments were applied June 14, 1999 at 1:00 pm with 65 F air, 75 F soil surface, 45% relative humidity, 20% clouds, 0 to 10 mph S to SW wind, dry soil surface, moist subsoil, excellent crop vigor, no dew present, and 6 to 8 inch corn. Weed species present were: 3 to 6 leaf (5 to 20 plants/ft^2) foxtail; 2 to 3 inch (1 to 5 plants/yd^2) common lambsquarters; 1 to 3 inch (10 to 20 plants/ft^2) redroot pigweed;1 to 3 inch (10 to 20 plants/ft^2) prostrate pigweed; and 1 to 4 inch (1 to 2 plants/yd^2) wild buckwheat. Treatments were applied to the center 6.67 feet of the 10 by 40 ft plots with a bicycle-wheel-type plot sprayer delivering 8.5 gpa at 40 psi through 8001 flat fan nozzles. The experiment had a randomized complete block design with three replicates per treatment.

Table. Celebrity with adjuvants-Carrington, ND (Zollinger and Fitterer).

Treatment [a]	Rate	June 28	June 28					July 13
		Corn	Fxtl [b]	Rrpw	Prpw	Colq	Wibw	Fxtl [b]
	(oz prod/A)	% (injury)	(% control)					(% control)
Accent&Distinct+NIS+28% UAN	0.34&2+0.25%+1.25%	0	83	90	85	88	47	80
Accent&Distinct+NIS+28% UAN	0.67&4+0.25%+1.25%	0	80	87	92	85	48	75
Accent&Distinct+PO	0.34&2+2 qt	0	87	83	85	83	40	83
Accent&Distinct+PO	0.67&4+2 qt	5	90	92	88	95	52	82
Accent&Distinct+PO+28% UAN	0.34&2+2 qt+1.25%	0	83	88	88	92	50	67
Accent&Distinct+PO+28% UAN	0.67&4+2 qt+1.25%	0	88	92	90	90	52	83
Accent&Distinct+Scoil	0.34&2+2 qt	0	93	85	88	89	38	92
Accent&Distinct+Scoil	0.67&4+2 qt	0	94	90	95	92	58	93
Accent&Distinct+Scoil+28% UAN	0.34&2+2 qt+1.25%	0	92	90	92	95	53	90
Accent&Distinct+Scoil+28% UAN	0.67&4+2 qt+1.25%	0	93	92	96	91	60	83
Untreated		0	0	0	0	0	0	0
LSD (0.05)		0	8	5	9	9	10	8

[a]NIS = nonionic surfactant = Activator 90; UAN = urea ammonium nitrate; PO = petroleum oil = Herbimax; Scoil = methylated seed oil.
[b]Fxtl = Girft and Yeft.

Crop and weeds were not stressed at application. Approximately 5% corn injury was observed from Accent&Distinct+PO at 0.67+4+2 qt. Injury was expressed as speckling on older leaves. All treatments provided complete redroot pigweed, prostrate pigweed, common lambsquarters, and wild buckwheat control at July 13 (data not shown). Generally, the order of adjuvant enhancement was Scoil>PO>NIS. Treatments at the same rate did not result in greater weed control from addition of fertilizer. Generally, greater weed control occurred with the higher rates when NIS or PO was added. When Scoil was added, generally, there were no difference in weed control.

Celebrity Plus (Accent&Distinct) with adjuvants-Wyndmere, ND. Zollinger and Fitterer. An experiment was conducted in Wyndmere, ND to evaluate weed control from Celebrity with adjuvants. Pioneer '39M81' corn was planted on April 28, 1999. POST treatments were applied June 3, 1999 at 10:30 to 12:00 pm with 67 F air, 70 F soil surface, 65% relative humidity, 100% clouds, 5 to 15 mph SE wind, dry soil surface, moist subsoil, poor crop vigor (chlorotic, stunted), no dew present, and 6 inch corn. Weed species present were: 1 to 4 leaf (50 to 300 plants/ft^2) foxtail; 1 to 4 inch (5 to 10 plants/ft^2) common lambsquarters; 1 to 3 inch (1 to 2 plants/ft^2) common cocklebur; and 1 to 3 inch (1 to 5 plants/yd^2) curly dock. Treatments were applied to the center 6.67 feet of the 10 by 40 ft plots with a bicycle-wheel-type plot sprayer equipped with a wind shield delivering 8.5 gpa at 40 psi through 8001 flat fan nozzles. The experiment had a randomized complete block design with three replicates per treatment.

Table. Celebrity with adjuvants-Wyndmere, ND (Zollinger and Fitterer).

		June 16				June 30
Treatment[a]	Rate	Fxtl[b]	Colq	Cocb	Cudo[b]	Fxtl[b]
	(oz prod/A)	(% control)				
Accent&Distinct+NIS+28% UAN	0.34&2+0.25%+1.25%	62	76	82	82	53
Accent&Distinct+NIS+28% UAN	0.67&4+0.25%+1.25%	68	72	83	90	57
Accent&Distinct+PO	0.34&2+2 qt	63	82	82	77	53
Accent&Distinct+PO	0.67&4+2 qt	72	83	93	88	67
Accent&Distinct+PO+28% UAN	0.34&2+2 qt+1.25%	67	80	88	89	57
Accent&Distinct+PO+28% UAN	0.67&4+2 qt+1.25%	80	82	95	95	75
Accent&Distinct+Scoil	0.34&2+2 qt	83	87	90	87	78
Accent&Distinct+Scoil	0.67&4+2 qt	77	88	93	95	83
Accent&Distinct+Scoil+28% UAN	0.34&2+2 qt+1.25%	87	90	93	93	80
Accent&Distinct+Scoil+28% UAN	0.67&4+2 qt+1.25%	85	90	95	95	90
Untreated		0	0	0	0	0
LSD (0.05)		7	6	8	8	10

[a]NIS = nonionic surfactant = Activator 90; UAN = urea ammonium nitrate; PO = petroleum oil = Herbimax; Scoil = methylated seed oil.
[b]Fxtl = Grft and Yeft, Cudo = curly dock.

Field conditions preceding and after application were hot and dry. Weeds were drought stressed at application. All treatments gave complete common lambsquarters, common cocklebur, and curly dock control at June 30 (data not shown). Generally, the order of adjuvant enhancement was Scoil>PO>NIS. Treatments at the same rate did not result in greater weed control, with the exception of foxtail, from the addition of fertilizer. Generally, greater weed control occurred with the higher rates when NIS or PO was added. When Scoil was added, generally, there were no difference in weed control.

Roundup Ultra with adjuvants-Casselton, ND. Zollinger and Fitterer. An experiment was conducted near Casselton, ND to evaluate weed control from Roundup Ultra applied with adjuvants including drift retardants. POST treatments were applied June 18, 1999 at 1:00 to 3:00 pm with 77 F air, 83 F soil surface, 65% relative humidity, 90% clouds, and 15 to 30 mph S wind, dry soil surface, moist subsoil, good crop vigor, and no dew present. Weed species present were: 1 to 5 inch (10 to 30 plants/ft^2) foxtail; 1 to 5 inch (5 to 10 plants/ft^2) wild mustard; 1 to 2 inch (1 plant/yd^2) redroot pigweed; 1 to 2 inch (1 to 2 plants/yd^2) common lambsquarters; and 1 to 6 inch (1 to 5 plants/ft^2) common cocklebur. Treatments were applied to the center 6.67 feet of the 10 by 40 ft plots with a bicycle-wheel-type plot sprayer equipped with a wind shield delivering 8.5 gpa at 40 psi through 8001 flat fan nozzles. The experiment had a randomized complete block design with three replications per treatment.

Table. Roundup Ultra with adjuvants-Casselton, ND (Zollinger and Fitterer).

Treatment[a]	Rate	August 4			
		Fxtl[b]	Rrpw	Colq	Cocb
	(oz prod/A)	(% control)			
Roundup Ultra	8	99	95	90	83
Roundup Ultra	4	73	52	40	52
Roundup Ultra+Choice	4+0.5% v/v	75	73	70	77
Roundup Ultra+AMS	4+8.5lb/100gal	98	92	83	85
Roundup Ultra+Placement+AMS	4+6+8.5lb/100gal	98	90	79	83
Roundup Ultra+AMS	4+17lb/100gal	98	80	70	80
Roundup Ultra+Placement+AMS	4+6+17lb/100gal	98	88	82	87
Roundup Ultra+WDA-191	4+9lb/100gal	98	93	90	86
Roundup Ultra+WDA-192	4+2.5gal/100gal	99	85	75	85
Roundup Ultra+WDA-194+AMS	4+6+8.5lb/100gal	93	86	86	86
Roundup Ultra+WDA-194+AMS	4+6+17lb/100gal	98	92	88	87
Roundup Ultra+WDA-196	4+9lb/100gal	96	90	82	83
Roundup Ultra+WDA-197	4+1gal/100gal	99	90	83	90
Roundup Ultra+CL9804	4+2.5% v/v	98	92	87	88
Roundup Ultra+CL9904	4+2.5% v/v	83	73	73	70
Roundup Ultra+Agri-Stay	4+1.5pt	70	60	55	55
Roundup Ultra+Corral AMS	4+2.5gal/100gal	98	87	73	80
Roundup Ultra+Dryve	4+15lb/100gal	93	87	77	83
Roundup Ultra+UltraGard	4+48/100gal	80	63	50	57
Roundup Ultra+Array	4+14lb/100gal	96	92	82	85
Roundup Ultra+Surf Plus	4+2.5% v/v	85	87	85	85
Untreated		0	0	0	0
LSD (0.05)		6	8	9	7

[a]Choice = water conditioning agent; AMS = ammonium sulfate; Placement = drift retardant; WDA-191, WDA-192, WDA-196, and WDA-197 = drift retardant+ammonium sulfate; WDA-194 = drift retardant; CL9804 = nonionic sufactant+ammonium sulfate; CL9904 = nonionic surfactant+ammonium sulfate+drift retardant; Agri-Stay = unclassified; Corral AMS = ammonium sulfate + drift retardant; Dryve = ammonium sulfate+drift retardant+deposition aid+anti-foam agent; UltraGard = drift retardant+antifoam+water conditioning agent; Array and Surf Plus = ammonium sulfate+drift retardant.
[b]Fxtl = Grft and Yeft.

Initial treatments were sprayed June 18, 1999 using 8 oz product/A of Roundup Ultra. When evaluated July 2 all treatments provided 99% control of green and yellow foxtail, wild mustard, redroot pigweed, common lambsquarters, and common cocklebur (data not shown). On July 16, all treatments were reapplied with half the concentration of Roundup Ultra to the same plots on a new flush of the original weed spectrum. All treatments completely controlled wild mustard (data not shown). Weeds were not stressed at application by lack of moisture. A wind shield was used at application due to strong wind conditions. High weed control ratings with some treatments were surprising considering the reduced rate of Roundup Ultra used in combination with windy conditions which may have also resulted in less herbicide intercepting plant foliage. Roundup Ultra was applied at a reduced rate to observe differences in weed control enhancement by various adjuvants including drift retardants. Weed control ratings varied widely by adjuvant. Most adjuvants with Roundup Ultra gave equal or greater weed control than Roundup Ultra applied alone at the same rate. Adjuvants that generally provided less enhancement of weed control were Choice, CL9904, Agri-Stay, and UltraGard.

Roundup Ultra with adjuvants-Wyndmere, ND. Zollinger and Fitterer. An experiment was conducted near Wyndmere, ND to evaluate weed control from Roundup Ultra with adjuvants. POST treatments were applied June 16, 1999 at 2:00 to 3:00 pm with 76 F air, 94 F soil surface, 26% relative humidity, 15% clouds, and 2 to 8 mph NE wind, dry soil surface, dry subsoil, poor crop vigor (drought stressed), and no dew present. Weed species present were: 3 to 10 inch (10 to 40 plants/ft^2) foxtail; 2 to 12 inch (2 to 10 plants/ft^2) common lambsquarters; 2 to 6 inch (2 plants/ft^2) redroot pigweed; and 5 to 10 inch (2 plants/ft^2) volunteer corn. Treatments were applied to the center 6.67 feet of the 10 by 40 ft plots with a bicycle-wheel-type plot sprayer delivering 8.5 gpa at 40 psi through 8001 flat fan nozzles. The experiment had a randomized complete block design with three replicates per treatment.

Table. Roundup Ultra with adjuvants-Wyndmere, ND (Zollinger and Fitterer).

Treatment[a]	Rate	June 30			July 13			
		Corn	Fxtl[b]	Colq	Corn	Fxtl[b]	Rrpw	Colq
	(oz prod/A)	(% control)						
Roundup Ultra	16	98	90	92	99	96	96	94
Roundup Ultra	8	77	52	47	93	80	83	77
Roundup Ultra+Choice	8+0.5% v/v	73	50	53	91	87	90	87
Roundup Ultra+AMS	8+8.5lb/100gal	83	67	60	98	89	91	92
Roundup Ultra+Placement+AMS	8+6+8.5lb/100gal	86	80	58	98	92	92	92
Roundup Ultra+AMS	8+17lb/100gal	95	78	63	99	92	90	92
Roundup Ultra+Placement+AMS	8+6+17lb/100gal	93	78	75	96	87	88	88
Roundup Ultra+WDA-191	8+9lb/100gal	78	72	55	99	85	90	90
Roundup Ultra+WDA-192	8+2.5gal/100gal	90	80	67	94	91	90	90
Roundup Ultra+WDA-194+AMS	8+6+8.5lb/100gal	85	65	58	93	95	92	90
Roundup Ultra+WDA-194+AMS	8+6+17lb/100gal	93	63	60	93	87	87	80
Roundup Ultra+WDA-196	8+9lb/100gal	93	77	63	99	96	93	87
Roundup Ultra+WDA-197	8+1gal/100gal	90	75	60	95	96	90	87
Roundup Ultra+CL9804	8+2.5% v/v	90	80	80	96	93	93	92
Roundup Ultra+CL9904	8+2.5% v/v	95	65	65	99	90	90	88
Roundup Ultra+Agri-Stay	8+1.5 pt	87	63	60	96	87	90	80
Roundup Ultra+Corral AMS	8+2.5gal/100gal	92	73	60	98	98	87	92
Roundup Ultra+Dryve	8+15lb/100gal	80	65	53	96	90	88	82
Roundup Ultra+UltraGard	8+48/100gal	87	60	50	94	93	90	85
Roundup Ultra+Array	8+14lb/100gal	90	77	67	98	92	93	88
Roundup Ultra+Surf Plus	8+2.5% v/v	88	75	70	96	93	90	93
Untreated		0	0	0	0	0	0	0
LSD (0.05)		14	15	12	6	8	7	9

[a]Choice = water conditioning agent; AMS = ammonium sulfate; Placement = drift retardant; WDA-191, WDA-192, WDA-196, and WDA-197 = drift retardant+ammonium sulfate; WDA-194 = drift retardant; CL9804 = nonionic surfactant+ammonium sulfate; CL9904 = nonionic surfactant+ ammonium sulfate+drift retardant; Agri-Stay = unclassified; Corral AMS = ammonium sulfate + drift retardant; Dryve = ammonium sulfate+drift+retardant+ deposition aid+anti-foam agent; UltraGard = drift retardant+antifoam+ water conditioning agent; Array and Surf Plus = ammonium sulfate+drift retardant.
[b]Fxtl = Grft and Yeft.

Redroot pigweed was controlled by all treatments on June 30. Roundup Ultra was applied at a reduced rate to detect differences in enhancement of weed control by various adjuvants including drift retardants. Weed control ratings varied widely by adjuvant. However, volunteer corn control was greater than 91% on July 13. Most adjuvants with Roundup Ultra gave equal or greater weed control than Roundup Ultra applied alone at the same rate. Adjuvants that generally provided less enhancement of weed control were Choice, WDA-194+AMS, and Agri-Stay.

Raptor with adjuvants-Casselton, ND. Zollinger and Fitterer. An experiment was conducted near Casselton, ND to evaluate weed control from POST applied herbicides. 'Traill' soybean was planted on May 27, 1999. POST treatments were applied June 18, 1999, at 1:00 to 3:00 pm with 77 F air, 83 F soil surface, 65% relative humidity, 90% clouds, and 15 to 30 mph S wind, dry soil surface, moist subsoil, good crop vigor, no dew present, to first trifoliate soybean. Weed species present were: 1 to 5 inch (10 to 30 plants/ft^2) foxtail; 1 to 5 inch (5 to 10 plants/ft^2) wild mustard; 1 to 2 inch (1 plant/yd^2) redroot pigweed; 1 to 2 inch (1 to 2 plants/yd^2) common lambsquarters; and 1 to 6 inch (1 to 5 plants/ft^2) common cocklebur. Treatments were applied to the center 6.67 feet of the 10 by 40 ft plots with a bicycle-wheel-type plot sprayer equipped with a wind shield delivering 8.5 gpa at 40 psi through 8001 flat fan nozzles. The experiment had a randomized complete block design with three replicates per treatment.

Table. Raptor with adjuvants-Casselton, ND (Zollinger and Fitterer).

		July 2			July 16			
Treatment[a]	Rate	Fxtl[b]	Colq	Cocb	Fxtl[b]	Rrpw	Colq	Cocb
	(oz prod/A)	(% control)						
Raptor+Destiny+28% UAN	4+1% v/v+1 qt	92	92	88	93	95	95	95
Raptor+Destiny+28% UAN	2+1% v/v+1 qt	77	73	73	93	88	88	90
Raptor+PO+28% UAN	2+1% v/v+1 qt	77	75	75	90	90	90	87
Raptor+CL9605+28% UAN	2+0.5% v/v+1 qt	70	67	67	80	73	77	82
Raptor+Newtone	2+1% v/v	85	85	85	87	87	87	87
Raptor+Preference+28% UAN	2+0.25% v/v+1 qt	73	70	70	80	63	67	77
Raptor+CL9910+28% UAN	2+0.25% v/v+1 qt	83	80	80	80	70	77	80
Raptor+CL9911+28% UAN	2+0.25% v/v+1 qt	67	63	63	80	73	77	78
Raptor+CL9908+28% UAN	2+0.5% v/v+1 qt	70	63	67	77	77	77	83
Raptor+CL9920+28% UAN	2+1.25% v/v+1 qt	60	57	57	70	77	73	73
Raptor+CL9920+28% UAN	4+1.25% v/v+1 qt	80	85	85	95	92	85	88
Raptor+Dispatch 2N	2+2.5 qt	67	68	68	77	70	70	73
Raptor+LI-111	2+1% v/v	83	87	87	93	90	93	95
Raptor+Breakout	2+1% v/v	65	65	65	78	70	75	70
Raptor+FirstMate	2+1% v/v	80	82	82	88	85	85	85
Raptor+Agri-Stay	2+1.5 pt	57	57	57	70	70	73	73
Raptor+Scoil	2+1.5 pt	80	87	85	88	83	85	88
Untreated		0	0	0	0	0	0	0
LSD (0.05)		7	6	5	3	7	5	3

[a]Destiny, Scoil = methylated seed oils; UAN = urea ammonium nitrate; PO = petroleum oil = Herbimax; Breakout, CL9605, NewTone and LI-111 = basic blend; Preference = nonionic surfactant; Dispatch 2N, Surfate = nonionic surfactant + nitrogen fertilizer; CL9910 = crop oil concentrate; CL9911 = nonionic surfactant; CL9908 = high concentrate crop oil; CL9920 = modified vegetable oil; Vortex = methylated seed oil + water conditioning agent; FirstMate = basic blend + methylated seed oil; Agri-Stay = unclassified adjuvant.
[b]Fxtl = Grft and Yeft.

Weeds were not stressed by lack of moisture at application. High weed control ratings with some treatments were surprising considering the reduced rate of Raptor used in combination with windy conditions which resulted in less herbicide intercepted by plant foliage. On July 2 all treatments controlled wild mustard and redroot pigweed. On July 16 all treatments controlled wild mustard. Adjuvants resulting in the best weed control with Raptor were PO+28% nitrogen, Newtone, CL9910+28% nitrogen, LI-111, FirstMate, and Scoil. Adjuvants resulting in reduced weed control with Raptor were CL9911+28% nitrogen, Dispatch 2N, Breakout, and Agri-Stay.

Raptor with adjuvants-Wyndmere, ND. Zollinger and Fitterer. An experiment was conducted near Wyndmere, ND to evaluate weed control from Raptor plus various adjuvants. POST treatments were applied June 3, 1999 at 10:30 to 12:00 pm with 67 F air, 70 F soil surface, 65% relative humidity, 100% clouds, and 5 to 15 mph SE wind, dry soil surface, moist subsoil, poor crop vigor (chlorotic, stunted), and no dew present. Weed species present were: 1 to 5 inch (50 to 300 plants/ft^2) foxtail; 1 to 4 inch (1 to 2 plants/yd^2) common lambsquarters; 1 to 3 inch (1 to 2 plants/yd^2) volunteer corn; 1 to 4 inch (1 to 2 plants/yd^2) common ragweed; and 1 to 5 inch (10 to 15 plants/ yd^2) wild mustard. Treatments were applied to the center 6.67 feet of the 10 by 40 ft plots with a bicycle-wheel-type plot sprayer equipped with a wind shield delivering 8.5 gpa at 40 psi through 8001 flat fan nozzles. The experiment had a randomized complete block design with three replicates per treatment.

Table. Raptor with adjuvants-Wyndmere, ND (Zollinger and Fitterer).

Treatment[a]	Rate	June 16				June 30		
		Fxtl[b]	Corn	Colq	Corw	Fxtl[b]	Colq	Corw
	(oz prod/A)	(% control)						
Raptor+Destiny+28% UAN	4+1% v/v+1qt	82	92	72	37	95	92	90
Raptor+Destiny+28% UAN	2+1% v/v+1qt	77	70	72	37	82	77	67
Raptor+PO+28% UAN	2+1% v/v+1qt	68	62	57	33	73	68	62
Raptor+CL9605+28% UAN	2+0.5% v/v+1qt	47	22	50	20	57	50	47
Raptor+Newtone	2+1% v/v	65	50	63	33	78	83	73
Raptor+Preference+28% UAN	2+0.25% v/v+1qt	52	30	53	20	57	53	33
Raptor+CL9910+28% UAN	2+0.25% v/v+1qt	65	52	55	17	75	75	68
Raptor+CL9911+28% UAN	2+0.25% v/v+1qt	43	15	50	10	37	33	27
Raptor+CL9908+28% UAN	2+0.5% v/v+1qt	53	20	68	25	72	77	67
Raptor+CL9920+28% UAN	2+1.25% v/v+1qt	50	23	57	20	57	57	47
Raptor+CL9920+28% UAN	4+1.25% v/v+1qt	60	35	60	27	93	90	83
Raptor+Dispatch 2N	2+2.5qt	62	40	63	27	67	53	50
Raptor+LI-111	2+1% v/v	65	60	70	30	77	80	70
Raptor+Breakout	2+1% v/v	67	38	67	30	67	63	57
Raptor+FirstMate	2+1% v/v	67	52	57	23	83	57	57
Raptor+Agri-Stay	2+1.5pt	52	30	53	23	63	62	57
Raptor+Scoil	2+1.5pt	78	73	68	37	78	80	70
Untreated		0	0	0	0	0	0	0
LSD (0.05)		8	6	6	8	6	7	5

[a]Destiny, Scoil = methylated seed oils; UAN = urea ammonium nitrate; PO = petroleum oil = Herbimax; Breakout, CL9605, NewTone, and LI-111 = basic blend; Preference = nonionic surfactant; Dispatch 2N, Surfate = nonionic surfactant + nitrogen fertilizer; CL9910 = crop oil concentrate; CL9911 = nonionic surfactant; CL9908 = high concentrate crop oil; CL9920 = modified vegetable oil; Vortex = methylated seed oil + water conditioning agent; FirstMate = basic blend + methylated seed oil; Agri-Stay = unclassified adjuvant.
[b]Fxtl = Grft and Yeft.

Weed species were stressed due to lack of water at application. All treatments controlled wild mustard. Adjuvant applied with Raptor at reduced rate of 2 fl oz/A resulted in a wide range of enhanced weed control and herbicide efficacy. Adjuvants that consistently improved weed control on June 16 and June 30 were Destiny+28% nitrogen and Scoil. In addition, on June 30, Newtone provided greater weed control compared to other 2 fl oz/A Raptor treatments. Some adjuvants that provided less herbicide enhancement for one or more weed species were CL9605+28% nitrogen, CL9911+28% nitrogen, and Agri-Stay. Common ragweed control was similar among treatments on June 16 but greater differences were observed on June 30.

Glyphosate efficacy is influenced by ammonium sulfate concentration, Fargo. (Ramsdale and Messersmith) The experiment was conducted to determine the effect of ammonium sulfate concentration on glyphosate efficacy. 'Valley' oat, 'Red Siberian' foxtail millet, and 'White' proso millet were seeded as strips side-by-side on May 27, 1999, near Fargo, ND. Plots 10 ft wide were laid out perpendicular to the seeded strips so that each plot contained the three assay species. Treatments were applied at 6:00 pm on June 30, 1999, with a bicycle-wheel-type plot sprayer equipped with four 8001 flat-fan nozzles at 20-inch spacing and delivering 8.5 gpa at 35 psi. Conditions at treatment were 75 F, 50% RH, wind at 5 mph, and sky cloudy. Oat was 10 to 12 inches, foxtail millet 12 to 14 inches, and proso millet 8 to 10 inches and each species was tillering. Experimental design was a randomized complete block with four replicates. The Rodeo® formulation of glyphosate was used and treatments were applied with 0.5% v/v oxysorbic (Tween 20) surfactant (ICI Surfactants). Reference treatments of the Roundup Ultra® formulation were also included.

			July 12			July 26
Treatment[a]	Rates	% AMS	Oat	Prmi	Fomi	Oat
	lb ae/A	w/v	% control			
Glyphosate	0.031	0	35	28	14	26
Glyt + AMS	0.031	0.5	48	39	32	51
Glyt + AMS	0.031	1.0	48	38	25	43
Glyt + AMS	0.031	2.0	44	36	25	26
Glyt	0.062	0	70	59	49	77
Glyt + AMS	0.062	0.5	75	63	55	82
Glyt + AMS	0.062	1.0	69	65	56	80
Glyt + AMS	0.062	2.0	61	55	46	76
Glyt	0.093	0	87	69	64	96
Glyt + AMS	0.093	0.5	88	75	68	95
Glyt + AMS	0.093	1.0	88	80	68	95
Glyt + AMS	0.093	2.0	76	73	63	87
Glyt	0.124	0	95	85	76	99
Glyt + AMS	0.124	0.5	95	86	79	100
Glyt + AMS	0.124	1.0	93	86	79	99
Glyt + AMS	0.124	2.0	80	78	69	93
Glyt-Ultra	0.062	0	47	46	46	35
Glyt-Ultra + AMS	0.062	1.0	53	55	45	58
CV			9	8	12	7
LSD (5%)			9	7	9	7

[a] Glyphosate = Rodeo® formulation; Glyt-Ultra = Roundup Ultra® forumulation; AMS = spray grade ammonium sulfate; All glyphostate treatments were applied with 0.5% v/v Tween 20 from ICI Surfactants.

Overall, glyphosate efficacy was maximized by adding 0.5% ammonium sulfate (AMS) regardless of glyphosate rate or assay species. Glyphosate plus 1.0% AMS provided similar control and did not enhance phytotoxicity beyond that provided by glyphosate plus 0.5% AMS. However, species control by glyphosate plus 2.0% AMS was generally less than the control provided by glyphosate plus 0.5% or 1.0% AMS and was similar to glyphosate applied alone. Oat control by glyphosate applied at 0.093 or 0.124 lb ae/A plus 2.0% AMS was significantly less than glyphosate applied alone. The label states that 17 lb AMS per 100 gallons water (2.0% w/v) should be added to glyphosate regardless of spray carrier water quality. Fargo city water was used for this study which has a low content of antagonistic salts. These data suggest that 2.0% AMS may antagonize glyphosate phytotoxicity when reduced rates are used and/or when the water has few antagonistic salts.

Tralkoxydim in spray water with 1.8 g/L NaHCO3, Fargo. (Roach and Davidson-Harrington) 'Oxen' hard red spring wheat was seeded April 29. Treatments were applied to 3.5 to 4 leaf wheat, 1.5 to 2.5 leaf wild oat, cotyledon to 2 leaf wild mustard and wild buckwheat, and cotyledon to 1 leaf Venice mallow on May 25 with 61° F, 46% RH, clear sky and 11 mph wind. Treatments were applied with a bicycle wheel type plot sprayer delivering 8.5 gpa at 35 psi through 8001 flat fan nozzles to a 7 ft wide area the length of 10 by 30 ft plots. The experiment was a randomized complete block design with four replicates.

		6/8/99		7/9/99	
Treatment	Rate	Wht	Wioa	Wht	Wioa
	oz ai/A		%		
Tralkoxydim+TF8035	2+0.5%	0	49	0	45
Tralkoxydim+TF8035+AMS	2+0.5%+24	3	87	0	69
Tralkoxydim+TF8035+AMS	2.8+0.5%+24	1	89	0	78
Tral+2,4-Dioe+TF8035	2+4+0.5%	0	65	0	44
Tral+Carf+24-Dioe+TF8035	2+0.13+4+0.5%	0	70	0	64
Tral+Brox&MCPA+TF8035	2+8+0.5%	0	77	0	48
Tral+Carf+2,4-Dioe+TF8035+AMS	2+0.13+4+0.5%+24	6	95	1	77
Tralkoxydim+Scoil	2+0.18gpa	0	88	0	75
Tralkoxydim+Vortex	2+0.18gpa	3	84	1	66
Tralkoxydim+ND191C5	2+1%	1	86	0	74
Tralkoxydim+ND191C5	2+2%	4	88	0	81
Tralkoxydim+Quad7	2+2%	6	97	3	91
Untreated	0	0	0	0	0
C.V. %		138	9	309	21
LSD 5%		4	9	NS	19
# OF REPS		4	4	4	4

Tralkoxydim, regardless of accompanying adjuvant or broadleaf control herbicide, did not injure wheat. Tralkoxydim rate was intentionally low and sodium bicarbonate, an antagonist of tralkoxydim efficacy, was added to enhance differences in adjuvant performance and broadleaf herbicide antagonism. All adjuvants tested were more effective than TF8035 alone with tralkoxydim at 0.125 lb/A and sodium bicarbonate. The inclusion of ammonium sulfate (AMS) with TF8035 enhanced tralkoxydim efficacy to equal that from other adjuvants. Tralkoxydim+ carfentrazone+2,4-D+AMS gave excellent wild oat control early, but control was similar to other treatments later in the season. Poor wild oat control from tralkoxydim at 0.125 lb/A with only TF8035 was apparently due to antagonism by sodium bicarbonate and was overcome by the addition of AMS.

Air-induction nozzle effects on glyphosate and paraquat efficacy, Fargo. (Ramsdale and Messersmith) Experiments were conducted to examine herbicide efficacy as influenced by application with various air-induction nozzle designs. 'Valley' oat, 'Red Siberian' foxtail millet, and 'White' proso millet were seeded as strips side-by-side on May 27, 1999. Plots 11.5 ft wide were laid out perpendicular to the seeded strips so that each plot contained the three assay species. Treatments were applied at 3:00 pm on July 2, 1999, with an all-terrain vehicle equipped with a four nozzle (20-inch spacing) boom offset to one side. Conditions at treatment were 81 F, 50% RH, wind at 5 mph, and sky cloudy. Oat was 10 to 12 inch, foxtail millet 12 to 14 inch, and proso millet 10 to 12 inch, and each species was tillering. Glyphosate was the Rodeo® formulation applied at 0.125 lb ae/A and paraquat was applied at 0.0625 lb ai/A. Each herbicide was applied with 0.25% v/v Activator 90 nonionic surfactant (Loveland Industries). Experimental design was a randomized complete block with four replicates, and separate experiments were conducted for each herbicide. Plots were evaluated visually on July 12.

				Glyphosate[b]			Paraquat		
Nozzle[a]	Volume	Speed	Pressure	Oat	Prmi	Fomi	Oat	Prmi	Fomi
	gpa	mph	psi	% control					
Conventional	7.5	8	40	90	84	86	70	80	83
AI TeeJet	7.5	9.6	60	88	83	90	73	84	85
Lurmark	7.5	9.6	60	87	79	83	71	85	84
Nozzle Systems	7.5	9.6	60	84	78	81	69	85	86
TurboDrop	7.5	9.6	60	85	79	82	75	88	89
Conventional	15	4	40	80	76	78	69	84	85
AI TeeJet	15	4.8	60	76	69	73	65	78	79
Lurmark	15	4.8	60	81	66	80	68	82	86
Nozzle Systems	15	4.8	60	78	76	77	59	77	75
TurboDrop	15	4.8	60	78	70	81	64	84	86
CV				5	6	6	7	6	6
LSD (5%)				6	7	7	7	7	7

[a] All nozzles were 11002 flat-fan nozzles. Conventional and AI TeeJet nozzles from Spraying Systems Co., Wheaton, IL; Lurmark = Lurmark Ultra-Lo-Drift™, Precision Fluid Control Products, Farmington, MN; Nozzle Systems, Winston, GA; TurboDrop from Greenleaf Technologies, Covington, LA.
[b] Glyphosate = Rodeo® formulation.

Paraquat or glyphosate applied with the four air-induction nozzle designs provided species control similar to application with a conventional nozzle at the same spray volume. Glyphosate and paraquat phytotoxicity both tended to be greater when applied at 7.5 versus 15 gpa. The assay species were large in this experiment; perhaps differences in control would be detected when the target species are very small.

Drift-reducing nozzle effects on glyphosate and paraquat efficacy, Fargo. (Ramsdale and Messersmith) Several nozzle manufacturers have introduced drift-reducing-type nozzles. Therefore, experiments were conducted to examine herbicide efficacy as influenced by application with various drift-reducing nozzle designs. 'Valley' oat, 'Red Siberian' foxtail millet, and 'White' proso millet were seeded as strips side-by-side on May 27, 1999. Plots 11.5 ft wide were laid out perpendicular to the seeded strips so that each plot contained the three assay species. Treatments were applied 7:00 to 9:00 am on June 25, 1999, with an all-terrain vehicle equipped with a four nozzle (20-inch spacing) boom offset to one side. Conditions at treatment were 75 F, 58% RH, wind at 3 to 6 mph, and sky cloudy. Oat was 6 to 8 inch, foxtail millet 7 to 10 inch, and proso millet 5 to 7 inch, and each species was tillering. Glyphosate was the Rodeo® formulation applied at 0.125 lb ae/A and paraquat was applied at 0.0625 lb ai/A. Each herbicide was applied with 0.25% v/v Activator 90 nonionic surfactant (Loveland Industries). Experimental design was a randomized complete block with four replicates, and separate experiments were conducted for each herbicide. Treatments consisted of conventional (40 psi), Drift Guard (30 psi), Turbo TeeJet (20 psi), AI TeeJet (70 psi), and TurboDrop (70 psi) flat-fan nozzles and three spray volumes of 5, 10, and 20 gpa. Spray volume was changed by altering application speed. Plots were evaluated visually on July 7.

	Glyphosate[b]			Paraquat		
Nozzle[a]	Oat	Prmi	Fomi	Oat	Prmi	Fomi
	% control					
Nozzle[c]						
Conventional	98	82	85	79	98	92
Drift Guard	98	81	83	76	97	92
Turbo TeeJet	98	80	81	77	96	90
AI TeeJet	98	83	84	77	97	93
TurboDrop	97	83	84	76	97	92
LSD (5%)	NS	NS	NS	NS	NS	NS
Volume[d]						
5 gpa	98	86	87	85	98	93
10 gpa	98	82	84	79	98	93
20 gpa	98	78	80	67	96	90
LSD (5%)	NS	2	2	2	1	2

[a] All nozzles were 11002 flat-fan nozzles. Conventional, Drift Guard, Turbo TeeJet and AI TeeJet nozzles from Spraying Systems Co., Wheaton, IL; TurboDrop from Greenleaf Technologies, Covington, LA.
[b] Glyphosate = Rodeo® formulation.
[c] Data averaged over spray volume.
[d] Data averaged over spray nozzle.

Paraquat or glyphosate applied with the four drift-reducing nozzles provided species control similar to application with a conventional nozzle regardless of spray volume. Glyphosate and paraquat phytotoxicity both tended to increase as spray volume decreased, especially for the species that were most difficult to control with each herbicide. The assay species were large in this experiment; perhaps significant differences in control would be detected when the target species are very small.

Weed control in corn. Zollinger and Fitterer. An experiment was conducted near Casselton, ND to evaluate weed control from herbicides applied at the PPI, PRE, and POST stages. Two rows of Interstate PayCo '4X85' corn and two rows of Pioneer '39D81' corn were planted in each plot and PPI and PRE treatments were applied on May 27, 1999. PPI treatments were applied and incorporated with a rototiller operated 2 inches deep at 9:00 am with 77 F air and 56 F soil at 2 to 4 inch depth. PRE treatments were applied at 9:30 am with 80 F air and 56 F soil at a 2 to 4 inch depth. PPI and PRE treatments had 56% relative humidity, 0% clouds, and 5 to 12 mph N wind, dry soil surface, and moist subsoil. The POST treatments were applied June 18, 1999 at 11:00 am with 72 F air, 86 F soil surface, 48% relative humidity, 30% clouds, and 5 to 15 SE mph wind, dry soil surface, dry subsoil, fair crop vigor (yellowing), no dew present, and 8 inch corn. Weed species present were: 2 to 5 inch, (5 to 20/ft^2) foxtail; 1 inch, cotyledons to 2 lf, (5 to 20/ft^2) wild mustard; 4 to 6 inch, 4 to 6 lf, (2 to 15/ft^2) common cocklebur; 1 to 3 inch, cotyledon to 2 lf, (2 to 5/ ft^2) common lambsquarters; and 1 to 2 inch, cotyledon to 2 lf, (1 to 5/ ft^2) redroot pigweed. Treatments were applied to the center 6.67 feet of the 10 by 40 ft plots with a bicycle-wheel-type plot sprayer equipped with a wind shield delivering 17 gpa at 40 psi through 8002 flat fan nozzles for PPI and PRE treatments and 8.5 gpa at 40 psi through 8001 flat fan nozzles for POST treatments. The experiment had a randomized complete block design with three replicates per treatment.

Treatment	Rate	July 2 Corn	July 2 Fxtl	July 16 Fxtl	Corn yield
	Product/A	% injury	— % control —		bu/A
PPI/POST					
DoublePlay/Clarity	5pt/1pt	7	99	93	46
PRE/POST					
Frontier/Distinct+NIS+28% UAN	32floz/6oz+0.25%+1.25qt	0	94	92	44
Frontier/Accent+Clarity+NIS+28% UAN	20floz/0.5oz+4.5oz+0.25%+1.25qt	0	96	88	44
POST					
Accent+Distinct+NIS+28% UAN	0.67oz+4oz+0.25%+1.25qt	0	83	77	38
Accent+Dicamba+NIS+28% UAN	0.67oz+6oz+0.25%+1.25qt	0	80	80	41
Accent+Dicamba+Atrazine+Scoil	0.33oz+6oz+0.28lb+1.5pt	0	91	90	39
LSD (0.05)		NS	9	4	NS

All treatments controlled wild mustard at July 16. All treatments controlled wild mustard, redroot pigweed, common lambsquarters, and common cocklebur at July 7 and July16. Foxtail species were green and yellow foxtail but more yellow foxtail occurred than green foxtail. Most treatments gave complete broadleaf weed control and greater than 80% yellow foxtail control. Addition of Atrazine to Accent+Distinct improved foxtail control. Corn yield ranged from 38 to 46 bu/A.

Celebrity in corn. Zollinger and Fitterer. An experiment was conducted in Casselton, ND to evaluate weed control from herbicides applied at the PRE and POST stages. Two rows of Interstate PayCo '4X85' corn and two rows of Pioneer '39D81' corn were planted in each plot, and PRE treatments were applied on May 27, 1999 at 10:00 to 11:00 am with 90 F air, 62 F soil at 2 to 4 inch depth, 55% relative humidity, 0% clouds, 0 to 5 mph N wind, dry soil surface, and moist subsoil. POST treatments were applied June 15, 1999 at 10:30 am with 70 F air, 105 F soil surface, 35% relative humidity, 10% clouds, 5 to 10 NE mph wind, dry soil surface, moist subsoil, good crop vigor (slightly yellow), no dew present, to 6 to 10 inch corn. Weed species present were: 1 to 3 inch, 2 to 4 lf, (10 to 30/ft^2) foxtail; 1 to 2 inch, cotyledon to 4 lf, (5 to 7/ft^2) wild mustard; 2 to 4 inch, 2 to 4 lf, (1 to 5/ft^2) redroot pigweed; 1 inch, cotyledon to 2 lf, (1 to 2/ ft^2) Venice mallow; and 2 to 4 inch, 2 to 4 lf, (7 to 12/ft^2) common cocklebur. Treatments were applied to the center 6.67 feet of the 10 by 40 ft plots with a bicycle-wheel-type plot sprayer equipped with a wind shield delivering 17 gpa at 40 psi through 8002 flat fan nozzles for PRE treatments and 8.5 gpa at 40 psi through 8001 flat fan nozzles for POST treatments. The experiment had a randomized complete block design with three replicates per treatment.

		June 29			July 12	
Treatment	Rate	Fxtl	Cocb	Vema	Fxtl	Cocb
	Product/A	% control				
PRE/POST						
Frontier/Accent+Dica+NIS+28% UAN	20floz/0.34oz+3oz+0.25%+1.25%	90	70	63	87	80
Frontier/Accent+Dica+NIS+28% UAN	32floz/0.34oz+3oz+0.25%+1.25%	85	63	63	79	87
Frontier/Accent+Dica+NIS+28% UAN	20floz/0.67oz+6oz+0.25%+1.25%	88	77	73	90	96
Frontier/Accent+Dica+NIS+28% UAN	32floz/0.67oz+6oz+0.25%+1.25%	93	75	53	91	96
Frtr/Accent+Dica+Clarity+NIS+28%	20floz/0.34oz+3oz+4floz+0.25%+1.25%	77	77	73	83	96
Frtr/Accent+Distinct+NIS+28% UAN	20floz/0.34oz+2oz+0.25%+1.25%	61	69	78	78	93
Frtr/Accent+Distinct+NIS+28% UAN	32floz/0.34oz+2oz+0.25%+1.25%	87	73	73	87	95
Frtr/Accent+Distinct+NIS+28% UAN	20floz/0.67oz+4oz+0.25%+1.25%	83	80	78	83	96
Frtr/Accent+Distinct+NIS+28% UAN	32floz/0.67oz+4oz+0.25%+1.25%	90	80	86	93	95
Frtr/Acct+Distinct+Clarity+NIS+28%	20floz/0.34oz+2oz+4floz+0.25%+1.25%	80	87	88	83	93
Frtr/Laddok S-12+Scoil	32floz/1.7pt+1%	67	99	99	67	95
Frtr/Acct+Dist+Marksman+NIS+28%	32floz/0.34oz+2oz+1pt+0.25%+1.25%	73	99	98	78	92
Frtr/Acct+Distinct+Laddok S-12+Scoil	32floz/0.34oz+2oz+1.25pt+1%	73	96	96	75	90
POST						
Accent+Dicamba+NIS+28% UAN	0.34oz+3oz+0.25%+1.25%	80	77	60	78	80
Accent+Dicamba+NIS+28% UAN	0.67oz+6oz+0.25%+1.25%	82	77	70	90	93
Accent+Distinct+NIS+28% UAN	0.34oz+2oz+0.25%+1.25%	75	75	70	73	92
Accent+Distinct+NIS+28% UAN	0.67oz+4oz+0.25%+1.25%	73	73	70	82	95
Untreated		0	0	0	0	0
LSD (0.05)		16	10	19	15	9

All treatments completely controlled redroot pigweed and common lambsquarters. Venice mallow was not uniform at July 12 and evaluations were not taken. Generally, applying Frontier did not improve foxtail control compared to POST applications. Substituting Distinct for dicamba improved broadleaf weed control more than the changing the rate of products used. Common cocklebur control generally was greater than 80% at July 12.

Preemergence weed control in corn-Carrington. Zollinger and Fitterer. An experiment was conducted near Carrington, ND to evaluate weed control from herbicides applied PRE and POST. Cargill '1877' corn was planted on May 17, 1999. PRE treatments were applied on May 19, 1999 at 10:30 to 12:00 pm with 73 F air, 57.2 F soil at 2 to 4 inch depth, 50% relative humidity, 10% clouds, and 5 to 7 mph S wind, dry soil surface, and moist subsoil. POST treatments were applied June 14, 1999 at 12:00 pm with 65 F air, 75 F soil surface, 45% relative humidity, 15% clouds, 0 to 5 mph S wind, dry soil surface, moist subsoil, excellent crop vigor, no dew present, to 6 to 8 inch corn. Weed species present were: 3 to 4 inch, 3 to 6 lf, (5 to 20/ft^2) foxtail; 2 to 3 inch, (1 to 5/yd^2) common lambsquarters; 1 to 3 inch, 6 to 7 lf, (10 to 20/ft^2) redroot pigweed; 2 to 3 inch, 2 to 3 lf (4-6/ft^2) Venice mallow; and 1 to 3 inch, 6 to 7 lf, (10 to 20/ft^2) prostrate pigweed. Treatments were applied to the center 6.67 feet of the 10 by 40 ft plots with a bicycle-wheel-type plot sprayer equipped with a wind shield delivering 17 gpa at 40 psi through 8002 flat fan nozzles for PRE treatments and 8.5 gpa at 40 psi through 8001 flat fan nozzles for POST treatments. The experiment had a randomized complete block design with three replicates per treatment.

The study was established on a sloping hill. Rep one was at the bottom of the slope in a heavy, high organic matter soil. Rep three was near the top of the slope on a light soil with less organic matter. Injury was not detected in Rep one but highly visible in rep two and three. Averaged values were lower than individual plot values recorded in Rep three. All treatments gave complete pigweed control at June 28 and July 13 and gave complete common lambsquarters control at July 13. Most treatments gave greater than 90% foxtail, prostrate and redroot pigweed, and common lambsquarters control. At July 13, no PRE treatment controlled wild buckwheat but all POST treatments completely controlled wild buckwheat.

Treatment	Rate	Corn				June 23					June 28			July 13	
		June 14	June 23	June 28	July 13	Fxtl	Rrpw	Prpw	Colq	Wibw	Fxtl	Colq	Wibw	Fxtl	Wibw
	Product/A	% injury				% control									
PRE															
Epic	11oz	5	12	0	7	93	95	98	99	37	97	96	37	93	0
Epic+Atrazine	11oz+0.55lb	3	7	0	2	93	99	99	99	89	98	99	79	95	0
Epic	9oz	8	20	5	12	87	90	85	90	10	92	99	33	83	0
Epic+Atrazine	9oz+0.55lb	0	5	0	0	92	99	99	99	96	98	99	83	95	17
Surpass	2.5pt	0	2	0	0	89	96	93	86	83	96	90	43	87	0
Surpass+Atrazine	2.5pt+0.55lb	0	0	0	0	99	99	99	99	99	99	99	83	98	0
Dual II Magnum	1.5pt	0	3	0	7	98	96	96	91	66	98	91	63	93	30
Dual II Magnum+Atrazine	1.5pt+0.55lb	0	0	0	0	87	96	95	93	68	94	96	60	90	40
Axiom+Balance	13oz+1.2oz	0	3	0	2	96	99	99	99	73	97	99	63	93	0
Axiom+Atrazine	19oz+0.55lb	0	0	0	0	93	96	95	96	85	97	96	65	95	0
WF2705	4.5pt	0	3	0	3	94	98	98	98	81	96	99	65	87	0
WF2705	5pt	0	4	0	0	90	98	98	98	86	97	99	57	91	0
PRE/POST															
Surpass/ZA 1296+PO+28% UAN	2.5pt/0.188pt+1%+2.5%	0	7	0	3	99	99	99	99	96	98	99	99	98	99
FulTime/ZA 1296+PO+28% UAN	6pt/0.188pt+1%+2.5%	0	0	0	0	99	99	99	99	96	99	99	99	99	99
FulTime/ZA 1296+PO+28% UAN	5pt/0.188pt+1%+2.5%	0	2	0	0	98	99	99	99	99	98	99	99	99	99
Frontier/Marksman+PO	30floz/3.5pt+1%	0	7	0	3	98	99	98	94	93	99	83	98	99	99
Dual II Magnum/NorthStar+PO+28% UAN	2.5pt/5oz+1qt+2qt	0	5	0	0	98	96	93	96	85	99	88	78	99	99
Untreated		0	0	0	0	0	0	0	0	0	0	0	0	0	0
LSD (0.05)		5	10	2	7	9	5	7	10	9	4	9	12	11	11

Preemergence weed control in corn-Casselton. Zollinger and Fitterer. An experiment was conducted in Casselton, ND to evaluate weed control from herbicides applied at the PRE and POST stages. Interstate PayCo '4X85' corn was planted and PRE treatments were applied on May 27, 1999 at 11:00 to 12:00 pm with 92 F air, 62 F soil at 2 to 4 inch depth, 58% relative humidity, 0% clouds, and 0 to 5 mph N wind, dry soil surface, and moist subsoil. POST treatments were applied June 15, 1999 at 10:00 to 10:30 am with 67 F air, 96 F soil surface, 35% relative humidity, 5% clouds, and 5 to 10 NE mph wind, dry soil surface, moist subsoil, good crop vigor, no dew present, to 6 to 10 inch/3 to 4 leaf corn. Weed species present were: 1 to 3 inch, 2 to 4 lf, (10 to 30/ft^2) foxtail; 1 to 2 inch, cotyledon to 4 lf, (3 to 7/ft^2) wild mustard; 2 to 4 inch, 2 to 4 lf (2-5/ft^2) redroot pigweed; 1 to 3 inch, 4 to 6 lf (1-4/ft^2)common lambsquarters; 2 to 3 inch, 2 to 3 lf (4-6/ft^2) Venice mallow; 2 to 4 inch, 1 to 3 lf (2-3/ft^2) wild buckwheat; and 2 to 4 inch, 2 to 4 lf, (5 to 10/ft^2) common cocklebur. Treatments were applied to the center 6.67 feet of the 10 by 40 ft plots with a bicycle-wheel-type plot sprayer equipped with a wind shield delivering 17 gpa at 40 psi through 8002 flat fan nozzles for PRE treatments and 8.5 gpa at 40 psi through 8001 flat fan nozzles for POST treatments. The experiment had a randomized complete block design with three replicates per treatment.

All treatments controlled wild mustard at July 12.Venice mallow was not evaluated at July 12 due to light and variable infestations. Adequate rainfall activated PRE herbicides. Foxtail populations had a much higher proportion of yellow than green foxtail. PRE treatments did not control foxtail. Most PRE/POST treatments controlled foxtail at June 29 but lower weed control occurred at July 12 because of successive weed flushes. PRE treatments gave variable redroot pigweed and common lambsquarters control and no common cocklebur, Venice mallow, and wild buckwheat control. Most PRE followed by POST treatments gave good to excellent broadleaf weed control at June 29 and July 12. Only Dual II followed by NorthStar gave greater than 90% grass and broadleaf weed control.

Treatment	Rate	June 29							July 12				
	Product/A	Fxtl	Wimu	Rrpw	Colq	Cocb	Vema	Wibw	Fxtl	Rrpw	Colq	Cocb	Wibw
		% control											
PRE													
Epic	11oz	60	83	70	80	20	0	7	70	83	83	7	0
Epic+Atrazine	11oz+0.55lb	73	96	99	99	33	0	8	77	99	99	0	0
Epic	9oz	63	89	99	99	23	0	0	70	99	99	0	0
Epic+Atrazine	9oz+0.55lb	78	83	99	99	17	0	0	70	89	89	0	0
Surpass	2.5pt	88	47	80	77	7	0	0	78	70	57	0	0
Surpass+Atrazine	2.5pt+0.55lb	87	86	99	93	30	33	26	77	96	81	7	0
Dual II Magnum	2.5pt	60	23	57	47	0	0	0	63	50	50	0	0
Dual II Magnum+Atrazine	2.5pt+0.55lb	70	53	67	60	7	0	0	72	80	73	0	0
Axiom+Balance	13oz+1.2oz	70	83	96	93	13	0	0	73	88	80	0	0
Axiom+Atrazine	19oz+0.55lb	43	73	53	63	0	0	0	53	40	40	0	0
WF2705	4.5pt	78	98	96	96	50	99	33	60	98	96	20	0
WF2705	5pt	70	99	99	99	53	99	48	57	96	89	20	0
PRE/POST													
Surpass/ZA 1296+PO+28% UAN	2.5pt/0.188pt+1+2.5%	90	99	99	99	99	99	89	78	99	99	98	66
FulTime/ZA 1296+PO+28% UAN	6pt/0.188pt+1%+2.5%	90	99	99	99	99	99	99	83	99	99	99	66
FulTime/ZA 1296+PO+28% UAN	5pt/0.188pt+1%+2.5%	98	99	99	99	99	99	99	88	99	99	96	99
Frontier/Marksman+PO	30floz/3.5pt+1%	68	99	99	99	99	99	99	57	99	99	99	99
Dual II Magnum/NorthStar+PO+28% UAN	2.5pt/5oz+1qt+2qt	98	99	99	99	99	99	99	93	99	99	99	83
Untreated		0	0	0	0	0	0	0	0	0	0	0	0
LSD (0.05)		11	16	8	12	7	6	9	10	15	16	12	13

Balance in corn-Casselton. Zollinger and Fitterer. An experiment was conducted at Casselton, ND to evaluate weed control with Balance applied at the PRE stage. Interstate Payco '4X85' corn was planted and PRE treatments were applied May 27, 1999 at 3:30 to 4:00 pm with 80 F air, 62 F soil at a depth of 2 to 4 inch, 65% relative humidity, 0% clouds, and 0 to 3 N mph wind, dry soil surface, and moist subsoil. Treatments were applied to the center 6.67 feet of the 10 by 40 ft plots with a bicycle-wheel-type plot sprayer delivering 17 gpa at 40 psi through 8002 flat fan nozzles. The experiment had a randomized complete block design with three replicates per treatment.

		June 22				July 5				
Treatment	Rate	Fxtl	Wimu	Cocb	Wibw	Fxtl	Rrpw	Colq	Cocb	Wibw
	Product/A	% control								
Balance	1.5oz	63	96	43	0	70	99	99	27	0
Balance	1.75oz	62	96	57	0	73	99	99	40	0
Balance	2oz	65	91	47	0	78	99	99	47	0
Atrazine	0.55lb	33	57	13	0	50	70	70	0	0
Balance+Atrazine	1.5oz+0.55lb	73	93	43	50	87	99	99	30	15
Balance+Atrazine	1.75oz+0.55lb	77	88	57	30	87	99	99	37	15
Balance+Atrazine	2oz+0.55lb	70	90	47	23	83	99	99	27	10
Surpass	1.25pt	67	37	17	0	77	77	77	7	0
Balance+Surpass	1.5oz+1.25pt	73	85	37	0	85	99	99	30	15
Balance+Surpass	1.75oz+1.25pt	73	78	43	3	80	99	99	43	30
Balance+Surpass	2oz+1.25pt	80	87	53	0	88	99	99	33	45
Surpass	2.5pt	72	57	17	0	88	90	90	7	0
EXP31809B	2oz	58	73	33	0	68	99	99	27	0
EXP31809B	2.6oz	58	77	50	0	72	99	99	23	0
EXP31809B	3oz	65	73	40	0	77	99	99	23	0
Untreated		0	0	0	0	0	0	0	0	0
LSD (0.05)		12	17	14	4	13	5	5	16	15

No corn injury was observed at 6/22. All treatments controlled common lambsquarters and redroot pigweed at 6/22 and 7/5. Adequate rain activated PRE treatments. Most treatments controlled redroot pigweed and common lambsquarters. Foxtail pressure was high and yellow foxtail escaped control. Green foxtail was completely controlled. Common cocklebur and wild buckwheat control was poor.

Balance in corn-Carrington. Zollinger and Fitterer. An experiment was conducted at Carrington, ND to evaluate weed control with Balance applied at the PRE stage. Cargill '1877' corn was planted on May 17, 1999. PRE treatments were applied on May 19, 1999 at 10:30 to 12:00 pm with 73 F air, 57 F soil at 2 to 4 inch depth, 50% relative humidity, 10% clouds, and 5 to 7 mph S wind, dry soil surface, and moist subsoil. Treatments were applied to the center 6.67 feet of the 10 by 40 ft plots with a bicycle-wheel-type plot sprayer delivering 17 gpa at 40 psi through 8002 flat fan nozzles. The experiment had a randomized complete block design with three replicates per treatment.

All treatments controlled wild mustard at 7/13. Injury ratings were none or low on 1st rep but were visible and increased on the 2nd and 3rd reps. Rain events occurred for 3 to 4 weeks after application. At July 13 only Surpass at 2.5 pt/A or Balance+Surpass at high rates gave greater than 90% foxtail control. Generally, only mixtures of herbicides (except EXP31809B) controlled redroot pigweed, prostrate pigweed, (including EXP31809B) and common lambsquarters. No treatments controlled wild buckwheat. Shaking the container containing EXP31809B prior to measuring amount to be applied resulted in bubbles and air saturating the formulation and prevented accurate measurement on a volume basis. This may a reason for reduced weed control from that product.

Treatment	Rate	Corn				June 23					June 28					July 13				
		June 14	June 23	June 28	July 13	Fxtl	Rrpw	Prpw	Colq	Wibw	Fxtl	Rrpw	Prpw	Colq	Wibw	Fxtl	Rrpw	Prpw	Colq	Wibw
	Product/A	% injury				% control														
Balance	1.5oz	2	3	7	20	72	80	76	83	7	75	72	70	79	23	60	63	57	83	0
Balance	1.75oz	5	5	10	20	82	87	85	93	5	81	87	90	96	33	73	80	73	89	0
Balance	2oz	8	10	3	15	93	93	93	93	33	94	94	94	98	33	88	77	57	66	0
Atrazine	0.55lb	0	5	3	5	71	76	73	73	57	73	65	63	40	32	52	50	50	83	0
Balance+Atrazine	1.5oz+0.55lb	2	2	2	0	90	93	93	94	40	95	97	96	89	63	78	80	80	80	10
Balance+Atrazine	1.75oz+0.55lb	2	2	3	0	92	98	98	98	88	95	98	98	99	67	83	99	99	99	10
Balance+Atrazine	2oz+0.55lb	3	5	8	0	92	96	93	96	93	96	99	97	99	82	87	99	93	99	10
Surpass	1.25pt	0	2	0	10	95	90	80	67	37	98	96	90	20	40	70	50	50	57	0
Balance+Surpass	1.5oz+1.25pt	4	2	2	0	96	99	99	99	63	98	99	99	99	55	93	99	99	99	0
Balance+Surpass	1.75oz+1.25pt	5	4	0	0	95	96	98	99	83	99	99	99	89	68	93	99	99	99	0
Balance+Surpass	2oz+1.25pt	8	12	4	20	99	99	99	99	73	99	99	99	99	53	95	99	99	99	0
Surpass	2.5pt	0	2	0	0	98	98	96	87	55	98	99	99	70	50	96	89	89	85	0
EXP31809B	2oz	3	2	3	30	73	86	76	88	43	82	83	81	93	47	73	50	88	99	0
EXP31809B	2.6oz	4	3	0	15	78	88	80	90	18	81	85	94	98	40	80	61	66	99	17
EXP31809B	3oz	10	7	3	10	82	96	95	95	27	80	95	96	98	57	83	83	80	99	17
Untreated		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LSD (0.05)		9	9	9	10	16	13	10	15	17	15	8	12	10	9	12	10	10	14	8

PRE/POST weed control in corn. Zollinger and Fitterer. An experiment was conducted at Casselton, ND to evaluate weed control from herbicides applied PRE, POST, and LPOST. Two rows of Interstate PayCo '4X85' corn and two rows of Pioneer '39D81' corn was planted in each plot, and all treatments received a PRE application of 20 fl oz of Frontier to suppress grass weeds and more accurately evaluate broadleaf weed control. Frontier was applied May 27, 1999 at 4:00 pm with 100 F air, 62 F soil at a depth of 2 to 4 inch, 62% relative humidity, 0% clouds, 0 to 3 N mph wind, dry soil surface, and moist subsoil. POST treatments were applied June 15, 1999 at 10:30 am with 70 F air, 105 F soil surface, 35% relative humidity, 10% clouds, 5 to 10 NE mph wind, dry soil surface, moist subsoil, good crop vigor, no dew present, to 6 to 10 inch corn. Weed species present were: 1 to 3 inch, 2 to 4 lf, (10 to 40/ft^2) foxtail; 1 to 2 inch, cotyledon to 4 lf, (1 to 5/ft^2) rosette wild mustard; 2 to 4 inch, 2 to 4 lf, (1 to 5/ft^2) wild buckwheat; and 2 to 4 inch, 1 to 3 lf, (2 to 8/ ft^2) common lambsquarters; 1 to 2 inch, cotyledon to 2 lf, (1 to 5/ ft^2) redroot pigweed; and 2 to 4 inch, 2 to 4 lf, (1 to 5/ft^2) common cocklebur. LPOST treatments were applied June 23, 1999 at 1:30 pm with 83 F air, 81 F soil surface, 75% relative humidity, 50% clouds, 5 to 8 W mph wind, dry soil surface, moist subsoil, excellent crop vigor, no dew present, to 8 to 14 inch corn. Weed species present were: 4 to 6 inch, 4 lf, (20 to 40/ft^2) foxtail; 1 to 2 inch, 2 to 4 lf, (1 to 5/ft^2) rosette wild mustard; 3 to 5 inch, 3 to 5 lf, (1 to 5/ft^2) wild buckwheat; and 4 to 6 inch, 3 to 5 lf, (2 to 8/ ft^2) common lambsquarters; 3 to 5 inch, 2 to 4 lf, (1 to 5/ ft^2) redroot pigweed; and 4 to 6 inch, 2 to 6 lf, (1 to 5/ft^2) common cocklebur. Treatments were applied to the center 6.67 feet of the 10 by 40 ft plots with a bicycle-wheel-type plot sprayer delivering 17 gpa at 40 psi through 8002 flat fan nozzles for PRE treatments and 8.5 gpa at 40 psi through 8001 flat fan nozzles using a wind shield for POST and LPOST treatments. The experiment had a randomized complete block design with three replicates per treatment.

All treatments controlled wild mustard, redroot pigweed, and common lambsquarters at 7/7 and 7/12. All treatments controlled wild mustard at 7/28. A reduced rate of Frontier was applied to suppress foxtail but allowed improved foxtail control from broadleaf herbicides. POST treatment containing Atrazine, Distinct, or NorthStar generally increased foxtail control. Most treatments gave excellent broadleaf weed control at the last evaluation. However, additional flush of cocklebur emerged after Aim and some other treatments. No wild buckwheat was detected after the July 7 evaluation.

Treatment	Rate	July 7				July 12		July 28			
	Product/A	Fxtl	Wimu	Cocb	Wibw	Fxtl	Cocb	Fxtl	Rrpw	Colq	Cocb
		% control									
POST											
Shotgun	2pt	70	99	99	99	72	98	-	-	-	-
Shotgun+PPC-140	1.5pt+0.33pt	75	99	96	99	72	96	-	-	-	-
PCC-196	2pt	80	99	99	99	68	99	-	-	-	-
PCC-196	3pt	87	99	96	99	80	93	-	-	-	-
Aim+NIS	0.33oz+0.25%	63	89	70	99	50	67	-	-	-	-
Aim+Clarity+NIS	0.33oz+0.5pt+0.25%	63	99	99	76	55	99	-	-	-	-
Aim+Atrazine+NIS	0.33oz+0.42lb+0.25%	77	99	83	99	67	75	-	-	-	-
Aim+Atrazine+Clarity+NIS	0.33oz+0.42lb+0.5pt+0.25%	72	99	99	99	55	93	-	-	-	-
Aim+Hornet+NIS	0.33oz+2.4oz+0.25%	63	99	99	99	67	98	-	-	-	-
Clarity+28% UAN	1pt+2.5%	70	96	99	99	55	99	-	-	-	-
Distinct+NIS+28% UAN	6oz+0.25%+1.25%	88	99	96	99	83	95	-	-	-	-
NorthStar+NIS+28% UAN	5oz+0.25%+2.5%	88	99	98	99	83	99	-	-	-	-
Hornet+NIS+28% UAN	2.4oz+0.25%+2.5%	73	80	83	99	75	90	-	-	-	-
LPOST											
Distinct+NIS+28% UAN	6oz+0.25%+1.25%	82	73	88	99	85	99	78	99	99	99
NorthStar+NIS+28% UAN	5oz+0.25%+2.5%	82	76	80	99	82	95	80	99	99	99
Hornet+NIS+28% UAN	2.4oz+0.25%+2.5%	75	96	63	99	63	73	50	93	93	99
Untreated		0	0	0	0	0	0	0	0	0	0
LSD (0.05)		16	17	13	17	14	8	10	14	1	0

Post emergence weed control in Corn-Carrington, ND. Zollinger and Fitterer. An experiment was conducted in Carrington, ND to evaluate weed control from combinations of post emergence herbicides including Accent. Cargill '1877' corn was planted on May 17, 1999. POST treatments were applied June 14, 1999 at 12:30 pm with 65 F air, 75 F soil surface, 45% relative humidity, 20% clouds, 0 to 5 mph S wind, dry soil surface, moist subsoil, excellent crop vigor, no dew present, and crop stage was 6 to 8 inch. Weed species present were: 3 to 4 inch (5 to 20 plants/ft^2) foxtail; 2 to 3 inch (1 to 5 plants/ft^2) wild mustard; 2 to 3 inch (1 to 5 plants/yd^2) common lambsquarters; 1 to 3 inch (10 to 20 plants/ft^2) redroot pigweed; 2 to 3 inch (1 to 5 plants/ft^2) biennial wormwood; and 1 to 3 inch (10 to 20 plants/ft^2) prostrate pigweed. Treatments were applied to the center 6.67 feet of the 10 by 40 ft plots with a bicycle-wheel-type plot sprayer delivering 8.5 gpa at 40 psi through 8001 flat fan nozzles. The experiment had a randomized complete block design with three replicates per treatment.

Table. Post emergence weed control in Corn-Carrington, ND (Zollinger and Fitterer).

		Corn		June 28					July 13	
Treatment [a]	Rate	June 28	July 13	Fxtl [b]	Rrpw	Prpw	Colq	Wibw	Fxtl [b]	Wibw
	(oz prod/A)	(% injury)		(% control)						
Accent+Aim+Atrazine+ NIS+28% UAN	0.67+0.33+0.42 lb+ 0.25% v/v+4 qt	5	0	78	91	88	90	57	88	83
Accent+Distinct+Marksman+Scoil	0.34+2+1 pt+1.5 pt	2	3	78	88	88	97	63	75	99
Accent+Distinct+Marksman+Scoil	0.34+2+1 pt+1.5 pt	0	7	75	91	90	94	68	77	99
Accent+Atrazine+Clarity+Scoil	0.34+0.42 lb+4+1.5 pt	0	2	87	91	86	94	60	88	77
Accent+Distinct+Scoil	0.34+2+1.5 pt	0	2	78	88	86	81	68	90	90
Accent+Distinct+Quad 7	0.34+2+1% v/v	10	2	90	88	83	90	50	94	99
Accent+Distinct+FirstMate	0.34+2+1% v/v	0	2	82	85	83	82	53	78	96
Accent+Distinct+Agri-Stay	0.34+2+1.5 pt	0	0	75	83	82	80	55	75	70
Accent+Hornet+Quad 7	0.34+2.4+1% v/v	0	0	85	78	75	73	30	87	43
Accent+NorthStar+Quad 7	0.34+5+1% v/v	0	0	87	80	80	95	50	86	70
Accent Gold+Quad 7	2.9+1% v/v	0	0	93	80	78	88	52	97	96
Accent Gold+Quad 7	2.5+1% v/v	0	0	93	80	80	72	38	94	82
Accent Gold+Clarity+Quad 7	2+4+1% v/v	5	0	90	85	78	80	58	96	90
Basis Gold+Scoil	14+1.5 pt	0	0	93	96	90	95	70	92	99
Basis Gold+Scoil	10.5+1.5 pt	7	0	92	90	83	96	73	89	96
Basis Gold+Accent+Scoil	7+0.1+1.5 pt	13	0	92	93	88	97	63	88	96
Untreated		0	0	0	0	0	0	0	0	0
LSD (0.05)		6	5	9	9	9	11	9	11	7

[a]NIS = nonionic surfactant = Activator 90; UAN = urea ammonium nitrate; Scoil = methylated seed oil; Quad 7 = basic blend; FirstMate = basic blend + methylated seed oil; Agri-stay = unclassified.
[b]Fxtl = Grft and Yeft.

All treatments provided complete control of redroot pigweed, prostrate pigweed, biennial wormwood, and wild mustard on July 13. Most treatments (except Accent+Hornet = 70% control) provided complete common lambsquarters on July 13. Weed control ranged from 73 to 97% on June 28 except wild buckwheat control ranged from 38 to 73%. A reduced rate of Accent Gold generally gave the least weed control. Accent+Distinct with Scoil or Quad 7 adjuvants gave equal or greater control than when combined with FirstMate or Agri-Stay. Quad 7 adjuvant with reduced rates of Accent Gold alone or with Clarity gave control equal to the highest rate plus Quad 7. Scoil adjuvant with reduced rates of Basis Gold alone or with additional Accent gave control equal to the highest rate plus Scoil.

Post emergence weed control in corn-Wyndmere, ND. Zollinger and Fitterer. An experiment was conducted in Wyndmere, ND to evaluate weed control from POST herbicide combinations plus adjuvants. Pioneer '39M81' corn was planted on April 28, 1999. POST treatments were applied June 3, 1999 at 10:30 to 12:00 pm with 67 F air, 70 F soil surface, 65% relative humidity, 100% clouds, 5 to 15 mph SE wind, dry soil surface, moist subsoil, poor crop vigor (chlorotic, stunted), no dew present, and crop stage was 6 inch. Weed species present were: 1 to 5 inch, (50 to 300 plants/ft^2) foxtail; 1 to 5 inch (5 to 10 plants/ft^2) common lambsquarters; 1 to 3 inch (1 plant/ft^2) redroot pigweed; 1 to 5 inch (1 to 10 plants/ft^2) eastern black nightshade; 1 to 5 inch (1 to 5 plants/yd^2) common ragweed; 1 to 4 inch (1 to 20 plants/ft^2) curly dock; and 1 to 5 inch (patches) common cocklebur. Treatments were applied to the center 6.67 feet of the 10 by 40 ft plots with a bicycle-wheel-type plot sprayer delivering 8.5 gpa at 40 psi through 8001 flat fan nozzles. The experiment had a randomized complete block design with three replicates per treatment.

Table. Post emergence weed control in corn-Wyndmere, ND (Zollinger and Fitterer).

Treatment[a]	Rate	June 16					June 30
		Fxtl[b]	Colq	Cocb[b]	Cudo[b]	Corw	Fxtl[b]
	(oz prod/A)	(% control)					
Accent+Aim+Atrazine+ NIS+28% UAN	0.67+0.33+0.42 lb+ 0.25% v/v+ 4 qt	78	80	77	87	57	78
Accent+Distinct+Marksman+Scoil	0.34+2+1 pt+1.5 pt	72	88	95	95	90	65
Accent+Distinct+Marksman+Scoil	0.34+2+1 pt+1.5 pt	60	91	93	93	93	72
Accent+atrazine+dicamba+Scoil	0.34+0.42 lb+4+1.5 pt	83	95	97	98	91	77
Accent+Distinct+Scoil	0.34+2+1.5 pt	80	88	90	90	90	82
Accent+Distinct+Quad 7	0.34+2+1% v/v	68	90	92	92	83	75
Accent+Distinct+FirstMate	0.34+2+1% v/v	73	72	90	83	78	75
Accent+Distinct+Agri-Stay	0.34+2+1.5 pt	65	62	90	77	73	63
Accent+Hornet+Quad 7	0.34+2.4+1% v/v	67	57	92	77	73	73
Accent+NorthStar+Quad 7	0.34+5+1% v/v	75	78	92	83	83	89
Accent Gold+Quad 7	2.9+1% v/v	80	68	92	83	82	91
Accent Gold+Quad 7	2.5+1% v/v	75	72	93	68	85	90
Accent Gold+Clarity+Quad 7	2+4+1% v/v	82	83	92	72	80	73
Basis Gold+Scoil	14+1.5 pt	82	95	95	90	76	83
Basis Gold+Scoil	10.5+1.5 pt	82	93	96	96	93	77
Basis Gold+Accent+Scoil	7+0.1+1.5 pt	85	93	96	98	93	83
Untreated		0	0	0	0	0	0
LSD (0.05)		8	5	11	8	6	10

[a]NIS = nonionic surfactant = Activator 90; UAN = urea ammonium nitrate; Scoil = methylated seed oil; Quad 7 = basic blend; FirstMate = basic blend + methylated seed oil; Agri-stay = unclassified.
[b]Fxtl = Grft and Yeft; Cocb = common cocklebur; Cudo = curly dock.

All treatments provided complete redroot pigweed and eastern black nightshade control on June 16. All treatments provided complete redroot pigweed, common lambsquarters, common cocklebur, curly dock, and eastern black nightshade control on June 30. Weed control was variable and ranged from 57 to 98% on June 16. Most treatment gave greater than 90% common cocklebur control on June 16. A reduced rate of Accent+Hornet generally gave the least weed control. Accent+Distinct with Scoil or Quad 7 adjuvants gave equal or greater weed control than when combined with FirstMate or Agri-Stay. Quad 7 adjuvant with reduced rates of Accent Gold alone or with dicamba gave weed control equal to the highest rate plus Quad 7. Scoil adjuvant with reduced rates of Basis Gold alone or with additional Accent gave weed control equal to the highest rate.

Weed control in Imi-corn. Zollinger and Fitterer. An experiment was conducted at Casselton, ND to evaluate weed control from PRE and POST applied herbicides. Garst '8973BLT' corn was planted and PRE treatments were applied on May 27, 1999 at 3:00 to 3:30 pm with 100 F air, 62 F soil at 2 to 4 inch depth, 65% relative humidity, 0% clouds, and 0 to 3 mph N wind, dry soil surface, and moist subsoil. POST treatments were applied June 15, 1999 at 9:30 to 10:30 pm with 67 F air, 96 F soil surface, 35% relative humidity, 5% clouds, and 3 to 8 mph NE wind, dry soil surface, moist subsoil, good crop vigor (slightly yellow), no dew present, to 6 to 10 inch corn. Weed species present were: 1 to 3 inch, 2 to 5 lf, (5 to 10/ft^2) foxtail; 1 to 2 inch, cotyledon to 4 lf, (3 to 7/ft^2) rosette wild mustard; and 2 to 4 inch, 2 to 4 lf, (5 to 15/ft^2) common cocklebur. Treatments were applied to the center 6.67 feet of the 10 by 40 ft plots with a bicycle-wheel-type plot sprayer delivering 17 gpa at 40 psi through 8002 flat fan nozzles for PRE treatments and 8.5 gpa at 40 psi through 8001 flat fan nozzles using a wind shield for POST treatments. The experiment had a randomized complete block design with three replicates per treatment.

Treatment	Rate	June 29		July 12	
		Fxtl	Cocb	Fxtl	Cocb
	Product/A	% control			
PRE					
Balance	1.5oz	83	33	90	68
Balance	2oz	93	57	93	83
PRE/POST					
Balance/Lightning+PO+AMS	1.5oz/1.28oz+1%+3lb	99	98	99	99
Balance/Lightning+PO+AMS	1.5oz/0.64oz+1%+3lb	99	95	99	96
Surpass/Shotgun	1.25pt/1.5pt	86	95	87	98
POST					
Lightning+Quad 7	1oz+1%	96	96	95	92
Lightning+Quad 7	1.28oz+1%	99	99	98	96
Lightning+Prowl+NIS+28% UAN	1.28oz+3pt+0.25%+2qt	99	96	98	98
Lightning+Atrazine+Scoil	1.28oz+0.42lb+1.5pt	99	95	99	96
Lightning+Clarity+NIS+28% UAN	1.28oz+4floz+0.25%+2qt	99	92	97	95
Lightning+Shotgun+NIS+28% UAN	1oz+1pt+0.25%+2qt	93	98	96	95
Shotgun	1.5pt	83	99	57	95
Shotgun	2pt	58	98	85	90
Shotgun+PCC-140	1.5pt+0.33pt	77	98	82	93
PCC-196	2pt	55	99	68	90
PCC-196	3pt	63	99	75	98
Untreated		0	0	0	0
LSD (0.05)		13	10	9	10

All treatments controlled wild mustard, redroot pigweed, common lambsquarters, and Venice mallow. Most treatments, except Shotgun, and PCC-196 gave greater than 90% foxtail control. Most treatments except Balance applied alone gave greater than 90% common cocklebur control.

Weed control in Liberty Link corn. Zollinger and Fitterer. An experiment was conducted near Casselton, ND to evaluate weed control from herbicides applied PRE and POST to Liberty Link corn. Garst '8773 BLT' corn was planted May 27, 1999. The PRE treatments were applied May 27, 1999 at 2:00 to 3:00 pm with 98 F air, 60 F soil at a depth of 2 to 4, 60% relative humidity, 0% clouds, and 0 to 5 N mph wind, dry soil surface, and moist subsoil. The POST treatments were applied June 18, 1999 at 10:00 am with 72 F air, 86 F soil surface, 48% relative humidity, 0% clouds, and 5 to 12 SE mph wind, dry soil surface, dry subsoil, fair crop vigor (yellowing), no dew present, to 8 inch corn. Weed species present were: 2 to 5 inch, (5 to 20/ft^2) foxtail; 1 inch, cotyledon to 2 lf, (5 to 20/ft^2) wild mustard; 2 to 4 inch, 2 to 4 lf, (1 to 5/ft^2) wild buckwheat; and 2 to 4 inch, 1 to 3 lf, (2 to 8/ ft^2) common lambsquarters; 4 to 6 inch, 4 to 6 lf, (2 to 15/ft^2) common cocklebur; and 1 to 2 inch, cotyledon to 2 lf, (1 to 5/ ft^2) redroot pigweed. Treatments were applied to the center 6.67 feet of the 10 by 40 ft plots with a bicycle-wheel-type plot sprayer delivering 17 gpa at 40 psi through 8002 flat fan nozzles for PRE treatments and 8.5 gpa at 40 psi through 8001 flat fan nozzles using a wind shield for POST treatments. The experiment had a randomized complete block design with three replicates per treatment.

All treatments controlled wild mustard, redroot pigweed, and common lambsquarters at 7/16. New flush of foxtail, redroot pigweed, common lambsquarters, common cocklebur, and wild buckwheat are observed in treatments containing the lowest rate of Balance or Liberty without atrazine or a residual herbicide. Slight corn injury was seen only at July 2. PRE treatments were activated by rainfall. Of the PRE treatments, only Balance+Atrazine at 2 oz/A +0.55 lb/A controlled grass and broadleaf weeds. Most POST treatments controlled grass and broadleaf weeds. However, Aim antagonized common cocklebur and wild buckwheat control.

Treatment	Rate	July 2	July 2			July 16			Corn
		Corn	Fxtl	Cocb	Wibw	Fxtl	Cocb	Wibw	yield
	Product/A	% injury	% control						bu/A
PRE									
Balance	1.5oz	2	87	30	0	73	30	0	-
Balance	2oz	7	90	33	0	87	40	0	-
Balance+Atrazine	2oz+0.55lb	2	99	73	99	99	86	99	42
Balance+Harness Xtra+Atrazine	2oz+1.25qt+0.55lb	2	83	33	0	77	47	33	48
PRE/POST									
Balance/Liberty+AMS	1.5oz/16floz+3lb	2	99	99	83	99	99	99	-
Balance/Liberty+AMS	1.5oz/20floz+3lb	2	96	83	99	99	93	99	-
Balance/Liberty+AMS	2oz/16floz+3lb	5	99	99	99	99	99	99	43
Balance/Liberty+AMS	2oz/20floz+3lb	2	99	99	99	99	99	99	-
Balance/Liberty+Atrazine+AMS	1.5oz/16floz+0.55lb+3lb	2	99	89	89	99	99	99	51
Surpass/Liberty+AMS	1.25pt/28floz+3lb	2	99	98	89	99	99	99	-
Axiom/Liberty+AMS	11oz/20floz+3lb	0	99	99	99	99	93	99	-
Axiom/Liberty+Atrazine+AMS	11oz/20floz+0.55lb+3lb	0	99	99	99	99	93	99	-
Epic/Liberty+AMS	8oz/20floz+3lb	2	99	99	99	99	96	99	60
Leadoff/Basis Gold+PO+28% UAN	1.5pt/14oz+1%+2qt	0	93	87	99	90	93	93	47
Bicep II Magnum/NorthStar+PO+28% UAN	2.1qt/5oz+1%+2qt	0	98	93	99	93	99	99	-
POST									
Liberty+AMS	28floz+3lb	0	98	98	99	80	83	93	-
Liberty+AMS	20floz+3lb	0	96	99	99	86	86	83	-
Liberty+Aim+AMS	20floz+0.33oz+3lb	0	96	98	99	83	73	67	38
Liberty ATZ+AMS	2.5pt+3lb	0	99	98	99	99	99	99	52
Accent Gold+Clarity+PO+28% UAN	2.9oz+4floz+1%+2qt	0	96	83	99	99	99	99	-
Untreated		0	0	0	0	0	0	0	-
LSD (0.05)		5	7	7	14	9	10	14	16

Roundup Ready Corn . Zollinger and Fitterer. An experiment was conducted at Casselton, ND to evaluate weed control from herbicides applied at the PRE and POST stages in Roundup Ready Corn. Dekalb 'DK359RR-P22' Roundup Ready corn was planted and PRE treatments were applied May 27, 1999 at 1:00 to 2:00 pm with 96 F air, 62 F soil at a depth of 2 to 4 inch, 60% relative humidity, 0% clouds, and 0 to 5 N mph wind, dry soil surface, and moist subsoil. EPOST treatments were applied June 9, 1999 at 9:30 am with 72 F air, 84 F soil surface, 70% relative humidity, 90% clouds, and 3 to 8 N mph wind, dry soil surface, moist subsoil, good crop vigor, no dew present, to 4 inch corn. Weed species present were: 1 to 3 inch, 2 to 3 lf, (10 to 40/ft^2) foxtail; 1 to 2 inch, cotyledon to 4 lf, (20 to 30/ft^2) rosette wild mustard; 1 to 3 inch, cotyledon to 2 lf, (1 to 2/ft^2) common lambsquarters; 1 inch, cotyledon to 2 lf, (1 to 2/yd^2) redroot pigweed; 1 to 3 inch, cotyledon to 4 lf, (10 to 15/ft^2) common cocklebur. POST treatments were applied June 23, 1999 at 2:00 pm with 83 F air, 81 F soil surface, 75% relative humidity, 50% clouds, and 5 to 8 W mph wind, dry soil surface, moist subsoil, excellent crop vigor, no dew present, to 8 to 14 inch corn. Weed species present were: 4 to 6 inch, 4 lf, (20 to 50/ft^2) foxtail; 1 to 2 inch, 2 to 3 lf, (1 to 3/ft^2) rosette wild mustard; and 4 to 6 inch, 2 to 6 lf, (1 to 3/ft^2) common cocklebur. LPOST treatments were applied July 2, 1999 at 11:00 pm with 73 F air, 78 F soil surface, 69% relative humidity, 20% clouds, and 3 to 7 SW mph wind, dry soil surface, moist subsoil, excellent crop vigor, no dew present, to 18 to 24 inch corn. Weed species present were: 2 to 6 inch, (2 to 4/ft^2) foxtail; cotyledon (2 to 5/ft^2) rosette wild mustard; 4 inch, (1 to 2/ft^2) common lambsquarters, and 4 to 6 inch, 2 to 6 lf, (1 to 2/ft^2) common cocklebur. Treatments were applied to the center 6.67 feet of the 10 by 40 ft plots with a bicycle-wheel-type plot sprayer equipped with a wind shield delivering 17 gpa at 40 psi through 8002 flat fan nozzles for PRE treatments and 8.5 gpa at 40 psi through 8001 flat fan nozzles for POST. LPOST treatments were applied with a backpack type sprayer delivering 8.5 gpa at 40 psi through 8002 flat fan nozzles. The experiment had a randomized complete block design with three replicates per treatment.

All treatments controlled wild mustard, redroot pigweed, and common lambsquarters at 7/7 and 7/16. Generally, all treatments containing Roundup Ultra resulted in excellent grass and broaldeaf weed control. Additional flushes of common cocklebur emerged in some plots lacking a residual herbicide. Treatments containing Balance PRE or Basis Gold POST did not control common cocklebur.

Treatment	Rate	July 7			July 16		July 21	
		Fxtl	Cocb	Vema	Fxtl	Cocb	Fxtl	Cocb
	Product/A	% control						
PRE								
Balance	1.5oz	70	20	27	63	0	53	7
Balance	2oz	90	27	40	83	27	80	37
Balance+Atrazine	2oz+0.55lb	77	23	89	90	60	83	53
Balance+Harness Xtra+Atrazine	2oz+1.25qt+0.55lb	96	43	99	86	63	66	50
PRE/POST								
Balance/Roundup Ultra+AMS	1.5oz/1.5pt+17lb/100gal	96	99	99	99	99	99	99
Balance/Roundup Ultra+AMS	2oz/1.5pt+17lb/100gal	99	99	99	99	99	99	99
Harness/Roundup Ultra+AMS	1pt/1.5pt+17lb/100gal	99	99	99	99	99	99	99
Harness Xtra/Roundup Ultra+AMS	2pt/1.5pt+17lb/100gal	99	99	99	99	99	99	99
Epic/Roundup Ultra+AMS	8oz/1.5pt+17lb/100gal	99	99	99	99	99	99	99
Epic/Roundup Ultra+AMS	13oz/1.5pt+17lb/100gal	99	99	99	99	99	99	99
Axiom/Roundup Ultra+AMS	11oz/1.5pt+17lb/100gal	99	99	99	99	99	96	99
Harness/Clarity	1qt/0.5pt	87	87	87	80	90	65	99
EPOST/LPOST								
Roundup Ultra+AMS/Roundup Ultra+AMS	1pt+17lb/100gal/1pt+17lb/100gal	88	83	83	99	99	99	99
Roundup Ultra+AMS/Roundup Ultra+AMS	1.5pt+17lb/100gal/1.5pt+17lb/100gal	98	86	86	99	99	99	99
Roundup Ultra+AMS+Harness	1pt+17lb/100gal+1pt	99	99	99	99	99	99	99
Roundup Ultra+AMS+Harness Xtra	1pt+17lb/100gal+2pt	99	99	99	99	99	99	99
POST								
MON 78126	1.5qt	99	99	99	99	99	99	99
MON 78126	2qt	99	99	99	99	99	99	99
Roundup Ultra+AMS	1.5pt+17lb/100gal	99	99	99	93	70	96	96
Roundup Ultra+AMS	2pt+17lb/100gal	99	99	99	93	80	94	96
Accent+Clarity+Atrazine+Scoil	0.67oz+4floz+0.42lb+1.5pt	80	96	99	99	99	88	99
Basis Gold+PO+28% UAN	14oz+2%+4qt	86	60	99	90	60	86	57
Accent Gold+PO+28% UAN	2.9oz+2%+4qt	96	96	99	99	99	99	99
Accent+Distinct+Marksman+Scoil	0.33oz+4oz+1pt+1.5pt	89	99	99	93	99	83	96
Untreated		0	0	0	0	0	0	0
LSD (0.05)		14	10	14	13	12	11	15

Soybean weed control systems. Zollinger and Fitterer. An experiment was conducted at NW-22 in Fargo, ND to evaluate weed control from PPI and POST applied herbicides. PPI treatments were applied and incorporated using a rototiller operated 2 inches deep on June 9, 1999 at 1:00 pm with 80 F air, 79 F soil at a depth of 2 to 4 inches, 69% relative humidity, 0% clouds, 5 to 10 mph SE wind, dry soil surface, and moist subsoil. 'Traill' soybeans were planted on June 10, 1999. EPOST treatments were applied on July 16, 1999 at 8:00 am with 67 F air, 75 F soil surface, 63% relative humidity, 0% clouds, 3 to 7 mph NW wind, dry soil surface, moist subsoil, no dew present, poor crop vigor due to excessive water (chlorotic/stunted), to first trifoliolate soybean. Weeds present were: 4 to 6 inch, (5 to 10/ft^2) foxtail and 2 to 3 inch, (5 to 15/ft^2) redroot pigweed. POST treatments were applied on July 21, 1999 at 1:00 pm with 88 F air, 97 F soil surface, 44% relative humidity, 0% clouds, 3 to 5 mph SE wind, dry soil surface, moist subsoil, no dew present, poor crop vigor, to 2 to 4 trifoliolate soybean. Weeds present were: 6 to 10 inch, (5 to 10/ft^2) foxtail and 4 to 6 inch, (5 to 15/ft^2) redroot pigweed. LPOST treatments were applied on July 29, 1999 at 8:00 am with 80 F air, 85 F soil surface, 62% relative humidity, 0% clouds, 0 to 3 mph NW wind, dry soil surface, moist subsoil, no dew present, fair crop vigor, to 6 trifoliolate soybean. Weeds present were: 6 inch, (5 to 10/ft^2) foxtail and 4 inch, (5 to 10/ft^2) redroot pigweed. Treatments were applied to the center 6.67 feet of the 10 by 40 ft plots with a bicycle-wheel-type plot sprayer equipped with a wind shield delivering 17 gpa at 40 psi through 8002 nozzles for PPI treatments and delivering 8.5 gpa at 40 psi through 8001 nozzles for POST treatments. The experiment has a randomized complete block design with three replicates per treatment.

Treatment	Rate	June 5	
		Grft&Yeft	Rrpw
	Product/A	% control	
PPI/POST			
Prowl/Raptor+NIS+28% UAN	3pt/4floz+0.25%+2qt	99	98
Treflan/Galaxy+PO	1qt/2pt+2pt	98	99
EPOST/LPOST			
Basagran+Poast+Blazer+PO/ Basagran+Poast+Blazer+PO	1pt+0.5pt+0.25pt+1pt/ 1pt+0.5pt+0.25pt+1pt	99	99
POST			
Basagran+Poast+Blazer+PO	2pt+1pt+0.5pt+1pt	92	92
Untreated		0	0
LSD (0.05)		3	9

All treatments gave near complete weed control. Soybeans were chlorotic and stunted due to poor growing conditions caused by excessive moisture and water saturated soils.

Soybean response to preemergence herbicides. Zollinger and Fitterer. An experiment was conducted near Wendall, MN to evaluate weed control from PRE and POST herbicides. Pioneer '90B72' soybean was planted May 22, 1999. PRE treatments were applied June 25, 1999 at 2:00 to 3:00 pm with 74 F air, 64 F soil at a 2 to 4 inch depth, 55% relative humidity, 0% clouds, 5 to 12 mph NW wind, dry soil surface, and moist subsoil. POST treatments were applied July 3, 1999 at 1:00 to 2:00 pm with 83 F air, 88 F soil surface, 90% relative humidity, 15% clouds, 15 to 25 mph SE wind, wet soil surface, wet subsoil, fair crop vigor (chlorotic), no dew present, and 3 trifoliate soybean. Weed species present were: 4 to 8 inch (2 to 4 plants/ft^2) foxtail; 2 to 5 inch (4 to 10 plants/ft^2) redroot pigweed; 3 to 4 inch (2 to 5 plants/ft^2) common lambsquarters; 1 to 3 inch (1 to 3 plants/ft^2) eastern black nightshade; 1 to 3 inch (1 to 3 plants/ft^2) Pennsylvania smartweed; 4 to 8 inch (1 to 5 plants/ft^2) common cocklebur; and 3 to 4 inch (2 to 7 plants/ft^2) lanceleaf sage. Treatments were applied to the center 6.67 feet of the 10 by 40 ft plots with a bicycle-wheel-type plot sprayer equipped with a wind shield delivering 17 gpa at 40 psi through 8002 flat fan nozzles for the PRE treatments and 8.5 gpa at 40 psi through 8001 flat fan nozzles for POST treatments. The experiment had a randomized complete block design with three replicates per treatment.

The premix of Domain gave similar weed control to flufenacet applied alone at higher rates for the first evaluation but gave greater weed control at July 16. Authority gave similar or greater weed control than Valor. Python controlled small-seeded broadleaf weeds. FirstRate controlled Pennsylvania smartweed and cocklebur and was the only PRE herbicide to control lanceleaf sage. Most PRE/POST herbicides controlled foxtail and broadleaf weeds present in this study.

Table. Soybean response to preemergence herbicides (Zollinger and Fitterer).

Treatment[a]	Rate	June 25							July 16					
		Fxtl[b]	Rrpw	Colq	Pesw	Cocb	Lals[b]	Ebns	Fxtl[b]	Rrpw	Colq	Cocb	Lals[b]	Ebns
	(Product/A)	(% control)												
PRE														
flufenacet	0.875 lb	85	50	60	82	12	10	16	70	27	33	0	0	0
flufenacet	1 lb	87	82	82	90	20	13	17	76	50	50	0	0	0
flufenacet	1.13 lb	92	90	88	92	20	25	70	80	50	52	20	33	20
Authority	4 oz	73	99	99	99	53	7	98	50	99	99	57	0	98
Authority	5.33 oz	82	99	99	99	63	0	99	80	99	99	63	0	99
Valor	2 oz	70	90	90	96	13	0	89	50	63	83	17	0	91
Valor	4 oz	70	83	99	99	13	0	96	60	66	83	10	0	99
Pursuit Plus	1.8 pt	96	99	99	99	43	77	99	95	99	99	57	63	98
Python	1 oz	30	99	99	99	30	43	99	52	99	99	48	17	96
FirstRate	0.7 lb	37	52	50	99	96	95	23	20	58	99	99	99	43
Domain	9 oz	53	63	63	63	0	0	20	57	50	50	17	0	0
Domain	13 oz	77	86	93	87	30	27	60	83	93	93	50	33	66
PRE/POST														
Valor/Roundup Ultra	2 oz/1.5 pt	-	-	-	-	-	-	-	99	99	99	83	89	99
Domain/Roundup Ultra	9 oz/1.5 pt	-	-	-	-	-	-	-	99	99	99	99	99	99
Authority/Assure II+PO	4 oz/8 oz+1% v/v	-	-	-	-	-	-	-	96	99	99	73	0	97
Authority/Raptor+Quad 7	4 oz/2 oz+1% v/v	-	-	-	-	-	-	-	99	99	99	99	73	99
Authority/Flexstar+Scoil	4 oz/0.75+1% v/v	-	-	-	-	-	-	-	89	99	93	99	99	99
Authority/Roundup Ultra	4 oz/1.5 pt	-	-	-	-	-	-	-	99	99	99	99	99	99
Authority/Roundup Ultra	2.67 oz/1.5 pt	-	-	-	-	-	-	-	99	99	99	99	99	99
Authority/Roundup Ultra	2.67 oz/1 pt	-	-	-	-	-	-	-	99	99	99	99	99	99
LSD (0.05)		12	8	8	8	11	18	20	14	12	14	15	21	11

[a]PO = petroleum oil = Herbimax; Quad 7 = basic blend; Scoil = methylated seed oil.
[b]Fxtl = Grft and Yeft, Lals = Lanceleaf sage.

Soil applied herbicide weed control in soybeans. Zollinger and Fitterer. An experiment was conducted in Colfax, ND to evaluate weed control from herbicides applied at the PRE and POST stages. Peterson Farm Seed '9905' Roundup Ready soybean was planted April 30, 1999. The PRE treatments were applied April 30, 1999 at 10:00 to 12:00 pm with 76 F air, 52 F soil at a 2 to 4 inch depth, 35% relative humidity, 0% clouds, 3 to 8 mph S wind, dry soil surface, and moist subsoil. The POST treatments were applied June 11, 1999 at 2:30 to 3:30 pm with 80 F air, 95 F soil surface, 50% relative humidity, 20% clouds, 3 to 7 mph NE wind, dry soil surface, moist subsoil, good crop vigor, no dew present, and unifoliate to first trifoliate soybean. Weed species present were: 2 to 5 inch (1 plant/ft^2) foxtail; 1 to 5 inch (2 to 5 plants/ft^2) redroot pigweed; 1 to 3 inch (1 to 3 plants/ft^2) Pennsylvania smartweed; 1 to 5 inch (1 to 4 plants/ft^2) biennial wormwood; 1 to 4 inch (1 to 4 plants/ft^2) common lambsquarters; 1 to 5 inch (1 to 2 plants/ft^2) eastern black nightshade; 1 to 4 inch (1 to 4 plants/ft^2) wild mustard; and 1 to 5 inch (1 to 2 plants/ft^2) marshelder. Treatments were applied to the center 6.67 feet of the 10 by 40 ft plots with a bicycle-wheel-type plot sprayer delivering 17 gpa at 40 psi through 8002 flat fan nozzles for the PRE treatments and 8.5 gpa at 40 psi through 8001 flat fan nozzles for the POST treatments. The experiment had a randomized complete block design with three replicates per treatment.

Precipitation occurred after application to activate soil applied herbicides. Crop and weeds were not stressed during evaluation period. Excellent crop competition provided additional suppression of weed flushes. On June 25 all herbicide treatments controlled redroot pigweed, common lambsquarters, Pennsylvania smartweed, marshelder, biennial wormwood, and eastern black nightshade. Authority applied alone did not control wild mustard. On July 9 all herbicide treatments controlled redroot pigweed, common lambsquarters, Pennsylvania smartweed, and biennial wormwood. Authority and Valor applied alone did not control foxtail. Authority at a reduced rate of 3.2 oz/A failed to control marshelder and eastern black nightshade. No soybean injury was observed at July 9.

Table. Soil applied herbicide weed control in soybeans (Zollinger and Fitterer).

Treatment [a]	Rate	June 25			July 9			
		Soybean	Fxtl [b]	Wimu	Fxtl [b]	Wimu	Mael [b]	Ebns
	(Product/A)	(% injury)	(% control)					
PRE								
Valor	3 oz	0	67	99	63	99	99	99
Valor	2 oz	5	60	99	70	99	99	99
Authority	5.33 oz	0	77	89	67	67	99	99
Authority	4.25 oz	0	73	70	77	66	83	93
Authority	3.2 oz	0	60	53	47	27	76	83
PRE/POST								
Valor/Select+PO	2 oz/6 oz+1% v/v	0	99	99	99	99	99	99
Valor/Cobra+PO	2 oz/6 oz+1% v/v	12	78	99	63	99	99	99
Valor/Cobra+Select+PO	2oz/6 oz+6 oz+1% v/v	5	99	99	99	99	99	99
Valor/Raptor+Quad 7	2 oz/2 oz+1% v/v	0	93	99	99	99	99	99
Valor/Roundup Ultra+AMS	3 oz/1 pt+8.5 lb/100gal	0	99	99	99	99	99	99
Authority/Assure II+PO	4.25 oz/8 oz+1% v/v	0	99	77	99	99	86	99
Authority/Pursuit+Quad 7	4.25 oz/0.72 oz+1% v/v	0	93	99	99	99	93	99
Authority/Raptor+Quad 7	4.25 oz/2 oz+1% v/v	0	99	99	96	99	99	99
Authority/FirstRate+Quad 7	4.25 oz/0.3 oz+1% v/v	0	63	99	93	99	99	99
Authority/Flexstar+Scoil	4.25 oz/0.75 pt+0.5% v/v	0	63	99	80	99	99	99
Authority/Roundup Ultra+AMS	4.25 oz/1.5 pt+8.5lb/100gal	0	99	99	99	99	99	99
Authority/Roundup Ultra+AMS	4.25 oz/1 pt+8.5lb/100gal	0	99	99	99	99	99	99
Sencor DF/Roundup Ultra+AMS	4 oz/1.5 pt+8.5lb/100gal	0	99	99	99	99	99	99
Domain/Roundup Ultra+AMS	9 oz/1.5 pt+8.5lb/100gal	0	99	99	99	99	99	99
Domain/Roundup Ultra+AMS	11 oz/1.5 pt+8.5lb/100gal	0	99	99	99	99	99	99
Untreated		0	0	0	0	0	0	0
LSD (0.05)		6	4	8	7	6	5	7

[a]PO = petroleum oil = Herbimax; Quad 7 = basic blend adjuvant; AMS = ammonium sulfate; Scoil = methylated seed oil adjuvant; Roundup Ultra = Roundup Ultra (3 lb ae/gal).
[b]Fxtl = Grft and Yeft, Mael = marshelder.

Post emergence weed control in soybeans. Zollinger and Fitterer. An experiment was conducted near Colfax, ND to evaluate weed control from POST applied herbicides. Peterson Farm Seed '9905' RR soybean was planted April 30, 1999. POST treatments were applied June 11, 1999 at 2:30 to 3:30 pm with 80 F air, 95 F soil surface, 50% relative humidity, 20% clouds, 3 to 7 NE mph wind, dry soil surface, moist subsoil, good crop vigor, no dew present and unifoliolate to second trifoliolate soybean. Weed species present were: 4 to 6 inch (1 plant/ft^2) foxtail; 1 to 5 inch (2 to 10 plants/ft^2) redroot pigweed; 1 to 6 inch,(5 to 12 plants/ft^2) common lambsquarters; 4 to 10 inch rosette (1 to 3 plants/yd^2) wild mustard; 2 to 6 inch (4 to 10 plants/ft^2) eastern black nightshade; 2 to 4 inch (1-5 plant/ft^2) biennial wormwood; 3 to 6 inch (1 to 2 plants/ ft^2) Pennsylvania smartweed; and 4 to 6 inch (1 plant/yd^2) marshelder. Treatments were applied to the center 6.67 feet of the 10 by 40 ft plots with a bicycle-wheel-type plot sprayer delivering 8.5 gpa at 40 psi through 8001 flat fan nozzles. The experiment had a randomized complete block design with three replicates per treatment.

Table. Post emergence weed control in soybeans (Zollinger and Fitterer).

		June 25				July 9			
Treatment[a]	Rate	Fxtl[b]	Rrpw	Colq	Biww[b]	Rrpw	Colq	Pesw	Biww[b]
	(Product/A)	(% control)							
Pursuit+Quad 7	1.08 oz+1% v/v	90	93	43	27	99	60	67	0
Raptor+Quad 7	4 oz+1% v/v	90	90	60	40	99	60	80	20
Flexstar+Fusilade DX+Scoil	0.75 pt+10 fl oz+1% v/v	90	83	40	30	96	33	57	27
Roundup Ultra+AMS	2 pt+8.5lb/100gal	99	99	99	99	99	99	99	99
Roundup Ultra+AMS	1.5 pt+8.5lb/100gal	99	99	99	99	99	99	99	99
Roundup Ultra+Pursuit+Quad 7	1 pt+2 fl oz+1% v/v	99	99	99	99	99	99	99	99
Roundup Ultra+Raptor+Quad 7	1 pt+3 fl oz+1% v/v	99	99	99	99	99	99	99	99
Roundup Ultra+Raptor+Quad 7	1 pt+2 fl oz+1% v/v	99	99	99	99	99	99	99	99
Roundup Ultra+FirstRate+Quad 7	1 pt+0.3 fl oz+1% v/v	99	83	78	96	78	83	65	99
Roundup Ultra+Flexstar+Scoil	1 pt+0.5 pt+1% v/v	87	65	70	55	63	68	99	68
Untreated		0	0	0	0	0	0	0	0
LSD (0.05)		6	4	5	6	6	10	11	8

[a]Quad 7 = basic blend; Scoil = methylated seed oil; AMS = ammonium sulfate.
[b]Fxtl = Grft and Yeft, Biww = biennial wormwood.

Crop and weeds were not stressed at application nor for several weeks after application. All treatments gave complete wild mustard, and marshelder (data not shown). All treatments gave complete Pennsylvania smartweed control on June 25 (data not shown). All treatments gave complete foxtail and eastern black nightshade control on July 9 (data not shown). Pursuit, Raptor, and Flexstar did not control common lambsquarters or biennial wormwood on June 25 and July 9 or Pennsylvania smartweed on July 9. Most treatments containing Roundup Ultra gave complete grass and broadleaf weed control. Roundup Ultra efficacy was antagonized by FirstRate and Flexstar resulting in reduced weed control. Roundup Ultra+Flexstar+Scoil gave low redroot pigweed control on July 9.

Touchdown on Roundup Ready Soybeans. Zollinger and Fitterer. An experiment was conducted at Casselton, ND to evaluate weed control from Touchdown in glyphosate resistant soybean. Peterson Farm Seed '9905 RR' Roundup Ready soybean was planted May 27, 1999. PRE treatments were applied May 27, 1999 at 4:00 to 4:30 pm with 80 F air, 62 F soil at a 2 to 4 inch depth, 65% relative humidity, 0% clouds, 0 to 3 N mph wind, dry soil surface, and moist subsoil. The POST treatments were applied June 14, 1999 at 11:30 to 12:00 pm with 62 F air, 81 F soil surface, 32% relative humidity, 0% clouds, 3 to 6 NE mph wind, dry soil surface, dry subsoil, good crop vigor, no dew present, to unifoliolate soybean. Weed species present were: 2 to 6 inch, 2 to 4 lf, (10 to 30/ft^2) foxtail; cotyledon to 2 lf, (10 to 20/ft^2) wild mustard; 2 to 6 inch, cotyledon to 6 lf, (2 to 25/ft^2) common cocklebur; cotyledon to 3 lf, (2 to 5/yd^2) common lambsquarters; and cotyledon to 2 lf, (1 to 3/yd^2) redroot pigweed. Treatments were applied to the center 6.67 feet of the 10 by 40 ft plots with a bicycle-wheel-type plot sprayer delivering 17 gpa at 40 psi through 8002 flat fan nozzles for the PRE treatments. POST treatments were applied with a bicycle-wheel-type plot sprayer equipped with a wind shield delivering 8.5 gpa at 40 psi through 8001 flat fan nozzles. The experiment had a randomized complete block design with three replicates per treatment.

Treatment	Rate	June 28	June 28	July 12					Soybean
		Soybean	Fxtl	Fxtl	Wimu	Rrpw	Colq	Cocb	yield
	Product/A	% injury	% control						bu/A
Touchdown	1.6pt	2	98	75	86	85	88	83	21
Touchdown+Basagran	1.6pt+2.5%	2	98	75	91	87	91	90	18
Frontier/Touchdown	24floz/1.6pt	0	95	87	99	96	99	92	18
Frontier/Touchdown	24floz/1.2pt	0	95	92	99	99	99	90	21
Touchdown+Flexstar+PO	1.6pt+12floz+0.5%	3	97	78	99	99	99	95	18
Touchdown+Flexstar+PO	1.6pt+8floz+0.5%	3	97	82	99	99	99	88	12
Touchdown+Flexstar+PO	1.2pt+12floz+0.5%	6	99	88	99	99	99	98	12
Touchdown+Flexstar+PO	1.2pt+8floz+0.5%	5	95	77	99	95	96	90	13
Touchdown+Fusilade DX+PO	1.2pt+4floz+0.5%	0	96	63	70	72	72	72	17
Untreated		0	0	0	0	0	0	0	11
LSD (0.05)		NS	4	10	4	9	10	10	5

All treatments controlled wild mustard, redroot pigweed, common lambsquarters, and common cocklebur at June 28. Many rain events occurred during the growing season, which resulted in many flushes of weeds in plots. Most plots had high populations of foxtail and cocklebur at harvest. Frontier applied PRE helped control foxtail flushes compared to only POST applications. No treatments resulted in greater than 6% soybean injury at June 28 and no injury was observed at July 12. Lack of weed control at July 12 was from emergence of weed flushes. Soybean yield ranged from 11 bu/A in the untreated plots to 21 bu/A. No explanation is given for variability in soybean yields based on good to excellent weed control for the first two to three weeks following soybean emergence.

Weed control in Roundup Ready soybeans. Zollinger and Fitterer. An experiment was conducted near Casselton, ND to evaluate weed control from Roundup Ultra applied at various stages alone or to plots previously treated with soil applied herbicides. PPI treatments were applied and incorporated on May 27 at 12:00 to 12:30 pm with 73 F air, 62 F soil at a 2 to 4 inch depth, 55% relative humidity, 0% clouds, 0 to 5 mph N wind, dry soil surface, and moist subsoil. Peterson Farm Seed '9905 RR' Roundup Ultra resistant soybean was planted and PRE treatments were applied on May 27, 1999 at 4:30 to 5:30 pm with 78 F air, 62 F soil at a 2 to 4 inch depth, 65% relative humidity, 0% clouds, 0 to 3 mph N wind, dry soil surface, and moist subsoil. EPOST treatments were applied June 9, 1999 at 9:30 to 10:30 am with 72 F air, 84 F soil surface, 70% relative humidity, 90% clouds, 5 to 10 mph N wind, dry soil surface, moist subsoil, good crop vigor, and no dew present to unifoliolate soybean. Weed species present were: 3 to 4 inch, (20 to 50 plants/ft^2) foxtail; 1 to 2 inch, (1 plant/yd^2) redroot pigweed; cotyledon, (10 to 15 plants/ft^2) wild mustard; and 1 to 3 inch, (15 to 20 plants/ft^2) common cocklebur. MPOST treatments were applied June 14, 1999 at 11:00 to 11:30 am with 60 F air, 81 F soil surface, 32% relative humidity, 0% clouds, 0 to 7 mph NE wind, dry soil surface, moist subsoil, good crop vigor, and no dew present to unifoliolate soybean. Weed species present were: 2 to 6 inch, (20 to 50 plants/ft^2) foxtail; 1 to 3 inch, (1 plant/yd^2) redroot pigweed; 1 to 3 inch, (10 to 15 plants/ft^2) wild mustard; and 2 to 5 inch, (12 to 20 plants/ft^2) common cocklebur. POST treatments were applied June 18, 1999 at 12:00 pm with 74 F air, 88 F soil surface, 48% relative humidity, 30% clouds, 7 to 15 mph SE wind, dry soil surface, dry subsoil, good crop vigor, no dew present unifoliolate soybean. Weed species present were: 2 to 6 inch, (20 to 50 plants/ft^2) foxtail; 1 to 2 inch, (1 to 5 plants/ft^2) redroot pigweed; 1 to 3 inch, (5 to 20 plants/ft^2) wild mustard; and 4 to 6 inch, (2 to 15 plants/ft^2) common cocklebur. LPOST treatments were applied June 23, 1999 at 3:00 pm with 83 F air, 81 F soil surface, 75% relative humidity, 50% clouds, 5 to 8 mph W wind, dry soil surface, moist subsoil, excellent crop vigor, no dew present to first trifoliolate soybean. Weed species present were: 4 to 6 inch, (20 to 50 plants/ft^2) foxtail; 1 to 3 inch, (1 to 5 plants/ft^2) redroot pigweed; 1 to 2 inch, (1 to 3 plants/ft^2) wild mustard; and 4 to 6 inch, (1 to 5 plants/ft^2) common cocklebur. LLPOST were applied on July 16, 1999 at 8:30 am with 67 F air, 75 F soil surface, 63% relative humidity, 0% clouds, 5 to 10 mph NW wind, moist soil surface, wet subsoil, fair (chlorotic) crop vigor, no dew present to 3 to 4 trifoliolate soybean. Weed species present were: 4 to 6 inch, (2 to 6 plants/ft^2) foxtail; 1 to 2 inch, (5 to 10 plants/ft^2) wild mustard; and 4 to 6 inch, (1 to 2 plants/ft^2) common cocklebur. Treatments were applied to the center 6.67 feet of the 10 by 40 ft plots with a bicycle-wheel-type plot sprayer equipped with a wind shield delivering 17 gpa at 40 psi through 8002 flat fan nozzles for the PPI and PRE treatments and 8.5 gpa at 40 psi through 8001 flat fan nozzles for the POST treatments. The experiment had a randomized complete block design with four replicates per treatment.

Several rain events occurred after most POST applications causing several weed flushes. Weed germination occurred even after five applications of Roundup Ultra resulting in low weed control ratings on July 10. At harvest, all plots except those with soil applied treatments had dense weed populations and large weeds. Observed soybean injury was restricted to PPI treatments and is attributed to prolonged periods of water-logged soil and poor early growing conditions in combination with PPI herbicides. Low overall yields were due to stress caused by excess moisture, continuous flushes of weeds after each rain event, and high weed density. Most soil applied treatments provided greater weed control than Roundup Ultra alone due to the lack of residual weed control from Roundup Ultra and heavy weed pressure occurring after multiple rain events. Plots with Roundup Ultra applied E/M/P/L, E/M and E/P plus trifluralin and alachlor tended to have higher yields than other plots with other treatments. Roundup Ultra applied E/M/P/L gave the greatest yield probably because weeds were controlled throughout the most critical soybean development stages of the growing season. Soybean applied with Roundup Ultra at E/M/P application interval gave less yield than E/M/P/L probably because of weed competition that developed after the last application. Plots treated with an E and P and/or L application of Roundup Ultra yielded more than other plots. Although Pursuit Plus, Prowl, Raptor, and Fusion+Flexstar gave excellent weed control throughout the season, yields were greatly reduced because of excessive rain.

Table. Weed control in Roundup Ultra resistant soybeans (Zollinger and Fitterer).

Treatment [a]	Rate	Application stage[b]	July 21	July 7						July 21				Soybean
			Soybean	Fxtl[c]	Wimu	Rrpw	Colq	Cocb	Cath	Fxtl[c]	Rrpw	Colq	Cocb	yield
	(lb/A)		(% injury)	(% control)										(bu/A)
Roundup Ultra/Roundup Ultra/ Roundup Ultra/Roundup Ultra	1 qt/1 qt/ 1 qt/1 qt	PRE/E/M/P	0	85	80	80	80	80	50	23	15	15	92	20
Roundup Ultra/Roundup Ultra/ Roundup Ultra/Roundup Ultra	1 qt/1 qt/ 1 qt/1 qt	E/M/P/L	0	85	80	80	80	80	50	38	21	21	92	28
Roundup Ultra/RU/RU	1 qt/1 qt/1 qt	M/P/L	0	85	80	80	80	80	50	33	10	10	93	15
Roundup Ultra/Roundup Ultra	1 qt/1 qt	P/L	0	85	80	80	80	80	50	43	26	26	93	13
Roundup Ultra	1 qt	L	0	85	80	80	80	80	50	50	33	33	92	12
Roundup Ultra/Roundup Ultra/RU	1 qt/1 qt/1 qt	E/M/P	3	85	80	80	80	81	50	54	24	24	92	20
Roundup Ultra/Roundup Ultra	1 qt/1 qt	E/M	0	85	80	80	80	80	50	20	29	29	92	13
Roundup Ultra	1 qt	E	0	73	82	70	70	70	45	15	5	5	28	4
Pursuit Plus/Roundup Ultra/ Roundup Ultra/Roundup Ultra	2.5 pt/1 qt/ 1 qt/1 qt	PPI/E/LL	29	97	99	99	99	87	38	99	99	99	99	6
Treflan/Roundup Ultra/ Roundup Ultra/Roundup Ultra	1.5 pt/1 qt/ 1 qt/1 qt	PPI/E/LL	12	90	78	90	90	65	38	98	99	99	99	18
Roundup Ultra	1 qt	M	0	75	74	74	74	25	41	5	5	5	10	10
Roundup Ultra	1 qt	P	0	85	80	80	80	80	50	54	53	48	90	13
Roundup Ultra/Roundup Ultra	1 qt/1 qt	E/P	0	85	80	80	80	80	50	35	21	21	91	20
Lasso/Roundup Ultra	2 qt/2 qt	PRE/P	0	98	86	97	97	95	91	90	89	86	90	18
Prowl/Raptor+Quad 7	3 pt/4 oz+1% v/v	PPI/P	11	98	98	98	98	94	43	98	99	99	95	5
Raptor+Quad 7	5 oz+1% v/v	P	3	90	87	83	81	83	58	86	92	92	91	6
Fusion+ Flexstar+Scoil	6 oz+ 0.75 pt+1.5 pt	P	0	86	80	80	80	80	51	68	88	84	95	18
Untreated			0	0	0	0	0	0	0	0	0	0	0	11
LSD (0.05)			7	7	6	6	6	8	10	16	14	13	4	5

[a]RU = Roundup Ultra; Quad 7 = basic blend; Scoil = methylated seed oil.
[b]E = EPOST; M = MPOST; P = POST; L = LPOST; LL = LLPOST.
[c]Fxtl = Grft and Yeft.

Reduced rate and split application of herbicides in soybean, Casselton.
(Ramsdale and Messersmith) Experiments were conducted to examine the potential of reducing herbicide rates in soybean by split application. 'Traill' soybean was planted in 30-inch rows on May 28, 1999, near Casselton, ND. All treatments were applied with a bicycle-wheel-type plot sprayer equipped with four 8001 flat-fan nozzles at 20-inch spacing. Plots were 10 by 30 ft and arranged in a randomized complete block with four replicates. All herbicide rates were lower than labeled rates and either applied in one single application or two applications each at half the single application rate. Data presented are evaluations made on July 28.

Date Treatment	June 8 1st Split	June 17 Single	June 24 2nd Split
Sprayer			
gpa	8.5	8.5	8.5
psi	35	35	35
Air temperature (F)	85	65	81
Relative humidity (%)	53	35	33
Wind (mph)	15-20	5-8	2-5
Sky	clear	clear	partly cloudy
Soybean	unifol	1 trif	2-3 tri
Common cocklebur			
leaf no.	coty-4	2-6	4-6
height (inch)	1-3	2-5	3-6
Yellow foxtail			
leaf no.	1-3	2-6	3-4
height (inch)	2-4	3-7	4-6

Split application of imazethapyr at 0.016 lb ai/A with either 1.0% Quad7 or 2.0% Scoil provided greater control of common cocklebur compared to one single application. Control for these treatments was similar to imazethapyr at 0.024 lb ai/A regardless of application timing. Yellow foxtail control by imazethapyr was similar between single and split applications. Split application of imazamox at 0.01 lb ai/A with either 1.0% Quad7 or 2.0% Scoil provided greater control of common cocklebur compared to one single application. However, common cocklebur control by imazamox at 0.01 lb ai/A was 15 to 20% less than imazamox applied at 0.016 lb ai/A. Control of common cocklebur by fomesafen or acifluorfen was similar for single and split applications regardless of tank mix partner. However, control of common cocklebur by a split application of lactofen increased 30 to 40% versus a single application. Control of yellow foxtail by quizalofop was poor and not affected by time of application. Sethoxydim or clethodim applied with either fomesafen or lactofen provided similar yellow foxtail control for single and split applications. Conversely, a split application of sethoxydim or clethodim applied in combination with acifluorfen increased yellow foxtail control versus a single application. Perhaps sethoxydim and clethodim were antagonized by acifluorfen which was overcome with the split application.

Treatment[a]	Rate[b]	Yellow foxtail		Common cocklebur	
		Single	Split	Single	Split
	lb ai/A	% control			
Imazethapyr experiment					
Imazethapyr + Act90 + 28%N	0.024 + 0.25% + 4.0%	95	-	93	-
Imazethapyr + Quad7	0.024 + 1.0%	87	91	87	93
Imazethapyr + Quad7	0.024 + 2.0%	92	91	88	91
Imazethapyr + Scoil	0.024 + 2.0%	88	91	84	94
Imazethapyr + Scoil	0.024 + 4.0%	92	93	87	96
Imazethapyr + Quad7	0.016 + 1.0%	84	86	78	88
Imazethapyr + Quad7	0.016 + 2.0%	86	83	78	81
Imazethapyr + Scoil	0.016 + 2.0%	83	88	75	91
Imazethapyr + Scoil	0.016 + 4.0%	88	87	83	89
CV		5		5	
LSD (5%)		6		6	
Imazamox experiment					
Imazamox + Act90 + 28%N	0.016 + 0.25% + 4.0%	86	-	78	-
Imazamox + Quad7	0.016 + 1.0%	80	84	74	78
Imazamox + Quad7	0.016 + 2.0%	87	85	83	82
Imazamox + Scoil	0.016 + 2.0%	82	88	79	85
Imazamox + Scoil	0.016 + 4.0%	88	91	90	90
Imazamox + Quad7	0.01 + 1.0%	70	71	55	64
Imazamox + Quad7	0.01 + 2.0%	76	75	60	64
Imazamox + Scoil	0.01 + 2.0%	78	81	62	70
Imazamox + Scoil	0.01 + 4.0%	78	79	67	69
CV		6		5	
LSD (5%)		6		5	
Broadleaf plus grass herbicide expt.					
Lactofen + sethoxydim	0.94 + 0.94	88	92	38	78
Acifluorfen + sethoxydim	0.125 + 0.94	77	86	68	63
Fomesafen + sethoxydim	0.118 + 0.94	88	96	91	90
Lactofen + quizalofop	0.94 + 0.042	56	45	51	80
Acifluorfen + quizalofop	0.125 + 0.042	44	46	66	71
Fomesafen + quizalofop	0.118 + 0.042	43	46	87	87
Lactofen + clethodim	0.94 + 0.046	91	92	36	76
Acifluorfen + clethodim	0.125 + 0.046	80	92	61	64
Fomesafen + clethodim	0.118 + 0.046	87	95	89	85
CV		9		7	
LSD (5%)		10		7	

[a] Act90 = Activator 90 nonionic surfactant by Loveland Industries Inc., Greeley, CO; 28%N = 28% urea ammonium nitrate fertilizer; Quad7 = adjuvant blend, Scoil = methylated vegetable oil by AGSCO, Grand Forks, ND.
[b] % = % v/v.

Control of biennial wormwood in soybean, Fargo. (George O. Kegode and Mark G. Ciernia). A field study was conducted to evaluate PRE and POST applied herbicides for control of biennial wormwood in soybean. Glyphosate-resistant soybeans (Asgrow AG0901) soybean was seeded in 30 inch rows on May 24. Glyphosate at 0.75 ae/A had been applied as a burndown treatment on May 20, 1999, since some biennial wormwood had already emerged by April 20. PRE treatments were applied within 24 hrs of soybean seeding and POST treatments were applied when biennial wormwood seedlings were 2 in tall. Split application of herbicides were: POST I, applied when biennial wormwood seedlings were 1 in tall; and POST II, applied when biennial wormwood seedlings were 3 in tall. All treatments were applied to the center 6.7 ft of the 10 by 30 ft plots with a bicycle-wheel-type sprayer equipped with a drift shield, delivering 17 gpa (PRE) and 8.5 gpa (POST) at 40 psi through 8002 flat fan nozzles. The experiment was in a randomized complete block design with four replicates per treatment. Biennial wormwood control and soybean injury was evaluated 14 and 28 days after herbicide application and soybean yield was measured at the end of the study. Biennial wormwood densities ranged from 1 to 6 plants ft^{-2} (and averaged 3 plants ft^2).

Application type:	PRE	POST	POST I	POST II
Date:	May 25	June 25	June 18	July 1
Time:	8:30 a.m.	8:00 a.m.	8:30 a.m.	1:00 p.m.
Cloud cover:	Clear	Partly cloudy	Mostly cloudy	Partly cloudy
Winds:	2 - 6 mph	3 - 7 mph	3 - 7 mph	2 - 5 mph
Air temperature:	15 C	26 C	18 C	21 C
Relative humidity:	44%	46%	45%	72%
Soybean stage:	-	3 Trifoliate	2 Trifoliate	3 - 4 Trifoliate
Weed stage:	-	6 - 8 leaf	4 - 6 leaf	8 - 11 leaf

			Biww[d]		Sobe inj		
Treatment[a]	Rate[b]	Timing[c]	14d	28d	14d	28d	Yield
	oz ai/A		———	———	%	———	lb/A
Flumioxazin	1	PRE	62	45	0	0	2450
Flumioxazin	1.5	PRE	55	28	0	0	1600
Flumioxazin	2	PRE	65	48	0	0	2400
Lactofen+COC	1.5+1%	POST	68	32	24	9	2450
Lactofen+COC	3.13+1%	POST	81	53	18	12	2350
Lact+COC/Lact+COC	1+1%/1+1%	POST I & II	58	31	14	5	2300
Glyphosate+AMS	12+23	POST	97	98	0	0	3550
Glyphosate+AMS	9+23	POST	96	96	1	0	3250
Glyt+AMS/Glyt+AMS	6+23/6+23	POST I & II	99	100	0	0	3250
Alachlor	32	PRE	61	30	0	0	2200
Metolachlor	31	PRE	44	23	0	0	2200
Dimethenamid	24	PRE	36	22	0	0	1700
Acifluorfen+NIS	4+0.25%	POST	32	7	5	5	2100
Acif+NIS/Acif+NIS	2+0.25/2+0.25	POST I & II	26	11	12	3	1500
Bentazon+PO	16+0.25 gpa	POST	78	42	12	6	2800
Bent+PO/ Bent+PO	8+0.25 gpa/ 8+0.25 gpa	POST I & II	91	90	0	0	3550
Thifensulfuron	0.083+0.25%	POST	74	49	6	2	2850
Flumiclorac+Lact+PO	0.43+3.2+0.13 gpa	POST	74	46	24	8	2850
Untreated	0	-	0	0	0	0	1750
C.V.%			15	27	84	134	33
LSD (0.05)			13	17	7	5	1200

[a]COC = crop oil concentrate (petroleum based); AMS = ammonium sulfate; NIS = non-ionic surfactant; PO = petroleum oil
[b]gpa = gallons per acre
[c]PRE = preemergence; POST = postemergence; POSTI & II = postemergence split treatments
[d]Biww = Biennial wormwood

Glyphosate provided the best control of biennial wormwood). Bentazon split applied provided better than 90% control of biennial wormwood (Table) and as a result soybean yield was similar to the glyphosate treatments. Continuous emergence of biennial wormwood seedlings, especially following rain events, was the primary reason for poor control by most of the herbicides.

Control of biennial wormwood in soybean Geneseo. (George O. Kegode and Mark G. Ciernia). A field study was conducted to evaluate POST applied herbicides for control of biennial wormwood in soybean. 'Wensman 3096' conventional soybean was seeded May 25. Soybeans were seeded in 20 inch rows. Glyphosate at 0.75 ae/A was applied as a burndown treatment on May 27. Application of POST herbicides, experimental design, and herbicidè evaluations were similar to the Fargo, ND study. Additional information pertinent to herbicide application follows. Wormwood population density ranged from 1 to 5 plants ft^{-2} (and averaged 2 plants ft^{-2}).

Application type:	POST	POST I	POST II
Date:	June 29	June 21	July 6
Time:	10:00 a.m.	11:30 a.m.	10:00 a.m.
Cloud cover:	Partly cloudy	Mostly cloudy	Clear
Winds:	5-8 mph from S	8-10 mph from SE	1-3 mph from W
Air temperature:	21 C	26 C	25 C
Relative humidity:	43%	53%	24%
Soybean stage:	2 Trifoliate	1 Trifoliate	5 Trifoliate
Weed stage	3 - 6 leaf	1 - 4 leaf	4 - 12 leaf

Treatment[a]	Rate[b]	Timing[c]	Biww[d]		Sobe Injury	
			14 d	28 d	14 d	28 d
	oz ai/A				%	
Lactofen+COC	1.5+1%	POST	54	42	27	18
Lactofen+COC	3.13+1%	POST	74	63	19	10
Lact+COC/Lact+COC	1+1%/1+1%	POST I & II	53	55	17	18
Glyphosate+AMS	12+23	POST	76	87	86	93
Glyphosate+AMS	9+23	POST	77	91	84	99
Glyt+AMS/Glyt+AMS	6+23/6+23	POST I & II	92	98	100	100
Acifluorfen+NIS	4+0.25%	POST	39	10	19	12
Acif+NIS/Acif+NIS	2+0.25/2+0.25	POST I & II	4	1	6	6
Bentazon+PO	16+0.25 gpa	POST	76	68	7	2
Bent+PO/Bent+PO	8+0.25 gpa/8+0.25gpa	POST I & II	63	77	4	5
Fomesafen&adju+MSO	2.82+1%	POST	45	22	7	5
Fomesafen&adju+MSO	1.88+1%	POST	26	8	6	5
Thifensulfuron	0.083+0.25%	POST	24	13	2	4
Flumiclorac+Lact+PO	0.43+3.2+0.13 gpa	POST	71	62	59	41
Imazethapyr+Quad7	0.76+1%	POST	35	15	14	6
Imazamox+Quad7	0.63+1%	POST	65	42	34	23
C.V.%			28	25	49	34
LSD 5%			22	17	21	14

[a]COC = crop oil concentrate (petroleum based); AMS = ammonium sulfate; NIS = non-ionic surfactant; PO = petroleum oil; adju = adjuvant.
[b]gpa = gallons per acre
[c]PRE = preemergence; POST = postemergence; POSTI & II = postemergence split treatments
[d]Biww = Biennial wormwood

Glyphosate provided the best control of biennial wormwood. However, bentazon as split application was less effective. Continuous emergence of biennial wormwood seedlings, especially following rain events, was the primary reason for poor control by a most of the herbicides.

Control of biennial wormwood in soybean, Wyndmere. (George O. Kegode and Mark G. Ciernia). A Field study was conducted to evaluate POST applied herbicides for control of biennial wormwood in soybean. "Pioneer 9093" soybeans soybean was seeded May 22, in 30 inch rows. Glyphosate at 0.75 ae/A was applied as a burndown treatment on May 25. Application of POST herbicides, experimental design, and herbicide evaluations were similar to the Fargo, ND study. Additional information pertinent to herbicide application are as follows. Biennial wormwood population density at ranged from 0 to 2 plants ft^{-2} (and averaged 1 plant ft^{-2}).

Application type:	POST	POST I	POST II
Date:	June 29	June 21	July 6
Time:	11:00 a.m.	10:30 a.m.	11:00 a.m.
Cloud cover:	Partly cloudy	Mostly cloudy	Clear
Winds:	7 - 10 mph	6 - 9 mph	6 - 8 mph
Air temperature:	22 C	27 C	27 C
Relative humidity:	45%	49%	37%
Soybean stage:	3 Trifoliate	2 Trifoliate	5 Trifoliate
Weed stage:	4 - 6 leaf	1 - 4 leaf	8 - 12 leaf

Treatment[a]	Rate[b]	Timing[c]	Biww[d]		Sobe inj	
			14 d	28 d	14 d	28 d
	oz ai/A		%			
Lactofen+COC	1.5+1%	POST	56	23	10	10
Lactofen+COC	3.13+1%	POST	56	38	16	11
Lact+COC/Lact+COC	1+1%/1+1%	POST I & II	40	36	8	3
Glyphosate+AMS	12+23	POST	84	58	0	0
Glyphosate+AMS	9+23	POST	77	58	0	0
Glyt+AMS/Glyt+AMS	6+23/6+23	POST I & II	94	75	0	0
Acifluorfen+NIS	4+0.25%	POST	40	23	4	2
Acif+NIS/Acif+NIS	2+0.25/2+0.25	POST I & II	18	3	3	2
Bentazon+PO	16+0.25 gpa	POST	51	19	1	2
Bent+PO/Bent+PO	8+0.25 gpa/8+0.25 gpa	POST I & II	44	56	2	2
Fomesafen&adju+MSO	2.82+1%	POST	54	21	1	1
Fomesafen&adju+MSO	1.88+1%	POST	48	31	1	1
Thifensulfuron	0.083+0.25%	POST	39	25	0	1
Flumiclorac+Lact+PO	0.43+3.2+0.13 gpa	POST	61	39	49	35
Imazethapyr+Quad7	0.76+1%	POST	37	26	8	1
Imazamox+Quad7	0.63+1%	POST	48	31	7	2
C.V.%			24	32	51	78
LSD (0.05)			18	16	5	5
# of Reps			4	4	4	4

[a]COC = crop oil concentrate (petroleum based); AMS = ammonium sulfate; NIS = non-ionic surfactant; PO = petroleum oil; adju = adjuvant.
[b]gpa = gallons per acre
[c]PRE = preemergence; POST = postemergence; POSTI & II = postemergence split treatments
[d]Biww = Biennial wormwood

Glyphosate provided the best control of biennial wormwood. However, bentazon as split application was less effective. Continuous emergence of biennial wormwood seedlings, especially following rain events, was the primary reason for poor control by a most of the herbicides used.

Biennial wormwood control. Zollinger and Fitterer. An experiment was conducted near the airport in Fargo, ND to evaluate weed control from dicamba and 2,4-D. Asgrow 'AG0901' Roundup Ready soybeans were planted on May 24, 1999. POST treatments were applied June 7, 1999 at 2:00 pm with 78 F air, 70 F soil surface, 70% relative humidity, 0% clouds, 3 to 8 mph SE wind, dry soil surface, moist subsoil, excellent crop vigor, no dew present, and unifoliolate soybean. Weed species present were: 10 to 12 inch, (1 to 10/ft^2), common lambsquarters; 2 to 4 inch, (5 to 20/ft^2) biennial wormwood; and 10 to 12 inch, (5 to 25/ ft^2), kochia. Treatments were applied to the center 6.67 feet of the 10 by 30 ft plots with a bicycle-wheel-type plot sprayer equipped with a wind shield delivering 8.5 gpa at 40 psi through 8001 flat fan nozzles. The experiment had a randomized complete block design with three replicates per treatment.

Treatment	Rate	June 24		July 5		
		Biww	Kocz	Biww	Kocz	Colq
	Product/A	% control				
Distinct+NIS+28% UAN	2oz+0.25%+1.25%	25	68	60	80	91
Distinct+NIS+28% UAN	4oz+0.25%+1.25%	35	80	70	95	96
Distinct+NIS+28% UAN	6oz+0.25%+1.25%	45	80	87	99	85
Distinct+NIS+28% UAN	8oz+0.25%+1.25%	57	92	96	99	93
Clarity+NIS+28% UAN	1pt+0.25%+1.25%	48	88	99	99	99
2,4-D amine+NIS+28% UAN	1pt+0.25%+1.25%	48	23	66	70	85
Untreated		0	0	0	0	0
LSD (0.05)		8	7	14	9	4

Weeds were actually taller than preferred at application. No common lambsquarters observed at 6/24. Biennial wormwood control generally was poor at 2 weeks after application (25 to 57% control). Only Distinct at 8 oz/A or Clarity at 1 pt/A gave greater than 90% control at July 5. Distinct at most rates gave greater than 90% control except 2 oz/A.

Soybean weed control - Airport. Zollinger and Fitterer. An experiment was conducted near the airport in Fargo, ND to evaluate Basagran applied in tankmix combinations. Asgrow 'AG0901' Roundup Ready soybean was planted on May 24, 1999. POST treatments were applied June 7, 1999 at 2:00 pm with 78 F air, 70 F soil surface, 70% relative humidity, 0% clouds, 3 to 8 mph SE wind, dry soil surface, moist subsoil, excellent crop vigor, no dew present, to unifoliolate soybean. Weed species present were: 10 to 12 inch (1 to 10/ft^2), common lambsquarters; 2 to 4 inch, (5 to 20/ft^2) biennial wormwood; 4 to 8 inch, (2/yd^2) common cocklebur; and 10 to 12 inch, (5 to 25/ ft^2) kochia. Treatments were applied to the center 6.67 feet of the 10 by 30 ft plots with a bicycle-wheel-type plot sprayer equipped with a wind shield delivering 8.5 gpa at 40 psi through 8001 flat fan nozzles. The experiment had a randomized complete block design with three replicates per treatment.

		June 24		July 7		
Treatment	Rate	Biww	Colq	Biww	Colq	Kocz
	Product/A	% control				
Basagran+Blazer+PO	1pt+1pt+1pt	60	33	63	50	63
Basagran+Raptor+Scoil	1pt+2oz+1pt	70	70	83	63	90
Basagran+Butyrac 200+Scoil	1pt+4floz+1pt	53	50	87	83	50
Basagran+Pinnacle+NIS	1pt+0.25oz+0.25%	68	77	90	90	57
Basagran+Flexstar+Scoil	1pt+0.75pt+1pt	83	37	90	40	77
Untreated		0	0	0	0	0
LSD(0.05)		14	13	10	12	15

Herbicides were applied later than desired. All treatments controlled common cocklebur. No kochia was observed at June 24. Biennial wormwood and common lambsquarters control was inadequate. At July 7, biennial control ranged from 63 to 90%, common lambsquarters from 40 to 90%, and kochia from 50 to 90% control.

Soybean herbicides with additives - Airport. Zollinger and Fitterer. An experiment was conducted near the airport in Fargo, ND to evaluate weed control from Basagran + Blazer applied with adjuvants. Asgrow 'AG0901' Roundup Ready soybean was planted on May 24, 1999. POST treatments were applied June 7, 1999 at 2:00 pm with 78 F air, 70 F soil surface, 70% relative humidity, 0% clouds, 3 to 8 mph SE wind, dry soil surface, moist subsoil, excellent crop vigor, no dew present, to unifoliolate soybean. Weed species present were: 10 to 12 inch, (1 to 10/ft^2), common lambsquarters; 2 to 4 inch, (5 to 20/ft^2) biennial wormwood; and 10 to 12 inch, (5 to 25/ ft^2), kochia. Treatments were applied to the center 6.67 feet of the 10 by 30 ft plots with a bicycle-wheel-type plot sprayer equipped with a wind shield delivering 8.5 gpa at 40 psi through 8001 flat fan nozzles. The experiment had a randomized complete block design with three replicates per treatment.

Treatment	Rate	June 24			July 7		
		Biww	Kocz	Colq	Biww	Kocz	Colq
	Product/A	% control					
Basagran+Blazer+NIS	1pt+1pt+0.25%	40	53	33	47	63	47
Basagran+Blazer+PO	1pt+1pt+1qt	58	77	37	60	67	33
Basagran+Blazer+AMS	1pt+1pt+17lb/100gal	58	70	33	40	42	20
Basagran+Blazer+28% UAN	1pt+1pt+4qt	57	67	20	53	80	37
Basagran+Blazer+Surfate	1pt+1pt+1%	53	80	23	67	83	40
Untreated		0	0	0	0	0	0
LSD (0.05)		12	9	10	15	15	9

Herbicides were applied later than desired. Weed control was inadequate at July 24. At July 7, weed control was variable and inadequate. However, PO and Surfate generally enhanced Basagran + Blazer the most.

Control of biennial wormwood with various herbicides. Brian Jenks and Gary Willoughby. Biennial wormwood has become a problem weed in crop production fields throughout North Dakota. Various herbicides were applied June 14 to a high population of biennial wormwood (2-10") to evaluate efficacy. No crop was seeded. Individual plots were 10 x 30 ft arranged in a RCBD with three replications. All postemergence treatments were applied with XR8001 flat fan nozzles delivering 10 gpa at 40 psi.

Glufosinate provided excellent control of biennial wormwood. Glyphosate at 0.75 lb was slightly more effective than 0.38 lb. Bromoxynil + MCPA burned down the wormwood soon after application, but substantial regrowth occurred after the first evaluation. Fomesafen, lactofen, and imazamox were not effective on biennial wormwood. Clopyralid activity on wormwood was very slow.

Table. Control of biennial wormwood with various herbicides.

Treatment[a]	Rate	June 21	August 31
		Biww	
	lb/A	control (%)	
Fomesafen + MSO	0.24 + 0.5%	37	12
Lactofen + COC	0.094 + 1%	62	15
Glyphosate + AMS	0.38 + 2%	84	82
Glyphosate + AMS	0.75 + 2%	96	96
Imazamox + Quad 7	0.039 + 1%	45	27
Glufosinate + AMS	0.44 + 3 lb	99	99
2,4-D ester	0.25	68	47
Clopyralid	0.035	13	48
Bromoxynil + MCPA	0.50	86	40
Untreated		0	0
LSD		7	15
CV		7	19

[a] Bromoxynil + MCPA applied as commercial premix

Lanceleaf sage control in soybean. Zollinger and Fitterer. An experiment was conducted near Wendall, MN to evaluate weed control from POST applied herbicides. Pioneer '90B72' soybean was planted May 22, 1999. POST treatments were applied July 3, 1999 at 1:00 to 2:00 pm with 83 F air, 88 F soil surface, 90% relative humidity, 15% clouds, 15 to 25 mph SE wind, wet soil surface, wet subsoil, fair crop vigor (chlorotic), no dew present, and 3 trifoliate soybean. Weed species present were: 4 to 8 inches (2 to 4 plants/ft^2) foxtail; 2 to 5 inches (4 to 10 plants/ft^2) redroot pigweed; 3 to 4 inches (2 to 5 plants/ft^2) common lambsquarters; 1 to 3 inches (1 to 3 plants/ft^2) eastern black nightshade; 4 to 8 inches (1 to 5 plants/ft^2) common cocklebur; and 3 to 4 inches (2 to 7 plants/ft^2) lanceleaf sage. Treatments were applied to the center 6.67 feet of the 10 by 40 ft plots with a bicycle-wheel-type plot sprayer equipped with a wind shield delivering 8.5 gpa at 40 psi through 8001 flat fan nozzles. The experiment had a randomized complete block design with three replicates per treatment.

Table. Lanceleaf sage control in soybean (Zollinger and Fitterer).

Treatment [a]	Rate	July 16					
		Fxtl[b]	Rrpw	Colq	Cocb	Lals[b]	Ebns
	(oz prod/A)	(% control)					
Cobra+PO	10+1qt	23	98	33	99	68	93
Cobra+PO	8+1qt	17	98	20	99	58	88
Cobra+PO	6+1qt	7	70	23	80	45	86
Galaxy+PO	2pt+1qt	57	95	73	96	56	99
Storm+PO	1.5pt+1qt	13	86	67	90	47	98
FirstRate+PO+28% UAN	0.3+1.5% v/v+2.5% v/v	33	40	23	92	50	0
Flexstar+Scoil	1pt+1% v/v	20	99	57	99	88	99
Flexstar+Scoil	0.75pt+1% v/v	20	99	50	99	66	99
Pursuit+Quad 7	2+1% v/v	78	92	33	80	33	91
Pursuit+Quad 7	3+1% v/v	82	95	20	91	73	93
Raptor+Quad 7	2+1% v/v	83	78	40	85	30	99
Raptor+Quad 7	3+1% v/v	93	93	67	60	50	99
Raptor+Quad 7	4+1% v/v	93	96	80	92	76	99
Raptor+Cobra+Scoil	2+4+1.5pt	96	99	96	93	93	99
Raptor+Cobra+Scoil	2+2+1.5pt	99	96	76	93	89	99
Raptor+Flexstar+Scoil	2+0.5pt+1.5pt	99	99	93	99	96	99
Raptor+Flexstar+Scoil	2+0.33pt+1.5pt	89	99	89	99	99	99
Roundup Ultra+AMS	2pt+10lb/100gal	99	99	99	99	99	99
Roundup Ultra+AMS	1.5pt+10lb/100gal	99	99	99	96	99	99
Roundup Ultra+AMS	1pt+10lb/100gal	99	96	99	93	99	99
Untreated		0	0	0	0	0	0
LSD (0.05)		18	10	11	6	9	7

[a]PO = petroleum oil = Herbimax; UAN = urea ammonium nitrate; Scoil = methylated seed oil adjuvant; Quad 7 = basic blend adjuvant; AMS = ammonium nitrate.
[b]Fxtl = Grft and Yeft, Lals = lanceleaf sage.

Cobra, Flexstar, and Galaxy and Storm premixes generally controlled redroot pigweed, common cocklebur, and eastern black nightshade. FirstRate controlled common cocklebur. Pursuit and Raptor at higher rates controlled green and yellow foxtail, redroot pigweed, common cocklebur, and eastern black nightshade. Addition of Cobra or Flexstar to a reduced rate of Raptor generally gave at least 90% control of all weeds present. Complete weed control was observed with Roundup Ultra at 1 to 2 pt/A. Only Raptor with Cobra or Flexstar and Roundup Ultra gave greater than 90% lanceleaf sage control.

Alfalfa response to Pursuit and Raptor. Meyer, Zollinger and Fitterer. An experiment will be conducted near Fargo to evaluate alfalfa tolerance to Pursuit and Raptor applied at different growth stages. Alfalfa was planted on April 28 , 1999. Cotyledon treatments were applied May 17 at 10:15 am with 56 F air, 56 F soil at 2 to 4 inch depth, 82% relative humidity, 100% clouds, 10 to 12 mph N wind, dry soil surface, and wet subsoil, no dew present and good was in good condition. First trifoliolate treatments were applied May 28 at 9:00 am with 68 F air, 74 F soil at 2 to 4 inch depth, 50% relative humidity, 50% clouds, 5 to 10 mph N wind, dry soil surface, and wet subsoil, no dew present and crop was in excellent condition. Third trifoliolate treatments were applied June 8 at 10:30 am with 72 F air, 86 F soil at 2 to 4 inch depth, 72% relative humidity, 100% clouds, 8 to 12 mph N wind, dry soil surface, wet subsoil, no dew present and crop was in excellent condition. The treatments were applied to the center 6.67 feet of the 10 by 25 ft plots with a bicycle-wheel-type sprayer equipped with a wind shield delivering 8.5 gpa at 40 psi through 8001 flat fan nozzles. The experiment has a randomized complete block design with three replications per treatment.

Table 1. Forage yield of alfalfa and percent weeds when treated with Pursuit and Raptor at three growth stages.

Treatment[a]	Growth stage	Forage yield			Weeds in forage	Weed control
		July 16	Sept 10	Total		
		tons DM/A			%	%
Pursuit						
	cotyledon	2.11	1.57	3.68	<1	99
	1st tri	2.06	1.58	3.64	<1	99
	3rd tri	1.88	1.52	3.40	<1	98
Raptor						
	cotyledon	2.13	1.73	3.86	4	86
	1st tri	1.83	1.56	3.39	<1	99
	3rd tri	1.99	1.53	3.52	1	98
Untreated		2.36	1.48	3.84	34	0
LSD (0.05)		0.29	NS	0.33	17	4

[a] Pursuit at 2 fl oz/A and Raptor at 3 fl oz/A plus Scoil at 1.5 pt/A.

Dormant versus spring-seeded canola. Brian Jenks, Kent McKay, and Gary Willoughby. Roundup Ready canola was seeded December 3, 1998 and April 23, 1999 into 7.5-inch rows at 700,000 pls/A. The canola was seeded into standing wheat stubble (very low residue). The canola not treated with a coating that inhibits germination. Individual plots were 12 x 30 ft and each treatment was replicated four times. Trifluralin and ethalfluralin granules were spread over individual plots with a Gandy granular applicator on December 4. One application of glyphosate was applied in the spring on May 25. The canola was harvested on August 9.

Table. Dormant versus spring-seeded canola.

Treatment	Rate	June 26			July 26			May 26	Yield
		Colq	Rrpw	Fxtl[a]	Colq	Rrpw	Fxtl[a]	Canola	
	lb/A	Control (%)						per sq ft	lb/A
Ethalfluralin (F)	1.15	75	91	89	71	85	74	4.8	1219
Ethalfluralin (S)	1.15	96	98	96	93	97	94	10.6	2063
Trifluralin (F)	1.15	60	85	87	58	83	76	4.5	1270
Trifluralin (S)	1.15	86	95	95	91	96	96	14.4	1935
Glyphosate (F)	0.38	85	89	76	81	88	53	4.7	1312
Glyphosate (S)	0.38	95	98	95	93	95	75	9.5	1914
Check (F)		0	0	0	0	0	0	6.3	1035
Check (S)		0	0	0	0	0	0	10.4	1676
LSD		14	13	6	11	12	13	2	341
CV		16	13	6	12	12	15	20	15

[a] Fxtl=green and yellow foxtail
(F)—fall seeded
(S)—spring seeded

We waited in late October and early November 1998 for the temperatures to go down low enough to inhibit seed germination. When that finally happened, we were greeted with 10 inches of snow in early November. Warm temperatures in November allowed the snow to melt and the soil to partially dry. We decided to seed in early December into wet, but hopefully frozen soil. The soil was not completely frozen at the time of seeding and soil moisture was very high in some areas.

The December-seeded canola began emerging about April 12. Time of emergence was quite variable, which resulted in varying stages of growth in May (i.e., some plants at 5-leaf stage while others in cotyledon stage). The dry month of April resulted in some stand loss due to soil crusting. We chose to try to break up the crust by going through the plot area with an empty drill. Stand counts taken on May 26 showed a significant difference in canola population in the fall vs. spring seeding. Stand counts ranged from 4-6 plants/ft^2 in the fall seeded plots compared to 10-14 plants/ft^2 in the spring seeded plots. Canola yields in the fall seeded plots were consistently 600 to 800 lb/A lower than the spring seeded plots. At least some of the stand loss and yield difference can be attributed to the soil crusting in April.

Weed control was better and more consistent in the spring seeded plots. Emergence of the spring seeded canola was more uniform and provided good suppression of weeds through crop competition. The low plant population of the fall seeded canola did not compete as well with weeds, even though herbicides provided some control. For example, glyphosate was applied May 25 and effectively controlled all emerged weeds. The higher canola population in the spring seeded plots helped shade out later emerging weeds, while the lower canola population in the fall seeded plots allowed later emerging weeds to be competitive through the remaining growing season. The same scenario occurred in the ethalfluralin and trifluralin plots, i.e., better weed control with a more competitive crop.

Timing of weed control in imidazolinone-tolerant canola. Brian Jenks, Kent McKay, and Gary Willoughby. Clearfield canola (45A71) was seeded May 3 into 7.5-inch rows at 700,000 pls/A. Herbicide treatments were applied preplant incorporated (Apr 30), early-post (June 1), mid-post (June 7), or late-postemergence (June 11). Individual plots were 10 x 30 ft arranged in a RCBD with three replications. PPI treatments were applied with a CO_2 pressurized bicycle sprayer delivering 20 gpa at 30 psi using XR80015 flat fan nozzles. All postemergence treatments were applied with XR8001 flat fan nozzles delivering 10 gpa at 40 psi. Heavy rains began the night the canola was seeded. We received almost 7 inches of rainfall before the early-post application (June 1). A portion of the first replication was under water for most of May. Canola was harvested August 10.

Table. Timing of weed control in imidazolinone-tolerant canola.

			June 25				July 26	
Treatment[a]	Rate	Timing[b]	Kocz	Fxtl[c]	Colq	Rrpw	Kocz	Yield
	lb/A		Control (%)					lb/A
Trifluralin	0.75	A	93	93	98	92	88	1495
Trifluralin / Quizalofop	0.75 / 0.055	A / C	94	95	97	98	79	1482
Ethalfluralin	0.75	A	92	93	97	99	89	1713
Ethalfluralin / Quizalofop	0.75 / 0.055	A / C	93	98	98	98	87	1558
Trifluralin / Imazamox	0.75 / 0.016	A / C	93	98	100	100	88	1530
Ethalfluralin / Imazamox	0.75 / 0.016	A / C	97	100	100	100	95	1563
Imazamox	0.016	B	65	78	63	96	62	1493
Imazamox	0.016	C	72	94	95	97	63	1444
Imazamox	0.016	D	78	95	90	97	63	1679
Imazamox	0.031	B	65	95	95	100	42	1374
Imazamox	0.031	C	85	99	100	100	67	1502
Imazamox	0.031	D	85	95	87	99	70	1418
Imazamox / Imazamox	0.016 / 0.016	B / D	70	100	100	100	62	1474
Imazamox / Imazamox	0.008 / 0.008	B / D	78	98	90	100	60	1492
Handweed check + Trifluralin / Imazamox	0.75 / 0.016	A / C	99	100	100	100	98	1491
Weedy check			0	0	0	0	0	1329
LSD			13	10	8	5	17	444
CV			10	7	5	3	14	17

[a] All imazamox treatments included NIS (0.25%) and 28% Nitrogen (1qt)
[b] A=PPI; B=cotyledon to 2-lf canola; C=3 to 4-lf canola; D=5 to 6-leaf canola
[c] Fxtl=green and yellow foxtail

Flea beetle pressure was extremely high in this field. Even though the canola seed was treated with Gaucho, we had to make a foliar insecticide application to help reduce the flea beetle pressure. The canola remained in the cotyledon to 2-leaf stage for an extended period due to the flea beetles and wet soil.

The objective of this study was to compare weed control from soil-applied products with imazamox at different rates and timings. The primary weeds were kochia, foxtails, lambsquarters, and pigweed. Other species present were shepherdspurse, field pennycress, and biennial wormwood. Trifluralin and ethalfluralin did not control the mustard species or biennial wormwood, but generally provided good control of kochia, foxtails, lambsquarters, and pigweed. Trifluralin or ethalfluralin followed by a postemergence application of imazamox was as effective or better than trifluralin or ethalfluralin alone.

Imazamox controlled foxtails, lambsquarters, pigweed, shepherdspurse, and field pennycress, but was weaker on kochia and biennial wormwood. The early application (cotyledon to 2-leaf) was not as effective as the later applications as it missed later flushes of weeds. Weed control with imazamox was generally higher with 0.031 lb compared to 0.016 lb. The split application of imazamox (0.016 lb + 0.016 lb) was also very effective on all weeds except kochia and biennial wormwood.

Wild oat and lambsquarters control with imazamox in imidazolinone-tolerant canola. Brian Jenks and Gary Willoughby. Clearfield canola (45A71) was seeded May 18 into 7.5-inch rows at 700,000 pls/A. Herbicide treatments were applied preplant incorporated (May 17), early-post (June 1), mid-post (June 5), or late-postemergence (June 10). Individual plots were 10 x 30 ft arranged in a RCBD with three replications. PPI treatments were applied with a CO_2 pressurized bicycle sprayer delivering 20 gpa at 30 psi using XR80015 flat fan nozzles. All postemergence treatments were applied with XR8001 flat fan nozzles delivering 10 gpa at 40 psi. Canola was harvested September 9.

Table. Wild oat and lambsquarters control with imazamox in imidazolinone-tolerant canola.

			June 21		July 26		
Treatment[a]	Rate	Timing[b]	Wioa	Colq	Wioa	Colq	Yield
	lb/A		Control (%)				lb/A
Trifluralin	0.75	A	48	57	48	40	575
Trifluralin / Imazamox	0.75 / 0.031	A / D	90	94	96	88	1270
Imazamox / Imazamox	0.016 / 0.016	B / D	98	93	97	82	1511
Imazamox	0.023	C	92	85	89	73	1405
Imazamox	0.031	C	96	87	95	73	1428
Imazamox	0.039	C	98	87	95	75	1567
Imazamox	0.047	C	98	91	97	83	1776
Imazamox	0.023	D	75	73	88	58	1354
Imazamox	0.031	D	86	75	93	65	1229
Imazamox	0.039	D	85	78	93	70	1306
Imazamox	0.047	D	86	84	94	68	1232
Untreated			0	0	0	0	77
LSD			6	10	6	12	340
CV			5	8	4	11	16

[a] Imazamox applied with nonionic surfactant and 28% N.
[b] A=PPI; B=cot to 2-lf canola (Jun 1); C=2 to 3-lf canola, 1-2" weeds (Jun 5); D=4 to 5-lf canola, 4-6" weeds (Jun 10)

Flea beetle pressure was extremely high and definitely slowed canola growth. In addition to the Gaucho-treated seed, we made a foliar insecticide application to help reduce flea beetle pressure. The canola remained in the cotyledon to 2-leaf stage for an extended period due to the flea beetles and wet soil.

Wild oat and lambsquarters densities were very high in this trial as evidenced by the low yield in the untreated check. Trifluralin provided only slight suppression of wild oat and lambsquarters. Imazamox was more effective on smaller wild oat (2 to 3 leaf) than on larger wild oat (5 to 6-leaf). Although imazamox controlled even the large wild oat, the later application time allowed wild oat and lambsquarters to reduce canola yield. Once wild oat was controlled, lambsquarters became much more competitive. Imazamox was weaker on lambsquarters compared to wild oat.

Weed control in Clearfield canola. Zollinger and Fitterer. An experiment was conducted in Prosper, ND to evaluate weed control in Clearfield canola at the PRE, POST, and LPOST stages. '45A71 Clearfield' canola was planted on May 28, 1999. PRE treatments were applied May 28, 1999 at 2:00 pm with 62 F air, 65 F soil at a 2 to 4 inch depth, 74% relative humidity, 30% clouds, 8 to 10 mph N wind, dry soil surface, and moist subsoil. POST treatments were applied June 24, 1999 at 11:00 to 12:00 pm with 80 F air, 87 F soil surface, 37% relative humidity, 0% clouds, 1 to 4 mph NW wind, dry soil surface, moist subsoil, good crop vigor, no dew present, and 5 to 6 lf canola. Weed species present were: 4 to 6 inch (1 to 5 plants/ft^2) foxtail; 2 to 3 inch (5 to 15 plants/ft^2) wild mustard; 4 to 6 inch (1 to 5 plants/ft^2) common cocklebur; 2 to 3 inch (5 to 15 plants/ft^2) redroot pigweed; and 1 to 3 inch (1 to 2 plants/ft^2) common lambsquarters. LPOST treatments were applied June 28, 1999 at 10:00 to 11:00 am with 65 F air, 68 F soil surface, 71% relative humidity, 100% clouds, 5 to 8 mph SW wind, wet soil surface, wet subsoil, good crop vigor, and dew present on 6 to 8 leaf canola. Weed species present were: 6 to 8 inch (5 to 10 plants/ft^2) foxtail. Treatments were applied to the center 6.67 feet of the 10 by 30 ft plots with a bicycle-wheel-type plot sprayer equipped with a wind shield delivering 17 gpa at 40 psi through 8002 flat fan nozzles for soil applied treatments and 8.5 gpa at 40 psi through 8001 flat fan nozzles for the POST treatments. The experiment had a randomized complete block design with three replicates per treatment.

Table. Weed control in Clearfield canola (Zollinger and Fitterer).

		Canola			July 1	July 12	July 22		
Treatment[a]	Rate	July 1	July 9	July 12	Cocb	Cocb	Rrpw	Colq	Cocb
	(oz prod/A)	(% injury)			(% control)				
PRE									
Valor+Select+PO+AMS	2+6+1qt+2.5lb	100	100	100	40	90	50	50	73
Post									
Select+PO	4+1qt	0	2	0	0	0	86	90	76
Select+PO	6+1qt	0	2	0	0	0	96	96	73
Select+PO	8+1qt	0	3	0	0	0	83	83	57
Select+Muster+PO	8+0.3+1qt	0	2	0	0	99	99	99	66
Assure II+Harmony GT+PO	8+0.33+1qt	2	0	0	50	90	99	99	99
Assure II+Harmony GT+PO	8+0.5+1qt	3	1	0	63	90	99	99	99
Assure II+Harmony GT+PO	8+0.67+1qt	7	5	5	70	78	99	99	99
Assure II+Harmony Extra+PO	8+0.29+1qt	8	6	3	63	94	99	99	99
Assure II+Harmony Extra+PO	8+0.33+1qt	10	4	0	60	99	99	99	99
Harmony Extra+PO	0.4+1qt	7	4	0	73	52	99	99	99
Accent+PO	0.5+1qt	0	2	0	13	63	99	99	99
Accent+PO	0.67+1qt	2	1	0	13	43	99	99	83
Accent+PO	1+1qt	0	0	0	23	47	99	99	99
Accent+Harmony GT+PO	0.67+0.33+1qt	5	2	0	40	58	99	99	99
LPost									
Select+PO	6+1qt	0	1	0	0	0	99	99	76
Select+PO	8+1qt	0	0	0	0	0	99	99	66
Assure II-P+PO	8+1qt	0	0	0	0	0	99	99	39
Untreated		0	0	0	0	0	99	99	66
LSD (0.05)		4	3	3	9	10	4	4	11

[a] PO = petroleum oil = Herbimax; AMS = ammonium sulfate.

The 7 to 10% canola injury on July 1 was attributed to Express in the Harmony Extra premix. Valor completely killed canola. No injury was observed from other treatments at July 22 (data not shown). All treatments provided complete foxtail control at all evaluations. With the exception of Valor, all treatments containing a herbicide to control broadleaf weeds controlled redroot pigweed, common lambsquarters, and wild mustard at all evaluation dates. Valor+Select gave 88 to 96% control of weeds mentioned previously (data not shown). High weed control ratings of most weeds and lack of subsequent weed flushes were attributed to high crop competition. Plots receiving just a POST grass herbicide gave 83 to 96% redroot pigweed and common lambsquarters control and 57 to 76% common cocklebur control at July 22. Plots applied with Harmony GT were observed to have 99% common cocklebur, a weed which normally is not controlled.

Canola tolerance to Select. Zollinger and Fitterer. An experiment was conducted near Prosper, ND to evaluate canola tolerance to Select. 'RRCA 3275' Roundup Ready canola was planted May 21, 1999. PRE treatments were applied on May 24, 1999 at 12:30 pm with 63 F air, 57 F soil at a 2 to 4 inch depth, 48% relative humidity, 80% clouds, and 3 to 7 mph NW wind, dry soil surface, and moist subsoil. POST treatments were applied June 23,1999 at 10:00 am with 73 F air, 80 F soil surface, 74% relative humidity, 20% clouds, 8 to 12 mph N wind, moist soil surface, moist subsoil, excellent crop vigor, no dew present, to 6 to 8 leaf canola. Weed species present were 4 to 8 inch (4 to 10 plants/ft^2) foxtail. LPOST treatments were applied July 1, 1999 at 11:00 am with 69 F air, 80 F soil surface, 69% relative humidity, 100% clouds, and 3 to 5 mph NW wind, moist soil surface, wet subsoil, excellent crop vigor, no dew present to early to mid-bloom canola. Weed species present were 4 to 8 inch (1 to 5 plants/ft^2) foxtail. Treatments were applied to the center 6.67 feet of the 10 by 30 ft plots with a backpack-type sprayer delivering 17 gpa at 40 psi through 8002 flat fan nozzles. POST and LPOST treatments were applied by a bicycle-wheel-type plot sprayer equipped with a wind shield at 8.5 gpa at 40 psi through 8001 flat fan nozzles. The experiment had a randomized complete block design with three replicates per treatment.

Table. Canola tolerance to Select (Zollinger and Fitterer).

Treatment [b]	Rate	Canola			Fxtl [a]	Canola
		July 7	July 15	July 21	July 15	yield
	(oz prod/A)	(% injury)			(% control)	(lb/A)
PRE/POST						
Valor/Select+PO+AMS	2/6+1qt+2.5 lb	43	37	17	95	957
POST						
Select+PO	4+1qt	0	0	0	99	830
Select+PO	6+1qt	3	8	6	99	759
Select+PO	8+1qt	5	17	6	99	788
Select+Muster+PO	8+0.3+1qt	12	25	30	99	724
LPOST						
Select+PO	6+1qt	13	50	43	99	615
Select+PO	8+1qt	20	72	62	99	594
Assure II+PO	8+1qt	0	0	0	98	808
Untreated		0	0	0	0	787
LSD (0.05)		4	9	19	3	278

[a]Fxtl = Grft and Yeft.
[b]PO = pertoleum oil = Herbimax; AMS = ammonium sulfate.

Precipitation was received twelve days after planting. Valor damage to canola was not evident until after the first precipitation. Canola in Valor plots, on June 4, was slightly cupped and some burning occurred to the cotyledons. Canola injury in Valor plots increased with time. On June 14 Valor caused 25 to 50% death in all reps, plants were constricted and pinched at the soil surface, causing them to break. Injury ratings for Valor were due to stand reduction. Select treatments caused flowers to abort and pods to be shortened and not fill. Select injury ratings on July 21 included pod deformation and stunting. LPOST Select at 6 fl oz/A caused more yield loss than Valor followed by Select. The Valor injury may have reduced uptake of Select. Assure II did not cause any injury. All treatments gave complete foxtail control.

Imi-canola tolerance to sulfonylurea herbicides. Brian Jenks, Kent McKay, and Gary Willoughby. We evaluated Imi canola tolerance to various herbicides applied either preplant incorporated or without incorporation. On May 21 we applied several herbicides to tilled soil. We incorporated the herbicide on one-half of the plot area, leaving the other one-half not incorporated. We seeded the canola immediately after the herbicide incorporation on one-half of the plot area. The herbicides were applied with a CO_2 pressurized bicycle sprayer delivering 20 gpa at 30 psi using XR80015 flat fan nozzles. No other herbicides were applied during the growing season. The canola was harvested on August 18.

We did not see differences in growth as the canola emerged. We did not rate the canola for injury, but we did note that about mid-season there was slight stunting in the triasulfuron + dicamba treatments, very slight stunting in the triasulfuron and metsulfuron + chlorsulfuron treatments, and no visible injury in the metsulfuron or prosulfuron treatments. The yields shown in the table are the average of two replications. We could not harvest the first replication due to high kochia populations. The other two replications had very little kochia present. Yields were higher where we incorporated the herbicides.

Table. Imi-canola tolerance to sulfonylurea herbicides.

Treatment	Rate	Incorporated Canola yield	No incorporation Canola yield
	lb/A	lb/A	lb/A
Prosulfuron	0.009	1322	844
Triasulfuron	0.013	1035	954
Triasulfuron + dicamba	0.074	1237	937
Metsulfuron + chlorsulfuron	0.012	1100	794
Metsulfuron	0.0038	1386	1152
Untreated		1309	1139
LSD		11	12
CV		51	78

Liberty for Weed Control in Canola. (Terry D. Gregoire, 1999) Devils Lake
Treatments were applied to Canola with a CO_2 pressured back pack sprayer using 8001 nozzles at 40 psi delivery 8.5 gpa. Conditions at various spray dates are included in the following Table 1.

Spray Date	Canola Leaf Stage	Foxtail Leaf Stage	Wild Oat Leaf Stage	Wild Mustard	Temperature	Sunlight	Time	Relative Humidity
June 11	2-3	3	2-3	2	60° F	Sunny	7:30 a.m	75%
June 14	3-4	3-4	3-4	4	65° F	P.C.	1:30 p.m.	60%
June 21	5-6	6	4 ½	6	65° F	P.C.	8 a.m.	80%

Trt No.	Trt Name	Rate Unit	Growth Stage	June 23	June 23		July 23	
				Crop Injury	Foxtail spp.	Broadleaf	Grasses	Broadleaf
				%	% control			
1	untreated			0.0	0.0	0.0	0.0	0.0
2	Liberty	1.2 pt/a	3-4 lf	0.0	77.5	80.0	83.3	96.3
2	Ams	3.0 lb/a	3-4 lf					
3	Liberty	1.7 pt/a	3-4 lf	0.0	65.0	67.5	92.0	95.0
3	Ams	3 lb/a	3-4 lf					
4	Liberty	2.1 pt/a	3-4 lf	0.0	90.0	90.0	92.3	98.8
4	Ams	3 lb/a	3-4 lf					
5	Liberty	2.1 pt/a	4-5 lf	0.0	73.8	85.0	99.3	100.0
5	Ams	3 lb/a	4-5 lf					
6	Liberty	2.1 pt/a	4-5 lf	0.0	91.3	90.0	99.3	98.8
6	Ams	3 lb/a	4-5 lf					
7	Liberty/Liberty	1.7 pt/a	3-4 lf	0.0	96.3	93.8	97.0	100.0
7	Ams	3 lb/a						
7	Liberty	1.7 pt/a	5-6 lf					
7	Ams	3 lb/a						
8	Liberty	1.7 pt/a	5-6 lf	0.0	65.0	81.3	98.3	97.5
8	Poast	.4 pt/a	5-6 lf					
8	Ams	3 lb/a						
9	Poast	.75 pt/a	3-4 lf	0.0	94.0	88.8	94.5	97.5
9	Stinger	.5 pt/a	3-4 lf					
9	Dash	2.5% v/v	3-4 lf					
10	Due to spray bottle contamination, data was useless and not reported.							
LSD (P=.05)				0.00	18.92	14.91	11.40	20.73
Standard Deviation				0.00	13.04	10.27	7.86	14.28
CV				0.0	17.71	13.34	9.18	16.59

Summary
There was no crop injury with any treatment. Treatment 10 had herbicide residual contamination that killed 95% of the canola. Four to five leaf and six leaf Liberty applications gave slightly better grass control than application of Liberty at the 3-4 leaf stage. Broadleaf control was good at all application dates and rates.

Excellent crop competition was helpful in increasing % grass control at low rates of Liberty application.

Timing of weed control in glyphosate-tolerant canola. Brian Jenks, Kent McKay, and Gary Willoughby. Roundup Ready canola (LG3235) was seeded May 3 into 7.5-inch rows at 700,000 pls/A. Herbicide treatments were applied preplant incorporated (Apr 30), early-post (June 1), mid-post (June 7), or late-postemergence (June 11). Individual plots were 10 x 30 ft arranged in a RCBD with three replications. PPI treatments were applied with a CO_2 pressurized bicycle sprayer delivering 20 gpa at 30 psi using XR80015 flat fan nozzles. All postemergence treatments were applied with XR8001 flat fan nozzles delivering 10 gpa at 40 psi. Heavy rains began the night the canola was seeded. We received almost 7 inches of rainfall before the early-post application (June 1). Canola was harvested August 10.

Table. Timing of weed control in glyphosate-tolerant canola.

			June 25				July 26	
Treatment[a]	Rate	Timing[b]	Kocz	Fxtl[c]	Colq	Rrpw	Kocz	Yield
	lb/A		Control (%)					lb/A
Trifluralin	0.75	A	78	91	100	100	58	1050
Trifluralin / Quizalofop	0.75 / 0.055	A / C	68	98	96	95	60	918
Ethalfluralin	0.75	A	79	97	100	98	68	828
Ethalfluralin / Quizalofop	0.75 / 0.055	A / C	81	99	97	98	73	775
Trifluralin / Glyphosate	0.75 / 0.38	A / C	100	100	100	100	96	1010
Ethalfluralin / Glyphosate	0.75 / 0.38	A / C	100	100	100	100	94	1093
Glyphosate	0.38	B	78	85	87	78	58	1110
Glyphosate	0.38	C	98	98	100	99	90	1206
Glyphosate	0.38	D	100	100	100	100	97	1386
Glyphosate / Glyphosate	0.38 / 0.38	B / D	100	99	100	100	95	1219
Glyphosate / Glyphosate	0.19 / 0.19	B / D	93	100	95	97	85	1330
Handweed Check + Trifluralin / Glyphosate	0.75 / 0.38	A / C	100	100	100	100	96	1100
Weedy Check			0	0	0	0	0	611
LSD			6	6	6	6	6	295
CV			4	4	4	4	5	17

[a] All glyphosate treatments included AMS (1%)
[b] A=PPI; B=cotyledon to 2-lf canola; C=3 to 4-lf canola; D=5 to 6-leaf canola
[c] Fxtl=green and yellow foxtail

Flea beetle pressure was extremely high in 1999. The canola seed was treated with Gaucho, but a foliar insecticide application was needed to help reduce the flea beetle pressure. The canola remained in the cotyledon to 2-leaf stage for an extended period due to the flea beetles and wet soil. The Roundup Ready canola emerged before other canola varieties in this same field but was hit hard by the flea beetles and never really looked good the rest of the year.

The objective of this study was to compare weed control from soil-applied products with glyphosate at different rates and timings. The primary weeds were kochia, foxtails, lambsquarters, and pigweed. Other species present were shepherdspurse, field pennycress, and biennial wormwood. Trifluralin and ethalfluralin did not control the mustard species or biennial wormwood, but generally provided good control of kochia, foxtails, lambsquarters, and pigweed. Trifluralin or ethalfluralin followed by a postemergence application of glyphosate was as effective or better than trifluralin or ethalfluralin alone.

Glyphosate was effective at any rate on kochia, foxtails, lambsquarters, redroot pigweed, biennial wormwood, field pennycress, and shepherdspurse. Glyphosate applied only at cotyledon to 2-leaf canola controlled emerged weeds, but missed a new flush of weeds that emerged soon after application. Canola yields were higher with the later application timings compared to the cotyledon to 2-leaf application. The split applications of glufosinate also provided effective weed control.

Canada thistle control in glyphosate-tolerant canola. Brian Jenks and Gary Willoughby. Roundup Ready canola (LG3235) was seeded May 19 into 7.5-inch rows at 700,000 pls/acre in a conventional tillage system. Individual plots (12 x 30 ft) received either a single application or a split application of glyphosate at various canola stages. All postemergence treatments were applied with XR8001 flat fan nozzles delivering 10 gpa at 40 psi. Each treatment was replicated four times. Treatments were applied on June 5 (1-4" weeds), June 10 (2-10" weeds), and June 16 (4-12" weeds). Canada thistle present in the entire plot were counted on June 5. Canola was harvested August 25.

Table. Canada Thistle Control in glyphosate-tolerant canola.

Treatment[a]	Rate	Timing[b]	June 5 Cath	Jun 28 Cath	Sep 1 Cath	August 25 Yield
	lb/A		density[c]	----------Control (%)-------		lb/A
Glyphosate	0.38	B	323	80	67	1476
Glyphosate	0.38	C	155	75	88	1221
Glyphosate / Glyphosate	0.38 / 0.38	A / C	198	85	90	1563
Glyphosate	0.56	B	246	83	84	1608
Glyphosate	0.56	C	171	77	85	1486
Glyphosate / Glyphosate	0.56 / 0.38	A / C	277	85	85	1688
Glyphosate	0.75	B	283	84	78	1463
Glyphosate	0.75	C	234	80	86	1371
Glyphosate / Glyphosate	0.75 / 0.38	A / C	166	87	87	1633
Clopyralid + Quizalofop	0.188 + 0.069	B	102	87	97	1035[d]
Weedy Check			360	0	0	376
LSD			214	7	11	261
CV			65	7	10	13

[a] All Glyphosate treatments applied with AMS (1%)
[b] A=coty to 2-leaf canola (Jun 5), B=3 to 4-leaf canola (Jun 10), C=5 to 6-leaf canola (Jun 16)
[c] These numbers represent the average Canada thistle density over the four replications
[d] The low yield was due to a high population of lambsquarters, not lack of Canada thistle control

Flea beetle pressure was extremely high this year. Even though the canola seed was treated with Gaucho, we had to make a foliar insecticide application to help reduce the flea beetle pressure. The canola crop emerged very nicely, but remained in the cotyledon to 2-leaf stage for an extended period. Much of the slow growth can be attributed to the heavy flea beetle pressure. This allowed the Canada thistle to get a good start without a lot of early shading from the canola crop.

Glyphosate at higher rates tended to burn down the thistle plants faster than the lower rate (0.38 lb). On June 28, Canada thistle control with the 3-4 leaf and split applications were somewhat higher than the late application (5-6 leaf canola), primarily due to the earlier spray date or more time to kill the plant. The final rating on September 1 generally showed better season-long control with the 5-6 leaf and split applications compared to the 3-4 leaf application. The 5-6 leaf and split applications tended to have fewer plants and the plants present were usually much shorter than those in the 3-4 leaf application. Some plots had much higher Canada thistle populations than others. With such high populations and varied emergence, it is likely that some plants were covered by others and were not sprayed.

Although we saw better control at the end of the season with the late treatment, delaying the application also allowed the Canada thistle to grow quickly which effectively reduced canola yield. Yields were 100-300 lbs higher with the 3-4 leaf or split applications than the 5-6 leaf application. The canola stand that received only the late application appeared more thin and somewhat shorter compared to plots where Canada thistle has been taken out earlier. The field also had a fairly heavy lambsquarters population that also contributed to yield reduction in late-applied treatments.

Clopyralid was very effective in controlling Canada thistle. However, because we did not put down a soil-applied product such as trifluralin, the heavy lambsquarters population was primarily responsible for reducing the canola yield in the clopyralid plots.

Roundup Ready canola crop tolerance and efficacy. Zollinger and Fitterer. An experiment was conducted near Prosper, ND to evaluate canola crop tolerance. PPI treatments were applied and incorporated with a rototiller to a two inch depth May 21, 1999 at 1:30 pm with 61 F air, 60 F soil 2 to 4 inch depth, 60% relative humidity, 50% clouds, and 5 to 8 mph S wind, dry soil surface, and moist subsoil. 'Hyola 357', 'Phoenix' and '45A71 Clearfield' canola was planted on May 21, 1999. EPOST treatments were applied June 7, 1999 at 9:00 to 9:30 am with 74 F air, 80 F soil surface, 75% relative humidity, 10% clouds, and 0 to 5 mph NW wind, dry soil surface, moist subsoil, excellent crop vigor, no dew present to 1 to 2 lf canola. Weed species present were 2 to 3 inch (1 to 5 plants/ft^2) foxtail. MPOST treatments were applied June 8, 1999 at 8:30 to 9:00 am with 70 F air, 69 F soil surface, 75% relative humidity, 100% clouds, and 0 to 5 mph E wind, moist soil surface, moist subsoil, excellent crop vigor, dew present to 2 to 3 leaf canola. Weed species present were 2 to 4 inch (1 to 5 plants/ft^2) foxtail and cotyledon to 2 leaf (1 plant/yd^2) common cocklebur. POST treatments were applied June 14, 1999 at 9:00 to 9:30 am with 68 F air, 74 F soil surface, 53% relative humidity, 20% clouds, and 0 to 5 mph NE wind, dry soil surface, moist subsoil, excellent crop vigor, no dew present to 3 to 4 leaf canola. Weed species present were 3 to 5 inch (1 to 5 plants/ft^2) foxtail and 2 leaf (1plant/yd^2) common cocklebur. LPOST treatments were applied June 23, 1999 at 11:15 am with 74 F air, 74 F soil surface, 75% relative humidity, 0% clouds, and 5 to 8 mph W wind, wet soil surface, moist subsoil, excellent crop vigor, dew present to 6 lf to early bolting canola. Weed species present were 6 inch (5 plants/yd^2) foxtail. Treatments were applied to the center 6.67 feet of the 10 by 25 ft plots with a bicycle-wheel-type plot sprayer delivering 17 gpa at 40 psi through 8002 flat fan nozzles for soil applied treatments and 8.5 gpa at 40 psi through 8001 flat fan nozzles using a wind shield for the POST treatments. The experiment had a randomized complete block design with three replicates per treatment.

Data is categorized in days after treatment (DAT), for easier comparisons. One to two leaf canola treated with Roundup Ultra showed yellowing 7 DAT, especially the older plants in the plots. Yellowing increased with later applications of Roundup Ultra. Yellowing was apparent 2 to 4 days after Roundup Ultra application and canola regained green coloring in 7 to 10 days. Minor injury was apparent 30 DAT. Injury ratings at 30 DAT reflect growth reduction. Yield differences appear to be random and not related to treatments.

Table. Roundup Ready canola crop tolerance and efficacy (Zollinger and Fitterer).

Treatment[a]	Rate	Growth Stage	Canola 7 DAT[b]	Canola 30 DAT[b]	Yield
	(pt/A)	(leaf)	(% injury[c])		(lb/A)
PRE/Post					
Treflan/Assure II	0.75/0.55	PRE/2-3	3	1	1320
Post/Post					
Roundup Ultra+AMS[d]/RU+AMS	1+17 lb/100gal/1+17 lb/100gal	1-2/5-6	0	0	933
Roundup Ultra+AMS/RU+AMS	1.5+17 lb/100gal/1+17 lb/100gal	1-2/5-6	0	0	1127
Roundup Ultra+AMS/RU+AMS	1.5+17 lb/100gal/1.5+17 lb/100gal	1-2/5-6	2	0	1053
Roundup Ultra+AMS/RU+AMS	2+17 lb/100gal/1+17 lb/100gal	1-2/5-6	0	0	1141
Roundup Ultra+AMS/RU+AMS	2+17 lb/100gal/2+17 lb/100gal	1-2/5-6	2	0	1209
Roundup Ultra+AMS/RU+AMS	4+17 lb/100gal/2+17 lb/100gal	1-2/5-6	2	0	1137
Post					
Roundup Ultra+AMS	1+17 lb/100gal	3-4	7	2	946
Roundup Ultra+AMS	1.5+17 lb/100gal	3-4	13	0	1107
Roundup Ultra+AMS	2+17 lb/100gal	3-4	25	5	1136
Roundup Ultra+AMS	4+17 lb/100gal	3-4	25	0	972
Roundup Ultra+AMS	1+17 lb/100gal	5-6	3	0	1177
Roundup Ultra+AMS	1.5+17 lb/100gal	5-6	0	0	992
Roundup Ultra+AMS	2+17 lb/100gal	5-6	2	0	1205
Roundup Ultra+AMS	4+17 lb/100gal	5-6	7	0	1123
Untreated - Hyola 357			0	0	1336
Liberty+AMS	34oz+17 lb/100gal	2-3	6	4	1414
Untreated - Phoenix			0	0	1239
Raptor+NIS	4 fl oz+0.25% v/v	2-3	0	2	1158
Untreated - 45A71 Clearfield			0	0	1265
LSD (0.05)			5	2	254

[a]Treflan and Roundup Ultra (RU) treatments were applied to Hyola 357; Liberty treatment was applied to Phoenix; Raptor treatment was applied to 45A71Clearfield, and NIS = nonionic surfactant = Activator 90.
[b]DAT = days after treatment.
[c]injury = yellowing at 7 DAT and growth reduction at 30 DAT, after final application.
[d]AMS = ammonium sulfate.

Glyphosate resistant canola crop tolerance and efficacy. Lukach, John R., Langdon ND 1999. The experiment includes PPI and Post applied treatments on Roundup Ready cultivar '3275'. Plots of IMI cultivar '45A71' and Liberty Link cultivar 'Phoenix', were also randomized in the trial with the recommended weed treatment compared against a paired treatment check. Fertilizer was applied for a 2500 lb/A yield goal and the PPI treatments applied at 3:00 pm on May 21, to a moist low residue soil surface. All plots were rototilled three inches deep and precipitation of 0.57 inch began about 11:00 pm on May 21. The plots were packed with a grain drill on May 26 and seeded with a three-point mount, drill box, double disk drill. Seeded plot size was 7.5 by 30 feet, 5 by 26 feet sprayed and 4 by 22 feet harvested. Harvest was swathing on Aug. 30 and combining on Sept. 20. No insect or disease problems occurred in the trial. All treatments were applied with a hand held boom with three 20 inch spaced nozzles. PPI treatments were at 17 gpa at 40 psi through 8002 flat fan nozzles. Post treatments were at 10 gpa at 35 psi through 8001 nozzles with a wind shield. Plant populations were determined on June 4. The averages were 19 canola, 9 wild oat and 42 smartweed plants per Foot Square where no PPI treatment had been applied. Grass weeds are wild oats and include a small amount of volunteer wheat. Broadleaf weeds are smartweed with only trace of buckwheat and other broadleaf weeds present in the experiment. Treatments were applied on June 13 to two-leaf canola, at 3:00 pm in a 10 mph north wind in cool cloudy conditions. The canola was 4 leaf for the June 19 treatments, which were applied at 9:00 am in a 6 mph southeast wind in cool sunny conditions. The canola was 6 leaf for the June 26 treatments, which were applied at 10:00 am in a 10 mph west wind in cool partly cloudy conditions with the crop canopy still wet from dew. The crop canopy of the plots sprayed on June 26 was very heavy. Plots with no previous weed control were 10 to 12 inches tall with much of the canola plants covered by weed foliage. The plots, which received Roundup at the two-leaf stage, had one leaf wild oat and small smartweed present under a dense canola canopy. The canola competition killed the late germinated weeds without need for herbicide control. The experiment had a randomized complete block design with three replicates.

Summary
The highest yield treatments, with no significant difference between them, were all treatments with Roundup Ultra applied at the 2 and 4 leaf stages regardless or rate, Trifluralin at 3 pt/A and Herbicide 273 at 3 pt/A. All Roundup rates applied at the six-leaf stage had reduced yield, though significantly higher than the check, due to early weed competition. Yields generally reflected smartweed control with Roundup, Muster, and Herbicide 273 giving excellent control. Liberty and Motive also gave excellent control of smartweed and wild oats though the control with Motive was slower. Trifluralin and Sonalan at 1.5 pt/A and Stinger at 1/3 pt/A gave about 50 % control of smartweed. Upbeet did not kill the canola but severe injury caused maturity to be delayed by an estimated 20+ days with those plots immature at harvest. Banvel treatments caused only minor canola injury and slightly delayed maturity but had reduced yields compared to the Roundup treatments, though not significantly different from the other chemical control treatments. Injury and weed competition affected physiological maturity and plant height. The plots with high weed competition had shorter plant height with delayed maturity when herbicide injury occurred. The treatments with Roundup applied at the two-leaf stage, thus low weed competition, don't reflect the visual injury noted in yield, maturity or height. The visual injury observations indicate that Roundup at the 1 pt/A rate will not injure the canola through the 6 leaf stage, but injury will be observed at the 2 pt/A rate at all leaf stages.

Table. Glyphosate resistant canola crop tolerance and efficacy Lukach, John R., Langdon ND 1999.

Treatment	Rate	Growth Stage	Seed Yield	26-June		6-July		Date Phys. Maturity	Plant Height	Initial Injury Symptoms
				Wioa	Smwe	Wioa	Smwe			
	lb ai/A	leaf	lb/A	(% control)				Aug.	cm	
Untreated	---	---	1240	0	0	0	0	23.0	102	
PPI & PPI/Post										
Trifluralin	0.75	PPI	1458	65	53	75	60	23.0	120	
Trifluralin	1.5	PPI	1932	85	73	90	86	24.3	117	
Ethalfluralin	0.55	PPI	1416	63	47	75	46	24.0	108	
Ethalfluralin	1.15	PPI	1684	82	60	90	80	23.7	111	
Trifluralin/ Glyphosate+AMS	0.75/0.56+8.3 lb/100gal	PPI/ 4	2156	100	100	100	100	23.3	110	
Trifluralin/ Sethoxydim+MSO	0.75/0.15+1 qt/a	PPI/ 4	1762	100	63	100	63	24.0	114	
Trifluralin/ Quizalofop-P+PO	0.75/0.55+1% v/v	PPI/ 4	1596	100	63	100	80	23.7	108	
Post/Post										
Glyphosate+AMS/glyt+AMS	0.357+8.3 lb/100gal/ 0.357+8.3 lb/100gal	2/ 6	1933	100	100	100	100	25.7	117	
Glyphosate+AMS/glyt+AMS	0.56+8.3 lb/100gal/ 0.357+8.3 lb/100gal	2/ 6	1898	100	100	100	100	26.3	127	
Glyphosate+AMS/glyt+AMS	0.56+8.3 lb/100gal/ 0.56+8.3 lb/100gal	2/ 6	2137	100	100	100	100	26.3	117	
Glyphosate+AMS/glyt+AMS	0.75+8.3 lb/100gal/ 0.357+8.3 lb/100gal	2/ 6	2191	100	100	100	100	25.0	117	
Glyphosate+AMS/glyt+AMS	0.75+8.3 lb/100gal/ 0.75+8.3 lb/100gal	2/ 6	1929	100	100	100	100	25.7	115	slight mottling
Glyphosate+AMS/glyt+AMS	1.5+8.3 lb/100gal/ 0.75+8.3 lb/100gal	2/ 6	1862	100	100	100	100	26.0	117	mod mottling
Post										
Glyphosate+AMS	0.357+8.3 lb/100gal	4	2112	100	99	100	100	24.3	103	
Glyphosate+AMS	0.56+8.3 lb/100gal	4	2005	100	100	100	100	24.7	111	slight chlorosis
Glyphosate+AMS	0.75+8.3 lb/100gal	4	1950	100	100	100	100	25.3	101	light mottling
Glyphosate+AMS	1.5+8.3 lb/100gal	4	1944	100	100	100	100	24.7	105	severely mottled
Glyphosate+AMS	0.357+8.3 lb/100gal	6	1666	0	0	100	84	25.7	108	
Glyphosate+AMS	0.56+8.3 lb/100gal	6	1755	0	0	100	93	26.3	103	
Glyphosate+AMS	0.75+8.3 lb/100gal	6	1714	0	0	100	100	26.3	93	
Glyphosate+AMS	1.5+8.3 lb/100gal	6	1687	0	0	100	100	28.0	97	mod mottling
Endothall/ Quizalofop-P+PO	0.75/ 0.77+1% v/v	4/ 6	1742	0	96	100	99	22.7	99	8% leaf burn
Endothall/ Quizalofop-P+PO	1.125/0.77+1% v/v	4/ 6	1953	0	99	100	99	24.3	100	23% leaf burn
Clopyralid/ Quizalofop-P+PO	0.125/0.77+1% v/v	4/ 6	1817	0	43	100	50	24.0	105	
Clopyralid+Quizalofop-P+NIS	0.125+0.77+0.25% v/v	4	1567	98	33	100	53	23.3	98	
Quizalofop-P+PO	0.55+1% v/v	4	1198	100	0	100	0	23.7	101	
Ethametsulfuron+Qufp-P+PO	0.225+.77+1% v/v	4	1796	99	70	100	99	24.3	108	slight chlorosis
Dicamba/ Quizalofop-P+PO	0.03/0.77+1% v/v	4/ 6	1685	0	60	100	73	25.0	103	
Dicamba/ Quizalofop-P+PO	0.06/0.77+1% v/v	4/ 6	1735	0	73	100	99	26.0	105	curled leaves
Dicamba/ Quizalofop-P+PO	0.09/0.77+1% v/v	4/ 6	1420	0	77	100	98	24.7	102	curled leaves
Dicamba+Quizalofop-P+PO	0.03+0.77+1% v/v	4	1680	97	60	100	83	25.3	103	curled leaves
Triflusulfuron+NIS	0.25oz+0.25% v/v	4	554	0	67	0	95	NM*	84	severe chlorosis to purple
Imazamox+NIS, 45A71	0.5+0.25% v/v	4	1743	72	58	100	100	27.3	118	
Untreated, 45A71	---	---	814	0	0	0	0	25.3	109	
Glufosinate+AMS, Phoenix	0.44+8.3 lb/100gal	4	2103	98	100	100	100	28.0	112	
Untreated, Phoenix	---	---	749	0	0	0	0	25.3	102	
LSD (0.05)			338	7	14	4	18	2.0	13	

Treatments on the Roundup Ready cultivar '3275', Imazamox applied to IMI cultivar, '45A71', glufosinate to Liberty Link, 'Phoenix'
Trifluralin -Treflan MTF, Glyphosate - Roundup Ultra, Dicamba -Banvel SGF
AMS - Ammonium Sulfate, MSO - Dash, PO - Herbimax, NIS-Activator 90
Wioa - Wild Oats, Smwe - Annual Smartweed, Ladysthumb
NM* not mature at harvest;

Roundup Ultra/insecticide tank-mixes in Roundup Ready canola. Zollinger and Fitterer. An experiment was conducted near Prosper, ND to evaluate injury from Roundup Ultra applied with insecticides at the cotyledon to 2 leaf stage. 'RRCA-3275' Roundup Ready canola was planted May 21, 1999. Treatments were applied on June 1, 1999 at 1:00 to 1:45 pm with 61 F air, 65 F soil surface, 63% relative humidity, 100% clouds, and 5 to 10 mph S wind, dry soil surface, moist subsoil, excellent crop vigor and no dew present to cotyledon canola. Treatments were applied to the center 6.67 feet of the 10 by 25 ft plots with a bicycle-wheel-type plot sprayer equipped with a wind shield delivering 8.5 gpa at 40 psi through 8001 flat fan nozzles. The experiment had a randomized complete block design with three replicates per treatment.

Table. Roundup Ultra/insecticide tank-mixes in Roundup Ready canola. (Zollinger and Fitterer).

Treatment	Rate	Canola
	(pt/A)	(% injury)
Roundup Ultra	1	0
Roundup Ultra+Warrior	1+2 oz	0
Roundup Ultra+Warrior	1+4 oz	0
Roundup Ultra+Asana XL	1+4.8 oz	0
Roundup Ultra+Asana XL	1+9.7 oz	0
Roundup Ultra+Sevin XLR Plus	1+1	0
Roundup Ultra+Sevin XLR Plus	1+2	0
Untreated		0

No injury was found with any treatment throughout the season.

Glyphosate/insecticide tank-mixes in glyphosate resistant canola. Lukach, John R.
The experiment, conducted at Langdon, ND, includes insecticide with Glyphosate treatments on the Roundup Ready cultivar '3275'. Fertilizer was applied for a 2500 lb/a yield goal. The plots were seeded on May 20 using a seven-row plot seeder with six-inch row spacing and 1.5 feet between plots. The seeded plot size was 5 by 30 feet, 5 by 26 feet sprayed and 4 by 20 feet harvested. Harvest was by straight combining on Sept. 10, with a light amount a shattering present. Harvest losses were minimal because walking between plots during the filling period minimized tangling of plots. The trial had only minor disease and lodging. Treatments were applied with a hand held boom with three 20 inch spaced nozzles at 10 gpa at 35 psi through 8001 nozzles on June 5 at 9:00 am with a light northwest wind. The canola was cotyledon and one leaf with few flea beetles present. Weeds included a trace of wild buckwheat and kochia with an average of three volunteer hard wheat per yard square. Rain, 0.70 inch, with light amount of pea size or smaller hail occurred on June 6. The experiment had a randomized complete block design with four replications.

No yellowing or visible signs of injury to the canola plants were seen with any of the treatments. The weed population was inadequate to determine if any antagonism between the Glyphosate and the insecticides occurred. Spray drift and competition by the canola caused control of volunteer wheat to be noted on the check treatment.

Table. Glyphosate/insecticide tank-mixes in glyphosate resistant canola. Langdon, ND, Lukach, John R.

Treatment	Rate lb/a ai	7-Jun Canola	12-Jun Wht	Harvest Wht	Seed Yield
	(lb/a)	% Injury	-------% Control-------		lb/a
Untreated	---	0	52	92	2064
Glyphosate	0.375	0	100	100	2083
Glyphosate+lambda cyhalothrin	0.375+0.15	0	100	100	2120
Glyphosate+lambda cyhalothrin	0.375+0.30	0	100	100	2110
Glyphosate+esfenvalerate	0.375+0.025	0	98	100	2021
Glyphosate+esfenvalerate	0.375+0.05	0	98	100	2105
Glyphosate+carbaryl	0.375+0.5	0	100	100	1966
Glyphosate+carbaryl	0.375+1.0	0	100	100	2104
LSD (0.05)			16	3	NS

Glyphosate =Roundup Ultra, lambda cyhalothrin =Warrior, esfenvalerate =Asana XL, Carbaryl =Seven XLR

Timing of weed control in glufosinate-tolerant canola. Brian Jenks, Kent McKay, and Gary Willoughby. Liberty Link canola (Invigor 2373) was seeded May 3 into 7.5-inch rows at 700,000 pls/A. Herbicide treatments were applied preplant incorporated (Apr 30), early-post (June 1), mid-post (June 7), or late-postemergence (June 11). Individual plots were 10 x 30 ft arranged in a RCBD with three replications. PPI treatments were applied with a CO_2 pressurized bicycle sprayer delivering 20 gpa at 30 psi using XR80015 flat fan nozzles. All postemergence treatments were applied with XR8001 flat fan nozzles delivering 10 gpa at 40 psi. Heavy rains began the night the canola was seeded. We received almost 7 inches of rainfall before the early-post application (June 1). Canola was harvested August 10.

Table. Timing of weed control in glufosinate-tolerant canola.

			June 25				July 26	
Treatment[a]	Rate	Timing[b]	Kocz	Fxtl[c]	Colq	Rrpw	Kocz	Yield
	lb/A		----------Control (%)----------					lb/A
Trifluralin	0.75	A	80	90	93	90	72	1203
Trifluralin / Quizalofop	0.75 / 0.055	A / C	73	98	94	94	72	1330
Ethalfluralin	0.75	A	80	95	100	100	77	1308
Ethalfluralin / Quizalofop	0.75 / 0.055	A / C	92	96	100	98	87	1228
Trifluralin / Glufosinate	0.75 / 0.26	A / C	99	100	100	100	97	1366
Ethalfluralin / Glufosinate	0.75 / 0.26	A / C	99	100	100	100	97	1310
Glufosinate	0.35	B	63	68	77	68	53	1252
Glufosinate	0.35	C	98	95	100	97	93	1456
Glufosinate	0.35	D	100	100	100	100	95	1385
Glufosinate	0.44	B	68	68	80	77	63	1521
Glufosinate	0.44	C	99	98	99	98	95	1384
Glufosinate	0.44	D	100	100	100	100	99	1528
Glufosinate / Glufosinate	0.22 / 0.22	B / D	99	100	100	100	95	1362
Glufosinate / Glufosinate	0.13 / 0.13	B / D	94	95	100	95	89	1469
Glufosinate + Quizalofop	0.26 + 0.034	C	97	94	97	100	89	1603
Handweed Check			100	99	100	99	96	1276
Trifluralin / Glufosinate	0.75 / 0.26	A / C						
Weedy Check			0	0	0	0	0	1198
LSD			10	8	13	12	12	248
CV			7	5	9	8	9	11

[a] All glufosinate treatments included AMS (3 lb/A)
[b] A=PPI; B=cotyledon to 2-lf canola; C=3 to 4-lf canola; D=5 to 6-leaf canola
[c] Fxtl=green and yellow foxtail

Flea beetle pressure was extremely high. The canola seed was treated with Gaucho, but we needed a foliar insecticide application to help reduce the flea beetle pressure. The canola remained in the cotyledon to 2-leaf stage for an extended period due to the flea beetles and wet soil.

The objective of this study was to compare weed control from soil-applied products with glufosinate at different rates and timings. The primary weeds were kochia, foxtails, lambsquarters, and pigweed. Other species present were shepherdspurse, field pennycress, and biennial wormwood. Trifluralin and ethalfluralin did not control the mustard species or biennial wormwood, but generally provided good control of kochia, foxtails, lambsquarters, and pigweed. Trifluralin or ethalfluralin followed by a postemergence application of glufosinate was as effective or better than trifluralin or ethalfluralin alone, however, canola yields were not significantly different.

Glufosinate was effective at any rate on kochia, foxtails, lambsquarters, redroot pigweed, biennial wormwood, field pennycress, and shepherdspurse. Glufosinate applied only at cotyledon to 2-leaf canola controlled emerged weeds, but missed a new flush of weeds that emerged soon after application. Canola yield was lower where 0.35 lb of glufosinate was applied at the cotyledon to 2-leaf stage compared to later applications of that same rate. However, where 0.44 lb was applied at the cotyledon to 2-leaf stage, canola yield was similar to the later applications. The split applications of glufosinate also provided effective weed control.

Wild oat control in glufosinate-tolerant canola. Brian Jenks and Gary Willoughby. Liberty Link canola (Invigor 2373) was seeded May 18 into 7.5-inch rows at 700,000 pls/A. Herbicide treatments were applied preplant incorporated (May 17), early-post (June 5), and mid-postemergence (June 11). Individual plots were 10 x 30 ft arranged in a RCBD with three replications. PPI treatments were applied with a CO_2 pressurized bicycle sprayer delivering 20 gpa at 30 psi using XR80015 flat fan nozzles. All postemergence treatments were applied with XR8001 flat fan nozzles delivering 10 gpa at 40 psi.

Due to heavy rains in early May the canola was not seeded until May 18. Flea beetle populations were high and caused significant damage to the canola. We originally planned to apply all postemergence treatments at the same time. However, wild oat pressure was heavy and the plants much larger in the glufosinate alone treatments (30 plants/sq ft, 3-4 leaf wild oat) that we decided to apply them earlier than the other treatments. Other plots had about 10 plants per sq ft and wild oat was about 1-leaf on June 5. We treated the remaining plots on June 11 when wild oat were in the 2 to 3-leaf stage. Glufosinate was more effective on the smaller wild oat compared to the plots where the wild oat density was higher and plants were larger. Increasing the rate of trifluralin above 0.50 lb did not improve weed control or yield. Glufosinate was more effective on lambsquarters than trifluralin or ethalfluralin.

Table. Wild oat control in glufosinate-tolerant canola.

			June 21		July 26		Sept 8
Treatment[a]	Rate	Timing[b]	Wioa	Colq	Wioa	Colq	Yield
	lb/A		----------Control (%)----------				lb/A
Untreated			0	0	0	0	391
Glufosinate	0.37	B	76	83	63	75	1215
Glufosinate	0.44	B	77	85	75	77	1296
Trifluralin / Glufosinate	0.50 / 0.26	A / C	91	100	91	93	1401
Trifluralin / Glufosinate	0.50 / 0.37	A / C	97	100	96	94	1592
Trifluralin / Glufosinate	0.50 / 0.44	A / C	98	100	98	97	1457
Trifluralin / Glufosinate	0.75 / 0.26	A / C	97	100	95	96	1265
Trifluralin / Glufosinate	0.75 / 0.37	A / C	100	100	99	98	1426
Trifluralin / Glufosinate	0.75 / 0.44	A / C	100	100	95	90	1418
Trifluralin / Glufosinate	1.0 / 0.37	A / C	98	100	93	90	1325
Trifluralin / Sethoxydim	0.75 / 0.07	A / C	99	83	97	67	1246
Ethalfluralin / Glufosinate	0.75 / 0.44	A / C	100	100	100	97	1344
Ethalfluralin / Sethoxydim	0.75 / 0.07	A / C	99	82	100	73	1460
LSD			10	9	11	14	462
CV			7	6	8	11	21

[a] All glufosinate treatments included AMS (3 lb/A), Sethoxydim applied with 2.5% MSO (Dash)
[b] A=PPI; B=coty to 2-leaf canola; C=3-leaf canola

Redroot pigweed control in glufosinate-tolerant canola. Brian Jenks and Gary Willoughby. Liberty Link canola (Invigor 2373) was seeded May 18 into 7.5-inch rows at 700,000 pls/A. Herbicide treatments were applied early-post (June 5), mid-post (June 10), or late-postemergence (June 16). Individual plots were 10 x 30 ft arranged in a RCBD with three replications. PPI treatments were applied with a CO_2 pressurized bicycle sprayer delivering 20 gpa at 30 psi using XR80015 flat fan nozzles. All postemergence treatments were applied with XR8001 flat fan nozzles delivering 10 gpa at 40 psi. Canola was harvested on August 26.

Glufosinate was effective on pigweed at any stage or rate. The highest canola yield was obtained with the full rate of glufosinate at 2 to 3-leaf canola or the split application. Clopyralid did provide some suppression of pigweed.

Application date	June 5	June 10	June 16
Application timing	POST I	POST II	POST III
Temperature (°F)			
Air	68	57	57
Soil	64	59	58
Relative humidity (%)	71	64	63
Canola stage	1 to 2- leaf	2 to 3-leaf	4 to 5-leaf
Rrpw size / density	0.5-1" / 84 per sq ft	1" / 84 per sq ft	1-4" / 12 per sq ft

Table. Redroot pigweed control in glufosinate-tolerant canola.

Treatment[a]	Rate	Timing[b]	June 19 Rrpw	Aug 19 Rrpw	Yield
	lb/A		---------Control (%)---------		lb/A
Untreated			0	0	1097
Glufosinate	0.26	A	95	94	2102
Glufosinate	0.37	A	95	93	1993
Glufosinate	0.44	A	96	95	2125
Glufosinate	0.37	B	99	99	2204
Glufosinate	0.44	B	99	99	2436
Glufosinate / Glufosinate	0.37 / 0.37	A / C	100	99	2392
Glufosinate + Sethoxydim	0.37 + 0.08	C	95	97	2073
Sethoxydim + Clopyralid + MSO	0.08 + 0.188 + 1%	A	0	30	1663
Sethoxydim + Clopyralid + MSO	0.08 + 0.188 + 1%	B	0	23	1377
LSD			1	11	474
CV			1	9	14

[a] All glufosinate treatments applied with AMS (3 lb/A)
[b] A=1 to 2-lf canola; B=2 to 3-lf canola; C=4 to 5-leaf canola

Herbicide Tolerant and Traditional Canola Production Systems Comparison. Johnson, B.L., R. Zollinger, B. Hanson, E. Eriksmoen, R. Henson

Evaluation of traditional and herbicide tolerant canola (HTC) performance was performed in a systems comparison study conducted at Prosper, Langdon, Hettinger, and Carrington, ND during the 1999 growing season. Six canola production systems were identified by cultivar type and corresponding herbicide compliment. Open-pollinated and hybrid cultivars were selected from traditional and herbicide tolerant varieties. Herbicide compliment for traditional cultivars was PPI Treflan (TR). Herbicide tolerant cultivars were Roundup Ready (RR), Liberty Link (LL), or Clearfield (CL). Replicated studies were solid seeded at 600,000 live seeds per acre in mid-May. Data collected included seed yield, seed weight, seed oil concentration, flowering date, weed species and intensity, plant lodging, and plant height. This report will focus on seed yield and crop value, and production costs associated with weed control and seed for planting.

Yield was not compromised by weed competition in these studies primarily because weed pressure was low to moderate and also control from the various herbicides was very good. Consequently system yield differences emphasize the cultivar component more than the herbicide factor. System yield ranking for Hettinger and Prosper indicated greater yield for hybrid systems 2 (Hyola 401-TR) and 5 (Hyola 357-RR) than open-pollinated systems 1 (Hudson-TR), 3 (LG3295-RR), 5 (Phoenix-LL), and 6 (45A71-CL). At Carrington and Langdon system 2, Hyola 401-TR performed intermediately with the high yielding RR hybrid Hyola 357, system 4, and the lower yielding open-pollinated RR, LL, and traditional cultivars. Greater weed pressure than observed in this study may benefit herbicide tolerant systems more than traditional systems but with low weed pressure traditional cultivars and herbicide tolerant cultivars generally performed equally. When considering the higher costs associated with HTC systems there is even greater equality among traditional and HTC systems and in some comparisons greater Net Return with the lower cost traditional systems.

Table . Production costs (herbicide + seed), seed yield and net return for six canola production systems comprised of traditional and herbicide tolerant cultivars and corresponding herbicide for weed control.

	System 1 (Treflan Hudson)	System 2 (Treflan Hyola 401)	System 3 (Roundup LG3295)	System 4 (Roundup Hyola 357)	System 5 (Liberty Phoenix)	System 6 (Raptor 45A71)
Herbicide and Seed cost* ($/A)	$23.00	$31.00	$31.00	$40.00	$38.00	$37.00
Carrington						
Yield (lb/A)	1620 bc	1880 ab	1760 abc	2040 a	1820 abc	1550 c
LSD (0.05) 310						
NET RETURN ** ($/A)	$139	$157	$145	$164	$144	$118
Langdon						
Yield (lb/A)	1840 bc	2120 ab	1690 c	2260 a	1840 bc	1570 c
LSD (0.05) 290						
NET RETURN ($/A)	$161	$181	$138	$186	$146	$120
Hettinger						
Yield (lb/A)	2460 b	3090 a	2500 b	3100 a	1870 c	2200 bc
LSD (0.05) 430						
NET RETURN ($/A)	$223	$278	$219	$270	$149	$183
Prosper						
Yield (lb/A)	1310 b	1840 a	1440 b	2060 a	1460 b	1300 b
LSD (0.05) 260						
NET RETURN ($/A)	$113	$153	$113	$166	$108	$ 93

* Cost is based on average retail prices for small quantities of seed and herbicide and does not reflect possible large volume discounts. Herbicide rates were 1.5 pt, 1.0 pt, 27 oz, and 4 oz per acre for Treflan, Roundup, Liberty, and Raptor, respectively. Open-pollinated seed costs were $2.20 to $2.40 per pound, and hybrid seed costs were $3.90 per pound. There was a $15.00 per acre technology fee associated with the Roundup Ready cultivars LG3295 and Hyola 357.

** Net Return $/A is based on a $0.10/lb seed value for yield minus herbicide and seed costs.

Weed control in dry beans. Brian Jenks, Kent McKay, and Gary Willoughby. Dry beans (Maverick) were planted May 27 in Washburn, ND. Flumioxazin, sulfentrazone, and flumetsulam were applied preemergence immediately after seeding. Postemergence treatments of imazamox and bentazon plus various adjuvants were applied on June 24. Individual plots were 10 x 30 ft arranged in a RCBD with three replications. PRE treatments were applied with a CO_2 pressurized bicycle sprayer delivering 20 gpa at 30 psi using XR80015 flat fan nozzles. All postemergence treatments were applied with XR8001 flat fan nozzles delivering 10 gpa at 40 psi. The dry beans were 1-2 trifoliate at time of application. Dry beans were harvested on September 16.

Table. Weed control in dry beans.

Treatment	Rate	Jul 8 Crop Injury	Jul 26 Crop Injury	July 8 Fxtl[a]	July 8 Rrpw	July 8 Wibw	Sept 14 Fxtl[a]	Sept 14 Rrpw	Sept 14 Wibw	Yield
	lb/A	%	%	Control (%)			Control (%)			lb/A
Untreated		0	0	0	0	0	0	0	0	755
Imazamox + NIS	0.023 0.25%	1	0	97	97	55	99	99	36	1950
Imazamox + NIS	0.031 0.25%	2	0	97	98	56	99	99	40	2189
Imazamox + Quad 7	0.031 1%	3	0	99	99	64	100	99	35	2070
Imazamox + COC	0.031 1%	2	0	98	99	56	99	99	35	1903
Imazamox + NIS + 28 % N	0.031 0.25% 1 qt	1	0	98	98	59	99	99	36	1989
Imazamox + Bentazon + NIS + 28 % N	0.031 0.25 0.25% 1 qt	0	0	97	98	59	99	98	38	1845
Imazamox + Bentazon + NIS + 28 % N	0.031 0.50 0.25% 1 qt	1	0	99	98	69	99	99	35	2028
Imazamox + Bentazon + NIS + 28 % N	0.016 0.25 0.25% 1 qt	0	0	89	94	48	93	97	35	1920
Flumioxazin	0.078	10	4	69	96	89	40	97	74	1520
Flumioxazin	0.125	12	5	69	94	82	43	95	68	1376
Sulfentrazone	0.125	0	0	25	68	70	18	70	58	1107
Sulfentrazone	0.25	0	0	50	89	68	33	86	59	1483
Flumetsulam	0.50	0	0	28	100	23	18	97	13	1400
LSD		3	1	10	8	14	8	6	10	423
CV		89	98	10	7	17	8	5	18	18

[a] Fxtl=Green and yellow foxtail

Dry bean stands were reduced approximately 25% in the flumioxazin treatments. Sulfentrazone did not cause a stand reduction. Imazamox + Quad 7 caused some initial leaf discoloration, but the dry beans quickly recovered. Dry bean yield in the sulfentrazone plot was lower than that of flumioxazin primarily due to lack of grass control.

Imazamox or imazamox + bentazon combinations effectively controlled foxtails, wild oat, redroot pigweed, and wild mustard. Imazamox was notably weaker on wild buckwheat which made harvest more difficult. Flumioxazin, sulfentrazone, and flumetsulam were fair to excellent on redroot pigweed. Flumioxazin and sulfentrazone somewhat suppressed wild buckwheat, however, lack of grass control probably aided in shading and holding down wild buckwheat.

Dry bean response to Frontier. Zollinger and Fitterer. An experiment was conducted near Prosper, ND to evaluate dry bean response to Frontier applied PPI, PRE, and POST. PPI treatments were applied and incorporated by operating a rototiller 2 inches deep on May 26, 1999 at 3:00 pm with 93 F air, 62 F soil at a 2 to 4 inch depth, 55% relative humidity, 0% clouds, 5 to 12 mph SW wind, dry soil surface, and moist subsoil. A single row of 'Maverick' and 'Remington' pinto and 'Norstar' and 'Navigator' navy bean were planted in each plot and PRE treatments were applied on June 1, 1999 at 2:30 pm with 62 F air, 59 F soil at a 2 to 4 inch depth, 58% relative humidity, 90% clouds, 5 to 12 mph S wind, dry soil surface, and moist subsoil. POST (unifoliate) treatments were applied on June 11, 1999 at 10:30 am with 69 F air, 78 F soil surface, 58% relative humidity, 3 to 8 mph NE wind, 10% clouds, dry soil surface, moist subsoil, excellent crop vigor, no dew present, and unifoliate dry bean. POST (1 to 3 trifoliate) treatments were applied on June 24, 1999 at 10:00 a.m with 81 F air, 85 F soil surfaces, 35% relative humidity, 2 to 5 mph NE wind, 35% clouds, dry soil surface, moist subsoil, excellent crop vigor, no dew present, and 1 to 3 trifoliate dry bean. Treatments were applied to the entire 10 by 40 ft plots with a bicycle-type-plot sprayer equipped with drift cones delivering 17 gpa at 40 psi through 8002 flat fan nozzles for the PPI and PRE treatments and 8.5 gpa at 40 psi through 8001 flat fan nozzles for POST treatments. The experiment had a randomized complete block design with three replicates per treatment.

Dry bean varieties were more tolerant to soil applied Frontier and Frontier-a than to POST applications. Greatest dry bean injury was found on July 8. Injury symptoms from Frontier and Frontier-a included stunting, chlorosis, leaf crinkling, and leaf puckering. On July 22 all dry bean varieties showed no injury symptoms (data not shown). Weed control from PPI treatments tended to be better than from other treatments. All herbicides gave poor common cocklebur control regardless of rate or application timing. Drybean yields were taken September, 28. No significant yields differences were found for any treatment.

Table. Dry bean response to Frontier.

Treatment[a]	Rate	June 22	July 1				July 5				July 8				July 8				Drybean
		Dry bean	Mav[b]	Rem[b]	Nor[b]	Nav[b]	Mav[b]	Rem[b]	Nor[b]	Nav[b]	Mav[b]	Rem[b]	Nor[b]	Nav[b]	Fxtl[c]	Cocb	Rrpw	Colq	yield
	prod/A	% injury													% control				lb/A
PPI																			
Eptam	2.5 pt	0	0	0	0	0	0	0	0	0	0	0	0	0	93	13	96	98	1844
Dual II Mag	1.15 pt	3	0	0	0	0	0	0	0	3	0	0	0	0	95	13	92	97	1899
Frontier	22 oz	5	0	0	0	0	0	2	2	3	0	0	0	0	96	13	98	98	1801
Frontier	44 oz	13	0	0	0	0	0	0	7	0	0	0	0	0	96	22	97	98	2285
Frontier-a	12 oz	4	0	2	2	2	0	0	0	0	0	0	0	0	96	33	93	97	2271
Frontier-a	24 oz	5	0	0	0	0	0	2	0	0	0	0	0	0	96	17	92	97	2299
PRE																			
Dual II Mag	1.15 pt	6	0	0	0	0	3	0	0	0	0	2	0	0	88	30	82	60	2271
Frontier	22 oz	4	0	0	0	0	0	0	0	2	2	0	0	0	96	33	60	65	2261
Frontier	44 oz	7	0	0	0	0	0	0	3	7	0	0	0	2	96	30	89	88	2100
Frontier-a	12 oz	9	0	0	0	0	0	0	0	0	0	0	0	0	97	13	78	93	2571
Frontier-a	24 oz	9	0	0	0	0	2	3	2	7	0	0	0	2	91	40	90	92	2155
Unifoliate																			
Dual II Mag	1.15 pt	2	0	0	0	0	0	0	0	0	0	0	0	0	92	7	37	52	1691
Frontier	22 oz	15	0	0	0	0	0	5	5	10	5	5	5	8	88	20	72	87	2359
Frontier	44 oz	12	0	2	2	2	2	3	2	5	8	8	8	12	92	30	53	87	2072
Frontier-a	12 oz	9	0	0	0	0	3	3	0	3	5	5	5	7	90	17	55	60	1903
Frontier-a	24 oz	15	0	0	0	0	0	3	3	7	12	13	12	12	92	20	53	70	2355
1 to 3 tri																			
Dual II Mag	1.15 pt	0	0	3	3	3	0	3	7	7	5	5	5	5	82	33	33	52	2392
Frontier	22 oz	0	0	3	3	3	3	3	3	3	5	5	5	5	88	13	58	78	2466
Frontier	44 oz	0	0	5	5	5	3	10	7	12	13	13	13	13	82	13	38	42	2185
Frontier-a	12 oz	0	0	5	5	5	0	2	3	8	10	10	10	10	92	15	37	58	2758
Frontier-a	24 oz	0	0	5	5	5	2	8	0	7	17	17	17	17	88	20	50	65	2090
Untreated		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1896
LSD (0.05)		7	NS	2	2	2	4	7	6	11	2	2	2	3	10	20	26	22	1012

[a]Frontier-a = a-isomer of Frontier.
[b]Mav = Maverick, Rem = Remington, Nor = Norstar, and Nav = Navigator.
[c]Fxtl = Grft and Yeft.

Dry bean response to preplant incorporated herbicides-Hatton, ND. Zollinger and Fitterer. An experiment was conducted near Hatton, ND to evaluate dry bean response to herbicides applied PPI. PPI treatments were applied and incorporated with a rototiller operated 2 inches deep on June 7, 1999 at 10:00 to 11:00 am with 93 F air, 69 F soil surface, 65% relative humidity, 5% clouds, 0 to 5 mph NW wind, dry soil surface, and moist subsoil. A single row of 'Norstar' and 'Navigator' navy and 'Remington' and 'Maverick' pinto bean were planted in each plot on June 7, 1999. Treatments were applied to the entire area of the 10 by 40 ft plots with a bicycle-wheel-type sprayer equipped with drift cones delivering 17 gpa at 40 psi through 8002 flat fan nozzles. The experiment had a randomized complete block design with three replicates per treatment.

Table. Dry bean response to preplant incorporated herbicides-Hatton, ND.

Treatment	Rate	June 23				July 1				July 19			
		Nor[a]	Nav[a]	Rem[a]	Mav[a]	Nor[a]	Nav[a]	Rem[a]	Mav[a]	Nor[a]	Nav[a]	Rem[a]	Mav[a]
	Product/A	% injury											
Spartan	2.67 oz	3	2	2	2	3	0	0	3	0	0	0	0
Spartan	4 oz	0	0	0	0	0	3	0	3	0	3	0	0
Spartan	5.33 oz	0	0	0	0	5	7	2	0	0	0	0	0
Spartan	8 oz	2	10	5	2	10	27	2	0	5	50	18	3
Valor	1 oz	5	0	3	0	3	0	0	0	0	0	0	0
Valor	1.5 oz	15	7	0	0	7	0	0	0	5	0	0	0
Valor	2 oz	9	7	2	5	10	2	2	10	0	3	3	10
Valor	3 oz	31	12	6	7	33	10	8	5	4	8	3	30
Python+Sonalan	0.92 oz+2.5 pt	3	0	6	5	0	0	0	3	5	8	0	0
Python+Sonalan	1.26 oz+2.5 pt	8	2	7	7	8	7	5	10	10	10	7	7
Python+Sonalan	1.88 oz+2.5 pt	17	9	12	2	10	3	7	3	8	15	4	0
Python+Sonalan	2.5 oz+2.5 pt	5	5	12	5	13	8	13	7	2	7	5	0
Python+Sonalan	2.5 oz+5 pt	8	8	8	12	10	7	7	8	5	13	9	9
Sonalan	2.5 pt	9	2	2	5	0	0	2	0	4	5	1	0
Sonalan	5 pt	10	5	8	5	7	0	0	3	2	0	0	0
Pursuit Plus+Prowl	1.8 pt+1.75 pt	4	5	10	5	7	0	0	0	12	12	3	5
Untreated		0	0	0	0	0	0	0	0	0	0	0	0
LSD (0.05)		13	9	8	9	26	9	9	9	9	11	14	15

[a]Nor = Norstar, Nav = Navigator, Rem = Remington, Mav = Maverick.

All treatments provided complete control of green and yellow foxtail, wild mustard, and redroot pigweed (data not shown). Dry bean tolerance of Spartan at rates of 5.33 oz/A or less, Valor rates of 1.5 oz/A or less, Python+Sonalan at 0.92 oz + 2.5 pt/A, and Sonalan at 2.5 pt/A was generally acceptable. No injury was observed on August 2 or later in the season (data not shown).

Dry bean response to preplant incorporated herbicides-Prosper, ND. Zollinger and Fitterer. An experiment was conducted, near Prosper, ND to evaluate dry bean response to herbicides applied PPI. PPI treatments were applied and incorporated with a rototiller operated 2 inches deep on May 26, 1999 at 3:00 pm with 93 F air, 62 F soil at a 2 to 4 inch depth, 55% relative humidity, 0% clouds, 5 to 12 mph SW wind, dry soil surface, and moist subsoil. 'Remington' pinto and 'Norstar' navy bean were planted in each plot on June 1, 1999. Treatments were applied to the center 6.67 ft of the 10 by 40 ft plots with a bicycle-wheel-type sprayer equipped with drift cones delivering 17 gpa at 40 psi through 8002 flat fan nozzles. The experiment had a randomized complete block design with three replicates per treatment.

Table. Dry bean response to preplant incorporated herbicides-Prosper, ND.

		June 18		June 22				June 29		June 29					July 12	
Treatment	Rate	Rem[a]	Nor[a]	Fxtl[b]	Cocb	Rrpw	Colq	Rem[a]	Nor[a]	Fxtl[b]	Rrpw	Colq	Wimu	Cocb	Rem[a]	Nor[a]
	Product/A	% injury		% control				% injury		% control					% injury	
Spartan	2.67 oz	0	0	50	13	83	95	2	0	57	99	99	23	23	3	2
Spartan	4 oz	2	5	63	23	90	98	5	2	58	95	99	40	17	2	0
Spartan	5.33 oz	3	10	75	30	94	95	5	3	57	96	99	46	17	1	7
Spartan	8 oz	0	10	62	43	95	98	5	0	57	99	99	60	13	5	8
Valor	1 oz	0	2	70	20	80	83	3	0	37	13	13	20	7	0	2
Valor	1.5 oz	0	0	73	13	91	81	2	2	33	33	33	33	7	0	0
Valor	2 oz	2	3	57	20	82	88	5	0	54	66	66	60	25	2	2
Valor	3 oz	3	7	60	23	92	93	3	3	53	73	70	43	20	5	3
Python+Sonalan	0.92 oz+2.5 pt	2	3	99	30	99	98	0	0	99	99	99	99	37	5	4
Python+Sonalan	1.26 oz+2.5 pt	3	2	99	43	98	99	3	0	99	99	99	99	47	5	3
Python+Sonalan	1.88 oz+2.5 pt	8	8	88	23	99	99	5	3	96	99	99	99	40	11	9
Python+Sonalan	2.5 oz+2.5 pt	8	13	96	27	99	98	3	3	86	99	99	99	43	5	10
Python+Sonalan	2.5 oz+5 pt	3	8	98	23	98	96	3	3	99	99	99	99	33	7	8
Sonalan	2.5 pt	0	0	93	20	96	98	2	2	83	99	89	23	7	2	0
Sonalan	5 pt	0	0	99	13	98	98	2	5	99	99	96	33	10	2	2
Pursuit Plus+Prowl	1.8 pt+1.75 pt	0	0	98	23	98	93	2	0	98	99	99	99	30	2	2
Untreated		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LSD (0.05)		5	9	26	23	15	13	NS	NS	34	20	20	38	21	7	8

[a]Rem = Remington and Nor = Norstar.
[b]Fxtl = Grft and Yeft.

First precipitation occurred four weeks after applications. Lower rates of Spartan and Python+Sonalan, and all rates of Valor, Sonalan, and Pursuit Plus showed good crop safety throughout the season. Spartan and Python provided less than 75% control of green and yellow foxtail. All treatments provided less than 47% control of common cocklebur. All rates of Python+Sonalan controlled green and yellow foxtail, redroot pigweed, and common lambsquarters on June 22 and 29 plus wild mustard on June 29.

Dry bean response to preemergence herbicides. Zollinger and Fitterer. An experiment was conducted near Prosper, ND to evaluate dry bean response to herbicides applied PRE. A single row of 'Navigator' and 'Norstar' navy and 'Remington' and 'Maverick' pinto bean were planted in each plot and PRE treatments were applied on June 1, 1999 at 2:30 to 3:00 pm with 64 F air, 60 F soil at a 2 to 4 inch depth, 56% relative humidity, 90% clouds, 5 to 12 mph S wind, dry soil surface, and moist subsoil. Treatments were applied to the entire area of the 10 by 40 ft plots with a bicycle-wheel-type sprayer equipped with drift cones delivering 17 gpa at 40 psi through 8002 flat fan nozzles. The experiment had a randomized complete block design with three replicates per treatment.

Table. Dry bean response to preemergence herbicides.

		June 29				July 12				June 22				June 29				
Treatment	Rate	Nav[a]	Nor[a]	Rem[a]	Mav[a]	Nav[a]	Nor[a]	Rem[a]	Mav[a]	Fxtl[b]	Rrpw	Colq	Cocb	Fxtl[b]	Wimu	Rrpw	Colq	Cocb
	Prod/A	% injury								% control								
Flufenacet	0.875 lb	0	3	0	0	0	0	0	0	80	32	52	0	45	30	30	30	10
Flufenacet	1 lb	7	10	10	10	0	0	0	0	70	20	63	0	-	33	33	33	13
Flufenacet	1.13 lb	0	0	0	0	0	0	0	0	70	12	53	3	20	33	53	53	7
Spartan	2.67 oz	0	0	0	0	0	0	2	0	75	80	85	0	15	40	63	63	13
Spartan	4 oz	0	0	0	0	0	0	0	0	72	85	94	0	50	33	50	50	23
Spartan	5.33 oz	3	10	13	5	2	2	2	2	78	93	96	0	40	63	60	57	0
Spartan	8 oz	5	7	5	0	0	0	0	0	70	92	96	7	0	0	30	23	7
Valor	1 oz	0	10	5	5	0	0	0	0	70	58	88	7	0	46	46	46	10
Valor	1.5 oz	7	10	13	10	0	0	0	0	53	73	94	0	0	0	0	0	0
Valor	2 oz	17	20	22	10	2	2	3	2	67	37	85	7	0	23	60	63	7
Valor	3 oz	13	22	20	17	6	8	7	6	67	63	88	7	30	23	50	50	7
Untreated		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LSD (0.05)		10	14	13	14	3	5	6	3	30	38	33	NS	72	61	77	74	28

[a]Nav = Navigator, Nor = Norstar, Rem = Remington, Mav = Maverick.
[b]Fxtl = Grft and Yeft.

The first precipitation occurred four weeks after treatment applications. Herbicides were not activated because of low precipitation, which resulted in poor weed control from most treatments. Under these conditions, Spartan treatments provided good to excellent control of redroot pigweed and common lambsquarters. Flufenacet at 1 lb/A, Spartan at 5.33 and 8 oz/A, and all rates of Valor caused dry bean injury on June 29. Dry beans generally recovered from injury before July 12 except dry beans treated with Valor at 3 oz/A.

Weed control in dry bean. Zollinger and Fitterer. An experiment was conducted in Prosper, ND to evaluate dry bean response to herbicides applied at the PRE and POST stages. 'Winchester' and 'Remington' pinto and 'Navigator' and 'Norstar' navy beans were planted and PRE treatments were applied on June 1, 1999 at 4:00 pm with 63 F air, 61 F soil at a 2 to 4 inch depth, 56% relative humidity, 90% clouds, 7 to 10 mph S wind, dry soil surface, and moist subsoil. POST (1WAP) treatments were applied on June 8, 1999 at 8:00 a.m. with 70 F air, 72 F soil surface, 80% relative humidity, 3 to 5 mph NW wind, 90% clouds, dry soil surface, and moist subsoil. POST (2WAP) treatments were applied on June 15, 1999 at 12:30 p.m. with 68 F air, 74 F soil surfaces, 32% relative humidity, 0 to 5 mph N wind, 50% clouds, dry soil surface, moist subsoil, good crop vigor, no dew present, to unifoliolate dry bean. Weed species present were: 1 to 4 lf, (1 to 5/ft^2), foxtail and cotyledon to 2 lf, (1 to 2/ft^2), redroot pigweed. POST (3WAP) treatments were applied on June 23, 1999 at 12:30 p.m. with 77 F air, 85 F soil surfaces, 61% relative humidity, 3 to 9 mph NW wind, 10% clouds, moist soil surface, moist subsoil, excellent crop vigor, no dew present, to 2 trifoliate dry bean. Weed species present were: 3 to 6 inch, (5 to 10/ft^2), foxtail; cotyledon to 2 lf, (2 to 5/ft^2), biennial wormwood; 2 to 6 inch, (3 to 8/ft^2), common lambsquarters; 2 to 4 inch, (2 to 5/ft^2), eastern black nightshade; and 2 to 5 inch, (2 to 7/ft^2), common cocklebur and 1 to 3 inch, (1 to 2/ft^2), redroot pigweed. POST (4WAP) treatments were applied on July 1, 1999 at 12:00 p.m. with 65 F air, 69 F soil surface, 83% relative humidity, 0 to 5 mph NW wind, 100% clouds, moist soil surface, moist subsoil, excellent crop vigor, no dew present, to 3 to 4 trifoliolate dry bean. Weed species present were: 4 to 8 inch, (5 to 10/ft^2), foxtail and 3 to 5 inch, (1 to 2/ft^2), redroot pigweed. Treatments were applied to 10 by 40 ft plots with a bicycle type plot sprayer equipped with a 10 ft boom and drift cones delivering 17 gpa at 40 psi through 8002 flat fan nozzles for the PRE treatments and 8.5 gpa at 40 psi through 8001 flat fan nozzles for the POST treatments. The experiment had a randomized complete block design with three replicates per treatment.

Most treatments provided good to excellent control of grass and broadleaf weeds except biennial wormwood and eastern black nightshade. Basagran applied alone at 1.5 pt/A gave between 50 and 60% biennial wormwood control. However, Frontier applied PRE followed by Basagran gave 70 to 80% biennial wormwood control. Basagran applied in multiple sequential applications gave 80 to 90% biennial wormwood control. Adding Pursuit or Raptor with Basagran did not improve biennial wormwood control compared to Basagran applied alone. Only treatments containing Frontier or Pursuit or Raptor controlled nightshade.

Treatment	Rate	July 8				July 16					
		Fxtl	Rrpw	Cocb	Biww	Fxtl	Rrpw	Colq	Biww	Ebns	Cocb
	Product/A	% control									
PRE/2WAP/3WAP											
Frontier/Basagran+Scoil/Basagran+Poast Plus+Scoil	20floz/0.8pt+1%/0.8pt+1.6pt+1%	98	99	99	90	96	96	99	84	99	99
PRE/3WAP											
Frontier/Basagran+Poast Plus+28% UAN	20floz/1.6pt+1.6pt+1.25%	99	99	99	85	99	99	99	75	99	99
Frontier/Basagran+Poast Plus+Scoil	20floz/1.6pt+1.6pt+1%	99	98	99	86	95	96	96	76	99	96
Frontier/Basagran+Pursuit+Poast Plus+28% UAN	20floz/1.6pt+0.36oz+1.6pt+1.25%	99	99	99	99	98	99	98	76	99	94
Frontier/Basagran+Pursuit+Poast Plus+Scoil	20floz/1.6pt+0.36oz+1.6pt+1%	98	99	99	88	94	89	89	72	99	99
Frontier/Basagran+Raptor+Poast Plus+28% UAN	20floz/1.6pt+2floz+1.6pt+1.25%	98	99	99	85	99	99	99	89	99	99
Frontier/Basagran+Raptor+Poast Plus+Scoil	20floz/1.6pt+2floz+1.6pt+1%	99	99	99	88	95	99	99	89	99	99
Frontier/Basagran+Frontier+Poast Plus+Scoil	20floz/1.6pt+12floz+1.6pt+1%	96	98	98	88	95	96	96	84	99	99
1WAP/2WAP/3WAP/4WAP											
Basagran+Poast Plus+Scoil/Basagran+Poast Plus+Scoil/ Basagran+Poast Plus+Scoil/Basagran+Poast Plus+Scoil	0.4pt+0.4pt+0.5%/0.4pt+0.4pt+0.5%/ 0.4pt+0.4pt+0.5%/0.4pt+0.4pt+0.5%	90	90	99	90	96	56	56	93	83	99
2WAP											
Assure II+PO	5floz+1.5%	76	0	0	0	80	0	0	0	0	0
Select+PO	4floz+1qt	86	0	0	0	89	0	0	0	0	0
Select+PO	6floz+1qt	98	0	0	0	99	0	0	0	0	0
Select+PO	8floz+1qt	99	0	0	0	99	0	0	0	0	0
Select+Basagran+PO	6floz+1.5pt+1qt	93	58	86	45	89	50	50	56	56	66
Select+Basagran+PO	8floz+1.5pt+1qt	95	68	89	48	80	53	53	53	53	69
Select+Raptor+PO	6floz+4floz+1qt	98	99	96	37	95	99	96	46	99	93
Select+Pursuit+PO	6floz+0.72oz+1qt	98	99	99	52	82	96	96	73	99	93
2WAP/3WAP											
Select+Basagran+PO/Select+PO	6floz+1.5pt+1qt/4floz+1qt	99	73	92	47	98	62	62	58	46	99
Select+Basagran+PO/Select+PO	8floz+1.5pt+1qt/4floz+1qt	99	75	93	42	96	62	62	53	43	99
2WAP/4WAP											
Frontier+Basagran+Poast Plus+Scoil/ Frontier+Basagran+Poast Plus+Scoil	20floz+0.8pt+0.8pt+1%/ 12floz+0.8pt+0.8pt+1%	96	86	99	63	85	73	79	59	79	99
Frontier+Basagran+Pursuit+Poast Plus+Scoil/ Frontier+Basagran+Poast Plus+Scoil	20floz+0.8pt+0.36oz+0.8pt+1%/ 12floz+0.8pt+0.8pt+1%	93	89	99	98	85	79	99	59	90	96
Untreated		0	0	0	0	0	0	0	0	0	0
LSD (0.05)		11	15	6	8	14	8	9	11	13	13

Dry bean tolerance to Raptor. Zollinger and Fitterer. An experiment was conducted near Prosper, ND to evaluate dry bean tolerance to Raptor applied POST. Dry bean was planted on June 1, 1999. Treatments were applied to nine dry bean varieties: 'Maverick' and 'Remington' (pinto), 'Frontier', 'Navigator', and 'Agri-1' (navy), 'T-39' and 'Shadow' (black), and 'Cal Early LRK' and 'Montcalm' (kidney). Treatments were applied on July 1, 1999 at 10:00 to 11:00 am with 63 F air, 68 F soil, 83% relative humidity, 100% clouds, 0 to 5 mph NW wind, moist soil surface, wet subsoil, good crop vigor, no dew present, and 2 to 4 trifoliolate dry bean. Weeds present were: 1 to 3 inch, foxtail (2 to 5/ft^2); 1 to 3 inch, redroot pigweed (2 to 5/ft^2); cotyledon, wild mustard (2 to 5/ft^2); and 1 to 3 inch, common cocklebur (1 to 2/ft^2). Treatments were applied to the center 6.67 ft of the 10 by 40 ft plots with a bicycle-wheel type sprayer equipped with a wind shield delivering 8.5 gpa at 40 psi through 8001 flat fan nozzles. The experiment had a randomized complete block design with three replicates per treatment

Table. Dry bean tolerance to Raptor.

		Dry bean yield								
Treatment[a]	Rate	Mav[b]	Rem[b]	Fron[b]	Nav[b]	Agri[b]	T-39	Shad[b]	Cal E[b]	Mont[b]
	Product/A	lb/A								
Raptor+NIS+28%	2 fl oz+0.25%+1%	1386	1697	2857	1913	2548	3544	2868	1477	1494
Raptor+NIS	3 fl oz+0.25%	1105	1645	2730	2065	2725	3043	2428	1828	1078
Raptor+NIS+28%	3 fl oz+0.25%+1%	1299	1486	2687	2765	2826	3082	3174	1934	1118
Raptor+Basagran+NIS +28%	3 fl oz+0.75 pt+0.25%+1%	1188	1288	2886	2081	2507	3321	2772	1800	1334
Untreated		1048	1398	2451	2176	2236	2880	2412	1177	1106
LSD (0.05)		818	494	807	646	343	1040	869	746	570

[a]NIS = nonionic surfactant = Activator 90 and 28% = 28-0-0 nitrogen fertilizer.
[b]Mav = Maverick, Rem = Remington, Fron = Frontier, Nav = Navigator, Agri = Agri-1, Shad = Shadow, Cal E = Cal Early LRK, Mont = Montcalm.

Plots were oversprayed with Basagran at 1.5 pt/A and Select at 10 oz/A to control common cocklebur and green and yellow foxtail. Dry bean injury was less than 2%, chlorosis was less than 5%, and growth reduction was less than 8% from treatments for all varieties on July 8 (data not shown). No injury of any type was observed on or after July 16. Dry bean yields were less for untreated plots than for treated plots probably due to competition from a second flush of green and yellow foxtail that only emerged in the untreated plots.

Dry bean response to postemergence herbicides. Zollinger and Fitterer. An experiment was conducted near Hatton, ND to evaluate dry bean response to herbicides applied POST. A single row each of 'Maverick' and 'Remington' pinto and 'Navigator' and 'Norstar' navy bean were planted in each plot on June 7, 1999. POST treatments were applied on July 2, 1999 at 9:00 to 10:00 am with 62 F air, 65 F soil surface, 83% relative humidity, 50% clouds, 0 to 3 mph SW wind, dry soil surface, moist subsoil, good crop vigor, dew present, and 1 to 2 trifoliate dry bean. Treatments were applied to the entire area of the 10 by 40 ft plots with a bicycle-wheel-type sprayer equipped with drift cones delivering 8.5 gpa at 40 psi through 8001 flat fan nozzles. The experiment had a randomized complete block design with three replicates per treatment.

Table. Dry bean response to postemergence herbicides.

Treatment[a]	Rate	July 16				Drybean yields			
		Mav[b]	Rem[b]	Nav[b]	Nor[b]	Mav	Rem	Nav	Nor
	Product/A	% injury				lb/A			
Raptor+NIS	3 fl oz+0.25%	0	0	0	0	1736	1573	2143	1790
Raptor+NIS	4 fl oz+0.25%	0	0	0	0	1523	1815	1972	2038
Raptor+Quad 7	4 fl oz+1%	0	2	0	0	1529	1865	1538	1874
Raptor+PO	4 fl oz+1%	0	0	0	0	2161	2050	2062	1413
Raptor+NIS+28% UAN	4 fl oz+0.25%+1qt	3	3	0	0	1847	1767	1720	1943
Raptor+Basagran+NIS+28% UAN	4 fl oz+1 pt+0.25%+1qt	0	0	0	0	2212	2293	2072	1871
Raptor+Basagran+NIS+28% UAN	4 fl oz+2 pt+0.25%+1qt	0	0	0	0	2163	2183	2311	2085
Pursuit+NIS	0.72 oz+0.25%	3	3	0	2	1963	2028	1971	1808
Flexstar+PO	0.8 pt+1%	0	5	7	3	-	-	-	-
Flexstar+PO	1 pt+1%	5	0	0	0	-	-	-	-
Reflex+PO	0.33 pt+1%	0	0	0	0	-	-	-	-
Reflex+PO	0.5 pt+1%	0	0	0	0	-	-	-	-
Reflex+PO	0.75 pt+1%	0	0	0	0	-	-	-	-
Reflex+PO	1 pt+1%	0	0	0	0	-	-	-	-
Reflex+Raptor+PO	0.75 pt+4 fl oz+1%	2	2	2	2	-	-	-	-
Reflex+Basagran+PO	0.75 pt+1 pt+1%	3	0	0	0	-	-	-	-
Reflex+Basagran+PO	0.75 pt+1.5 pt+1%	0	0	0	0	-	-	-	-
Untreated		0	0	0	0	2156	1825	2167	1825
LSD (0.05)		NS	NS	5	NS	534	430	681	430

[a]NIS = nonionic surfactant = Activator 90, Quad 7 = basic blend adjuvant, PO = petroleum oil = Herbimax, and UAN = urea ammonium nitrate.
[b]Mav = Maverick, Rem = Remington, Nav = Navigator, and Nor = Norstar,

Experiment was maintained weed free throughout the season. Minimal crop injury was observed on June 16 and no injury was visible on July 30 (data not shown) from all treatments. Treatments provided excellent crop safety to dry bean varieties tested. Raptor at 4 fl oz/A plus NIS or Quad 7 reduced yields of Maverick compared to the untreated check. Yields of Remington, Navigator, and Norstar were not significantly reduce compared to the untreated checks.

Dry bean response to Select. Zollinger and Fitterer. An experiment was conducted near Prosper, ND, to evaluate dry bean response to Select applied at the EPOST stage. A single row of 'Winchester' and 'Remington' pinto and 'Navigator' and 'Norstar' navy beans were planted in each plot on June 1, 1999. EPOST treatments were applied on June 24, 1999 at 11:00 am with 80 F air, 90 F soil, 36% relative humidity, 5% clouds, 8 to 12 mph NW wind, dry soil surface, moist subsoil, good crop vigor, no dew present, to first trifoliate dry bean. Weed species present were: 1 to 3 inch, 2 to 3 lf, (10 to 40/ft^2) foxtail; 1 to 2 inch, cotyledon to 4 lf, (20 to 30/ft^2) wild mustard; 1 to 3 inch, cotyledon to 2 lf, (1 to 2/ft^2) common lambsquarters; 1 inch, cotyledon to 2 lf, (1 to 2/yd^2) redroot pigweed; 1 to 3 inch, cotyledon to 4 lf, (10 to 15/ft^2) common cocklebur. Treatments were applied to the entire area of the 10 by 40 ft plots with a bicycle-wheel type sprayer equipped with drift cones delivering 8.5 gpa at 40 psi through 8001 flat fan nozzles. The experiment had a randomized complete block design with three replicates per treatment.

		July 8			
Treatment	Rate	Rrpw	Colq	Cocb	Wimu
	Product/A	% control			
Select+PO	6floz+1qt	0	0	0	0
Select+PO	8floz+1qt	0	0	0	0
Select+Basagran+PO	6floz+1.5pt+1qt	22	18	99	99
Select+Basagran+PO	8floz+1.5pt+1qt	23	30	99	99
Select+Raptor+PO	6floz+4floz+1qt	95	72	99	99
Select+Pursuit+PO	6floz+0.72oz+1qt	95	68	99	99
Untreated		0	0	0	0
LSD (0.05)		7	11	0	0

All dry bean varieties tested showed no injury from any treatment. Green and yellow foxtail were completely controlled by all treatments. Select tank mixes gave complete control of common cocklebur and wild mustard. Select plus Raptor and Pursuit gave the greatest control of redroot pigweed and common lambsquarters.

Dry bean response to herbicides. Zollinger and Fitterer. An experiment was conducted near Prosper, ND, to evaluate dry bean response to POST herbicides. 'Remington' pinto and 'Navigator' navy beans (DEB) were planted in each plot on June 1, 1999. POST treatments were applied on July 1, 1999 at 9:00 to 10:00 am with 62 F air, 67 F soil, 83% relative humidity, 100% clouds, 0 to 5 mph NW wind, moist soil surface, wet subsoil, good crop vigor, no dew present, and 2 to 4 trifoliate dry bean. Weeds present were: 4 to 6 inch, (5 to 10/ft^2), foxtail; 2 to 8 inch, (5 to 10/ft^2), redroot pigweed; cotyledon to 2 lf, (2 to 5/ft^2), wild mustard; 2 to 6 inch, (3 to 8/ft^2), common lambsquarters; 2 to 4 inch, (2 to 5/ft^2), kochia; and 2 to 5 inch, (2 to 7/ft^2), common cocklebur. Treatments were applied to the center 6.67 ft of the 10 by 40 ft plots with a bicycle-wheel-type sprayer equipped with a wind shield delivering 8.5 gpa at 40 psi through 8001 flat fan nozzles. The experiment had a randomized complete block design with three replicates per treatment.

		July 6		July 8	July 16		July 30		July 8			
Treatment	Rate	Rem	Nav	DEB	Rem	Nav	Rem	Nav	Rrpw	Colq	Cocb	Kocz
	Product/A	% injury			% injury				% control			
Reflex+Scoil	1pt+1.5pt	25	8	10	3	2	0	0	77	77	80	57
Reflex+Agri-Stay	1pt+1.5pt	9	2	3	2	3	0	0	50	50	60	33
Flexstar+Scoil	1pt+1.5pt	25	17	13	12	5	3	3	82	77	93	47
Flexstar+Agri-Stay	1pt+1.5pt	20	10	10	12	8	0	2	77	75	85	47
Raptor+Scoil	4floz+1.5pt	12	5	8	0	0	2	2	70	70	80	57
Raptor+Agri-Stay	4floz+1.5pt	7	2	5	0	0	0	0	50	50	53	33
Cobra+Scoil	3floz+1.5pt	33	23	25	13	17	5	8	77	80	60	50
Cobra+Agri-Stay	3floz+1.5pt	35	20	23	7	3	2	2	78	63	88	63
Galaxy+Scoil	1pt+1.5pt	27	20	20	2	5	3	5	72	72	72	47
Galaxy+Agri-Stay	1pt+1.5pt	17	8	12	3	3	0	2	58	58	65	43
Untreated		0	0	0	0	0	0	0	0	0	0	0
LSD (0.05)		8	5	7	7	6	5	4	24	21	23	23

Agri-stay reduced dry bean injury with all herbicides except Cobra on July 6. On July 16 and 30 Agri-Stay reduced dry bean injury over Scoil only with Cobra. Generally, weed control was reduced with Agri-Stay over Scoil except with Cobra. Weed control with Cobra plus Agri-Stay was similar to Cobra plus Scoil.

Weed control in Flax, Fargo. (Roach, Ronald F. and Janet D. Davidson-Harrington) 'Neche' hard red spring wheat was seeded May 24. Treatments were applied to 2 to 6 inch flax, cotyledon to 6 leaf redroot pigweed, and 2 leaf to flowering wild mustard on June 18 with 60° F, cloudy sky and 10 to 15 mph wind. Treatments were applied with a bicycle wheel type plot sprayer delivering 8.5 gpa at 35 psi through 8001 flat fan nozzles to a 7 ft wide area the length of 10 by 30 ft plots. The experiment was a randomized complete block design with four replicates.

Treatment	Rate	Jun 22				Jul 31			
		Flax	Yeft	Wimu	Rrpw	Fota	Yeft	Rrpw	KOCZ
	oz ai/A	%							
MCPA-ioe+seth+MVO	4+3+0.18gpa	3	88	98	45	0	99	43	15
Brox+seth+MVO	4+3+0.18gpa	25	96	95	79	29	99	0	25
Brox&MCPA+seth+MVO	8+3+0.18gpa	30	95	99	91	21	99	69	45
Brox&MCPA+seth	8+3	30	94	99	91	28	99	65	48
Clpy&MCPA+seth+MVO	4.5+3+0.18gpa	6	75	98	78	0	99	71	0
Clpy&MCPA+seth+MVO	9+3+0.18gpa	19	88	98	92	19	99	64	0
Fluroxypyr+clpy&MCPA+ seth+MVO	0.5+4.5+ 3+0.18gpa	50	91	99	93	89	99	18	0
Fluroxypyr+picloram+ MCPA-ioe+seth+MVO	0.5+0.25+ 4+3+0.18gpa	44	86	98	90	91	99	0	0
Carf+MCPA-ioe	0.13+4	90	70	99	99	84	0	98	50
Carf+MCPA-ioe+Seth+ MVO	0.13+4+3+ 0.18gpa	96	95	99	98	85	99	63	38
Imam+2,4-Dioe+MVO	0.25+4+0.18gpa	31	88	99	98	78	99	99	48
Thif+MCPA-ioe+Act90	0.25+4+0.18gpa	13	20	98	92	29	73	99	43
Thif+MCPA-ioe+MVO	0.25+4+0.18gpa	9	40	98	91	14	75	99	24
Thif+MCPA-ioe+seth+ MVO	0.25+4+3+ 0.18gpa	21	87	99	97	29	99	99	30
Untreated	0	0	0	0	0	0	0	0	0
C.V. %		29	19	2	8	24	4	17	118
LSD 5%		13	20	2	9	13	5	14	NS
# OF REPS		4	4	4	4	4	4	4	2

Growing conditions were very wet and flax was chlorotic at treatment, which probably accounted for the severe injury from most herbicides. Fluroxypyr, carfentrazone, and imazamox were too injurious for further consideration for weed control in flax. The most effective treatment for full season weed control was thifensulfuron+MCPA+sethoxydim+methylated vegetable oil adjuvant; however, kochia control was not adequate with any treatment. Thifensulfuron normally controls kochia unless the kochia is ALS resistant or when it emerges after treatment. Redroot pigweed usually is not adequately controlled by conventional treatments, so thifensulfuron could provide an important alternative. Flax apparent tolerance to clopyralid indicates potential for Canada thistle control. Canada thistle was not present in the area, but clopyralid is known to be effective on this weed. Thifensulfuron treatments without sethoxydim appeared to control yellow foxtail but not green foxtail.

Flax tolerance to various herbicides. Brian Jenks, Kent McKay, and Gary Willoughby. We evaluated flax tolerance to sulfentrazone applied PRE and various herbicides applied POST. Flax was seeded May 26. Sulfentrazone was applied PRE May 27 and all but one postemergence treatment was applied June 25 (flax 4 to 6-inches). One bromoxynil + MCPA treatment was applied July 2 when flax was about 10 inches tall. The PRE treatment was applied with a CO_2 pressurized bicycle sprayer delivering 20 gpa at 30 psi using XR80015 flat fan nozzles. All postemergence treatments were applied with XR8001 flat fan nozzles delivering 10 gpa at 40 psi. Flax was harvested on September 21.

Sulfentrazone did not cause any visible injury, but did not control wild buckwheat which contributed to the lower yield. Bromoxynil + MCPA at either stage controlled wild buckwheat. However, bromoxynil + MCPA applied at 10-inch flax caused severe twisting of the main flax stem. The flax appeared shorter and more thin compared to the early application. Thifensulfuron and imazamox caused moderate stunting early in the season and delayed maturity. The flax recovered considerably as the season progressed. Clopyralid + MCPA caused slight stunting initially. Clopyralid + MCPA controlled wild buckwheat much better than imazamox.

Table. Flax tolerance to various herbicides.

Treatment	Rate	Jul 21 Flax Injury	Aug 24 Flax Injury	Yield
	lb/A	%	%	bu/A
Sulfentrazone	0.125	0	0	15
Thifensulfuron + NIS	0.0156	37	13	20
Bromoxynil + MCPA	0.50	4	4	18
Clopyralid + MCPA	0.46	6	9	19
Clopyralid + MCPA	0.61	9	9	22
Imazamox	0.031	19	10	17
Bromoxynil + MCPA[1]	0.50	18	25	17
Untreated		0	0	4
LSD		11	12	7
CV		51	78	23

[1] Applied to 10-inch flax

Volunteer flax control. Brian Jenks and Gary Willoughby. We evaluated several herbicides for volunteer flax control. We seeded flax May 26 and applied the most of the herbicides on June 18 when flax was about 2" tall. The high rate of fluroxypyr was applied June 28 to 4-6" flax. Individual plots were 10 x 30 ft arranged in a RCBD with three replications. All treatments were applied with XR8001 flat fan nozzles delivering 10 gpa at 40 psi.

Tribenuron + 2,4-D, dicamba + 2,4-D, and carfentrazone did not control flax. Adding fluroxypyr to tribenuron + 2,4-D increased control by 30%. Fluroxypyr at higher rates provided slightly better control than the lower fluroxypyr rate and quinclorac.

Table. Volunteer flax control.

Treatment	Rate	July 21 Vol. flax
	lb/A	Control (%)
Tribenuron + 2,4-D ester + NIS	0.008 + 0.25 + 0.25%	48
Tribenuron + 2,4-D ester + Fluroxypyr	0.008 + 0.25 + 0.062	77
Fluroxypyr	0.094	91
Fluroxypyr	0.125	96
Quinclorac + MSO	0.188 + 24 fl oz	80
Carfentrazone + NIS + AMS	0.008 + 0.25% + 1%	38
Dicamba + 2,4-D ester	0.125 + 0.25	42
Untreated		0
LSD		10
CV		10

Weed control with pre- and post-applied herbicides in pinto bean. (Endres, Gregory J., Robert A. Henson, Laura L. Karlsrud, and Jerrold J. Schneider) The objectives of the experiment were to evaluate annual weed control and pinto bean tolerance to PRE- and POST-applied herbicides, including selected herbicide combinations and rates, adjuvants, and application timing. The experiment was conducted on a Heimdahl loam soil with 6.6 pH and 3.5% organic matter at Carrington, ND in 1999. A randomized complete block design with four replications was used. Herbicide treatments were applied to the center 6.67 ft of 10 by 25 ft plots. A hooded bicycle-wheel-type plot sprayer was used for pre-applied treatments and a backpack sprayer for post-applied treatments. On June 8, 'Maverick' pinto bean was planted in 30-inch rows at a pure live seeding rate of 70,000 seeds/A. PRE treatments were applied at 17.2 gal/A and 30 psi through 8002 flat fan nozzles on June 10 with 67 F, 50% RH, overcast sky, and 13 mph wind. POST treatments were applied at 20.7 gal/A and 35 psi through 8002 flat fan nozzles. POST 1 treatments were applied on June 23 with 60 F, 90% RH, clear sky, and 9 mph wind to unifoliate bean, 3- to 4-leaf yellow and green foxtail, 0.5-inch tall redroot and prostrate pigweed, 0.5- to 2-inch tall common lambsquarters, and 0.5- to 2-inch tall wild mustard. POST 2 treatments were applied on June 29 with 60 F, 78% RH, 90% cloudy sky, and 11 mph wind to 2-trifoliate bean, 3- to 4-leaf yellow and green foxtail, 1- to 1.5-inch tall redroot and prostrate pigweed, 2-inch tall common lambsquarters, and 1- to 3-inch tall wild mustard. POST 3 treatments were applied on July 7 with 58 F, 83% RH, clear sky, and 2 mph wind to 3- to 5-trifoliate bean, 2-inch tall to headed yellow and green foxtail, 1- to 8-inch tall redroot and prostrate pigweed, 1- to 8-inch tall common lambsquarters, and 6-inch tall to flowering wild mustad. Pinto bean was harvested on September 17 to determine seed yield.

Table 1. Weed control in pinto bean (Endres, Henson, Karlsrud, and Schneider).

Treatment[a]	Rate	2 wk after treatment				4 wk after treatment			
		Fota[b]	Piwe[c]	Colq	Wimu	Fota[b]	Piwe[c]	Colq	Wimu
	lb/A	% control							
Untreated	——	0	0	0	0	0	0	0	0
PRE/POST 2									
SAN 52H/bent+seth+UAN	0.94/1+0.2+1.25%	98	96	98	99	97	98	99	99
SAN 582H/bent+seth+MSO	0.94/1+0.2+0.94%	97	96	97	99	97	97	99	99
SAN 582H/bent+seth+imep+UAN	0.94/1+0.2+0.016+1.25%	97	99	99	99	97	99	99	99
SAN 582H/bent+seth+imep+MSO	0.94/1+0.2+0.016+0.94%	98	98	99	99	98	99	99	99
SAN 582H/bent+seth+immx+UAN	0.94/1+0.2+0.016+1.25%	97	99	99	99	98	99	99	99
SAN 582H/bent+seth+immx+MSO	0.94/1+0.2+0.016+0.94%	98	99	98	99	97	99	99	99
SAN 582H/SAN 582H+bent+seth +MSO	0.94/0.56+1+0.2+ 0.94%	98	90	98	97	97	95	98	99
PRE/POST 1/POST 3									
SAN 582H/bent+MSO/bent+seth+ MSO	0.94/0.5+1.0%/0.5+0.2+ 1%	96	98	99	98	98	98	99	99
POST 1/POST 3									
SAN 582H+bent+seth+MSO/ SAN 582H+bent+seth+MSO	0.9+0.5+0.1+0.9%/ 0.6+0.5+0.1+0.9%	98	93	99	99	99	96	99	99
SAN 582H+bent+imep+seth+ MSO/SAN 582H+bent+ seth+MSO	0.94+0.5+0.016+0.1+ 0.9%/0.6+0.5+0.1+0.9%	98	96	99	99	98	97	99	99
POST 3									
Imazamox+NIS	0.02+0.25%	73	79	59	96	73	84	74	98
Imazamox+NIS	0.03+0.25%	77	87	68	96	81	91	75	96
Imazamox+Quad7	0.03+1%	89	94	80	98	94	96	87	98
Imazamox+MSO	0.03+1.0%	79	91	81	95	81	96	85	99
Imazamox+NIS+UAN	0.03+0.25%+1qt	81	94	74	97	83	96	77	99
Imazamox+bentazon+NIS+UAN	0.03+0.25+0.25%+1qt	79	90	87	95	79	93	97	99
Imazamox+bentazon+NIS+UAN	0.031+0.5+0.25%+1qt	78	89	81	97	77	89	90	95
Imazethapyr+NIS	0.031+0.25%	66	75	42	93	67	74	62	92
LSD (0.05)		6	4	9	3	5	5	7	4

[a]UAN=Class APM 28, a surfactant + fertilizer from Cenex; MSO=Scoil, a methylated vegetable oil from AGSCO; NIS=Class Preference, a nonionic surfactant from Cenex, St. Paul, MN; Quad 7= a surfactant blend from AGSCO, Grand Forks ND.

[b]Foxtail=Yellow and green.

[c]Pigweed=Redroot and prostrate.

Table 2. Pinto bean response to herbicide treatments (Endres, Henson, Karlsrud, and Schneider).

Treatment[a]	Rate	Pinto bean Injury 2 WAT	Pinto bean Injury 4 WAT	Seed yield
	lb/A	%		(bu/A)
Untreated		0	0	762
PRE/POST 2				
SAN 582H/bentazon+sethoxydim+UAN	0.94/1+0.2+1.25%	16	2	2235
SAN 582H/bentazon+sethoxydim+MSO	0.94/1+0.2+0.94%	6	0	2344
SAN 582H/bent+seth+imep+UAN	0.94/1+0.2+0.016+1.25%	5	0	2420
SAN 582H/bent+seth+imep+MSO	0.94/1+0.2+0.016+0.94%	5	0	2404
SAN 582H/bent+seth+ imazamox+UAN	0.94/1+0.2+0.016+1.25%	3	0	2436
SAN 582H/bent+seth+immx+MSO	0.94/1+0.2+0.016+0.94%	0	0	2284
SAN 582H/SAN 582H+bent+seth+MSO	0.94/0.6+1+0.2+0.94%	9	0	2241
PRE/POST 1/POST 3				
SAN 582H/bent+MSO/bent+seth+MSO	0.94/0.5+1%/0.5+0.2+1.0%	4	1	1882
POST 1/POST 3				
SAN 582H+bent+seth+MSO/ SAN 582H+bent+seth+ MSO	0.94+0.5+0.1+0.94%/ 0.56+0.5+0.1+0.94%	2	0	2250
SAN 582H+bent+imep+seth+MSO/SAN 582H+bent+seth+MSO	0.94+0.5+0.02+0.1+0.94%/0.56+0 .5+0.1+0.94%	3	0	2070
POST 3				
Imazamox+NIS	0.023+0.25%	1	1	1835
Imazamox+NIS	0.031+0.25%	2	1	1980
Imazamox+Quad7	0.031+1%	3	2	2156
Imazamox+MSO	0.031+1%	0	0	2092
Imazamox+NIS+UAN	0.031+0.25%+1qt	1	0	2158
Imazamox+bentazon+NIS+UAN	0.031+0.5+0.25%+1qt	0	0	2207
Imazethapyr+NIS	0.31+0.25%	0	0	1651
LSD (0.05)		6	NS	317

[a]UAN=Class APM 28, a surfactant + fertilizer from Cenex; MSO=Scoil, a methylated vegetable oil from AGSCO; NIS=Class Preference, a nonionic surfactant from Cenex, St. Paul, MN; Quad 7- a surfactant blend from AGSCO, Grand Forks ND.

Weed control with treatments including SAN 582H, bentazon, and sethoxydim were excellent, ranging from 90 to 99% (Table 1). Imazamox provided 95 to 99% control of wild mustard. Control of foxtail, pigweed, and common lambsquarters generally was greater with imazamox at 0.031 lb/A + NIS compared to the lower rate of 0.023 lb/A. Imazamox at 0.031 lb/A + Quad7 gave improved foxtail control compared to imazamox plus the other adjuvants tested. Also, imazamox at 0. 031 lb/A + Quad7 or MSO gave improved common lambsquarters control compared to imazamox + NIS. The addition of bentazon to imazamox provided improved common lambsquarters control compared to imazamox + NIS. The low rate of bentazon + imazamox provided weed control similar to the high rate of bentazon. Imazamox generally provided better weed control than imazethapyr

Dry bean injury was low, ranging from 0 to 16% when visually evaluated 2 weeks after treatment (WAT) and 0 to 2% when evaluated 4 WAT (Table 2). Injury consisted of biomass reduction. Dry bean seed yield generally was similar among treatments that included SAN 582H, bentazon, and sethoxydim. Yield in plots treated with imazamox at 0.023 lb/A + NIS and imazethapyr generally were lower than in plots treated with other imazamox treatments applied at POST 3.

Grain legume response to sulfentrazone, Carrington, 1999. (Endres, Henson, Schneider, and Zwinger) The experiment was conducted to evaluate field pea, lentil, and chickpea tolerance to sulfentrazone. The experiment was conducted on a Heimdahl loam soil with 6.6 pH and 3.5% organic matter at the NDSU Carrington Research Extension Center. The experiment was a randomized complete block design with four replicates. Herbicide treatments were applied to the center 6.67 ft of 10 by 25 ft plots with a hand-boom plot sprayer at 10.4 gal/A at 35 psi through 8001 flat fan nozzles. PPI treatments were applied on May 17 with 55 F, 74% RH, 75% cloudy sky, and 14 mph wind and incorporated twice using a field cultivator with a rolling basket set at a 2-inch depth. 'Profi' field pea was planted at 300,000 PLS/A, >Crimson= lentil was planted at 60 lb/A, and >Sanford= chickpea was planted at 130,700 PLS/A on May 20 in 7-inch rows at a 2-inch depth. PRE treatments were applied on May 21 with 56 F, 63% RH, 20% cloudy sky, and 7 mph wind. Field pea was harvested with a plot combine on August 24. A pre-harvest treatment of glyphosate at 0.75 lb/A was applied on August 19 to the lentil and the crop was harvested August 25. A pre-harvest treatment of glyphosate at 0.75 lb/A was applied on September 10 to the chickpea and the crop

Table 1. Weed control in grain legumes with sulfentrazon

		2 wk after treatment (6/17)			
Treatment	Rate	Fota[a]	Piwe[b]	Wibu	Wimu
	(lb/A)	% control			
Field pea:					
Untreated	----	0	0	0	0
PPI	0.125	65	90	78	48
PPI	0.25	77	99	96	89
PPI	0.5	85	99	70	90
PRE	0.125	60	88	70	0
PRE	0.25	73	99	87	21
PRE	0.5	86	99	99	41
LSD (0.05)		10	13	23	24
Lentil:					
Untreated	----	0	0	0	0
PPI	0.125	63	53	68	71
PPI	0.25	68	71	91	65
PPI	0.5	81	97	99	79
PRE	0.125	20	65	70	0
PRE	0.25	58	91	79	0
PRE	0.5	76	99	99	47
LSD (0.05)		16	9	12	16
Chickpea:					
Untreated	----	0	0	0	0
PPI	0.125	48	59	60	66
PPI	0.25	67	64	73	68
PPI	0.5	77	88	93	72
PRE	0.125	24	65	63	0
PRE	0.25	57	88	95	21
PRE	0.5	71	92	95	10
LSD (0.05)		20	12	15	18

[a]Fota=Yellow and green foxtail.
[b]Piwe=Redroot and prostrate pigweed.

Table 2. Grain legume response to sulfentrazone.

Treatment	Rate	Crop injury 6/4	Crop injury 6/17	Seed 7/16	yield
	(lb/A	%			(bu/A)
Field pea:					
Untreated	----	0	0	0	42.8
PPI	0.125	0	0	0	52.6
PPI	0.25	0	0	0	58.5
PPI	0.5	0	8	2	56.2
PRE	0.125	0	3	0	60.4
PRE	0.25	0	1	0	57.7
PRE	0.5	0	0	0	53.0
LSD (0.05)		NS	NS	NS	10.5
Lentil:					
Untreated	----	0	0	0	522.5
PPI	0.125	18	18	0	778.5
PPI	0.25	26	17	7	921.0
PPI	0.5	43	57	21	902.0
PRE	0.125	2	4	0	671.9
PRE	0.25	5	28	9	738.4
PRE	0.5	18	58	16	895.9
LSD (0.05)		13	11	12	167.6
Chickpea:					
Untreated	----	0	0	0	511.8
PPI	0.125	0	3	0	489.5
PPI	0.25	11	0	0	636.7
PPI	0.5	9	4	0	679.2
PRE	0.125	0	0	0	558.4
PRE	0.25	0	5	0	792.2
PRE	0.5	0	6	0	1062.5
LSD (0.05)		6	NS	NS	304.0

Weed control generally improved with increased rates of sulfentrazone (Table 1). Sulfentrazone at 0.25 and 0.5 lb/A controlled foxtail 57 to 86%, pigweed 64 to 99%, and wild buckwheat 70 to 99%. PPI sulfentrazone controlled wild mustard 48 to 90% which was considerably higher compared to control with PRE sulfentrazone. Field pea and chickpea injury from sulfentrazone was low or absent (Table 2). Lentil injury increased with higher rates of sulfentrazone. Injury at the low rate of sulfentrazone ranged from 0 to 18% while injury at the high rate was 16 to 58%. Although injury was present, lentil seed yield was generally greater and increased with higher rates of sulfentrazone compared to the untreated check.

Field pea response to herbicides, Carrington, 1999. (Endres, Henson, Schatz and Zwinger) The experiment was conducted to evaluate weed control and field pea tolerance to selected soil- and POST-applied herbicides. The experiment was conducted on a Heimdahl loam soil with 6.6 pH and 3.5% organic matter at the NDSU Carrington Research Extension Center. Plot size was 10 by 25 ft. Herbicide treatments were applied to a 6.67 by 25 ft area with a hand-boom plot sprayer at 10.3 gal/A at 35 psi through 8001 flat fan nozzles. PPI treatments were applied on May 17 with 54 F, 84% RH, 75% cloudy sky, and 14 mph wind and incorporated twice using a field cultivator with a rolling basket set at a 3-inch depth. On May 20, 'Profi' field pea was planted in 7-inch rows at a pure live seed rate of 300,000 seeds/A. PRE treatments were applied on May 21 with 58 F, 68% RH, 20% cloudy sky, and 7 mph wind. POST treatments were applied on June 10 with 55 F, 81% RH, clear sky, and 7 mph wind to 3- to 4-inch tall field pea, 1- to 4-leaf yellow and green foxtail, 1- to 1.5-inch tall common lambsquarters, 1- to 2-inch tall redroot and prostrate pigweed, 2-inch tall wild buckwheat, and 2-to 3-inch tall wild mustard. Soil-applied treatments were visually evaluated for weed control and field pea injury (stand and/or biomass reduction) on June 16 and July 9, and POST treatments on June 23 and July 8. Field pea was harvested with a plot combine on August 24 to determine seed yield. The experiment was a randomized complete block design with four replicates.

Table 1. Weed control in field pea.

Treatment[a]	Rate	2 wk after treatment					4 wk after treatment				
		Fota[b]	Colq	Piwe[c]	Wibu	Wimu	Fota[b]	Piwe[c]	Colq	Wibu	Wimu
	(lb/A)	% control									
Untreated	---	0	0	0	0	0	0	0	0	0	0
PPI											
Ethalfluralin	0.75/										
+ Metribuzin	0.031	70	70	72	76	66	92	91	85	93	97
PRE											
Metribuzin +	0.188										
Sulfentrazone	+0.188	25	69	68	77	48	33	92	79	82	65
Isoxaflutole +	0.069 +										
Flufenacet	0.33	0	0	0	0	25	0	0	0	0	13
Metribuzin/	0.25/										
Imazamox +	0.031 +										
NIS(POST)	0.25%	84	86	95	43	98	91	81	96	41	97
Metribuzin/	0.25/										
Sethoxydim +	0.048 +										
PO(POST)	1.0%	92	15	0	0	80	91	0	0	0	0
POST											
Imazamox+	0.023+										
NIS	0.25%	77	65	91	10	98	78	79	93	0	99
Imazamox+	0.031+										
NIS	0.25%	79	68	87	29	97	86	63	92	0	98
Imazamox +	0.031										
NIS +	+0.25% +										
AMS	2 pt	81	93	98	26	98	93	93	98	24	98
Imazamox +	0.031										
Bentazon +	+0.75										
NIS + AMS	+0.25% +	76	79	96	55	98	76	96	97	0	99
	2 pt										
LSD (0.05)		16	15	11	19	17	19	13	8	15	13

[a] Isoxaflutole+Flufenacet=Epic, a commercial tankmix from Bayer; NIS=Class Preference, a nonionic surfactant from Cenex, St. Paul, MN; AMS=Bronc, ammonium sulfate from Wilbur-Ellis, Fresno, CA; PO=Herbimax, an oil-surfactant from Loveland Industries, Greeley CO.
[b]Fota=Yellow and green foxtail.
[c]Piwe=Redroot and prostrate pigweed.

Table 2. Field pea response to herbicide treatments.

Treatment[a]	Rate	Field pea			
		Injury		Seed	Test
		2 WAT	4 WAT	yield	weight
	lb/A	%		bu/A	lb/bu
Untreated		0	0	37.6	63.4
PPI					
Ethalfluralin + Metribuzin	0.75/0.031	0	0	49.6	63.8
PRE					
Metribuzin + Sulfentrazone	0.188 +0.188	0	0	47.5	63.7
Isoxaflutole + Flufenacet	0.069 +0.33	0	0	39.4	63.6
Metribuzin/ Imazamox + NIS(POST)	0.25/0.031 + 0.25%	0	0	55.0	63.1
Metribuzin/ Sethoxydim + PO (POST)	0.25/0.048 + 1.0%	0	0	48.9	63.8
POST					
Imazamox+ NIS	0.023+ 0.25%	0	0	48.5	63.7
Imazamox+ NIS	0.031+ 0.25%	0	0	52.9	64.0
Imazamox + NIS + AMS	0.031 +0.25% + 2 pt	23	11	49.4	63.5
Imazamox + Bentazon + NIS + AMS	0.031 +0.75+0.25% + 2 pt	0	0	52.5	63.6
LSD (0.05)		1	2	6.4	NS

[a] Isoxaflutole+Flufenacet=Epic, a commercial tankmix from Bayer; NIS=Class Preference, a nonionic surfactant from Cenex, St. Paul, MN; AMS=Bronc, ammonium sulfate from Wilbur-Ellis, Fresno, CA; PO=Herbimax, an oil-surfactant from Loveland Industries, Greeley CO.
[b]Fota=Yellow and green foxtail.
[c]Piwe=Redroot and prostrate pigweed.

Ethalfluralin + metribuzin provided 85 to 97% control of all weeds present in the trial when visually evaluated 4 wk after treatment (WAT)(Table 1). Metribuzin + sulfentrazone controlled broadleaf weeds 65 to 92% but foxtail control was unsatisfactory 4 WAT. Emerged weeds present and dry conditions following application of isoxaflutole + flufenacet likely caused the lack of weed control associated with the treatment. Imazamox at 0.023 lb/A provided similar weed control except common lambsquarters at 4 WAT as the higher rate. The addition of ammonium sulfate (AMS) to imazamox improved common lambsquarters control. Field pea was injured with the tank mixture of AMS and Imazamox + NIS, but seed yield was similar to the highest yield recorded in the trial (Table 2). Foxtail had the highest plant density of weeds speciies present in the trial and pea yield generally was highest with treatments that controlled foxtail.

Weed control in potato. Zollinger and Fitterer. An experiment was conducted near Glyndon, MN to evaluate weed control from herbicides applied PRE and POST. 'Russet Burbank' potato was seeded May 25, 1999, with Admire insecticide applied in-furrow. PRE treatments were applied on June 2, 1999 at 7:00 to 8:00 am with 68 F air, 63 F soil at a 2 to 4 inch depth, 30% relative humidity, 20% clouds, 0 to 5 mph SE wind, dry soil surface, and moist subsoil. Plots were hilled on June 2, 1999. POST treatments were applied on June 14, 1999 at 1:30 to 2:00 pm with 74 F air, 90 F soil surface, 30% relative humidity, 5% clouds, 5 to 8 mph N wind, dry soil surface, moist subsoil, good crop vigor, no dew present, and 1 to 6 inch potato. Weeds present were: 1 to 3 leaf, foxtail (5 to 10/ft^2) and 1 to 2 inch, redroot pigweed (1 to 3/ft^2). Treatments were applied to the center 6.67 feet of 12 by 25 foot plots with a back-pack sprayer delivering 17 gpa at 40 psi through 8002 flat fan nozzles for PRE treatments and delivering 8.5 gpa at 40 psi through 8001 flat fan nozzles for POST applications. The experiment had a randomized complete block design with three replicates per treatment.

Table. Weed control in potato.

		June 14	June 24					July 13		
Treatment[a]	Rate	GR[b]	Fxtl[c]	Rrpw	Colq	Kocz	Corw	Fxtl[c]	Rrpw	Colq
	Product/A	%	% control							
PRE										
Frontier+Sencor	25 fl oz+0.67 lb	0	98	99	99	99	99	98	99	99
Frontier-a+Sencor	13.6 fl oz+0.67 lb	0	98	99	99	99	96	99	99	99
Frontier-a+Matrix	13.6 fl oz+1 oz	0	95	99	99	99	99	94	99	99
Sencor+Eptam	0.67 lb+3/4 pt	0	82	98	99	92	96	90	99	99
Prowl+Sencor	2.4 pt+0.67 lb	0	95	99	98	98	99	98	99	99
Eptam+Matrix	3.4 pt+1 oz	0	90	98	95	96	98	93	98	95
Sencor	0.67 lb	0	90	94	94	82	97	93	98	99
Matrix	1 oz	0	82	95	95	93	99	90	95	95
Spartan	2.67 oz	10	60	96	96	96	98	80	96	99
Spartan	4 oz	3	67	98	98	99	99	83	90	96
Spartan	5 oz	8	65	98	96	98	98	83	95	96
Spartan	8 oz	30	78	99	99	99	99	87	96	98
Spartan+Sencor	4 oz+0.33 lb	5	90	96	98	98	99	92	99	99
Dual II Magnum	1.5 pt	0	96	85	78	85	93	92	95	91
POST										
Select+PO	6 fl oz+1 qt	0	99	0	0	0	0	95	0	0
Select+PO	8 fl oz+1 qt	0	99	0	0	0	0	95	0	0
Select+PO	12 fl oz+1 qt	0	99	0	0	0	0	99	0	0
Select+Sencor+PO	8 fl oz+0.5 lb+1 qt	0	98	99	89	86	99	99	99	99
Poast+PO	24 fl oz+1 qt	0	99	0	0	0	0	80	0	0
Untreated		0	0	0	0	0	0	0	0	0
LSD (0.05)		9	15	6	9	8	4	11	6	5

[a]PO = petroleum oil = Herbimax, Frontier-a = a-isomer of Frontier.
[b]GR = growth reduction.
[c]Fxtl = Grft and Yeft.

Growth reduction rating on June 14 reflects damage due to Colorado potato beetle feeding. An interaction occurred with Admire and Spartan. This interaction inhibited Admire from controlling beetles. As the rate of Spartan increased the effectiveness of Admire decreased allowing more beetle damage to the potato plant. Select showed complete safety to potato. Spartan gave poor to fair green and yellow foxtail control on June 24, but control from Spartan+Sencor was better. Control of redroot pigweed, common lambsquarters, and kochia was lower from Dual II Magnum than other treatments on June 24. Kochia and common ragweed were completely controlled on July 13 (data not shown). Experiment was terminated after severe hail damage.

Potato response to Frontier. Zollinger and Fitterer. An experiment was conducted near Glyndon, ND to evaluate potato response to Frontier applied PRE. 'Russet Burbank' potato was seeded May 25, 1999. Plots were hilled and PRE treatments were applied on June 2, 1999 at 7:00 to 8:00 am with 68 F air, 63 F soil at a 2 to 4 inch depth, 30% relative humidity, 20% clouds, 0 to 5 mph SE wind, dry soil surface, and moist subsoil. Treatments were applied to the center 6.67 feet of 12 by 25 foot plots with a back-pack sprayer delivering 17 gpa at 40 psi through 8002 flat fan nozzles. The experiment had a randomized complete block design with three replicates per treatment.

Table. Potato response to Frontier.

		June 24	June 24			
Treatment[a]	Rate	Potato injury	Rrpw	Colq	Kocz	Corw
	Product/A	%	% control			
Frontier	50 fl oz	0	98	92	97	99
Frontier-a	14 fl oz	0	98	95	97	99
Frontier-a	28 fl oz	0	98	94	98	98
Frontier-a	56 fl oz	0	96	98	99	99
Dual II Magnum	2.7 pt	0	98	95	96	99
Dual II Magnum	5.5 pt	0	98	98	97	99
Sencor DF	1 lb	0	96	96	97	99
Untreated		0	0	0	0	0
LSD (0.05)		NS	2	4	2	1

[a]Frontier-a = a-isomer of Frontier

No potato injury was found throughout the season. Common lambsquarters control ranged from 92 to 98%. All treatments gave excellent control of redroot pigweed, kochia, and common ragweed. The experiment was terminated on July 3 because of a hail storm.

Potato tolerance to Select. Zollinger and Fitterer. An experiment was conducted near Prosper, ND, to evaluate potato tolerance to Select. 'Russet Burbank' potato was seeded June 1, 1999. POST treatments were applied on June 29, 1999 at 10:30 to 11:00 am with 65 F air, 68 F soil surface, 71% relative humidity, 100% clouds, 5 to 8 mph SW wind, wet soil surface, wet subsoil, excellent crop vigor, no dew present, to 4 to 6 inch potato. Treatments were applied to the center 6.67 feet of 12 by 25 foot plots with a back-pack sprayer delivering 8.5 gpa at 40 psi through 8001 flat fan nozzles. The experiment had a randomized complete block design with four replicates per treatment.

		Potato		
Treatment	Rate	July 1	July 6	July 12
	Product/A	% injury		
Select+PO	6floz+1qt	0	0	0
Select+PO	8floz+1qt	0	1	0
Select+PO	12floz+1qt	0	1	0
Select+Sencor DF+PO	8floz+0.5lb+1qt	5	4	0
Poast+PO	24floz+1qt	0	0	0
Untreated		0	0	0
LSD (0.05)		0	3	0

All treatments provided excellent safety to potato. Highest potato injury was 5% with Select+Sencor DF.

Potato dessication with Liberty. Zollinger and Fitterer. An experiment was conducted near Prosper, ND to evaluate potato vine desiccation from Liberty. 'Red Norland' potato was seeded June 1 and one hilling was performed on June 6, 1999. Treatments were applied on August 28, 1999 at 11:00 to 11:30 am with 76 F air, 75 F soil surface, 46% relative humidity, 40% clouds, 0 to 3 mph NW wind, dry soil surface, moist subsoil, and no dew present. The crop was beginning to yellow. Treatments were applied to the center 6.67 feet of the 12 by 25 ft plots with a CO_2 pressurized backpack sprayer delivering 26 gpa at 40 psi through 8003 flat fan nozzles. The experiment had a randomized complete block design with four replicates per treatment.

Table. Potato dessication with Liberty.

Treatment[a]	Rate	Vine dessication					Potato yield
		August 31	September 2	September 8	September 11	September 18	
	fl oz/A	%					cwt/A
Liberty+AMS	48+3 lb	40	49	95	98	100	395
Liberty	48	15	26	94	98	100	407
Diquat	16	48	55	86	95	100	409
Untreated		0	0	0	0	0	504
LSD (0.05)		9	12	6	3	0	81

[a]AMS = ammonium sulfate.

Weather was wet, cloudy, and cool for six days after application. Vine dessication was more rapid from Liberty+ AMS than from Liberty alone. On September 8, vine dessication was similar from Liberty with or without AMS. Liberty+AMS dessicated as rapidly as Diquat and had greater dessication than Diquat on September 8. At September 11, 14 days after treatment, no differences were found between treatments. Vines in untreated plots were killed just prior to harvest. This provided an extra three weeks of growth which contributed to increased yield.

Desicate II performance with adjuvants on potato. Zollinger and Fitterer. An experiment was conducted near Prosper, ND to evaluate Desicate II performance with adjuvants. 'Russet Burbank' potato was seeded June 1, and one hilling was performed on June 6, 1999. Each treatment consisted of split applications at beginning of natural senescence and then 7 days following. The first application was made on September 9, 1999 at 10:00 to 10:30 am with 61 F air, 65 F soil surface, 61% relative humidity, 0% clouds, 5 to 8 mph NW wind, moist soil surface, wet subsoil, and no dew present. Crop was beginning to yellow. Split treatments were applied September 17, 1999 at 2:30 to 3:00 pm with 77 F air, 68 F soil surface, 49% relative humidity, 35% clouds, 8 to 10 mph S wind, moist soil surface, wet subsoil, and no dew present. Treatments were applied to the center 6.67 feet of the 12 by 25 ft plots with a CO_2 pressurized back-pack delivering 26 gpa at 40 psi through 8003 flat fan nozzles. The experiment had a randomized complete block design with three replicates per treatment.

The two week period following applications was wet and cloudy which slowed dessication. Potato leaf tissue was 75 to 88% killed before sequential applications were made. A sequential application of Desicate II or Diquat was needed to desicate stems. Stem dessication tended to be faster with sequential applications of Desicate II+AMS. Two weeks after initial application, significant differences in stem or leaf dessication were not observed from any treatment. Vines in the untreated treatment were killed just prior to harvest. This provided two weeks of extra growth which contributed to the yield increase. Treatments with Desicate II+AMS as the initial application had lower skin set values, which may lead to increased bruising during harvesting.

Table. Desicate II performance with adjuvants on potato.

Treatment[b]	Rate	1 DAT[a]		3 DAT		5 DAT		7 DAT		9 DAT		11 DAT		13 DAT		Potato yield	Skin set
		Stem	Leaf	Stem	Leaf	Stem	Leaf	Stem	Leaf	Stem	Leaf	Stem	Leaf	Stem	Leaf		
	Product/A	% dessication														cwt/A	oz/in
BNS[c]/7 DAT																	
Desicate II+LI 700/Diquat+Activator 90	3 pt+16oz/100 gal/1.5 pt+0.25%	0	5	10	35	17	58	35	83	77	100	82	100	93	100	123	63
Desicate II+AMS/Diquat+Activator 90	3 pt+17lb/100 gal/1.5 pt+0.25%	0	5	10	38	17	57	32	85	72	100	77	100	93	100	124	51
Desicate II+LI 700/Diquat+Activator 90	3 pt+32oz/100 gal/1.5 pt+0.25%	0	10	8	30	15	52	35	78	77	100	80	100	95	100	154	59
Desicate II+LI 700+AMS/Diquat+Activator 90	3 pt+16 oz/100 gal+17lb/100 gal/1.5 pt+0.25%	0	7	10	42	18	58	33	85	63	97	73	98	96	100	114	60
Desicate II/Diquat+Activator 90	3 pt/1.5 pt+0.25%	0	7	8	30	10	48	33	80	82	100	87	100	98	100	141	69
Desicate II+AMS/Desicate II+AMS	3 pt+17lb/100 gal/3 pt+17lb/100 gal	0	5	10	48	18	68	33	88	88	100	93	100	99	100	150	55
Diquat+Activator 90/Diquat+Activator 90	1.5 pt+0.25%/1.5 pt+0.25%	0	17	10	43	13	58	33	75	73	100	80	100	95	100	143	60
Untreated		0	0	0	0	0	0	0	0	0	0	0	0	0	0	164	60
LSD (0.05)		0	4	3	12	11	21	11	24	15	4	16	2	6	0	45	14

[a]DAT = days after final treatment.
[b]LI700 and Activator 90 = nonionic surfactant, AMS = ammonium sulfate.
[c]BNS = beginning of natural senescence.

Post emergence weed control in safflower, Williston 1999. (Riveland and Bradbury) The experiment was conducted to study safflower response to selected herbicides that control broadleaf weeds in other crops. 'Finch' safflower was planted no till in 7 inch rows at 22 lbs/a on May 7. Treatments were applied on June 15 to 5-6 -leaf safflower, 2-6 -leaf green foxtail, 1-3 inch Russian thistle and red root pigweed, and 2-4 inch Kochia with 65 F, 57% RH, mostly cloudy sky, and 5 to 9 mph NNE wind. Plants were damp at the beginning of application but were dry at the end of the 2 hour interval. Treatments were applied with a plot sprayer mounted on a G-Allis Chalmers tractor with wind cones and delivering 8.6 gals/a at 30 psi through 8001 flat fan nozzles to a 6.67 ft wide area the length of 10 by 24 ft plots. The experiment was a randomized complete block design with four replications. The plots were harvested for yield September 22. Weed pressure was light.

Table 1: Crop injury and weed control data.

Treatment[a]	Rate	Crop injury[b] July	Crop injury[b] Sept.	Grft	Rrpw	Ruth
	oz/a ai	---- % ----		----%	control----	
Thif&trib+Activator 90	0.225+0.25%	0	2	0	81	96
Thif&trib+Activator 90	0.1875+0.25%	0	2	0	85	93
Thif&trib+Activator 90	0.15+0.25%	0	0	0	88	94
Thif&trib+Activator 90	0.125+0.25%	0	1	0	79	96
Thif&trib+Activator 90	0.094+0.25%	0	1	0	87	93
Thif&trib+seth+Destiny	0.125+3+0.25 gpa	0	4	94	95	96
Thif&trib+seth+Destiny	0.15+3+0.25 gpa	1	4	94	95	98
Metsulfuron+Activator 90	0.06+0.25%	7	23	16	97	98
Metsulfuron+Activator 90	0.04+0.25%	2	13	0	94	98
Mets+seth+Destiny	0.04+3+0.25 gpa	6	26	91	97	98
Clsu&mets+Activator.90	0.1875+0.25%	6	25	58	95	98
Clsu&mets+Activator.90	0.15+0.25%	9	24	40	90	96
Clsu&mets+Activator 90	0.125+0.25%	3	10	25	94	96
Clsu&mets+Activator.90	0.1875+0.125%	2	11	66	95	97
Metsulfuron+Activator.90	0.05+0.25%	1	10	8	95	95
Quizalofop-P+Destiny	0.88+1%	0	1	95	0	0
Thif&trib+quiz+Destiny	0.125+0.88+1%	1	1	93	94	97
Clsu&mets+seth+Destiny	0.125+3+0.25 gpa	9	36	89	97	97
Mets+quiz+Destiny	0.04+0.88+1%	3	19	90	95	96
Thif&trib+mets+Activator.90	0.094+0.04+0.25%	4	14	0	93	85
Fluroxypyr	0.67 (2)	0	6	0	0	44
Ethametsulfuron+Activator.90	0.2475(0.33)+0.25	0	3	0	66	34
Sethoxydim+Destiny	3+0.25 gpa	0	0	97	0	0
Weedy Control	0	0	0	0	0	0
EXP MEAN		2	10	40	75	79
C.V. %		100	71	27	14	13
LSD (0.05)		3	10	15	14	15

[a]- Destiny - MSO from Cenex Activator 90 a NIS from Loveland, UAP.
gpa= gallon per acre

[b] - Crop injury visually rated July 11 and September 21.

Table 2: Agronomic data.

Treatment[a]	Rate	Test Weight	Seed Oil	Crop Yield	Crop Injury[b] July	Sept
	oz/a ai	lbs/b	%OD#	lbs/a	---- %	---
Thif&trib+Activator 90	0.225+0.25%	43.9	34.8	1082	0	2
Thif&trib+Activator 90	0.1875+0.25%	43.7	35.0	1221	0	2
Thif&trib+Activator 90	0.15+0.25%	43.7	35.0	1071	0	0
Thif&trib+Activator 90	0.125+0.25%	44.2	35.3	1177	0	1
Thif&trib+Activator 90	0.094+0.25%	44.0	35.5	1091	0	1
Thif&trib+seth+Destiny	0.125+3+0.25 gpa	44.2	34.9	1153	0	4
Thif&trib+seth+Destiny	0.15+3+0.25 gpa	44.0	35.1	1261	1	4
Metsulfuron+Activator 90	0.06+0.25%	43.7	34.9	1092	7	23
Metsulfuron+Activator 90	0.04+0.25%	43.8	35.0	1101	2	13
Mets+sethoxydim+Destiny	0.04+3+0.25 gpa	44.0	34.7	966	6	26
Clsu&mets+Activator 90	0.1875+0.25%	43.7	34.6	1022	6	25
Clsu&mets+Activator 90	0.15+0.25%	43.5	34.5	1128	9	24
Clsu&mets+Activator 90	0.125+0.25%	43.7	34.8	1209	3	10
Clsu&mets+Activator 90	0.1875+0.125%	43.7	34.7	1162	2	11
Metsulfuron+Activator 90	0.05+0.25%	43.8	34.7	1102	1	10
Quizalofop+Destiny	0.88+1%	43.3	34.7	1177	0	1
Thif&trib+quiz+Destiny	0.125+0.88+1%	43.6	35.0	1204	1	1
Clsu&mets+seth+Destiny	0.125+3+0.25 gpa	44.0	34.8	994	9	36
Thif&trib+mets+Activator.90	0.094+0.04+0.25%	43.8	35.1	1131	3	19
Mets+Quiz+Destiny	0.04+0.88+1%	43.7	34.6	1121	4	14
Fluroxypyr	0.67	43.5	34.5	1148	0	6
Ethametsulfuron+Activator 90	0.2475+0.25%	43.5	35.1	1153	0	3
Seth+Destiny	3+0.25 gpa	44.1	35.2	1217	0	0
Weedy Control	0	44.1	35.1	1114	0	0
EXP MEAN		43.8	34.9	1129	2	10
C.V. %		1.2	1.4	10	100	71
LSD (0.05)		NS	NS	154	3	10

[a]- Destiny-MSO from Cenex Activator 90 a NIS from Loveland, UAP.
G = gallon

[b]- Crop injury visually rated July 11 and September 21.

- % oil content on an oven dry basis and determined with an NMR machine.

None of the treatments resulted in statistically significant yield increases or reductions compared to the weedy control. Weed pressure was light. All application rates of chlorosulfuron&metsulfuron and metsulfuron caused some crop injury. These two herbicides in combination with sethoxydim caused the highest crop injury ratings and tended to reduce yields by 10 to 15%. No crop injury occurred when Thifensulfuron&tribenuron was applied alone or in combination with sethoxydim or quizalofop-P and the combinations tended to increase yields slightly compared to the weedy control.

Weed control in sunflower. Brian Jenks, Kent McKay, and Gary Willoughby. We evaluated several registered and experimental herbicides for weed control in sunflower. Sunflower (CL803) was seeded May 20 into 30-inch rows at 20,000 seeds/A. Herbicide treatments were applied preplant incorporated (May 19) or preemergence (May 21). Only metolachlor, flumioxazin, and sulfentrazone were applied PRE. Individual plots were 10 x 30 ft arranged in a RCBD with three replications. PPI and PRE treatments were applied with a CO_2 pressurized bicycle sprayer delivering 20 gpa at 30 psi using XR80015 flat fan nozzles. The crop was not harvested due to hail and wind damage.

Flumioxazin caused initial crop stunting and slight stand reduction. By mid-season the crop appeared to catch up with the sunflower in the other treatments. Flumioxazin provided good control of mustard species, kochia, lambsquarters, and pigweed; but was weak on wild buckwheat and foxtails. Sulfentrazone and flumioxazin were active on the same weeds, but control with flumioxazin was generally equal to or slightly higher than sulfentrazone. Based on this and other studies, it appears that a postemergence grass herbicide will be needed in combination with flumioxazin or sulfentrazone.

Table. Weed control in sunflower.

		June 16						September 20					
Treatment	Rate	Must[a]	Kocz	Wibw	Colq	Rrpw	Fxtl[b]	Must[a]	Kocz	Wibw	Colq	Rrpw	Fxtl[b]
	lb/A	Control (%)						Control (%)					
Pendimethalin	1.5	25	93	80	98	93	92	20	80	47	93	89	94
Trifluralin	1.0	17	97	68	100	92	93	17	87	47	96	91	96
Ethalfluralin	1.125	30	100	82	100	93	100	18	95	70	98	92	97
Ethalfluralin+ EPTC	0.56 + 1.3	42	92	73	98	93	93	27	83	53	96	92	97
Metolachlor	1.9	90	27	0	73	78	96	86	17	0	70	70	88
Flumioxazin	0.094	99	97	82	97	100	75	96	91	53	90	93	40
Sulfentrazone	0.125	90	97	27	77	63	43	87	82	30	67	63	30
Sulfentrazone	0.188	90	97	57	92	77	50	87	88	33	73	70	35
Sulfentrazone	0.25	94	98	57	95	88	57	92	92	37	75	77	33
Untreated		0	0	0	0	0	0	0	0	0	0	0	0
LSD		15	7	15	16	10	11	6	8	17	11	9	13
CV		17	6	18	12	9	10	8	7	29	9	8	14

[a] Must=Mustard species field pennycress and shepherdspurse

[b] Fxtl=Green and yellow foxtail

Soil applied weed control in sunflower. Zollinger and Fitterer. An experiment was conducted, in Oriska, ND to evaluate sunflower response to PPI and PRE herbicides. PPI treatments were applied and incorporated to a 2 inch depth on May 31, 1999 at 12:00 to 1:00 pm with 55 F air, 57 F soil at a 2 to 4 inch depth, 45% relative humidity, 25% clouds, 5 to 11 mph N wind, moist soil surface, and moist subsoil. Cargill 'F914313' sunflowers were planted and PRE treatments were applied on May 31, 1999 at 1:00 to 2:00 pm with 55 F air, 57 F soil at a 2 to 4 inch depth, 45% relative humidity, 25% clouds, 5 to 11 mph N wind, moist soil surface, and moist subsoil. Treatments were applied to the center 6.67 ft of the 10 by 40 ft plots with a bicycle-wheel-type sprayer equipped with a wind shield delivering 17 gpa at 40 psi through 8002 flat fan nozzles. The experiment had a randomized complete block design with three replicates per treatment.

Table. Soil applied weed control in sunflower (Zollinger and Fitterer).

Treatment	Rate	Sunflower			June 22					July 6			
		June 15	June 22	July 6	Fxtl[a]	Wimu	Colq	NS[b]	Lisa[c]	Fxtl	Wimu	Colq	Hans
	(Product/A)	(% injury)			(% control)					(% control)			
PPI													
Spartan	3.2 oz	0	2	0	70	87	96	96	0	53	60	96	42
Spartan	4.25 oz	2	1	0	77	88	98	98	0	73	73	99	52
Spartan	5.33 oz	5	5	0	78	93	95	98	0	70	77	99	63
Spartan+Treflan	3.2 oz+1.5 pt	3	1	0	88	72	99	88	10	75	43	93	67
Spartan+Treflan	4.25 oz+1.5 pt	0	0	0	82	90	95	91	20	80	50	99	68
Spartan+Treflan	5.33 oz+1.5 pt	7	3	0	83	90	97	91	32	82	57	99	63
Treflan	1.5 pt	0	0	0	73	77	95	30	17	60	27	83	20
Treflan	2 pt	0	0	0	70	83	93	42	7	68	20	90	32
Prowl	2.4 pt	0	0	0	65	53	90	30	10	73	43	83	47
Prowl	3.6 pt	0	0	0	73	73	93	67	22	77	47	90	53
PRE													
Spartan	8 oz	2	0	0	77	93	97	88	0	83	65	99	65
Spartan+Dual II Magnum	4.25 oz+2 pt	0	0	0	91	87	91	82	0	92	56	93	83
Dual II Magnum	2 pt	0	0	0	80	55	87	58	0	92	20	57	43
Milestone	1.25 oz	0	0	0	53	53	82	63	0	53	43	60	43
Milestone	1.6 oz	0	0	0	63	68	83	72	0	60	43	90	70
Milestone	1.88 oz	0	0	0	73	80	87	85	17	68	50	96	70
Milestone+Prowl	1.25 oz+3 pt	2	0	10	60	78	93	90	37	60	43	95	57
Milestone+Prowl	1.6 oz+3 pt	0	0	17	67	83	93	92	40	63	50	98	63
Untreated		0	0	0	0	0	0	0	0	0	0	0	0
LSD (0.05)		5	3	7	8	14	11	6	14	16	15	15	16

[a]Fxtl = Grft and Yeft.
[b]NS = Ebns and Hans.
[c]Lisa = lanceleaf sage.

Significant rainfall did not occur for 3 to 4 weeks after application. Sunflower injury from Spartan at 5.33 oz/A alone or with Treflan was expressed as interveinal yellowing and puckering. At July 6, all treatments gave 0% lanceleaf sage control. At July 6 all treatments gave 100% eastern black nightshade control except Treflan and Prowl applied alone which provided near 0% control (data not shown). Addition of Treflan to Spartan applied PPI improved foxtail control. Spartan applied PRE at 8 oz/A gave similar weed control as 5.33 oz/A applied PPI. With the exception of wild mustard control, Spartan+Dual II Magnum provided excellent weed control. Milestone applied alone or with Prowl did not give adequate weed control.

Sunflower cultivar response to herbicides. Zollinger and Fitterer. An experiment was conducted at Oriska, ND to evaluate sunflower response to herbicides applied at PPI and PRE stages. PPI treatments were applied and incorporated to a 2 inch depth on May 31, 1999 at 4:30 to 5:00 pm with 64 F air, 62 F soil at a 2 to 4 inch depth, 45% relative humidity, 60% clouds, 3 to 7 mph NE wind, moist soil surface, and moist subsoil. Two coded Dekalb hybrids and eight coded Dekalb inbred sunflower cultivars were planted and PRE treatments were applied on May 31, 1999 at 7:30 to 9:00 pm with 61 F air, 63 F soil at a 2 to 4 inch depth, 45% relative humidity, 100% clouds, 0 to 5 mph NE wind, moist soil surface, and moist subsoil. Treatments were applied to the center 6.67 ft of the 10 by 100 ft plots with a bicycle-wheel-type sprayer equipped with drift cones delivering 17 gpa at 40 psi through 8002 flat fan nozzles. The experiment had a randomized complete block with split block design with three replications per treatment.

Herbicide rates used were X and 2X based on soil type at study location. Commercial designations of sunflower lines were not provided to researchers. Sunflower cultivars were grouped and planted according to seed size. Seed from H1, H2, H3 sunflower cultivars had large seed, H4, H11, H12, and CAR1 had medium size seed, and H6, H7, H8 had small seed. No rainfall occurred between herbicide application and June 22 evaluation. At the June 22 evaluation, sunflower injury ranged from 0 to 16% but very little sunflower response was observed due to lack herbicide activation by rainfall. Injury symptoms were general yellowing and puckering. 'CAR 1' exhibited the most injury and chlorosis across the entire treated area. Despite lack of rain after application most soil-applied grass herbicides controlled green and yellow foxtail. Most herbicides at 1X and 2X controlled wild mustard, common lambsquarters, and kochia. Only sulfentrazone (PPI and PRE) 2X, acetochlor, San 582H, and flurtamone &aclonifen controlled biennial wormwood. At July 6, no sunflower injury greater than 10% occurred from herbicides at 1X. Acetochlor, San 582H, flumioxazin, oxyfluorfen, and sulfentrazone herbicides at 2X caused significant injury to H1, H2, H3, H6, and H8 sunflower cultivars. Injury symptoms were primarily stunting and chlorosis. Sunflower cultivars with large and medium seed were injured less than cultivars with small seed from herbicides at 2X rates. Sunflower hybrids were injured less than inbreds at 2X herbicide rates. No delay in sunflower flowering resulted from herbicides at 1X and 2X or reduced sunflower height from herbicides at 1X rate. Acetochlor and sulfentrazone PRE at 2X rates reduced sunflower height as compared to sunflower treated with herbicides at 1X rates. Reduced plant heights (Table 2) from untreated sunflower plants were caused by weed competition.

Ethalfluralin =	Sonalan
Sulfentrazone =	Spartan
Pendimethalin =	Prowl
Metolachlor =	Dual II Magnum
Dimethenamid =	Frontier
Acetochlor =	Surpass
Flumioxazin =	Valor
Azafeniden =	Milestone
Oxyfluorfen =	Goal
Oxiadiazon =	Ronstar
Prometryne =	Prometryn
Oxadiargyl =	Raft
Flurochloridone =	Racer
Flurtamone & aclonefin =	Nikyl

Table 1. Weed control and sunflower cultivar injury (Zollinger and Fitterer).

Treatment	Rate	June 22	June 22					July 6 (coded sunflower line)									
		Sunflower	Fxtl[a]	Biww[a]	Colq	Wimu	Kocz	H3	H2	H1	H4	H12	H11	CAR1	H6	H7	H8
	(lb/A)	(% injury)	(% control)					(% injury)									
PPI																	
Ethalfluralin	1.2	0	82	55	99	55	93	0	0	0	0	0	3	0	0	0	7
Ethalfluralin	2.4	2	96	77	99	67	99	3	0	2	0	3	5	0	13	0	20
Sulfentrazone	0.25	0	87	87	99	99	99	3	2	0	0	0	0	2	3	7	3
Sulfentrazone	0.5	0	88	97	99	98	99	27	13	5	7	7	12	13	17	17	13
PRE																	
Pendimethalin	1.5	0	82	35	99	48	99	0	0	0	0	0	0	0	0	0	0
Pendimethalin	3.0	0	88	57	99	58	99	0	0	0	0	0	0	0	0	0	0
S-metolachlor	1.9	0	93	27	83	25	99	5	0	5	2	2	0	0	5	0	0
S-metolachlor	3.8	2	92	41	99	43	99	3	0	3	0	0	0	0	0	0	0
Dimethenamid	1.5	0	94	69	99	43	99	2	3	0	0	0	0	0	13	0	3
Dimethenamid	3.0	8	93	92	99	66	99	15	8	13	3	10	8	8	18	3	22
Acetochlor&safener	3.0	2	96	90	99	65	96	5	3	7	5	5	10	3	18	2	7
Acetochlor&safener	6.0	16	95	90	99	78	99	20	17	15	13	10	18	8	40	13	30
Sulfentrazone	0.25	2	82	87	99	96	99	5	0	0	0	0	0	0	5	0	0
Sulfentrazone	0.5	9	95	93	99	98	99	40	23	20	15	17	8	10	25	13	8
Flumioxazin	0.063	0	77	65	89	99	99	7	2	0	0	0	2	0	10	0	2
Flumioxazin	0.125	0	75	72	99	98	99	15	10	7	5	7	15	7	30	13	13
Azafenidin	0.125	0	80	82	66	98	99	0	0	3	3	0	3	0	10	3	0
Azafenidin	0.25	2	88	88	99	99	99	5	2	3	5	3	0	2	15	0	3
Oxyfluorfen	0.25	0	88	82	99	98	96	0	0	0	0	0	0	0	0	0	0
Oxyfluorfen	0.5	2	95	88	99	99	99	20	10	5	10	10	8	12	25	12	8
Oxadiazon	0.67	3	83	60	99	85	70	0	3	0	0	0	0	0	0	0	0
Oxadiazon	1.33	7	85	75	99	95	90	7	7	0	3	0	0	10	5	10	10
Prometryn	0.45	2	30	27	62	79	99	0	2	0	0	3	0	0	0	0	0
Prometryn	0.9	2	73	60	99	96	99	0	0	3	0	0	0	0	10	0	0
Oxadiargyl	0.32	0	87	47	99	98	99	0	0	0	0	0	0	0	0	0	0
Oxadiargyl	0.64	2	88	82	99	96	99	0	0	0	0	0	0	0	0	0	0
Flurochloridone	0.67	2	77	60	99	97	99	0	2	0	0	0	0	0	7	0	0
Flurochloridone	1.33	2	87	60	99	99	99	0	0	0	0	0	0	0	8	0	0
Flurtamone&aclonifen	0.51&1.	0	87	92	99	99	99	0	0	3	5	0	2	3	13	7	3
Flurtamone&aclonifen	1.0&3.8	6	93	95	99	96	99	10	3	8	2	5	5	0	18	0	7
Untreated		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LSD (0.05)		4	10	15	13	7	9	9	10	9	6	7	9	7	11	7	10

[a]Fxtl = Grft and Yeft, Biww = biennial wormwood..

Table 2. Sunflower flowering date and height (Zollinger and Fitterer).

Treatment	Rate	Sunflower flowering (coded line)										Sunflower height at R5.5 (coded line)									
		H3	H2	H1	H4	H12	H11	CAR1	H6	H7	H8	H3	H2	H1	H4	H11	H12	CAR1	H6	H7	H8
	(lb/A)	(days to R5.1)										(inches)									
PPI																					
Ethalfluralin	1.2	70	72	70	72	71	66	66	71	71	77	70	47	59	64	69	71	55	54	63	58
Ethalfluralin	2.4	69	72	69	70	71	67	66	71	72	76	71	49	54	64	72	73	55	56	59	57
Sulfentrazone	0.25	68	71	67	71	71	66	66	71	71	75	63	45	57	66	70	72	52	61	61	54
Sulfentrazone	0.5	72	71	68	72	71	66	66	72	74	79	64	45	57	61	71	72	52	62	59	50
PRE																					
Pendimethalin	1.5	69	71	68	71	70	66	66	71	71	77	68	47	58	65	71	75	50	60	63	58
Pendimethalin	3.0	68	71	67	71	71	66	66	72	72	76	67	47	60	67	73	70	57	60	67	56
S-metolachlor	1.9	69	71	69	71	70	66	67	71	71	76	66	47	56	66	74	74	56	62	66	60
S-metolachlor	3.8	68	70	68	72	71	66	66	71	71	75	70	50	55	64	73	74	54	61	65	58
San 582H	1.5	68	71	67	71	70	67	67	71	71	77	66	48	56	60	74	72	51	63	63	58
San 582H	3.0	71	72	70	71	69	66	66	75	72	80	65	47	54	61	75	74	53	56	62	53
Acetochlor&safener	3.0	70	72	70	72	71	67	66	73	75	78	67	50	58	63	71	70	50	60	62	45
Acetochlor&safener	6.0	70	71	71	72	71	69	67	74	75	79	63	46	54	61	74	74	48	56	60	49
Sulfentrazone	0.25	69	70	70	71	71	66	66	71	72	78	70	47	56	64	72	74	51	59	63	52
Sulfentrazone	0.5	72	72	71	71	70	67	67	72	74	78	66	45	52	61	70	72	52	58	54	53
Flumioxazin	0.063	71	71	68	71	72	67	66	71	72	76	69	49	55	64	70	77	55	60	63	53
Flumioxazin	0.125	70	71	67	72	69	68	66	72	73	78	67	48	56	64	71	75	51	57	61	60
Azafenidin	0.125	68	70	67	71	71	65	66	70	71	78	67	48	57	66	74	73	53	59	63	58
Azafenidin	0.25	69	71	67	72	70	65	65	72	71	77	67	49	55	63	71	73	50	58	59	57
Oxyfluorfen	0.25	70	71	68	71	69	66	66	72	73	76	68	46	55	65	68	73	50	55	64	53
Oxyfluorfen	0.5	69	71	68	71	69	65	65	72	74	80	65	47	54	67	72	72	46	54	61	52
Oxadiazon	0.67	69	71	69	72	70	66	67	74	76	79	67	44	55	63	70	76	52	57	58	53
Oxadiazon	1.33	68	70	69	71	70	66	67	73	73	80	65	45	55	61	67	72	46	54	55	50
Prometryn	0.45	67	70	67	70	70	66	66	71	71	75	63	46	57	63	67	70	54	56	60	50
Prometryn	0.9	68	71	67	71	69	66	66	72	74	75	63	41	48	57	63	68	48	49	62	51
Oxadiargyl	0.32	69	69	68	71	71	66	66	71	71	46	66	50	50	60	66	75	46	51	63	55
Oxadiargyl	0.64	68	69	68	71	71	66	65	71	71	75	66	49	54	61	69	68	50	57	60	53
Flurochloridone	0.67	68	72	68	71	69	66	65	71	71	76	64	44	54	59	70	76	46	56	64	54
Flurochloridone	1.33	69	71	67	71	69	66	66	73	75	78	68	47	53	60	69	67	54	59	60	51
Flurtamone&aclonifen	0.51&1.9	68	71	67	72	70	66	66	71	74	77	67	47	52	59	67	67	53	53	58	51
Flurtamone&aclonifen	1.0&3.8	69	71	68	71	71	66	66	71	71	78	62	44	55	58	67	69	49	54	55	52
Untreated		67	70	67	72	70	67	66	71	71	76	55	47	50	59	68	70	52	58	62	51
LSD (0.05)		3	3	3	1	2	2	2	3	4	3	3	2	2	3	1	4	2	4	2	4

Planting depth and moisture effect on sunflower tolerance to Valor. Zollinger and Fitterer. An experiment was conducted near Prosper, ND, to evaluate sunflower response to Valor under an irrigated and non-irrigated environment. Two rows of Cargill 'SF187' and Seeds 2000 'Bigfoot' sunflowers were planted on June 8, 1999. PRE treatments were applied on June 9, 1999 at 8:30 to 9:00 am with 75 F air, 68 F soil at a 2 to 4 inch depth, 70% relative humidity, 95% clouds, 0 to 3 mph N wind, dry soil surface, and moist subsoil. Treatments were applied to the 10 by 40 ft plots with a bicycle-wheel type sprayer equipped with a 10 ft boom and drift cones delivering 17 gpa at 40 psi through 8002 flat fan nozzles. The experiment had a randomized complete block design with three replicates per treatment.

Table 1. Effect of planting depth and moisture on sunflower tolerance to Valor - Dry.

		June 22	June 22		June 29		July 5	
Treatment	Rate	Snfl	Fxtl	Rrpw	SF187	Bigfoot	SF187	Bigfoot
	Product/A	% injury	— % control —		% injury			
1 inch planting depth								
Untreated		0	0	0	0	0	0	0
Valor	2oz	5	50	87	9	9	8	5
Valor	3oz	7	50	87	17	17	12	12
Valor	4oz	9	45	93	30	30	22	23
2 inch planting depth								
Untreated		0	0	0	0	0	0	0
Valor	2oz	7	60	45	10	10	10	8
Valor	3oz	5	57	96	20	20	22	23
Valor	4oz	16	63	87	37	37	28	28
LSD (0.05)		3	12	34	6	6	7	8

Table 2. Effect of planting depth and moisture on sunflower tolerance to Valor - Irrigated

		June 22	June 22		June 29		July 6	
Treatment	Rate	Snfl	Fxtl	Rrpw	SF187	Bigfoot	SF187	Bigfoot
	Product/A	% injury	— % control —		% injury			
1 inch planting depth								
Untreated		0	0	0	0	0	0	0
Valor	2oz	4	75	94	11	11	7	8
Valor	3oz	7	87	95	18	18	12	15
Valor	4oz	7	82	98	28	28	22	23
2 inch planting depth								
Untreated		0	0	0	0	0	0	0
Valor	2oz	7	82	93	14	14	8	13
Valor	3oz	8	73	88	25	25	23	27
Valor	4oz	11	70	88	33	33	32	27
LSD (0.05)		5	20	12	0	7	6	8

Study was to be conducted under dry and irrigated conditions. Due to over 1 inch of rainfall in the two weeks following application both studies received the same amount of precipitation. Therefore both studies were treated the same. Initially sunflower injury was not significantly different between the 1 inch and 2 inch planting depth when comparing respective treatments. On July 5, sunflower injury was slightly higher for sunflowers planted 2 inches deep over respective treatments at a 1 inch planting depth. Sunflower injury increased with increased Valor rates regardless of planting depth.

Sunflower tolerance to Valor. Zollinger and Fitterer. An experiment was conducted near Prosper, ND, to evaluate sunflower response to PRE and POST herbicides. Twenty one days before planting (dbp) treatments were applied on May 20, 1999 at 5:00 pm with 79 F air, 62 F soil at a 2 to 4 inch depth, 34% relative humidity, 50% clouds, 5 to 10 mph NW wind, dry soil surface, and moist subsoil. 15 days before planting treatments were applied on May 28, 1999 at 1:00 to 1:30 pm with 83 F air, 61 F soil at a 2 to 4 inch depth, 25% relative humidity, 90% clouds, 8 to 15 mph S wind, dry soil surface, and moist subsoil. Two rows of Cargill 'SF187' and two rows of Interstate '6111A' sunflowers were planted in each plot and PRE treatments were applied on June 8, 1999 at 4:30 to 5:30 pm with 89 F air, 100 F soil surface, 50% relative humidity, 0% clouds, 10 to 15 mph SE wind, dry soil surface, and moist subsoil. POST treatments were applied on June 29, 1999 at 9:00 to 10:00 am with 65 F air, 68 F soil surface, 71% relative humidity, 100% clouds, 5 to 8 mph SW wind, wet soil surface, wet subsoil, good crop vigor, no dew present, and 4 to 6 lf sunflower. Weeds present were 6 to 12 inch, (2 to 5/ft^2) foxtail and 4 to 6 inch (5 to 10/ft^2) redroot pigweed. Treatments were applied to the 10 by 40 ft plots with a bicycle-wheel type sprayer equipped with a 10 ft boom and drift cones delivering 17 gpa at 40 psi through 8002 flat fan nozzles. The experiment had a randomized complete block design with three replicates per treatment.

Sunflower injury at June 2 decreased as application timing of Valor was closer to planting date. Sunflower injury at June 29 and June 6 increased as application date of Valor approached planting date. Authority caused slight sunflower injury on June 22 but was safe at all applications dates later in the season. Overall, Interstate 6111A seemed to be slightly less tolerant than Cargill SF187 to Valor. No injury was found at the 14 day after application or later ratings. Weed control was similar from all treatments regardless of application timing.

Treatment	Rate	June 22	June 22		June 29		July 6	
		Snfl	Fxtl	Rrpw	SF187	6111A	SF187	6111A
	Product/A	% injury	— % control —		% injury			
21dbp/PRE								
Valor/Roundup Ultra+AMS	3oz/1.5pt+2.5lb	5	87	96	3	6	7	8
Valor/Roundup Ultra+AMS	4oz/1.5pt+2.5lb	7	83	94	2	5	10	12
21dbp/PRE/POST								
Valor/Roundup Ultra+AMS/Select+PO	3oz/1.5pt+2.5lb/7floz+1pt	15	85	94	5	3	10	10
15dbp								
Valor+Roundup Ultra+AMS	2oz+1.5pt+2.5lb	9	87	93	2	3	18	15
Valor+Roundup Ultra+AMS	3oz+1.5pt+2.5lb	10	87	98	3	7	13	13
Valor	3oz	7	85	99	3	6	12	13
Authority	4oz	2	80	96	6	1	0	0
Authority	8oz	3	87	97	0	0	5	3
15dbp/POST								
Valor+Roundup Ultra+AMS/Select+PO	3oz+1.5pt+2.5lb/7floz+1pt	7	93	97	0	11	15	15
Roundup Ultra+AMS/Select+Asana XL+PO	1.5pt+2.5lb/7floz+5.8oz+1pt	3	83	98	5	0	0	0
Authority/Assure II+PO	4oz/9oz+1pt	2	88	97	0	0	0	0
Authority/Assure II+PO	8oz/9oz+1pt	3	83	97	0	0	0	0
PRE								
Roundup Ultra+AMS/Poast+PO	1.5pt+2.5lb/1pt+1pt	2	90	95	0	0	0	0
Roundup Ultra+AMS	1.5pt+2.5lb	3	92	93	0	0	0	0
Valor+Roundup Ultra+AMS	2.0oz+1.5pt+2.5lb	7	87	98	12	20	15	13
Valor+Select+PO	2.0oz+6floz+1pt	5	87	93	11	19	12	17
PRE/POST								
Authority/Assure II+PO	4oz/9oz+1%	5	85	96	0	0	0	0
Untreated		0	0	0	0	0	0	0
LSD (0.05)		5	10	6	4	5	4	5

Imidazolinone resistant sunflower tolerance. Zollinger and Fitterer. An experiment was conducted, near Prosper, ND to evaluate imidazolinone resistant sunflower response to POST applied imidazolinone herbicides. A hybrid imi-sunflower line was planted on June 8, 1999. EPOST treatments were applied on July 1, 1999 at 1:30 pm with 69 F air, 80 F soil surface, 69% relative humidity, 65% clouds, 3 to 5 mph N wind, dry soil surface, moist subsoil, excellent crop vigor, and no dew present to 4 to 6 lf sunflower. Treatments were applied to the center 6.67 ft of the 10 by 25 ft plots with a bicycle-wheel-type sprayer equipped with a wind shield delivering 8.5 gpa at 40 psi through 8001 flat fan nozzles. The experiment had a randomized complete block design with three replicates per treatment.

Table. Imidazolinone resistant sunflower tolerance. (Zollinger and Fitterer).

Treatment[a]	Rate	July 9			July 16		
		Injury	Chlorosis	GR[b]	Injury	Chlorosis	GR[b]
	(Product/A)	(%)					
Raptor+NIS+28% UAN	4 fl oz+0.25%+2 qt	3	0	0	0	0	0
Raptor+NIS+28% UAN	8 fl oz+0.25%+2 qt	7	0	0	0	0	0
Raptor+NIS+28% UAN	12 fl oz+0.25%+2 qt	13	8	7	7	1	7
Raptor+Scoil	12 fl oz+1.5 pt	10	5	3	12	1	5
Pursuit+NIS+28% UAN	1.08 fl oz+0.25% v/v+2qt	3	0	0	0	0	0
Pursuit+NIS+28% UAN	2.16 fl oz+0.25% v/v+2qt	0	0	0	0	0	0
Lightning+NIS+28% UAN	1.28 oz+0.25%v/v+2qt	0	0	0	0	0	0
Lightning+NIS+28% UAN	2.56 oz+0.25% v/v+2qt	1	0	0	0	0	0
Untreated		0	0	0	0	0	0
Handweeded Check		0	0	0	0	0	0
LSD (0.05)		7	5	4	7	1	2

[a]NIS = non ionic sufactant; UAN = urea ammonium nitrate; Scoil = methylated seed oil.
[b]GR = growth reduction.

Raptor was applied at X, 2X, and 3X rates with NIS+28% nitrogen and at 3X with Scoil. Pursuit and Lightning were applied at X and 2X. On July 6, injury did not exceed 13% for any treatment. On July 16, injury was observed only with Raptor at 12 fl oz and did not exceed 12% injury. At later evaluations (data not shown), chlorosis had disappeared and stunted plants had recovered.

Sunflower tolerance to Select. Zollinger and Fitterer. An experiment was conducted near Fargo, ND, to evaluate sunflower response to POST herbicides. Pioneer '6111A' sunflowers were planted on June 11, 1999. POST treatments were applied on July 13, 1999 at 8:30 to 9:00 am with 70 F air, 75 F soil surface, 83% relative humidity, 60% clouds, no wind, dry soil surface, moist subsoil, excellent crop vigor, no dew present, 2 to 4 lf sunflower. No weeds were present. Treatments were applied to the 10 by 40 ft plots with a backpack type sprayer equipped with a 6.67 ft boom delivering 8.5 gpa at 40 psi through 8001 flat fan nozzles. The experiment had a randomized complete block design with three replicates per treatment.

Treatment	Rate	Sunflower
	Product/A	% injury
Select+PO	6floz+1qt	0
Select+PO	8floz+1qt	0
Select+PO	12floz+1qt	0
Poast+PO	16floz+1qt	0
Untreated		0
LSD (0.05)		0

No injury was found for any treatment at any rate.

Sethoxydim + imazamethabenz tank mixtures in sunflower, Carrington, 1999. (Endres, Henson, and Schneider) The experiment was conducted to evaluate sunflower tolerance and weed control with sethoxydim + imazamethabenz tank mixtures. The experiment was conducted on a Heimdahl loam soil with 7.8 pH and 3.1% organic matter at the NDSU Carrington Research Extension Center. PPI ethalfluralin at 1.0 lb/A was applied across the test area. On May 27, Cargill SF270 oilseed sunflower was planted in 30-inch rows at a rate of about 30,000 PLS/A. Sunflower density was thinned on June 16 to 20,000 plants/A. The experiment was a randomized complete block design with four replicates. Herbicide treatments were applied to the center 6.67 ft of 10 by 25 ft plots with a hand-boom plot sprayer at 10.3 gal/A at 35 psi through 8001 flat fan nozzles. The POST 1 treatment were applied on June 11 with 65 F, 65% RH, 100% cloudy sky, and 7 mph wind to VC- to V2-stage sunflower and cotyledon-stage wild mustard. POST 2 treatments was applied on June 28 with 63 F, 55% RH, 60% cloudy sky, and 12 mph wind to V6- to V8-stage sunflower and 1-inch tall to early-flowering wild mustard. The POST 3 treatment was applied on July 2 with 60 F, 93% RH, 80% cloudy sky, and 6 mph wind to V8-stage sunflower and 1-inch tall to early-flowering wild mustard. Sunflower heads were hand-harvested from an area of 5 by 12 ft/plot on October 4 and machine-threshed.

Table. Wild mustard control and sunflower response to herbicide treatments.

Herbicide Treatment[a]	Timing	Rate	Wimu control		Days to		Plant height	Sunflower Seed yield	Sunflower Test weight
			2WAT[b]	4WAT	R5.1[c]	R9[d]			
		(lb/A)	%		J day[e]		ft	bu/A	lb/bu
Untreated	--	--	0	0	221	268	4.3	1453	28.2
Immb+NIS	POST 2	0.188+ 0.25%	86	93	221	268	4.3	1402	28.6
Immb+NIS	POST 2	0.25+ 0.25%	83	78	221	268	4.3	1420	28.1
Seth+MSO	POST 2	0.188+ 2.5%	0	0	222	269	4.4	1188	28.0
Immb+Seth+MSO	POST 2	0.063+0.188+2.5%	54	59	222	268	4.3	1667	28.3
Immb+Seth+MSO	POST 2	0.125+ 0.188+ 2.5%	71	75	222	268	4.2	1461	28.5
Immb+Seth+MSO	POST 2	0.188+ 0.188+ 2.5%	75	81	222	268	4.4	1864	28.3
Immb+Seth+MSO	POST 2	0.25+ 0.188+ 2.5%	77	88	221	268	4.2	1349	28.6
Immb+Seth+MSO	POST 1	0.125+ 0.188+ 2.5%	92	81	221	268	4.4	1593	28.1
Immb+Seth+MSO	POST 3	0.125+ 0.188+ 2.5%	77	86	221	267	4.2	1506	28.6
Acif+NIS	POST 2	0.125+ 0.25%	48	70	222	268	4.3	1453	28.9
LSD (0.05)			12	11	NS	NS	NS	NS	NS

[A]NIS=Class Preference, a nonionic surfactant from Cenex, St. Paul, MN; MSO=Destiny, a methylated seed oil from Cenex, St. Paul, MN.
[b]WAT=wk after treatment.
[c]R5.1=beginning of flowering period.
[d]R9=physiological maturity.
[e]J day=Julian day calendar.

Wild mustard control with imazamethabenz at 0.188 or 0.25 lb/A ranged from 78 to 93%(Table 1). Imazamethabenz at 0.063 lb/A + sethoxydim provided only 54-59% control of wild mustard. The tank mixture of sethoxydim + imazamethabenz at 0.188 or 0.25 lb/A did not reduce wild mustard control. Acifluorfen control of wild mustard ranged from 48 to 70%. Sunflower injury was not visually detected among treatments(data not shown). Also, no treatment differences were detected as measured by days to first flower or physiological maturity, plant height at harvest, seed yield, or test weight.

Evaluation of diflufenzopyr with auxin herbicides for leafy spurge control. Rodney G. Lym. (Department of Plant Sciences, North Dakota State University, Fargo, ND 58105). Previous research at North Dakota State University has shown that both initial and long-term leafy spurge control is increased when diflufenzopyr was applied with auxin herbicides. Diflufenzopyr is an auxin transport inhibitor (ATI), which suppresses the transport of naturally occurring IAA and synthetic auxin-like compounds in plants. In general, diflufenzopyr interferes with the auxin balance needed for plant growth. The purpose of this research was to evaluate the effect of varying the ratio of auxin herbicide:diflufenzopyr on both short- and long-term leafy spurge control.

The first experiment was established near Valley City, ND on September 17, 1997 when leafy spurge was in the fall growth stage with 2 to 3 inch regrowth from the stem and no leaves remaining on the main stem. The herbicides were applied using a hand-boom sprayer delivering 8.5 gpa at 35 psi. The air temperature was 68 F with a dewpoint of 58 F and the sky was clear. The plots were 10 by 30 feet and replicated four times in a randomized complete block design. Leafy spurge topgrowth was visually evaluated with control based on percent stand reduction compared to the untreated check.

Leafy spurge control increased or tended to increase when diflufenzopyr was applied with an auxin herbicide, especially dicamba and picloram (Table 1). Leafy spurge control averaged 54% 12 MAT (months after treatment) when diflufenzopyr was applied with dicamba compared to only 20% when dicamba was applied alone. Control increased from 66 to 90% when diflufenzopyr was applied with picloram compared to the herbicide alone. Leafy spurge control also tended to increase when diflufenzopyr was applied with imazapic even though that herbicide is classified as an ALS inhibitor.

Long-term leafy spurge control increased when diflufenzopyr was applied with all herbicides evaluated except quinclorac (Table 1). For example, leafy spurge control averaged 68% 24 MAT when diflufenzopyr was applied with picloram at 8 oz/A or picloram plus 2,4-D at 8 + 16 oz/A but only 30 and 43%, respectively, when the herbicides were applied alone. Quinclorac averaged 50% control 24 MAT when applied at 16 oz/A alone or with diflufenzopyr.

The second experiment was established to evaluate the optimum ratio of diflufenzopyr when applied with dicamba or quinclorac. The diflufenzopyr ratio varied from the standard ratio of 2.5:1 herbicide:ATI to 5:1 and 10:1. The experiment was established near Jamestown and Valley City, North Dakota, in early June 1998 when leafy spurge was in the true-flower growth stage.

Both initial foliage injury 1 MAT and top growth control 3 MAT were higher when diflufenzopyr was applied with dicamba and quinclorac compared to the herbicide applied alone (Table 2). However, injury and control were similar regardless of diflufenzopyr rate. For instance, leafy spurge control with dicamba applied alone averaged 84% 3 MAT but increased to an average of 97% when applied with diflufenzopyr. Control with quinclorac alone averaged 78% but increased to an average of 97% when applied with diflufenzopyr. Control was also increased to 78% when

diflufenzopyr was applied with glyphosate plus 2,4-D compared to 44% with the herbicides alone.

As in the previous experiment, the addition of diflufenzopyr increased long-term leafy spurge control when applied with dicamba compared to dicamba alone and averaged 57 and 25% control, respectively, 15 MAT (Table 2). The increase in control was similar regardless of the herbicide:diflufenzopyr ratio. Unlike the first experiment, long-term leafy spurge control was increased when diflufenzopyr was applied with quinclorac which averaged 80% control 15 MAT compared to only 54% when quinclorac was applied alone (Tables 1 and 2). The reason for the increase in long-term control when diflufenzopyr was applied with quinclorac in the second experiment but not the first is not known. Differences in application rate probably are not the reason since both the quinclorac and diflufenzopyr rate was less in the second than the first experiment. However, in the first experiment quinclorac was applied in the fall compared to a spring application in the second experiment

The third and fourth experiments were established to evaluate the optimum ratio of diflufenzopyr when applied with picloram or picloram plus 2,4-D for leafy spurge control. Diflufenzopyr was applied from 1.6 to 6.4 oz/A with picloram at 8 oz/A or picloram plus 2,4-D at 4 + 16 oz/A. Leafy spurge was in the true-flower growth stage, the air temperature was 63 F with a dew point of 57 F on June 9, 1998 when the third experiment was established. In the fourth experiment, leafy spurge was in the fall regrowth stage with approximately 15% yellow foliage, the air temperature was 78 F with a dew point of 60 F.

As in the previous experiments long-term leafy spurge control was increased when diflufenzopyr was applied with picloram or picloram plus 2,4-D compared to the herbicides alone and the increase was similar regardless of the herbicide:diflufenzopyr ratio (Tables 3 and 4). Leafy spurge control averaged 88 and 83% 15 MAT when picloram or picloram plus 2,4-D was applied with diflufenzopyr compared to 62 or 38%, respectively, when the herbicides were applied alone in June (Table 3).

In general, long-term leafy spurge control was also increased when diflufenzopyr was applied with picloram or picloram plus 2,4-D in the fall, but the increase was erratic (Table 4). For instance, leafy spurge control with picloram plus 2,4-D at 4 plus 16 oz/A averaged only 1% 12 MAT compared to a range from 36 to 65% control when the same treatment was applied with diflufenzopyr. However, there was no clear trend between the amount of diflufenzopyr applied with picloram plus 2,4-D and leafy spurge control.

In summary, diflufenzopyr increased long-term leafy spurge control when applied with auxin herbicides and the increase was independent of the herbicide:diflufenzopyr ratio. The most consistent and greatest increases in long-term control came when diflufenzopyr was applied with picloram, picloram plus 2,4-D, or dicamba.

Table 1. Diflufenzopyr applied with various herbicides in the fall for leafy spurge control.

Treatment	Rate	Control/MAT[a]			
		9	12	15	24
	oz/A	%			
Dicamba + X-77 + 28% N	32 + 0.25% + 1.25%	65	20	3	0
Dicamba + diflufenzopyr[b] + X-77 + 28% N	32+12.8+0.25%+1.25%	78	54	11	5
Picloram	8	89	66	48	30
Picloram + diflufenzopyr	8 + 3.2	100	90	67	68
Picloram + 2,4-D	8 + 16	95	78	70	43
Picloram + 2,4-D + diflufenzopyr	8 + 16 + 3.2	99	88	85	67
Quinclorac + Scoil[c]	16 + 1 qt	99	89	74	48
Quinclorac + diflufenzopyr + Scoil[c]	16 + 6.4 + 1 qt	100	95	67	53
Imazapic + Sun-It[c] + 28% N	2 + 1 qt + 1 qt	95	84	52	20
Imazapic + diflufenzopyr + Sun-It[c] + 28% N	2 + 0.8 + 1 qt + 1 qt	99	96	66	47
LSD (0.05)		14	16	25	26

[a] Months after treatment.
[b] Commercial mixture of dicamba plus diflufenzopyr - Distinct (BAS-662).
[c] Methylated seed-oil by AGSCO.

Table 2. Diflufenzopyr applied at various ratios with herbicides for leafy spurge control averaged over two locations in North Dakota.

Treatment	Rate	Foliage injury	Control/MAT[a]		
		1 MAT[a]	3	12	15
	oz/A	%			
Dicamba + X-77 + 28% N	32 + 0.25% + 1 qt	64	84	29	25
Dicamba + diflufenzopyr + X-77 + 28% N	32 + 3.2 + 0.25% + 1 qt	67	94	75	58
Dicamba + diflufenzopyr + X-77 + 28% N	32 + 6.4 + 0.25% + 1 qt	78	99	89	57
Dicamba + diflufenzopyr + X-77 + 28% N	32 + 12.8 + 0.25% + 1 qt	70	98	83	59
Quinclorac + Scoil[b]	12 + 1 qt	47	78	85	54
Quinclorac + diflufenzopyr + Scoil[b]	12 + 1.6 + 1 qt	61	96	96	83
Quinclorac + diflufenzopyr + Scoil[b]	12 + 3.2 + 1 qt	60	97	98	82
Quinclorac + diflufenzopyr + Scoil[b]	12 + 4.8 + 1 qt	66	98	96	75
Glyphosate + 2,4-D[c]	6 + 10	88	44	31	17
Glyphosate + 2,4-D[c] + diflufenzopyr	6 + 10 + 6.4	84	78	53	27
LSD (0.05)		8	8	14	13

[a] Months after treatment.
[b] Methylated seed-oil by AGSCO.
[c] Commercial formulation - Landmaster BW.

Table 3. Leafy spurge control with picloram or picloram plus 2,4-D applied with various ratios of diflufenzopyr in June 1998 near Valley City, North Dakota.

Treatment	Rate	Control/MAT[a]		
		3	12	15
	oz/A	%		
Picloram + diflufenzopyr	8 + 1.6	99	96	85
Picloram + diflufenzopyr	8 + 3.2	99	99	88
Picloram + diflufenzopyr	8 + 4.8	99	99	90
Picloram + diflufenzopyr	8 + 6.4	99	99	89
Picloram + 2,4-D + diflufenzopyr	4 + 16 +1.6	99	90	79
Picloram + 2,4-D + diflufenzopyr	4 + 16 + 3.2	98	93	82
Picloram + 2,4-D + diflufenzopyr	4 + 16 + 4.8	99	96	85
Picloram + 2,4-D + diflufenzopyr	4 + 16 + 6.4	99	98	85
Picloram	8	92	85	62
Picloram + 2,4-D	4 + 16	80	79	38
LSD (0.05)		5	11	13

[a] Months after treatment.

Table 4. Leafy spurge control with picloram or picloram plus 2,4-D applied with various ratios of diflufenzopyr in September 1998 near Valley City, North Dakota

Treatment	Rate	Control/MAT[a]	
		9	12
	oz/A	%	
Picloram + diflufenzopyr	8 + 1.6	99	66
Picloram + diflufenzopyr	8 + 3.2	97	44
Picloram + diflufenzopyr	8 + 4.8	99	83
Picloram + diflufenzopyr	8 + 6.4	99	74
Picloram + 2,4-D + diflufenzopyr	4 + 16 +1.6	88	36
Picloram + 2,4-D + diflufenzopyr	4 + 16 + 3.2	93	65
Picloram + 2,4-D + diflufenzopyr	4 + 16 + 4.8	95	45
Picloram + 2,4-D + diflufenzopyr	4 + 16 + 6.4	95	40
Picloram	8	88	53
Picloram + 2,4-D	4 + 16	45	1
LSD (0.05)		12	26

[a] Months after treatment.

Evaluation of diflufenzopyr with auxin herbicides for Canada thistle and spotted knapweed control. Rodney G. Lym. (Department of Plant Sciences, North Dakota State University, Fargo, ND 58105). The auxin transport inhibitor (ATI) diflufenzopyr suppresses the transport of naturally occurring IAA and synthetic auxin-like compounds in plants. The purpose of this research was to evaluate Canada thistle and spotted knapweed control by auxin herbicides applied with diflufenzopyr.

In the first experiment auxin herbicides were applied at approximately 50% below the normal use rate for season-long control to more quickly determine if diflufenzopyr caused increased weed control compared to the herbicides applied alone. The experiment was established near Fargo on June 13, 1997, with an air temperature of 82 F and a dew point of 66 F. Canada thistle was in the early bud growth stage and 4 to 16 inches tall. The herbicides were applied using a hand-boom sprayer delivering 8.5 gpa at 35 psi. The plots were 10 by 30 feet and treatments were replicated four times in a randomized complete block design. All treatments were applied with the surfactant X-77 at 0.25% plus 28% N at 1.25%, (v/v). Canada thistle foliage injury was visually evaluated 1 MAT (month after treatment) and control based on percent stand reduction compared to the control was evaluated 3 and 12 MAT.

Canada thistle foliage injury was increased when diflufenzopyr was applied with any of the herbicides evaluated (Table 1). Plants treated with diflufenzopyr plus herbicide desiccated faster and tended to turn black in color rather than brown as observed when plants were treated with

only a herbicide. The greatest increase in foliage injury occurred when diflufenzopyr was applied with picloram, 2,4-D, or quinclorac, which averaged 77% foliage injury 1 MAT compared to only 34% when the herbicides were applied alone.

Canada thistle control 3 MAT increased when diflufenzopyr was applied with dicamba, 2,4-D, quinclorac, and clopyralid compared to the herbicides applied alone (Table 1). The most dramatic increase occurred when diflufenzopyr was applied with quinclorac. Quinclorac generally does not control Canada thistle, yet when applied with diflufenzopyr control 3 MAT averaged 67% compared to only 6% when the herbicide was applied alone. Control increased from 37 to 70% with dicamba and from 44 to 83% with 2,4-D when the herbicides were applied with diflufenzopyr compared to herbicides alone. No treatment provided satisfactory control 12 MAT.

The second experiment evaluated Canada thistle control with dicamba, quinclorac, and clopyralid plus 2,4-D at standard use rates alone and with diflufenzopyr at various ratios (herbicide:ATI) Treatments were applied on June 9, 1998, near Fargo as previously described. Canada thistle plants were beginning to bolt and were 4 to 10 inches tall.

Canada thistle control with quinclorac was greatly improved when the herbicide was applied with diflufenzopyr compared to quinclorac alone (Table 2). Control averaged 64% when quinclorac was applied at 12 oz/A plus diflufenzopyr compared to only 5% when the herbicide was applied alone 2 MAT. However, control was similar regardless of the ratio of quinclorac:diflufenzopyr. Initial control with dicamba and clopyralid plus 2,4-D was similar whether the herbicides were applied alone or with the ATI. Canada thistle control with dicamba and clopyralid plus 2,4-D was higher 15 MAT when the herbicides were applied with diflufenzopyr compared to the herbicides alone. The increase in control was independent of the diflufenzopyr application rate.

The third experiment was established on June 9, 1999, to evaluate dicamba and quinclorac applied at various rates with diflufenzopyr for Canada thistle control. Canada thistle was in the early-bolt growth stage and 5 to 10 inches tall. The weather was hot and humid with an air temperature of 84 F, a dew point of 75 F, and the soil temperature at 1 inch was 92 F. There was a tendency for increased Canada thistle control at a given herbicide rate as the diflufenzopyr application rate increased (Table 3). The data were quite variable between replications; however, due to frequent heavy rains that caused the experiment to be under water much of the growing season.

The fourth experiment evaluated diflufenzopyr applied with various herbicides for spotted knapweed control. The experiment was established near Hawley, MN, on June 12, 1997, and treatments were applied as previously described. Spotted knapweed was in the early bolt growth stage, 4 to 6 inches tall, and had been mowed in August 1996. Spotted knapweed control was similar regardless of herbicide or the addition of diflufenzopyr (Table 4). Spotted knapweed control was quite variable over the entire experiment; however, there was a trend for long-term spotted knapweed control to be improved when diflufenzopyr was applied with any of the herbicides evaluated, except dicamba. Spotted knapweed control averaged over all herbicides evaluated except dicamba was 67% 24 MAT when the treatment included diflufenzopyr compared

to 27% control when the herbicides were applied alone.

In summary, Canada thistle control improved when diflufenzopyr was applied with an auxin herbicide compared to the herbicide alone. Generally, control was similar regardless of the ratio of herbicide to diflufenzopyr. There was a trend for long-term spotted knapweed control to be improved when diflufenzopyr was applied with all auxin herbicides evaluated, except dicamba. In general, diflufenzopyr will improve long-term perennial weed control with auxin herbicides, but the increase is dependant on the herbicide and/or weed evaluated.

Table 1. Canada thistle control with auxin herbicides applied either alone or with diflufenzopyr in June 1997.

Treatment	Rate	Foliage inj[a]	Control	
		1 MAT[b]	3 MAT[b]	12 MAT[b]
	— oz/A —		— % —	
Dicamba	4	54	37	15
Dicamba + diflufenzopyr[c]	4 + 1.6	76	70	11
Picloram	2	46	94	24
Picloram + diflufenzopyr	2 + 0.8	89	88	13
2,4-D	4	36	44	18
2,4-D + diflufenzopyr	4 + 1.6	65	83	18
Picloram + 2,4-D	2 + 4	63	93	24
Picloram + 2,4-D + diflufenzopyr	2 + 4 + 0.8	84	94	34
Quinclorac	8	19	6	1
Quinclorac + diflufenzopyr	8 + 3.2	76	67	11
Clopyralid	1.6	65	83	19
Clopyralid + diflufenzopyr	1.6 + 0.6	88	97	34
LSD (0.05)		13	21	NS

[a] Based on foliage topgrowth injury with 0 = no injury and 100 = all topgrowth killed.
[b] Months after treatment.
[c] Commercial mixture of dicamba plus diflufenzopyr - Distinct.

Table 2. Diflufenzopyr applied at various ratios with auxin herbicides for Canada thistle control in June 1998.

Treatment	Rate	Control/MAT[a]		
		2	12	15
	oz/A	%		
Dicamba + X-77 + 28% N	8 + 0.25% + 1 qt	81	8	0
Dicamba + diflufenzopyr + X-77 + 28% N	8 + 0.8 + 0.25% + 1 qt	84	22	23
Dicamba + diflufenzopyr + X-77 + 28% N	8 + 1.6 + 0.25% + 1 qt	84	31	27
Dicamba + diflufenzopyr + X-77 + 28% N	8 + 3.2 + 0.25% + 1 qt	96	28	10
Quinclorac + Scoil[b]	12 + 1 qt	5	6	0
Quinclorac + diflufenzopyr + Scoil[b]	12 + 1.6 + 1 qt	68	2	0
Quinclorac + diflufenzopyr + Scoil[b]	12 + 3.2 + 1 qt	51	9	7
Quinclorac + diflufenzopyr + Scoil[b]	12 + 4.8 + 1 qt	73	9	0
Clopyralid + 2,4-D[c]	4 + 16	94	56	13
Clopyralid + 2,4-D[c] + diflufenzopyr	4 + 16 + 2	97	42	65
Clopyralid + 2,4-D[c] + diflufenzopyr	4 + 16 + 4	100	63	51
Clopyralid + 2,4-D[c] + diflufenzopyr	4 + 16 + 8	100	36	42
LSD (0.05)		24	24	20

[a] Months after treatment.
[b] Methylated seed-oil by AGSCO.
[c] Commercial formulation-Curtail

Table 3. Evaluation of dicamba and quinclorac applied with various rates of diflufenzopyr for Canada thistle control.

Treatment	Rate	Control/ 4 MAT[a]
	lb/A	— % —
Dicamba + diflufenzopyr + X-77	2 + 0.8 + 0.25%	73
Dicamba + diflufenzopyr + X-77	2 + 0.2 + 0.25%	81
Dicamba + diflufenzopyr + X-77	1 + 0.4 + 0.25%	87
Dicamba + diflufenzopyr + X-77	1 + 0.1 + 0.25%	59
Dicamba + diflufenzopyr + X-77	0.5 + 0.2 + 0.25%	49
Dicamba + diflufenzopyr + X-77	0.5 + 0.05 + 0.25%	38
Quinclorac + diflufenzopyr + Scoil[b]	0.75 + 0.3 + 1 qt	21
Quinclorac + diflufenzopyr + Scoil[b]	0.75 + 0.075 + 1 qt	8
Quinclorac + diflufenzopyr + Scoil[b]	0.5 + 0.20 + 1 qt	28
Quinclorac + diflufenzopyr + Scoil[b]	0.5 + 0.05 + 1 qt	14
Quinclorac + diflufenzopyr + Scoil[b]	0.25 + 0.10 + 1 qt	24
Quinclorac + diflufenzopyr + Scoil[b]	0.25 + 0.025 + 1 qt	0
Diflufenzopyr + X-77	0.10 + 0.25%	0
Diflufenzopyr + X-77	0.20 + 0.25%	0
Diflufenzopyr + X-77	0.40 + 0.25%	0
Diflufenzopyr + X-77	0.80 + 0.25%	0
Picloram + 2,4-D	0.5 + 1	99
LSD (0.05)		28

[a] Months after treatment.
[b] Methylated seed-oil by AGSCO.

Table 4. Diflufenzopyr applied with various auxin herbicides for spotted knapweed control in June 1997.

Treatment[a]	Rate	Foliage injury	Control/MAT[b]			
		1 MAT[b]	3	12	15	24
	oz/A	%				
Dicamba	4	68	69	84	78	70
Dicamba + diflufenzopyr	4 + 1.6	63	48	48	51	41
Picloram	2	55	28	40	34	21
Picloram + diflufenzopyr	2 + 0.8	61	42	83	68	68
2,4-D	4	61	48	40	44	33
2,4-D + diflufenzopyr	4 + 1.6	70	71	79	76	68
Picloram + 2,4-D	2 + 4	40	25	36	33	16
Picloram + 2,4-D + diflufenzopyr	2 + 4 + 0.8	51	55	65	59	66
Quinclorac	8	46	50	50	66	51
Quinclorac + diflufenzopyr	8 + 3.2	57	68	85	82	73
Clopyralid	1.6	49	26	45	33	16
Clopyralid + diflufenzopyr	1.6 + 0.6	70	68	79	68	61
LSD (0.05)		NS	NS	NS	NS	NS

[a] All treatments were applied with X-77 + 28% N at 0.25% + 1.25%, respectively.
[b] Months after treatment.

Imazapic applied for 3 consecutive years for leafy spurge control. Rodney G. Lym. (Plant Sciences Department, North Dakota State University, Fargo, ND 58105). Imazapic (Plateau) has been registered for leafy spurge control in non-cropland. The label states that imazapic should be applied with a methylated seed oil (MSO) adjuvant plus 28% urea nitrogen. Also, the manufacturer recommends imazapic be applied in the fall prior to a killing frost or as a split application in the fall and the following spring. The purpose of these experiments was to evaluate imazapic for leafy spurge control and grass injury applied alone or with a MSO adjuvant in the spring or fall for 3 years.

Leafy spurge control with imazapic was evaluated following application in mid-summer or fall for 3 years at two locations in North Dakota. The herbicide treatments were applied using a tractor-mounted sprayer delivering 8.5 gpa at 35 psi. The plots were 10 by 30 feet and replicated four times with the herbicide treatments in a randomized complete block design. Herbicides were applied near Valley City or Jamestown on July 3, 1996, when the leafy spurge was in the flowering to seed-set growth stage. The air temperature was approximately 80 F and the soil temperature at the 4 inch depth was 57 F at Valley City and 69 F at Jamestown. The fall treatments were applied at both locations on September 9 when the leafy spurge was in the fall regrowth growth stage and the air temperature was in the mid 80s. Treatments were reapplied in 1997 and 1998 on similar dates.

Imazapic applied in mid-summer at Valley City did not control leafy spurge when visually evaluated the year of treatment (Table 1). However, control by imazapic at 2 and 4 oz/A averaged 94 and 99%, respectively in May 1997. Imazapic at 4 oz/A provided 93% leafy spurge control in September 1997 with minimal grass injury, but 4 oz/A is above the maximum labeled use rate of 3 oz/A. Imazapic fall-applied at 2 or 4 oz/A provided excellent leafy spurge control the following spring but grass injury was very noticeable and averaged 43%. Imazapic applied at 1 or 2 oz/A with MSO provided 92% leafy spurge control when evaluated in the fall 12 MAT, which was higher than the standard picloram plus 2,4-D treatment which averaged 47%.

Imazapic applied at 1 or 2 oz/A plus an MSO provided 84 and 95% leafy spurge control, respectively, 13 months after the last treatment (Table 1), with no visible grass injury. The grasses had recovered from the injury observed following the initial treatment and were not injured by the subsequent treatments. Leafy spurge control from imazapic fall-applied averaged greater than 95% control one year after the third application and was similar to the standard treatment of picloram plus 2,4-D.

Leafy spurge control with imazapic applied in mid-summer tended to be less at Jamestown than Valley City (Tables 1 and 2). Only imazapic at 4 oz/A provided greater than 90% control in May 1997 at Jamestown (Table 2). Control averaged 99% in September following a second application of picloram plus 2,4-D, but only was 71% or less with a second application of imazapic. Grass injury could not be evaluated in September 1997 because of severe hail damage at the research location.

Imazapic applied in the fall at Jamestown provided excellent (99%) leafy spurge control in May 1997 regardless of application rate (Table 2). In contrast to the high grass injury observed at Valley City (Table 1), only imazapic at 4 oz/A fall-applied injured grass (18%) (Table 2). Leafy spurge control averaged 97% 12 and 24 MAT with both imazapic applied alone at 4 oz/A or at 2 oz/A with MSO compared to 26% with picloram plus 2,4-D.

The best long-term treatments at Jamestown averaged 90% leafy spurge control in Sept. 1999 and included imazapic at 4 oz/A applied for 3 years in July or September, and imazapic at 2 oz/A plus an MSO applied in the fall for 3 years. Imazapic applied with an MSO provided better long-term leafy spurge control than imazapic applied alone at comparable rates.

In general, imazapic applied in the fall provided better leafy spurge control than the mid-summer treatment and control was improved when the herbicide was applied with a MSO compared to imazapic applied alone. Grass injury to cool season species tended to be higher when imazapic was applied in July compared to fall-applied, but the grasses recovered by 12 MAT.

Table 1. Imazapic for leafy spurge control annually applied in mid-summer or fall for 3 yr at Valley City, ND.

Treatment[a]	Rate	Evaluation									
		Sept. 1996		May 1997		Sept 1997		June 98	Aug 98	June 99	Sept 99
		Cont	Grass inj.	Cont	Grass inj.	Cont	Grass inj.	Control	Control	Control	Control
	oz/A	%									
Imazapic (summer)	2	0	0	94	10	74	5	90	95	77	79
Imazapic (summer)	4	0	0	99	28	93	5	50	93	93	90
Imazapic + MSO[b] (summer)	1 + 1 qt	0	0	0	8	87	3	82	96	85	84
Imazapic + MSO[b] (summer)[c]	2 + 1 qt	0	0	99	28	73	16	59	96	91	95
Picloram + 2,4-D (summer)	4 + 16	74	4	75	0	38	0	26	96	83	93
Imazapic (fall)[c]	2			100	36	71	0	99	85	98	97
Imazapic (fall)[c]	4			100	53	99	0	100	98	99	99
Imazapic + MSO[b] (fall)[c]	1 + 1 qt			100	20	92	0	99	82	91	97
Imazapic + MSO[b] (fall)[c]	2 + 1 qt			100	40	92	0	99	85	96	99
Picloram + 2,4-D (fall)[c]	8 + 16			99	13	47	0	95	86	95	96
LSD (0.05)		34	NS	20	25	25	NS	26	10	9	NS

[a] Treatments applied July 2, (summer) and September 9, 1996 (fall).
[b] Methylated seed oil was SunIt by AGSCO.
[c] Treatments reapplied 1997. All treatments were reapplied in 1998.

Table 2. Imazapic for leafy spurge control annually applied in mid-summer or fall for 3 yr at Jamestown, ND.

Treatment[a]	Rate	Evaluation									
		Sept 1996		May 1997		Sept. 1997	June 1998		Aug 1998	June 1999	Sept. 1999
		Cont	Grass inj.	Cont	Grass inj.	Cont	Cont	Grass inj.	Control	Control	Control
	oz/A	%									
Imazapic (summer)	2	0	0	0	0	0	34	0	22	20	6
Imazapic (summer)	4	13	14	92	1	71	96	2	99	96	88
Imazapic + MSO[b] (summer)	1 + 1 qt	28	0	33	0	13	58	0	36	37	11
Imazapic + MSO[b] (summer)	2 + 1 qt	17	0	72	0	45	85	0	82	76	67
Picloram + 2,4-D (summer)	4 + 16	46	0	15	0	99	42	0	87	40	56
Imazapic (fall)	2			99	5	28	97	0	45	100	74
Imazapic (fall)	4			100	18	97	100	23	99	100	91
Imazapic + MSO[b] (fall)	1 + 1 qt			99	6	70	99	0	29	95	66
Imazapic + MSO[b] (fall)	2 + 1 qt			100	6	96	100	6	96	100	90
Picloram + 2,4-D (fall)	8 + 16			95	0	26	97	0	26	99	73
LSD (0.05)		14	10	19	6	18	10	5	17	14	18

[a] Treatments applied July 2, (summer) and September 9, 1996 (fall). All treatments were reapplied in 1997 and 1998.
[b]Methylated seed oil was SunIt by AGSCO.

Control of leafy spurge with imazapic at Hettinger. Eric Eriksmoen. (Hettinger Research and Extension Center). This experiment was conducted on leafy spurge infested rangeland. Grass species present were a combination of Kentucky bluegrass, smooth brome and western wheatgrass. Soil at the test location was a fine sandy loam with a pH of 7.3 and an organic matter content of 3.8%. Imazapic treatments were applied on September 29, 1997, to leafy spurge 9 days following frost when the temperature reached 24 F. Leafy spurge stems were green but leafless. Conditions at application were 64 F air temperature, wind at 2 mph from the NW, sky was clear, soil surface was dry and subsoil was moderately moist. A late spring application was applied to leafy spurge in the bloom growth stage on May 19, 1998, with 73 F air temperature, wind at 3 mph from the NW, sky was sunny and clear, soil surface was dry and subsoil had good moisture. Treatments were applied with a pickup mounted sprayer delivering 10 gpa at 40 psi through 8004 flat fan nozzles to a plot size of 30 by 30 feet. The experiment was a randomized complete block design with three replications. Evaluations were on May 26, 1998, for leafy spurge control and grass height, on October 1, 1998, for leafy spurge control and stems per meter square and on May 28, 1999 for stems per meter square.

Treatment	Application	Rate	May 26, 1998		Oct. 1, 1998		May 28, 1999	
			Control	Grass	Control	Stems	Control*	Stems
		oz/A Product	%	inches	%	m	%	m
1. Untreated			0	9.3	0	50+	0	78
2. Imazapic+Sun-it II+28-0-0	Fall 97	16 + 32 + 32	99	3.7	93	1	77	18
3. Imazapic+Sun-it II+28-0-0	Fall 97	24 + 32 + 32	99	1.3	93	1	83	13
4. Imazapic+Sun-it II+28-0-0	Fall 97	16 + 32 + 32	98	3.0	99	0	83	13
Imazapic+Destiny+28-0-0	Spg 98	8 +32 + 32						
5. Imazapic+Destiny+28-0-0	Spg 98	24 + 32 + 32	—	—	88	14	87	10
C.V. %			1.5	40	8.7	78		98
LSD 5%			2	3.4	13	17		50

*Percent control based on stem counts.

Summary: Percent leafy spurge control was based on visual estimations on the first two evaluations and based on actual stem counts on the final evaluation. Leafy spurge control was almost 100% 8 months after application and was greater than 90% 12 months after application for all fall applied treatments (trts 2, 3 & 4). Leafy spurge control declined to below 85 percent on these treatments 20 months after application although the stem counts were still significantly lower than the untreated check. There was no difference between the fall/spring split application (trt 4) and the fall applied higher rate of imazapic (trt 3) for leafy spurge control at 20 months after application, and only slightly (but not significantly) higher control than the fall applied lower rate of imazapic (trt 1). The spring applied imazapic treatment (trt 5) had lower leafy spurge control at 12 months after application (87%) than all of the fall applied imazapic treatments at 12 months after application (>90%). Grass species were severely, but temporarily, stunted at 8 months after application with the smooth brome exhibiting the greatest amount of injury. All grass species recovered completely by the end of this study.

Evaluation of imazapic for spotted knapweed and perennial sowthistle control. Rodney G. Lym. (Plant Sciences Department, North Dakota State University, Fargo, 58105). Imazapic has been used for rangeland renovation including leafy spurge control and has a narrower weed control spectrum than the more commonly used picloram plus 2,4-D. The purpose of this research was to evaluate imazapic for spotted knapweed control in an industrial location and perennial sowthistle control in cropland.

The first experiment to evaluate imazapic applied alone or with picloram for spotted knapweed control was established on a moderate infestation of spotted knapweed near Hawley, MN. Herbicides were applied on June 12, 1997 (spring) or September 18, 1997 (fall) using a hand-boom sprayer delivering 8.5 gpa at 35 psi. All treatments containing imazapic were applied with a methylated seed oil (MSO). The experiment was in a randomized complete block design with four replications and each plot was 10 by 30 feet. Evaluations were based on visual percent stand reduction compared to an untreated control.

Imazapic applied alone did not control spotted knapweed regardless of application date (Table 1). Control averaged less than 30% with some grass injury observed following the spring applied treatments. Picloram at 4 oz/A applied alone or with imazapic provided nearly complete spotted knapweed control in May 1999. The treatments could not be evaluated in August 1999 because the study area had been mowed.

The second experiment was established at the same location as the first to evaluate imazapic applied with 2,4-D for spotted knapweed control. The treatments were applied on June 30, 1998 when spotted knapweed was in the early bolt growth stage. The air temperature was 66 F, the dew point was 54 F, and the soil temperature at 2 inches was 65 F. Imazapic did not provide satisfactory spotted knapweed control whether applied alone or with 2,4-D (Table 2).

The third experiment evaluated imazapic applied alone or with clopyralid plus 2,4-D for perennial sowthistle control. The experiment was established near Fargo, ND in a dense stand of perennial sowthistle. Herbicides were applied as previously described on June 30, 1998, when perennial sowthistle was in the rosette growth stage just prior to bolting. The air temperature was 72 F and the dew point was 67 F. All imazapic treatments were applied with an MSO.

Imazapic applied with 2,4-D provided better perennial sowthistle control than either herbicide applied alone (Table 3). For instance, imazapic applied at 3 oz/A alone provided 65% perennial sowthistle control 2 months after treatment (MAT) but control declined to 26% 12 MAT. However, when imazapic was applied at 3 oz/A with 2,4-D at 4 or 8 oz/A control improved to an average of 90% and 61% 2 and 12 MAT, respectively. Clopyralid provided the best long-term perennial sowthistle control which averaged 94% 12 MAT.

In general, imazapic provided poor spotted knapweed and perennial sowthistle control when applied alone regardless of application date. The addition of 2,4-D with imazapic improved perennial sowthistle but not spotted knapweed control compared to imazapic applied alone.

Imazapic applied with picloram provided similar spotted knapweed control to picloram applied alone.

Table 1. Imazapic applied alone and with picloram in May or September 1997 for spotted knapweed control.

		August 1997		May 1998		Aug 1998	May 1999
Treatment	Rate	Control	Grass inj.	Control	Grass inj.	Control	Control
Spring applied	— oz/A —			%			
Imazapic + MSO[a]	2 + 1 qt	28	5	23	0	10	5
Imazapic + MSO[a]	2.5 + 1 qt	5	11	0	0	0	0
Imazapic + MSO[a]	3 + 1 qt	13	16	13	0	0	5
Imazapic + picloram + MSO[a]	2 + 4 + 1 qt	100	20	99	0	100	90
Imazapic + picloram + MSO[a]	2.5 + 4 + 1 qt	100	27	97	0	99	88
Picloram	4	100	5	99	0	99	94
Fall applied							
Imazapic + MSO[a]	2 + 1 qt			21	0	5	0
Imazapic + MSO[a]	2.5 + 1 qt			24	0	5	7
Imazapic + MSO[a]	3 + 1 qt			11	0	13	13
Imazapic + picloram + MSO[a]	2 + 4 + 1 qt			99	13	100	95
Imazapic + picloram + MSO[a]	2.5 + 4 + 1 qt			100	18	99	91
Picloram	4			99	7	100	94
LSD (0.05)		21	22[b]	30	7	11	11

[a] Methylated seed oil was Sun-It by AGSCO.
[b] LSD = (0.10).

Table 2. Spotted knapweed control with imazapic applied alone or with 2,4-D in June 1998.

Treatment	Rate	Control/MAT[a] 2	12
	— oz/A —	— % —	
Imazapic + Scoil[b]	2 + 1 qt	11	22
Imazapic + Scoil[b]	3 + 1 qt	11	1
Imazapic + 2,4-D + Scoil[b]	2 + 4 + 1 qt	13	6
Imazapic + 2,4-D + Scoil [b]	3 + 4 + 1 qt	12	16
Imazapic + 2,4-D + Scoil[b]	2 + 8 + 1 qt	13	6
Imazapic + 2,4-D + Scoil[b]	3 + 8 + 1 qt	12	15
2,4-D	4	7	31
2,4-D	8	16	5
Picloram	4	99	83
LSD (0.05)		3	27

[a] Months after treatment.
[b] Methylated seed-oil by AGSCO.

Table 3. Perennial sowthistle control with imazapic applied alone or with 2,4-D in June 1998.

Treatment	Rate	Control/MAT[a] 2	12
	oz/A	— % —	
Imazapic + Scoil[b]	2 + 1 qt	81	26
Imazapic + Scoil[b]	3 + 1 qt	65	26
Imazapic + 2,4-D + Scoil[b]	2 + 4 + 1 qt	44	29
Imazapic + 2,4-D + Scoil[b]	3 + 4 + 1 qt	96	60
Imazapic + 2,4-D + Scoil[b]	2 + 8 + 1 qt	92	61
Imazapic + 2,4-D + Scoil[b]	3 + 8 + 1 qt	84	62
2,4-D	4	10	50
2,4-D	8	11	59
Clopyralid	4	95	94
LSD (0.05)		20	25

[a] Months after treatment.
[b] Methylated seed-oil by AGSCO.

Leafy spurge control with alternating applications of imazapic and picloram plus 2,4-D. Rodney G. Lym. (Department of Plant Sciences, North Dakota State University, Fargo, ND 58105). Imazapic is an ALS inhibiting herbicide recently labeled for leafy spurge control in non-cropland. Research at North Dakota State University has shown that occasionally imazapic will injure certain grass species. The purpose of this research was to evaluate imazapic applied alone, in rotation with picloram plus 2,4-D, or the three herbicides applied together for long-term leafy spurge control.

The experiment was established at Jamestown and Valley City, North Dakota in a dense stand of leafy spurge. Initial herbicide treatments were applied in early June during the true-flower growth stage or in mid-September when leafy spurge was in the fall regrowth growth stage. Initial treatments of imazapic were followed by picloram plus 2,4-D. Likewise, initial treatments of picloram plus 2,4-D were followed by imazapic. Imazapic was applied at 1 or 2 oz/A in the spring or fall, respectively. Picloram plus 2,4-D was applied at the general use rate of 4 + 16 oz/A in the spring or 8 + 16 oz/A in the fall. The three-way mixture of picloram plus 2,4-D plus imazapic was applied once in the spring or fall with no follow-up treatment.

Treatments were applied with a hand-held sprayer delivering 8.5 gpa at 35 psi. The experiment was a randomized complete block design with four replications at both locations and plots were 10 by 30 feet. Control was based on percent stand reduction as compared to the untreated check.

Table. Leafy spurge control with imazapic combined or alternated with picloram and 2,4-D applied in the spring of fall at two locations.

				August 1998			June 1999			Sept. 1999		
Treatment	Rate	Treatment	Rate	JMS[a]	VC[a]	Mean	JMS[a]	VC[a]	Mean	JMS[a]	VC[a]	Mean
	— oz/A —		- oz/A -	% control								
Spring 1998		Fall 1998										
Picloram+2,4-D	4+16	Imazapic+Scoil+28% N	2+1qt+1qt	85	88	86	99	99	99	70	95	82
Imazapic+Scoil+28% N	1+1qt+1qt	Picloram+2,4-D	8+16	28	58	43	99	99	99	53	82	67
Picloram+2,4-D+imazapic +Scoil+28% N	4+16+1+ 1qt+1qt	None		99	95	97	95	99	99	97	99	98
LSD (0.05)				11	16	7[b]						
Fall 1998		Spring 1999										
Picloram+2,4-D	8+16	Imazapic+Scoil+28% N	1+1qt+1qt				98	94	96	82	91	87
Imazapic+Scoil+28% N	2+1qt+1qt	Picloram + 2,4-D	8+16				99	99	99	96	98	97
Picloram+2,4-D+ imazapic +Scoil+28% N	8+16+2+ 1qt+1qt	None					99	99	99	59	64	61
LSD (0.05)							NS	2	NS	11	16	9[c]

[a] JMS = Jamestown, VC = Valley City

[b] Significant interaction between locations. Control with imazapic at Valley City was higher than at Jamestown.

[c] Control at Valley City is higher than at Jamestown.

The three herbicide mixture of picloram plus 2,4-D plus imazapic applied once in the spring provided the best long-term leafy spurge control (Table). Control averaged across locations was 98% in September 1999, 15 months after treatment. This high level of control was unexpected and is similar to picloram applied alone at 32 oz/A. The same three-herbicide treatment applied in the fall only averaged 61% control 12 months after treatment. The best split treatments were picloram plus 2,4-D applied in the spring followed by imazapic in the fall and imazapic fall-applied followed by picloram plus 2,4-D in the spring.

Picloram plus 2,4-D applied annually for 13 years to control leafy spurge. Rodney G. Lym and Calvin G. Messersmith. Picloram is an effective herbicide for leafy spurge control, especially when applied at rates from 1 to 2 lb/A. However, the high cost of picloram at 1 to 2 lb/A makes it uneconomical to treat large acreages in pasture and rangeland weed control programs. Research by North Dakota State University has suggested that picloram at 0.25 to 0.5 lb/A applied annually will give satisfactory leafy spurge control after 3 to 5 yr. The purposes of this experiment were to establish the number of annual applications of picloram needed to provide 90 to 100% control of leafy spurge and to investigate possible synergism between picloram and 2,4-D.

The experiment was established at three locations in North Dakota and began on August 25, 1981 at Dickinson, September 1, 1982 at Sheldon, and on June 11, 1982 at Valley City. Dickinson had a loamy fine sand soil with pH 6.6 and 3.6% organic matter, Sheldon had a fine sandy loam with pH 7.7 and 2.1% organic matter, and Valley City had a loam with pH 6.7 and 9.4% organic matter. Dickinson, located in western North Dakota, generally receives much less precipitation than the other two sites located in eastern North Dakota. All treatments were applied annually except 2,4-D alone which was applied biannually (both spring and fall). Picloram and picloram plus 2,4-D were applied in late August 1981 and in June of 1982 through 1986. The Sheldon and Dickinson locations were discontinued following the fall evaluations in 1985 and spring evaluations in 1989, respectively. The Valley City site has received ten picloram and picloram plus 2,4-D treatments and 20 2,4-D treatments prior to the evaluation in June 1992. The plots were 10 by 30 ft and each treatment was replicated four times in a randomized complete block design. Evaluations were a visual estimate of percent stand reduction as compared to the control.

Leafy spurge control averaged 79% across all treatments 48 MAFT (months after first treatment) and declined slightly to 71% following the 1988 drought (60 and 72 MAFT) before increasing to 87% in 1990 (84 MAFT) (Table). Leafy spurge control 96 MAFT (June 1991) increased by an average of 24, 12, and 9% when 2,4-D at 1 to 2 lb/A was applied with picloram at 0.25, 0.38 or 0.5 lb/A, respectively, as compared to picloram alone. However, by 108 MAFT (June 1992) only control with picloram at 0.25 lb/A was increased by 2,4-D and averaged 68 and 85%, respectively. In general, the 2,4-D rate did not influence control when applied with picloram. Leafy spurge control averaged 80% with 2,4-D alone following 10 yr of biannual treatments.

Picloram at 0.5 lb/A alone and all picloram at 0.38 or 0.5 lb/A plus 2,4-D treatments provided or nearly provided the target of 90% leafy spurge control following four annual applications (Table). Control did not increase or increased only slightly with subsequent retreatments in these small plot experiments which have a constant pressure for reinfestation from plants in the plot borders. Since control had not or only slightly changed since 1987, the retreatments were discontinued after 1995. The only leafy spurge topgrowth observed in 1995 was in the control plots and from encroachment from plot borders.

To evaluate the longevity of control after the annual and biannual treatments had been discontinued, picloram at 2 lb/A was applied to the control plots and all borders in September 1995. Leafy spurge control averaged over 97% in June 1996 12 months after the treatments had been discontinued (data not shown). However, by September control had declined to an average of

51% in the 2,4-D only plots. Thus, even after 13 yr of biannual treatments of 2,4-D, leafy spurge regrew rapidly the year after treatments had been discontinued. Leafy spurge control from the 2,4-D only treatments began to decline rapidly in 1997, 2 yr after treatments were stopped and averaged 73 and 40%, in June and August 1997, respectively (data not shown). By August 1998, leafy spurge control from the 2,4-D only treatments had declined to less than 30%. In contrast, the average control for picloram at 0.25, 0.38 or 0.5 lb/A applied with 2,4-D averaged 91, 98, and 99%, respectively, in August 1997 (data not shown) and 68, 89, and 94% in August 1998. Control began to decline with any treatment that contained picloram at 0.25 lb/A 4 yr after the last treatment and averaged 77% in September 1999 (Table). However, treatments that contained picloram at 0.38 or 0.5 lb/A averaged 93%, respectively.

Table. Leafy spurge control with annual picloram or picloram plus 2,4-D treatments and biannual 2,4-D treatments from 1982 to 1995 in North Dakota.

		1999		Months after first treatment									
Herbicide	Rate	June	Sept	12	24	36	48	60	72	84	96	108	120
	— lb/A—	% control[a]											
Picloram	0.25	93	86	39	48	48	58	49	38	64	56	68	96
Picloram	0.38	93	92	65	62	52	77	69	67	96	72	91	99
Picloram	0.5	89	81	65	71	81	86	77	71	92	81	91	99
2,4-D biannually	1	38	28	22	30	38	50	39	55	70	69	74	82
2,4-D biannually	1.5	36	24	22	24	26	45	49	49	62	57	66	74
2,4-D biannually	2	39	33	19	30	26	54	54	62	75	67	78	83
Picloram+2,4-D	0.25+1	75	69	52	66	63	85	73	76	92	80	85	95
Picloram+2,4-D	0.25+1.5	61	73	58	66	70	85	77	62	88	73	82	99
Picloram+2,4-D	0.25+2	75	80	57	62	66	83	76	77	91	88	88	99
Picloram+2,4-D	0.38+1	93	93	69	72	70	90	84	76	96	82	89	97
Picloram+2,4-D	0.38+1.5	91	93	68	74	76	93	84	79	88	83	92	99
Picloram+2,4-D	0.38+2	96	95	68	59	76	91	86	82	96	86	95	99
Picloram+2,4-D	0.5+1	89	97	71	75	84	94	87	82	96	84	97	99
Picloram+2,4-D	0.5+1.5	98	99	64	73	80	97	91	88	99	95	98	99
Picloram+2,4-D	0.5+2	94	96	76	75	81	95	91	88	99	90	96	99
LSD (0.05)		25	30	18	14	19	14	14	15	19	17	14	10
Mean of treatments				52	55	63	79	72	70	87	78	86	94

[a]Mean values through 48 and 72 months after first treatment include data from the Sheldon and Dickinson locations which were discontinued after 1985 and 1989, respectively.

NDSU perennial weed demo experiment 193.

Leafy spurge demonstration plots, Ekre station.

Annual application date and treatment	Cost[a]	Rate	Control									
			1994		1995		1997		1998		1999	
			June	Sept	June	Sept	June	Sept	June	Sept	June	Sept
	$/A	— lb/A —	%									
September (begun in 1993)												
Picloram + 2,4-D amine	28	0.5+1	90	80	98	95	100	99	100	88	100	92
Picloram	25	0.5	95	70	100	98	100	97	100	92	100	95
Picloram + 2,4-D amine	14	0.25+1	98	48	100	65	100	95	100	85	100	90
2,4-D amine	6	2	10	5	75	40	90	55	80	45	78	60
Dicamba	36	2	85	20	90	50	97	73	95	75	85	95
Glyphosate + 2,4-D[b]	8	0.4+0.6	80[c]	25[c]	35[e]	45	60[f]	0	..	..	..	40
Imazapic + Scoil + 28 N[g]	20	0.125+1 qt+1 qt					99	95	100	95	99	75
June (begun in 1994)												
Picloram	13	0.25		20[d]	30	68	80	78	88	83	87	90
Fosamine	80	8		78[d]	77	87	7	98	85	60	90	90
Picloram + 2,4-D amine	28	0.5+1		63[d]	65	98	100	100	95	98	100	95
Picloram	25	0.5		33[d]	45	97	97	98	97	98	100	96
Picloram + 2,4-D amine	14	0.25+1		0[d]	•	25	68	90	90	98	83	96
2,4-D amine	6	2		0[d]	•	0	12	87	20	90	7	15
Dicamba	36	2		0[d]	•	23	50	100	50	90	18	55
Glyphosate + 2,4-D[b]	8	0.4+0.6		0[d]	•	25	35	0	70	98	20	10

[a] Annual treatment cost, but does not include application cost.

[b] Commercial formulation (Landmaster BW).

[c] Grass injury was 60% in June 94 and 10% in Sept, treatment was discontinued after 1995 application because grass injury averaged 87%.

[d] Rain fell within 2 hours of treatment, resulting in much below average control.

[e] Grass injury was 60%.

[f] Grass injury was 30% and retreatments were stopped.

[g] Imazapic was first applied in Sept. 1996.

Evaluation of 2,4-D and clopyralid applied with various plant growth regulators for perennial weed control.
Rodney G. Lym. (Department of Plant Sciences, North Dakota State University, Fargo, ND 58105). The herbicide 2,4-D remains one of the most cost-effective treatments for broadleaf weed control. 2,4-D is often applied with other auxin herbicides for improved perennial weed control compared to the herbicides applied alone. The purpose of this research was to evaluate various formulations of 2,4-D applied with clopyralid alone and with various plant growth regulators for leafy spurge, Canada thistle, and spotted knapweed control.

The experiments were established in mid-September 1998 near Jamestown and Fargo, ND and Hawley, MN for the leafy spurge, Canada thistle, and spotted knapweed experiments, respectively. The experiments were a randomized complete block design with four replications at all locations. Treatments were applied with a hand-held sprayer delivering 8.5 gpa at 35 psi. The plots were 10 by 30 feet. Treatments were visually evaluated in late-May 1999 with control based on percent stand reduction as compared to the control. The 2,4-D acid plus dikegulac formulations NB30111A and NB30111B were not water soluble and were not applied.

2,4-D applied with picloram was the only treatment evaluated that controlled leafy spurge the following growing season and averaged 99% (Table 1). 2,4-D applied as a mixed amine and acid formulation at 16 oz/A provided less than 10% leafy spurge control 9 months after treatment (MAT) and control was similar when 2,4-D was applied with sulfentrazone, flumioxazin, or dikegulac.

Clopyralid applied alone at 3 or 6 oz/A provided an average of 77% Canada thistle control 9 MAT (Table 2). Control was similar when clopyralid was applied with 2,4-D mixed amine or as the commercial mixture in Curtail. However, control decreased when clopyralid was applied with 2,4-D in the NB20656 formulation and only averaged 44%. 2,4-D applied with a plant growth regulator did not improve Canada thistle control compared to 2,4-D applied alone.

2,4-D mixed amine and acid formulations applied at 16 oz/A provided similar spotted knapweed control and averaged 68% 9 MAT (Table 3). 2,4-D acid applied with dikegulac tended to provide better spotted knapweed control than the herbicide applied alone, but control declined when 2,4-D was applied with flumioxazin.

Table 1. Evaluation of 2,4-D applied with clopyralid or various plant growth regulators in September for leafy spurge control.

Treatment	Rate	Formulation	Control 9 MAT[a]
	– oz/A –		— % —
2,4-D mixed amine[b]	16	3.8 lb/gal	9
2,4-D acid (NB20652)	16	1.88 lb/gal	8
2,4-D acid (NB30075)	16	40.3%	4
2,4-D acid+ sulfentrazone (NB20663)	16 + 0.96	1.85 + 0.11 lb/gal	8
2,4-D acid + flumioxazin (NB30073)	16 + 0.96	51.5% +3.1%	8
2,4-D acid+ dikegulac (NB20830)	16 + 4	1.58 + 0.4 lb/gal	6
2,4-D acid + dikegulac (NB30111A)	16 + 63.8	9.1% + 36.3%	DNA[c]
2,4-D acid + dikegulac (NB30111B)	16 + 63.8	9.1% + 36.3%	DNA[c]
Picloram + 2,4-D	8 + 16	2 lb/gal + 3.8 lb/gal	99
LSD (0.05)			10

[a] Months after treatment.
[b] Mixed amine salts (2:1 dimethylamine:diethanolamine) - Hi-Dep.
[c] Did not apply, formulation caused nozzle plugging.

Table 2. Evaluation of 2,4-D with applied with clopyralid or various plant growth regulators in September for Canada thistle control.

Treatment	Rate	Formulation	Control 9 MAT[a]
	– oz/A –		— % —
2,4-D mixed amine[b]	16	3.76 lb/gal	19
2,4-D mixed amine[b] + clopyralid (Stinger)	16 + 3	3.76 lb/gal + 3 lb/gal	78
2,4-D + clopyralid (Curtail)	16 + 3	2.38 lb/gal	78
2,4-D + clopyralid (NB20656)	16 + 3	3.76 + 0.38 lb/gal	44
Clopyralid (Stinger)	3	2 lb/gal	75
Clopyralid (Stinger)	6	2 lb/gal	78
2,4-D acid + dikegulac (NB30111A)	16 + 63.8	9.1% + 36.3%	DNA[c]
2,4-D acid + dikegulac (NB30111B)	16 + 63.8	9.1% + 36.3%	DNA[c]
2,4-D acid + sulfentrazone (NB20663)	8 + 0.48	1.85 + 0.11 lb/gal	43
2,4-D acid + dikegulac (NB20830)	24	1.58 + 0.4 lb/gal	31
2,4-D acid + flumioxazin (NB30073)	16 + 0.96	51.5% + 3.1%	31
2,4-D acid (NB30075)	16	40.3%	16
2,4-D acid (NB20652)	24 + 6	1.88 lb/gal	43
LSD (0.05)			20

[a] Months after treatment.
[b] Mixed amine salts (2:1 dimethylamine:diethanolamine) - Hi-Dep.
[c] Did not apply, formulation caused nozzle plugging.

Table 3. Evaluation of 2,4-D applied with clopyralid or various plant growth regulators in September for spotted knapweed control.

Treatment	Rate	Formulation	Control 9 MAT[a]
	– oz/A –		— % —
2,4-D mixed amine[b]	16	3.76 lb/gal	69
2,4-D acid (NB20652)	16	1.88 lb/gal	67
2,4-D acid (NB30075)	16	40.3%	71
2,4-D acid + sulfentrazone (NB20663)	16 + 0.96	1.85 + 0.11 lb/gal	66
2,4-D acid + flumioxozin (NB30073)	16 + 0.96	51.5% + 3.1%	44
2,4-D acid + dikegulac (NB20830)	16 + 4	1.58 + 0.4 lb/gal	80
2,4-D acid + dikegulac (NB30111A)	16 + 63.8	9.1% + 36.3%	DNA[c]
2,4-D acid + dikegulac (NB30111B)	16 + 63.8	9.1% + 36.3%	DNA[c]
Picloram	8	2 lb/gal	92
LSD (0.05)			21

[a] Months after treatment.
[b] Mixed amine salts (2:1 dimethylamine:diethanolamine) - Hi-Dep.
[c] Did not apply, formulation caused nozzle plugging.

Evaluation of chlorsulfuron and metsulfuron for Canada thistle and spotted knapweed control. Rodney G. Lym. (Plant Sciences Department, North Dakota State University, Fargo, ND 58105). Chlorsulfuron and metsulfuron are labeled for a variety of weeds found in pasture, rangeland, and right-of-ways. The purpose of this research was to evaluate these sulfonylurea herbicides for long-term Canada thistle and spotted knapweed control in industrial sites.

The first experiment was established on September 11, 1998, on a Fargo clay soil near the campus of North Dakota State University. Canada thistle was in both the bolted growth stage following seed-set and in the rosette stage typical of fall growth. The air temperature was 82 F with a dew point of 72 F and the soil temperature at the 2 inch depth was 85 F. A killing frost did not occur until November 9 when the low temperature was 9 F. Herbicides were applied using a hand-held sprayer delivering 8.5 gpa at 35 psi. The experiment was a randomized complete block design with four replications. Canada thistle control was based on visible percent stand reduction compared to the untreated check and total vegetation control was based on 0% for complete cover to 100% for no plant cover.

Canada thistle control ranged from 84% to 93% when chlorsulfuron was applied at 0.75 to 2.25 oz/A 9 months after treatment (MAT) which was similar to or better than the standard treatment of clopyralid plus 2,4-D (Table 1). Total vegetation control increased as the chlorsulfuron application rate increased and averaged 90% when the herbicide was applied at 2.25 oz/A. Metsulfuron applied at 0.6 and 1.2 oz/A provided 100% Canada thistle top growth control the following season and 54 and 70% total vegetation control, respectively. Dicamba applied alone or with 2,4-D provided 86 and 99% Canada thistle control, respectively, but total vegetation control was14 and 58%, respectively. The treatments could not be further evaluated because of continual heavy rains and flooding of the experiment location.

The second experiment was established on June 30, 1998 near Hawley, MN to evaluate chlorsulfuron and metsulfuron for spotted knapweed control. The soil was very sandy and the spotted knapweed was in the early bolt growth stage. The air temperature was 61 F, the dew point was 54 F, and the soil temperature at 2 inches was 65 F. The application methods and experimental design was the same as the first experiment. Neither herbicide provided satisfactory spotted knapweed control regardless of the application rate or whether applied alone or with 2,4-D and dicamba (Table 2). Clopyralid plus 2,4-D at 4 + 24 oz/A provided 94 and 75% control, 12 and 15 MAT, respectively, the best long-term spotted knapweed control of the herbicides evaluated.

Table 1. Canada thistle and total vegetation (bare ground) control with chlorsulfuron and metsulfuron 9 months after a fall applied treatment.

Treatment	Rate	Canada thistle control	Total veg. control
	oz/A	%	
Chlorsulfuron + Silwet[a]	0.75 + 0.25%	84	76
Chlorsulfuron + Silwet[a]	1.5 + 0.25%	95	75
Chlorsulfuron + Silwet[a]	2.25 + 0.25%	93	90
Metsulfuron + Silwet[a]	0.6 + 0.25%	100	54
Metsulfuron + Silwet[a]	1.2 + 0.25%	100	70
Metsulfuron + 2,4-D + dicamba + Silwet[a]	0.6 + 16 + 4 + 0.25%	86	70
Metsulfuron + 2,4-D + dicamba + Silwet[a]	1.2 + 16 + 4 + 0.25%	100	90
Dicamba + Silwet[a]	4 + 0.25%	86	14
Dicamba + 2,4-D + Silwet[a]	4 + 16 + 0.25%	99	58
Clopyralid + 2,4-D + Silwet[a]	4 + 24 + 0.25%	86	5
LSD (0.05)		8	24

[a] Silicone surfactant.

Table 2. Spotted knapweed control with chlorsulfuron and metsulfuron applied in June on a sandy gravely soil.

Treatment	Rate	Control/MAT[a]		
		3	12	15
	oz/A	%		
Chlorsulfuron + Silwet[b]	0.75 + 0.25%	7	25	3
Chlorsulfuron + Silwet[b]	1.5 + 0.25%	15	39	5
Chlorsulfuron + Silwet[b]	2.25 + 0.25%	29	14	0
Metsulfuron + Silwet[b]	0.6 + 0.25%	34	31	10
Metsulfuron + Silwet[b]	1.2 + 0.25%	34	30	23
Metsulfuron + 2,4-D + dicamba + Silwet[b]	0.6 + 16 + 4 + 0.25%	64	52	31
Metsulfuron + 2,4-D + dicamba + Silwet[b]	1.2 + 16 + 4 + 0.25%	71	55	23
Dicamba + Silwet[b]	4 + 0.25%	61	70	33
Dicamba + 2,4-D + Silwet[b]	16 + 4 + 0.25%	65	45	11
Clopyralid + 2,4-D + Silwet[b]	4 + 24 + 0.25%	96	94	75
LSD (0.05)		44	37	29

[a] Months after treatment.
[b] Silicone surfactant.

Evaluation of dicamba and quinclorac applied alone and with diflufenzopyr for general broadleaf weed control in pasture. Rodney G. Lym and Katheryn M. Christianson. (Department of Plant Sciences, North Dakota State University, Fargo, ND 58105). Previous research at North Dakota State University has shown that leafy spurge and Canada thistle control increased when the auxin transport inhibitor diflufenzopyr was applied with various auxin herbicides compared to the herbicides alone. Quinclorac was recently labeled for leafy spurge control. A unique attribute of this herbicide compared to other herbicides used for leafy spurge control is that quinclorac has a narrow spectrum of weed control and does not injure many desirable broadleaf plants. The purpose of this research was to evaluate diflufenzopyr applied alone and with quinclorac or dicamba for general broadleaf weed control in pasture.

The experiment was established in a pasture that contained a variety of broadleaf weeds on the NDSU Albert Ekre Experiment Station near Walcott, ND. Herbicides were applied on June 14, 1999 when most of the weeds were in the vegetative growth stage either alone or with diflufenzopyr at a ratio of 2.5:1 or 10:1 herbicide:ATI. Treatments were applied with a hand sprayer delivering 8.5 gpa at 35 psi. The plots were 10 by 30 feet and replicated four times in a randomized complete block design.

The major species present included wild licorice [Pursh *Glycyrrhiza lepidota* (Nutt.)], hairy vervain (*Verbena stricta* Vent.), and goldenrod (*Solidago* spp.), with common ragweed (*Ambrosia artemisiifolia* L.) and common milkweed (*Asclepias syriaca* L.) found occasionally throughout the experiment. None of the major weed species was found in every plot so prior to herbicide application each plot was evaluated for species presence or absence. Weed control was evaluated on August 18, 1999 and based on presence or absence of the various species.

Quinclorac applied alone or with diflufenzopyr generally did not injure wild licorice or common milkweed (Table). However, quinclorac did injure hairy vervain, goldenrod and ragweed and the amount of injury increased as the quinclorac application rate increased and if diflufenzopyr was applied with the herbicide. For example, quinclorac applied at 0.25 and 0.75 lb/A alone reduced the number of plots that contained goldenrod from 100% prior to treatment to 50 and 25%, respectively, by September. The plants that remained had auxin-like injury symptoms. When quinclorac was applied with diflufenzopyr goldenrod control was nearly 100% regardless of quinclorac application rate or diflufenzopyr ratio. Quinclorac controlled ragweed whether applied alone or with diflufenzopyr.

In general, dicamba controlled goldenrod and ragweed, but not wild licorice regardless if applied alone or with diflufenzopyr (Table). Dicamba only slightly injured hairy vervain when applied alone, but injury increased dramatically when dicamba was applied with diflufenzopyr. Diflufenzopyr applied alone tended to injure hairy vervain, goldenrod, and ragweed but not wild licorice, or common milkweed. Injury was independent of diflufenzopyr application rate regardless of weed species.

In summary, diflufenzopyr applied alone injured several weed species evaluated in this study. The addition of diflufenzopyr to quinclorac caused increased goldenrod injury compared to quinclorac applied alone. Also, hairy vervain injury and control increased when diflufenzopyr was applied with dicamba compared to dicamba applied alone. Thus, the spectrum of weeds controlled by an auxin herbicide will likely increase when diflufenzopyr is applied with the herbicide and the amount of increase is herbicide and weed species dependent.

Treatment	Rate	Wild licorice		Hairy vervain		Goldenrod		Ragweed		Milkweed	
		Pre[a]	Post[a]	Pre[a]	Post[a]	Pre[a]	Post[a]	Pre[b]	Post[b]	Pre[b]	Post[b]
	lb/A	- % of plots in the treatment with plants -						Plants found occasionally			
Quinclorac+Scoil	0.25+1 qt	100	75	75	100*i*[d]	100	50*i*[d]	a	a	p	p
Quinclorac+Scoil	0.5+1 qt	100	100	0	50	100	25*i*[d]	a	a	p	p
Quinclorac+Scoil	0.75+1 qt	75	50*i*[d]	50	75*i*[d]	100	25*i*[d]	p	a	a	a
Quin[c]+diflu[c] + Scoil	0.25+0.025+1 qt	75	75	50	50*i*[d]	100	0	p	a	p	p
Quin[c]+diflu[c] + Scoil	0.25+0.1+1 qt	50	50	75	25*i*[d]	100	0	p	a	a	a
Quin[c]+diflu[c] + Scoil	0.5+0.05+1 qt	50	50	0	25	100	25*i*[d]	p	a	a	a
Quin[c]+diflu[c] + Scoil	0.5+0.2+1 qt	100	75	50	25*i*[d]	100	0	a	a	p	p
Quin[c]+diflu[c] + Scoil	0.75+0.075+1 qt	75	75	50	0	100	0	p	a	a	a
Quin[c]+difluc + Scoil	0.75+0.3+1 qt	75	50	50	0	100	0	p	a	a	a
Dicamba+X-77	0.5+0.25%	100	75	25	75	100	25*i*[d]	p	a	p	p
Dicamba+X-77	1+0.25%	75	50	25	50*i*[d]	100	0	p	a	p	p
Dicamba+X-77	2+0.25%	75	75	50	0	100	0	a	a	p	*i*[d]
Dicamba+diflu[c]+X-77	0.5+0.05+0.25%	100	75	25	25	100	0	p	a	p	a
Dicamba+diflu[c]+X-77	0.5+0.2+0.25%	75	75	50	25	100	25	p	a	p	p
Dicamba+diflu[c]+X-77	1+0.1+0.25%	50	50	0	0	100	0	p	a	a	a
Dicamba+diflu[c]+X-77	1+0.4+0.25%	75	75	25	0	100	25	p	a	a	a
Dicamba+diflu[c]+X-77	2+0.2+0.25%	75	50	50	0	100	0	p	a	p	p
Dicamba+diflu[c] +X-77	2+0.8+0.25%	75	0	100	0	100	0	a	a	p	a
Diflufenzopyr+X-77	0.1+0.25%	25	50	50	25	100	25*i*[d]	p	a	p	p
Diflufenzopyr+X-77	0.2+0.25%	75	50	75	50*i*[d]	100	50*i*[d]	a	a	p	p
Diflufenzopyr+X-77	0.4+0.25%	100	75	75	50*i*[d]	100	75*i*[d]	a	a	a	a
Diflufenzopyr+X-77	0.8+0.25%	50	25	25	25*i*[d]	100	50*i*[d]	p	a	p	p
Picloram+2,4-D	0.5+1	100	25	0	0	100	25	p	a	p	a

[a] Percent of plots with plant present prior to and following herbicide application.

[b] P = plants were present, a = plants were absent in any of the plots prior to or following herbicide application.

[c] Quin = quinclorac, diflu = diflufenzopyr.

[d] Plants were present but had auxin herbicide type injury or were otherwise stunted.

Leafy spurge control with *Aphthona nigriscutis* alone or combined with herbicides. Rodney G. Lym, Don A. Mundal, and Robert B. Carlson. An experiment to evaluate the effect of herbicide application timing on biocontrol insect population and leafy spurge control was established on a private farm near Cuba, North Dakota. Approximately 500 *Aphthona nigriscutis* were released in July 1989 in a moderately dense patch of leafy spurge. The insects established and began to spread to other patches of leafy spurge within the pasture prior to the beginning of this experiment.

The experiment was established in two patches of leafy spurge approximately 5000 square feet each and about 100 yards apart. The treatments included picloram plus 2,4-D at 0.5 + 1 lb/A fall applied, picloram plus 2,4-D at 0.25 + 1 lb/A spring applied, and an untreated control. Herbicides were applied annually beginning with the initial spring treatment on June 5, 1992, and the first fall treatment on September 10, 1992. Herbicides were reapplied at similar dates from 1993 to 1995. The plots were 15 by 50 feet, and treatments were replicated four times (two per patch). *A. nigriscutis* population was evaluated by sweep counts with a standard insect collection net and are reported as a mean of three square meters (five sweeps equals 1 m^2).

Leafy spurge stem density declined rapidly when herbicides were fall applied to plants infested with *A. nigriscutis* (Table 1). The leafy spurge stand declined from 164 stems/m^2 in 1992, to 10 stems/m^2 the following year. Leafy spurge gradually declined with the insect alone treatment from 187 stems/m^2 in June 1992 to 5 stems/m^2 by May 1995. Both the insect alone and fall-applied herbicide plus insect treatments provided more rapid leafy spurge stem reduction than the spring-applied herbicides plus insects treatment. Herbicides applied in June prevent the adult flea beetles from feeding on those plants, and thus probably reduce egg laying and subsequent larvae feeding.

Leafy spurge stem density continued to decline over time and averaged 11 stems/m^2 in 1999. Since herbicide application was stopped after 1995, the decline is due to control by *Aphthona* flea beetles alone (Table 1). Control tended to be better with the picloram plus 2,4-D applied in the fall with insects and the insects alone treatment compared to the same herbicides applied in the spring. It is likely that the *A. nigriscutis* will maintain long-term leafy spurge control without further chemical treatments.

The *A. nigriscutis* population gradually increased over time from 1993 to 1996 and averaged 90 adults/m^2 in 1997 and 1998 regardless of treatment (Table 2). Flea beetle population began to decline in 1997 as the leafy spurge density decreased. There was an average of only 23 beetles/m^2 in 1998 regardless of the initial treatment. Thus, 9 yr after the initial release of flea beetles, the population appeared to be in equilibrium with the leafy spurge population. It took 4 yr less for this equilibrium to be reached when herbicides were used in conjunction with the biocontrol agents compared to the insects alone.

In summary, the fall herbicide treatment combined with the biological control agent *Aphthona nigriscutis* provided more rapid leafy spurge control than the insects alone. The leafy spurge density gradually declined when only insects were present and took 3 yr longer to reduce the infestation to the same level achieved in 1 yr by the herbicide-plus-insect combination treatment and 4 yr longer than herbicides alone (based on long-term averages). Leafy spurge density and *A. nigriscutis* population had reached an equilibrium by 6 yr after the first herbicide treatment and are expected to maintain acceptable long-term leafy spurge control.

Table 1. Leafy spurge stem density after treatment with *Aphthona nigriscutis* alone or combined with herbicide treatments near Cuba, ND.

		Stem density/evaluation date							
Treatment[a]	Rate	June 1992	May 1993	May 1994	May 1995	June 1996	June 1997	June 1998	June 1999
	lb/A	No./m^2							
Picloram + 2,4-D (Spring)	0.25+1	220	208	134	16	22	13	15	17
Picloram + 2,4-D (Fall)	0.5+1	164	10	11	0.5	0.5	12	11	9
Insect only	. .	187	150	99	5	13	17	17	7
LSD (0.05)		30	27	20	10	10	NS	NS	5

[a] Herbicides annually applied in June or September from 1992 to 1995.

Table 2. Effect of herbicide application on *Aphthona nigriscutis* population 3 yr after the biocontrol insect had established.

		A. nigriscutis counts[b]/year							
Treatment[a]	Rate	1992	1993	1994	1995	1996	1997	1998	1999
	lb/A	No./m^2							
Picloram + 2,4-D (Spring)	0.25+1	1	0	19	76	25	12	17	19
Picloram + 2,4-D (Fall)	0.5+1	21	52	40	30	18	8	26	20
Insects only	. .	12	28	132	70	96	23	27	24
LSD (0.05)		5	16	63	26	29	6	NS	NS

[a] Herbicides annually applied in June or September from 1992 through 1995.
[b] Highest number collected during sampling from June through September.

Evaluation of *Aphthona czwalinae/lacertosa* combined with various auxin herbicides for leafy spurge control. Rodney G. Lym and Katheryn M. Christianson. (Plant Sciences Dept., North Dakota State University, Fargo, ND 58105). Previous research at North Dakota State University has found that a combination of *Aphthona* spp. flea beetles with picloram plus 2,4-D provides more rapid and better leafy spurge control than either method used alone. The purpose of this research was to evaluate leafy spurge control using a mixed population of *A. czwalinae/lacertosa* flea beetles alone or combined with picloram and/or 2,4-D for leafy spurge control.

The experiment was established on a 2 acre area of leafy spurge where biocontrol agents had not previously been introduced near Buffalo, ND. The leafy spurge density was moderate to high and averaged 128 stems/m^2. The soil was a loam with 45:37:18 sand:silt:clay, 26% organic matter, and a pH of 8. The experiment was a randomized complete block design with two blocks of paired plots and four replications. The treatment block that included *Aphthona* spp. was separated from the herbicide only treatment block by 300 feet.

Foliar cover, percent forbs and grass, and leafy spurge density were determined on June 6, 1996, using a 0.25 m daubenmier frame. There were four counts diagonally across each plot. Approximately 10,000 *Aphthona czwalinae/lacertosa* were released into the insect block on July 10, 1996 with 2,000 released per replication and an additional 2,000 in an X formation across the block. *Aphthona* spp. population was evaluated by sweep counts with a standard insect collection net in late-June in 1997 and subsequent years. Population counts are reported as a mean of three square meters (five sweeps equals 1 m^2).

Herbicide treatments were applied using a hand-boom sprayer delivering 8.5 gpa at 35 psi in mid-September 1997 and again in 1998 to the same plots. Herbicides were applied to both the herbicide only and insect plus herbicide blocks in September because *Aphthona* spp. adults have completed their life-cycle by then. Leafy spurge stand counts were determined in May of each year in the manner as previously described. Visual evaluations of leafy spurge control were determined in late-August to early-September of each year and were an estimate of percent stand reduction as compared to the control .

Leafy spurge was the major plant species present when the experiment began (Table). In general, leafy spurge stem density was lower when picloram and 2,4-D were applied alone or in combination to leafy spurge infested with *Aphthona* spp. compared to no biocontrol agents. For instance, leafy spurge stem density averaged 39 and 24 stems/m^2 in 1998 when picloram was applied alone or with 2,4-D, respectively, in 1997 without *Aphthona* spp. compared to 8 and 1 stems/m^2, respectively, when *Aphthona* were present. 2,4-D applied alone did not reduce the leafy spurge stem density after two annual application and averaged 118 stems/m^2 in 1999 compared to 0.8 stems/m^2 when applied to leafy spurge infested with *Aphthona* spp.

Although the combination of *Aphthona* spp. and herbicides reduced the leafy spurge stem density to near 0 when evaluated in May 1999, the reduction was short-lived (Table). After 3 yr, leafy spurge control only averaged 9% with the insect alone. Control averaged 73% following two annual applications of picloram or picloram plus 2,4-D and was similar whether or not the

treatments were combined with the biocontrol agent.

Aphthona czwalinae/lacertosa established and were found in low numbers in 1997, 1 yr after release (data not shown). The biocontrol agent population gradually increased over time and averaged 103 adults/m^2 in 1999 in the insect only treatment (Table). The adult population was lower when combined with a herbicide treatment compared to the insects alone which is probably due to the lower number of leafy spurge stems available for adult feeding.

		Visual cover[a]		Leafy spurge							
		Forbs		Stand count[b]				Control[c]		Flea beetles	
Treatment	Rate	grass	Litter	1996	1997	1998	1999	1998	1999	1998	1999
	– lb/A –	— % —		— No./m^2 —				— % —		No./ m^2	
Herbicide only											
Picloram + 2,4-D	0.5 + 1	31	9	128	167	24	3	44	71		
2,4-D	1	23	9	138	173	139	118	5	0		
Picloram	0.5	31	12	137	151	39	0.5	36	87		
Untreated	...	47	13	120	170	144	101	0	0		
Herbicide with insects											
Picloram + 2,4-D	0.5 + 1	31	15	129	144	1	0	73	58	13	13
2,4-D	1	26	13	146	166	66	0.8	23	54	25	34
Picloram	0.5	30	15	122	157	8	0	45	76	15	7
Insects only	...	47	13	103	81	47	13	3	9	17	103
LSD (0.05)		10	NS	NS	38	25	13	22	25	6	41

[a] Average of four evaluations per plot made prior to insect release and to be repeated at end of study.
[b] Average of four 0.25m^2 counts per plot evaluated in late-May each year.
[c] Visual evaluations made in late-August to early-September each year.

Summary of research progress at the Gilbert C. Grafton State Military Reservation. Rodney G. Lym and Katheryn M. Christianson. (Plant Sciences Department, North Dakota State University, Fargo, 58105) The long-term goal of this project is to control leafy spurge in a wide variety of environments using biological control and grazing management while minimizing the use of herbicides. Each control tool can successfully be used at Camp Grafton South (CGS); however, because of the mission to train troops on this land, varying terrain and ecosystems, and past history of land use, not all tools can be used successfully in all parts of CGS.

The purpose of the current research is to evaluate long-term leafy spurge control a) with herbicides combined insect biocontrol agents, b) with various herbicides in a rotational program, and c) with imazapic. Imazapic is a new herbicide that works best when applied in the fall and may be a very useful management tool on CGS.

An experiment to evaluate the effect of herbicide application timing on biocontrol insect establishment and leafy spurge control was established on 15 July 1993 when 30,000 *A. czwalinae/lacertosa* were released and stand density evaluated (Table 1). The treatments included picloram plus 2,4-D at 0.5 + 1 lb/A fall applied, picloram plus 2,4-D at 0.25 + 1 lb/A spring applied, and an insects-only untreated control. The initial herbicide treatment was fall-applied on September 24, 1993 or spring-applied on 22 June 1994 and repeated at approximately the same dates in 1994 and 1995. Herbicide treatments were discontinued in 1996. All treatments were replicated three times. *A. czwalinae/lacertosa* population and leafy spurge density were evaluated annually beginning in 1994.

The integration of herbicides with biocontrol insects provided more rapid leafy spurge control than either method used alone. The combination of picloram plus 2,4-D applied in the fall with *Aphthona* spp. flea beetles reduced leafy spurge stem density to less than 3 stems/m^2 following two annual treatments (1995) a level of control not reached by the insects alone until 1999 (Table 1). Biological control of leafy spurge was termed "successful" in 1999 when leafy spurge stem density averaged 15 stems/m^2 or less and the *Aphthona* population averaged 30 adults/m^2 regardless of original treatment. The insects had generally moved out of the experimental area in 1999, six years after release as there were very few stems remaining for them to feed on.

Herbicide treatments did not affect the *A. czwalinae/lacertosa* population which established rapidly at this location on CGS (Table 2). More adult flea beetles were found in the fall-applied herbicide treatment plots than either of the other treatments. This is similar to previous research which has shown that herbicides fall-applied on leafy spurge infested with flea beetle biocontrol agents results in more rapid leafy spurge control and a faster increase in flea beetle population than either control method used alone. The flea beetle population was generally stagnant until 1996, when there was a large increase observed, especially in the insect only treatment which averaged 75 beetles/m^2. The average beetle population increased again in 1998 with the most found in the insect only or insect plus fall-applied herbicide treatments.

A project to demonstrate leafy spurge control at CGS using presently labeled and some soon to be

labeled herbicides was established in 1997 (Table 3). Treatments were spring or fall applied annually to one plot (15 by 50 feet) and were designed to demonstrate how much control and how long to expect control to last for each of the herbicides currently recommended for use on CGS.

The picloram plus 2,4-D combination treatment and imazapic have provided good initial leafy spurge control at CGS without grass injury. Picloram plus 2,4-D at 0.5 + 1 lb/A provided better initial leafy spurge control than picloram plus 2,4-D at 0.25 + 1 lb/A, but also costs twice as much. Glyphosate plus 2,4-D (Landmaster BW) has not provided as good of leafy spurge control at CGS as in other areas of the state, which is unfortunate because it is much less expensive than other commonly used herbicides for leafy spurge control.

Once imazapic (Plateau) is cleared for use on grazing land, this compound will be a welcome addition to the leafy spurge management program at CGS. Leafy spurge control has averaged 90 to 100% in the initial trial at CGS with little or no grass injury. This compound is less expensive than the standard picloram plus 2,4-D treatment and is safe to use near trees. Initial control averaged 98% in the spring following the first fall treatment and 55% in August 1999 2 years after the second treatment which was higher than any other fall-applied treatment (Table 3).

Imazapic was found to be safe for use under trees at CGS. Leafy spurge control averaged 100% with imazapic compared to 89% with picloram plus 2,4-D in June 1997 (Table 4). There was 23% grass injury with imazapic applied at 3 oz/A. Control remained high 12 MAT with both imazapic treatments and averaged 95% control compared to 48% with picloram plus 2,4-D and the grass had recovered. Control declined by September 1998, to an average of 60% compared to no control with the picloram plus 2,4-D treatment. No injury to the trees was observed.

Previous research at North Dakota State University has indicated that imazapic will provide season long control but may injure cool season grasses, especially at the maximum use rate of 3 oz/A. The label recommends to apply imazapic with methylated seed oil (MSO) and 28% nitrogen for maximum leafy spurge control. However, adding adjuvants also increases treatment cost. The objective of this study was to evaluate imazapic applied with or without adjuvants to maximize leafy spurge control and minimize grass injury.

The experiment was established September 10, 1997 on a dense stand of leafy spurge on a steep hill located in the northeast corner of CGS. Imazapic was applied at 1 or 2 oz/A alone, with a MSO, with nitrogen, or with a MSO plus nitrogen. The standard treatment for comparison was picloram plus 2,4-D applied at 8 + 16 oz/A. Treatments were applied to leafy spurge in the fall regrowth growth stage with a CO_2 pressurized handboom sprayer delivering 8.5 gpa at 35 psi. The air temperature was 83 F and the dew point 61 F. The first killing frost occurred October 13, 1997, over 1 month after application. The experiment was a randomized complete block design, replicated four times, and each plot was 10 by 30 feet. Treatments were reapplied September 22, 1998 to the same plots.

Leafy spurge control with imazapic increased when the herbicide was applied with a MSO compared to alone (Table 5). Treatments that included a MSO averaged 90% control in May 1999, regardless of application rate, compared to only 22 or 72% control with imazapic at 1 or 2 oz/A alone, respectively. Imazapic applied in 1997 and 1998 at 2 oz/A with MSO plus 25%N averaged 50% control by September 1999, compared to 20% with the current standard treatment of picloram plus 2,4-D at 0.5 + 1 lb/A.

Leafy spurge control was not consistently increased when nitrogen was added to imazapic (Table 5). Nitrogen did not increase leafy spurge control with imazapic applied at 1 oz/A alone or with MSO. However, imazapic at 2 oz/A plus MSO and 28% N provided slightly better leafy spurge control at 77% by September 1998, compared to 58% with imazapic at 2 oz/A plus a MSO.

Leafy spurge control with imazapic at Camp Grafton South has generally been less than observed in other areas of the state. The reason for the shorter term control are not known. Perhaps the herbicide dissipates from the root zone faster on the hilly and sandy terrain of CGS then it does in other areas. However, control was still better with imazapic than the currently used herbicides.

Table 1. Leafy spurge control with *A. czwalinae/lacertosa* and herbicide treatments, first treatment applied fall 1993 on Camp Grafton South.

Treatment	Rate	Leafy spurge stand count									
		1993	1994		1995		1996		1997	1998	1999
		July	May	Aug	May	Aug	June	Aug	June	June	June
	– lb/A –	No./m^2									
Picloram + 2,4-D (Spring)	0.25 + 1	128	154	73	154	26	29	11	3	15	8
Picloram + 2,4-D (Fall)	0.5 + 1	124	2	79	3	74	7	44	20	35	17
Insects only		122	146	75	159	122	150	129	67	66	20
LSD (0.05)		NS	14	NS	18	14	13	15	9	10	5

Table 2. The effect of herbicide treatment on *A. czwalinae/lacertosa* population in leafy spurge.

		A. czwalinae/lacertosa					
		1994	1995	1996	1997	1998	1999
Treatment	Rate	June	June	July	July	June	June
	— lb/A —	———	No./m^2	———		———	
Picloram + 2,4-D (Spring)	0.25 + 1	3	12	36	3	28	28
Picloram + 2,4-D (Fall)	0.5 + 1	10	32	22	17	57	23
Insects only	. . .	7	12	75	22	48	38
LSD (0.05)		NS	17[a]	20	9	18	NS

[a] LSD = (0.10)

Table 3. Demonstration of leafy spurge control with various herbicides at Camp Grafton South.

		1998			1999	
		May		August	May	August
Annual treatment	Rate	Control	Grs inj.	Control[b]	Control	Control
	— oz/A —	———		%	———	
Applied in June						
Picloram	4	..	..	20	12	50
Picloram + 2,4-D	4 + 16	..	..	50	7	80
Picloram + 2,4-D	8 + 16	..	..	55	83	90
Picloram	8	..	..	30	75	95
Fosamine	128	..	..	12	63	95
2,4-D	32	..	..	12	8	5
Dicamba	32	..	..	12	0	25
Glyphosate + 2,4-D[a]	16	..	..	73	8	50[c]
Fall						
Picloram	8	85	15	45	92	40
Picloram + 2,4-D	8 + 16	88	25	33	92	25
Picloram + 2,4-D	4 + 16	78	10	10	86	30
2,4-D	32	20	0	0	50	0
Dicamba	32	65	5	40	75	20
Glyphosate + 2,4-D[a]	16	70	10	15	85[c]	10[c]
Imazapic + Sunit+ 28% N	2 + 1 qt + 1qt	98	10	60	95	55

[a] Commercial formulation - LandmasterBW.
[b] No grass injury was observed
[c] Approximaelty 20% grass injury observed.

Table 4. Imazapic for leafy spurge control near trees established on Camp Grafton South.

Treatment[a]	Rate	Evaluation					
		1997				1998	
		June		Sept.		June	Sept.
		Control	Grass inj.	Control	Grass inj.	Control	Control
	— oz/A —	— % —					
Imazapic + MSO[b] + 28% N	2 + 1 qt + 1 qt	100	11	93	0	56	52
Imazapic + MSO[b] + 28% N	3 + 1 qt +1 qt	100	23	96	3	84	66
Picloram + 2,4-D	8 + 16	89	0	48	0	6	0
LSD (0.05)		8	9	14	NS	32	26

[a] Treatments applied August 29, 1996.
[b] Methylated seed oil was Sun-It II by AGSCO.

Table 5. Imazapic fall-applied with and without adjuvants for leafy spurge control at CGS.

Treatment[a]	Rate	Evaluation					
		May 1998		September 1998		1999	
		Control	Grass injury	Control	Grass injury	May	Aug
	— oz/A —	— % —					
Imazapic	1	7	0	6	0	22	0
Imazapic	2	30	1	3	0	72	2
Imazapic + MSO[b]	1 + 1qt	91	9	36	0	93	25
Imazapic + MSO[b]	2 + 1qt	98	6	58	0	94	35
Imazapic + 28% N	1 + 1qt	11	0	1	0	43	0
Imazapic + 28% N	2 + 1qt	43	1	7	0	66	0
Imazapic + MSO[b] + N	1 + 1qt + 1qt	85	9	33	0	79	8
Imazapic + MSO[b] + N	2 + 1qt + 1qt	98	4	77	0	95	50
Picloram + 2,4-D	8 + 16	41	0	11	0	69	20
Control	0	0	0	0	0	0	
LSD (0.05)		14	NS	14	NS	21	16

[a] Treatments were applied September 10, 1997 and September 22, 1998.
[b] Methylated seed oil was Sun-It II by Agsco.

TEAM leafy spurge research and demonstration results. Rodney G. Lym and Katheryn M. Christianson. (Plant Sciences Department, North Dakota State University, Fargo, ND 58105). TEAM Leafy Spurge is a five-year IPM research and demonstration project funded by the USDA-ARS in partnership with the USDA-Animal and Plant Health Inspection Service. The long-term goal is to provide landowners and land managers with leafy spurge control techniques based on IPM strategies. Most of the demonstration plots and research areas are located along the Little Missouri River in southwestern North Dakota. The purpose of this part of the project was to demonstrate leafy spurge control with various herbicides and an integrated management program using biological and chemical control methods. The herbicide demonstration included representative treatments for both short- and long-term control at various costs including treatments for a variety of environments from open range land to under trees and near stream banks and under trees.

The herbicide demonstration area was established on the Roger Meyers Ranch, Medora, ND, in May 1998. The initial herbicide application for spring treatments was made on June 6, 1998 and the mid-summer treatment of glyphosate plus 2,4-D (Campaign) was applied on July 3, 1998 (Table 1). The initial fall-applied treatments were made on September 6, 1998. Retreatments were applied to the same plots in June and September 1999. The demonstration plots were 15 by 50 feet and were not replicated. Leafy spurge control was visually evaluated and based on percent stand reduction compared to the untreated control.

Leafy spurge control was generally similar to that expected based on long-term research at North Dakota State University (Table 1). 2,4-D only provided short-term top growth control but is the least expensive of the herbicides evaluated. The most commonly used treatment in North Dakota is picloram plus 2,4-D at 0.25 + 1 lb/A or 0.5 + 1 lb/A applied as an annual treatment. Occasionally, the higher rate is applied the first year, followed by the lower rate in subsequent years. Control averaged 10 and 67% 12 months after treatment (MAT) in June when picloram plus 2,4-D was applied at 0.5 + 1 lb/A or 0.25 + 1 lb/A, respectively. Fosamine can be used up to the waters edge, but control only averaged 10% 12 MAT in this trial. The fosamine formulation was evaluated in greenhouse trials and found to be defective, thus the herbicide was reapplied in 1999. Dicamba at 2 lb/A only provided short-term control and is not cost-effective for leafy spurge. Glyphosate plus 2,4-D is the least expensive treatment evaluated that also provided longer-term control. This treatment was alternated with picloram plus 2,4-D in 1999 to avoid possible grass injury.

Imazapic provided the best leafy spurge control of any of the fall applied treatments evaluated and averaged 95% in June 1999 compared to 60% with picloram plus 2,4-D. No other treatment applied in the fall of 1998 provided satisfactory leafy spurge control in 1999.

A herbicide-biocontrol agent demonstration area was also established on the Roger Meyers Ranch in 1998. Both *Aphthona nigriscutis* and the mixed species *A. czwalinae/lacertosa* had been initially introduced into this area in 1993. Although present in small numbers the population had not increased from year to year and the leafy spurge infestation continued to expand.

The demonstration area was established in May 1998, and leafy spurge density and flea beetle population were determined in July (Table 2). Flea beetles were present in low numbers and no additional biocontrol insects were released. Herbicide treatments were applied in mid-September 1998 and included picloram plus 2,4-D, imazapic, and quinclorac. The plots were 15 by 50 feet and the treatments were applied so that an insect only treatment bordered at least one side of each herbicide treated plot.

Imazapic reduced the leafy surge stand the most of the treatments evaluated and averaged only 8 stems/m^2 compared to 114 stems/m^2 prior to treatment in 1998 (Table 2). Stem density increased with the *Aphthona* only treatment from 136 to 173 stems/m^2 in 1998 and 1999, respectively, even though there was a dramatic increase in adult beetles over the same time period. It is expected that once the leafy spurge stem density is decreased by the combination treatments, the *Aphthona* spp. flea beetles will maintain acceptable leafy spurge control.

Table 1. TEAM leafy spurge herbicide demonstration trial, Roger Meyers Ranch, Medora, ND.

Application time and treatment	Rate	Application time and treatment	Rate	Control[a] Sept 98	June 99	Sept 99	Cost[a]
	oz/A		oz/A				
Spring and summer					%		$/A
1998 treatment		1999 treatment					
2,4-D amine	16	2,4-D amine	16	40	0	10	12
Picloram	4	Picloram	4	60	10	90	20
Picloram + 2,4-D	4 + 16	Picloram + 2,4-D	4 + 16	75	10	90	32
Picloram + 2,4-D	8 + 16	Picloram + 2,4-D	4 + 16	95	67	98	42
Picloram	16	Picloram	16	100	95	95	80
Fosamine	128	Fosamine	128	15	10	75	80[c]
Dicamba	32	Dicamba	32	80	0	92	80
Glyphosate + 2,4-D[b]	6 + 10	Glyphosate + 2,4-D[b]	6 + 10	87	40	5	18
Glyphosate + 2,4-D[b]	6 + 10	Picloram + 2,4-D	4 + 16	87	50	96	25
Fall applied							
1998 treatment		1999 treatment					
Picloram	8	Picloram	8		45	25	40
2,4-D amine	16	2,4-D amine	16		0	0	12
Picloram + 2,4-D	8 + 16	Picloram + 2,4-D	8 + 16		60	40	52
Dicamba	32	Dicamba	32		10	10	80
Imazapic + MSO + 28% N	2 + 1 qt + 1 qt	Imazapic + MSO + 28% N	2 + 1 qt + 1 qt		95	30	38
Imazapic + MSO + 28% N	2 + 1 qt + 1 qt	Picloram + 2,4-D	8 + 16		95	35	39

[a] Herbicide cost for 1998 and 1999 treatments, does not include application costs.
[b] Commercial formulation Campaign

[c] The fosamine formulation applied in 1998 was defective and the costs only include the 1999 retreatment.

Table 2. TEAM leafy spurge herbicide insect IPM demonstration project, Roger Meyers Ranch, Medora, ND.

Treatment	Rate	Stand count[a]		*Aphthona* spp.[b]	
		1998	1999	1998	1999
	oz/A	——— No./m^2 ———			
Picloram + 2,4-D	8 + 16	108	81	17	90
Imazapic + MSO + 28% N	2 + 1 qt + 1 qt	114	8	7	20
2,4-D	16	92	128	14	105
Aphthona spp. alone		136	173	17	90
LSD (0.05)		NS	25	NS	43

[a] Evaluated in June each year.
[b] Mixed population of *Aphthona nigriscutis*, *A. czwalinae*, and *A. lacertosa*, estimated in July each year.

Response of the prairie fringed orchid to herbicides for leafy spurge control. John J. Sterling, Rodney G. Lym, and Donald R. Kirby. (Plant Sciences and Animal and Range Sciences Department, North Dakota State University, Fargo, ND 58105). Approximately 15 to 20% of the Sheyenne National Grassland in southeastern North Dakota is infested with leafy spurge. These infestations threaten habitat of the western prairie fringed orchid, which is on the federal threatened and endangered species list. The purpose of this research was to evaluate various herbicide treatments to control leafy spurge while sustaining western prairie fringed orchid populations and other non-target species.

The first experiment was established to evaluate various herbicides for leafy spurge control in an area likely to support the western prairie fringed orchid on the Sheyenne National Grassland. Herbicides included glyphosate plus 2,4-D, imazapic plus MSO plus 28% N and quinclorac plus MSO and were applied in September 1997 and reapplied in 1998 to the same plots. Treatments were applied using a hand-held sprayer delivering 8.5 gpa at 35 psi. The plots were 10 by 30 feet, in a randomized complete block design with four replications. Leafy spurge stem density and control was evaluated in July 1998 and 1999, 10 and 22 months after the first treatment (MAFT), respectively.

Quinclorac and imazapic provided the best leafy spurge control and reduced leafy spurge density to an average of 5 and 45 stems/m^2 10 and 22 MAFT, respectively, compared to 158 and 314 stems/m^2, respectively, in the untreated control (Table 1). There was a tendency for leafy spurge stem density to decline as the herbicide application rate increased. Glyphosate plus 2,4-D reduced

stem density less than quinclorac or imazapic and control was similar to the untreated check 22 MAFT.

A seed bank study was conducted in conjunction with the herbicide efficacy trial. Each plot was divided in half and five soil cores were taken from both the left and right side for a total of 10 cores per plot. The top 2.5 cm of the soil surface plus the litter layer was removed using a standard golf cup cutter (10 cm in diameter). Soil cores were taken in May 1998 and the soil was washed through a 4 mm sieve and a 0.2 mm sieve to remove coarse and fine materials. Samples were then spread 3 to 5 mm deep on a layer of sterile sand (approximately 1 cm deep) over a 2 inch layer of potting soil. Seed from a total of 56 composite (4 replications, 7 herbicide treatments, 2 subsamples) soil cores were grown in the greenhouse. Seedlings were counted and removed after identification. Leafy spurge comprised 40% of all germinated seedlings, with grasses 25%, forbs 22%, grasslike 10%, and other species 3% (Table 2).

The second experiment was established at two locations in July 1998 to evaluate herbicide efficacy on the western prairie fringed orchid. The orchid populations were located in an exclosure located on the Sheyenne National Grassland and along a right-of-way of Highway 27 adjacent to the Grassland. A total of 48 orchids in the exclosure and 40 orchids along Highway 27 were tagged for treatment and later identification. The treatments included glyphosate plus 2,4-D at 0.4 + 0.6 lb/A, imazapic plus MSO plus 28% N at 0.125 lb +1qt + 1qt/A and quinclorac plus MSO at 1lb + 1qt/A and an untreated control. The plots were 1 m^2 located randomly within the exclosure and along Highway 27 with 12 and 10 replications, respectively. Orchids were counted on July 6, 1999 (10 MAFT) in the exclosure. However, orchids could not be counted at the Highway 27 location because of persistent flooding during the growing season.

The growth of the western prairie fringed orchid was not affected by the herbicides evaluated in this study. At least one orchid reappeared in 9 of 11 replications of the quinclorac treatment (one plot was lost) (Figure 1). Orchids reappeared in 7 of 12 replications of the imazapic and glyphosate plus 2,4-D treatments with one or more orchids present where they reappeared. The orchid reappeared in 6 of 12 replications of the control with one or more orchids where they reappeared. Orchid numbers were highest following the quinclorac treatments with 21 orchids reappearing in 1999, while imazapic, glyphosate plus 2,4-D and the untreated control had 11, 16 and 13 orchids, respectively (Figure 2).

In summary, both quinclorac and imazapic controlled leafy spurge when fall applied with no affect on the western prairie fringed orchid. Leafy spurge likely will be the first and most abundant plant to appear following a disturbance of the soil surface or after removal of the current vegetation canopy using herbicides. Thus a long-term management plan is needed to control this weed in western prairie fringed orchid habitat.

Table 1. Effect of fall applied herbicides on leafy spurge stem density applied twice[a].

Treatment	Rate	Stem density MAFT[b] 10	22
	lb/A	%	
Quinclorac+MSO	0.8+1qt	10	62
Quinclorac+MSO	1+1qt	0	19
Imazapic+MSO+28%N	0.0625+1qt+1qt	9	77
Imazapic+MSO+28%N	0.125+1qt+1qt	1	22
Glyphosate + 2,4-D	0.2+0.3	140	300
Glyphosate + 2,4-D	0.4+0.6	78	296
Control		158	314
LSD (0.05)		57	111

[a] Treatments applied in September 1997 and 1998.
[b] Months after first treatment.

Table 2. Evaluation of the seed bank in a leafy spurge infestation averaged over treatment[a].

Plant class	Total species present		Desirable	Undesirable
	— % —	— no. —	%	
Leafy spurge	40	NA	NA	NA
Grasses	25	13	15	85
Grasslike	10	2	NA	NA
Forb	22	28	14	86
Other	3	1	NA	NA

[a] Soil was sampled for seed in approximately 9 months after the first herbicide treatment. Data are averaged over the treatments detailed in Table 1.

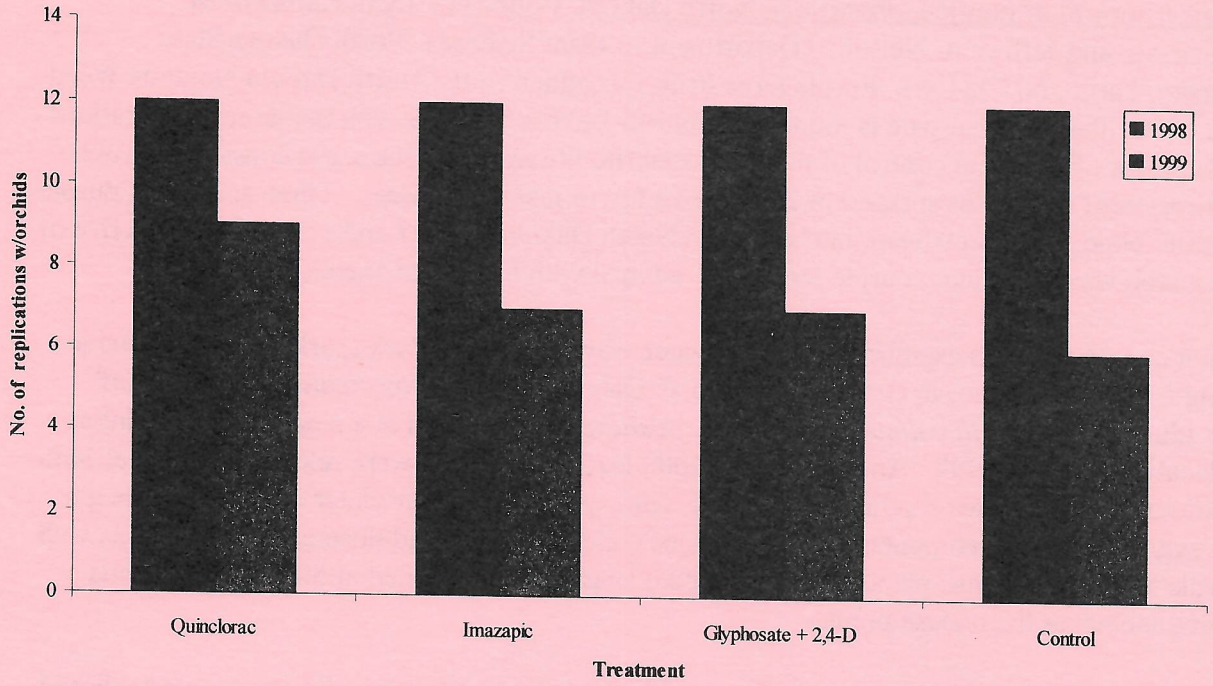

Figure 1. Effect of herbicide treatment on western prairie fringed orchid reappearance the following growing season.

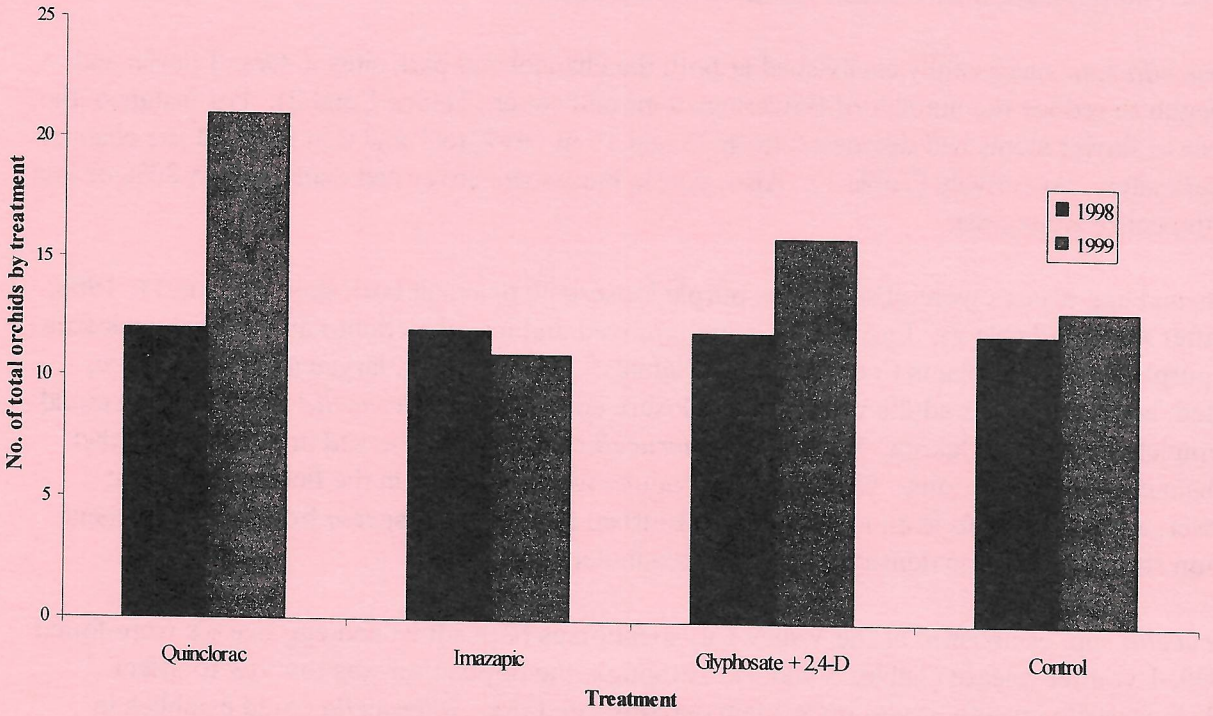

Figure 2. Total number of western prairie fringed orchids that regrew following a fall herbicide treatment.

Biological control of purple loosestrife in North Dakota. Rodney G. Lym, Katheryn M. Christianson, and Jeffrey A. Nelson. (Department of Plant Sciences, North Dakota State University, Fargo, ND 58105). Purple loosestrife was added to the North Dakota Noxious Weed List in 1996. Purple loosestrife is found in 11 North Dakota counties with the largest infestations in urban areas. Biological control of purple loosestrife fits well in urban areas considering public apprehension of herbicides sprayed in close proximity to residential areas. Three species of purple loosestrife biological agents were introduced in North Dakota in 1997 and 1998. The objective of this research was to evaluate purple loosestrife control with biological agents.

The first experiment was established along a water way at Sertoma Park (park site) and along a walking trial (channel site) in Grand Forks, North Dakota in 1997. Approximately 5,000 leaf beetle adults, *Galerucella calmariensis* and *G. pusilla*, were released at a single release point at both locations in June 1997. An additional 10,000 leaf beetle adults were released in 1999 at both locations at the same release points as in 1997. *Galerucella* spp. overwinter as adults and begin to lay eggs soon after emergence. The number of *Galerucella* spp. adults and egg masses, as well as purple loosestrife stems, plant height, and spike length were recorded at 50 foot increments from and including the release point.

A second experiment to evaluate purple loosestrife control with *Gallerucella* spp. was established in Chataque Park along the Sheyenne River in Valley City, North Dakota. Approximately 4,000 and 10,000 leaf beetle adults were released at a single release point in June 1998 and 1999, respectively. A demonstration area was also established along the Souris River on the east and west ends of Minot, North Dakota in 1998. Evaluation of purple loosestrife reduction and *Gallerucella* population was similar to the first experiment.

Galerucella spp. successfully established at both the channel and park sites in Grand Forks and had begun to reduce the number of flowering stems and cover (Tables 1 and 2). For instance, the number of flower stems had decreased from 25 and 19 in 1997, to 1 and 0 in 1999, at the channel and park sites, respectively (Table 1). Also, purple loosestrife cover had decreased to 20% or less over the entire study area.

Adults and egg masses were observed on purple loosestrife plants at both sites on June 11, 1998, 1 yr after release (Table 2). Egg masses were removed and introduced into an artificial enclosure with purple loosestrife plants to evaluate egg viability. Eggs hatched, larvae increased in size, pupated, and emerged as adults within the enclosure confirming *Galerucella* spp. life cycle could be completed in North Dakota. Few adult *Galerucella* spp. were observed in the field at either the channel or park locations. The reason few adults were observed in the field is unknown; however, adults will drop from foliage when disturbed and readily disperse from the experiment location so the population density may have been underestimated.

Galerucella spp. established at the Valley City location as both adults and egg masses were found in 1999, 1 yr after release (Tables 3 and 4). Although, the population was too low to affect purple loosestrife growth, it was once again demonstrated that *Galerucella* could establish in

North Dakota.

An experiment was established at Sertoma Park to evaluate the effect of *Hylobius transversevittatus*, a root feeding weevil, on purple loosestrife in July 1997. Approximately 1,000 *H. transversevittatus* eggs were placed into cut purple loosestrife stems or on the roots. This biological agent is nocturnal so evaluations of population density were not conducted. However, the effect of *H. transversevittatus* on purple loosestrife was evaluated by estimating stem density, plant height, and spike length in four square meter quadrats within the experiment.

Purple loosestrife stems that had been infested with *H. transversevittatus* eggs were harvested in September 1997 and dissected to determine egg viability and larval feeding. Over 50% of the harvested stems contained *H. transversevittatus* larvae. Larvae were allowed to feed but failed to develop into adults under artificial conditions. There was little reduction in stem density, stem height, and spike length from the *H. transversevittatus* release site the first 2 yrs following release (Table 5). However, numerous purple loosestrife plants appeared stunted and flowered later than plants outside the release area. Delayed flowering maybe an indication of *H. transversevittatus* larval feeding.

North Dakota State University initiated an outreach program for biological control of purple loosestrife in 1998. An implementation grant from the National Biological Control Institute provided funds to release *G. calmariensis* and *G. pusilla* at locations in Minot and Valley City, North Dakota. An educational tour was held at the Valley City location in July 1999. The demonstration areas at Minot were flooded due to frequent heavy rains and subsequent rises in the Souris River. A tour could not be held, however, *Gallerucella* spp. adults were observed on plants at the west Minot location in May 1999 (data not shown).

In summary, *Gallerucella* spp. have establish in North Dakota and have over-wintered for 2 yr. Purple loosestrife cover decreased at the Grand Forks location 2 yr after release even though *Gallerucella* spp. populations were low.

Table 1. Purple loosestrife control with *Galerucella* spp. released in 1997 at two locations in Grand Forks, ND.

Distance from release[a]	Flowering stems			Stem height		Cover		
	1997	1998	1999	1997	1998	1997	1998	1999
Channel site	—— No. ——			—— m ——		—— % ——		
0 (release)	25	60	1	1.3	1.7	100	75	5
50 ft	10	8	5	1.3	1.7	33	18	8
100 ft	15	26	23	1.2	1.8	38	34	18
150 ft	12	0	0	1.2	0	10	0	0
Park site								
0 (release)	19	10	0	1.5	1.1	60	25	0
50 ft	27	19	16	1.3	1.1	45	19	11
100 ft	20	13	16	1.3	1.1	33	28	15
150 ft	17	16	5	1.3	1.3	55	15	8

[a] Estimates of purple loosestrife control were made in mid-July each year.

Table 2. Population change over time of *Galerucella spp.* on purple loosestrife at two locations in Grand Forks, ND.

Distance from release[a]	1998 Adult	1998 Egg masses	1999 Adult	1999 Larvae	1999 Egg masses
	—— No.——		——— No.———		
Channel site					
0 (release)	0	12	1	0	1
50 ft	0	2	1	0	0
100 ft	0	1	1	0	1
150 ft	0	0	0	0	0
Park site					
0 (release)	2	21	3	0	0
50 ft	0	3	0	1	0
100 ft	0	0	0	4	0
150 ft	0	1	0	5	2

[a] Estimates of *Galerucella* adults and egg masses were made in July of each year.

Table 3. Purple loosestrife control with *Galerucella* spp. released in 1998 in Valley City, ND.

Distance from release[a]	Flowering stems 1998	Stem 1998	Stem 1999	Stem height 1999	Spike length 1999
	—— No.——	—— No.——		——— m^2 ———	
0 (release)	0	10	15	1.4	0
25 feet	6	14	19	1.2	10
50 feet	0	35	14	0.9	6

[a] Estimates of purple loosestrife control were made in mid-July each year.

Table 4. Population change over time of *Galerucella spp.* on purple loosestrife at Valley City, ND.

Distance from release[a]	1998 Eggs	1998 Larvae	1998 Adults	1999 Eggs	1999 Larvae	1999 Adults
	——— No. ———					
0 (release)	0	2	1	0	0	0
25 feet	2	1	0	2	0	2
50 feet	0	1	0	6	0	2

[a] Estimates of *Galerucella* adults and egg masses were made in July of each year.

Table 5. Purple loosestrife control with *Hylobius transversovittatus* introduced as eggs in Grand Forks, ND[a].

Flower stems			Stem		Stem height		Spike length	
1997	1998	1999	1997	1998	1997	1998	1997	1998
——— No./m^2 ———					——— m ———			
25	24	31	85	24	1.9	1.5	0.6	0.4

[a] Approximately 1000 eggs were placed into cut purple loosestrife stem in July 1997.

Canada thistle control in glyphosate resistant canola. Katheryn M. Christianson and Rodney G. Lym. (Department of Plant Sciences, North Dakota State University, Fargo, ND 58105). There are very few herbicides registered for broadleaf control in canola especially for a perennial weed such as Canada thistle. The objective of this experiment was to determine the effect glyphosate applied at various canola growth stages on crop yield and Canada thistle control.

The experiment was established at Fargo in a dense Canada thistle stand. Fertilizer was added based on soil tests for the site and incorporated May 24, 1999 and Monsanto 3753 canola was seeded later on the same date. Herbicides were applied at the 1- to 2-leaf, 3- to 4-leaf, and 5- to 6-leaf canola growth stages, on June 9, June 15, and June 24, respectively. The treatments were applied with a CO_2 backpack sprayer delivering 8.5 gpa at 35 psi. The plots were 10 by 30 feet, and the experiment was a randomized complete block design with four replicates. Canola chlorosis, plant height reduction, flowering, and Canada thistle control were evaluated and compared to the untreated check.

Glyphosate application caused minimal chlorosis when applied at all growth stages except the 5- to 6-leaf stage which averaged 23% (Table). Also, there was a tendency for plant height to be reduced when glyphosate was applied to canola at the 5- to 6-leaf stage. Plant height was reduced 31% when clopyralid plus quizalofop was applied at the 3- to 4-leaf stage. There was no significant difference in flowering 37 DAT regardless of treatment.

Canola production was the greatest, 1134 lb/A, when glyphosate was applied at 0.56 lb/A to the 1- to 2-leaf stage followed by glyphosate at 0.375 lb/A at the 5- to 6-leaf stage (Table). Canola yield tended to decline when glyphosate was applied later in the growing season. For instance, canola yield averaged 1028 lb/A when glyphosate was applied at the 1-to 2-leaf and again at the 5- to 6-leaf growth stage compared to an average of 988 lb/A and 775 lb/A when plants were treated once at the 3- to 4-leaf or 5- to 6-leaf stage, respectively. In general, canola production was lower than average due to early wet conditions delaying the planting date followed by hot dry conditions after planting.

All herbicide treatments provided greater than 90 and 95% Canada thistle control 30 DAT and at harvest, respectively. Canada thistle control still averaged 93% at 30 days after harvest regardless of the herbicide treatment.

In summary, Canada thistle control was similar regardless of the canola growth stage at application. However, canola yield tended to decline the later in the growing season the initial glyphosate application was made.

Table. Canada thistle control in glyphosate resistant canola.

Treatment	Rate	Crop growth stage	Canola				Canada thistle	
			Chlorosis 30 DAT[a]	Height Reduct.	Flowering 37 DAT[a]	Yield	30 DAT[a]	30 DAH[b]
	lb/A		%			lb/A	% control	
Glyphosate	0.375 / 0.375	1 to 2 lf / 5 to 6 lf	3/6	0/0	31	1012	98	98
Glyphosate	0.56 / 0.375	1 to 2 lf / 5 to 6 lf	3/0	1/0	33	1134	100	98
Glyphosate	0.75 / 0.375	1 to 2 lf / 5 to 6 lf	10/21	1/11	25	940	98	93
Glyphosate	0.375	3 to 4 lf	9	8	31	913	95	97
Glyphosate	0.56	3 to 4 lf	1	5	38	1124	100	97
Glyphosate	0.75	3 to 4 lf	5	11	30	957	100	97
Glyphosate	0.375	5 to 6 lf	15	16	25	592	93	93
Glyphosate	0.56	5 to 6 lf	28	6	28	845	90	98
Glyphosate	0.75	5 to 6 lf	26	20	31	885	95	96
Clopyralid + quizalofop + 1% PO	0.19+0.068+1%	3 to 4 lf	13	31	23	810	98	99
Untreated check	...	...	0	0	15	359	0	0
LSD (0.05)			11	15	15	178	NS	NS

[a] DAT is days after treatment.
[b] DAH is days after harvest.

Grass tolerance to imazapic herbicide at Hettinger. (Erik Eriksmoen). Two rates of imazapic herbicide (16 and 8 oz/A product) were applied to established but dormant plots of seven warm season and 81 cool season grass species on September 16, 1998, with 65 F air temperature, 62% RH, sunny sky, and 5 mph wind. Treatments wee applied with a pickup mounted sprayer delivering 10 gpa at 40 psi through 8004 flat fan nozzles to a 5 foot wide by 5 foot long plot. The experiment was not randomized. Grass injury was evaluated on May 28 1999 (8 MAT).

Grass species	Stunting	
	Imazapic	
	16 oz/A	8 oz/a
	%	
WARM SEASON GRASSES		
Garden sand bluestem	0	0
Killdeer sidoats grama	0	0
ND-4115 little bluestem	0	0
9063064 blue grama	0	0
ND-95 prairie sandreed	0	0
Bison big bluestem	0	0
Dacotah switchgrass	0	0
COOL SEASON GRASSES		
FAIRWAY WHEATGRASS	0	0
Parkway	0	0
Kirk	0	0
SD-77	0	0
Ephraim	0	0
Ruff	0	0
NEAC1	0	0
NEAC2	25	5
CRESTED WHEATGRASS		
Summit	10	5
Nordan	30	30
NEAD1	0	0
FAIRWAY X CRESTED CROSS		
Hycrest	0	0
Hycrest #2	0	0
SIBERIAN WHEATGRASS		
P-27	0	0
INTERMEDIATE WHEATGRASS		
Chief	0	0
Clarke	0	0
MON-1813	0	0
Oahe	10	0
SD-54	5	5
Slate	5	0
NETI1	10	5
NETI2	0	0
NETI3	5	0
NE50c3	0	0
NECASPIAN3	5	0
PUBESCENT WHEATGRASS		
Greenleaf	0	0
MON-759	0	0
I2781	5	5
TALL WHEATGRASS		
Orbit	0	0
Alkar	0	0
Platte	0	0
QUACKGRASS		
RS Hoffman	50	25

continued

	Imazapic	
	16 oz/A	8 oz/a
	%	
SMOOTH BROMEGRASS		
Magna	25	25
S-7133	0	0
Manchar	50	25
Rebound	0	0
Cottonwood	25	5
Lincoln	40	25
SMOOTH X MEADOW BROME CROSS		
S-9183	50	50
MEADOW BROMEGRASS		
Fleet	25	5
Paddock	5	0
Regar	0	0
RUSSIAN WIDRYE		
Mayak	0	0
Swift	50	50
Cabree	0	0
Vinall	0	0
MON-1808	0	0
MON-1831	0	0
Bozoisky Select	10	5
PI-272136	0	0
Syn A NL	0	0
MAMMOTH WILDRYE		
ND-691	40	25
PI-478832	60	50
Volga	20	10
EUROPEAN DUNEGRASS		
ND-2100	10	5
ALTAI WILDRYE		
Prairieland	0	0
Pearl	5	5
Eejay	25	10
DANHURIAN WILDRYE		
Arthur	0	0
BASIN WILDRYE		
M-718	25	0
PI-478831	5	0
Magnar	0	0
BEARDLESS WILDRYE		
Shoshone	0	0
BLUEBUNCH WHEATGRASS		
PI-232127	5	5
PI-232128	0	0
Goldar	50	25
Secar	0	0
BLUEBUNCH X QUACK CROSS		
RS-1 Hybird N	25	0
RS-1 Hybrid R	15	5
INDIAN RYEGRASS		
Mandan 57-2	0	0
Nezpar	0	0
GREEN NEEDLEGRASS		
Lodorm	30	10
SD-93	15	0

continued

	Imazapic	
	16 oz/A	8 oz/A
THICKSPIKE WHEATGRASS	%	
Elbee	15	5
Critana	25	10
WESTERN WHEATGRASS		
Walsh	0	0
Rodan	0	0
Flintlock	0	0
SLENDER WHEATGRASS		
Revenue	0	0
Adanac	0	0
Pryor	0	0
Primar	0	0

SUMMARY: Because this experiment was not replicated, the above data should be used with caution. None of the warm season grass species exhibited stunting. As a group, the crested wheatgrass, quackgrass, smooth bromegrass, smoothe x meadow brome cross, mammoth wildrye, alti wildrye, bluebunch tended to be more susceptible to stunting caused by imazapic herbicide. Individualspecies within these groups exhibited variable levels of stunting from 0 to 60%. As a group, the fairway wheatgrass, fairway x crested cross, Siberian wheatgrass, bubescent wheatgrass, tall wheatgrass, dahurian wheatgrass and slender wheatgrasses expressed a high level of tolerance to imazapic herbicide.

Evaluation of in-crop, pre-harvest, and post-harvest applications, or combinations of these for Canada thistle and Dandelion control. Brian Jenks, Kent McKay, and Gary Willoughby. Munich durum was seeded May 29, 1998 in a conventional tillage system. Various herbicide treatments were applied either in-crop, pre-harvest, or post-harvest. Our objective was to evaluate how effectively these treatments would control Canada thistle into the 1999 growing season. Individual plots were 12 x 50 ft and each treatment was replicated three times.

1998 In-crop evaluation

Clopyralid + 2,4-D (94%) was the most effective treatment in the study. Canada thistle control with 2,4-D amine was better than normally expected (70%). Control with dicamba + 2,4-D, tribenuron + 2,4-D, and bromoxynil + MCPA ranged from 71 to 80%. However, after harvest the Canada thistle plants were coming back very strong in the above treatments except for clopyralid + 2,4-D.

Dicamba + diflufenzopyr alone or with quinclorac provided 78 to 83% Canada thistle control. Dicamba + diflufenzopyr contains dicamba and diflufenzopyr, which BASF refers to as an auxin transport inhibitor that has a synergistic effect with dicamba on perennial weeds. The 2 oz/A rate was injurious to wheat and in not likely to be labeled for wheat.

The pre-harvest glyphosate applications were very effective as there were very few Canada thistle plants remaining when we applied the post-harvest treatments, approximately 3 weeks after harvest. The post-harvest glyphosate was also very effective as all above-ground Canada thistle vegetation was necrotic within a couple weeks after application. The fallow plots were set up to do the "Hunter Method." The Canada thistle rosettes were a little larger than desired (4-6" tall), but glyphosate burned them down very well. In contrast, Canada thistle control with dicamba + diflufenzopyr was poor. The thistle plants were curled, but were still very green.

1999 Spring Evaluation

The in-crop treatments applied in 1998 generally provided poor long-term control of Canada thistle and dandelion based on comparisons to densities in July 1999. Canada thistle density in the untreated plot increased 226% compared to the density in spring 1998. Thistle densities also increased in the other in-crop treatments: tribenuron + 2,4-D (109%), dicamba + diflufenzopyr (142%), and dicamba + diflufenzopyr + quinclorac (175%). Thistle density was lower in the in-crop treatment of clopyralid + 2,4-D, where the density only increased slightly (2%).

Pre-harvest and post-harvest glyphosate applications provided better Canada thistle and dandelion control compared to in-crop treatments. Canada thistle control with pre-harvest glyphosate ranged from 89-94% and dandelion control was 73-86%. Post-harvest glyphosate was slightly more effective on Canada thistle (90-99%) and dandelion (97-99%) compared to the pre-harvest application. Dicamba + diflufenzopyr was not effective on Canada thistle or dandelion. We applied dicamba + diflufenzopyr at 2 oz/A, which we have since learned is lower than what will be recommended (4 to 8 oz/A) for a fall application.

Following the May 29, 1999 visual evaluation we tilled the plot area and seeded spring wheat. Canada thistle shoots started to emerge by the third week of June. By July 8, 1999 there were more Canada thistle shoots emerging that we had hoped. However, Canada thistle densities in July 1999 were generally lower than in spring 1998 where pre-harvest or post-harvest glyphosate treatments were applied. Densities in pre-harvest treatments were +20%, -5%, -20%, and -69%. Densities in the post-harvest treatments were -3%, -19%, and -37%.

It is clear from these data that in-crop applications in wheat may knock back Canada thistle during the growing season, but for long-term control a pre-harvest or post-harvest application is probably necessary. We don't get sufficient re-growth of Canada thistle following harvest every year, but we should try to take advantage of it when we can.

Treatment	Rate	Stage	Cath Control 27-Aug-98	Durum Yield 16-Sep-98	Cath Control 29-May-99	Dandelion Control 29-May-99	Cath Population* 8-Jul-99
	oz ai		%	bu/A	%	%	
Untreated			0	24	0	0	226%
In-crop treatments							
Tribenuron	0.125	5-leaf	80	29	12	0	109%
2,4-D ester	6	5-leaf					
Clopyralid + 2,4-D	9.6	5-leaf	94	30	43	7	2%
Dicamba + diflufenzopyr	1.4	5-leaf	83	22	0	0	142%
Dicamba + diflufenzopyr	1.4	5-leaf	78	24	17	0	175%
Quinclorac	3	5-leaf					
Pre-Harvest treatments							
2,4-D amine	4	5-leaf	70	29	89	76	-5%
Glyphosate	12	PRE-H					
Dicamba	1.5	5-leaf	80	27	91	83	-20%
2,4-D ester	4	5-leaf					
Glyphosate	12	PRE-H					
Tribenuron	0.125	5-leaf	80	28	91	73	20%
2,4-D ester	6	5-leaf					
Glyphosate	12	PRE-H					
Bromoxynil + MCPA	8	5-leaf	71	29	94	86	-69%
Glyphosate	12	PRE-H					
Dicamba	1.5	5-leaf	77	28	37	0	71%
2,4-D ester	4	5-leaf					
Dicamba + diflufenzopyr	1.4	PRE-H					

*Percent increase or decrease in Canada thistle population in 1999 compared to 1998.

Treatment	Rate	Stage	Cath Control 27-Aug-98	Durum Yield 16-Sep-98	Cath Control 29-May-99	Dandelion Control 29-May-99	Cath Population* 8-Jul-99
	oz ai		%	bu/A	%	%	
Post-Harvest treatments							
Dicamba	1.5	5-leaf	79	28	95	99	-19%
2,4-D ester	4	5-leaf					
Glyphosate	12	POST-H					
Tribenuron	0.125	5-leaf	77	31	90	97	-3%
2,4-D ester	6	5-leaf					
Glyphosate	12	POST-H					
Clopyralid + 2,4-D	9.6	5-leaf	93	34	99	98	-37%
Glyphosate	12	POST-H					
Fallow method							
Fallow Glyphosate	12	Sept			90	99	-22%
Fallow Dicamba + diflufenzopyr	1.4	Sept			45	77	41%

*Percent increase or decrease in Canada thistle population in 1999 compared to 1998.

Common Milkweed Control - 1998. Zollinger and Fitterer. An experiment was conducted near Buxton, ND, to evaluate common milkweed control from POST applied herbicides. Prebud treatments were applied to 1 to 14 inch (bud, 1 to 15/yd^2) common milkweed on June 10, 1998 10:15 am with 64 F air, 68 F soil, 62% RH, 4 to 9 mph S wind, 100% clouds, dry soil surface, moist subsoil. Common milkweed vigor was excellent, and no dew was present at application. Treatments applied 10 days following prebud treatments were applied to 1 to 14 inch (bud, 1 to 15/yd^2) common milkweed (growing point of milkweed shoots were dead or severely injured form the first treatment) on June 25, 1998, at 1:00 pm with 72 F air, 74 F soil surface, 70% relative humidity, 3 to 5 mph SW wind, 70% clouds, wet soil surface, wet subsoil, and no dew was present at application. Treatments were applied to the center 6.67 feet of 10 by 40 ft plots with a bicycle-wheel-type sprayer equipped with drift cones delivering 8.5 gpa at 40 psi through 8001 flat fan nozzles. The experiment had a randomized complete block design with three replicates per treatment.

		Common milkweed			
		1998			1999
Treatment[a]	Rate	June 25	July 6	Aug 5	June 25
	Product/A	(% control)			
Prebud					
Roundup Ultra+AMS	3 qt+17 lb/100 gal	75	77	58	3
Touchdown+NIS+AMS	2.4 qt+0.25% v/v+17 lb/100 gal	75	80	65	0
Distinct+NIS+28% UAN	8 oz+0.25% v/v+1 qt	40	55	62	3
Starane	0.67 pt	10	15	13	5
Starane	1.33 pt	22	20	23	3
Distinct+Starane+NIS+28% UAN	6 oz+0.67 pt+0.25% v/v+1 qt	42	50	58	7
Distinct+Starane+NIS+28% UAN	6 oz+1.33 pt+0.25% v/v+1 qt	50	58	62	7
Distinct+NIS+28% UAN	6 oz+0.25% v/v+1 qt	42	48	48	7
Prebud/10 DAA					
Distinct+NIS+28% UAN/ Distinct+NIS+28% UAN	4 oz+0.25% v/v+1 qt/ 4 oz+0.25% v/v+1 qt	32	47	67	7
Distinct+NIS+28% UAN/ Distinct+NIS+28% UAN	3 oz+0.25% v/v+1 qt/ 3 oz+0.25% v/v+1 qt	33	48	78	7
LSD (0.05)		12	13	16	0

[a]AMS = ammonium sulfate, NIS = nonionic surfactant (Activator 90).

No herbicide treatment gave over 80% common milkweed control at any evaluation. Roundup Ultra initially gave greater milkweed control than other treatments applied. However, at the August 5 evaluation, no differences were observed except reduced control from Starane applied alone. At the August 5 evaluation, common milkweed control generally ranged from 48 to 78%, excluding the Starane treatments. Evaluations on June 25, 1999, 12 months after applications showed no control of common milkweed from all treatments.

Common milkweed control - 1999. Zollinger and Fitterer. An experiment was conducted near Buxton, ND, to evaluate common milkweed control from POST applied herbicides. Prebud treatments were applied to 1 to 14 inch (bud, 1 to 15/yd^2) common milkweed on June 25, 1999 at 10:00 to 10:30 am with 80 F air, 84 F soil, 35% relative humidity, 5 to 10 mph SE wind, 30% clouds, moist soil surface, and moist subsoil. Common milkweed vigor was excellent and no dew was present at application. Weeds present were: 4 to 18 inch, prebud to bud, (2 to 3/ft^2) common milkweed. Treatments applied 10 days following prebud were applied July 14, 1999 at 6:00 pm with 80 F air, 90 F soil surface, 65% relative humidity, 5 to 10 mph SW wind, 25% clouds, wet soil surface, wet subsoil, and no dew was present at application. Treatments were applied to the center 6.67 feet of 10 by 40 ft plots with a back-pack type sprayer delivering 8.5 gpa at 40 psi through 8001 flat fan nozzles The experiment had a randomized complete block design with three replicates per treatment.

Treatment	Rate	Common milkweed	
		July 9, 1999	July 22,1999
	Product/A	% control	
Prebud			
Roundup Ultra+AMS	3qt+17lb/100gal	40	92
Touchdown+NIS+AMS	2.4qt+0.25%+17lb/100gal	37	83
Distinct+NIS+28-0-0	8oz+0.25%+1qt	15	82
Distinct+NIS+28-0-0	6oz+0.25%+1qt	8	62
Starane	0.67pt	3	43
Starane	1.33pt	3	34
Distinct+Starane+NIS+28-0-0	6oz+0.67pt+0.25%+1qt	13	50
Distinct+Starane+NIS+28-0-0	6oz+1.33pt+0.25%+1qt	12	57
Prebud/10 DAA			
Distinct+NIS+28-0-0/ Distinct+NIS+28-0-0	4oz+0.25%+1qt/ 4oz+0.25%+1qt	7	57
Distinct+NIS+28-0-0/ Distinct+NIS+28-0-0	3oz+0.25%+1qt/ 3oz+0.25%+1qt	5	55
Untreated		0	0
LSD (0.05)		7	12

On July, 9 no treatment provided over 40% control of common milkweed. Roundup Ultra and Touchdown initially gave greater control than other treatments. Roundup Ultra, Touchdown, and Distinct at 8 oz/A provided over 80% control on July 22. Other treatments provided less than 63% common milkweed control.