Yellow Section: Camelina, Canola, Carrot, Chickpea, Cover Crops, Dry Bean, Dry Pea, Faba Bean, Flax, Hemp, Potato, Sunflower, Pumpkin, and Turf.

Yellow Section: Camelina, Canola, Carrot, Chickpea, Cover Crops, Dry Bean, Dry Pea, Faba Bean, Flax, Hemp, Potato, Sunflower, Pumpkin, and Turf. .....Continued:

SU Camelina Response to Herbicides. Howatt and Mettler. Camelina was planted near Fargo on May 15. Treatments were applied to two- to four-leaf Camelina and 1 to 4 inch redroot pigweed and Venice mallow on June 7 with 77°F, 52% relative humidity, 30% cloud cover, 9 mph wind at 135°, and moist soil at 70°F. Treatments were applied with a backpack sprayer delivering 8.5 gpa at 40 psi through 11001 TT nozzles to a 7 foot wide are the length of 10 by 30 foot plots. The experiment was a randomized complete block design with four replicates. Harvest for yield was on August 3.

			Camelina											
Treatment	Rate	Seed	6/21 Injury	6/21 Stand	6/21 Vigor	7/23 Height	8/03 Yield	1st Flower	50% Flower	Full Flower	6/21 Rrpw	6/21 Vema	7/23 Rrpw	7/23 Vema
	oz ai/A		%	%	1 to 5	cm	bu/A	days after planting			%	%	%	%
Untreated	0	17CS1115	0	81	3	54	9	37	45	56	85	92	85	85
Thif-sg+NIS	0.057+0.1%	17CS1115	0	84	4	53	10	37	46	56	86	77	99	74
Thif-sg+NIS	0.086+0.1%	17CS1115	11	74	3	54	8	40	48	56	89	82	99	79
Thif-sg+NIS	0.17+0.1%	17CS1115	26	72	2	50	12	43	53	61	95	91	99	75
Untreated	0	MIDAS	0	79	3	53	10	38	46	56	79	70	88	63
Thif-sg+NIS	0.057+0.1%	MIDAS	100	0							89	81		
Thif-sg+NIS	0.086+0.1%	MIDAS	100	0							90	84		
Thif-sg+NIS	0.17+0.1%	MIDAS	100	0							94	86		
CV			5	28	18	3	44	4	3	4	6	11	4	17
LSD (0.05)			3	15	1	2	NS	3	2	3	8	14	6	20

Stand establishment was uneven. Some of this could be attributed to Canada thistle pressure which was not expected, but there were intermittent gaps in the row as well. 'Midas' camelina was very susceptible to thifensulfuron. Relative vigor ratings indicated sluggish growth of SU-camelina at the high rate of thifensulfuron, but 0.086 oz ai/A (6 g ai/ha) also caused visible chlorosis and delay of leaf development (injury) compared with untreated camelina. Final height was slightly shorter with the high rate of thifensulfuron and flowering was delayed by almost a week but seed maturity and yield were not affected. We believe yield was affected by exceptionally hot weather in June. Wheat and canola trials at this location had yields as much as half what is typical. In addition, control of grass weeds occurred before flowering but may have affected seed set. Treating canola too close to flowering can affect the fertility of developing florets. The entire season from seeding to harvest was only about 80 days. Direct harvest occurred before seedpods began to shatter.

Weed spectrum did not include wild mustard this year. This also was attributed to warmer than typical spring temperatures. The untreated was weeded by hand twice during the season. The low rate of thifensulfuron gave 86% control of redroot pigweed in June but had killed all pigweed by the middle of July. Venice mallow is more difficult to control, but thifensulfuron at 0.086 oz/A provided about 80% control. Relatively short and thin camelina canopy did not outcompete remaining mallow plants.

Adjuvant influence on herbicide injury in SU Canola. Dr. Howatt, Mettler, and Harrington. 'NDSU 5507' canola was seeded near Fargo on May 14. Study area was treated with Mustang Max for control of flea beetles at 1 to 2 leaf canola. Treatments were applied to 4 leaf canola on June 7 with 72°F, 58% relative humidity, 30% cloud cover, 5 mph wind velocity, and wet soil at 68°F. Treatments were applied with a backpack sprayer delivering 8.5 gpa at 40 psi through 11001 TT nozzles to a 7 foot wide area the length of 10 by 30 foot plots. The experiment was a randomized complete block design with four replicates.

Treatment	Rate	6/15 Canola	6/21 Canola	7/6 Canola	8/21 Yield
	oz ai/A	%	%	%	bu/A
Untreated Check	0	0	0	1	12
Thif&Trib-D+R-11	0.23+0.5%	10	22	6	8
Thif&Trib-D+Rainer	0.23+0.5%	10	19	10	8
Thif&Trib-D+Insist 90	0.23+0.5%	11	21	10	9
Thif&Trib-D+Prefer 90	0.23+0.5%	11	25	10	9
Thif&Trib-D+White Water	0.23+0.5%	10	14	6	10
Thif&Trib-D+Clethodim+Renegade	0.23+1.5+1%	13	26	14	8
Thif&Trib-D+Clethodim+Renegade	0.23+3+2%	15	37	21	6
Thif&Trib-D+Cerium Elite	0.23+0.25%	9	16	6	9
Thif&Trib-D+Renegade	0.23+1%	9	15	6	10
Thif&Trib-D+MSO	0.23+1%	11	20	9	9
Thif&Trib-D+PO	0.23+1%	8	13	7	9
Thif&Trib-D+Clet+PO	0.23+1.5+1%	12	22	9	9
Thif&Trib-D+Clet+PO	0.46+3+2%	17	34	21	7
CV		21	24	36	24
LSD P=0.5		3	7	5	3

Canola was recovering from flea beetle feeding when treatments were applied. Treatments without clethodim resulted in 8 to 11% injury one week after application regardless of adjuvant. Addition of clethodim increased chlorosis response by 4%. A month after application, canola response of stunting and chlorosis was 6 to 10% when treatment did not include clethodim. Treated areas appeared to have less dense inflorescence than untreated areas and almost all treated areas produced less yield than the untreated, but yield of all treatments was substantially reduced by an environmental factor.

Grass herbicides for the SU Canola system. Dr. Howatt, Mettler, and Harrington. 'ND Vitpro' wheat was seeded near Fargo on May 4. Treatments were applied when neighboring canola trials were in the 3 leaf stage to 3 leaf wheat and 2 to 3 leaf wild oat on May 31 with 69°F, 77% relative humidity, 90% cloud cover, and 5.5 mph wind velocity at 360°and moist soil at 62°F. Treatments were applied with a backpack sprayer delivering 8.5 gpa at 40 psi through 11001 TT nozzles to a 7 foot wide area the length of 10 by 30 foot plots. The experiment was a randomized complete block design with four replicates.

Treatment	Rate	6/8 Wheat	6/8 Wioa	6/14 Wheat	6/14 Wioa	6/28 Wheat	6/28 Wioa
	oz ai/A	%	%	%	%	%	%
Untreated Check	0	0	0	0	0	0	0
Thif&Trib-D+NIS	0.23+0.25%	0	0	0	0	0	0
Thif&Trib-D+NIS	0.23+0.5%	0	0	0	0	0	0
Thif&Trib-D+Clet+PO	0.23+1.5+1%	40	40	82	75	93	96
Thif&Trib-D+Clet+NIS	0.23+1.5+0.25%	37	37	80	71	85	89
Thif&Trib-D+Clet-V+Renegade	0.23+1+1%	45	45	84	80	92	97
Thif&Trib-D+Clet SM+NIS	0.23+1+0.25%	42	42	87	84	98	99
Thif&Trib-D+Clet SM+NIS	0.23+1.5+0.25%	45	45	90	85	99	99
Thif&Trib-D+Seth+MSO	0.23+7.5+1%	47	47	90	86	99	99
Thif&Trib-D+Quiz+PO	0.23+0.87+1%	40	40	84	76	98	95
Thif&Trib-D+Quiz+NIS	0.23+0.87+0.25%	32	32	80	72	97	93
Thif&Trib-D+Quiz+NIS	0.23+1.32+0.25%	32	32	82	75	98	95
Thif&Trib-D+Nico-P+NIS	0.23+0.5+0.25%	40	40	79	70	96	94
Thif-V+Nico-P+NIS	0.21+0.5+0.25%	35	35	77	71	98	94
CV		17	17	3	4	3	2
LSD P=0.5		7	7	3	3	3	2

Thifensulfuron and tribenuron did not visibly affect wheat or wild oat. This is not surprising because the herbicides are registered for broadleaf weed control in wheat. But the herbicides have given strong suppression of yellow foxtail, so wild oat might have been effected.

Control of wheat and wild oat was similar for each herbicide on June 8, 1 week after application. Control was less than 50% at this time. Clet SM (Select Max) and sethoxydim provided the greatest control values for wheat and wild oat on June 14, and provided 99% control by June 28. Clethodim gave better control with petroleum oil as an adjuvant compared with non-ionic surfactant, but quizalofop activity was not influenced by rate or adjuvant type. Nicosulfuron gave similar wheat control to group 1 herbicides but slightly less control of wild oat.

Single Active Weed Control in SU Canola. Dr. Howatt and Mettler. Canola supplied by Rotam was seeded near Fargo. Treatments (3L) were applied to 3 to 4 leaf canola, 3 leaf yellow foxtail, 1 to 8 inch redroot pigweed and common lambsquarters, and 1 to 14 inch Canada thistle on June 7 with 74°F, 45% relative humidity, 80% cloud cover, 11 mph wind at 125°, and moist soil at 69°F. Treatments (7 DAT) were applied to 5 to 6 leaf canola on June 13 with 76°F, 46% relative humidity, 10% cloud cover, 6 to 7 mph wind at 225°, and damp soil at 71°F. All treatments were applied with a backpack sprayer delivering 8.5 gpa at 40 psi through 11001 TT nozzles to a 7 foot wide area the length of 10 by 30 foot plots. The experiment was a randomized complete block design with four replicates.

Treatment	Rate	Appl Code	6/15 Canola	6/15 Yeft	6/15 Rrpw	6/15 Colq	6/22 Canola	6/22 Yeft	6/22 Rrpw	6/22 Colq	7/6 Canola	7/23 Canola	8/8 Canola
	oz ai/A		%	%	%	%	%	%	%	%	%	%	%
Untreated Check	0		0	0	0	0	0	0	0	0	30	30	30
Thif&Trib-D	0.23	3L	0	65	81	74	5	76	95	95	0	0	0
Thif&Trib-D+NIS	0.23+0.25%	3L	0	66	84	76	2	85	95	95	0	0	0
Thif&Trib-D+Clet+NIS	0.23+1.5+0.25%	3L	0	64	85	77	5	93	95	95	0	0	0
Thif&Trib-D	0.45	3L	0	62	81	71	2	64	95	95	0	0	0
Thif&Trib-D+NIS	0.45+0.25%	3L	0	61	81	74	5	83	95	95	0	0	0
Thif-V	0.23	3L	0	42	71	61	1	69	95	95	0	0	0
Thif-V+NIS	0.23+0.25%	3L	0	61	84	72	4	75	95	95	0	0	0
Thif-V+PO	0.23+1%	3L	0	35	72	50	0	75	95	95	1	1	1
Thif-V+Clet+NIS	0.23+1.5+0.25%	3L	0	81	85	77	4	91	95	95	0	0	0
Thif-V+Clet+PO	0.23+1.5+1%	3L	0	84	84	72	3	93	95	95	0	0	0
Thif-V+Clet+Renegade	0.23+1.5+16	3L	0	75	84	74	1	96	95	95	0	0	0
Thif-V	0.45	3L	0	50	81	71	2	65	95	95	1	1	1
Thif-V+NIS	0.45+0.25%	3L	0	65	79	66	4	74	95	95	0	0	0
Trib-C	0.08	3L	0	52	77	61	4	72	95	95	1	1	1
Trib-C+NIS	0.08+0.25%	3L	0	55	81	69	8	74	95	95	0	0	0
Trib-C+Clet+NIS	0.08+1.5+0.25%	3L	0	75	84	72	4	89	95	95	0	0	0
Trib-C	0.15	3L	0	52	81	71	5	76	95	95	0	0	0
Trib-C+NIS	0.15+0.25%	3L	0	50	75	60	4	77	95	95	1	1	1
Thif-V+NIS/ Trib-C+NIS	0.23+0.25%/ 0.08+0.25%	3L/ 7DAT	0	61	81	66	3	71	95	95	1	1	1
Trib-C+NIS/ Thif-V+NIS	0.08+0.25%/ 0.23+0.25%	3L/ 7DAT	0	62	82	70	3.8	65	95	95	1	1	1
C.V.			0	8	4	5	93	9	0	0	234	234	24
LSD P=0.5			.	6	4	5	5	10	.	.	6	6	6

Canola response to herbicide treatments was less than 10% at any evaluation, and generally less than 5%. Thifensulfuron and/or tribenuron suppressed yellow foxtail but inclusion of clethodim brought control up to about 80% after 1 week. Foxtail control exceeded 90% with clethodim by June 22. Although broadleaf weed control varied depending on specific treatment, control was generally good that resulted from herbicide activity. This in combination with vigorous canola growth resulted in consistent broadleaf weed control by June 22 of 95%. Some small plants remained in each plot. Some remained with herbicide symptomology and some were newly emerged plants. In either case, plants under the canola canopy were not thriving and not believed to be of consequence to the crop.

SU Canola Response to Pyridate. Dr. Howatt and Mettler. Canola seed provided by Rotam was seeded near Fargo. Treatments were applied to 4 leaf canola, 3 leaf yellow foxtail, and 1 to 8 inch redroot pigweed and common lambsquarters on June 7 with 73°F, 47% relative humidity, 20% cloud cover, 8 mph wind at 125°, and moist soil at 68°F. Treatments were applied with a backpack sprayer delivering 8.5 gpa at 40 psi through 11001 TT nozzles to a 7 foot wide area the length of 10 by 30 foot plots. The experiment was a randomized complete block design with four replicates.

Treatment	Rate	6/15 Canola	6/15 Yeft	6/15 Rrpw	6/15 Colq	6/22 Canola	6/22 Yeft	6/22 Rrpw	6/22 Colq	7/6 Canola	7/23 Yeft	7/23 Rrpw	7/23 Colq	8/2 Yeft	8/2 Rrpw	8/2 Colq
	oz ai/A	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
Untreated Check	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0
Thif&Trib-D+NIS	0.23+0.25%	0	47	81	75	3	91	95	95	1	91	95	95	91	95	95
Thif&Trib-D+NIS	0.45+0.25%	0	62	85	75	4	94	95	95	1	94	95	95	94	95	95
Nico-P+NIS	0.5+0.25%	0	67	82	66	2	95	95	95	0	95	95	95	95	95	95
Nico-P+NIS	1+0.25%	0	74	89	67	0	94	95	95	0	94	95	95	94	95	95
Pyridate+NIS	7.5+0.25%	35	10	55	37	40	5	95	95	36	5	95	95	5	95	95
Pyridate+NIS	15+0.25%	52	5	74	56	64	17	95	95	60	17	95	95	17	95	95
Pyridate+NIS	22.5+0.25%	79	10	89	65	71	20	95	95	80	20	95	95	20	95	95
Thif&Trib-D+Nico-P+NIS	0.23+0.45+0.25%	0	76	90	76	1	97	95	95	1	97	95	95	97	95	95
Thif&Trib-D+Pyridate+NIS	0.23+7.5+0.25%	45	20	76	69	35	5	95	95	25	5	95	95	5	95	95
Thif&Trib-D+Pyridate+NIS	0.23+15+0.25%	72	32	79	71	61	27	95	95	57	27	95	95	27	95	95
Thif&Trib-D+Pyridate+NIS	0.23+22.5+0.25%	75	52	87	74	76	30	95	95	76	30	95	95	30	95	95
Thif&Trib-D+Nico-P+Pyridate+NIS	0.23+0.45+7.5+0.25%	42	67	74	67	14	93	95	95	8	93	95	95	93	95	95
Thif&Trib-D+Pyridate+PO	0.23+7.5+1%	40	20	77	64	42	32	95	95	22	32	95	95	32	95	95
Thif&Trib-D+Clet+Pyridate+PO	0.23+1.5+7.5+1%	37	60	71	61	22	35	95	95	14	35	95	95	35	95	95
CV		11	21	5	8	35	14	0	0	40	14	0	0	14	0	0
LSD P=0.5		5	12	5	7	15	10	.	.	15	10	.	.	10	.	.

Thifensulfuron, tribenuron, and nicosulfuron did not elicit more than 4% response in canola. Pyridate resulted in initial response of 35 to 80% injury based on application rate. Response to pyridate was not greatly influenced by addition of other herbicides. Response was rapid chlorosis leading to substantial necrosis at higher rates. Plants remained inhibited for an extended period and plants that remained were relatively very small during flowering.

Rapid activity of pyridate on yellow foxtail antagonized the effect of group 2 herbicides on this weed. Eventual control of redroot pigweed and common lambsquarters was not altered by inclusion of pyridate.

Grass herbicides in SU Canola. Howatt, Mettler, and Harrington. 'Quad' Canola was seeded near Fargo on May 14. Study area was treatment with Mustang Max when canola was 2 leaf to control flea beetles. Treatments were applied to 3 to 4 leaf canola, 3 leaf yellow foxtail, and 1 to 8 inch redroot pigweed and common lambsquarters on June 7 with 72°F, 62 relative humidity, 20% cloud cover, 6.5 mph wind velocity and moist soil at 67°F. Treatments were applied with a backpack sprayer delivering 8.5 gpa at 40 psi through 11001 TT nozzles to a 7 foot wide area the length of 10 by 30 foot plots. The experiment was a randomized complete block design with four replicates. Harvest for yield was August 10.

Treatment	Rate	6/15 Canola	6/15 Yeft	6/15 Rrpw	6/15 Colq	6/15 Vema	6/22 Canola	6/22 Yeft	6/22 Rrpw	6/22 Colq	6/22 Vema	7/6 Canola	8/10 Yield
	oz ai/A	%	%	%	%	%	%	%	%	%	%	%	buA
Untreated Check	0	0	0	0	0	0	9	0	0	0	0	7	5
Handweeded Check	0	0	87	85	83	83	5	93	93	93	95	0	15
Thif&Trib-D+NIS	0.23+0.25%	0	42	79	69	71	3	67	95	95	95	0	14
Thif&Trib-D+NIS	0.23+0.5%	0	40	80	69	70	4	57	95	95	95	0	14
Thif&Trib-D+Clet+PO	0.23+1.5+1%	1	76	79	70	71	4	95	95	95	95	1	19
Thif&Trib-D+Clet+NIS	0.23+1.5+0.25%	2	71	82	74	74	5	91	95	95	95	0	18
Thif&Trib-D+Clet-V+Renegade	0.23+1+1%	0	75	85	76	77	0	95	95	95	95	1	19
Thif&Trib-D+Clet SM+NIS	0.23+1+0.25%	0	75	82	76	71	2	96	95	95	95	1	18
Thif&Trib-D+Clet SM+NIS	0.23+1.5+0.25%	4	75	84	74	74	6	95	95	95	95	1	16
Thif&Trib-D+Seth+MSO	0.23+7.5+1%	8	80	85	74	79	9	98	95	95	95	0	20
Thif&Trib-D+Quiz+PO	0.23+0.87+1%	8	72	82	74	74	10	90	95	95	95	0	19
Thif&Trib-D+Quiz+NIS	0.23+0.87+0.25%	6	72	84	71	74	6	88	95	95	95	4	19
Thif&Trib-D+Quiz+NIS	0.23+1.32+0.25%	0	71	80	71	71	4	91	95	95	95	0	16
Thif&Trib-D+Nico-P+NIS	0.23+0.5+0.25%	0	79	84	71	71	6	98	95	95	95	1	22
Thif-V+Nico-P+NIS	0.21+0.5+0.25%	0	79	86	74	74	1	95	95	95	95	0	20
∞													
CV		103	8	7	9	9	59	5	1	1	0	142	20
LSD P=0.5		3	8	8	9	9	4	6	1	1	.	2	5

Canola response was 10% or less to each herbicide treatment at any evaluation. Discoloration of the growing point and new tissue was present with some treatments on June 15. Slight stunting was included with the injury rating June 22 and was the primary observation on July 6. Yield was affected by an environmental factor. Herbicide treatment did not result in less yield than the hand-weeded check.

Thifensulfuron and tribenuron gave about 40% control of yellow foxtail on June 15. This activity was supplemented in several treatments with herbicides to control grasses, which resulted in 70 to 80% control 1 week after treatment. By June 22, treatments that included grass herbicides generally provided more than 90% foxtail control. By this date, broadleaf weed control was consistently 95% across species. The herbicide effect was aided at this time by a full and vigorous canola canopy. The hand-weeded check at this time was rated at 93 to 95% control of weeds present.

Broadleaf Control in SU Canola. Dr. Howatt, Mettler, and Harrington. 'Quad' canola was seeded near Fargo on May 14. Study area was treated with Mustang max at 1 to 2 leaf canola to control flea beetles. Treatments were applied to 3 to 4 leaf canola, 3 leaf yellow foxtail, 1 to 6 inch redroot pigweed, and 1 to 8 inch common lambsquarters on June 7 with 71°F, 61% relative humidity, 20% cloud cover, 5 to 7 mph wind velocity at 100°, and moist soil at 66°F. Treatments were applied with a backpack sprayer delivering 8.5 gpa at 40 psi through 11001 TT nozzles to a 7 foot wide area the length of 10 by 30 foot plots. The experiment was a randomized complete block design with four replicates.

Treatment	Rate	6/15 Canola	6/15 Yeft	6/15 Rrpw	6/15 Colq	6/22 Canola	6/22 Yeft	6/22 Rrpw	6/22 Colq	7/6 Canola	8/10 Yield
	oz ai/A	%	%	%	%	%	%	%	%	%	bu/A
Untreated Check	0	0	0	0	0	0	0	0	0	5	4
Handweeded Check	0	0	52	57	62	-	-	-	-	-	7
Thif&Trib-D+NIS	0.23+0.25%	6	55	81	74	0	72	95	95	0	20
Thif&Trib-D+Quin+PO	0.23+1.45+0.5%	11	75	84	75	5	65	95	95	1	17
Thif&Trib-D+Quin+Clpy+PO	0.23+1.45+3+0.5%	4	74	81	71	3	71	95	95	0	13
Thif&Trib-D+Clpy+NIS	0.23+3+0.25%	3	50	84	75	3	61	95	95	0	13
Thif&Trib-D+Clet+Clpy+NIS	0.23+1.5+3+0.25%	4	70	86	77	4	69	95	95	0	15
Thif&Trib-D+Quiz+Clpy+NIS	0.23+1.32+3+0.25%	5	71	84	75	2	69	95	95	0	11
Thif&Trib-D+Quiz+Quin+NIS	0.23+1.32+1.45+0.25%	4	74	86	74	6	83	95	95	5	11
Thif&Trib-D+Seth+Clpy+MSO	0.23+7.5+3+1%	6	86	86	77	2	97	95	95	0	17
Thif&Trib-D+Seth+Quin+MSO	0.23+7.5+1.45+1	7	86	87	79	4	97	95	95	2	18
Trib-C+NIS	0.11+0.25%	1	45	84	75	6	71	95	95	0	16
Thif-V+NIS	0.21+0.25%	0	50	86	71	6	60	95	95	0	9
Thif-V+Clpy+NIS	0.21+3+0.25%	5	50	81	75	2	47	95	95	0	13
CV		83	9	5	5	103	9	0	0	102	47
LSD P=0.5		5	8	6	5	5	9	.	.	2	9

Canola injury on June 15 was general chlorosis at the growing point while July evaluation identified slight height reduction and less floral mass for a few treatments. Canola was generally quite tolerant of the treatments. Addition of herbicide to control grass did not increase canola response as has been observed in other studies this year and previously. Yield was influenced by environmental factors but did not appear to be inhibited by herbicide treatments.

Thifensulfuron and tribenuron gave about 50% control of yellow foxtail. Later evaluation included substantial competition effect of the canola, but the evaluation on June 15 was a very open crop canopy. Herbicide symptoms of chlorosis and slowed emergence of new leaf tissue indicated inhibitory effects of the herbicide even though these herbicides are not known for strong grass efficacy. Sethoxydim provided the best complement for foxtail control resulting in 97% control on June 22.

Control of redroot pigweed and common lambsquarters was similar across herbicide treatments. Symptoms of thifensulfuron and tribenuron are considered slow to develop, but strong effect was observed 1 week after application. By June 22, 2 weeks after application, control of pigweed and lambsquarters was 95% for all herbicide treatments. At this point, canola development provided shading of the ground which would greatly inhibit establishment or growth of new weed seedlings.

Mulches for Weed Management in Carrot. Gramig and Boll.

Objective:

Evaluate non-chemical weed management options for vegetable crop production under organic management systems for weed suppression.

1) Major activities completed: Experiments were established at Fargo ND and Absaraka ND in 2018. Three surface mulch (SM) [hydromulch (HM), compost blanket (CB) and no surface mulch (NO)] and five living mulch (LM) treatments [perennial ryegrass (PR), red clover (RC), white clover (WC), weed-free check (WF) and weedy check (WK)] with four replications result in 15 unique treatments per block and 60 experimental units per site. Carrot (Daucus carota L.) was used as a 'model' direct seeded vegetable crop. Carrot was chosen because it is a relatively difficult vegetable to grow, so would provide the most challenging test of the various treatments. HM consisted of shredded newspaper and water. CB consisted of hemp hurd and composted cow manure in a 1:1 mixture.

Elements of this research project were also planted on two local small-scale vegetable farms to explore feasibility and provide demonstrations. One farmer is a formal collaborator on the grant that is funding the project.

2) Data collected:

Weed counts were assessed in LM and SM treatments at the beginning, middle and end of the 2018 growing season. Counts were species-specific and were combined across four quadrat samples taken systematically. In the living mulch. Quadrats measured 0.0625m2 and were sampled along a diagonal transect. In the carrot rows, 0.0175m2 quadrats were sampled on alternating sides of carrot in-row area. The first two samples were non-destructive to determine weed density and species composition and the final sample was destructive to determine final dry biomass. Decagon dataloggers were paired with soil water sensors to measure soil water status associated with surface mulches. A series of soil cores was removed from each plot prior to establishment of living mulches to determine baseline soil status for each plot.

3) Summary statistics and discussion of results: ANOVA was used to test the effect of LM, SM, and LM*SM interaction on carrot emergence, carrot yield, and weed suppression. At Absaraka, only the SM treatments impacted carrot emergence. Mean carrot emergence for hydromulch was 20.4 carrots m-1, for compost blanket was 14.7 carrots m-1, and for no mulch (control) was 34.6 carrots m-1. Both compost blanket and hydromulch reduced carrot emergence compared to the no mulch control. At Fargo we saw a different result. Simple effects of both LM ($p = 0.0022$) and SM ($p < 0.0001$) were significant. For the living mulch effect, the presence of white clover and red clover enhanced carrot emergence. Carrot emergence in red clover plots was greater than in weed-free plots (11.9 vs. 4.1 carrots m-1). Carrot emergence was greater in plots containing white clover compared to weed-free checks (14.1 vs. 4.1 carrots m-1). Carrot emergence in white clover plots was also greater than carrot emergence in weedy checks (14.1 vs. 6.6 carrots per m-1). That's a much more complicated picture than what was seen at Absaraka, where the LM treatments did not impact carrot emergence. Regarding surface mulch effects, results at Fargo were also different compared to the Absaraka site. Carrot emergence also differed among SM treatments at Fargo, but

in a different way. At Fargo carrot emergence was greater in the compost blanket treatment compared to both the hydromulch and no mulch treatments (16.4 vs. 5.5 and 6.8 carrots m-1, respectively). In 2019, we hope to fine tune carrot planting and mulching techniques to reduce surface mulch impacts on carrot emergence. Surface mulches were associated with lower weed density and biomass compared to the no surface mulch control. Compost blanket was associated with the lowest weed density, but hydromulch was associated with the lowest total weed biomass. Absence of surface mulch was associated with reduced carrot yield (fresh weight) compared to compost blanket and hydromulch. Results suggest that in-row surface mulches effectively suppressed weeds in strip tillage living mulch systems. Living mulch species did not affect weed count or biomass within the in-row area where carrots were planted. Soil water data have not been analyzed yet. The durability and weed suppression of the relatively simple and low-cost surface mulch formulations suggests adoption may be immediately feasible for growers looking to utilize biodegradable mulching in direct seeded vegetable crops.

Broadleaf weed control using pyridate (Tough) herbicide in chickpea

Caleb Dalley, HREC, Hettinger, ND 2018

Chickpea 'Leader,' a medium-sized Kabuli-type, was planted at a rate of 150 lb/A at a depth of 3 inches on May 9, 2018 using a John Deere 1590 no-till drill. Chickpea inoculant was applied in-furrow during planting. Prior to planting, the entire field was treated with glyphosate (32 oz/A, 1.0 lb ai/A) to control winter annual weeds. Chickpea emerged on May 23. Herbicide treatments were applied on June 5 using a tractor-mounted research plot sprayer at a spray volume of 20 gallons per acre. This trial was designed to evaluate pyridate application rate without adjuvant and to compare methylated seed oil (MSO) verses crop oil concentrate (COC) adjuvants for broadleaf weed control. Additionally, treatments were included to determine if clethodim (Select) could be safely tank-mixed with pyridate. Also, we evaluated a single versus sequential applications of pyridate. Weeds present at time of application included kochia (2 to 5 inches), common lambsquarters (2 to 4 inches), Russian thistle (1 to 3 inches), and green foxtail (1 to 2 inches). Chickpea were evaluated for injury 8 days after treatment and no injury was observed for any of the herbicide treatments applied. The sequential treatments were applied on June 14, 9 days after the initial application. Chickpea were again evaluated for injury 7 days after the sequential application and no injury was observed for any herbicide treatment. At this same time, kochia, common lambsquarters, and green foxtail were visually evaluated for control (0-100 with 0 being no control, similar to the untreated and 100 being complete control or death of plants). At two weeks after the initial treatment application, kochia control increased from 44 to 59 to 68% when Tough herbicide was applied at 0.75, 1, and 1.5 pt/A, respectively. When Tough was applied at 1.5 pt/A with MSO or COC adjuvants, kochia control increased to 75 and81%, respectively. Tank-mixing Tough with Select did not antagonize kochia control. When Tough was applied sequentially using 1.5 pt/A twice, kochia control increased to 89%, this was similar to sequential applications of 1.5 pt/A followed by 0.75 pt/A that resulted in 90% control of kochia. Sequential applications of 0.75 pt/A resulted in only 73% kochia control and was similar to a single application at 1.5 pt/A. Control of common lambsquarters followed similar trends to that of kochia with the best control occurring with sequential applications of either 1.5 pt/A twice or 1.5 pt/A followed by 0.75 pt/A that resulted in 95% control of common lambsquarters. When Select was tank-mixed with Tough, green foxtail was controlled 94 to 98% 16 days after treatment, indicating that there was no antagonism for this tank-mix. Tough alone did not control green foxtail. At 30 days after the first application, similar trends occurred for weed control with one exceptions. There was no apparent advantage to use of either MSO or COC adjuvants as control of both kochia and common lambsquarters was similar with and without these adjuvants. This was also true for Russian thistle that was evaluated at this timing. Results from this trial indicate that pyridate (Tough herbicide) has potential use for broadleaf weed control in chickpea. Pyridate is a contact herbicide with no residual effect on weed control that will only control weeds present at time of application and with smaller weeds being controlled better than larger ones. It will best be utilized with other management options, such as following PRE herbicide application or possibly being tank-mixed with other PRE herbicides labelled for use in chickpea. Pyridate does offer potential POST control of broadleaf weeds in chickpea with is not currently an option with current registered herbicides. Further evaluations of PRE/POST combinations with pyridate as well as tank-mixes need to be considered.

Table. Chickpea response and weed control following application of pyridate (Tough) herbicide treatments at Hettinger, ND.

			chickpea			kochia			common lambsquarters			Russian thistle	
			8 DAT	16 DAT	30 DAT	16 DAT	30 DAT	49 DAT	16 DAT	30 DAT	49 DAT	30 DAT	49 DAT
Treatment	Rate	Timing	% injury			% control							
1Untreated	—	—	0	0	0	0	0	0	0	0	0	0	0
2Tough	0.75pt/a	A	0	0	0	44g	42f	54d	34e	41d	50e	49f	53e
3Tough	1pt/a	A	0	0	0	59f	58e	66c	58d	76bc	78cd	66e	76d
4Tough	1.5pt/a	A	0	0	0	68e	71cd	75b	77c	90a	89ab	80cd	81cd
5Tough	1.5pt/a	A	0	0	0	81c	79bc	79b	85b	88ab	81bcd	78cde	80cd
COC	2pt/a	A											
6Tough	1.5pt/a	A	0	0	0	75cd	79bc	81b	88ab	89a	91a	85bc	90b
MSO	2pt/a	A											
7Tough	1.5pt/a	A	0	0	0	81bc	75c	80b	86b	87ab	85abc	82bcd	85bc
Select	6oz/a	A											
COC	2pt/a	A											
8Tough	1.5pt/a	A	0	0	0	77cd	77bc	76b	84b	87ab	89ab	81cd	84c
Select	6oz/a	A											
MSO	2pt/a	A											
9Tough	1.5pt/a	A	0	0	0	89ab	88a	91a	95a	95a	92a	98a	100a
Select	6oz/a	A											
COC	2pt/a	A											
Tough	1.5pt/a	B											
COC	2pt/a	B											
10Tough	0.75pt/a	A	0	0	0	73de	66d	79b	72c	70c	72d	71de	81cd
Select	6oz/a	A											
COC	2pt/a	A											
Tough	0.75pt/a	B											
COC	2pt/a	B											
11Tough	1.5pt/a	A	0	0	0	90a	85ab	92a	95a	89a	94a	93a	100a
Select	6oz/a	A											
COC	2pt/a	A											
Tough	0.75pt/a	B											
COC	2pt/a	B											
LSD P=.05			.	.	.	7.27	8.14	7.88	7.12	12.72	9.46	3.90	5.52
Treatment F			0.000	0.000	0.000	31.249	23.794	16.725	58.371	13.033	16.394	1418.604	50.055
Treatment Prob(F)			1.0000	1.0000	1.0000	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001

Means followed by same letter or symbol do not significantly differ (P=.05, LSD)

Treatment timing 'A' was applied on June 5, 2018; timing 'B' was applied on June 14, 2018

Comparison of spray volume and adjuvant use for broadleaf weed control using pyridate (Tough) herbicide in chickpea

Caleb Dalley, HREC, Hettinger, ND 2018

Chickpea 'Leader,' a medium-sized Kabuli-type, were planted at a rate of 150 lb/A at a depth of 3 inches on May 9, 2018 using a John Deere 1590 no-till drill. Chickpea inoculant was applied in-furrow during planting. Prior to planting, the entire field was treated with glyphosate (32 oz/A, 1.0 lb ai/A) to control winter annual weeds. Chickpea emerged on May 23. Herbicide treatments were applied on June 5 using a tractor-mounted research plot sprayer. Spray volumes of 10, 20, and 30 gallons per acre were compared with and without crop oil concentrate (COC) adjuvant. Weeds present at time of application included kochia (2 to 5 inches) and Russian thistle (1 to 3 inches). Chickpea was evaluated for injury 8, 16, and 31 days after treatment (DAT) and there was no injury observed with any treatment. At 16 DAT, kochia control was less (69%) when Tough plus COC was applied at a spray volume of 10 gallons per acre compared with spray volumes of 20 and 30 gallons per acre, 81 and 88% control, respectively. However, when evaluated at 31 and 49 DAT, no differences in kochia control was observed when comparing spray volumes, although there appeared to be a small advantage when using COC adjuvant verses no adjuvant. Russian thistle was controlled equally well regardless of spray volume or COC adjuvant. While initially it appear that a higher spray volume may increase weed control, the impact did not carry through at later evaluations.

Table. Chickpea response and weed control following application of pyridate (Tough) herbicide treatments at spray volumes of 10, 20, and 30 gallons per acre.

			chickpea			kochia			Russian thistle		
			8 DAT	16 DAT	31 DAT	16 DAT	31 DAT	49 DAT	8 DAT	31 DAT	49 DAT
Treatment	Rate	Volume	% injury			% control					
1Untreated	—	—	0	0	0	0	0	0	0	0	0
2Tough	1.5pt/a	10	0	0	0	69bc	73bc	77	84	85	88
3Tough	1.5pt/a	10	0	0	0	69bc	75abc	79	95	83	92
COC	1.25pt/a		0	0	0						
4Tough	1.5pt/a	20	0	0	0	65c	64bc	74	79	81	85
5Tough	1.5pt/a	20				81ab	77ab	78	90	81	92
COC	1.25pt/a		0	0	0						
6Tough	1.5pt/a	30				64c	63c	73	90	86	93
7Tough	1.5pt/a	30	0	0	0	74abc	71bc	76	86	87	70
COC	1.25pt/a										
8Tough	1.5pt/a	30				88a	87a	85	100	89	90
COC	2.5pt/a		0	0	0						
LSD P=.05			.	.	.	14.05	13.27	9.67	16.45	12.95	24.72
Treatment F			0.000	0.000	0.000	3.364	3.344	1.588	1.622	0.494	0.926
Treatment Prob(F)			1.0000	1.0000	1.0000	0.0211	0.0216	0.2076	0.1984	0.8048	0.4998

Means followed by same letter or symbol do not significantly differ (P=.05, LSD)

Fall-planted cover crop tolerance to soybean herbicides, Carrington, 2018. Greg Endres and Mike Ostlie. The trial was conducted at the NDSU Carrington Research Extension Center with support from the North Dakota Soybean Council to evaluate the tolerance of six fall-planted, cool-season cover crops on ground previously treated with seven soybean herbicides that have soil residual. Experimental design was a randomized complete block with split-plot arrangement (whole plot = cover crop and subplot = herbicide) and three replicates. The field trial was established on a conventionally-tilled Heimdal-Emrick loam soil with 3.3% organic matter and 5.6 pH (0-6-inch depth). Asgrow 'AG05X8' dicamba-tolerant soybean was planted on May 16 in 22-inch rows. A hand-held boom sprayer was used delivering 17 gpa at 35 psi through TeeJet flat fan 8001 nozzles to the center 6.7 ft of 10- by 100-ft strips. Five PRE herbicides were applied on May 28 with 72 F, 61% RH, and 4 MPH wind on dry soil to emerging (VE) stage soybean. Following PRE herbicide application, 1.5 inches of rain occurred on June 1. Two POST herbicides were applied on June 7 with 76 F, 36% RH, and 9 mph wind on dry soil to first trifoliate (V1) stage soybean. Following POST herbicide application, 0.9 inch of rain occurred during June 10-12. Soybean at the seed formation (R5) stage were terminated by mowing on August 8. Rainfall from May 28 to November 2 totaled 10.5 inches, but rainfall during July 5 through September 19 totaled 0.8 inches. Due to the extended dry period, cover crop planting was delayed until September 24, when sufficient soil moisture was present for seed germination and seedling emergence. Cover crop species included barley, winter rye, field pea, flax, radish, and turnip. Cool and wet soil conditions after planting delayed cover crop development. Barley and winter rye at one-leaf stage, and field pea at 1-inch height were visually evaluated on November 2 for biomass and stand reduction. Cold weather and snow accumulation did not allow additional evaluation.

Plant injury was not observed with winter rye and field pea (Table). Barley injury ranged from 2-3 percent with the PRE herbicides Valor, Zidua, and Pursuit.

Table.

Herbicide			Cover crop injury[1]		
			2-Nov		
Treatment	Rate	Application timing[2]	Barley	Winter rye	Field pea
	fl oz product/A		%		
Sencor 75 DF	0.33 lb	PRE	0	0	0
Spartan 4F	10	PRE	0	0	0
Valor SX	3 oz	PRE	3	0	0
Zidua SC	4	PRE	3	0	0
Pursuit	3	PRE	2	0	0
Engenia + CA Ridion	12.8 + 2% v/v	POST	0	0	0
Flexstar + MSO	12 + 24	POST	0	0	0
C.V. (%)			399.5		
LSD (0.10)			NS		

[1]Biomass and/or stand reduction.

[2]PRE=May 28; POST=June 7.

Soybean herbicide injury to fall cover crops. Dr. Howatt and Mettler. Xtend soybean was seeded near Fargo on May 24. Preemergence treatments were applied to soil May 25 with 77°F, 58% relative humidity, 0% cloud cover, 3 mph wind velocity at 225°, and dry soil at 70°F. Post treatments were applied to 6 trifoliolate soybean, 8 inch field pennycress, 10 to 12 inch redroot pigweed, and 5 to 8 inch common lambsquarters on June 28 with 86°F, 60% relative humidity, moderately cloudy sky, 4.2 mph wind at 225°, and soil temperature of 80°F. All treatments were applied with a backpack sprayer delivering 17 gpa at 40 psi through 11002 TT nozzles to a 7 foot wide area the length of 10 by 40 foot plots. Xtend soybean was flailed August 7. Cover crops (barley (mixed varieties), winter rye, field pea (Green Arrow), flax (ND Gold), radish (Buster Forage), lentil (Richlea), and turnip) were direct seeded into soybean stubble and residue near Fargo on August 22 with a Great Plains drill with width of 6 ft. The experiment was a randomized complete block design with four replicates.

Treatment	Rate	Appl Code	9/12 Barley	9/12 Rye	9/12 Pea	9/12 Flax	9/12 Radish	9/12 Lentil	9/12 Turnip
Untreated Check	0		0	0	0	0	0	0	0
Metribuzin	4	PRE	0	0	0	0	4	0	5
Sulfentrazone	6	PRE	5	9	0	3	52	24	44
Flumioxazin-EZ	1.5	PRE	0	0	0	0	0	0	0
Pyroxasulfone-SC	2.6	PRE	0	1	0	0	6	0	10
Imazamox	0.75	PRE	6	8	0	21	54	3	50
Dicamba-E+CARid	8+2%	June28	0	0	0	0	0	0	0
Fomesafen+MSO	0.176+24	June28	0	0	0	0	0	0	0
Immx+MSO+UAN	0.625+24+2.5%	June28	0	0	0	1	1	0	0
CV			303	138	0.0	156	103	101	133
LSD P=.05			6	4	.	7	19	4	23

Treatment	Rate	Appl Code	9/26 Barley	9/26 Rye	9/26 Pea	9/26 Flax	9/26 Radish	9/26 Lentil	9/26 Turnip
Untreated Check	0		0	0	0	0	0	0	0
Metribuzin	4	PRE	0	0	0	0	0	0	0
Sulfentrazone	6	PRE	7	4	0	0	57	40	44
Flumioxazin-EZ	1.5	PRE	0	0	0	0	0	0	0
Pyroxasulfone-SC	2.6	PRE	0	0	0	0	1	0	2
Imazamox	0.75	PRE	9	6	0	60	74	15	79
Dicamba-E+CARid	8+2%	June28	0	0	0	0	0	0	0
Fomesafen+MSO	0.176+24	June28	0	0	0	0	0	0	0
Immx+MSO+UAN	0.625+24+2.5%	June28	0	0	0	0	0	0	0
CV			93	147	0	41	38	52	61
LSD P=.05			2	2	.	4	8	5	12

Sulfentrazone and imazamox PRE to soybean caused substantial stand loss to radish and turnip seeded 3 months later. However, imazamox applied POST to soybean did not have detrimental effect on species. Injury, when present, to species other than radish and turnip generally was abnormal growth or discoloration.

Fall and Spring Applications of Sulfentrazone and Metolachlor for Weed Control in Dry Field Peas

Caleb Dalley, HREC, Hettinger, ND 2018

A trial was conducted to evaluate fall and spring applications of sulfentrazone and metolachlor for weed control in dry field peas. Fall treatments were applied on October 17, 2017 to a no-till field site previously planted to spring wheat. Treatments were applied using a tractor-mounted research plot spray at a spray volume of 10 gallons per acre. Downy brome had emerged prior to this application timing and was mostly in the 1-leaf stage. Winter weather prevented evaluation of plots until spring. In the spring, prior to planting, fall applications were 100% effective in controlling downy brome shepherd's purse and prickly lettuce. Field peas 'Nettes' were planted on May 3, 2018 using a John Deere 1590 no-till drill. On May 5, spring preemergence treatments were applied using the same equipment as fall treatments. All preemergence treatments included glyphosate plus AMS to control emerged weeds. Spring treatments were also nearly 100% effective at controlling downy brome and shepherd's purse. Residual control of green foxtail was generally better with spring application than fall, but control of kochia and common lambsquarters was very similar for both application timings. Evaluations taken on June 26th, 250 days after fall application of sulfentrazone resulted in 88 to 95% control of common lambsquarters and 87 to 91% control of kochia. Unfortunately, a severe hailstorm on the night of June 26 resulted in total defoliation of the peas and weeds making further evaluation of weed control impossible and prevented collection of yield data as well. It was impressive how well spring weeds were controlled with fall preemergence applications. Further research looking at fall herbicide applications for weed control prior to planting peas should be pursued.

Table. Effect of fall and spring preemergence herbicide treatments for weed control in field peas at Hettinger, ND

Treatment	Rate oz/A	Timing	Pea	Downy brome		Shepherd's purse		Kochia			Green foxtail		Common lambsquarters	
			18 DAE	-11 DAE	7 DAE	-11 DAE	7 DAE	7 DAE	18 DAE	43 DAE	18 DAE	43 DAE	18 DAE	43 DAE
			% injury	% control										
1Untreated		Fall	0	0b	0c	0c	0d	0c	0.0d	0f	0g	0c	0c	0e
2Glyphosate Broadaxe XC	32 25	Fall	0	100a	100a	100a	99a	100a	91.3a	91ab	70e	63a	94a	92a
3Glyphosate Broadaxe XC	32 19	Fall	0	100a	100a	100a	100a	95a	80.0c	90ab	58f	36b	86b	93a
4Glyphosate Broadaxe XC Dual II	32 19 10	Fall	0	100a	100a	100a	100a	98a	85.0bc	88b	78cd	73a	90ab	95a
5Glyphosate Broadaxe XC Dual II	32 19 16	Fall	0	100a	100a	100a	100a	96a	85.0bc	91ab	80bcd	74a	93a	88a
6Glyphosate Dual II	32 32	Fall	0	100a	100a	100a	100a	44b	0.0d	13e	75de	66a	0c	0e
7Glyphosate	32	Fall	0	100a	96b	97ab	90bc	0c	0.0d	0f	0g	0c	0c	0e
8Glyphosate	32	Fall + Spring	0	100a	100a	95b	99a	95a	0.0d	0f	0g	0c	0c	0e
9Glyphosate Broadaxe XC	32 25	Spring	0	0b	100a	0c	98a	100a	91.0a	93ab	85a	78a	94a	87ab
10Glyphosate Broadaxe XC	32 19	Spring	0	0b	100a	0c	96ab	100a	89.1ab	96a	83abc	74a	90ab	90a
11Glyphosate Broadaxe XC Dual II	32 10 16	Spring	0	0b	100a	0c	99a	98a	86.3ab	80c	77d	75a	86b	75c
12Glyphosate Broadaxe XC Dual II	32 10 23	Spring	0	0b	100a	0c	94abc	96a	90.0ab	93ab	83ab	78a	86b	78bc
13Glyphosate Dual II	32 32	Spring	0	0b	99a	0c	98a	95a	0.0d	25d	79bcd	76a	0c	0e
14Glyphosate	32	Spring	0	0b	100a	0c	89c	98a	0.0d	0f	0g	0c	0c	0e
LSD P=.05			.	.	2.13	3.25	6.69	8.32	5.8	6.7	5.0	17.4	4.0	9.4
Treatment F			0.000	0.000	1283.6	2036.3	125.2	157.6	475.7	340.1	425.1	31.0	1053.4	161.9
Treatment Prob(F)			1.0000	1.0000	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001

Means followed by same letter or symbol do not significantly differ (P=.05, LSD)

Fall treatments were applied on October 19. Spring treatments were applied on May 5. Peas were planted on May 3

All treatments included AMS at 8.5 lbs/100 gallons

Dry pea, lentil, and sunflower tolerance to fall-applied 2,4-D and dicamba. (Minot). The objective of this study was to determine if fall-applied 2,4-D or dicamba will carry over to injure spring planted dry pea, lentil, or sunflower. 2,4-D was applied at 1 and 2 pt, and dicamba was applied at 4 and 8 fl oz. The herbicides were applied September 28, October 13, and October 25, 2017. Dry pea, lentil, and sunflower were planted May 7, 14, and 30, respectively.

Dry pea and sunflower exhibited no visible injury symptoms. Lentil was injured by 2,4-D at 2 pt and both dicamba rates. Lentil injury also tended to increase with later applications. No injury symptoms were observed with lentil following 2,4-D at 1 pt.

Title. Dry pea, lentil, and sunflower tolerance to fall-applied 2,4-D and dicamba. (1807)

			Density			Height					
			Dry pea	Sunflower	Lentil	Dry pea	Sunflower	Lentil	Lentil Injury		
Treatment	Rate	Timing		Jun-22			Jul-24		Jun-12	Jun-27	Aug-9
			----------m of row----------			----------cm----------			----------%----------		
Untreated			10.8	4.3	21.1	64.9	68.7	31.6	0	0	0
2,4-D-ester	1 pt	Sep-28	9.3	5.0	17.1	65.5	78.4	35.3	0	0	0
2,4-D-ester	1 pt	Oct-13	10.7	4.4	13.9	62.5	81.8	34.1	0	0	0
2,4-D-ester	1 pt	Oct-25	9.2	4.2	14.5	67.4	77.0	32.7	0	0	0
2,4-D-ester	2 pt	Sep-28	11.6	5.0	14.2	59.0	80.8	31.1	0	0	15
2,4-D-ester	2 pt	Oct-13	10.7	5.5	9.6	60.6	92.8	30.2	0	0	13
2,4-D-ester	2 pt	Oct-25	10.0	4.0	14.4	66.3	86.6	31.7	0	0	12
Dicamba	4 oz	Sep-28	11.7	4.1	13.6	61.4	73.3	32.1	0	0	15
Dicamba	4 oz	Oct-13	9.3	4.3	8.8	63.2	76.1	31.8	0	0	28
Dicamba	4 oz	Oct-25	10.1	4.8	9.3	64.4	89.6	30.7	0	0	40
Dicamba	8 oz	Sep-28	10.9	6.0	7.8	66.4	81.9	31.1	0	0	42
Dicamba	8 oz	Oct-13	10.3	4.4	5.3	67.3	85.4	25.6	0	0	53
Dicamba	8 oz	Oct-25	9.7	4.8	3.8	56.0	86.5	24.9	0	0	75
LSD (0.05)			NS	NS	6.4	NS	NS	4.4	NS	NS	18.3

Preemergence weed control in Dry Bean. Dr. Howatt, Mettler, and Harrington. 'Eclipse' black bean was seeded near Fargo on May 22. Preemergence treatments were applied May 22 with 74°F, 35% relative humidity, 25% cloud cover, 4 mph wind velocity at 180°, and dry soil at 60°F. Treatments were applied with a backpack sprayer delivering 17 gpa at 40 psi through 11002 TT nozzles to a 7 foot wide area the length of 10 by 30 foot plots. The experiment was a randomized complete block design with four replicates.

Treatment	Rate	5/29	6/5 DEB	6/5 Yeft	6/5 Rrpw	6/5 Colq	6/18 DEB	6/18 Rrpw	6/18 Colq	6/18 Vema
Untreated Check	0		5	0	0	0	5	0	0	0
Pendimethalin-h	15.2		5	72	86	91	5	85	90	67
Flumioxazin	0.75		5	72	91	91	5	89	92	80
SA-0370104	2.4		5	65	84	90	5	71	84	56
SA-0370104+Pend-h	1.6+15.2		5	74	87	89	5	87	93	66
SA-0370104+Pend-h	2.4+15.2		5	71	85	91	5	88	95	81
SA-0370104+Flum	1.6+0.5		5	62	89	87	5	84	90	70
SA-0370104+Flum	2.4+0.5		5	72	91	92	5	84	90	79
Suen&metolachlor	22.7		11	85	95	95	24	96	96	86
Dimethenamid-p	16		5	84	89	91	5	90	86	74
CV		.	17	12	5	4	44	5	4	7
LSD P=0.5		.	1	12	6	5	4	6	4	7

Environmental conditions resulted in slight injury to dry bean at both evaluations. Only sulfentrazone and metolachlor caused a greater level of injury relative to the untreated. This injury persisted through the season and was present on newer leaves in addition to causing stunted plants and slower development. This treatment also provided the greatest activity on weeds although other treatments gave similar control without damaging the crop. Flumioxazin provided about 90% control of pigweed and lambsquarters and 80% control of Venice mallow. The high rate of SA-0370104 applied with either pendimethalin or flumioxazin gave good control of weeds in this study but SA-0370104 alone gave fair control of pigweed and poor control of Venice mallow.

Pinto bean response to low dose rates of dicamba and glyphosate, Carrington, 2017.
(Greg Endres and Mike Ostlie)

The multi-year field study continued (from 2015) at the NDSU Carrington Research Extension Center to examine the response of pinto bean to low dose (drift) rates of dicamba and glyphosate. Experimental design was a randomized complete block with three replications. The experiment was conducted on a dryland, conventionally-tilled Heimdal-Emrick loam soil. 'Lariat' was planted on May 31 in 22-inch rows at a rate to achieve 70,000 plants/A. Herbicide treatments were applied to the center 6.67 ft of 20 ft wide (9 rows) by 24 ft length plots with a CO_2-hand-boom plot sprayer delivering 9 gal/A at 35 psi through 8001 flat fan nozzles on July 18 with 79 F, 37% RH and 4 mph wind to pre- to bud to early bloom plants. XtendiMax (dicamba) application rates were targeted at 0.0193, 0.193 and 1.93 fl oz/A; Roundup PowerMax (glyphosate) rates were targeted at 0.025, 0.25 and 2.5 fl oz/A; plus herbicide combinations paired at low, medium and high rates. Plants from three herbicide-treated rows at 12 ft length of treatment numbers 1-2, 5-6 and 8 were hand-pulled and placed in windrows on September 12 and seed harvested with a plot combine on September 13 (Table). Plants from treatments 4, 7, and 10 were immature before October 13 killing frost (23 F). Treatments 3-4, 7, and 9-10 were hand-pulled October 16 and seed harvested on October 19.

Plant injury, based on visual evaluation of biomass reduction and chlorosis/necrosis, generally increased with increasing herbicide rates (Table). Compared to the untreated check, canopy closure was reduced by 7-12 percentage points with the low- and medium-rates of dicamba and dicamba plus glyphosate, and reduced 13-15 percentage points with the high rate of dicamba, glyphosate, and dicamba plus glyphosate. Also compared to the untreated check, plant maturity was delayed 6 days with the low rate of dicamba plus glyphosate, and 27-38 days with the medium and high rates of dicamba and dicamba plus glyphosate. Seed yield with the low rate of dicamba, and the low and medium rates of glyphosate were statistically similar to the untreated check. The medium rate of dicamba, and low and medium rates of dicamba plus glyphosate reduced yield 943 to 1192 lb/A compared to the untreated check. The high rate of dicamba and glyphosate, and dicamba plus glyphosate drastically reduced seed yield. The high rate of dicamba plus glyphosate resulted in no seed yield. Test weight was reduced with high herbicide rates. Also, seed size was reduced with the medium and high rates of dicamba and dicamba plus glyphosate, and with the high rate of glyphosate. Seed germination was 13% and 41% with the high rate of dicamba and glyphosate, respectively, compared to 78% with the untreated check.

Table.

Treatment		Plant						Seed				Seedling weight
		Biomass reduction (%)		Chlorosis/ necrosis (0-9)[1]		Canopy closure (%)	PM[2]	Yield	TWT	number /lb	Germ	
No.	Description[4]	7/31	8/8	7/31	8/8	8/17	Jday	lb/A	lb/bu		%	g/plt[4]
1	untreated check	0	0	0	0	87	248	3372	59.9	1161	78	1.1
2	Clarity L	22.7	26.7	0	2	80	251	2658	58.8	1082	77	1.3
3	Clarity M	23.3	37.3	0	3	79	276	2429	57.4	1243	70	1.0
4	Clarity H	37.7	46	2	4	74	286	529.1	53.9	1348	13	1.2
5	RU PM L	13.3	13.3	0	1	85	246	2964	59.1	1181	75	1.3
6	RU PM M	11.3	15	0	1	84	246	2752	59.2	1167	78	1.2
7	RU PM H	40	41.7	4	3	72	286	596.9	53.5	1389	41	1.0
8	Clarity + RU PM L	20	29.7	0	2	80	254	2180	58.3	1094	78	1.2
9	Clarity + RU PM M	31.7	36.7	2	3	75	275	2208	58.2	1326	66	0.9
10	Clarity + RU PM H	48.3	50.3	5	5	72	286	0	x	x	x	x
mean		25	30	1	2	79	266	2318	57.9	1224	63	1.1
C.V. (%)		16.5	24.0	53.3	26.9	5.7	0.5	23.0	2.5	3.6	14.8	11.4
LSD (0.05)		7	12	3	1	8	2	932	2.5	76	16	0.2

[1]0=none, 9=all tissue affected.

[2]PM=Physiological maturity. 23 degrees occurred on Jday 286 to terminate growth of treatments 4, 7 and 10.

[3]XtendiMax rates (fl oz/A): L=0.0193; M=0.193; H=1.93. Roundup PowerMax rates (fl oz/A): L=0.025; M=0.25; H=2.5.

[4]Average plant weight (grams) of seedlings 2-3 weeks after planting of harvested seed.

Pinto bean response to low dose rates of dicamba and glyphosate, Carrington, 2018.
(Greg Endres and Mike Ostlie)

The multi-year field study continued (from 2015) at the NDSU Carrington Research Extension Center to examine the response of pinto bean to low dose (drift) rates of dicamba and glyphosate. Experimental design was a randomized complete block with three replications. The experiment was conducted on a dryland, conventionally-tilled Heimdal-Emrick loam soil. 'ND Palomino' was planted on May 29 in 22-inch rows at a rate to achieve ≥70,000 plants/A. Herbicide treatments were applied with a CO_2-hand-boom plot sprayer delivering 9 gal/A at 35 psi through 8001 flat fan nozzles on July 9 with 74 F, 73% RH and 4 mph wind to bud to early bloom (V8-R1) plants. XtendiMax (dicamba) application rates were targeted at 0.0193, 0.193 and 1.93 fl oz/A; Roundup PowerMax (glyphosate) rates were targeted at 0.025, 0.25 and 2.5 fl oz/A; plus herbicide combinations paired at low, medium and high rates. All treatments included Activator 90 (NIS) at 0.25% v/v. Plants from three herbicide-treated rows at 12 ft length of treatment numbers 1, and 5-6 were hand-pulled and placed in windrows on August 30 and seed harvested with a plot combine on August 31 (Table). Plants from treatments 2 and 8 were hand-pulled and placed in windrows on September 14 and seed harvested on September 25. Plants from treatments 3-4, 7, and 9-10 were killed by frost (28 F) on September 28. Plants from treatments 3, 7, and 9 were hand-pulled and placed in windrows on October 2 and seed harvested on October 18. Plants from treatments 4 and 10 were too heavily damaged by herbicide to produce seed, thus were not harvested.

Plant injury, based on visual evaluation of biomass reduction and chlorosis/necrosis, increased with increasing herbicide rates (Table). Compared to the untreated check, canopy cover decreased with increasing herbicide rates. The high rate of dicamba, glyphosate, and dicamba plus glyphosate had 29-35% canopy reduction compared to the untreated check. Plant maturity was similar among the untreated check and the low and medium rates of glyphosate, but was delayed 16-35 days with all other herbicide treatments. Seed yield with the low rate of dicamba (trt 2), and the low and medium rates of glyphosate (trts 5 and 6) were statistically similar to the untreated check. Yield reduction with the medium rate of dicamba, high rate of glyphosate, and low and medium rates of dicamba plus glyphosate ranged from 7 to 50 percent compared to yield with the untreated check. The high rates of dicamba, and dicamba plus glyphosate resulted in no seed yield.

Table.

Treatment		Plant						Seed	
		Biomass reduction (%)		Chlorosis/necrosis (0-9)[1]		Canopy closure (%)	PM[2]	Yield	count
No.	Description	7/20	7/30	7/20	7/30	7/30	Jday	lb/A	no./lb
1	untreated check	0	0	0	0	93	237	1579	1500
2	XtendiMax L	27	27	2	3	82	253	1205	1447
3	XtendiMax M	34	38	4	4	71	272	348	1562
4	XtendiMax H	47	52	6	6	66	272	0	x
5	RU PM L	7	7	0	1	89	237	1183	1549
6	RU PM M	11	12	1	1	91	237	1451	1505
7	RU PM H	38	38	5	4	67	272	117	1478
8	XtendiMax + RU PM L	28	29	3	3	81	253	785	1553
9	XtendiMax + RU PM M	38	40	4	4	72	272	371	1357
10	XtendiMax + RU PM H	55	65	7	7	60	272	0	x
mean		28	31	1	3	77	258	880	1494
C.V. (%)		20.7	17.4	13.2	15.5	5.4	0.2	29.7	10.1
LSD (0.05)		10	9	1	1	7	1	458	NS

[1]0=none, 9=all tissue affected.

[2]PM=Physiological maturity. 28 degrees occurred on Jday 271 to terminate growth of treatments 3-4, 7 and 9-10.

[3]XtendiMax rates (fl oz/A): L=0.0193; M=0.193; H=1.93. Roundup PowerMax rates (fl oz/A): L=0.025; M=0.25; H=2.5.

Pinto bean response following winter rye cover crop, Carrington, 2018.
(Greg Endres and Mike Ostlie)

The trial was conducted in 2018, at the NDSU Carrington Research Extension Center with support from Northarvest Dry Bean Growers Association to examine the performance of pinto bean with winter rye grown as a preplant (PP) cover crop (seeded in the fall of the previous growing season). Experimental design was a randomized complete block with four replications. The dryland trial was established on a conventionally tilled Heimdal-Emrick loam soil with 3.7% organic matter, 6.6 pH, 20 ppm P, 299 ppm K, and 1.0 ppm Zn. 'ND Dylan' rye was direct seeded into oat stubble in 7-inch rows at about 60 lb/A on October 4, 2017. 'Lariat' pinto bean was planted into tilled soil or rye residue at 83,300 seeds/acre in 21-inch rows on May 31, 2018. North Dakota Agricultural Weather Network (NDAWN) monthly rain (inches): April = 0.06; May = 1.28; June = 4.63; July = 2.65; and August = 0.24.

Rye termination treatments were designated by method and timing:
1. Tillage (2x roto-till) on October 17 (13 days after seeding rye) followed by preemergence (PRE) Roundup PowerMax (32 fl oz/A) plus NIS+AMS (Class Act NG; 2.5% v/v) and Spartan Charge (5 fl oz/A) on May 31 (conventional check).
2. PP tillage (2x roto-till) on April 26 (rye 1- to 2-leaf).
3. PP Roundup PowerMax plus NIS+AMS on April 26.
4. PP Roundup PowerMax plus NIS+AMS on April 26 followed by PRE Roundup PowerMax plus NIS+AMS and Spartan Charge (5 fl oz/A) on May 31.
5. PP Roundup PowerMax plus NIS+AMS on May 14 (rye 4-leaf plus tillers).
6. PP Roundup PowerMax plus NIS+AMS on May 30 (rye boot stage with some heads emerging).

Raptor (4 fl oz/A) plus MSO (Destiny; 24 fl oz/A) and AMS (12 lb/100 gal) was applied across trial on June 15 for post-emergence (POST) control of green and yellow foxtail, and rye escapes. Also, Raptor plus SelectMax (12 fl oz/A) and MSO HC (16 fl oz/A) were POST applied to treatments 2-3 and 5 on June 28 for control of foxtail escapes. Herbicide treatments were applied with a hand-boom sprayer delivering 10 gpa through 8001 flat-fan nozzles at 35 psi.

Bean plants were hand-pulled for field drying on August 29 and seed harvested with a plot combine on August 31.

Rye termination method and timing had minimal influence on dates of bean plant emergence, flowering, and maturity (Table 1). Plant stand was similar among treatments. Plant stand across treatments (50,590 plants/acre) was 61% of planting rate. Mid-July canopy closure was greatest with the conventional check (trt 1), while late July/early August evaluations generally indicated similar canopy closure among treatments. Also, pod height was similar among treatments.

Table 1. Pinto bean response to rye cover crop, Carrington, 2018.

	Plant[a]								Seed		
Trt no.	Emergence	Stand (20-Jun)	Flower (R1)	Canopy closure (%)			Maturity (R9)	Pod ht	Yield	Test weight	Count
				12-Jul	31-Jul	1-Aug[b]					
	DOY	plt/A	DOY				DOY	cm	lb/A	lb/bu	no./lb
1	163	51,936	198	61	86	80	235	2	1171	55.6	1241
2	163	48,853	199	33	72	72	237	2	1080	55.6	1205
3	164	48,853	199	35	75	76	237	2	1104	55.8	1268
4	163	52,648	198	49	83	87	236	1	1237	55.7	1262
5	164	48,616	199	36	72	71	237	1	919	54.7	1223
6	163	52,648	198	49	81	81	235	2	1127	55.4	1279
Mean	163	50,592	199	44	78	78	236	1	1106	55.5	1246
CV (%)	0.4	11.0	0.4	15.9	6.3	11.0	0.3	95.0	24.9	1.3	7.8
LSD (0.10)	1	NS	1	9	6	NS	1	NS	NS	NS	NS

[a]DOY (day of year): 163=June 12; 199=July 18; 236=Aug 24. Plant stage at stand count = VC.

[b]Canopeo reading.

Soil moisture was adequate for bean plant establishment and vegetative stage growth. However, during bean reproductive (seed production) stages, rainfall was limited to 0.72 inches (NDAWN) from July 5 to August 31. Thus, trial seed yield was greatly reduced. Yield, test weight and seed size were similar among treatments (Table 1). Yield with treatment 4 tended to be greater than others, likely due to increased soil moisture and weed control with PRE herbicide after planting; treatment 5 tended to have lowest yield.

Soil moisture was measured at 4-inch depth with a hand-held tester during mid-May to mid-July (Table 2). Soil moisture was consistently lower with rye termination at bean planting time with glyphosate (trt 6), when measured May 14 and 31, and June 15, compared to the standard check (trt 1). Also, soil moisture was reduced by half with early spring rye termination with tillage (trt 2) compared to treatment 1. Soil moisture was similar among all treatments when measured June 28 and July 12.

Table 2. Soil moisture with pinto bean following a rye cover crop , Carrington, 2018.

Trt no.	Soil moisture[a]				
	14-May	31-May	15-Jun	28-Jun	12-Jul
			%		
1	21.5	18.1	24.2	24.0	20.8
2	10.6	17.6	22.3	25.0	23.0
3	20.5	20.0	22.0	22.3	21.4
4	20.5	20.4	24.7	23.5	22.8
5	19.9	19.7	22.1	23.6	22.4
6	17.7	11.1	20.9	23.2	20.7
Mean	18.4	17.8	22.7	23.6	21.8
CV (%)	13	12.9	5.8	6.2	11.0
LSD (0.10)	3.0	2.8	1.6	NS	NS

[a]Measured with Extech Instruments MO750 soil moisture meter at 4-inch soil depth.

The trial contained grassy weeds: green and yellow foxtail, and rye escapes, plus late-season Kentucky bluegrass. Rye control at bean planting (May 31) was excellent (94-99%) with spring PP tillage or glyphosate (trts 2-5) (Table 3). Foxtail control was excellent at bean planting with presence of living rye (trt 6). Control of rye generally was excellent at June 15 and 28, and July 12 evaluations. Foxtail control was excellent (94-95%) on June 28 with PRE herbicides followed by POST Raptor or rye terminated at bean planting (trts 1, 4, and 6). Grass control generally was excellent with all treatments on July 12.

Table 3. Weed control in pinto bean following a rye cover crop , Carrington, 2018.

Trt no.	Weed control[a]							
	31-May		15-Jun		28-Jun		12-Jul	
	rye	grass	rye	grass	rye	grass	rye	grass
	%							
1	74	71	99	75	99	95	99	96
2	98	0	91	38	94	63	99	95
3	94	63	85	61	85	69	96	90
4	96	50	99	73	99	94	99	92
5	99	44	99	51	99	69	99	89
6	0	93	99	71	99	95	99	89
Mean	77	54	95	61	96	81	99	92
CV (%)	6.7	36.3	5.5	19.5	5.0	8.5	1.7	5.7
LSD (0.10)	6	24	6	15	6	9	NS	NS

[a]Grass=green and yellow foxtail, plus Kentucky bluegrass on July 12.

In summary, lack of adequate rainfall and stored soil moisture during the bean reproductive period greatly reduced yield potential among all treatments. Delay of rye termination until bean planting (trt 6) reduced early season soil moisture for bean plants compared to the standard check. However, this treatment substituted for weed control obtained with the PRE herbicide while bean yield was similar to the standard check.

Faba bean tolerance to PRE and POST herbicides. (Minot). The objective of the study was to evaluate faba bean tolerance to preemergence (PRE) and postemergence (POST) herbicides. Faba bean was planted on May 4. PRE and POST herbicides were applied May 5 and June 4, respectively. Sharpen, Metribuzin, Valor, Fierce, Raptor, and Tough are not labeled for use in faba bean as of 2018.

Treatments containing Metribuzin caused significant faba bean injury where many plants just turned black and died. We have not observed this Metribuzin injury in previous years, which may be attributed, in part, to the sandy loam soil. Raptor and Tough caused moderate to severe injury. Faba bean in the Raptor treatment recovered more than in previous years. Raptor applied with Basagran caused significantly less crop injury. The yield data in the table are confounded by crop injury as well as weed pressure, primarily lambsquarters. Basagran and Raptor treatments effectively controlled lambsquarters. Spartan-containing products generally provided good lambsquarters control, but had a few escapes. Valor and Fierce provided fair to good control of lambsquarters. Sharpen at 2 oz did not control lambsquarters. Dry soil conditions in May likely hindered activation of soil-applied herbicides.

Table. Faba bean tolerance to PRE and POST herbicides. (1818)

			Injury			Height	Yield	Test wt.
Treatment	Rate	Timing	Jun-14	Jul-16	Aug-2	Jul-24	Aug-15	Aug-15
			——%——			–cm–	lb/A	lb/bu
Untreated			0	0	0	105	937	65.2
Sharpen	2 oz	PRE	0	0	0	104	1379	65.6
Spartan	4 oz	PRE	0	0	0	100	2024	66.0
Spartan + Sharpen	4 oz + 1 fl oz	PRE	0	0	0	104	2305	66.2
Authority MTZ	12 oz	PRE	30	25	26	92	1786	65.8
BroadAxe	25 oz	PRE	0	0	0	98	2553	65.9
Metribuzin	0.5 lb	PRE	60	51	52	88	1260	65.6
Prowl H2O	3 pt	PRE	0	0	0	99	1983	66.0
Valor	2 oz	PRE	0	0	0	106	1806	66.1
Fierce	3 oz	PRE	0	0	0	99	2176	65.9
Prowl H2O / Basagran + COC	2 pt / 2 pt + 1.5 pt	PRE / POST	9	8	8	93	2053	65.6
Prowl H2O / Raptor[a]	2 pt / 4 fl oz	PRE / POST	35	22	24	85	1954	65.4
Prowl H2O / Basagran + Raptor[b]	2 pt / 1 pt + 4 fl oz	PRE / POST	9	6	6	96	2741	66.0
Tough	1.5 pt	POST	65	49	53	83	1063	65.1
LSD (0.05)			6.2	12.0	12.1	11.6	675	0.6
CV							22	

[a] *Applied with MSO (1.5 pt) and 28% N (2.5%)*

[b] *Applied with MSO (1.5 pt)*

Weed Control in faba bean (Prosper, ND) – H. Hatterman-Valenti, B. Johnson, and C. Auwarter.
This study was conducted at the Agric. Expt. Stn. near Prosper, North Dakota to evaluate pyroxasulfone crop safety and season-long weed control strategies in faba bean. 'Fan Fare' was seeded May 22 and harvested September 11. Preemergence (Appl. Code A) applications were made 5/25, three days after seeding, while POST (Appl. Code B) applications occurred on 6/7 when beans were 2-3 trifoliate stage. All herbicides were applied with a CO_2 backpack sprayer and a hand-boom equipped with XR8002 nozzles delivering 20 GPA at 40 PSI.

Table 1. Weed control evaluations.

Weed Code			COLQ	RRPW	GRFT	COCB	COLQ	RRPW	GRFT	COCB
Rating Date			Jun-13-2018	Jun-13-2018	Jun-13-2018	Jun-13-2018	Aug-3-2018	Aug-3-2018	Aug-3-2018	Aug-3-2018
Days After First/Last Applic.			19 6	19 6	19 6	19 6	70 57	70 57	70 57	70 57
No. Treatment	Rate	Unit	%							
1 Pyroxasulfone	42.35	g/a	100.0 a	99.3 ab	96.3 ab	98.9 a	92.5 c	67.5 a	87.5 c	71.9 d
2 Pyroxasulfone	60	g/a	100.0 a	98.1 b	95.0 ab	98.1 a	95.0 bc	46.3 a	92.5 b	84.0 c
3 Pyroxasulfone	92.82	g/a	100.0 a	99.9 a	93.8 b	95.4 a	95.0 bc	68.8 a	96.3 ab	88.8 c
4 Spartan	4.5	fl oz/a	100.0 a	100.0 a	98.8 ab	99.7 a	100.0 a	98.8 a	96.3 ab	100.0 a
Dual Magnum	2	pt/a								
Pyroxasulfone	42.35	g/a								
5 Spartan	4.5	fl oz/a	100.0 a	100.0 a	100.0 a	99.7 a	100.0 a	100.0 a	98.8 a	100.0 a
Dual Magnum	2	pt/a								
Pyroxasulfone	47.06	g/a								
6 Spartan	4.5	fl oz/a	100.0 a	100.0 a	98.8 ab	99.9 a	100.0 a	98.8 a	100.0 a	100.0 a
Dual Magnum	2	pt/a								
Pyroxasulfone	58.82	g/a								
7 Spartan	4.5	fl oz/a	100.0 a	100.0 a	98.5 ab	99.7 a	97.5 ab	98.8 a	96.3 ab	96.3 b
Dual Magnum	2	pt/a								
8 Untreated			0.0 b	0.0 c	0.0 c	0.0 b	0.0 d	0.0 b	0.0 d	0.0 e

Table 2. Crop injury evaluations and faba bean yields.

Crop Name			Fava Bean	Fava Bean	Fava Bean
Rating Date			Jun-13-2018	Aug-3-2018	Sept-11-2018	Sept-11-2018
Days After First/Last Applic.			19 6	70 57		
No. Treatment	Rate	Unit	%		g/100 ft2	lbs/A
1 Pyroxasulfone	42.35	g/a	0.0 b	0.0 a	1054.00 a	1011.283 a
2 Pyroxasulfone	60	g/a	0.0 b	0.0 a	1147.30 a	1100.800 a
3 Pyroxasulfone	92.82	g/a	0.0 b	0.0 a	1041.15 a	998.953 a
4 Spartan	4.5	fl oz/a	0.0 b	0.0 a	1176.23 a	1128.553 a
Dual Magnum	2	pt/a				
Pyroxasulfone	42.35	g/a				
5 Spartan	4.5	fl oz/a	6.3 b	0.0 a	1034.33 a	992.405 a
Dual Magnum	2	pt/a				
Pyroxasulfone	47.06	g/a				
6 Spartan	4.5	fl oz/a	7.5 b	0.0 a	1018.60 a	977.318 a
Dual Magnum	2	pt/a				
Pyroxasulfone	58.82	g/a				
7 Spartan	4.5	fl oz/a	0.0 b	0.0 a	1194.55 a	1146.135 a
Dual Magnum	2	pt/a				
8 Untreated			0.0 b	0.0 a	916.18 a	879.045 a

Faba bean were injured early by treatments 5 and 6, but plants outgrew injury (Table 2). Weed pressures were light so all treatments provided early season weed control. By August 3, the preemergence applications of pyroxasulfone alone did not provide sufficient RRPW control (Table 1). High COLQ and COCB control evaluations were due to a few plants observed in the untreated plots and not necessarily from the herbicide applications. The addition of pyroxasulfone applied postemergence did not statistically increase weed control compared to Spartan + Dual Magnum alone applied preemergence with the exception of COCB.

Weed Control in faba bean (Fargo, ND) – H. Hatterman-Valenti, B. Johnson, and C. Auwarter.
This study was conducted at the main Agric. Expt. Stn. just west of the NDSU campus, Fargo, North Dakota to evaluate pyroxasulfone crop safety and season-long weed control strategies in faba bean. 'Tabasco' was seeded May 24 and harvested September 11. Preemergence (Appl. Code A) applications were made 5/25, one day after seeding, while POST (Appl. Code B) applications occurred on 6/7 when beans were 1-2 trifoliate stage. All herbicides were applied with a CO_2 backpack sprayer and a hand-boom equipped with XR8002 nozzles delivering 20 GPA at 40 PSI.

Table 1. Weed control evaluations.

Weed Code			RRPW	GRFT	VEMA	RRPW	GRFT	VEMA
Rating Date			Jun-13-2018	Jun-13-2018	Jun-13-2018	Jun-27-2018	Jun-27-2018	Jun-27-2018
Days After First/Last Applic.			19 6	19 6	19 6	33 20	33 20	33 20
No. Treatment	Rate	Unit	%					
1 Pyroxasulfone	42.35	g/a	47.5 abc	22.5 bc	18.8 b	67.5 a	20.0 b	31.3 b
2 Pyroxasulfone	60	g/a	25.0 bc	46.3 abc	22.5 b	46.3 a	22.5 b	18.8 b
3 Pyroxasulfone	92.82	g/a	67.5 ab	65.0 ab	42.5 ab	68.8 a	55.0 a	40.0 b
4 Spartan	4.5	fl oz/a	75.0 ab	93.8 a	80.0 a	98.8 a	72.5 a	77.5 a
Dual Magnum	2	pt/a						
Pyroxasulfone	42.35	g/a						
5 Spartan	4.5	fl oz/a	100.0 a	95.0 a	85.0 a	100.0 a	93.8 a	81.3 a
Dual Magnum	2	pt/a						
Pyroxasulfone	47.06	g/a						
6 Spartan	4.5	fl oz/a	100.0 a	95.0 a	87.5 a	98.8 a	88.8 a	87.5 a
Dual Magnum	2	pt/a						
Pyroxasulfone	58.82	g/a						
7 Spartan	4.5	fl oz/a	75.0 ab	93.8 a	81.3 a	98.8 a	92.5 a	82.5 a
Dual Magnum	2	pt/a						
8 Untreated			0.0 c	0.0 c	0.0 b	0.0 b	0.0 b	0.0 b

Table 2. Crop injury evaluations and faba bean yields.

Crop Name				Fava Bean	Fava Bean	Fava Bean
Rating Date			Jun-13-2018	Jun-27-2018	Sept-11-2018	Sept-11-2018
Days After First/Last Applic.			19 6	33 20		
No. Treatment	Rate	Unit	%		g/100 ft2	Lbs/A
1 Pyroxasulfone	42.35	g/a	0.0 a	0.0 a	268.75 c	257.86 c
2 Pyroxasulfone	60	g/a	0.0 a	0.0 a	297.88 c	285.80 c
3 Pyroxasulfone	92.82	g/a	0.0 a	0.0 a	418.88 bc	401.90 bc
4 Spartan	4.5	fl oz/a	0.0 a	0.0 a	573.20 ab	549.97 ab
Dual Magnum	2	pt/a				
Pyroxasulfone	42.35	g/a				
5 Spartan	4.5	fl oz/a	0.0 a	0.0 a	782.68 a	750.95 a
Dual Magnum	2	pt/a				
Pyroxasulfone	47.06	g/a				
6 Spartan	4.5	fl oz/a	0.0 a	0.0 a	639.93 ab	613.998 ab
Dual Magnum	2	pt/a				
Pyroxasulfone	58.82	g/a				
7 Spartan	4.5	fl oz/a	0.0 a	0.0 a	584.35 ab	560.67 ab
Dual Magnum	2	pt/a				
8 Untreated			0.0 a	0.0 a	196.55 c	188.58 c

Faba bean were not injured by any of the herbicide applications (Table 2). The preemergence applications of pyroxasulfone alone did not provide sufficient weed control, even when evaluated early at19 days after treatment (Table 1). The addition of pyroxasulfone applied postemergence did not statistically increase weed control compared to Spartan + Dual Magnum alone applied preemergence.

Flax Tolerance to Preemergence and Postemergence Herbicides

Caleb Dalley, HREC, Hettinger, ND 2018

Flax 'York' was planted on May 15, 2018 at 38 lb/A at a depth of 1.5 inches using a John Deere 1590 no-till drill. Prior to planting, on May 4, the entire field was treated with glyphosate (Cornerstone 5 Plus @ 32 oz/A) to control winter annual weeds. Urea fertilizer (46-0-0) was applied on May 2 at a rate of 45 lb/A. Preemergence herbicide treatments were applied on May 16 using a tractor mounted research spray using a spray volume of 10 gallons per acre. Flax emerged on May 24. Postemergence treatments were applied on June 5. Flax was evaluated visually for injury at 7, 15, and 38 days after postemergence treatments were applied. Injury from POST application of Talinor was severe (61 to 81%), whereas PRE application of Talinor caused little or no injury. However, Talinor acts primarily as a POST herbicide and resulted in little control of either common mallow or kochia. POST applications of Talinor provided fair control of both common mallow and kochia. Armezon caused injury (bleaching) to flax with the injury being greater when applied at 0.75 oz/A compared with 0.5 oz/A at 15 DAT. Armezon in this trial provided only fair control of common mallow or kochia. Bison (bromoxynil plus MCPA) also caused minor injury to flax and provided fair to poor control of common mallow and kochia. Basagran caused very little injury to flax and fair control of common mallow but poor control of kochia. Raptor caused moderate injury to flax (29% 15 DAT) but provided excellent control of common mallow and fair control of kochia. The tank-mix of Basagran plus Raptor showed less injury to flax 15 DAT and also provided excellent common mallow control and fair control of kochia. Flax was harvested on September 28. Flax yield was reduced by POST Talinor treatments and in the untreated control. Even though moderate injury occurred following Raptor application, flax yield was not reduced and was second highest numerically or all treatments. Note: trial was impacted by a severe hailstorm on the night of June 26 that completely defoliated flax and weeds in this trial. This may have impacted both weed control and yield potential in this trial.

Table. Flax response and weed control following preemergence and postemergence herbicide application.

			Flax			Common mallow		Kochia	Flax	
			7 DAT	15 DAT	38 DAT	15 DAT	38 DAT	15 DAT	Yield	Test
Treatment	Rate	Timing	—— % Injury ——			——— % control ———			LB/A	LB/BU
1 Untreated			0	0	0	0	0	0	937bc	49.33bc
2 Coact+	2.75oz/a	PRE	0e	0f	0c	5d	28e	0d	1067ab	51.53ab
Talinor	13.7oz/a									
COC	1% v/v									
3 Coact+	3.6oz/a	PRE	9d	0f	4c	0d	45d	23c	989ab	51.75a
Talinor	18.2oz/a									
COC	1% v/v									
4 Coact+	2.75oz/a	POST	73b	61b	70a	65b	56bcd	55ab	731cd	47.40c
Talinor	13.7oz/a									
COC	1% v/v									
5 Coact+	3.6oz/a	POST	81a	78a	74a	74a	70b	65ab	651d	49.85ab
Talinor	18.2oz/a									
COC	1% v/v									
6 Armezon	0.5oz/a	POST	14cd	0f	0c	64bc	60bc	63ab	1174a	51.55ab
COC	1% v/v									
7 Armezon	0.75oz/a	POST	12d	13de	4c	65b	69b	49b	1038ab	50.43ab
COC	1% v/v									
8 Bison	1pt/a	POST	10d	14d	5c	55c	53cd	50ab	947abc	51.10ab
9 Basagran	1pt/a	POST	3e	6ef	3c	63bc	64bc	48b	1061ab	50.58ab
COC	1% v/v									
10 Raptor	4oz/a	POST	18c	29c	15b	80a	100a	70a	1118ab	51.15ab
NIS	0.25% v/v									
28% N	2.5% v/v									
11 Basagran	1pt/a	POST	11d	18d	14b	80a	92a	66ab	1094ab	51.90a
Raptor	4oz/a									
MSO	1% v/v									
LSD P=.05			4.94	6.89	8.05	8.45	14.92	17.75	229.1	4.94
Treatment F			267.731	121.505	98.073	112.363	28.870	13.547	4.072	267.731
Treatment Prob(F)			0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0017	0.0001

Means followed by same letter or symbol do not significantly differ (P=.05, LSD)
PRE, preemergence treatments were applied on May 16; POST, postemergence treatments were applied on June 5.

Flax Tolerance to Preemergence Herbicides at Hettinger, ND

Caleb Dalley, HREC, Hettinger, ND 2018

Flax 'York' was planted on May 15, 2018 at 38 lb/A at a depth of 1.5 inches using a John Deere 1590 no-till drill. Prior to planting, on May 4, the entire field was treated with glyphosate (Cornerstone 5 Plus @ 32 oz/A) to control winter annual weeds. Urea fertilizer (46-0-0) was applied on May 2 at a rate of 45 lb/A. Preemergence herbicide treatments were applied on May 16 using a tractor mounted research spray using a spray volume of 10 gallons per acre. Flax emerged on May 24. Flax was evaluated for injury on June 12 (27 days after treatment (DAT)) and Jul 13 (58 DAT). The only treatment causing visual injury was the herbicide acetochlor (Warrant) resulting in 8% and 19% injury at 27 and 58 DAT, respectively. Stand and height counts were measured on June 19 and while there were no significant differences in stand or height, flax height following acetochlor was lowest of all treatments. Common mallow control 27 DAT was greatest (81%) following application of sulfentrazone plus metolachlor (Broadaxe plus Dual II Magnum), and similar to sulfentrazone plus pyroxasulfone (Spartan plus Zidua), flumioxazin plus pyroxasulfone (Fierce) and pendimethalin (Prowl H2O) with control ranging from 74 to 76%. All other treatments resulted in poor control of common mallow. Baryard control was best following application of metolachlor (Dual II Magnum) sulfentrazone plus metolachlor, pendimethalin, and dimethenamid (Outlook). Control of barnyardgrass with these treatments was only fair (74 to 79%). All other treatments provided poor control of barnyardgrass. Plots were impacted by a severe hailstorm on the night of June 26 resulting in nearly complete defoliation. Further evaluations were not taken do to the damage to the plots. However, plot yields were measured on September 28. While yields showed no statistically significant differences, yields were lowest following application of acetochlor and second lowest in the untreated control. Yields ranged from 787 to 1015 LB/A. Test weight of flax was lowest following application of acetochlor. From these results, it appears that there are several options that could be pursued for preemergence weed control in flax. Although, the herbicide acetochlor may be too injurious to flax.

Table. Flax response and weed control following preemergence herbicide application.

		Flax			Common mallow	Barnyardgrass	Kochia	Flax	
		Injury	Stand	height	27 DAT	27 DAT	27 DAT	Yield	Test
Treatment	Rate	%	plants/m	cm	——————% control——————			LB/A	LB/BU
1 Untreated		0b	187	20	0c	0f	0e	836-	53c
2 Zidua	3oz/a	0b	216	21	0c	71bcd	70b	1012-	56abc
3 Spartan Zidua	4oz/a 1.5oz/a	0b	221	21	76a	68cd	78ab	1016-	58a
4 Warrant	1.5qt/a	8a	213	19	5c	63d	66b	787-	49d
5 Dual II Magnum	1.5pt/a	0b	196	20	0c	75abc	74ab	873-	55abc
6 BroadAxe Dual II Magnum	22.8oz/a 5.2oz/a	0b	206	21	81a	78ab	84a	908-	57ab
7 Fierce	3oz/a	0b	195	21	74a	74abc	74ab	870-	56abc
8 Prowl H2O	3pt/a	0b	221	20	76a	79a	67b	967-	55abc
9 Valor	2oz/a	0b	228	21	30b	45e	46c	872-	54c
10 Outlook	18oz/a	0b	229	20	23b	74abc	21d	967-	55bc
LSD P=.05		2.3	43.3	1.8	7.8	8.7	11.3	204.6	2.9
Treatment F		9.000	0.940	0.846	179.594	63.687	48.965	1.188	5.741
Treatment Prob(F)		0.0001	0.5082	0.5821	0.0001	0.0001	0.0001	0.3417	0.0002

Means followed by same letter or symbol do not significantly differ (P=.05, LSD)

Flax PRE evaluation for pigweed management. Ostlie

A flax study was established in 2018 near Carrington, ND to evaluate PRE products for pigweed species management. The trial was planted and sprayed on May 15, followed by an activating rain within 24 hours. Heavy pigweed infestation prevented flax harvest from this trial. Pigweeds consisted of a roughly 50/50 mixture of redroot pigweed and Powell amaranth.

Treatment	Stand	Phytotoxicity	Pigweeds	Pigweeds
	plant/a	6/6/2018	21 DAE	preharvest
check	1774064	0.0	0.0	0.0
Zidua	1831769	6.3	26.3	30.0
Spartan + Zidua	1901311	1.3	61.3	63.8
Warrant	1905750	3.8	6.3	0.0
Dual II Magnum	1645135	5.0	67.5	22.5
Spartan Elite + Dual Magnum	1751870	3.8	72.5	66.3
Fierce	1518397	3.8	56.3	77.5
Prowl H2O	1722277	6.3	0.0	0.0
Valor	1735594	5.0	5.0	8.8
Outlook	1534365	6.3	75.0	68.8
LSD (0.05)	222680	5.4	23.4	8.3

Flax stand was reduced with some herbicide combinations, including Fierce and Outlook. Injury to the emerged plants was less noticeable with only minor injury symptoms appearing, largely in the form of less vigor. Early and late season pigweed control followed largely the same trends. Some products faired very poor overall, with almost no noticeable differences following Valor, Prowl H2O, and Warrant. Dual II Magnum provided moderate early season control, but pigweeds were able to emerge later in the season. Fierce provided the greatest season-long control of pigweeds, even though both components of the product faired poor alone. It is unclear if the loss in flax stand with Fierce and Outlook would result in a yield reduction.

Industrial Hemp response to herbicides. Dr. Howatt and Mettler. Industrial hemp was seeded near Fargo June 4. Treatments were applied to 4 leaf hemp on June 28 with 86°F, 60% relative humidity, moderately clouded sky, 4.2 mph wind at 225°, and dry soil at 80°F. Treatments were applied with a backpack sprayer delivering 8.5 gpa at 40 psi through 11001 TT nozzles to a 7 foot wide area the length of 10 by 30 foot plots. The experiment was a randomized complete block design with four replicates.

Treatment	Rate	7/12 Hemp	7/23 Hemp
Untreated Check	0	0	0
Clopyralid	1.5	4	0
Fluroxypyr	1.5	85	81
Thifensulfuron-sg+NIS	0.2+0.25%	63	47
Mesotrione+PO+UAN	1.5+20+2.5%	82	72
Bromoxynil	4	9	7
Fomesafen+PO	3+20	89	82
Metribuzin+PO	3+20	82	63
Bentazon+PO	12+20	93	93
Carfentrazone+NIS	0.128+0.25%	23	15
Glufosinate+AMS	6.4+24	96	94
Halauxifen	0.075	32	37
Imazamox+NIS+UAN	0.5+0.25%+32	40	25
CV		8	11
LSD P=.05		8	9

Clopyralid and bromoxynil were quite safe to hemp resulting in less than 10% injury. Carfentrazone caused moderate injury, but since carfentrazone does not translocate, hemp plants seemed to recover quickly from loss of leaf tissue. These are candidates for further investigation of herbicide registrations in hemp. Bentazon and glufosinate provided more than 90% control and offer the best options for control of volunteer hemp. Mesotrione, metribuzin, or fomesafen provided good control but surviving plants produced substantial regrowth and use for volunteer management would rely on substantial crop competition. Fluroxypyr gave 85% control and effect was longer lasting than mesotrione, metribuzin, or fomesafen.

2018 Bicyclopyrone Weed Control in Direct-Seeded Onion. H. Hatterman-Valenti and C. Auwarter.

This study was conducted at the Oakes Research Extension Center to evaluate bicyclopyrone containing treatments vs commercial standards in direct-seeded onion. Four varieties of yellow sweet Spanish onions (Calibra, Delgado, Hamilton and Sedona) were planted on April 30, 2018 at a rate of 250,000 seeds/acre. Plots were 4 rows by 20 feet with 18" centers arranged in a randomized complete block design with 4 replicates. Treatments were sprayed throughout the growing season with a CO2 pressurized sprayer equipped with 8002 XR flat fan nozzles with a spray volume of 20 GPA and a pressure of 40 psi. Extension recommendations were used for cultural practices throughout the year. Plots were harvested on 9/17 and graded into various categories.

Table 1. Herbicide application information.

Date:	5/10 (10 DAP)	5/24 (24 DAP)	6/7 (38 DAP)
Crop Stage:	PRE (A)	Flag - 1 Leaf (B)	2 Leaf (C)
Weed Size (Colq,Rrpw):	None	2"	2" – 10"
Air Temperature (F):	43	67	75
Relative Humidity (%):	44	87	42
Wind (MPH):	10	9	9
Soil Temperature @ 4" (F)	52	65	75
Soil Moisture:	Adequate	Excess	Adequate
Cloud Cover:	90	20	0
Next Rain or Irrigation:	5/11	5/28	6/11

All herbicide treatments provided season-long redroot pigweed control and all herbicide treatments except treatment 10 (Goaltender + Buctril) provided season-long common lambsquarters control (Table 2). All treatments with A16003 tended to reduce onion stands regardless of the onion cultivar. Greatest total yields occurred with the handweeded plots followed by plots treated with Satellite HydroCap, GoalTender, and Buctril regardless of the onion cultivar.

Table 2. Calibra, Delgado, Hamilton and Sedona stand count, weed control and injury.

Trt No.	Treatment Name	Rate	Rate Unit	Appl Code	------10 Row-ft Stand Count 30 DAP--------- Calibra	Delgado	Hamilton	Sedona	30 DAP Colq % Control	30 DAP Rrpw % Control	30 DAP % Injury	49 DAP Colq % Control	49 DAP Rrpw % Control
1	Handweeded Check				52.0 a	42.7 ab	59.5 a	62.1 a	100.0 a	100.0 a	0.0 g	100.0 a	100.0 a
2	A16003	3.42	fl oz/a	A	21.5 c	12.4 de	11.3 d	28.7 c	98.8 a	100.0 a	38.5 d	95.0 ab	100.0 a
3	Satellite HydroCap	2	pt/a	A	54.8 a	46.5 a	57.5 a	57.1 ab	100.0 a	98.8 a	6.1 f	96.3 ab	97.5 a
4	A16003	3.42	fl oz/a	A	10.5 d	9.5 e	11.8 d	29.3 c	100.0 a	100.0 a	71.1 c	98.8 ab	100.0 a
	Satellite HydroCap	2	pt/a	A									
5	A16003	2.57	fl oz/a	B	29.8 bc	22.4 cd	43.5 b	45.2 b	91.3 b	98.8 a	22.2 e	90.0 b	97.5 a
	Preference	0.25	% v/v	B									
6	A16003	3.42	fl oz/a	B	37.2 ab	27.6 bc	45.8 b	44.2 b	88.8 b	98.8 a	25.6 e	91.3 ab	97.5 a
	Preference	0.25	% v/v	B									
7	Buctril	1	pt/a	B	39.4 ab	21.1 cd	26.3 c	28.6 c	98.8 a	100.0 a	26.2 e	97.5 ab	100.0 a
	Goal Tender	4	fl oz/a	C									
8	A16003	2.57	fl oz/a	B	10.1 d	1.7 f	4.0 de	2.6 d	100.0 a	100.0 a	92.7 b	100.0 a	100.0 a
	Preference	0.25	% v/v	B									
	Buctril	1	pt/a	B									
9	A16003	3.42	fl oz/a	B	4.6 d	0.8 f	2.3 de	3.2 d	100.0 a	100.0 a	95.3 b	98.8 ab	100.0 a
	Preference	0.25	% v/v	B									
	Buctril	1	pt/a	B									
10	Goal Tender	4	fl oz/a	B	54.8 a	42.7 ab	62.5 a	56.5 ab	52.5 c	97.5 a	6.1 f	52.5 c	98.8 a
	Buctril	1	pt/a	C									
11	Satellite HydroCap	2	pt/a	A	54.0 a	39.9 ab	57.0 a	56.3 ab	100.0 a	100.0 a	7.3 f	98.8 ab	98.8 a
	Goal Tender	4	fl oz/a	B									
	Buctril	1	pt/a	B									
12	A16003	3.42	fl oz/a	A	0.4 e	0.0 f	0.0 e	0.1 e	100.0 a	100.0 a	99.7 a	100.0 a	100.0 a
	Buctril	1	pt/a	B									
LSD P=.05					3.08 – 12.58	3.59-11.77	7.55	1.66 – 10.53	4.60	2.40	2.29 - 6.28	5.51	2.29

Table 3. Calibra harvested bulb count in 10 row-ft.

Trt No.	Treatment Name	Rate	Rate Unit	Appl Code	9/17 0 – 1"	9/17 1" – 2.25"	9/17 2.25" – 3"	9/17 3" – 4"	9/17 >4"	9/17 Total
1	Handweeded Check				0.0 a	6.7 bc	26.0 a	17.9 a	0.3 a	54.0 a
2	A16003	3.42	fl oz/a	A	0.1 a	5.0 bcd	5.8 b	2.7 bc	0.0 a	15.1 cd
3	Satellite HydroCap	2	pt/a	A	0.1 a	19.7 a	18.4 a	0.7 cd	0.0 a	39.7 ab
4	A16003	3.42	fl oz/a	A	0.3 a	3.9 bcd	4.3 bc	3.5 bc	0.3 a	13.4 cd
	Satellite HydroCap	2	pt/a	A						
5	A16003	2.57	fl oz/a	B	0.1 a	5.8 bcd	0.1 d	0.0 d	0.0 a	6.7 de
	Preference	0.25	% v/v	B						
6	A16003	3.42	fl oz/a	B	0.1 a	8.0 abc	0.4 cd	0.6 cd	0.0 a	8.8 de
	Preference	0.25	% v/v	B						
7	Buctril	1	pt/a	B	0.0 a	18.6 a	8.3 b	0.6 cd	0.0 a	29.6 bc
	Goal Tender	4	fl oz/a	C						
8	A16003	2.57	fl oz/a	B	0.0 a	1.5 cd	2.0 bcd	0.7 cd	0.0 a	4.6 de
	Preference	0.25	% v/v	B						
	Buctril	1	pt/a	B						
9	A16003	3.42	fl oz/a	B	0.1 a	0.9 cd	0.6 cd	1.0 cd	0.0 a	3.3 de
	Preference	0.25	% v/v	B						
	Buctril	1	pt/a	B						
10	Goal Tender	4	fl oz/a	B	1.0 a	3.7 bcd	0.0 d	0.0 d	0.0 a	4.0 de
	Buctril	1	pt/a	C						
11	Satellite HydroCap	2	pt/a	A	0.0 a	11.9 ab	27.8 a	7.6 b	0.0 a	48.0 ab
	Goal Tender	4	fl oz/a	B						
	Buctril	1	pt/a	B						
12	A16003	3.42	fl oz/a	A	0.0 a	0.0 d	0.1 d	0.4 cd	0.0 a	0.4 e
	Buctril	1	pt/a	B						
LSD P=.05					0.94 - 0.98	4.51 - 9.67	1.89 - 9.65	1.61 - 10.09	0.30	5.01 - 17.19

Table 4. Calibra cwt/acre.

Trt No.	Treatment Name	Rate	Rate Unit	Appl Code	9/17 0 – 1"	9/17 1" – 2.25"	9/17 2.25" – 3"	9/17 3" – 4"	9/17 >4"	9/17 Total
1	Handweeded Check				0.000 a	24.856 bc	198.416 ab	246.998 a	7.388 a	490.155 a
2	A16003	3.42	fl oz/a	A	0.024 a	18.352 c	45.554 c	46.216 bcd	0.000 a	113.139 bcd
3	Satellite HydroCap	2	pt/a	A	0.020 a	70.772 a	127.783 b	8.109 cd	0.000 a	211.263 b
4	A16003	3.42	fl oz/a	A	0.151 a	11.373 cd	37.441 c	65.179 bc	6.540 a	124.268 bcd
	Satellite HydroCap	2	pt/a	A						
5	A16003	2.57	fl oz/a	B	0.072 a	14.925 c	1.913 de	0.000 d	0.000 a	18.239 e
	Preference	0.25	% v/v	B						
6	A16003	3.42	fl oz/a	B	0.036 a	25.780 bc	3.556 de	9.626 cd	0.000 a	39.718 cde
	Preference	0.25	% v/v	B						
7	Buctril	1	pt/a	B	0.000 a	65.080 a	64.193 c	6.746 cd	0.000 a	145.700 bc
	Goal Tender	4	fl oz/a	C						
8	A16003	2.57	fl oz/a	B	0.000 a	5.300 cd	25.031 cd	12.308 cd	0.000 a	48.558 cde
	Preference	0.25	% v/v	B						
	Buctril	1	pt/a	B						
9	A16003	3.42	fl oz/a	B	0.077 a	3.279 cd	5.374 de	18.371 cd	0.000 a	30.944 de
	Preference	0.25	% v/v	B						
	Buctril	1	pt/a	B						
10	Goal Tender	4	fl oz/a	B	0.391 a	4.422 cd	0.000 e	0.000 d	0.000 a	5.802 e
	Buctril	1	pt/a	C						
11	Satellite HydroCap	2	pt/a	A	0.000 a	52.994 ab	221.766 a	108.411 b	0.000 a	385.971 a
	Goal Tender	4	fl oz/a	B						
	Buctril	1	pt/a	B						
12	A16003	3.42	fl oz/a	A	0.000 a	0.000 d	1.360 de	7.076 cd	0.000 a	8.405 e
	Buctril	1	pt/a	B						
LSD P=.05					0.39 - 0.47	15.52 – 25.97	16.02 – 77.20	38.81 – 112.06	8.32	37.74 – 165.78

Table 5. Delgado harvested bulb count in 10 row-ft.

Trt No.	Treatment Name	Rate	Rate Unit	Appl Code	9/17 0 – 1"	9/17 1" – 2.25"	9/17 2.25" – 3"	9/17 3" – 4"	9/17 >4"	9/17 Total
1	Handweeded Check				0.0 a	1.3 bc	14.7 ab	23.6 a	0.5 a	41.0 a
2	A16003	3.42	fl oz/a	A	0.0 a	2.2 bc	2.3 c	1.6 cde	0.3 a	8.0 bc
3	Satellite HydroCap	2	pt/a	A	0.1 a	19.3 a	11.6 ab	0.5 de	0.0 a	32.7 a
4	A16003	3.42	fl oz/a	A	0.3 a	1.4 bc	1.3 c	5.7 bc	0.3 a	10.1 bc
	Satellite HydroCap	2	pt/a	A						
5	A16003	2.57	fl oz/a	B	0.0 a	0.9 bc	0.2 c	0.0 e	0.0 a	1.2 cd
	Preference	0.25	% v/v	B						
6	A16003	3.42	fl oz/a	B	0.0 a	0.9 bc	0.0 c	0.1 de	0.0 a	1.3 cd
	Preference	0.25	% v/v	B						
7	Buctril	1	pt/a	B	0.0 a	4.5 bc	9.2 b	2.6 cd	0.0 a	16.5 b
	Goal Tender	4	fl oz/a	C						
8	A16003	2.57	fl oz/a	B	0.1 a	0.1 bc	0.3 c	0.3 de	0.3 a	1.6 cd
	Preference	0.25	% v/v	B						
	Buctril	1	pt/a	B						
9	A16003	3.42	fl oz/a	B	0.0 a	0.2 bc	0.3 c	0.1 de	0.0 a	0.7 cd
	Preference	0.25	% v/v	B						
	Buctril	1	pt/a	B						
10	Goal Tender	4	fl oz/a	B	0.4 a	3.6 bc	0.0 c	0.0 e	0.0 a	4.6 bcd
	Buctril	1	pt/a	C						
11	Satellite HydroCap	2	pt/a	A	0.0 a	6.5 b	19.2 a	9.8 b	0.3 a	36.3 a
	Goal Tender	4	fl oz/a	B						
	Buctril	1	pt/a	B						
12	A16003	3.42	fl oz/a	A	0.0 a	0.0 c	0.1 c	0.0 e	0.0 a	0.1 d
	Buctril	1	pt/a	B						
LSD P=.05					0.83 - 9999	2.75 – 9.91	1.57 – 7.41	1.35 – 7.48	0.54	3.46 – 15.34

Table 6. Delgado cwt/acre.

Trt No.	Treatment Name	Rate	Rate Unit	Appl Code	9/17 0 – 1"	9/17 1" – 2.25"	9/17 2.25" – 3"	9/17 3" – 4"	9/17 >4"	9/17 Total
1	Handweeded Check				0.000 a	6.108 bcd	123.156 ab	339.352 a	15.160 a	491.222 a
2	A16003	3.42	fl oz/a	A	0.000 a	7.813 bcd	24.064 c	32.058 c	6.428 a	80.252 b
3	Satellite HydroCap	2	pt/a	A	0.040 a	69.034 a	94.468 ab	8.263 c	0.000 a	178.949 b
4	A16003	3.42	fl oz/a	A	0.218 a	4.483 bcd	13.885 c	106.331 b	9.370 a	141.211 b
	Satellite HydroCap	2	pt/a	A						
5	A16003	2.57	fl oz/a	B	0.000 a	2.120 cd	2.800 c	0.000 c	0.000 a	5.432 c
	Preference	0.25	% v/v	B						
6	A16003	3.42	fl oz/a	B	0.000 a	2.306 cd	0.000 c	2.800 c	0.000 a	6.697 c
	Preference	0.25	% v/v	B						
7	Buctril	1	pt/a	B	0.000 a	20.791 bc	81.761 b	39.314 c	0.000 a	145.060 b
	Goal Tender	4	fl oz/a	C						
8	A16003	2.57	fl oz/a	B	0.032 a	0.084 d	3.394 c	4.589 c	6.205 a	15.858 c
	Preference	0.25	% v/v	B						
	Buctril	1	pt/a	B						
9	A16003	3.42	fl oz/a	B	0.000 a	0.687 cd	3.777 c	2.358 c	0.000 a	8.300 c
	Preference	0.25	% v/v	B						
	Buctril	1	pt/a	B						
10	Goal Tender	4	fl oz/a	B	0.259 a	7.921 bcd	0.000 c	0.000 c	0.000 a	9.527 c
	Buctril	1	pt/a	C						
11	Satellite HydroCap	2	pt/a	A	0.000 a	27.489 b	164.338 a	132.137 b	7.675 a	338.489 a
	Goal Tender	4	fl oz/a	B						
	Buctril	1	pt/a	B						
12	A16003	3.42	fl oz/a	A	0.000 a	0.000 d	1.242 c	0.000 c	0.000 a	1.242 c
	Buctril	1	pt/a	B						
LSD P=.05					0.50 - 9999	7.35 – 24.22	15.42 – 64.52	24.42 – 117.75	16.08	24.77 – 155.17

Table 7. Hamilton harvested bulb count in 10 row-ft.

Trt No.	Treatment Name	Rate	Unit	Appl Code	9/17 0 – 1"	9/17 1" – 2.25"	9/17 2.25" – 3"	9/17 3" – 4"	9/17 >4"	9/17 Total
1	Handweeded Check				0.0 b	2.7 abc	20.0 a	32.4 a	0.1 b	57.0 a
2	A16003	3.42	fl oz/a	A	0.3 b	0.8 bc	2.0 b	2.1 cde	0.1 b	6.4 cd
3	Satellite HydroCap	2	pt/a	A	0.0 b	17.2 a	18.8 a	1.6 cde	0.0 b	39.6 ab
4	A16003	3.42	fl oz/a	A	1.5 a	1.2 bc	2.1 b	3.9 cd	0.6 a	10.2 cd
	Satellite HydroCap	2	pt/a	A						
5	A16003	2.57	fl oz/a	B	0.0 b	7.0 ab	2.3 b	0.4 e	0.0 b	10.8 cd
	Preference	0.25	% v/v	B						
6	A16003	3.42	fl oz/a	B	0.3 b	6.4 ab	1.9 b	0.4 e	0.0 b	10.1 cd
	Preference	0.25	% v/v	B						
7	Buctril	1	pt/a	B	0.0 b	2.9 abc	14.9 a	5.2 c	0.0 b	25.1 bc
	Goal Tender	4	fl oz/a	C						
8	A16003	2.57	fl oz/a	B	0.3 b	0.4 bc	0.5 b	0.6 e	0.0 b	2.0 de
	Preference	0.25	% v/v	B						
	Buctril	1	pt/a	B						
9	A16003	3.42	fl oz/a	B	0.3 b	2.1 abc	2.1 b	0.9 de	0.0 b	7.0 cd
	Preference	0.25	% v/v	B						
	Buctril	1	pt/a	B						
10	Goal Tender	4	fl oz/a	B	0.8 ab	12.9 a	1.1 b	0.0 e	0.0 b	22.0 bc
	Buctril	1	pt/a	C						
11	Satellite HydroCap	2	pt/a	A	0.0 b	7.4 ab	28.1 a	12.7 b	0.0 b	52.3 a
	Goal Tender	4	fl oz/a	B						
	Buctril	1	pt/a	B						
12	A16003	3.42	fl oz/a	A	0.0 b	0.0 c	0.0 b	0.0 e	0.0 b	0.0 e
	Buctril	1	pt/a	B						
LSD P=.05					0.81	2.95 – 12.34	4.13 – 12.02	1.64 – 17.90	0.32 – 0.42	8.05 – 17.87

Table 8. Hamilton cwt/acre.

Trt No.	Treatment Name	Rate	Unit	Appl Code	9/17 0 – 1"	9/17 1" – 2.25"	9/17 2.25" – 3"	9/17 3" – 4"	9/17 >4"	9/17 Total
1	Handweeded Check				0.000 a	12.516 bcd	169.020 a	470.858 a	9.370 b	670.751 a
2	A16003	3.42	fl oz/a	A	0.113 a	2.347 cd	20.809 b	34.448 cd	6.668 b	66.172 de
3	Satellite HydroCap	2	pt/a	A	0.000 a	59.824 a	137.040 a	27.487 cd	0.000 b	232.900 c
4	A16003	3.42	fl oz/a	A	0.863 a	4.084 cd	20.016 b	83.060 bc	26.675 a	135.704 cd
	Satellite HydroCap	2	pt/a	A						
5	A16003	2.57	fl oz/a	B	0.000 a	14.848 bcd	17.531 b	4.725 cd	0.000 b	43.634 de
	Preference	0.25	% v/v	B						
6	A16003	3.42	fl oz/a	B	0.175 a	20.038 a-d	16.080 b	6.182 cd	0.000 b	51.031 de
	Preference	0.25	% v/v	B						
7	Buctril	1	pt/a	B	0.000 a	15.679 bcd	136.455 a	79.642 bc	0.000 b	244.007 c
	Goal Tender	4	fl oz/a	C						
8	A16003	2.57	fl oz/a	B	0.400 a	0.821 d	7.987 b	8.075 cd	0.000 b	22.478 ef
	Preference	0.25	% v/v	B						
	Buctril	1	pt/a	B						
9	A16003	3.42	fl oz/a	B	0.240 a	8.303 bcd	14.575 b	15.616 cd	0.000 b	48.241 de
	Preference	0.25	% v/v	B						
	Buctril	1	pt/a	B						
10	Goal Tender	4	fl oz/a	B	0.305 a	38.453 ab	10.816 b	0.000 d	0.000 b	54.089 de
	Buctril	1	pt/a	C						
11	Satellite HydroCap	2	pt/a	A	0.000 a	31.832 abc	211.054 a	189.219 b	0.000 b	448.955 b
	Goal Tender	4	fl oz/a	B						
	Buctril	1	pt/a	B						
12	A16003	3.42	fl oz/a	A	0.000 a	0.000 d	0.000 b	0.000 d	0.000 b	0.000 f
	Buctril	1	pt/a	B						
LSD P=.05					0.5344	12.31 – 33.03	36.50 – 95.98	40.22 – 173.60	12.51	61.57 – 208.70

Table 9. Sedona harvested bulb count in 10 row-ft.

Trt No.	Treatment Name	Rate	Rate Unit	Appl Code	9/17 0 – 1"	9/17 1" – 2.25"	9/17 2.25" – 3"	9/17 3" – 4"	9/17 >4"	9/17 Total
1	Handweeded Check				0.0 a	8.4 a	27.2 a	26.0 a	0.0 a	62.0 a
2	A16003	3.42	fl oz/a	A	0.5 a	10.2 a	1.8 cd	1.3 cd	0.0 a	19.0 c
3	Satellite HydroCap	2	pt/a	A	0.3 a	23.1 a	16.4 ab	1.7 cd	0.0 a	45.8 b
4	A16003	3.42	fl oz/a	A	1.3 a	6.7 a	6.0 bc	13.0 b	2.0 a	29.5 c
	Satellite HydroCap	2	pt/a	A						
5	A16003	2.57	fl oz/a	B	0.8 a	14.1 a	7.2 bc	0.3 cd	0.0 a	23.3 c
	Preference	0.25	% v/v	B						
6	A16003	3.42	fl oz/a	B	0.5 a	13.0 a	6.9 bc	0.7 cd	0.0 a	22.5 c
	Preference	0.25	% v/v	B						
7	Buctril	1	pt/a	B	0.0 a	7.4 a	14.4 ab	6.3 bc	0.0 a	28.8 c
	Goal Tender	4	fl oz/a	C						
8	A16003	2.57	fl oz/a	B	0.5 a	0.0 b	0.5 cd	0.7 cd	0.0 a	2.5 d
	Preference	0.25	% v/v	B						
	Buctril	1	pt/a	B						
9	A16003	3.42	fl oz/a	B	0.3 a	0.4 b	0.1 cd	0.6 cd	0.0 a	2.0 d
	Preference	0.25	% v/v	B						
	Buctril	1	pt/a	B						
10	Goal Tender	4	fl oz/a	B	0.5 a	18.2 a	1.5 cd	0.1 d	0.0 a	28.0 c
	Buctril	1	pt/a	C						
11	Satellite HydroCap	2	pt/a	A	0.0 a	9.5 a	26.3 a	11.3 b	0.0 a	49.3 b
	Goal Tender	4	fl oz/a	B						
	Buctril	1	pt/a	B						
12	A16003	3.42	fl oz/a	A	0.0 a	0.2 b	0.0 d	0.0 d	0.0 a	0.3 d
	Buctril	1	pt/a	B						
LSD P=.05					0.89	4.10 – 11.33	3.53 – 12.62	2.58 – 11.05	1.7	12.62

Table 10. Sedona cwt/acre.

Trt No.	Treatment Name	Rate	Rate Unit	Appl Code	9/17 0 – 1"	9/17 1" – 2.25"	9/17 2.25" – 3"	9/17 3" – 4"	9/17 >4"	9/17 Total
1	Handweeded Check				0.000 a	30.411 a	254.874 a	416.798 a	0.000 b	705.280 a
2	A16003	3.42	fl oz/a	A	0.094 a	31.261 a	14.296 cd	20.823 c	0.000 b	88.404 cd
3	Satellite HydroCap	2	pt/a	A	0.036 a	76.911 a	120.203 ab	30.298 c	0.000 b	256.713 bc
4	A16003	3.42	fl oz/a	A	0.543 a	21.282 a	62.751 bc	227.724 b	59.663 a	374.508 b
	Satellite HydroCap	2	pt/a	A						
5	A16003	2.57	fl oz/a	B	0.234 a	47.231 a	51.151 bc	6.176 c	0.000 b	109.774 cd
	Preference	0.25	% v/v	B						
6	A16003	3.42	fl oz/a	B	0.052 a	43.819 a	61.026 bc	13.948 c	0.000 b	128.417 cd
	Preference	0.25	% v/v	B						
7	Buctril	1	pt/a	B	0.000 a	32.251 a	127.364 ab	83.954 c	0.000 b	248.893 bc
	Goal Tender	4	fl oz/a	C						
8	A16003	2.57	fl oz/a	B	0.191 a	0.000 b	5.979 cd	18.132 c	0.000 b	29.943 de
	Preference	0.25	% v/v	B						
	Buctril	1	pt/a	B						
9	A16003	3.42	fl oz/a	B	0.012 a	0.888 b	2.469 cd	14.451 c	0.000 b	19.430 de
	Preference	0.25	% v/v	B						
	Buctril	1	pt/a	B						
10	Goal Tender	4	fl oz/a	B	0.060 a	53.447 a	17.242 cd	1.711 c	0.000 b	85.630 cd
	Buctril	1	pt/a	C						
11	Satellite HydroCap	2	pt/a	A	0.000 a	38.694 a	206.318 a	148.019 b	0.000 b	400.912 b
	Goal Tender	4	fl oz/a	B						
	Buctril	1	pt/a	B						
12	A16003	3.42	fl oz/a	A	0.000 a	0.326 b	0.000 d	0.000 c	0.000 b	0.326 e
	Buctril	1	pt/a	B						
LSD P=.05					0.35 – 0.48	11.16 – 38.41	33.06 – 118.46	38.83 – 176.79	18.19	34.38 – 241.75

Effect of pyroxasulfone tank mixtures on Russet Burbank and Umatilla Russet. Robinson, Brandvik and Ihry. Russet Burbank and Umatilla Russet were planted near Park Rapids, MN on May 17, 2018 in plots measuring 12 ft wide x 25 ft long. Soil characteristics were 92% sand, 6% silt, 2% clay with 1.2% organic matter and a pH of 5.8. Treatments were applied on May 25 as a preemergence treatment with shoots 3 to 4 inches below the top of the hill. All treatments were applied to the center of the plots with a 9-ft-wide boom equipped with XR11002 flat fan nozzles calibrated to deliver 15 gallons per acre. Potatoes emerge on June 2, 2017. Plots were rated for crop injury and weed control at 1, 2 and 4 weeks after emergence. Harvest occurred on September 19, 2018. The experiment was a randomized complete block design with 4 treatments.

Significant crop injury was observed when sulfentrazone was included in the treatment. Weed control was relatively good with most treatments, as weed pressure was low in this trial. Yields were similar across treatments.

Table 4. Estimated visual rating of crop injury of Umatilla Russet and Russet Burbank. Weed control ratings of red root pigweed, common lambsquarters, hairy nightshade and Eastern black nightshade at 1, 2 and 4 weeks after emergence at Hubbard, MN 2018.

Treatment		Rate		Umatilla Russet			Russet Burbank			Red Root Pigweed			Hairy Nightshade			Common Lambsquarters		
				Crop injury (%)			Crop injury (%)			Efficacy (%)			Efficacy (%)			Efficacy (%)		
				6/8	6/19	7/6	6/8	6/19	7/6	6/8	6/19	7/	6/8	6/19	7/6	6/8	6/19	7/6
1	Non-treated check			100	100	100	100	100	100	0	0	0	0	0	0	0	0	0
2	Zidua	3.5	fl oz/a	95	100	100	98	100	100	100	75	100	100	100	100	95	75	85
	Metribuzin	0.5	lb/a															
3	Zidua	3.5	fl oz/a	98	100	100	100	100	100	98	98	75	100	100	100	98	100	100
	Dual	1	pt/a															
4	Sulfentrazone	3	oz/a	95	100	100	95	100	100	93	75	75	100	75	80	93	75	80
5	Zidua	3.5	fl oz/a	96	100	100	100	100	100	100	100	100	100	100	100	100	100	100
	Metribuzin	0.5	lb/a															
	Dual	1	pt/a															
	Matrix	1.5	oz/a															
6	Zidua	3.5	fl oz/a	97	100	100	100	100	100	100	100	100	100	100	100	100	100	88
	Metribuzin	0.5	lb/a															
	Dual	1	pt/a															
7	Metribuzin	0.5	lb/a	92	100	100	97	100	100	96	100	100	96	100	100	96	98	90
	Dual	1	pt/a															
	Sulfentrazone	3	oz/a															
Mean				96	100	100	98	100	100	84	78	79	85	82	83	83	78	78
CV[1]				4	-	-	3	-	-	8	34	34	3	23	18	9	34	29
LSD[2] p=0.05				*ns*	-	-	*ns*	-	-	*10*	*39*	*39*	*4*	*28*	*22*	*11*	*39*	*33*
LSD p=0.10				*4*	-	-	*ns*	-	-	*8*	*33*	*33*	*3*	*23*	*18*	*9*	*33*	*27*

[1]The CV stands for coefficient of variation and is expressed as a percentage. The CV is a measure of variability in the trial. Large CVs mean a large amount of variation that could not be attributed to differences in the treatments.

[2]The LSD (least significant difference) values beneath the columns apply only to the numbers in the column in which they appear. If the difference between two treatments exceeds the LSD value at 0.05 or 0.10, it means that with 95 or 90 percent confidence, respectively, the higher-numbered treatments has a significant advantage. When the difference between two treatments is less than the LSD value, no significant difference was found between the two under these growing conditions.

Table 5. Yield of Russet Burbank potato (cwt/a) as affected by various herbicide preemergence treatments in Hubbard, MN 2018.

	Treatment	Rate		<4 oz	4-6 oz	6-10 oz	10-14 oz	>14 oz	Total yield	Total Marketable	US#1 >4 oz	US#2 >4 oz	>6 oz	>10 oz
				cwt/a									%	
1	Non-treated check			127	178	162	21	11	500	373	358	14	38	6
2	Zidua	3.5	fl oz/a	176	197	158	22	5	558	382	369	13	33	5
	Metribuzin	0.5	lb/a											
3	Zidua	3.5	fl oz/a	161	179	128	25	2	495	334	318	16	31	5
	Dual	1	pt/a											
4	Sulfentrazone	3	oz/a	137	171	172	50	12	542	404	386	18	42	11
5	Zidua	3.5	fl oz/a	137	183	165	50	12	547	410	392	19	41	11
	Metribuzin	0.5	lb/a											
	Dual	1	pt/a											
	Matrix	1.5	oz/a											
6	Zidua	3.5	fl oz/a	192	219	119	16	0	546	355	345	9	25	3
	Metribuzin	0.5	lb/a											
	Dual	1	pt/a											
7	Metribuzin	0.5	lb/a	153	185	172	41	9	560	408	387	20	39	8
	Dual	1	pt/a											
	Sulfentrazone	3	oz/a											
	Mean			155	187	154	32	7	535	381	365	16	36	7
	CV			17	13	23	89	109	10	14	13	69	25	79
	LSD p=0.05			*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*
	LSD p=0.10			*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*

Table 6. Tuber number per plot of Russet Burbank potato as affected by various herbicide preemergence treatments in Hubbard, MN 2018.

Treatment		Rate		<4 oz	4-6 oz	6-10 oz	10-14 oz	>14 oz	Total yield	Total Marketable	US#1 >4 oz	US#2 >4 oz	>6 oz	>10 oz
				tuber number/a									%	
1	Non-treated check			72,782	58,262	35,393	3,086	1,089	170,610	97,829	94,380	3,449	24	3
2	Zidua	3.5	fl oz/a	99,644	64,614	34,485	3,086	545	202,373	102,729	99,644	3,086	19	2
	Metribuzin	0.5	lb/a											
3	Zidua	3.5	fl oz/a	92,565	58,988	28,314	3,449	182	183,497	90,932	87,483	3,449	18	2
	Dual	1	pt/a											
4	Sulfentrazone	3	oz/a	80,405	55,176	37,208	6,897	1,271	180,956	100,551	97,647	2,904	25	5
5	Zidua	3.5	fl oz/a	77,864	60,440	35,756	6,897	1,271	182,226	104,363	100,370	3,993	24	5
	Metribuzin	0.5	lb/a											
	Dual	1	pt/a											
	Matrix	1.5	oz/a											
6	Zidua	3.5	fl oz/a	111,804	72,600	25,894	2,420	0	212,718	100,914	98,494	2,420	13	1
	Metribuzin	0.5	lb/a											
	Dual	1	pt/a											
7	Metribuzin	0.5	lb/a	87,483	60,258	36,845	5,990	908	191,483	104,000	100,370	3,630	23	4
	Dual	1	pt/a											
	Sulfentrazone	3	oz/a											
Mean				88,935	61,477	33,413	4,546	752	189,123	100,188	96,912	3,276	21	3
CV				18	13	22	88	109	10	10	9	54	31	91
LSD p=0.05				*23,193*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*
LSD p=0.10				*19,191*	*ns*	*ns*	*ns*	*ns*	*22,060*	*ns*	*ns*	*ns*	*ns*	*ns*

Table 7. Yield of Umatilla Russet potato (cwt/a) as affected by various herbicide preemergence treatments in Hubbard, MN 2018.

	Treatment	Rate		<4 oz	4-6 oz	6-10 oz	10-14 oz	>14 oz	Total yield	Total Marketable	US#1 >4 oz	US#2 >4 oz	>6 oz	>10 oz
				cwt/a									%	
1	Non-treated check			87	166	173	71	38	535	448	424	23	53	20
2	Zidua	3.5	fl oz/a	98	143	228	71	29	569	471	443	28	57	18
	Metribuzin	0.5	lb/a											
3	Zidua	3.5	fl oz/a	97	154	175	51	27	505	407	380	28	50	15
	Dual	1	pt/a											
4	Sulfentrazone	3	oz/a	85	154	169	42	24	474	389	366	24	48	14
5	Zidua	3.5	fl oz/a	87	141	205	80	42	554	468	430	38	59	21
	Metribuzin	0.5	lb/a											
	Dual	1	pt/a											
	Matrix	1.5	oz/a											
6	Zidua	3.5	fl oz/a	98	132	209	77	19	534	436	424	12	56	17
	Metribuzin	0.5	lb/a											
	Dual	1	pt/a											
7	Metribuzin	0.5	lb/a	123	164	193	64	29	573	450	426	23	49	15
	Dual	1	pt/a											
	Sulfentrazone	3	oz/a											
Mean				97	151	193	65	30	535	438	413	25	53	17
CV				28	20	25	49	76	17	21	21	52	19	41
LSD p=0.05				*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*
LSD p=0.10				*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*

Table 8. Tuber number per plot of Umatilla Russet potato as affected by various herbicide preemergence treatments in Hubbard, MN 2018.

Treatment		Rate		<4 oz	4-6 oz	6-10 oz	10-14 oz	>14 oz	Total yield	Total Marketable	US#1 >4 oz	US#2 >4 oz	>6 oz	>10 oz
				tuber number/a									%	
1	Non-treated check			50,276	53,543	36,845	9,801	3,630	154,094	103,818	100,188	3,630	33	9
2	Zidua	3.5	fl oz/a	56,084	46,827	47,735	9,983	2,723	163,350	107,267	102,366	4,901	37	8
	Metribuzin	0.5	lb/a											
3	Zidua	3.5	fl oz/a	54,813	50,276	37,752	7,260	2,723	152,823	98,010	92,021	5,990	31	6
	Dual	1	pt/a											
4	Sulfentrazone	3	oz/a	47,916	49,913	35,937	5,808	2,360	141,933	94,017	89,117	4,901	31	6
5	Zidua	3.5	fl oz/a	48,824	46,283	42,653	10,890	3,812	152,460	103,637	96,921	6,716	39	10
	Metribuzin	0.5	lb/a											
	Dual	1	pt/a											
	Matrix	1.5	oz/a											
6	Zidua	3.5	fl oz/a	54,087	42,290	44,105	10,527	1,815	152,823	98,736	95,651	3,086	38	9
	Metribuzin	0.5	lb/a											
	Dual	1	pt/a											
7	Metribuzin	0.5	lb/a	68,970	53,180	40,838	8,894	2,904	174,603	105,815	100,914	4,901	30	7
	Dual	1	pt/a											
	Sulfentrazone	3	oz/a											
Mean				54,424	48,901	40,838	9,023	2,852	156,012	101,614	96,740	4,875	34	8
CV				29	20	24	79	71	15	18	18	41	27	48
LSD p=0.05				*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*
LSD p=0.10				*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*

Effect of pyroxasulfone on potato cultivars. Robinson, Brandvik and Ihry. Eight potato cultivars (Bannock russet, Clearwater Russet, Ivory Russet, Lamoka, Russet Burbank, Russet Norkotah, Shepody, and Dakota Russet) were planted near Park Rapids, MN on May 14, 2018 in plots measuring 6 ft wide x 25 ft long. Soil characteristics were 92% sand, 6% silt, 2% clay with 1.2% organic matter and a pH of 5.8. Treatments were applied on May 25 as a preemergence treatment with shoots 3 to 4 inches below the top of the hill. All treatments were applied to the center of the plots with a 9-ft-wide boom equipped with XR11002 flat fan nozzles calibrated to deliver 15 gallons per acre. Potatoes emerge around June 1, 2017. Plots were rated for crop injury and weed control at 1, 2 and 4 weeks after emergence. Harvest occurred on September 17, 2018. The experiment was a randomized complete block design with 3 treatments.

Significant crop injury was not expressed at the 3.5 or 7 oz/a rates of pyroxasulfone at any of the timings. There was no significant yield loss between 0, 3.5 and 7 oz/a within cultivars tested. Potato crop safety to pyroxasulfone was good when treatments were applied with shoots at 3 to 4 inches below the top of the hill.

Table 1. Estimated visual rating of crop injury (%) and efficacy (%) on control of various weeds in Hubbard, MN 2018.

Cultivar	Treatment	Rate	Crop injury			Common Lambsquarters			PN Smartweed			Hairy Nightshade			Eastern Black Nightshade	
		oz/a	%			Efficacy (%)										
			6/8	6/19	7/6	6/8	6/19	7/6	6/8	6/19	7/6	6/8	6/19	7/6	6/19	7/6
Bannock Russet	NT	0	100	100	100	0	0	0	0	0	0	0	0	0	0	0
Bannock Russet	Zidua	3.5	100	100	100	100	100	87	67	65	80	100	93	100	100	100
Bannock Russet	Zidua	7	100	100	100	100	100	100	100	100	100	100	97	100	100	100
Clearwater	NT	0	100	100	100	0	0	0	0	0	0	0	0	0	0	0
Clearwater	Zidua	3.5	100	100	100	100	95	100	100	80	100	100	97	100	97	100
Clearwater	Zidua	7	100	100	100	100	80	100	100	100	100	100	100	100	100	100
Ivory Russet	NT	0	100	100	100	0	0	0	0	0	0	0	0	0	0	0
Ivory Russet	Zidua	3.5	100	100	100	100	100	100	100	80	93	100	100	100	100	100
Ivory Russet	Zidua	7	100	100	100	100	100	100	100	97	93	98	67	100	67	80
Lamoka	NT	0	100	100	100	0	0	0	0	0	0	0	0	0	0	0
Lamoka	Zidua	3.5	100	100	100	100	95	100	100	82	100	100	100	100	100	100
Lamoka	Zidua	7	100	100	100	100	100	100	67	100	100	100	100	100	100	100
Russet Burbank	NT	0	100	100	100	0	0	0	0	0	0	0	0	0	0	0
Russet Burbank	Zidua	3.5	100	100	100	100	100	100	98	100	100	100	100	100	100	100
Russet Burbank	Zidua	7	100	100	100	100	100	100	100	80	100	100	100	100	100	100
Russet Burbank	Outlook	21	100	100	100	100	100	92	83	77	80	77	40	93	55	100
Russet Norkotah	NT	0	100	100	100	0	0	0	0	0	0	0	0	0	0	0
Russet Norkotah	Zidua	3.5	100	100	100	100	100	100	100	95	100	100	100	100	100	100
Russet Norkotah	Zidua	7	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Shepody	NT	0	100	100	100	0	0	0	0	0	0	0	0	0	0	0
Shepody	Zidua	3.5	100	100	100	100	100	100	100	83	100	100	100	100	100	100
Shepody	Zidua	7	98	100	100	100	100	100	100	97	100	100	100	100	100	100
Shepody	Outlook	21	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Dakota Russet	NT	0	100	100	100	0	0	0	0	0	0	0	0	0	0	0
Dakota Russet	Zidua	3.5	100	100	100	98	90	87	67	77	77	98	100	100	95	95
Dakota Russet	Zidua	7	100	100	100	100	100	100	100	93	100	100	100	100	100	100
Dakota Russet	Outlook	21	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Mean			100	100	100	70	69	69	66	63	68	69	66	70	67	69
CV			1	-	-	1	11	10	30	30	17	7	21	3	22	10
LSD p=0.05			ns	-	-	1	13	11	33	31	18	7	23	4	24	11
LSD p=0.10			ns	-	-	1	11	9	27	26	15	6	19	3	20	9

Table 2. Graded yield (cwt/a) of seven cultivars treated with pyroxasulfone in Hubbard, MN 2018.

Cultivar	Product	Rate	<4 oz	4-6 oz	6-10 oz	10-14 oz	>14 oz	Total yield	Total Marketable	US#1 >4 oz	US#2 >4 oz	>6 oz	>10 oz
		oz/a	cwt/a									%	
Bannock Russet	Non-treated	0	35	74	121	108	44	383	348	326	21	71	40
Bannock Russet	Zidua	3.5	33	60	153	138	74	459	425	407	18	79	47
Bannock Russet	Zidua	7	35	73	157	79	31	374	339	322	18	71	30
Clearwater	Non-treated	0	120	147	131	21	10	429	309	301	8	37	7
Clearwater	Zidua	3.5	167	196	107	13	2	485	318	310	8	25	3
Clearwater	Zidua	7	192	199	84	9	0	484	292	288	4	19	2
Ivory Russet	Non-treated	0	23	60	130	94	32	339	315	265	51	74	32
Ivory Russet	Zidua	3.5	45	98	202	90	24	459	414	372	42	67	24
Ivory Russet	Zidua	7	56	115	182	36	2	391	335	311	24	56	9
Lamoka	Non-treated	0	32	95	226	78	22	453	421	412	9	72	22
Lamoka	Zidua	3.5	63	131	199	54	3	451	388	382	6	57	13
Lamoka	Zidua	7	59	97	152	71	19	398	339	337	2	62	23
Russet Burbank	Non-treated	0	91	153	208	48	17	516	425	395	30	52	12
Russet Burbank	Zidua	3.5	129	205	182	42	8	565	437	398	39	40	9
Russet Burbank	Zidua	7	111	154	179	59	24	528	416	383	34	50	16
Russet Burbank	Outlook	21	132	187	155	27	0	502	369	352	17	37	5
Russet Norkotah	Non-treated	0	46	87	167	95	32	427	381	367	13	68	29
Russet Norkotah	Zidua	3.5	44	83	192	119	80	518	474	465	10	75	37
Russet Norkotah	Zidua	7	48	75	210	142	44	519	471	460	11	76	36
Shepody	Non-treated	0	50	78	204	105	61	498	447	418	29	74	33
Shepody	Zidua	3.5	39	65	199	119	45	466	428	387	41	78	35
Shepody	Zidua	7	34	63	155	113	88	453	419	370	49	78	44
Shepody	Outlook	21	24	59	175	132	102	491	467	386	82	83	46
Dakota Russet	Non-treated	0	64	126	205	49	15	459	395	378	17	58	14
Dakota Russet	Zidua	3.5	37	89	211	63	25	425	388	375	12	70	20
Dakota Russet	Zidua	7	72	164	223	65	11	534	462	445	16	55	14
Dakota Russet	Outlook	21	99	171	201	26	0	497	398	383	15	48	6
Mean			70	115	174	74	30	463	393	370	23	61	22
CV			42	27	25	39	96	17	18	18	86	16	42
LSD p=0.05			*48*	*51*	*71*	*47*	*47*	*ns*	*ns*	*ns*	*32*	*16*	*15*
LSD p=0.10			*40*	*43*	*59*	*39*	*39*	*ns*	*96*	*91*	*27*	*13*	*13*

Table 3. Tuber number per plot of of seven cultivars treated with pyroxasulfone in Hubbard, MN 2018.

Cultivar	Product	Rate	<4 oz	4-6 oz	6-10 oz	10-14 oz	>14 oz	Total yield	Total Marketable	US#1 >4 oz	US#2 >4 oz	>6 oz	>10 oz
		oz/a	Tuber number /a									%	
Bannock Russet	Non-treated	0	18,876	21,296	22,264	12,826	3,630	78,892	60,016	56,144	3,872	50	21
Bannock Russet	Zidua	3.5	17,424	17,424	27,830	16,698	6,292	85,668	68,244	65,582	2,662	59	27
Bannock Russet	Zidua	7	17,908	20,812	28,314	9,438	2,420	78,892	60,984	57,838	3,146	51	16
Clearwater	Non-treated	0	67,034	46,222	26,862	2,904	484	143,506	76,472	74,294	2,178	22	2
Clearwater	Zidua	3.5	92,444	61,710	22,990	1,694	242	179,080	86,636	84,458	2,178	14	1
Clearwater	Zidua	7	88,088	51,062	14,520	968	0	154,638	66,550	65,824	726	10	1
Ivory Russet	Non-treated	0	15,730	22,264	32,912	12,342	2,662	85,910	70,180	63,646	6,534	56	18
Ivory Russet	Zidua	3.5	22,022	27,830	38,236	11,374	2,420	101,882	79,860	73,084	6,776	50	13
Ivory Russet	Zidua	7	28,314	35,090	36,058	4,598	242	104,302	75,988	71,874	4,114	40	5
Lamoka	Non-treated	0	17,666	29,282	46,222	10,648	2,178	105,996	88,330	86,636	1,694	55	12
Lamoka	Zidua	3.5	39,688	46,464	45,738	8,954	484	141,328	101,640	99,704	1,936	39	7
Lamoka	Zidua	7	33,638	30,250	31,702	10,164	1,936	107,690	74,052	73,568	484	43	12
Russet Burbank	Non-treated	0	43,076	43,318	38,478	6,292	1,452	132,616	89,540	83,974	5,566	35	6
Russet Burbank	Zidua	3.5	71,632	66,792	39,204	5,808	726	184,162	112,530	105,028	7,502	25	3
Russet Burbank	Zidua	7	55,176	45,254	33,154	6,534	2,178	142,296	87,120	81,554	5,566	31	7
Russet Burbank	Outlook	21	67,760	56,144	32,186	3,630	0	159,720	91,960	88,572	3,388	23	2
Russet Norkotah	Non-treated	0	27,588	28,556	35,090	13,552	3,388	108,174	80,586	77,440	3,146	48	16
Russet Norkotah	Zidua	3.5	26,136	27,346	41,382	17,908	8,470	121,242	95,106	93,654	1,452	55	21
Russet Norkotah	Zidua	7	25,410	22,748	41,382	18,876	4,356	112,772	87,362	85,426	1,936	57	21
Shepody	Non-treated	0	24,200	21,780	37,268	12,826	5,324	101,398	77,198	73,568	3,630	54	18
Shepody	Zidua	3.5	26,862	22,022	42,592	16,940	4,114	112,530	85,668	78,408	7,260	57	19
Shepody	Zidua	7	18,876	19,118	31,218	15,246	7,986	92,444	73,568	67,034	6,534	60	27
Shepody	Outlook	21	15,004	19,844	38,720	19,360	9,680	102,608	87,604	76,714	10,890	66	28
Dakota Russet	Non-treated	0	31,702	35,816	39,204	5,808	1,210	113,740	82,038	78,892	3,146	41	7
Dakota Russet	Zidua	3.5	23,958	30,492	47,674	9,680	2,662	114,466	90,508	88,330	2,178	53	12
Dakota Russet	Zidua	7	46,706	59,290	55,176	10,648	1,210	173,030	126,324	122,210	4,114	38	7
Dakota Russet	Outlook	21	53,240	52,514	40,898	3,388	0	150,040	96,800	93,654	3,146	34	3
Mean			37,635	35,583	35,825	9,967	2,805	121,816	84,180	80,263	3,917	43	12
CV			46	25	34	44	96	29	28	28	83	21	49
LSD p=0.05			*28,264*	*20,578*	*ns*	*7,238*	*4,421*	*58,579*	*ns*	*ns*	*ns*	*15*	*10*
LSD p=0.10			23,594	*17,178*	*16,709*	*6,041*	*3,690*	*48,898*	*ns*	*ns*	*4,439*	*12*	*8*

Carryover of herbicides in potato production systems

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Summary of 2018 research study

Herbicide injury to potato plants is a common concern in potato production because of the high value of potatoes and the sensitivity of potatoes other herbicides. Herbicide injury commonly occurs from soil carryover, drift from nearby herbicide treatment and from residues carried over in seed. One of the common herbicides that is used in dry bean production prior to potato is imazamox (Raptor). The purpose of this project was to evaluate the effects of imazamox carryover in soil on potato growth, development and tuber yield. Soil characteristics were 84% sand, 12% silt and 4% clay with 1.25% organic matter and a pH of 6.6. Raptor was applied at 0, 1, 2 and 4 oz/a in the August 15, 2017. Following herbicide application, the field was planted to a mustard green manure crop, was tilled that fall, but not fumgiated. Russet Burbank and Umatilla Russet whole seed (2-3 oz) and cut seed (2-2.5 oz) were planted on May 11, 2018 and harvested in September 19, 2018.

Raptor treatments had no effect on yield or marketable yield. The rates of 1 and 2 oz/a Raptor caused an increase in tubers <4 oz, and decrease in tubers sized 10-14 oz. This slight shift in tuber size resulted in a smaller percentage of tubers <6 oz when compared to the non-treated check. Differences were found between Russet Burbank and Umatilla Russet, which was expected. One important item that was learned, is that without fall fumigation it seemed that microbial breakdown of imazamox occurred and there were no carryover issues as yields were similar across treatments. A study was initiated in 2018 with treatments of 0, 1, 2, 4 and 8 oz/a Raptor and metam-sodium was applied in strips across plots to determine the effects of fumigation on imazamox breakdown.

Table 1. Effects of Raptor (imazamox) on Russet Burbank and Umatilla Russet yield in 2018 near Hubbard, MN.

Herbicide	Rate (oz/a)	<4 oz	4-6 oz	6-10 oz	10-14 oz	>14 oz	Total yield	Marketable yield	US#1 >4 oz	US#2 >4 oz	>6 oz	>10 oz
		cwt/a									%	
Non-treated	0	104 ab*	153	205	71 a	22 ab	555	452	434	18	53 ab	17 a
Raptor	1	130 a	173	184	49 b	10 b	546	416	404	12	44 b	11 b
Raptor	2	127 ab	173	188	53 ab	19 ab	560	433	412	21	46 ab	13 ab
Raptor	4	105 b	162	202	67 ab	28 a	564	459	442	17	53 a	17 a
p-value		*0.0376*	*0.3565*	*0.3404*	*0.0364*	*0.0055*	*0.8848*	*0.2322*	*0.2360*	*0.3348*	*0.0129*	*0.0021*

*Means separated with Tukey pair-wise comparison at p=0.05

Table 2. Effects of Raptor (imazamox) on Russet Burbank and Umatilla Russet tuber number in 2018 near Hubbard, MN.

Herbicide	Rate (oz/a)	<4 oz	4-6 oz	6-10 oz	10-14 oz	>14 oz	Total yield	Marketable yield	US#1 >4 oz	US#2 >4 oz	>6 oz	>10 oz
		tuber number/a									%	
Non-treated	0	60,031 ab	49,958	43,469	9,892 a	2,133 ab	165,483	105,452	102,366	3,086	34 ab	8 ab
Raptor	1	76,282 a	56,369	39,463	6,897 b	985 b	179,996	103,714	101,277	2,437	28 b	5 b
Raptor	2	72,963 ab	56,436	39,887	7,474 ab	1,815 ab	178,575	105,612	101,854	3,758	28 ab	6 ab
Raptor	4	60,130 b	52,571	43,005	9,353 ab	2,712 a	167,770	107,640	104,672	2,968	34 a	8 a
p-value		*0.0405*	*0.3448*	*0.3307*	*0.0403*	*0.0095*	*0.1943*	*0.8906*	*0.8911*	*0.5133*	*0.0240*	*0.0062*

Table 3. Effects of Raptor (imazamox) on Russet Burbank cut, Russet Burbank whole, Umatilla Russet cut and Umatilla Russet whole seed on yield in 2018 near Hubbard, MN.

Seed type	<4 oz	4-6 oz	6-10 oz	10-14 oz	>14 oz	Total yield	Marketable yield	US#1 >4 oz	US#2 >4 oz	>6 oz	>10 oz
	cwt/a									%	
RB cut	133 a	172 ab	172 c	50 b	11 b	537	405 b	389 b	15 b	43 c	11 c
RB whole	141 a	199 a	177 bc	31 b	12 b	560	419 ab	411 ab	8 b	39 c	7 c
Umatilla cut	78 b	128 c	214 ab	88 a	38 a	546	468 a	452 a	16 ab	62 a	23 a
Umatilla whole	111 a	161 b	215 a	72 a	22 b	580	469 a	443 ab	27 a	53 b	16 b
p-value	*<0.0001*	*<0.0001*	*0.0016*	*<0.0001*	*<0.0001*	*0.2297*	*0.0091*	*0.0206*	*0.0003*	*<0.0001*	*<0.0001*

Table 4. Effects of Raptor (imazamox) on Russet Burbank cut, Russet Burbank whole, Umatilla Russet cut and Umatilla Russet whole seed on tuber number in 2018 near Hubbard, MN.

Seed type	<4 oz	4-6 oz	6-10 oz	10-14 oz	>14 oz	Total yield	Marketable yield	US#1 >4 oz	US#2 >4 oz	>6 oz	>10 oz
	tuber number/a									%	
RB cut	76,871 a	56,414 ab	37,069 b	6,961 bc	1,068 b	178,382 a	101,512	99,078	2,434 b	26 c	5 bc
RB whole	79,704 a	64,977 a	38,426 ab	4,408 c	1,141 b	188,656 a	108,952	107,707	1,245 b	24 c	3 c
Umatilla cut	46,075 b	41,512 c	44,597 a	12,290 a	3,578 a	148,052 b	101,977	99,255	2,723 b	42 a	11 a
Umatilla whole	64,385 ab	52,196 b	45,509 a	9,935 ab	2,140 b	174,164 a	109,779	104,468	5,311 a	34 b	7 b
p-value	*0.0001*	*<0.0001*	*0.0037*	*<0.0001*	*<0.0001*	*0.0003*	*0.2058*	*0.2590*	*<0.0001*	*<0.0001*	*<0.0001*

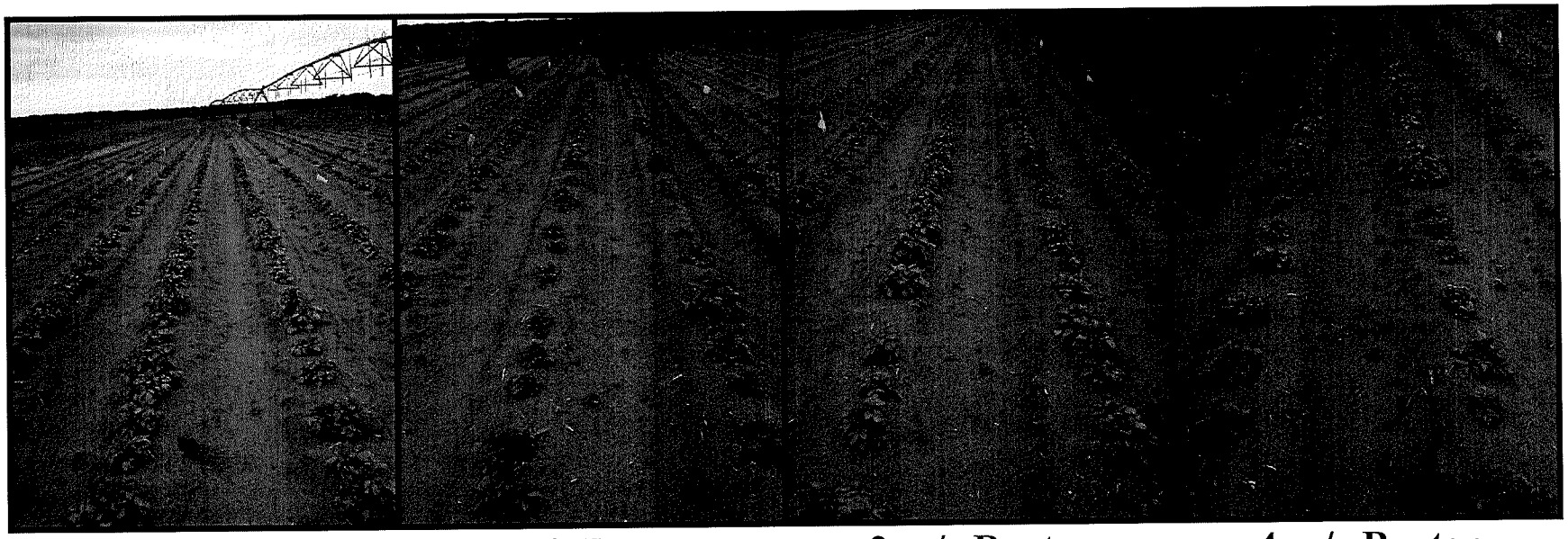

Figure 1. Pictures of 0, 1, 2 and 4 oz/a R aptor on June 8, 2018.

Adjuvant Comparison with Potato Desiccants, Grand Forks1. H. Hatterman-Valenti and C. Auwarter.

This study was conducted at the Northern Plains Potato Growers Association dryland research site near Grand Forks, ND to evaluate different adjuvants when added to a common vine desiccant, diquat, on 'Red Norland' potato. Plots were 4 rows by 20 feet arranged in a randomized complete block design with 4 replicates. Seed pieces (2 oz) were planted on 36-inch rows and 12-inch spacing on June 19, 2018. Extension recommendations were used for cultural practices throughout the year. Plots were sprayed on August 27 with a CO2 pressurized sprayer equipped with 8002 XR flat fan nozzles with a spray volume of 20 GPA and a pressure of 40 psi. Plots were rated 1, 3 and 8 days after planting (DAP).

Table 1. Herbicide application information.

Date:	8/27
Air Temperature (F):	57
Relative Humidity (%):	78
Wind (MPH):	10
Soil Moisture:	Excess
Cloud Cover (%):	100
Next Rain:	8/31

Table 2. Percent Necrosis on Leaves and Stems, NDVI and Canopy Cover ratings.

Trt No.	Treatment Name	Rate	Rate Unit	Appl Code	1 DAA		3 DAA			8 DAA		
					Leaf Senescence	NDVI	Leaf Senescence	Stem Senescence	NDVI	Leaf Senescence	Stem Senescence	Canopy
1	Reglone	1	pt/a	A	13.8 a	0.73150 a	48.8 a	25.0 a	0.50565 b	87.5 a	80.0 a	4.546 b
2	Reglone	1	pt/a	A	11.3 a	0.68550 a	47.5 a	22.5 a	0.53558 b	83.8 a	71.3 a	9.944 b
	Preference	0.25	% v/v	A								
3	Reglone	1	pt/a	A	13.8 a	0.69143 a	45.0 a	21.3 a	0.52878 b	85.0 a	75.0 a	6.004 b
	Accudrop	0.25	% v/v	A								
4	Reglone	1	pt/a	A	8.3 a	0.69730 a	43.3 a	20.0 a	0.53187 b	70.0 a	60.0 a	13.912 b
	Noble	3	fl oz/a	A								
5	Reglone	1	pt/a	A	16.3 a	0.73373 a	43.8 a	21.3 a	0.54995 b	84.7 a	78.3 a	3.479 b
	Accudrop	0.25	% v/v	A								
	Noble	3	fl oz/a	A								
6	Reglone	1	pt/a	A	16.7 a	0.66645 a	36.7 a	18.3 a	0.56087 b	88.3 a	73.3 a	8.924 b
	Preference	0.25	% v/v	A								
	Interlock	4	fl oz/a	A								
7	Reglone	1	pt/a	A	17.5 a	0.67120 a	53.8 a	27.5 a	0.54123 b	81.3 a	73.8 a	8.075 b
	Accudrop	0.25	% v/v	A								
	Interlock	4	fl oz/a	A								
8	Reglone	1	pt/a	A	15.0 a	0.74157 a	47.5 a	22.5 a	0.52398 b	77.0 a	68.8 a	5.326 b
	AG8050	6.4	fl oz/a	A								
9	Reglone	1	pt/a	A	18.8 a	0.74090 a	45.0 a	25.0 a	0.52208 b	81.3 a	71.3 a	9.186 b
	AG14039	8	fl oz/a	A								
10	Untreated				0.0 b	0.68137 a	0.0	0.0 b	0.80433 a	0.0 b	0.0 b	51.429 a
			LSD P=.05		7.19	0.1000	18.71	12.25	0.0335	14.37	15.44	5.52 – 14.51

Reglone alone provided just as much leaf and stem necrosis as reglone plus an adjuvant (Table 2). The use of NDVI or % Canopy Coverage data resulted in similar statistical results as using % necrosis data. The use of NDVI or %Canopy Cover provides ways to evaluate necrosis without the subjectiveness of the visible rating system.

Adjuvant Comparison with Potato Desiccants, Grand Forks2. H. Hatterman-Valenti and C. Auwarter.

This study was conducted at the Northern Plains Potato Growers Association dryland research site near Grand Forks, ND to evaluate different adjuvants when added to a common vine desiccant, diquat, on 'Red Norland' potato. Plots were 4 rows by 20 feet arranged in a randomized complete block design with 4 replicates. Seed pieces (2 oz) were planted on 36-inch rows and 12-inch spacing on June 19, 2018. Extension recommendations were used for cultural practices throughout the year. Plots were sprayed on August 27 with a CO2 pressurized sprayer equipped with 8002 XR flat fan nozzles with a spray volume of 20 GPA and a pressure of 40 psi. Plots were rated 1, 3 and 8 days after planting (DAP).

Table 1. Herbicide application information.

Date:	8/27
Air Temperature (F):	57
Relative Humidity (%):	78
Wind (MPH):	10
Soil Moisture:	Excess
Cloud Cover (%):	100
Next Rain:	8/31

Table 2. Percent Necrosis on Leaves and Stems, NDVI and Canopy Cover ratings.

Trt No.	Treatment Name	Rate	Unit	Appl Code	1 DAA		3 DAA			8 DAA		
					Leaf Senescence	NDVI	Leaf Senescence	Stem Senescence	NDVI	Leaf Senescence	Stem Senescence	Canopy
1	Untreated				0.0 b	0.69073 a	0.0 b	0.0 b	0.79793 a	0.0 b	0.0 b	41.14 a
2	Reglone	1	pt/a	A	15.0 a	0.70277 a	53.8 a	30.0 a	0.53830 b	86.3 a	78.8 a	3.64 b
3	Reglone	1	pt/a	A	13.8 a	0.73803 a	53.8 a	26.3 a	0.50120	93.3 a	85.0 a	1.89 b
	Activate Plus	0.1	% v/v	A								
4	Reglone	1	pt/a	A	7.5 ab	0.69960 a	47.5 a	25.0 a	0.50658 b	78.8 a	70.0 a	7.40 b
	AG17054	0.1	% v/v	A								
5	Reglone	1	pt/a	A	10.0 ab	0.78647 a	55.0 a	28.8 a	0.52905 b	87.5 a	76.3 a	4.29 b
	AG17055	0.1	% v/v	A								
6	Reglone	1	pt/a	A	3.3 ab	0.81165 a	58.3 a	31.7 a	0.53815 b	86.7 a	76.7 a	3.34 b
	AG17056	0.1	% v/v	A								
7	Reglone	1	pt/a	A	10.0 ab	0.68360 a	53.8 a	27.5 a	0.50933 b	89.5 a	81.3 a	2.89 b
	Activate Plus	0.25	% v/v	A								
			LSD P=.05		8.73	0.148	16.53	11.24	0.040	12.24	12.90	3.48 – 10.55

Reglone alone provided just as much leaf and stem necrosis as reglone plus an adjuvant (Table 2). The use of NDVI or % Canopy Coverage data resulted in similar statistical results as using % necrosis data. The use of NDVI or %Canopy Cover provides ways to evaluate necrosis without the subjectiveness of the visible rating system.

Adjuvant Comparison with halosulfuron in Pumpkin, Fargo. H. Hatterman-Valenti and C. Auwarter.

This study was conducted at the NDSU AES main station at Fargo, ND to evaluate different adjuvants when added to halosulfuron on pumpkin. Plots were individual plants in a row arranged in a randomized complete block design with three replicates. Pumpkin seed was planted May 30 on a 10 ft grid pattern. Extension recommendations were used for cultural practices throughout the year. Plots were sprayed on August 27 with a CO2 pressurized sprayer equipped with 8002 XR flat fan nozzles with a spray volume of 20 GPA and a pressure of 40 psi. Plots were rated 1, 3 and 8 days after planting (DAP).

Table 1. Herbicide application information.

Date:	6/22
Air Temperature (F):	73
Relative Humidity (%):	70
Wind (MPH):	5
Soil Moisture:	dry
Cloud Cover (%):	50
Next Rain:	6/24

Table 2. Percent pumpkin injury and weed control evaluations.

Pest Code No.	Name	Rate	Unit	Pumpkin Jun-29-2018 %	GRFT Jun-29-2018 %	VEMA Jun-29-2018 %	RRPW Jun-29-2018 %	Pumpkin Jul-13-2018 %	GRFT Jul-13-2018 %	VEMA Jul-13-2018 %	RRPW Jul-13-2018 %
1	Untreated			0.0 c	0.0 a	0.0 c	0.0 b	0.0 a	0.0 a	0.0 c	0.0 d
2	Sandea	0.5	oz/a	3.3 bc	0.0 a	16.7 bc	15.0 b	0.0 a	1.7 a	13.3 c	16.7 cd
3	Sandea	0.5	oz/a	5.0 abc	0.0 a	71.7 a	60.0 a	0.0 a	23.3 a	60.0 ab	40.0 a-d
	Preference	0.25	% v/v								
4	Sandea	0.5	oz/a	1.7 c	0.0 a	30.0 b	23.3 ab	0.0 a	0.0 a	30.0 bc	23.3 bcd
	InterLock	3	fl oz/a								
5	Sandea	0.5	oz/a	15.0 a	0.0 a	75.0 a	58.3 a	0.0 a	8.3 a	56.7 ab	46.7 a-d
	Preference	0.25	% v/v								
	InterLock	3	fl oz/a								
6	Sandea	0.5	oz/a	6.7 abc	0.0 a	65.0 a	55.0 a	0.0 a	10.0 a	70.0 ab	46.7 a-d
	AG16134	0.25	% v/v								
7	Sandea	0.5	oz/a	6.7 abc	0.0 a	73.3 a	53.3 a	0.0 a	18.3 a	71.7 ab	46.7 a-d
	AG16134	0.25	% v/v								
	InterLock	3	fl oz/a								
8	Sandea	0.5	oz/a	13.3 ab	0.0 a	76.7 a	63.3 a	0.0 a	11.7 a	58.3 ab	46.7 a-d
	AG8050	6.4	fl oz/a								
9	Sandea	0.5	oz/a	8.3 abc	0.0 a	85.0 a	51.7 a	0.0 a	20.0 a	90.0 a	68.3 ab
	Prime Oil	1	% v/v								
10	Sandea	0.5	oz/a	8.3 abc	0.0 a	73.3 a	65.0 a	0.0 a	6.7 a	76.7 ab	56.7 abc
	Supurb HC	1	pt/a								
11	Sandea	0.5	oz/a	13.3 ab	0.0 a	80.0 a	65.0 a	3.3 a	13.3 a	80.0 ab	73.3 a
	AG14039	8	fl oz/a								
12	Sandea	0.5	oz/a	13.3 ab	0.0 a	80.0 a	65.0 a	0.0 a	13.3 a	80.0 ab	70.0 ab
	Supurb HC	1.5	pt/a								
LSD P=.05				6.38	.	19.07	26.60	2.82	14.55	30.44	29.08

Sandea plus adjuvants (Preference +Interlock, AG8050, AG14039, and Superb HC) caused 13-15% crop injury 7 DAT (Table 2). Sandea + Prime Oil provided best Venice mallow control (90%) 21DAT. Sandea + AG14039 or Superb HC provided best redroot pigweed control (73, 70%) 21 DAT, almost two-fold more than Sandea + Preference.

Sunflower response and weed control from herbicides applied pre-plant and post-plant preemergence near Hettinger, ND

Caleb Dalley, HREC, Hettinger, ND 2018

A trial was established on May 22, 2018 to determine sunflower response and weed control following early pre-plant (EPP) and preemergence (PRE) herbicide treatments. On May 31, sunflower were planted in 30-inch rows using a John Deere planter at a rate of 20,000 seeds/A at a depth of 1.5 inches. Nine days prior to planting, and EPP treatments were applied using a hand-held back-pack sprayer with a 76-inch spray boom. PRE treatments were applied on June 4 using the same procedures. All EPP and PRE treatments were tank-mixed with glyphosate (Cornerstone 5 Plus @ 32 oz/A plus AMS at 8.5 lbs/100 Gal). The delay between planting and PRE application was due to persistent winds that prevented application. Sunflower emerged on June 7. Weeds emerging in trial included green foxtail and wild buckwheat. Green foxtail was controlled equally well when treatments were applied preplant or PRE. Wild buckwheat control was almost always greater following preplant application compared with PRE application. This may be due to greater amounts of rainfall after preplant vs PRE application which allowed for greater emergence of wild buckwheat following the PRE application timing. Sunflower yield was not affected by herbicide treatment or timing of herbicide treatment. Although yield in untreated plots was numerically the lowest, the difference was not significant. Weed populations in this trial were low, which was likely the reason for lack of yield response to herbicide treatments.

Table. Sunflower response and weed control following early pre-plant and preemergence herbicide treatments.

				Green foxtail		Wild buckwheat		
	Rate		Sunflower	28 DAT	42 DAT	28 DAT	42 DAT	Sunflower yield
Treatment	oz/A	Timing	% injury	% control				lb/A
1Untreatead			0	0	0	0	0	3280
2Authority Supreme	8.5	EPP	0	87ab	88b	90a	91ab	3580
3Spartan Charge	5.75	EPP	0	71d	66d	90a	94a	3637
4Spartan Elite	26	EPP	0	98a	96a	90ab	91ab	3893
5Zidua SC	4	EPP	0	89ab	91ab	75bc	82bc	3625
6Authority Supreme	5.8	PRE	0	88ab	93ab	68c	75c	3985
7Authority Supreme	8.5	PRE	0	94ab	94ab	68c	74c	4110
8Spartan Charge	3.75	PRE	0	74cd	79c	71c	79bc	3856
9Spartan Elite	19	PRE	0	85bc	92ab	73c	78c	3823
10Zidua SC	3	PRE	0	88ab	95a	78abc	86abc	3679
LSD P=.05			.	10.76	7.01	13.89	11.74	602.05
Treatment F			0.000	4.439	15.797	3.672	3.086	0.926
Treatment Prob(F)			1.0000	0.0029	0.0001	0.0079	0.0183	0.5213

Means followed by same letter or symbol do not significantly differ (P=.05, LSD)
EPP, early pre plant treatments, applied on May 22 (9 days before planting; PRE, preemergence treatments, applied on June 4 (4 days after planting)

Dandelion control with herbicides. Dr. Howatt and Mettler. The experiment was established near Fargo on October 13, 2017. Treatments were applied to dandelion and thistle October 13 with 42°F, 57% relative humidity, 0% cloud cover, 3 mph wind velocity at 355°, and dry soil at 52°F. Treatments were applied with a backpack sprayer delivering 8.5 gpa at 40 psi through 11001 TT nozzles to a 7 foot wide area the length of 10 by 30 foot plots. The experiment was a randomized complete block design with four replicates.

Treatment	Rate	2018 Dandelion	2018 Thistle
MCPA	16	21	0
Fluroxypyr	16	20	7
2,4-D	16	25	0
2,4-DP	16	0	0
Dicamba-C	2	22	0
Halauxifen&Florasulam+NIS+AMS	0.3+0.25%+11	25	0
Triclopyr-U	4	24	0
Aminopyralid	1.25	99	99
Quinclorac&Sulfentrazone&2,4-D&Dicamba	24.6	70	66
Carfentrazone&2,4-D&MCPP&Dicamba	17.6	25	7
MCPA&Dicamba&Triclopyr	25.2	24	5
Triclopyr&Sulfentrazone&2,4-D&Dicamba	20	24	7
2,4-D&MCPP&Dicamba	26	23	7
Untreated Check	0	0	0
CV		81	94
LSD P=.05		33	19

Only aminopyralid provided exceptional and extended control of dandelion and Canada thistle.

Creeping Charlie control with herbicides. Dr. Howatt and Mettler. The experiment was established near Absaraka, North Dakota on October 12, 2017. Treatments were applied to creeping Charlie on October 12 with 62°F, 48.6% relative humidity, 0% cloud cover, 0.9 mph wind velocity at 0° and dry soil at 61°F. Treatments were applied with a backpack sprayer delivering 8.5 gpa at 40 psi through 11001 TT nozzles to a 7 foot wide area the length of 10 by 30 foot plots. The experiment was a randomized complete block design with four replicates.

		7/12/2018
Treatment	Rate	Creeping Charlie
2,4-D	16	93
2,4-DP	16	85
Dicamba-C	2	65
Fluroxypyr	2	27
Quinclorac&Sulfentrazone&2,4-D&Dicamba	24.6	96
Triclopyr-U	4	75
Quinoclorac+MSO	8+32	67
Halauxifen&Florasulam+NIS+AMS	0.3+0.25%+11	63
Carfentrazone&2,4-D&MCPP&Dicamba	17.6	70
MCPA&Dicamba&Triclopyr	25.2	82
Triclopyr&Sulfentrazone&2,4-D&Dicamba	20	88
2,4-D&MCPP&Dicamba	26	78
Untreated Check	0	0
CV		10
LSD P=.05		11

The premix of quinclorac and sulfentrazone and 2,4-D and dicamba provided 96% control of creeping Charlie 10 months after application. 2,4-D provided 93% control but 2,4-DP only gave 85% control. Triclopyr gave 75% control but the addition of sulfentrazone and 2,4-D and dicamba increased control to 88% while the addition of MCPA and dicamba gave 82% control.