Tan Section: Application Technology Page

Liberty and AMS with Adjuvants. Zollinger, Richard K., Angela J. Kazmierczak, and Devin A. Wirth. An experiment was conducted near Hillsboro, ND to evaluate the efficacy of Liberty and AMS with different adjuvants. Flax, amaranth, quinoa, and tame buckwheat were planted on June 11, 2013. POST treatments were applied on July 10, 2013 at 8:30 am with 83.4 F air, 73.4 F soil at a four inch depth, 25% relative humidity, 10% cloud cover, 5-7 mph N wind, dry soil moisture, good plant vigor, and no dew present. Plant height and density at time of application was 6-10" (1-10/ft^2) flax, 6-10" (1-15/yd^2) amaranth, 8-12" (2-15/yd^2) quinoa, 6-10" (1-5/yd^2) tame buckwheat. Soil characteristics were: 68.5% sand, 18.3% silt, 13.2% clay, sandy loam texture, 2.1% OM and 6.3 pH. Treatments were applied to the center 6.7 feet of the 10 by 40 foot plots with a backpack-type plot sprayer delivering 17 gpa at 40 psi through 11002 Turbo TeeJet nozzles. The experiment had a randomized complete block design with three replicates per treatment.

Table. Liberty and AMS with Adjuvants. (Zollinger, Wirth, Kazmierczak)

		7 DAA				14 DAA				28 DAA			
Treatments	Rate	Flax	Amar	Quin	Tabw	Flax	Amar	Quin	Tabw	Flax	Amar	Quin	Tabw
	(Product/A)	% control				% control				% control			
POST													
Liberty	22fl oz	72	70	70	73	75	73	73	78	80	78	82	95
Liberty+AMS	22fl oz+8.5lb/100gal	92	90	90	90	96	96	97	98	96	90	93	98
Liberty+AMS	22fl oz+17lb/100gal	97	95	95	96	97	95	95	96	96	85	93	98
Liberty+AMS 20/10	22fl oz+10lb/100gal	93	92	92	93	93	93	93	95	92	83	90	99
Liberty+AMS 2000	22fl oz+17lb/100gal	88	90	90	90	92	92	92	95	92	83	90	99
Liberty+Doubledown	22fl oz+2.5% v/v	72	68	70	70	72	70	72	75	80	65	87	99
Liberty+Amsol Plus	22fl oz+5% v/v	77	73	73	73	73	73	72	72	80	70	72	95
Liberty+Downdraft+AMS	22fl oz+2fl oz+8.5lb/100gal	65	62	62	65	65	68	68	75	77	83	83	98
Liberty+Downdraft+AMS	22fl oz+4fl oz+8.5lb/100gal	90	83	85	90	90	93	92	98	87	83	91	98
LSD (0.05)		7	7	8	6	6	7	8	9	10	19	13	4

Liberty with Glycerol. Zollinger, Richard K., Angela J. Kazmierczak, and Devin A. Wirth. An experiment was conducted near Hillsboro, ND to evaluate the efficacy of Liberty with glycerol, a humectant. Flax, amaranth, quinoa, and tame buckwheat were planted on June 11, 2013. POST treatments were applied on July 16, 2013 at 11:00 am with 89 F air, 78.8 F soil at a four inch depth, 42% relative humidity, 15% cloud cover, 8-10 mph S wind, dry soil moisture, good plant vigor, and no dew present. Plant height and density at time of application was 12-18" (10-20/ft^2) flax, 18-24" (10-20/yd^2) amaranth, 18-24" (10-20/yd^2) quinoa, 18-24" (10-20/yd^2) tame buckwheat. Soil characteristics were: 68.5% sand, 18.3% silt, 13.2% clay, sandy loam texture, 2.1% OM and 6.3 pH. Treatments were applied to the center 6.7 feet of the 10 by 40 foot plots with a backpack-type plot sprayer delivering 17 gpa at 40 psi through 11002 Turbo TeeJet nozzles. The experiment had a randomized complete block design with three replicates per treatment.

Glycerol has been shown to have humectant activity and keep spray droplets in a moist state for a longer period of time to allow better deposition of the active ingredient on the leaf surface. This study was designed to test the humectant influence of glycerol with Liberty. Glycerol improved and also decreased weed control depending on concentration.

Table. Liberty with Glycerol. (Zollinger, Wirth, Kazmierczak)

		14 DAA				28 DAA			
Treatments	Rate	Flax	Amar	Quin	Tabw	Flax	Amar	Quin	Tabw
	(Product/A)	% control				% control			
POST									
Liberty	18fl oz	65	53	58	72	68	50	62	70
Liberty+AMS	18fl oz+3lb	68	62	62	85	78	62	63	85
Liberty+AMS+Glycerol	18fl oz+3lb+0.5% v/v	52	80	68	77	50	80	72	78
Liberty+AMS+Glycerol	18fl oz+3lb+1% v/v	78	78	58	87	83	77	76	90
Liberty+AMS+Glycerol	18fl oz+3lb+2.5% v/v	38	40	42	70	42	40	42	70
Liberty+AMS+Glycerol	18fl oz+3lb+5% v/v	60	47	43	70	67	42	45	70
Liberty	22fl oz	68	52	65	73	68	50	70	77
Liberty+AMS	22fl oz+3lb	68	68	70	83	72	65	65	82
Liberty+AMS+Glycerol	22fl oz+3lb+0.5% v/v	68	60	63	83	70	60	73	88
Liberty+AMS+Glycerol	22fl oz+3lb+1% v/v	78	68	65	83	85	68	73	88
Liberty+AMS+Glycerol	22fl oz+3lb+2.5% v/v	55	42	42	70	58	42	48	70
Liberty+AMS+Glycerol	22fl oz+3lb+5% v/v	67	67	48	73	73	65	62	75
LSD (0.05)		9	7	9	5	6	6	5	4

Liberty with Adjuvants. Zollinger, Richard K., Angela J. Kazmierczak, and Devin A. Wirth. An experiment was conducted near Hillsboro, ND to evaluate the efficacy of Liberty with different adjuvants. Flax, amaranth, quinoa, and tame buckwheat were planted on June 11, 2013. POST treatments were applied on July 10, 2013 at 8:30 am with 83.4 F air, 73.4 F soil at a four inch depth, 25% relative humidity, 10% cloud cover, 5-7 mph N wind, dry soil moisture, good plant vigor, and no dew present. Plant height and density at time of application was 6-10" (1-10/ft^2) flax, 6-12" (1-15/yd^2) amaranth, 8-16" (1-10/yd^2) quinoa, 8-12" (1-5/yd^2) tame buckwheat, and 6-16" (1-15/yd^2) redroot pigweed. Soil characteristics were: 68.5% sand, 18.3% silt, 13.2% clay, sandy loam texture, 2.1% OM and 6.3 pH. Treatments were applied to the center 6.7 feet of the 10 by 40 foot plots with a backpack-type plot sprayer delivering 17 gpa at 40 psi through 11002 Turbo TeeJet nozzles. The experiment had a randomized complete block design with three replicates per treatment.

AMS enhanced Liberty. Generally, most other adjuvants did not influence herbicide activity or had a negative affect.

Table.Liberty with Adjuvants. (Zollinger, Wirth, Kazmierczak)

Treatments	Rate	14 DAA				14 DAA				28 DAA			
	(Product/A)	Flax	Amar	Quin	Tabw	Flax	Amar	Quin	Tabw	Flax	Amar	Quin	Tabw
		% control				% control				% control			
POST													
Liberty	22fl oz	67	50	50	50	70	62	62	62	72	57	73	90
Liberty+AMS	22fl oz+3lb	92	92	92	92	92	92	92	92	77	72	85	99
Liberty+NIS	22fl oz+0.25% v/v	73	65	65	65	72	68	65	77	70	52	70	96
Liberty+PO	22fl oz+qt	73	68	67	67	73	67	65	67	70	50	55	96
Liberty+MSO	22fl oz+1.25pt	63	65	63	63	60	62	60	60	60	60	48	93
Liberty+Destiny HC	22fl oz+1pt	73	73	73	73	73	73	72	78	63	58	75	93
Liberty+NIS+AMS	22fl oz+0.25% v/v+3lb	70	75	77	77	62	76	76	78	60	50	73	96
Liberty+PO+AMS	22fl oz+1qt+3lb	50	70	68	70	50	68	67	77	37	55	58	96
Liberty+MSO+AMS	22fl oz+1.25pt+3lb	30	40	40	40	30	40	40	40	23	33	35	96
Liberty+Destiny HC+AMS	22fl oz+1pt+3lb	82	82	82	82	72	85	88	92	60	60	73	99
Basta		82	60	62	62	86	60	68	82	84	47	63	90
LSD (0.05)		11	5	6	6	7	8	8	9	9	14	14	7

Glyphosate and Clarity with Adjuvants. Zollinger, Richard K., Angela J. Kazmierczak, and Devin A. Wirth. An experiment was conducted near Hillsboro, ND to evaluate the efficacy of glyphosate and clarity with different adjuvants in hard water. Flax, amaranth, sunflower, and conventional corn were planted on June 11, 2013. POST treatments were applied on July 16, 2013 at 9:30 am with 89 F air, 78.8 F soil at a four inch depth, 42% relative humidity, 15% cloud cover, 8-10 mph S wind, dry soil moisture, good plant vigor, and no dew present. Plant height and density at time of application was 10-16" (10-20/ft^2) flax, 10-20" (5-20/yd^2) amaranth, 18-30" (10-20/yd^2) sunflower, and 30-36" (10-20/yd^2) conventional corn. Soil characteristics were: 68.5% sand, 18.3% silt, 13.2% clay, sandy loam texture, 2.1% OM and 6.3 pH. Treatments were applied to the center 6.7 feet of the 10 by 40 foot plots with a backpack-type plot sprayer delivering 8.5 gpa at 40 psi through 11001 Turbo TeeJet nozzles. The experiment had a randomized complete block design with three replicates per treatment.

Low pH caused by some adjuvants may be below the pKa of the herbicides and change the herbicide into the acid form in some treatments. The efficacy of glyphosate acid shows higher efficacy than of the salt in many treatments. Dicamba and 2,4-D will precipitate at pH 1. pka of glyphosate = 2.6 - water solubility = 2%. pKa of 2,4-D = 2.64-3.31 – water solubility = 0.09%. pka of dicamba = 1.97 - water solubility = ~0.06%/4500 mg/l. Surfactant + AMS provided the greatest weed control and overcame hard water antagonism compared to other adjuvants used.

Table. Glyphosate and Clarity with Adjuvants. (Zollinger, Wirth, Kazmierczak)

Treatments	Rate			14 DAA				28 DAA			
				Flax	Amar	Snfl	Corn	Flax	Amar	Snfl	Corn
	(Product/A)	Hard Water	pH of Solution	% control				% control			
POST											
Touchdown HT+R-11	9.7fl oz+1% v/v	0 ppm	4.8	22	67	62	55	22	72	63	60
Touchdown HT+R-11+AMS	9.7fl oz+1% v/v+8.5lb/100gal	0 ppm	4.8	62	68	63	50	75	75	83	83
Touchdown HT+R-11+AMS	9.7fl oz+1% v/v+8.5lb/100gal	1000 ppm	5.0	52	68	63	72	60	70	68	80
Touchdown HT+Full Load	9.7fl oz+0.5% v/v	1000 ppm	4.8	35	78	63	50	43	78	70	57
Touchdown HT+Hel-Fire+Induce	9.7fl oz+0.5% v/v+0.5% v/v	1000 ppm	3.2	15	62	60	57	18	67	65	62
Touchdown HT+Brimstone+R-11	9.7fl oz+0.5% v/v+0.5% v/v	1000 ppm	3.0	45	63	62	57	47	72	77	73
Touchdown HT+Full Load	9.7fl oz+1% v/v	1000 ppm	4.6	40	70	68	60	43	75	70	69
Touchdown HT+Hel-Fire+Induce	9.7fl oz+1% v/v+0.5% v/v	1000 ppm	3.2	33	75	65	40	35	78	77	72
Touchdown HT+Brimstone+R-11	9.7fl oz+1% v/v+0.5% v/v	1000 ppm	2.4	31	69	68	63	55	67	72	72
Clarity+R-11+AMS	8fl oz+1% v/v+8.5lb/100gal	0 ppm	6.5	17	30	25	0	18	32	30	7
Clarity+R-11+AMS	8fl oz+1% v/v+8.5lb/100gal	1000 ppm	6.6	10	37	28	0	7	35	28	0
Clarity+Full Load	8fl oz+0.5% v/v	1000 ppm	5.5	15	37	23	3	15	37	23	0
Clarity+Hel-Fire+Induce	8fl oz+0.5% v/v+0.5% v/v	1000 ppm	2.5	12	32	25	0	12	32	25	0
Clarity+Brimstone+R-11	8fl oz+0.5% v/v+0.5% v/v	1000 ppm	2.3	28	35	23	0	32	38	28	0
Touchdown HT+Clarity+R-11+AMS	7.2fl oz+6fl oz+1% v/v+8.5lb/100gal	0 ppm	4.9	57	67	50	66	62	74	58	71
Touchdown HT+Clarity+R-11+AMS	7.2fl oz+6fl oz+1% v/v+8.5lb/100gal	1000 ppm	4.9	74	72	53	53	74	78	60	65
Touchdown HT+Clarity+Full Load	7.2fl oz+6fl oz+0.5% v/v	1000 ppm	4.8	35	63	47	37	38	60	52	37
Touchdown HT+Clarity+Hel-Fire+Induce	7.2fl oz+6fl oz+0.5% v/v+0.5% v/v	1000 ppm	3.0	35	65	47	38	35	68	50	40
Touchdown HT+Clarity+Brimstone+R-11	7.2fl oz+6fl oz+0.5% v/v+0.5% v/v	1000 ppm	3.0	28	63	45	43	33	67	52	52
LSD (0.05)				10	7	6	14	9	10	8	18

Efficacy of Herbicides at Different pH in hard water. Zollinger, Richard K., Angela J. Kazmierczak, and Devin A. Wirth. An experiment was conducted near Hillsboro, ND to evaluate the efficacy of herbicides at different pH in hard water. Flax, amaranth, sunflower, and conventional corn were planted on June 11, 2013. POST treatments were applied on July 11, 2013 at 10:00 am with 86.3 F air, 76.3 F soil at a four inch depth, 43% relative humidity, 0% cloud cover, 8-10 mph SSW wind, dry soil moisture, good plant vigor, and no dew present. Hydrochloric Acid was added to treatments 2, 7, 12, and 17 to drop the pH to 4. Water was hardened to 1018 ppm using $CaCl_2$, $MgCl_2$, and $FeCl_3$ ($FeCl_3$ at 18 ppm).Plant height and density at time of application was 8-12" (10-15/ft^2) flax, 10-14" (10-20/yd^2) amaranth, 12-18" (10-20/yd^2) sunflower, and 24-30" (15-25/yd^2) conventional corn. Soil characteristics were: 68.5% sand, 18.3% silt, 13.2% clay, sandy loam texture, 2.1% OM and 6.3 pH. Treatments were applied to the center 6.7 feet of the 10 by 40 foot plots with a backpack-type plot sprayer delivering 8.5 gpa at 40 psi through 11001 Turbo TeeJet nozzles. The experiment had a randomized complete block design with three replicates per treatment.

Reducing spray solution did not always have a positive effect. AMS did overcome hard water antagonism as did Hellfire adjuvant in several treatments. Hellfire reduces spray solution pH to ~2.

Table.Efficacy of Herbicides at Different pH in Hard Water. (Zollinger, Wirth, Kazmierczak)

			14 DAA				28 DAA			
Treatments	Rate		Flax	Amar	Snfl	Corn	Flax	Amar	Snfl	Corn
	(Product/A)	Hard water (ppm)	% control				% control			
POST										
RU PM	14.2fl oz	1018	40	50	52	53	40	72	60	78
RU PM (pH 4)	14.2fl oz	1018	33	67	58	63	60	82	68	85
RU PM+AMS	14.2fl oz+8.5lb/100gal	1018	55	82	67	77	67	90	74	87
RU PM+Hellfire	14.2fl oz+0.5% v/v	1018	55	77	60	60	74	87	78	79
RU PM+Quest	14.2fl oz+0.5% v/v	1018	33	75	57	72	43	88	70	88
HM2028	32fl oz	1018	25	73	63	65	32	85	67	88
HM2028(pH 4)	32fl oz	1018	28	70	67	83	33	85	72	94
HM2028+AMS	32fl oz+8.5lb/100gal	1018	43	80	67	82	57	90	75	93
HM2028+Hellfire	32fl oz+0.5% v/v	1018	25	63	55	70	32	73	58	88
HM2028+Quest	32fl oz+0.5% v/v	1018	25	68	60	55	27	67	60	77
Clarity	16fl oz	1018	22	50	52	0	23	52	50	10
Clarity (pH 4)	16fl oz	1018	53	50	50	0	55	50	45	3
Clarity+AMS	16fl oz+8.5lb/100gal	1018	23	47	50	0	22	57	50	2
Clarity+Hellfire	16fl oz+0.5% v/v	1018	52	50	47	0	61	57	47	12
Clarity+Quest	16fl oz+0.5% v/v	1018	27	37	43	0	28	37	43	8
Liberty	27.3fl oz	1018	83	67	77	50	85	50	83	55
Liberty (pH 4)	27.3fl oz	1018	73	73	73	58	78	67	72	58
Liberty+AMS	27.3fl oz+8.5lb/100gal	1018	97	82	77	53	96	67	75	53
Liberty+Hellfire	27.3fl oz+0.5% v/v	1018	83	72	82	62	90	67	87	70
Liberty+Quest	27.3fl oz+0.5% v/v	1018	75	67	73	50	88	50	87	62
LSD (0.05)			8	9	7	9	10	11	7	11

* RU PM= Roundup Powermax

Glyphosate and Dicamba with Different Adjuvants. Zollinger, Richard K., Angela J. Kazmierczak, and Devin A. Wirth. An experiment was conducted near Hillsboro, ND to evaluate the efficacy of glyphosate and dicamba with different adjuvants. Flax, amaranth, tame buckwheat, and canola were planted on June 11, 2013. POST treatments were applied on July 11, 2013 at 11:05 am with 86.3 F air, 76.3 F soil at a four inch depth, 43% relative humidity, 0% cloud cover, 8-10 mph SSW wind, dry soil moisture, good plant vigor, and no dew present. Plant height and density at time of application was 8-14" (5-15/ft^2) flax, 10-18" (10-20/yd^2) amaranth, 10-18" (10-20/yd^2) tame buckwheat, and 8-12" (15-25/yd^2) canola. Soil characteristics were: 68.5% sand, 18.3% silt, 13.2% clay, sandy loam texture, 2.1% OM and 6.3 pH. Treatments were applied to the center 6.7 feet of the 10 by 40 foot plots with a backpack-type plot sprayer delivering 10 gpa at 40 psi through 11001 Turbo TeeJet nozzles. The experiment had a randomized complete block design with three replicates per treatment.

Glyphosate and dicamba have activity on flax, amaranth, and buckwheat. Clarity has very little activity on canola which shows how glyphosate 'friendly' the emulsifier is in oil adjuvants.

Table. Glyphosate and Clarity with Different Adjuvants. (Zollinger, Wirth, Kazmierczak)

Treatments	Rate	14 DAA				28 DAA			
		Flax	Amar	Tabw	Canola	Flax	Amar	Tabw	Canola
	(Product/A)	% control				% control			
POST									
Touchdown HT+Clarity	7.2fl oz+3.2fl oz	22	52	53	33	22	53	60	50
Touchdown HT+Clarity+N Pak AMS	7.2fl oz+3.2fl oz+2.5% v/v	22	50	50	37	22	53	63	43
Touchdown HT+Clarity+Class Act NG	7.2fl oz+3.2fl oz+2.5% v/v	43	63	62	67	45	82	77	75
Touchdown HT+Clarity+Prime Oil+N Pak AMS	7.2fl oz+3.2fl oz+1% v/v+2.5% v/v	43	53	53	57	40	55	62	63
Touchdown HT+Clarity+Superb HC+Class Act NG	7.2fl oz+3.2fl oz+1pt+2.5% v/v	63	72	65	77	63	73	82	85
Touchdown HT+Clarity+Superb HC+AG8034	7.2fl oz+3.2fl oz+1pt+2% v/v	73	65	67	62	78	67	87	70
Touchdown HT+Clarity+Superb HC+AG8034+Interlock	7.2fl oz+3.2fl oz+1pt+2% v/v+4fl oz	65	60	70	65	63	60	82	75
Touchdown HT+Clarity+MSO+N Pak AMS	7.2fl oz+3.2fl oz+1% v/v+2.5% v/v	47	52	60	58	50	53	73	63
Touchdown HT+Clarity+Destiny HC+Class Act NG	7.2fl oz+3.2fl oz+1pt+2.5% v/v	60	80	70	73	60	88	87	85
Touchdown HT+Clarity+Destiny HC+AG8034	7.2fl oz+3.2fl oz+1pt+2% v/v	58	70	62	57	57	77	77	70
Touchdown HT+Clarity+AG11011	7.2fl oz+3.2fl oz+1% v/v	53	52	62	62	57	55	85	78
Touchdown HT+Clarity+Superb HC+AG13061	7.2fl oz+3.2fl oz+1pt+0.5% v/v	55	52	58	57	57	50	73	65
Touchdown HT+Clarity+Superb HC+AG13062	7.2fl oz+3.2fl oz+1pt+0.5% v/v	40	55	57	60	40	55	75	72
Touchdown HT+Clarity+Superb HC+AG13063	7.2fl oz+3.2fl oz+1pt+0.5% v/v	47	55	60	53	48	53	72	65
LSD (0.05)		6	8	9	8	7	6	7	8

Glyphosate and Select Max with Different Adjuvants. Zollinger, Richard K., Angela J. Kazmierczak, and Devin A. Wirth. An experiment was conducted near Hillsboro, ND to evaluate the efficacy of glyphosate and Select Max with different adjuvants. Flax, amaranth, quinoa, and tame buckwheat were planted on June 11, 2013. POST treatments were applied on July 16, 2013 at 11:25 am with 89 F air, 78.8 F soil at a four inch depth, 42% relative humidity, 15% cloud cover, 8-10 mph S wind, dry soil moisture, good plant vigor, and no dew present. Plant height and density at time of application was 10" (5-15/ft^2) flax, 8-18" (10-20/yd^2) amaranth, 18-24" (10-20/yd^2) quinoa, and 18-24" (10-20/yd^2) tame buckwheat. Soil characteristics were: 68.5% sand, 18.3% silt, 13.2% clay, sandy loam texture, 2.1% OM and 6.3 pH. Treatments were applied to the center 6.7 feet of the 10 by 40 foot plots with a backpack-type plot sprayer delivering 8.5 gpa at 40 psi through 11001 Turbo TeeJet nozzles. The experiment had a randomized complete block design with three replicates per treatment.

Flax and amaranth are key bioassay species because Select has no activity and will just show glyphosate activity and also show to what level the oil emulsifier is glyphosate 'friendly' or glyphosate 'antagonistic'. Foxtail millet is controlled by both glyt and Select. RR corn is controlled only by Select and will show the level of oil enhancement on a lipophilic herbicide.
Susceptibility:
Glyt = flax, amaranth, and foxtail millet
Select = foxtail millet, and RR corn

Table. Glyphosate and Select Max with Different Adjuvants. (Zollinger, Wirth, Kazmierczak)

Treatments	Rate	14 DAA				28 DAA			
	(Product/A)	Flax	Amar	Fomi	Corn	Flax	Amar	Fomi	Corn
		% control				% control			
POST									
Touchdown HT+Select Max	8fl oz+6fl oz	25	62	38	42	25	62	42	42
Touchdown HT+Select Max+Between	8fl oz+6fl oz+0.5% v/v	33	83	75	70	37	83	82	73
Touchdown HT+Select Max+Succeed	8fl oz+6fl oz+1% v/v	25	70	43	52	25	70	43	52
Touchdown HT+Select Max+Downdraft	8fl oz+6fl oz+6fl oz	22	62	72	60	22	62	73	60
Touchdown HT+Select Max+Translate	8fl oz+6fl oz+0.5% v/v	20	60	63	48	20	60	63	50
Touchdown HT+Select Max+Airforce	8fl oz+6fl oz+0.5% v/v	40	63	75	45	40	63	75	55
LSD (0.05)		5	4	7	7	5	4	7	7

Glyphosate and Clethodim with Different Rates of Adjuvants. Zollinger, Richard K., Angela J. Kazmierczak, and Devin A. Wirth. An experiment was conducted near Hillsboro, ND to evaluate the efficacy of glyphosate and clethodim with different rates of adjuvants. Flax, amaranth, foxtail millet, and RR corn were planted on June 11, 2013. POST treatments were applied on July 10, 2013 at 4:00 pm with 84 F air, 84.4 F soil at a four inch depth, 28% relative humidity, 25% cloud cover, 2-4 mph N wind, dry soil moisture, good plant vigor, and no dew present. Plant height and density at time of application was 8-12" (10-15/ft^2) flax, 12-18" (10-20/yd^2) amaranth, 12-18" (10-20/yd^2) foxtail millet, and 20-24" (15-25/yd^2) RR corn. Soil characteristics were: 68.5% sand, 18.3% silt, 13.2% clay, sandy loam texture, 2.1% OM and 6.3 pH. Treatments were applied to the center 6.7 feet of the 10 by 40 foot plots with a backpack-type plot sprayer delivering 10 gpa at 40 psi through 11001 Turbo TeeJet nozzles. The experiment had a randomized complete block design with three replicates per treatment.

The species were chosen to indicate herbicide activity by individual herbicides and combinations: Glyphosate has activity on flax, amaranth, and foxtail millet. Select has activity on foxtail millet and RR corn.

Table. Glyphosate and Clethodim with Different Rates of Adjuvants. (Zollinger, Wirth, Kazmierczak)

Treatments	Rate	14 DAA				28 DAA			
		Flax	Amar	Fomi	Corn	Flax	Amar	Fomi	Corn
	(Product/A)	% control				% control			
POST									
Touchdown HT+Select+R-11+AMS	9.7fl oz+6fl oz+1% v/v+8.5lb/100gal	92	92	99	50	93	88	99	67
Touchdown HT+Select+Prime Oil	9.7fl oz+6fl oz+2pt	22	68	92	73	22	69	92	77
Touchdown HT+Select+MSO	9.7fl oz+6fl oz+1.5pt	47	80	99	82	47	80	98	78
Touchdown HT+Select+Superb HC	9.7fl oz+6fl oz+0.25pt	45	58	92	47	43	62	99	62
Touchdown HT+Select+Superb HC	9.7fl oz+6fl oz+0.5pt	32	67	95	75	32	73	98	73
Touchdown HT+Select+Superb HC	9.7fl oz+6fl oz+1pt	30	66	96	45	30	63	96	50
Touchdown HT+Select+Superb HC	9.7fl oz+6fl oz+2pt	37	80	99	60	37	78	99	60
Touchdown HT+Select+Destiny HC	9.7fl oz+6fl oz+0.25pt	63	81	93	67	63	80	99	67
Touchdown HT+Select+Destiny HC	9.7fl oz+6fl oz+0.5pt	48	85	95	78	50	75	99	73
Touchdown HT+Select+Destiny HC	9.7fl oz+6fl oz+1pt	45	64	99	78	43	58	96	65
Touchdown HT+Select+Destiny HC	9.7fl oz+6fl oz+2pt	55	83	98	89	55	77	96	90
Touchdown HT+Select+CLNOV775	9.7fl oz+6fl oz+0.25pt	58	70	95	70	67	70	99	65
Touchdown HT+Select+CLNOV775	9.7fl oz+6fl oz+0.5pt	55	68	99	83	60	63	98	83
Touchdown HT+Select+CLNOV775	9.7fl oz+6fl oz+1pt	74	73	99	77	75	72	98	72
Touchdown HT+Select+CLNOV775	9.7fl oz+6fl oz+2pt	71	83	99	92	73	83	99	92
LSD (0.05)		8	8	2	9	7	6	4	12

Clethodim with Adjuvants. Zollinger, Richard K., Angela J. Kazmierczak, and Devin A. Wirth. An experiment was conducted near Hillsboro, ND to evaluate the efficacy of clethodim with different adjuvants. RR corn and foxtail millet were planted on June 11, 2013. POST treatments were applied on July 11, 2013 at 9:30 am with 86.3 F air, 76.3 F soil at a four inch depth, 43% relative humidity, 0% cloud cover, 8-10 mph SSW wind, dry soil moisture, good plant vigor, and no dew present. Plant height and density at time of application was 10-18" (15-25/ft^2) foxtail millet and 20-24" (15-25/yd^2) RR corn. Soil characteristics were: 68.5% sand, 18.3% silt, 13.2% clay, sandy loam texture, 2.1% OM and 6.3 pH. Treatments were applied to the center 6.7 feet of the 10 by 40 foot plots with a backpack-type plot sprayer delivering 8.5 gpa at 40 psi through 11001 Turbo TeeJet nozzles. The experiment had a randomized complete block design with three replicates per treatment.

Shadow 3 is a 3 lb/gal formulation of clethodim.

Table. Clethodim with Adjuvants. (Zollinger, Wirth, Kazmierczak)

		7 DAA		14 DAA		28 DAA	
Treatments	Rate	Fomi	Corn	Fomi	Corn	Fomi	Corn
	(Product/A)	% control		% control		% control	
POST							
Shadow+COC+AMS	3fl oz+1% v/v+0.75lb	23	33	37	50	40	68
Shadow 3+COC+AMS	2fl oz+1% v/v+0.75lb	20	30	32	52	48	62
Shadow+COC+AMS	6fl oz+1% v/v+0.75lb	20	30	53	67	55	82
Shadow 3+COC+AMS	4fl oz+1% v/v+0.75lb	20	30	60	65	63	79
Shadow 3+HCOC+AMS	4fl oz+0.5% v/v+0.75lb	20	30	65	77	72	91
Shadow 3+HCOC+AMS	4fl oz+1% v/v+0.75lb	20	30	63	74	65	90
Shadow 3+MSO+AMS	4fl oz+1% v/v+0.75lb	20	30	60	77	67	92
Shadow 3+NIS+AMS	4fl oz+0.5% v/v+0.75lb	33	43	63	70	67	68
Select Max+NIS+AMS	12fl oz+0.25% v/v+0.75lb	47	53	73	86	84	97
LSD (0.05)		10	9	6	10	7	8

Clethodim and Glyphosate with Adjuvants. Zollinger, Richard K., Angela J. Kazmierczak, and Devin A. Wirth. An experiment was conducted near Hillsboro, ND to evaluate the efficacy of clethodim and glyphosate with different adjuvants. Amaranth and RR corn were planted on June 11, 2013. POST treatments were applied on July 11, 2013 at 9:45 am with 86.3 F air, 76.3 F soil at a four inch depth, 43% relative humidity, 0% cloud cover, 8-10 mph SSW wind, dry soil moisture, good plant vigor, and no dew present. Plant height and density at time of application was 10-16" (15-25/ft^2) amaranth and 20-24" (15-25/yd^2) RR corn. Soil characteristics were: 68.5% sand, 18.3% silt, 13.2% clay, sandy loam texture, 2.1% OM and 6.3 pH. Treatments were applied to the center 6.7 feet of the 10 by 40 foot plots with a backpack-type plot sprayer delivering 8.5 gpa at 40 psi through 11001 Turbo TeeJet nozzles. The experiment had a randomized complete block design with three replicates per treatment.

Shadow 3 is a 3 lb/gal formulation of clethodim.

Table. Clethodim and Glyphosate with Adjuvants. (Zollinger, Wirth, Kazmierczak)

Treatments	Rate	7 DAA		14 DAA		28 DAA	
		Amar	Corn	Amar	Corn	Amar	Corn
	(Product/A)	% control		% control		% control	
POST							
Glyphosate+AMS	22fl oz+0.75lb	95	0	95	0	95	0
Glyphosate+AMS+Shadow+COC	22fl oz+0.75lb+6fl oz+1% v/v	92	40	93	73	93	70
Glyphosate+AMS+Shadow 3+COC	22fl oz+0.75lb+4fl oz+1% v/v	90	40	93	73	94	82
Glyphosate+AMS+Shadow 3+HCOC	22fl oz+0.75lb+4fl oz+0.5% v/v	97	30	97	82	97	90
Glyphosate+AMS+Shadow 3+HCOC	22fl oz+0.75lb+4fl oz+1% v/v	96	30	96	63	96	75
Glyphosate+AMS+Shadow 3	22fl oz+0.75lb+4fl oz	95	20	95	42	95	52
Glyphosate+AMS+Shadow 3+NIS	22fl oz+0.75lb+4fl oz+0.25% v/v	96	23	96	52	96	52
Glyphosate+AMS+Shadow 3+NIS	22fl oz+0.75lb+4fl oz+0.5% v/v	93	30	93	63	93	62
Glyphosate+AMS+Select Max+NIS	22fl oz+0.75lb+12fl oz+0.25% v/v	96	27	96	78	96	89
LSD (0.05)		5	5	5	8	4	7

Clethodim, Basagran, and Raptor with Adjuvants. Zollinger, Richard K., Angela J. Kazmierczak, and Devin A. Wirth. An experiment was conducted near Hillsboro, ND to evaluate the efficacy of clethodim, basagran and raptor with different adjuvants. Pinto beans, quinoa, and RR corn were planted on June 11, 2013. POST treatments were applied on July 11, 2013 at 10:00 am with 86.3 F air, 76.3 F soil at a four inch depth, 43% relative humidity, 0% cloud cover, 8-10 mph SSW wind, dry soil moisture, good plant vigor, and no dew present. Plant height and density at time of application was 6-10" (10-15/ft^2) pinto bean, 10-18" (10-20/yd^2) quinoa, and 18-24" (15-25/yd^2) RR corn. Soil characteristics were: 68.5% sand, 18.3% silt, 13.2% clay, sandy loam texture, 2.1% OM and 6.3 pH. Treatments were applied to the center 6.7 feet of the 10 by 40 foot plots with a backpack-type plot sprayer delivering 8.5 gpa at 40 psi through 11001 Turbo TeeJet nozzles. The experiment had a randomized complete block design with three replicates per treatment.

Shadow 3 is a 3 lb/gal formulation of clethodim. Pinto dry bean injury was stunting and necrosis. Basagran antagonized clethodim.

Table. Clethodim,Basagran, and Raptor with Adjuvants. (Zollinger, Wirth, Kazmierczak)

Treatments	Rate	7 DAA			14 DAA			28 DAA		
		Pinto	Quin	Corn	Pinto	Quin	Corn	Pinto	Quin	Corn
	(Product/A)	% control			% control			% control		
POST										
Shadow+COC+AMS	6fl oz+1% v/v+0.75lb	0	0	47	0	0	85	0	0	96
Shadow 3+COC+AMS	4fl oz+1% v/v+0.75lb	0	0	47	0	0	87	0	0	96
Shadow+Basagran+COC+AMS	6fl oz+24fl oz+1% v/v+0.75lb	28	75	28	22	82	35	22	82	50
Shadow 3+Basagran+COC+AMS	4fl oz+24fl oz+1% v/v+0.75lb	17	72	32	17	78	42	17	82	50
Shadow+Raptor+Basagran+COC+AMS	6fl oz+2fl oz+24fl oz+1% v/v+0.75lb	22	68	22	17	72	43	17	95	52
Shadow 3+Raptor+Basagran+COC+AMS	4fl oz+2fl oz+24fl oz+1% v/v+0.75lb	17	68	20	17	78	27	17	95	50
Basagran+Raptor+COC+AMS	32fl oz+4fl oz+1% v/v+0.75lb	18	73	20	17	92	25	17	98	40
LSD (0.05)		5	6	4	4	7	7	4	5	2

Glyphosate and Clethodim with Different Rates of Adjuvants. Zollinger, Richard K., Angela J. Kazmierczak, and Devin A. Wirth. An experiment was conducted near Hillsboro, ND to evaluate the efficacy of glyphosate and clethodim with different rates of adjuvants. Flax, amaranth, foxtail millet, and RR corn were planted on June 11, 2013. POST treatments were applied on July 11, 2013 at 10:20 am with 86.3 F air, 76.3 F soil at a four inch depth, 43% relative humidity, 0% cloud cover, 8-10 mph SSW wind, dry soil moisture, good plant vigor, and no dew present. Plant height and density at time of application was 6-12" (5-15/ft^2) flax, 8-16" (25-30/yd^2) amaranth, 12-18" (10-20/ft^2) foxtail millet, and 20-24" (15-25/yd^2) RR corn. Soil characteristics were: 68.5% sand, 18.3% silt, 13.2% clay, sandy loam texture, 2.1% OM and 6.3 pH. Treatments were applied to the center 6.7 feet of the 10 by 40 foot plots with a backpack-type plot sprayer delivering 8.5 gpa at 40 psi through 11001 Turbo TeeJet nozzles. The experiment had a randomized complete block design with three replicates per treatment.

Flax and amaranth are key bioassay species because Select has no activity and will just show glyphosate activity and also show to what level the oil emulsifier is glyphosate 'friendly' or glyphosate 'antagonistic'. Foxtail millet is controlled by both glyt and Select. RR corn is controlled only by Select and will show the level of oil enhancement on a lipophilic herbicide.
Susceptibility:
Glyt = flax, amaranth, and foxtail millet
Select = foxtail millet, and RR corn

Table. Glyphosate and Select with Different Rates of Adjuvants. (Zollinger, Wirth, Kazmierczak)

		14 DAA				28 DAA			
Treatments	Rate	Flax	Amar	Fomi	Corn	Flax	Amar	Fomi	Corn
	(Product/A)	% control				% control			
POST									
Touchdown HT+Select+R-11+AMS	7.2fl oz+6fl oz+1% v/v+8.5lb/100gal	75	88	99	57	82	89	99	48
Touchdown HT+Select+SuperSpread MSO	7.2fl oz+6fl oz+1pt	23	60	93	67	22	60	90	62
Touchdown HT+Select+DRX 101	7.2fl oz+6fl oz+1pt	23	63	92	63	23	55	92	53
Touchdown HT+Select+Superb HC	7.2fl oz+6fl oz+1pt	43	80	95	63	40	75	98	63
Touchdown HT+Select+Destiny HC	7.2fl oz+6fl oz+1pt	37	82	95	67	45	77	96	68
Touchdown HT+Select+CLNOV775	7.2fl oz+6fl oz+1pt	62	78	99	67	62	83	99	68
Touchdown HT+Select+DRX 102	7.2fl oz+6fl oz+0.5pt	28	63	95	55	27	60	95	55
Touchdown HT+Select+DRX 102	7.2fl oz+6fl oz+1pt	35	60	87	55	35	57	90	50
Touchdown HT+Select+MLR-1	7.2fl oz+6fl oz+5pt	37	80	96	62	40	81	98	60
Touchdown HT+Select+MLR-1	7.2fl oz+6fl oz+1pt	43	67	95	58	45	74	95	60
Touchdown HT+Select+MLR-3	7.2fl oz+6fl oz+0.5pt	43	73	98	63	45	75	98	57
Touchdown HT+Select+MLR-3	7.2fl oz+6fl oz+1pt	50	70	96	62	58	72	96	65
Touchdown HT+Select+Duce	7.2fl oz+6fl oz+1pt	40	65	90	68	50	67	95	78
Touchdown HT+Select+Kixyt	7.2fl oz+6fl oz+1pt	47	85	88	73	52	83	98	73
Touchdown HT+Select+Savvy	7.2fl oz+6fl oz+1pt	40	53	95	68	48	57	95	70
Touchdown HT+Select+SURFOM 8874	7.2fl oz+6fl oz+1pt	47	77	92	78	48	73	95	75
Touchdown HT+Select+UAD-1315	7.2fl oz+6fl oz+1pt	0	0	0	0	0	0	0	0
Touchdown HT+Select+UAD-1348	7.2fl oz+6fl oz+1pt	33	72	95	68	32	72	95	78
LSD (0.05)		7	10	4	9	8	11	2	10

Glyphosate and Clarity with Different Rates of Adjuvants. Zollinger, Richard K., Angela J. Kazmierczak, and Devin A. Wirth. An experiment was conducted near Hillsboro, ND to evaluate the efficacy of glyphosate and clarity with different rates of adjuvants. Flax, amaranth, tame buckwheat, and canola were planted on June 11, 2013. POST treatments were applied on July 11, 2013 at 11:25 am with 86.3 F air, 76.3 F soil at a four inch depth, 43% relative humidity, 0% cloud cover, 8-10 mph SSW wind, dry soil moisture, good plant vigor, and no dew present. Plant height and density at time of application was 10-14" (10-15/ft^2) flax, 8-18" (5-15/yd^2) amaranth, 10-18" (10-20/yd^2) tame buckwheat, and 8-12" (15-25/yd^2) canola. Soil characteristics were: 68.5% sand, 18.3% silt, 13.2% clay, sandy loam texture, 2.1% OM and 6.3 pH. Treatments were applied to the center 6.7 feet of the 10 by 40 foot plots with a backpack-type plot sprayer delivering 8.5 gpa at 40 psi through 11001 Turbo TeeJet nozzles. The experiment had a randomized complete block design with three replicates per treatment.

Glyphosate and dicamba have activity on flax, amaranth, and buckwheat. Clarity has very little activity on canola which shows how glyphosate 'friendly' the emulsifier is in oil adjuvants.

Table. Glyphosate and Clarity with Different Rates of Adjuvants. (Zollinger, Wirth, Kazmierczak)

		14 DAA				28 DAA			
Treatments	Rate	Flax	Amar	Tabw	Canola	Flax	Amar	Tabw	Canola
	(Product/A)	% control				% control			
POST									
Touchdown HT+Clarity+R-11+AMS	7.2fl oz+4fl oz+1% v/v+8.5lb/100gal	32	32	40	35	32	35	43	27
Touchdown HT+Clarity+SuperSpread MSO	7.2fl oz+4fl oz+1pt	43	47	48	45	43	48	48	35
Touchdown HT+Clarity+DRX 101	7.2fl oz+4fl oz+1pt	35	47	62	50	33	45	62	37
Touchdown HT+Clarity+Superb HC	7.2fl oz+4fl oz+1pt	18	33	40	27	20	42	42	18
Touchdown HT+Clarity+Destiny HC	7.2fl oz+4fl oz+1pt	22	37	45	23	20	35	42	18
Touchdown HT+Clarity+CLNOV775	7.2fl oz+4fl oz+1pt	50	40	38	32	52	45	40	22
Touchdown HT+Clarity+DRX 102	7.2fl oz+4fl oz+0.5pt	22	33	37	32	22	35	43	25
Touchdown HT+Clarity+DRX 102	7.2fl oz+4fl oz+1pt	47	43	60	33	42	52	58	27
Touchdown HT+Clarity+MLR-1	7.2fl oz+4fl oz+5pt	28	32	45	38	28	32	50	37
Touchdown HT+Clarity+MLR-1	7.2fl oz+4fl oz+1pt	27	33	47	35	28	33	55	33
Touchdown HT+Clarity+MLR-3	7.2fl oz+4fl oz+0.5pt	30	35	43	38	30	35	60	35
Touchdown HT+Clarity+MLR-3	7.2fl oz+4fl oz+1pt	37	33	47	37	40	40	53	32
Touchdown HT+Clarity+Duce	7.2fl oz+4fl oz+1pt	53	65	77	62	53	78	78	78
Touchdown HT+Clarity+Kixyt	7.2fl oz+4fl oz+1pt	60	63	85	70	63	63	85	77
Touchdown HT+Clarity+Savvy	7.2fl oz+4fl oz+1pt	20	23	38	37	22	23	40	25
Touchdown HT+Clarity+SURFOM 8874	7.2fl oz+4fl oz+1pt	35	42	57	35	35	48	58	33
Touchdown HT+Clarity+UAD-1315	7.2fl oz+4fl oz+1pt	32	37	52	43	30	43	53	32
Touchdown HT+Clarity+UAD-1348	7.2fl oz+4fl oz+1pt	32	30	42	27	32	30	52	23
LSD (0.05)		7	6	8	8	6	5	12	8

Glyphosate and Saflufenacil with Different Rates of Adjuvants. Zollinger, Richard K., Angela J. Kazmierczak, and Devin A. Wirth. An experiment was conducted near Hillsboro, ND to evaluate the efficacy of glyphosate and saflufenacil with different rates of adjuvants. Flax, amaranth, quinoa, and tame buckwheat were planted on June 11, 2013. POST treatments were applied on July 11, 2013 at 11:45 am with 86.3 F air, 76.3 F soil at a four inch depth, 43% relative humidity, 0% cloud cover, 8-10 mph SSW wind, dry soil moisture, good plant vigor, and no dew present. Plant height and density at time of application was 6-12" (10-15/ft^2) flax, 10-14" (10-20/yd^2) amaranth, 10-14" (10-20/yd^2) quinoa, 8-12" (1-10/yd^2) tame buckwheat, and 8-14" (1-15/yd^2) redroot pigweed. Soil characteristics were: 68.5% sand, 18.3% silt, 13.2% clay, sandy loam texture, 2.1% OM and 6.3 pH. Treatments were applied to the center 6.7 feet of the 10 by 40 foot plots with a backpack-type plot sprayer delivering 8.5 gpa at 40 psi through 11001 Turbo TeeJet nozzles. The experiment had a randomized complete block design with three replicates per treatment.

Both glyphosate and Sharpen have activity on all species used. Oil adjuvant antagonism occurred with some treatments.

Table. Glyphosate and Sharpen with Different Rates of Adjuvants. (Zollinger, Wirth, Kazmierczak)

		14 DAA				28 DAA			
Treatments	Rate	Flax	Amar	Quin	Tabw	Flax	Amar	Quin	Tabw
	(Product/A)	% control				% control			
POST									
Touchdown HT+Sharpen+R-11+AMS	7.2fl oz+1fl oz+1% v/v+8.5lb/100gal	60	73	73	75	67	81	83	88
Touchdown HT+Sharpen+SuperSpread MSO	7.2fl oz+1fl oz+1pt	42	57	52	53	38	48	57	65
Touchdown HT+Sharpen+DRX 101	7.2fl oz+1fl oz+1pt	65	86	88	88	53	70	82	90
Touchdown HT+Sharpen+Superb HC	7.2fl oz+1fl oz+1pt	30	45	45	43	30	47	57	70
Touchdown HT+Sharpen+Destiny HC	7.2fl oz+1fl oz+1pt	50	93	87	92	47	76	92	99
Touchdown HT+Sharpen+CLNOV775	7.2fl oz+1fl oz+1pt	53	75	65	65	65	87	82	98
Touchdown HT+Sharpen+DRX 102	7.2fl oz+1fl oz+0.5pt	52	69	66	83	47	50	53	85
Touchdown HT+Sharpen+DRX 102	7.2fl oz+1fl oz+1pt	60	78	68	73	38	60	55	78
Touchdown HT+Sharpen+MLR-1	7.2fl oz+1fl oz+5pt	52	72	68	82	48	58	62	78
Touchdown HT+Sharpen+MLR-1	7.2fl oz+1fl oz+1pt	63	92	82	91	62	65	67	85
Touchdown HT+Sharpen+MLR-3	7.2fl oz+1fl oz+0.5pt	52	65	92	89	60	67	93	95
Touchdown HT+Sharpen+MLR-3	7.2fl oz+1fl oz+1pt	75	94	92	94	65	85	93	98
Touchdown HT+Sharpen+Duce	7.2fl oz+1fl oz+1pt	52	95	72	95	52	85	80	97
Touchdown HT+Sharpen+Kixyt	7.2fl oz+1fl oz+1pt	65	82	68	83	65	77	72	90
Touchdown HT+Sharpen+Savvy	7.2fl oz+1fl oz+1pt	55	82	78	83	60	93	89	99
Touchdown HT+Sharpen+SURFOM 8874	7.2fl oz+1fl oz+1pt	63	96	92	96	50	92	89	96
Touchdown HT+Sharpen+UAD-1315	7.2fl oz+1fl oz+1pt	0	0	0	0	0	0	0	0
Touchdown HT+Sharpen+UAD-1348	7.2fl oz+1fl oz+1pt	70	96	95	97	70	93	92	98
LSD (0.05)		8	7	7	8	12	12	10	9

Glyphosate and tembotrione with Different Rates of Adjuvants. Zollinger, Richard K., Angela J. Kazmierczak, and Devin A. Wirth. An experiment was conducted near Hillsboro, ND to evaluate the efficacy of glyphosate and tembotrione with different rates of adjuvants. Flax, amaranth, foxtail millet, and RR soybean were planted on June 11, 2013. POST treatments were applied on July 11, 2013 at 10:45 am with 86.3 F air, 76.3 F soil at a four inch depth, 43% relative humidity, 0% cloud cover, 8-10 mph SSW wind, dry soil moisture, good plant vigor, and no dew present. Plant height and density at time of application was 6-12" (5-15/ft^2) flax, 8-16" (25-30/yd^2) amaranth, 12-18" (10-20/ft^2) foxtail millet, and 8-12" (5-20/yd^2) RR soybean. Soil characteristics were: 68.5% sand, 18.3% silt, 13.2% clay, sandy loam texture, 2.1% OM and 6.3 pH. Treatments were applied to the center 6.7 feet of the 10 by 40 foot plots with a backpack-type plot sprayer delivering 8.5 gpa at 40 psi through 11001 Turbo TeeJet nozzles. The experiment had a randomized complete block design with three replicates per treatment.

Flax is a key bioassay species because Laudis has no activity and will just show glyphosate activity and also show to what level the oil emulsifier is glyphosate 'friendly' or glyphosate 'antagonistic'. Amaranth and foxtail millet are controlled by both glyt and Laudis. RR soy is controlled only by Laudis and will show level of oil adjuvant enhancement on a lipophilic herbicide.
Glyphosate has activity on: flax, amaranth, and foxtail milllet
Laudis has activity on: amaranth, foxtail millet, and RR soybean

Table. Glyphosate and Laudis with Different Rates of Adjuvants. (Zollinger, Wirth, Kazmierczak)

Treatments	Rate	14 DAA				28 DAA			
	(Product/A)	Flax	Amar	Fomi	Soy	Flax	Amar	Fomi	Soy
		% control				% control			
POST									
Touchdown HT+Laudis+R-11+AMS	7.2fl oz+1.5fl oz+1% v/v+8.5lb/100gal	68	95	99	18	67	92	99	20
Touchdown HT+Laudis+SuperSpread MSO	7.2fl oz+1.5fl oz+1pt	22	55	80	48	20	55	83	35
Touchdown HT+Laudis+DRX 101	7.2fl oz+1.5fl oz+1pt	18	48	78	43	23	48	85	38
Touchdown HT+Laudis+Superb HC	7.2fl oz+1.5fl oz+1pt	22	70	95	45	28	70	95	40
Touchdown HT+Laudis+Destiny HC	7.2fl oz+1.5fl oz+1pt	23	63	95	38	27	65	95	42
Touchdown HT+Laudis+CLNOV775	7.2fl oz+1.5fl oz+1pt	48	67	92	47	53	73	95	67
Touchdown HT+Laudis+DRX 102	7.2fl oz+1.5fl oz+0.5pt	18	58	90	40	18	58	90	40
Touchdown HT+Laudis+DRX 102	7.2fl oz+1.5fl oz+1pt	22	47	88	35	22	50	90	35
Touchdown HT+Laudis+MLR-1	7.2fl oz+1.5fl oz+5pt	27	65	94	43	27	63	94	38
Touchdown HT+Laudis+MLR-1	7.2fl oz+1.5fl oz+1pt	27	60	93	53	30	60	93	53
Touchdown HT+Laudis+MLR-3	7.2fl oz+1.5fl oz+0.5pt	28	65	92	47	32	63	94	48
Touchdown HT+Laudis+MLR-3	7.2fl oz+1.5fl oz+1pt	45	88	97	35	52	86	97	47
Touchdown HT+Laudis+Duce	7.2fl oz+1.5fl oz+1pt	38	79	95	53	35	71	95	53
Touchdown HT+Laudis+Kixyt	7.2fl oz+1.5fl oz+1pt	40	75	93	48	35	65	95	45
Touchdown HT+Laudis+Savvy	7.2fl oz+1.5fl oz+1pt	35	55	92	38	35	52	92	47
Touchdown HT+Laudis+SURFOM 8874	7.2fl oz+1.5fl oz+1pt	37	82	95	47	38	82	95	55
Touchdown HT+Laudis+UAD-1315	7.2fl oz+1.5fl oz+1pt	43	78	96	48	40	73	96	47
Touchdown HT+Laudis+UAD-1348	7.2fl oz+1.5fl oz+1pt	30	63	90	48	37	63	93	52
LSD (0.05)		6	7	3	9	7	6	3	10

Experimental Adjuvants with Herbicides. Zollinger, Richard K., Angela J. Kazmierczak, and Devin A. Wirth. An experiment was conducted near Hillsboro, ND to evaluate the efficacy of Touchdown HT and Laudis with different adjuvants. Flax, amaranth, foxtail millet, and soybeans were planted on June 11, 2013. POST treatments were applied on July 11, 2013 at 10:45 am with 86.3 F air, 76.3 F soil at a four inch depth, 43% relative humidity, 0% cloud cover, 8-10 mph SSW wind, dry soil moisture, good plant vigor, and no dew present. 68.5% sand, 18.3% silt, 13.2% clay, sandy loam texture, 2.1% OM and 6.3 pH. Plant height and density at time of application was 6 to 12 inch (15 to 20/ft^2) flax, 8 to 16 inch (25 to 30/yd^2) amaranth, 12 to 18 inch (10 to 20 yd^2) foxtail millet, and 8 to 12 inch (5 to 20/ft^2) RR soybean. Treatments were applied to the center 6.7 feet of the 10 by 40 foot plots with a backpack-type plot sprayer delivering 8.5 gpa at 40 psi through 11001 Turbo TeeJet nozzles. The experiment had a randomized complete block design with three replicates per treatment.

Flax has tolerance to Laudis. RR soybean was planted.

Table. Experimental Adjuvants with Herbicides. (Zollinger, Wirth, Kazmierczak)

		14 DAA				28 DAA			
Treatments	Rate	Flax	Amar	Fomi	Soy	Flax	Amar	Fomi	Soy
	(Product/A)	% control				% control			
POST									
Touchdown HT+R-11	9.7fl oz+1% v/v	74	83	99	0	75	83	98	0
Touchdown HT+R-11+AMS	9.7fl oz+1% v/v+8.5lb/100gal	93	93	99	0	92	92	96	0
Touchdown HT+CSGN2	9.7fl oz+0.1pt	62	93	99	0	65	93	96	0
Touchdown HT+CSGN2	9.7fl oz+0.3pt	65	88	99	0	70	88	98	0
Laudis+R-11+AMS	2fl oz+1% v/v+8.5lb/100gal	35	33	30	57	35	52	23	73
Laudis+CLNOV775+AMS	2fl oz+0.3pt+8.5lb/100gal	0	40	23	63	0	48	20	70
Laudis+FOP61US+AMS	2fl oz+0.25% v/v+8.5lb/100gal	0	48	27	55	0	52	17	68
Laudis+FOP0960+AMS	2fl oz+0.15% v/v+8.5lb/100gal	20	60	33	58	20	60	22	67
Laudis+CSGN2	2fl oz+0.1pt	0	25	13	47	0	28	10	22
Laudis+CSGN2	2fl oz+0.3pt	0	27	15	48	0	27	10	23
Laudis+CSGN2	2fl oz+1pt	0	28	12	48	0	32	10	20
Laudis+CSGN2+CLNOV775	2fl oz+0.3pt+0.1pt	0	35	20	57	0	38	10	65
Laudis+CSGN2+CLNOV775	2fl oz+0.3pt+0.3pt	0	38	30	62	0	50	17	77
LSD (0.05)		4	8	7	5	4	7	6	11

Experimental Adjuvants with Herbicides. Zollinger, Richard K., Angela J. Kazmierczak, and Devin A. Wirth. An experiment was conducted near Hillsboro, ND to evaluate the efficacy of Touchdown HT and Callisto with different adjuvants. Flax, amaranth, foxtail millet, and soybeans were planted on June 11, 2013. POST treatments were applied on July 11, 2013 at 10:45 am with 86.3 F air, 76.3 F soil at a four inch depth, 43% relative humidity, 0% cloud cover, 8-10 mph SSW wind, dry soil moisture, good plant vigor, and no dew present. 68.5% sand, 18.3% silt, 13.2% clay, sandy loam texture, 2.1% OM and 6.3 pH. Plant height and density at time of application was 6 to 12 inch (15 to 20/ft^2) flax, 8 to 16 inch (25 to 30/yd^2) amaranth, 12 to 18 inch (10 to 20 yd^2) foxtail millet, and 8 to 12 inch (5 to 20/ft^2) RR soybean. Treatments were applied to the center 6.7 feet of the 10 by 40 foot plots with a backpack-type plot sprayer delivering 8.5 gpa at 40 psi through 11001 Turbo TeeJet nozzles. The experiment had a randomized complete block design with three replicates per treatment.

Flax has tolerance to Callisto. RR soybean was planted.

Table. Experimental Adjuvants with Herbicides 2. (Zollinger, Wirth, Kazmierczak)

		14 DAA				28 DAA			
Treatments	Rate	Flax	Amar	Fomi	Soy	Flax	Amar	Fomi	Soy
	(Product/A)	% control				% control			
POST									
Touchdown HT+R-11	9.7fl oz+1% v/v	74	83	99	0	75	83	98	0
Touchdown HT+R-11+AMS	9.7fl oz+1% v/v+8.5lb/100gal	93	93	99	0	92	92	96	0
Touchdown HT+CSGN2	9.7fl oz+0.1pt	62	93	99	0	65	93	96	0
Touchdown HT+CSGN2	9.7fl oz+0.3pt	65	88	99	0	70	88	98	0
Callisto+R-11+AMS	2fl oz+1% v/v+8.5lb/100gal	35	33	30	57	35	52	23	73
Callisto+CLNOV775+AMS	2fl oz+0.3pt+8.5lb/100gal	0	40	23	63	0	48	20	70
Callisto+FOP61US+AMS	2fl oz+0.25% v/v+8.5lb/100gal	0	48	27	55	0	52	17	68
Callisto+FOP0960+AMS	2fl oz+0.15% v/v+8.5lb/100gal	20	60	33	58	20	60	22	67
Callisto+CSGN2	2fl oz+0.1pt	0	25	13	47	0	28	10	22
Callisto+CSGN2	2fl oz+0.3pt	0	27	15	48	0	27	10	23
Callisto+CSGN2	2fl oz+1pt	0	28	12	48	0	32	10	20
Callisto+CSGN2+CLNOV775	2fl oz+0.3pt+0.1pt	0	35	20	57	0	38	10	65
Callisto+CSGN2+CLNOV775	2fl oz+0.3pt+0.3pt	0	38	30	62	0	50	17	77
LSD (0.05)		2	8	7	3	3	10	7	5

Glyphosate and Tembotrione with Different Rates of Adjuvants 2. Zollinger, Richard K., Angela J. Kazmierczak, and Devin A. Wirth. An experiment was conducted near Hillsboro, ND to evaluate the efficacy of glyphosate and tembotrione with different rates of adjuvants. Flax, amaranth, foxtail millet, and RR soybean were planted on June 11, 2013. POST treatments were applied on July 10, 2013 at 4:00 pm with 84 F air, 84.4 F soil at a four inch depth, 28% relative humidity, 25% cloud cover, 2-4 mph N wind, dry soil moisture, good plant vigor, and no dew present. Plant height and density at time of application was 6-12" (5-15/ft^2) flax, 8-16" (15-30/yd^2) amaranth, 12-18" (10-20/ft^2) foxtail millet, and 8-12" (5-20/yd^2) RR soy. Soil characteristics were: 68.5% sand, 18.3% silt, 13.2% clay, sandy loam texture, 2.1% OM and 6.3 pH. Treatments were applied to the center 6.7 feet of the 10 by 40 foot plots with a backpack-type plot sprayer delivering 10 gpa at 40 psi through 11001 Turbo TeeJet nozzles. The experiment had a randomized complete block design with three replicates per treatment.

The species were chosen to indicate herbicide activity by individual herbicides and combinations: Glyphosate has activity on flax, amaranth, and foxtail millet. Laudis has activity on amaranth, foxtail millet and RR soybean. CLNOV775 has more activity at lower use rates than other adjuvants used in this study.

Table. Glyphosate and Tembotrione with Different Rates of Adjuvants. (Zollinger, Wirth, Kazmierczak)

		14 DAA				28 DAA			
Treatments	Rate	Flax	Amar	Fomi	Soy	Flax	Amar	Fomi	Soy
	(Product/A)	% control				% control			
POST									
Touchdown HT+R-11+AMS	9.7fl oz+1% v/v+8.5lb/100gal	88	87	99	13	95	93	95	0
Touchdown HT+Laudis+Prime Oil	9.7fl oz+1.5fl oz+2pt	23	63	98	62	27	60	90	60
Touchdown HT+Laudis+MSO	9.7fl oz+1.5fl oz+1.5pt	37	68	98	68	40	67	96	88
Touchdown HT+Laudis+Superb HC	9.7fl oz+1.5fl oz+0.25pt	25	77	99	50	30	82	98	45
Touchdown HT+Laudis+Superb HC	9.7fl oz+1.5fl oz+0.5pt	25	75	99	57	28	83	99	50
Touchdown HT+Laudis+Superb HC	9.7fl oz+1.5fl oz+1pt	32	68	98	52	42	73	98	47
Touchdown HT+Laudis+Superb HC	9.7fl oz+1.5fl oz+2pt	35	70	99	62	47	81	93	68
Touchdown HT+Laudis+Destiny HC	9.7fl oz+1.5fl oz+0.25pt	40	78	99	58	47	78	98	63
Touchdown HT+Laudis+Destiny HC	9.7fl oz+1.5fl oz+0.5pt	32	75	99	60	42	77	98	63
Touchdown HT+Laudis+Destiny HC	9.7fl oz+1.5fl oz+1pt	45	76	99	63	74	81	96	77
Touchdown HT+Laudis+Destiny HC	9.7fl oz+1.5fl oz+2pt	68	84	99	69	76	86	96	87
Touchdown HT+Laudis+CLNOV775	9.7fl oz+1.5fl oz+0.25pt	62	75	99	67	76	77	98	60
Touchdown HT+Laudis+CLNOV775	9.7fl oz+1.5fl oz+0.5pt	72	82	99	70	81	78	93	83
Touchdown HT+Laudis+CLNOV775	9.7fl oz+1.5fl oz+1pt	78	78	99	72	84	81	96	68
Touchdown HT+Laudis+CLNOV775	9.7fl oz+1.5fl oz+2pt	79	92	99	77	89	93	99	95
LSD (0.05)		7	7	2	9	6	6	4	10

Spray droplet size and nonselective grass. Howatt, Roach, and Harrington. Hard red spring wheat was seeded May 14 near Fargo. Treatments were applied to 5 leaf wheat and 3 leaf yellow foxtail on June 19 with 81° F, 47% relative humidity, clear sky, 7 to 9 mph wind at 150°, and dry soil at 65° F. Treatments were applied with a sprayer mounted on a 4X4 all terrain vehicle delivering 10 gpa through XR11003; XR11004;AIXR11004; AI11004; and TTI11004 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	Spray	7/3 Wht	7/3 Yeft	7/22 Wht	7/22 Yeft
	oz/A		%	%	%	%
Immx+NIS+UAN	0.5+0.25%+32	F	85	80	99	78
Immx+NIS+UAN+Inter	0.5+0.25%+32+4	F	85	80	99	79
Immx+NIS+UAN	0.5+0.25%+32	M	85	80	99	83
Immx+NIS+UAN+Inter	0.5+0.25%+32+4	M	85	80	99	80
Immx+NIS+UAN	0.5+0.25%+32	C	85	80	99	81
Immx+NIS+UAN+Inter	0.5+0.25%+32+4	C	85	80	99	81
Immx+NIS+UAN	0.5+0.25%+32	XC	85	80	99	80
Immx+NIS+UAN+Inter	0.5+0.25%+32+4	XC	85	80	99	78
Immx+NIS+UAN	0.5+0.25%+32	UC	85	80	99	81
Immx+NIS+UAN+Inter	0.5+0.25%+32+4	UC	85	80	99	79
Clet[a]+NIS	1+0.25%	F	85	70	99	78
Clet+NIS+Interlock	1+0.25%+4	F	85	70	99	80
Clet+NIS	1+0.25%	M	85	70	99	79
Clet+NIS+Interlock	1+0.25%+4	M	85	70	99	80
Clet+NIS	1+0.25%	C	85	70	99	79
Clet+NIS+Interlock	1+0.25%+4	C	85	70	99	79
Clet+NIS	1+0.25%	XC	85	70	99	79
Clet+NIS+Interlock	1+0.25%+4	XC	85	70	99	79
Clet+NIS	1+0.25%	UC	85	70	99	79
Clet+NIS+Interlock	1+0.25%+4	UC	85	70	99	78
CV			0	0	0	5
LSD 5%			0	0	0	5

[a] The formulation of clethodim was Select Max from Valent Corp.

Plants were larger than desired at application because of persistent precipitation and saturated soil condition that prevented earlier application and reoccurred after treatments were applied. This has not been good environment for imazamox efficacy in other trials and even seemed to be detrimental to clethodim activity. Imazamox provided better yellow foxtail control than clethodim on July 3, but herbicides gave similar control of wheat and yellow foxtail on July 22. Efficacy of these herbicides was not affected by droplet size of herbicide spray or addition of Interlock. Control of grasses has been less affected by spray droplet size than broadleaf control in previous research.

Spray droplet size and selective grass. Dr. K. Howatt, R. Roach, and J. Harrington. Hard red spring wheat was seeded May 14 near Fargo. Treatments were applied to 5 leaf wheat and 3 leaf yellow foxtail on June 19 with 75° F, 64% relative humidity, 20% cloud cover, 7 to 9 mph wind at 150°, and dry soil at 65° F. Treatments were applied with a sprayer mounted on a 4X4 all terrain vehicle delivering 10 gpa with XR11003; XR11004; AIXR11004; AI11004; and TTI11004 nozzles to a 6 foot wide area the length of 10 by 30 foot plots. The experiment was a randomized complete block design with four replicates.

Treatment	Rate	Spray	7/3 Yeft	7/22 Yeft
	oz/A		%	%
Fenx	0.8	Fine	90	87
Fenx+Interlock	0.8+4	Fine	90	86
Fenx	0.8	Medium	90	86
Fenx+Interlock	0.8+4	Medium	90	89
Fenx	0.8	Coarse	90	84
Fenx+Interlock	0.8+4	Coarse	90	85
Fenx	0.8	Extra coarse	90	87
Fenx+Interlock	0.8+4	Extra coarse	90	85
Fenx	0.8	Ultra coarse	90	87
Fenx+Interlock	0.8+4	Ultra coarse	90	86
Flcz&Flox	2	Fine	60	53
Flcz&Flox+Interlock	2+4	Fine	60	53
Flcz&Flox	2	Medium	60	50
Flcz&Flox+Interlock	2+4	Medium	60	58
Flcz&Flox	2	Coarse	60	58
Flcz&Flox+Interlock	2+4	Coarse	60	48
Flcz&Flox	2	Extra coarse	60	48
Flcz&Flox+Interlock	2+4	Extra coarse	60	53
Flcz&Flox	2	Ultra coarse	60	45
Flcz&Flox+Interlock	2+4	Ultra coarse	60	48
CV			0	7
LSD 5%			0	6

Plants were larger than desired at application because of persistent precipitation and saturated soil condition that prevented earlier application and reoccurred after treatments were applied. This has not been good environment for flucarbazone efficacy in other trials and even seemed to be detrimental to fenoxaprop activity. Fenoxaprop gave better control of yellow foxtail than flucarbazone. This was expected because of intrinsic differences of the chemicals and the influence of the weather. Yellow foxtail control with fenoxaprop was not affected by spray droplet size or addition of Interlock. Averaged across Interlock addition, flucarbazone applied in coarse droplet spectrum or smaller tended to give better control than spray equipment set to give larger droplet sizes. Addition of Interlock did not provide consistent benefit for flucarbazone control of yellow foxtail but tended to help when larger droplet sizes were the target.

Spray droplet size and PGR. Howatt, Roach, and Harrington. Treatments were applied using various nozzles to achieve (F)ine (XR11003), (M)edium (XR1104), (C)oarse (AIXR1104), (XC) extra coarse(AI1104), and (UC) ultra coarse (TTI11004) spray droplets. Quinoa, amaranth, flax and tame buckwheat were seeded on July 11. Treatments were applied to quinoa, amaranth, flax, and tame buckwheat that were 4 to 6 inches tall on July 30 with 72°F, 90% cloud-cover, 2 mph wind at 315°, and dry soil at 65°F. Treatments were applied with a sprayer mounted on a 4X4 all-terrain vehicle delivering 10 gpa at 35 psi through the various 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	Spray	8-4 Quinoa	8-4 Amar	8-4 Flax	8-4 Tabw	8-28 Quinoa	8-28 Amar	8-28 Flax	8-28 Tabw
	oz/A		%	%	%	%	%	%	%	%
Dicamba	2	F	53	53	18	58	87	83	38	81
Dicamba+Interlock	2+4	F	64	53	38	53	94	83	53	80
Dicamba	2	M	73	69	33	64	94	89	45	86
Dicamba+Interlock	2+4	M	75	65	40	61	94	86	56	85
Dicamba	2	C	58	55	18	61	89	84	33	85
Dicamba+Interlock	2+4	C	70	60	40	63	94	90	59	85
Dicamba	2	XC	43	48	13	53	79	79	28	81
Dicamba+Interlock	2+4	XC	58	55	45	56	89	83	58	83
Dicamba	2	UC	48	53	13	55	89	83	28	61
Dicamba+Interlock	2+4	UC	53	45	40	55	93	85	63	85
2,4-D acid	8	F	93	93	70	78	99	99	73	97
2,4-D acid+Interlock	8+4	F	81	83	56	71	99	96	74	94
2,4-D acid	8	M	91	91	66	79	99	99	81	98
2,4-D acid+Interlock	8+4	M	93	94	75	81	99	99	83	98
2,4-D acid	8	C	93	94	71	79	99	99	85	98
2,4-D acid+Interlock	8+4	C	94	94	71	78	99	99	84	97
2,4-D acid	8	XC	94	90	69	78	99	99	85	98
2,4-D acid+Interlock	8+4	XC	93	90	65	70	99	99	83	97
2,4-D acid	8	UC	90	88	65	73	98	98	81	96
2,4-D acid+Interlock	8+4	UC	93	90	64	76	99	98	84	97
CV			15	14	22	10	3	5	18	11
LSD 5%			16	14	15	10	5	6	16	14

Plants were allowed to get taller than preferred for complete weed control to emphasize differences among treatments under adverse conditions. 2,4-D generally gave more control of the species included than dicamba. Response to treatments seemed to be affected by slight differences in plant size at application and resulted in relatively large LSDs for most evaluations. Medium and course spray droplet spectra tended to result in greater weed control with both herbicides than smaller or larger droplet sizes. This trend was strongest with evaluation of dicamba efficacy 5 DAT. Interlock influence was inconsistent except with dicamba on flax. Flax control with dicamba was improved with addition of interlock, especially at the larger droplet spectra.