Tan Section: Adjuvant and Application Technology Page

Adjuvants for Flucarbazone 2.0 control of Yellow Foxtail. Dr. Howatt, Mettler, and Harrington. 'Glenn' hard red spring wheat was seeded near Fargo on May 6. Treatments were applied to 4 to 5 leaf wheat and 2 to 3 leaf yellow foxtail on June 16 with 88°F, 46% relative humidity, 10% cloud cover, 3 mph wind velocity at 225°, and dry soil at 79°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 three replicates.

Treatment	Rate	6/30 yeft	7/15 yeft
	oz ai/A	%	%
Flcz2.0	0.32	60	68
Flcz2.0+Preference	0.32+0.25%	63	77
Flcz2.0+Preference+AG02013	0.32+0.25%+4	68	87
Flcz2.0+AG13064	0.32+3	68	80
Flcz2.0+AG8050	0.32+6.4	63	78
Flcz2.0+AG14039	0.32+8	67	82
Flcz2.0+AG14039	0.32+12	62	87
CV		4	6
LSD P=.05		5	9

Wheat did not exhibit response to any treatment. Control on June 30 with flucarbazone alone was 60%. Control was enhanced with addition of Preference+AG02013, AG13064, or AG14039. On July 15, each of the adjuvant treatments improved control of foxtail with flucarbazone, 68%. Preference+AG02013 or AG14039 with flucarbazone resulted in the highest control, 87%, while AG13064 only improved control with flucarbazone to 80%.

Adjuvants for Thiencarbazone control of Wild Oat. Dr. Howatt, Mettler, and Harrington. 'Glenn' hard red spring wheat was seeded near Fargo on May 6. Treatments were applied to 3 leaf wheat and 1 to 4 leaf wild oat on June 5 with 87°F, 35% relative humidity, 10% cloud cover, 6 mph wind velocity at 90°, and dry soil at 77°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 three replicates.

Treatment	Rate	6/19 wioa	7/03 wioa
	oz ai/A	%	%
Thiencarbazone	0.06	75	72
Thcz+Preference	0.06+0.25%	75	88
Thcz+Preference+AG02013	0.06+0.25%+4	75	91
Thcz+AG13064	0.06+3	75	88
Thcz+AG8050	0.06+6.4	75	89
Thcz+AG14039	0.06+8	75	91
Thcz+AG14039	0.06+12	75	91
CV		0	3
LSD P=.05		.	5

Wheat did not show visible response to treatments. Wild oat symptoms did not differ across treatments on June 19. On July 3, thiencarbazone gave 72% control of wild oat. All adjuvant treatments increased control with thiencarbazone to an average of 89%. Adjuvant treatments could not be separated.

Adjuvants for Pyroxsulam control of Wild Oat. Dr. Howatt, Mettler, and Harrington. 'Glenn' hard red spring wheat was seeded near Fargo on May 6. Treatments were applied to 3 leaf wheat and 1 to 4 leaf wild oat on June 5 with 87°F, 35% relative humidity, 10% cloud cover, 6 mph wind velocity at 90°, and dry soil at 77°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 three replicates.

Treatment	Rate	6/19 wioa	7/03 wioa
	oz ai/A	%	%
Pxlm	0.18	75	63
Pxlm+Preference	0.18+0.25%	75	83
Pxlm+Preference+AG02013	0.18+0.25%+4	75	90
Pxlm+AG13064	0.18+3	75	88
Pxlm+AG8050	0.18+6.4	75	87
Pxlm+AG14039	0.18+8	75	91
Pxlm+AG14039	0.18+12	75	94
CV		0	3
LSD P=.05		.	5

Wheat did not show visible response to treatments. Wild oat symptoms did not differ across treatments on June 19. On July 3, pyroxsulam gave 63% control of wild oat. All adjuvant treatments increased control with pyroxsulam. AG14039 improved control of wild oat with pyroxsulam to as much as 94% at the high rate. Preference+AG02013 gave similar flucarbazone improvement to 90%, but Preference only increased control with pyroxsulam to 83%.

Adjuvants for Kochia control with Bromoxynil&2,4-D&fluroxypyr. Dr. Howatt, Mettler, and Harrington. 'Tradition' barley was seeded near Rogers, North Dakota on May 6. Treatments were applied to 3 to 4 leaf barley and 1 to 6 inch kochia on June 8 with 72°F, 43% relative humidity, less than 5% cloud cover, 4.4 mph wind velocity at 90°, and dry 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 area the length of 10 by 30 foot plots. The experiment was a randomized complete block design with three replicates.

Treatment	Rate	6/20 koch	7/4 koch	7/17 koch
	oz ai/A	%	%	%
Brox&2,4-D&Flox	8	77	93	92
Brox&2,4-D&Flox+AG13064	8+3	82	91	92
Brox&2,4-D&Flox+Preference+AG02013	8+0.25%+4	82	95	97
Brox&2,4-D&Flox+AG8050	8+6.4	88	88	88
Brox&2,4-D&Flox+AG14039	8+8	72	89	97
Brox&2,4-D&Flox	12	96	94	95
Brox&2,4-D&Flox+AG13064	12+3	77	70	82
Brox&2,4-D&Flox+Preference+AG02013	12+0.25%+4	80	83	80
Brox&2,4-D&Flox+AG8050	12+6.4	92	92	95
Brox&2,4-D&Flox+AG14039	12+8	90	95	96
CV		5	4	4
LSD P=.05		8	7	6

Treatments did not cause injury to barley. Initial herbicide control of kochia at the low rate was improved with AG8050 but this did not last to the next evaluation. Initial control with the high rate of herbicide was 96%. Control was only 77% with AG13064 or Preference and AG02013. This level of reduced control persisted through the season.

Adjuvant protection of triallate. Howatt, Mettler, Davidson. Incorporated triallate was applied and immediately incorporated with two passes of a field cultivator before remaining treatments (except those containing Extend because of delivery delay) were applied May 6 with 72°F, 19% relative humidity, 5% cloud cover, 5 mph wind at 45° and damp to dry soil at 60°F. 'Glenn' hard red spring wheat was seeded near Fargo on May 6. The Extend treatment was applied to pre-spike to 1 leaf wild oat May 19 with 57°F, 35% relative humidity, 100% cloud cover, 7 mph wind velocity at 80° and damp to dry soil at 50°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	6/19 wioa	6/30 wioa
	oz ai/A	%	%
Triallate (PRE)	16	63	48
Triallate (PPI)	16	94	90
Triallate+Extend	16+0.5%	50	10
Triallate+Grounded	16+32	40	28
Triallate+Infuse	16+32	70	48
Triallate+Ad-Here	16+16	68	33
Triallate+Ad-Here	16+32	70	60
Untreated Check	0	0	0
CV		13	18
LSD P=.05		10	10

Wheat did not show visible injury of herbicide symptoms. Triallate that was incorporated provided 90% control of wild oat. Control was nearly half that when incorporation was not performed. Only Ad-Here at 32 fl oz/A started to overcome the deficit in control without incorporation, but control was only 60%. A higher rate could possibly provide more benefit, but the cost of product could become prohibitive. Treatments that included Extend were applied late in germination and wild oat likely were not sufficiently exposed before seedling establishment to see triallate effect.

Adjuvant protection for Triallate and Pyroxasulfone. Dr. Howatt, Mettler, and Harrington. Triallate (PPI) was applied and immediately incorporated with two passes of a field cultivator before remaining treatments (except those containing Extend because of delayed delivery) were applied on May 6 with 72°F, 19% relative humidity, 5% cloud cover, 5 mph wind at 45°, and damp to dry soil at 60°F. 'Glenn' hard red spring wheat was seeded near Fargo on May 6. Treatments containing Extend were applied to near spike stage grasses May 19 with 57°F, 35% relative humidity, 100% cloud cover, 7 mph wind velocity at 80°, and damp to dry soil at 50°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 30 foot plots. The experiment was a randomized complete block design with four replicates.

Treatment	Rate	6/19 wioa	6/30 wioa
	oz ai/A	%	%
Triallate (PPI)	16	89	88
Pysf	0.85	53	25
Triallate+Pysf	16+0.85	89	86
Triallate+Extend	16+0.5%	23	5
Triallate+Grounded	16+32	59	38
Triallate+Pysf+Extend	16+0.85+0.5%	38	5
Triallate+Pysf+Grounded	16+0.85+32	76	40
Untreated Check	0	0	0
CV		16	25
LSD P=.05		12	13

Wheat did not express symptoms of herbicide damage. Incorporated triallate provided 88% control of wild oat. Non-incorporated triallate+pyroxasulfone provided similar control to this even though triallate would not have been stabilized with cultivation and pyroxasulfone alone only gave 25% control. Additives to enhance and prolong activity of soil applied herbicides were not a sufficient substitute for lack of triallate incorporation. Treatments that included Extend were applied late in germination and wild oat likely were not sufficiently exposed before seedling establishment to see triallate effect.

Adjuvant for soil herbicides. Dr. Howatt, Mettler, and Harrington. The experiment was established on a non-cropped plot with bare ground near Fargo. Treatments were applied to soil on June 1 with 82°F, 12% relative humidity, 5% cloud cover, and 8 mph wind velocity at 225° and dry 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	Jun-29-2017 weeds	Jul-6-2017 weeds
Trifluralin	12	23	15
Trif+Grounded	12+32	38	20
Trif+Extend	12+32	40	23
Trif+Ad-Here	12+32	40	33
Pendimethalin	16	48	40
Pend+Grounded	16+32	50	40
Pend+Extend	16+32	48	40
Pend+Ad-Here	16+32	53	43
Acetochlor	18	58	46
Aceto+Grounded	18+32	45	28
Aceto+Extend	18+32	53	38
Aceto+Ad-Here	18+32	48	30
Pyroxasulfone	1.7	73	51
Pxsf+Grounded	1.7+32	60	58
Pxsf+Extend	1.7+32	74	63
Pxsf+Ad-Here	1.7+32	51	51
Dimethenamid-P	12	73	55
Dime-P+Grounded	12+32	71	58
Dime-P+Extend	12+32	69	66
Dime-P+Ad-Here	12+32	78	68
Sulfentrazone	4.5	97	98
Suen+Grounded	4.5+32	97	97
Suen+Extend	4.5+32	95	97
Suen+Ad-Here	4.5+32	98	99
CV		15	28
LSD P=.05		13	20

Weed emergence was almost exclusively redroot pigweed, waterhemp, and common lambsquarters. The poor level of weed control with several herbicides resulted in large LSD, and means could not be separated within herbicide group. Sulfentrazone provided 98% control of weeds without additive but additive did not antagonize control. Control with acetochlor tended to decrease with all additives. Control with pendimethalin and pyrozasulfone tended to increase with additives. And control with trifluralin tended to increase with additive, possibly because the additives prevented some of the trifluralin loss due to volatility or photodegradation as treatments were not incorporated.

PI Herbicides With and Without AdHere Followed by POST Applications. Richard K. Zollinger, Devin A. Wirth, Jason W. Adam

An experiment was conducted near Mayville, ND to evaluate weed control from **PPI herbicides incorporated immediately after application at a 4 inch depth** and POST herbicides. PPI treatments were applied on May 22, 2017 at 11:35 PM with 53.2 F air, 51.8 F soil at a four inch depth, 25% RH, 75% cloud cover, 8-10 mph NNW wind, and adequate soil moisture. POST treatments were applied on June 20, 2017 at 2:00 PM with 72 F air, 80 F soil, 43% RH, 30% cloud cover, 2-3 mph NNE wind, and adequate soil moisture. Weeds present were: corw 2-4" at 2-4/ft2, yeft 4-6" at 6-8/ft2, colq 2-4" at 1-2/ft2, wibw 1-2" at 1-2/yd2. Soil characteristics were: 23.1% sand, 52% silt, 24.9% clay, Silt Loam, 4.5% OM, and 7.7 pH. Treatments were applied to the center 7 feet of the 10 by 40 foot plots with a backpack-type plot sprayer delivering 17 gpa through 11002 TTI nozzles at 40 psi. The experiment had a randomized complete block design with three replicates per treatment.

Eptam is extremely volatile while sonalan is affected by photodegradation. Both herbicides were tankmixed with multiple adjuvants designed to protect pre-emergent herbicides from degradation and volatilization on the soil surface. Herbicide treatments were incorporated **immediately** after application. As the rate of Eptam AdHere increased, so did weed control. There was no or little added weed control with any POST applications except for Flexstar+MSO.

Table. PPI Herbicides With and Without AdHere followed by POST applications (Zollinger, Wirth, Adams).

		14 DA PPI			28 DA PPI			56 DA PPI		
Treatment	Rate	rrpw	colq	corw	rrpw	colq	corw	rrpw	colq	corw
	(Product/A)	------% control------			------% control-------			------% control------		
PPI) Eptam+Sonalan	1pt+2pt	99	99	70	80	80	60	70	70	37
PPI) Eptam+Sonalan+AdHere	1pt+2pt+1pt	99	99	70	72	72	52	72	72	45
PPI) Eptam+Sonalan	2pt+2pt	99	99	70	80	80	50	80	80	50
PPI) Eptam+Sonalan+AdHere	2pt+2pt+1pt	99	99	70	93	93	75	87	87	63
PPI) Eptam+Sonalan	3pt+2pt	99	99	70	90	90	72	90	90	73
PPI) Eptam+Sonalan+AdHere	3pt+2pt+1pt	99	99	70	93	93	77	93	93	78
PPI) Eptam+Sonalan+AdHere POST) Basagran+MSO	1pt+2pt+1pt 2pt+1pt	99	99	70	90	90	50	95	95	88
POST) Basagran+MSO	2pt+1pt	0	0	0	0	0	0	0	0	0
PPI) Eptam+Sonalan+AdHere POST) Permit+MSO	1pt+2pt+1pt 0.67oz	99	99	70	90	90	60	90	90	90
POST) Permit+MSO	0.67oz+1pt	0	0	0	0	0	0	0	0	0
PPI) Eptam+Sonalan POST) Flexstar+MSO	1pt+2pt+1pt 0.75pt+1pt	99	99	70	90	90	60	90	90	93
POST) Flexstar+MSO	0.75pt+1pt	0	0	0	0	0	0	99	60	75
LSD		0	0	0	9	9	7	5	5	6

ɪtam with Extender/Protector Adjuvants. Richard K. Zollinger, Devin A. Wirth, Jason W. Adams. An experiment was conducte ːar Mayville, ND to evaluate weed control from **PPI herbicides incorporated into the soil 1 hour after application at a 4 inch ːpth**. PPI treatments were applied on May 22, 2017 at 11:50 AM with 53.2 F air, 49.8 F soil at a four inch depth, 25% RH, 75% ɔud cover, 8-10 mph NNW wind, and adequate soil moisture. Soil characteristics were: 23.1% sand, 52% silt, 24.9% clay, Silt ːam, 4.5% OM, and 7.7 pH. Treatments were applied to the center 6.7 feet of the 10 by 40 foot plots with a backpack-type pl rayer delivering 17 gpa through 11002 TTI nozzles at 40 psi. The experiment had a randomized complete block design with ree replicates per treatment.

ɪtam is an extremely volatile herbicide that was tankmixed with multiple adjuvants designed to protect pre-emergent ːrbicides from degradation and volatilization on the soil surface. Treatments were incorporated **1 hour** after application to low environmental effects to act on the Eptam. Weed control decreased from 14 to 56 days after application (DAA). The ldition of AdHere and Infuse provided the best weed control from 14 to 56 DAA.

ble. Eptam with Extender/Protector Adjuvants (Zollinger, Wirth, Adams).

		14 DAA			28 DAA			56 DAA		
ːatment	Rate	rrpw	colq	corw	rrpw	colq	corw	rrpw	colq	corw
	(Product/A)	------% control------			------% control------			------% control------		
tam	3pt	99	99	90	83	83	83	77	77	77
tam+Grounded	3pt+4floz	99	99	93	86	86	85	85	85	83
tam+Grounded	3pt+1pt	99	99	88	90	90	88	58	58	58
tam+AdHere	3pt+1pt	99	99	95	97	96	95	90	90	90
tam+MCS 100	3pt+8floz	99	99	93	94	90	87	65	65	65
tam+MCS 101	3pt+8floz	99	99	93	99	99	93	77	77	77
tam+MCH 101	3pt+8floz	99	99	95	98	96	95	67	67	67
tam+MCG 100	3pt+8floz	99	99	95	88	90	88	82	82	80
tam+Infuse	3pt+2pt	99	99	95	93	93	92	91	91	90
tam+Sorbyx	3pt+1pt	99	99	95	99	99	95	80	80	80
tam+Extend	3pt+0.5%v/v	99	99	90	90	90	85	63	63	63
tam+InPlace	3pt+8floz	70	70	70	73	73	73	63	63	63
D		0	0	4	9	9	6	12	12	12

nalan with Extender/Protector Adjuvants. Richard K. Zollinger, Devin A. Wirth, Jason W. Adams. An experiment was nducted near Mayville, ND to evaluate weed control from **PPI herbicides incorporated into the soil 2 days after application a 4 inch depth**. PPI treatments were applied on May 22, 2017 at 12:25 PM with 53.2 F air, 49.8 F soil at a four inch depth, % RH, 75% cloud cover, 8-10 mph NNW wind, and adequate soil moisture. Soil characteristics were: 23.1% sand, 52% silt, .9% clay, Silt Loam, 4.5% OM, and 7.7 pH. Treatments were applied to the center 6.7 feet of the 10 by 40 foot plots with a ckpack-type plot sprayer delivering 17 gpa through 11002 TTI nozzles at 40 psi. The experiment had a randomized complete ock design with three replicates per treatment.

nalan was tankmixed with multiple adjuvants designed to protect pre-emergent herbicides from degradation and latilization on the soil surface. Treatments were incorporated **2 days** after application to allow environmental effects to act the Sonalan. Weed control decreased from 14 to 56 days after application (DAA). The addition of AdHere provided the best eed control from 14 to 28 DAA, however weed control dramatically decreased after 56 DAA. The addition of Grounded at 4 z, MCG 100, Infuse, and Sorbyx provided the most consistent weed control from 14 to 56 DAA.

ble. Sonalan with Extender/Protector Adjuvants (Zollinger, Wirth, Adams).

		14 DAA			28 DAA			56 DAA		
eatment	Rate	rrpw	colq	corw	rrpw	colq	corw	rrpw	colq	corw
	(Product/A)	------% control------			------% control------			------% control------		
nalan	2pt	70	70	70	72	72	57	70	70	45
nalan+Grounded	2pt+4floz	98	98	93	87	87	67	82	83	60
nalan+Grounded	2pt+1pt	99	97	96	83	83	68	70	78	72
nalan+AdHere	2pt+1pt	96	96	93	93	93	83	54	78	80
nalan+MCS 100	2pt+8floz	98	98	92	83	83	83	73	75	80
nalan+MCS 101	2pt+8floz	87	83	80	72	72	77	68	67	65
nalan+MCH 101	2pt+8floz	99	99	93	92	92	68	63	63	45
nalan+MCG 100	2pt+8floz	80	73	70	85	82	43	82	82	33
nalan+Infuse	2pt+2pt	92	92	86	88	88	68	85	85	62
nalan+Sorbyx	2pt+1pt	93	93	83	88	88	65	83	83	65
nalan+Extend	2pt+0.5%v/v	90	90	78	87	87	70	65	65	60
nalan+InPlace	2pt+8floz	92	92	85	87	87	67	65	67	48
D		4	7	7	9	9	13	23	11	14

tam Plus Sonalan with Extender/Protector Adjuvants. Richard K. Zollinger, Devin A. Wirth, Jason W. Adams. An experiment ıs conducted near Mayville, ND to evaluate weed control from **PRE herbicides**. PRE treatments were applied on May 22, 201 12:05 PM with 53.2 F air, 49.8 F soil at a four inch depth, 25% RH, 75% cloud cover, 8-10 mph NNW wind, and adequate soil ɔisture. Soil characteristics were: 23.1% sand, 52% silt, 24.9% clay, Silt Loam, 4.5% OM, and 7.7 pH. Treatments were applied the center 6.7 feet of the 10 by 40 foot plots with a backpack-type plot sprayer delivering 17 gpa through 11002 TTI nozzles 40 psi. The experiment had a randomized complete block design with three replicates per treatment.

tam is extremely volatile while sonalan is affected by photodegradation. Both herbicides were tankmixed with multiple juvants designed to protect pre-emergent herbicides from degradation and volatilization on the soil surface. PRE treatments ere **not** incorporated after application to allow environmental effects to act on each herbicide. Weed control stayed relatively nsistent from 14 to 56 days after application (DAA). The addition of most adjuvants only slightly increased weed control.

ɔle. Eptam Plus Sonalan with Extender/Protector Adjuvants (Zollinger, Wirth, Adams).

		14 DAA			28 DAA			56 DAA		
ıtment	Rate	rrpw	colq	corw	rrpw	colq	corw	rrpw	colq	corw
	(Product/A)	------% control------			------% control------			------% control------		
ɪam+Sonalan	3pt+2pt	42	42	42	33	33	32	33	33	32
ɪam+Sonalan+Grounded	3pt+2pt+4floz	50	50	50	45	45	45	43	43	43
ɪam+Sonalan+Grounded	3pt+2pt+1pt	60	60	60	57	57	55	42	42	42
ɪam+Sonalan+AdHere	3pt+2pt+1pt	53	53	53	50	50	45	23	23	23
ɪam+Sonalan+MCS 100	3pt+2pt+8floz	43	43	43	60	60	53	53	53	47
ɪam+Sonalan+MCS 101	3pt+2pt+8floz	50	50	50	25	25	25	0	0	0
ɪam+Sonalan+MCH 101	3pt+2pt+8floz	43	43	43	40	40	33	23	23	23
ɪam+Sonalan+MCG 100	3pt+2pt+8floz	43	43	43	43	43	43	25	23	23
ɪam+Sonalan+Infuse	3pt+2pt+2pt	50	50	50	50	50	40	50	50	35
ɪam+Sonalan+Sorbyx	3pt+2pt+1pt	50	50	50	50	50	48	50	50	25
ɪam+Sonalan+Extend	3pt+2pt+0.5%v/v	40	40	40	40	40	20	40	40	10
ɪam+Sonalan+InPlace	3pt+2pt+8floz	30	30	30	20	20	20	20	20	10
ɔ		7	7	7	4	4	5	4	5	5

'eed control using Roundup with and without surfactant. Richard K. Zollinger, Devin A. Wirth, Jason W. Adams. An (periment was conducted near Mayville, ND to evaluate whether or not there is a need for additional surfactants with a fully aded glyphosate formulation. POST treatments were applied on June 20, 2017 at 2:25 PM with 72 F air, 80 F soil at a four inc epth, 43% RH, 30% cloud cover, 2-3 mph NNE wind, and adequate soil moisture. Weeds present at the time of POST)plications were: corw 6-8" at 6-8/ft2, and colq 6-8" at 6-8/ft2, wibw 4-6" at 1-2/ft2, rrpw 4-6" at 1-2/ft2, and yeft 8-10" at 1( )/ft2. Soil characteristics were: 23.1% sand, 52% silt, 24.9% clay, Silt Loam, 4.5% OM, and 7.7 pH. Treatments were applied tc ıe center 6.7 feet of the 10 by 40 foot plots with a backpack-type plot sprayer delivering 8.5 gpa through 11001 TT nozzles at) psi. The experiment had a randomized complete block design with three replicates per treatment.

)undup Powermax controlled all other weeds except wild buckwheat. Roundup Powermax at 22 floz was only enhanced by b ainier EA at either rates. Roundup Powermax at 32 floz was enhanced with the addition of both Activator 90 and Rainier EA a ther rates. Not all surfactants enhance glyphosate.

Table. Weed control using Roundup with and without surfactant (Zollinger, Wirth, Adams)

Treatment[1]	Rate	14 DAA Wibw
	(Product/A)	-% control-
RUPM	22 floz	62
RUPM+LI-700	22floz+0.25%v/v	50
RUPM+Activator 90	22floz+0.25%v/v	45
RUPM+Rainier EA	22floz+0.25%v/v	76
RUPM+LI-700	22floz+0.5%v/v	47
RUPM+Activator 90	22floz+0.5%v/v	58
RUPM+Rainier EA	22floz+0.5%v/v	86
RUPM	32floz	59
RUPM+LI-700	32floz+0.25%v/v	60
RUPM+Activator 90	32floz+0.25%v/v	69
RUPM+Rainier EA	32floz+0.25%v/v	83
RUPM+LI-700	32floz+0.5%v/v	62
RUPM+Activator 90	32floz+0.5%v/v	68
RUPM+Rainier EA	32floz+0.5%v/v	95
LSD		5

[1] RUPM = Roundup Powermax

Roundup Powermax with Approved Adjuvants. Richard K. Zollinger, Devin A. Wirth, Jason W. Adams. An experiment was conducted near Hillsboro, ND to evaluate Roundup Powermax enhancement with approved adjuvants. Flax, amaranth, sunflowers, and conventional corn were planted on June 1, 2017. POST treatments were applied on July 5, 2017 from 10-2 with 88 F air, 75 F soil at a four inch depth, 45% RH, 0% cloud cover, 0-1 mph NW wind, and adequate soil moisture. Weeds present at the time of POST applications were: flax 10-12" at 10/ft2, amaranth 13-16" at 20/ft2, sunflowers 20-24" at 5/ft2, and conventional corn 16-18" at 5/ft2. Soil characteristics were: 15.3% sand, 53.9% silt, 30.8% clay, silty clay loam, 6.2% OM, and 7.5 pH. Treatments were applied to the center 6.7 feet of the 10 by 40 foot plots with a backpack-type plot sprayer delivering 12 gpa through 110015 TTI nozzles at 40 psi. The experiment had a randomized complete block design with three replicates per treatment.

Species control was similar from 14 to 28 days after application. The addition of AMS provided the most species control. Class Act Ridion was the best non-AMS water-conditioner over all species.

Table. Roundup Powermax with Approved Adjuvants (Zollinger, Wirth, Adams).

		14 DAA				28 DAA			
Treatment[1]	Product/Acre	Flax	Amar	Snfl	Corn	Flax	Amar	Snfl	Corn
		----------% control----------				----------% control----------			
(DW) RUPM	22floz	90	72	73	73	90	72	83	75
(HW) RUPM	22floz	60	62	62	62	63	52	62	62
(DW) RUPM+AMS	22floz+8.5lb/100gal	96	86	82	83	96	86	92	96
(HW) RUPM+AMS	22floz+8.5lb/100gal	96	75	82	83	96	75	92	93
(HW) RUPM+Class Act Ridion	22floz+0.5%v/v	93	82	77	78	95	82	78	78
(HW) RUPM+Choice Trio	22floz+0.5%v/v	96	71	73	73	96	68	75	78
(HW) RUPM+Cornbelt Vaporgard	22floz+0.5%v/v	93	75	72	70	93	75	75	82
(HW) RUPM+FS Attero	22floz+0.5%v/v	96	62	67	72	96	65	67	85
(HW) RUPM+FS Certin	22floz+0.5%v/v	96	75	73	73	97	67	70	72
(HW) RUPM+Leeway II	22floz+0.5%v/v	97	73	80	72	97	72	72	83
(HW) RUPM+Traverse D	22floz+0.5%v/v	97	63	68	60	97	62	68	63
(HW) RUPM+Ensure Max	22floz+0.5%v/v	96	65	70	73	96	63	70	75
(HW) RUPM+Serenity	22floz+0.5%v/v	96	65	67	63	96	63	67	63
(HW) RUPM+Zaar	22floz+1%v/v	96	57	65	67	97	67	75	90
LSD		3	5	5	6	2	4	4	4

[1] DW = Distilled Water, HW = 1,000 ppm Hard Water, RUPM = Roundup Powermax

Engenia with Approved Adjuvants. Zollinger, Richard K., Devin A. Wirth, Jason W. Adams. An experiment was conducted near Hillsboro, ND to evaluate Engenia enhancement with approved adjuvants. Amaranth, quinoa, tame buckwheat, and sunflowers were planted on June 1, 2017. POST treatments were applied on July 5, 2017 from 10-2 with 88 F air, 75 F soil at a four inch depth, 45% RH, 0% cloud cover, 0-1 mph NW wind, and adequate soil moisture. Weeds present at the time of POST applications were: amaranth 13-16" at 20/ft2, quinoa 8-14" at 20/ft2, tame buckwheat 16-18" at 20/ft2, and sunflowers 20-24" at 5/ft2. Soil characteristics were: 15.3% sand, 53.9% silt, 30.8% clay, silty clay loam, 6.2% OM, and 7.5 pH. Treatments were applied to the center 6.7 feet of the 10 by 40 foot plots with a backpack-type plot sprayer delivering 12 gpa through 110015 TTI nozzles at 40 psi. The experiment had a randomized complete block design with three replicates per treatment.

The addition of Class Act Ridion, a non-AMS water-conditioner, provided the best overall species control in hard water across all species.

Table. Engenia with Approved Adjuvants (Zollinger, Wirth, Adams).

		14 DAA				28 DAA			
Treatment[1]	Product/Acre	Amar	Quin	Tabw	Snfl	Amar	Quin	Tabw	Snfl
		----------% control----------				----------% control----------			
(DW) Engenia	12.8floz	42	42	62	63	62	62	72	73
(HW) Engenia	12.8floz	25	32	37	37	28	37	35	42
(DW) Engenia+AMS	12.8floz+8.5lb/100gal	52	67	67	63	62	88	67	85
(HW) Engenia+AMS	12.8floz+8.5lb/100gal	63	65	69	58	62	87	67	72
(HW) Engenia+Class Act Ridion	12.8floz+0.5%v/v	68	75	77	69	58	92	83	89
(HW) Engenia+Choice Trio	12.8floz+0.5%v/v	63	79	79	72	63	89	79	75
(HW) Engenia+Cornbelt Vaporgard	12.8floz+0.5%v/v	47	65	65	68	57	75	65	70
(HW) Engenia+FS Attero	12.8floz+0.5%v/v	55	57	57	57	57	67	57	58
(HW) Engenia+FS Certin	12.8floz+0.5%v/v	40	40	53	63	45	45	53	63
(HW) Engenia+Leeway II	12.8floz+0.5%v/v	60	72	70	63	66	92	73	65
(HW) Engenia+Traverse D	12.8floz+0.5%v/v	53	72	74	73	55	93	76	93
(HW) Engenia+Ensure Max	12.8floz+0.5%v/v	48	63	58	47	48	73	53	48
(HW) Engenia+Serenity	12.8floz+0.5%v/v	50	62	62	60	53	72	72	70
(HW) Engenia+Zaar	12.8floz+1%v/v	68	75	72	70	70	95	82	77
LSD		6	5	5	5	4	5	4	4

[1]DW = Distilled Water, HW = 1,000 ppm Hard Water

Limiting Dicamba Movement with Adjuvants. Dr. Howatt, Mettler, and Harrington. 'ND12-24081' soybean was seeded near Fargo on May 15. Treatments were applied to 2 to 3 trifoliolate soybean on June 29 with 70°F, 67% humidity, 99% cloud cover, and 3 mph wind velocity at 0° and moist soil at 68°F. Treatments were applied with a backpack sprayer delivering 17 gpa at 40 psi through AIXR 11002 nozzles to a 7 foot wide area the length of 10 by 30 foot plots. This was a non-replicated demonstration.

Treatment	Rate	7/6 injury distance	7/19 injury distance	8/10 injury distance
	oz ae/A	ft	ft	ft
AMS+NIS+Glyt-4.5+Dica-C	23+0.25%+12+8	20	75	80
Full Load Comp+Glyt-4.5+Dica-C	0.375%+12+8	10	60	70
Cado Max+Full Load+Glyt-4.5+Dica-C	0.25%+0.375%+12+8	10	40	50
Full Load+Drift Fiant+Glyt-4.5+Dica-C	0.375%+0.15%+12+8	7	35	40
# of reps		1	1	1

Initial injury pattern, distance, diminishing intensity from source, and direction was consistent with presumed and observed droplet movement during the application. On subsequent dates, injury at the extremity of movement was consistent for a long distance and occurred in all directions from the initial injury area, even upwind of prevailing air movement. This seems to indicate volatilization had occurred several days after the initial movement. Size of the potential volatility ring seemed more related to the particle drift area than the treated area.

Xtendimax with Adjuvants. Zollinger, Richard K., Devin A. Wirth, Jason W. Adams. An experiment was conducted near Hillsboro, ND to evaluate Xtendimax enhancement with adjuvants. Flax, amaranth, quinoa, and tame buckwheat were planted on June 1, 2017. POST treatments were applied on June 26, 2017 from 11-3 with 72 F air, 68.5F soil at a four inch depth, 34.2% RH, 40% cloud cover, 5-8 mph NW wind, and adequate soil moisture. Weeds present at the time of POST applications were: flax 5-6" at 20/ft2, amaranth 6-7" at 20/ft2, quinoa 3-6" at 10/ft2, and tame buckwheat 3-6" at 20/ft2. Soil characteristics were: 15.3% sand, 53.9% silt, 30.8% clay, silty clay loam, 6.2% OM, and 7.5 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 through 11001 TT nozzles at 40 psi. The experiment had a randomized complete block design with three replicates per treatment.

The addition of MSO to Xtendimax in both distilled and hard water provided the best overall species control whether AMS was added or not.

Table. Xtendimax with Adjuvants (Zollinger, Wirth, Adams).

		14 DAA				28 DAA			
Treatment[1]	Product/Acre	Flax	Amar	Quin	Tabw	Flax	Amar	Quin	Tabw
		----------% control----------				----------% control----------			
(DW) Xtendimax+Rainier EA	17floz+0.5%v/v	60	52	93	80	62	53	88	77
(DW) Xtendimax+Aqua-Veta	17floz+2floz	25	27	68	67	23	25	70	65
(DW) Xtendimax+Blue Diamond	17floz+0.5%v/v	38	47	87	58	37	45	88	60
(DW) Xtendimax+MSO	17floz+1.5pt	75	63	93	82	77	65	94	85
(DW) Xtendimax+Rainier EA+AMS	17floz+0.5%v/v+8.5lb/100gal	68	65	95	72	65	63	96	75
(DW) Xtendimax+Blue Diamond+AMS	17floz+0.5%v/v+8.5lb/100gal	35	50	90	67	33	48	88	85
(DW) Xtendimax+MSO+AMS	17floz+1.5pt+8.5lb/100gal	72	63	98	87	73	65	99	96
(HW) Xtendimax+Rainier EA+AMS	17floz+0.5%v/v+8.5lb/100gal	43	38	90	67	42	42	92	95
(HW) Xtendimax+Blue Diamond+AMS	17floz+0.5%v/v+8.5lb/100gal	50	48	92	68	40	50	92	78
(HW) Xtendimax+MSO+AMS	17floz+1.5pt+8.5lb/100gal	72	63	98	86	70	68	98	91
LSD		5	5	4	5	3	3	4	2

[1]DW = Distilled Water, HW = 1,000 ppm Hard Water

Dicamba and Glyphosate with Adjuvants. Zollinger, Richard K., Devin A. Wirth, Jason W. Adams. An experiment was conducted near Hillsboro, ND to evaluate dicamba and glyphosate enhancement with adjuvants. Amaranth, quinoa, tame buckwheat, and sunflowers were planted on June 1, 2017. POST treatments were applied on July 5, 2017 from 10-2 with 88 F air, 75 F soil at a four inch depth, 45% RH, 0% cloud cover, 0-1 mph NW wind, and adequate soil moisture. Weeds present at the time of POST applications were: amaranth 13-16" at 20/ft2, quinoa 8-14" at 20/ft2, tame buckwheat 16-18" at 20/ft2, and sunflowers 20-24" at 5/ft2. Soil characteristics were: 15.3% sand, 53.9% silt, 30.8% clay, silty clay loam, 6.2% OM, and 7.5 pH. Treatments were applied to the center 6.7 feet of the 10 by 40 foot plots with a backpack-type plot sprayer delivering 12 gpa through 110015 TT nozzles at 40 psi. The experiment had a randomized complete block design with three replicates per treatment.

Species control was similar from 14 to 28 days after application. The addition of any adjuvant increased Engenia and Engenia + Buccaneer Plus. However, the addition of either Plexus or Capsule to Engenia increased species control more than the additions of either Astonish or Contrast. Once Buccaneer Plus was added to the tank-mix, there were very few differences in species control regardless of adjuvant added.

Table. Dicamba and Glyphosate with Adjuvants (Zollinger, Wirth, Adams).

		14 DAA				28 DAA			
Treatment	Product/Acre	Amar	Quin	Tabw	Snfl	Amar	Quin	Tabw	Snfl
		----------% control----------				----------% control----------			
Engenia	10floz	40	42	42	58	37	42	45	58
Engenia+Astonish	10floz+54floz/100gal	42	58	55	58	43	57	58	60
Engenia+Contrast	10floz+2.5lb/100gal	33	48	45	55	33	45	45	58
Engenia+Plexus	10floz+12floz	33	72	63	60	33	65	60	60
Engenia+Capsule	10floz+0.5%v/v	52	60	58	65	48	60	57	65
Engenia+Buccaneer Plus	10floz+22floz	23	50	60	60	23	52	60	60
Engenia+Buccaneer Plus+Astonis	10floz+22floz+54floz/100gal	62	90	90	85	64	92	90	85
Engenia+Buccaneer Plus+Contrast	10floz+22floz+2.5lb/100gal	70	93	83	85	70	93	83	80
Engenia+Buccaneer Plus+Plexus	10floz+22floz+12floz	58	90	85	83	58	93	88	88
Engenia+Buccaneer Plus+Capsule	10floz+22floz+0.5%v/v	70	90	87	83	70	92	85	82
LSD		7	7	7	6	7	6	6	4

Water conditioning for glufosinate. Dr. Howatt, Mettler, and Harrington. '30208LL' (plot A) and 'ND12-24081' (not glufosinate-resistant, plot B) soybean, respectively, were planted in two different plots near Fargo on May 19. Paired treatments were designed to provide similar benefit of the adjuvant to glufosinate activity. All treatments were mixed by adding the AMS or ET-4000 first to the hard water carrier (7g CaCl2 and 2.3g MgCl2 per 3 gal of water) followed by the herbicides. Treatments were applied to 2 trifoliolate soybean, 4 to 5 inch common lambsquarters, 4 inch waterhemp, and 5 to 6 inch yellow foxtail on June 20 with 57°F, 80% relative humidity, 10% cloud cover, 6 mph wind velocity at 360°and damp soil at 60°F, at site A. Site B treatments were applied to 3 trifoliolate soybean, 2 to 3 inch common lambsquarters, 2 to 5 inch waterhemp, 2 to 5 inch redroot pigweed, and 1 to 2 inch Venice mallow on July 7 with 70°F 69% relative humidity, 0% cloud cover, 4 mph wind velocity at 270°, and moist soil at 69°F. Both sites were applied using a backpack sprayer delivering 17 gpa at 40 psi through 11002 TT nozzles to 7 foot wide areas the length of 10 by 30 foot plots. The experiments were randomized complete block designs with three replicates at site A and four replicates at site B.

Treatment	Rate	7/04 a wahe	7/04 a colq	7/04 a yeft	7/14 b colq	7/14 b soya	7/14 b pgwd	7/14 b vema
	oz ai/A	%	%	%	%	%	%	%
Gluf-l+s-Meto-M+AMS-L	4.7+12+38	82	47	78	48	81	88	55
Gluf-l+s-Meto-M+ET-4000	4.7+12+1%	80	62	82	60	84	90	68
Gluf-l+s-Meto-M+AMS-L	4.7+12+48	75	50	83	58	83	91	64
Gluf-l+s-Meto-M+ET-4000	4.7+12+1.25%	73	53	83	65	84	90	70
Gluf-l+s-Meto-M+AMS-L	4.7+12+58	78	57	82	64	81	90	55
Gluf-l+s-Meto-M+ET-4000	4.7+12+1.5%	80	57	83	64	85	91	69
CV		7	9	3	8	3	2	8
LSD P=.05		9	9	5	7	3	3	8

Treatment	Rate	7/19 a all	7/20 b colq	7/20 b soya	7/20 b pgwd	7/20 b vema	7/28 b colq	7/28 b vema
	oz ai/A	%	%	%	%	%	%	%
Gluf-l+s-Meto-M+AMS-L	4.7+12+38	0	28	91	90	28	38	20
Gluf-l+s-Meto-M+ET-4000	4.7+12+1%	0	35	93	91	30	40	23
Gluf-l+s-Meto-M+AMS-L	4.7+12+48	0	30	94	90	33	35	25
Gluf-l+s-Meto-M+ET-4000	4.7+12+1.25%	0	35	94	94	30	40	28
Gluf-l+s-Meto-M+AMS-L	4.7+12+58	0	38	94	94	35	35	28
Gluf-l+s-Meto-M+ET-4000	4.7+12+1.5%	0	38	95	95	38	38	35
CV		0	13	3	2	14	15	18
LSD P=.05		.	7	4	3	7	8	7

*a or b placed before the weed evaluations indicate site a or b.

Glufosinate did not perform as expected this year in several related studies, especially on common lambsquarters. At site A, control was not consistently related to adjuvant rate on July 4, and by July 19, treatments could not be differentiated from each other or the check strip between plots. Site B demonstrated generally better control of Venice mallow, common lambsquarters, and soybean with glufosinate plus ET-4000 than liquid AMS but only a slight effect of rate. Control of pigweeds, either redroot or waterhemp, was quite consistent across treatments. Pigweeds and soybean with live tissue were not found on July 28. Control of remaining species with glufosinate on this date still tended to be better with ET-4000 than liquid AMS, although by small numerical values.

ank-mix enhancement with Water Conditioning Adjuvants. Richard K. Zollinger, Devin A. Wirth, Jason W. Adams. An xperiment was conducted near Mayville, ND to evaluate weed control and soybean injury from POST herbicide enhancement ith water conditioning adjuvats. Soybeans were seeded on May 19, 2017. POST treatments were applied on June 20, 2017 at 00 PM with 72 F air, 80 F soil at a four inch depth, 43% RH, 30% cloud cover, 2-3 mph NNE wind, and adequate soil moisture. 'eeds present at the time of POST applications were: corw 4-6" at 4-6/ft2, colq 4-6" at 6-8/ft2, wibw 2-4" at 1-2/yd2, and yef 6" at 8-10/ft2. Soil characteristics were: 23.1% sand, 52% silt, 24.9% clay, Silt Loam, 4.5% OM, and 7.7 pH. Treatments were pplied to the center 6.7 feet of the 10 by 40 foot plots with a backpack-type plot sprayer delivering 8.5 gpa through 11001 TT ozzles at 40 psi. The experiment had a randomized complete block design with three replicates per treatment.

ne addition of ET-4000 provided more weed control than the addition of Bronc. With Sinister at 4.2 fl oz/A there was little eed control improvement as ET-4000 rate increased from 0.5% to 1.5% v/v. However, with Sinister at 6.6 fl oz/A common igweed control increased as ET-4000 rate increased from 0.5% to 1.5% v/v. As the rate of Sinister increased, so did the weed ntrol.

ble. Tank-mix enhancement with water conditioning adjuvants (Zollinger, Wirth, Adams).

			7 DAA				14 DAA				28 DAA			
eatment[1]	Rate	pH	Soy	Yeft	Colq	Corw	Soy	Yeft	Colq	Corw	Soy	Yeft	Colq	Corw
	(Product/A)		-% inj-	-----% control------			-% inj-	-----% control------			-% inj-	-----% control------		
W) Durango+Sinister+Moccasin +R-11+Bronc	10.6floz+4.2floz+0.75pt +0.25%v/v+3%v/v	4.9	22	73	65	65	0	99	99	65	0	99	99	52
W) Durango+Sinister+Moccasin +R-11+ET-4000	10.6floz+4.2floz+0.75pt +0.25%v/v+0.5%v/v	3.2	22	80	75	72	0	99	99	70	0	99	99	58
W) Durango+Sinister+Moccasin +R-11+ET-4000	10.6floz+4.2floz+0.75pt +0.25%v/v+1%v/v	2.6	22	75	70	70	0	99	99	68	0	99	99	67
W) Durango+Sinister+Moccasin +R-11+ET-4000	10.6floz+4.2floz+0.75pt +0.25%v/v+1.5%v/v	2.0	25	80	60	60	0	99	99	52	0	99	99	42
W) Durango+Sinister+Moccasin +R-11+Bronc	10.6floz+6.6floz+0.75pt +0.25%v/v+3%v/v	4.4	20	88	77	75	0	99	99	45	0	99	99	35
W) Durango+Sinister+Moccasin +R-11+ET-4000	10.6floz+6.6floz+0.75pt +0.25%v/v+0.5%v/v	2.9	20	85	71	71	0	99	99	62	0	99	99	66
W) Durango+Sinister+Moccasin +R-11+ET-4000	10.6floz+6.6floz+0.75pt +0.25%v/v+1%v/v	2.4	22	87	68	70	0	99	99	70	0	99	99	76
W) Durango+Sinister+Moccasin +R-11+ET-4000	10.6floz+6.6floz+0.75pt +0.25%v/v+1.5%v/v	2.1	18	89	72	73	0	99	99	77	0	99	99	82
D			4	7	8	6	0	0	0	5	0	0	0	4

W = 500 ppm Hard Water

Home-made HSMOC. Zollinger, Richard K., Devin A. Wirth, Jason W. Adams. An experiment was conducted near Hillsboro, ND to create an HSMOC using different mixtures of formulated MSO and NIS adjuvants. Flax, amaranth, quinoa, and RR soybeans were planted on June 1, 2017. POST treatments were applied on July 4, 2017 from 8-11 with 82 F air, 70.6 F soil at a four inch depth, 67% RH, 0% cloud cover, 5-10 mph SSE wind, and adequate soil moisture. Weeds present at the time of POST applications were: flax 10-12" at 10/ft2, amaranth 12-16" at 20/ft2, quinoa 12-16" at 10/ft2, and RR soybeans 9-11" at 10/ft2. Soil characteristics were: 15.3% sand, 53.9% silt, 30.8% clay, silty clay loam, 6.2% OM, and 7.5 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 through 11001 TT nozzles at 40 psi. The experiment had a randomized complete block design with three replicates per treatment.

The purpose of this trial was to test different combinations of MSO + NIS adjuvants to "create" or "mimic" an industry HSMOC adjuvants. Results varied depending on MSO type and NIS type; however, some combinations of MSO + NIS provided similar or better species control than formulated HSMOC adjuvants.

Table. Home-made HSMOC (Zollinger, Wirth, Adams).

		14 DAA				28 DAA			
Treatment	Rate	Flax	Amar	Quin	Soy	Flax	Amar	Quin	Soy
	(Product/A)	--------% control--------				---------% control---------			
TDHT[1]+Laudis+Upland+Rainier EA	9.6floz+1.5floz+0.67pt+158mls	62	50	78	50	72	52	83	60
TDHT+Laudis+Upland+Wet-Sol	9.6floz+1.5floz+0.67pt+158mls	43	25	62	50	40	25	58	50
TDHT+Laudis+Upland+Wet-Cit	9.6floz+1.5floz+0.67pt+158mls	42	35	62	50	32	33	52	50
TDHT+Laudis+Upland+Preference	9.6floz+1.5floz+0.67pt+158mls	43	30	55	50	45	30	57	50
TDHT+Laudis+Upland+Activator 90	9.6floz+1.5floz+0.67pt+158mls	33	32	67	50	30	33	68	50
TDHT+Laudis+Hasten EA+Rainier EA	9.6floz+1.5floz+0.67pt+158mls	77	50	70	48	86	50	82	55
TDHT+Laudis+Hasten EA+Wet-Sol	9.6floz+1.5floz+0.67pt+158mls	40	35	58	50	40	35	53	45
TDHT+Laudis+Hasten EA+Wet-Cit	9.6floz+1.5floz+0.67pt+158mls	33	33	60	50	25	33	62	40
TDHT+Laudis+Hasten EA+Preference	9.6floz+1.5floz+0.67pt+158mls	33	30	52	50	23	32	35	50
TDHT+Laudis+Hasten EA+Activator 90	9.6floz+1.5floz+0.67pt+158mls	37	32	55	48	37	33	53	45
TDHT+Laudis+MSO Leci-Tech+Rainier EA	9.6floz+1.5floz+0.67pt+158mls	62	42	72	48	82	52	83	57
TDHT+Laudis+MSO Leci-Tech+Wet-Sol	9.6floz+1.5floz+0.67pt+158mls	43	33	48	47	43	32	47	43
TDHT+Laudis+MSO Leci-Tech+Wet-Cit	9.6floz+1.5floz+0.67pt+158mls	35	33	65	50	37	35	58	50
TDHT+Laudis+MSO Leci-Tech+Preference	9.6floz+1.5floz+0.67pt+158mls	49	38	68	48	48	38	62	45
TDHT+Laudis+MSO Leci-Tech+Activator 90	9.6floz+1.5floz+0.67pt+158mls	32	30	58	50	32	30	55	42
TDHT+Laudis+MES-100+Rainier EA	9.6floz+1.5floz+0.67pt+158mls	40	25	53	45	35	32	45	43
TDHT+Laudis+MES-100+Wet-Sol	9.6floz+1.5floz+0.67pt+158mls	30	35	50	50	30	35	43	43
TDHT+Laudis+MES-100+Wet-Cit	9.6floz+1.5floz+0.67pt+158mls	38	43	68	48	40	45	45	43
TDHT+Laudis+MES-100+Preference	9.6floz+1.5floz+0.67pt+158mls	42	42	70	55	43	43	62	52
TDHT+Laudis+MES-100+Activator 90	9.6floz+1.5floz+0.67pt+158mls	45	42	58	48	72	45	57	47
TDHT+Laudis+Destiny HC	9.6floz+1.5floz+1pt	52	50	63	50	52	53	60	50
TDHT+Laudis+Hybrid	9.6floz+1.5floz+1pt	93	60	75	48	94	60	74	47
TDHT+Laudis+Glacier EA	9.6floz+1.5floz+1pt	68	47	73	50	68	50	75	60
TDHT+Laudis+Hot-MES	9.6floz+1.5floz+1pt	33	38	57	48	32	42	50	47
LSD		6	6	9	3	4	5	5	3

[1] TDHT - Touchdown HiTech (Unloaded Glyphosate)

Touchdown HiTech and Engenia with HSOC Adjuvants. Zollinger, Richard K., Devin A. Wirth, Jason W. Adams. An experiment was conducted near Hillsboro, ND to evaluate Touchdown HiTech and Engenia enhancement with HSOC adjuvants. Amaranth, quinoa, LL canola, and RR soybeans were planted on June 1, 2017. POST treatments were applied on July 4, 2017 from 8-11 with 82 F air, 70.6 F soil at a four inch depth, 67% RH, 0% cloud cover, 5-10 mph SSE wind, and adequate soil moisture. Weeds present at the time of POST applications were: amaranth 12-16" at 20/ft2, quinoa 12-16" at 10/ft2, LL canola 12-14" at 20/ft2, and RR soybeans 9-11" at 10/ft2. Soil characteristics were: 15.3% sand, 53.9% silt, 30.8% clay, silty clay loam, 6.2% OM, and 7.5 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 through 11001 TT nozzles at 40 psi. The experiment had a randomized complete block design with three replicates per treatment.

The tank-mix of Touchdown Hi-Tech and Engenia was used to mimic a "Roundup Xtend" system. The addition of Hybrid to the tank-mix increased control the most, followed by Glacier EA and Duce.

Table. Touchdown HiTech and Engenia with HSOC Adjuvants (Zollinger, Wirth, Adams).

		14 DAA				28 DAA			
Treatment	Product/Acre	Amar	Quin	Cano	Soyb	Amar	Quin	Cano	Soyb
		----------% control----------				----------% control----------			
Touchdown HiTech+Engenia	9.6floz+6.5floz	58	43	33	73	58	53	40	75
Touchdown HiTech+Engenia+Rainier EA	9.6floz+6.5floz+0.5%v/v	47	72	67	74	53	88	73	83
Touchdown HiTech+Engenia+Noble MSO	9.6floz+6.5floz+1.5pt	52	68	47	75	52	78	45	85
Touchdown HiTech+Engenia+Destiny HC	9.6floz+6.5floz+1.5pt	42	75	40	65	45	91	60	95
Touchdown HiTech+Engenia+Hybrid	9.6floz+6.5floz+1.5pt	68	77	70	78	82	96	80	98
Touchdown HiTech+Engenia+Glacier EA	9.6floz+6.5floz+1.5pt	52	60	52	65	72	95	62	90
Touchdown HiTech+Engenia+Kixyt	9.6floz+6.5floz+1.5pt	45	55	50	65	67	82	70	85
Touchdown HiTech+Engenia+Duce	9.6floz+6.5floz+1.5pt	65	73	53	76	83	93	73	96
Touchdown HiTech+Engenia+Savvy	9.6floz+6.5floz+1.5pt	43	67	60	73	65	77	70	83
Touchdown HiTech+Engenia+Hot-MES	9.6floz+6.5floz+1.5pt	32	45	37	60	52	65	35	73
LSD		6	7	7	7	5	6	4	6

Enlist Duo with HSOC Adjuvants. Richard K. Zollinger, Devin A. Wirth, Jason W. Adams. An experiment was conducted near Hillsboro, ND to evaluate Enlist Duo enhancement HSOC adjuvants. Amaranth, quinoa, tame buckwheat, and RR soybeans were planted on June 1, 2017. POST treatments were applied on July 4, 2017 from 8-11 with 82 F air, 70.6 F soil at a four inch depth, 67% RH, 0% cloud cover, 5-10 mph SSE wind, and adequate soil moisture. Weeds present at the time of POST applications were: amaranth 12-16" at 20/ft2, quinoa 12-16" at 10/ft2, tame buckwheat 16-18" at 30/ft2, and RR soybeans 9-11" at 10/ft2. Soil characteristics were: 15.3% sand, 53.9% silt, 30.8% clay, silty clay loam, 6.2% OM, and 7.5 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 through 11001 TT nozzles at 40 psi. The experiment had a randomized complete block design with three replicates per treatment.

The addition of Hybrid increased species control the most.

Table. Enlist Duo with HSOC Adjuvants (Zollinger, Wirth, Adams).

		14 DAA				28 DAA			
Treatment	Product/Acre	Amar	Quin	Tabw	Soyb	Amar	Quin	Tabw	Soyb
		----------% control----------				----------% control----------			
Enlist Duo	1.75pt	58	72	70	52	58	62	60	52
Enlist Duo+Rainier EA	1.75pt+0.5%v/v	52	65	55	33	62	70	72	53
Enlist Duo+Noble MSO	1.75pt+1.5pt	40	47	50	35	60	93	70	65
Enlist Duo+Destiny HC	1.75pt+1.5pt	63	70	45	43	73	99	83	90
Enlist Duo+Hybrid	1.75pt+1.5pt	87	88	79	85	93	99	93	97
Enlist Duo+Glacier-EA	1.75pt+1.5pt	70	83	71	53	80	99	84	83
Enlist Duo+Kixyt	1.75pt+1.5pt	70	75	62	55	72	85	72	78
Enlist Duo+Duce	1.75pt+1.5pt	47	67	57	53	67	77	67	63
Enlist Duo+Savvy	1.75pt+1.5pt	73	73	63	53	75	75	67	67
Enlist Duo+Hot-MES	1.75pt+1.5pt	53	62	62	58	60	72	72	67
LSD		5	7	6	14	4	5	5	7

Liberty or Clarity at Varying Spray Qualities. Richard K. Zollinger, Devin A. Wirth, Jason W. Adams. An experiment was conducted near Fargo, ND to evaluate lambsquarters efficacy with Liberty or Clarity at varying spray qualities. POST treatments were applied on June 29, 2017 from 1:00-2:00 with 68 F air, 65F soil at a four inch depth, 40% RH, 50% cloud cover, 4-6 mph NW wind, and adequate soil moisture. Weeds present at the time of POST applications were: 8-16" common lambsquarters at 20/ft2. Treatments were applied to the center 15 feet of the 20 by 40 foot plots with a pulse width modulation sprayer mounted to a Polaris Ranger. The experiment had a randomized complete block design with three replicates per treatment.

Lambsquarters was the only weed observed. Lambsquarters stand was very thick with differing heights throughout the study which increased variation. There were very few differences in lambsquarters control with the use of different nozzles.

Table. Mesotrione with Varying Wilger Spray Nozzles (Zollinger, Wirth, Adams).

Treatment	Product/Acre	Wilger Spray Nozzle	14 DAA Colq	28 DAA Colq
			-% control-	-% control-
Untreated			2	10
Mesotrione+Preference	3oz+0.25%v/v	ER Nozzle	2	20
Mesotrione+Preference	3oz+0.25%v/v	SR Nozzle	5	30
Mesotrione+Preference	3oz+0.25%v/v	MR Nozzle	10	27
Mesotrione+Preference	3oz+0.25%v/v	DR Nozzle	17	37
Mesotrione+PO	3oz+1pt	ER Nozzle	15	23
Mesotrione+PO	3oz+1pt	SR Nozzle	18	33
Mesotrione+PO	3oz+1pt	MR Nozzle	15	30
Mesotrione+PO	3oz+1pt	DR Nozzle	20	35
LSD			7	23

Liberty or Clarity at Varying Spray Qualities. Richard K. Zollinger, Devin A. Wirth, Jason W. Adams. An experiment was conducted near Fargo, ND to evaluate lambsquarters efficacy with Liberty or Clarity at varying spray qualities. POST treatments were applied on June 6, 2017 from 9:00-2:00 with 76 F air, 67F soil at a four inch depth, 35% RH, 20% cloud cover, 7-9 mph S wind, and adequate soil moisture. Weeds present at the time of POST applications were: 8-16" common lambsquarters at 20/ft2. Treatments were applied to the center 15 feet of the 20 by 40 foot plots with a pulse width modulation sprayer mounted to a Polaris Ranger. The experiment had a randomized complete block design with three replicates per treatment.

Lambsquarters was the only weed observed. Lambsquarters stand was very thick with differing heights throughout the study which increased variation. There were very few differences within treatments at all spray qualities.

Table. Liberty or Clarity at Varying Spray Qualities (Zollinger, Wirth, Adams).

			14 DAA	28 DAA
Treatment	Product/Acre	Spray Quality	Colq	Colq
			-% control-	-% control-
Untreated			0	0
Liberty	22floz	5 GPA, 150 Microns	3	7
Liberty	22floz	5 GPA, 300 Microns	18	20
Liberty	22floz	5 GPA, 450 Microns	20	27
Liberty	22floz	5 GPA, 600 Microns	18	27
Liberty	22floz	5 GPA, 750 Microns	20	23
Liberty	22floz	5 GPA, 900 Microns	18	30
Liberty	22floz	20 GPA, 150 Microns	18	30
Liberty	22floz	20 GPA, 300 Microns	17	32
Liberty	22floz	20 GPA, 450 Microns	17	23
Liberty	22floz	20 GPA, 600 Microns	17	33
Liberty	22floz	20 GPA, 750 Microns	15	28
Liberty	22floz	20 GPA, 900 Microns	22	23
Clarity	8floz	5 GPA, 150 Microns	35	57
Clarity	8floz	5 GPA, 300 Microns	52	72
Clarity	8floz	5 GPA, 450 Microns	40	58
Clarity	8floz	5 GPA, 600 Microns	37	65
Clarity	8floz	5 GPA, 750 Microns	38	53
Clarity	8floz	5 GPA, 900 Microns	37	55
Clarity	8floz	20 GPA, 150 Microns	37	55
Clarity	8floz	20 GPA, 300 Microns	32	58
Clarity	8floz	20 GPA, 450 Microns	33	63
Clarity	8floz	20 GPA, 600 Microns	32	57
Clarity	8floz	20 GPA, 750 Microns	32	47
Clarity	8floz	20 GPA, 900 Microns	32	47
LSD			9	12

Roundup Weathermax with Clarity at Varying Spray Qualities. Richard K. Zollinger, Devin A. Wirth, Jason W. Adams. An experiment was conducted near Fargo, ND to evaluate lambsquarters efficacy with Roundup Weathermax with Clarity at varying spray qualities. POST treatments were applied on June 6, 2017 from 9:00-2:00 with 76 F air, 67F soil at a four inch depth, 35% RH, 20% cloud cover, 7-9 mph S wind, and adequate soil moisture. Weeds present at the time of POST applications were: 8-16" common lambsquarters at 20/ft2. Treatments were applied to the center 15 feet of the 20 by 40 foot plots with a pulse width modulation sprayer mounted to a Polaris Ranger. The experiment had a randomized complete block design with three replicates per treatment.

Lambsquarters was the only weed observed. Lambsquarters stand was very thick with differing heights throughout the study which increased variation. Lambsquarters control increased as micron size increased.

Table. Roundup Weathermax with Clarity at Varying Spray Qualities (Zollinger, Wirth, Adams).

Treatment	Product/Acre	Spray Quality	14 DAA Colq	28 DAA Colq
			-% control-	-% control-
Untreated			0	0
Roundup Weathermax+Clarity	22floz+8floz	150 Microns	0	3
Roundup Weathermax+Clarity	22floz+8floz	300 Microns	25	47
Roundup Weathermax+Clarity	22floz+8floz	450 Microns	43	57
Roundup Weathermax+Clarity	22floz+8floz	600 Microns	47	62
Roundup Weathermax+Clarity	22floz+8floz	750 Microns	52	67
Roundup Weathermax+Clarity	22floz+8floz	900 Microns	48	63
LSD			13	12

Enlist Duo at Varying Spray Qualities. Richard K. Zollinger, Devin A. Wirth, Jason W. Adams. An experiment was conducted near Fargo, ND to evaluate lambsquarters efficacy with Enlist Duo at varying spray qualities. POST treatments were applied on June 6, 2017 from 9:00-2:00 with 76 F air, 67F soil at a four inch depth, 35% RH, 20% cloud cover, 7-9 mph S wind, and adequate soil moisture. Weeds present at the time of POST applications were: 8-16" common lambsquarters at 20/ft2. Treatments were applied to the center 15 feet of the 20 by 40 foot plots with a pulse width modulation sprayer mounted to a Polaris Ranger. The experiment had a randomized complete block design with three replicates per treatment.

Lambsquarters was the only weed observed. Lambsquarters stand was very thick with differing heights throughout the study which increased variation. Lambsquarters control increased as micron size increased.

Table. Enlist Duo at Varying Spray Qualities (Zollinger, Wirth, Adams).

			14 DAA	28 DAA
Treatment	Product/Acre	Spray Quality	Colq	Colq
			-% control-	-% control-
Untreated			0	0
Enlist Duo	3.5pt	150 Microns	0	7
Enlist Duo	3.5pt	300 Microns	42	52
Enlist Duo	3.5pt	450 Microns	65	82
Enlist Duo	3.5pt	600 Microns	65	88
Enlist Duo	3.5pt	750 Microns	72	90
Enlist Duo	3.5pt	900 Microns	65	87
LSD			14	12

Genetic enhancer with glyphosate. Dr. Howatt, Mettler, and Harrington. RR2X soybean 'ND12-24081' were seeded near Fargo on May 19. Preemergence treatment of metolachlor&metribuzin at 2.4 lb per acre were applied on May 19 with 62°F, 28% relative humidity, and 60% cloud cover, 6 mph wind at 90° and dry soil at 58°F. POST treatments were applied to 2 to 3 trifoliolate soybeans, 5 inch redroot pigweed and waterhemp, 6 inch common lambsquarters, and 4 inch common ragweed on June 26 with 68°F, 34% relative humidity, 0% cloud cover, and 2.5 mph wind velocity at 315° and dry soil at 64°F. A second application of each treatment was applied to 6 inch common lambsquarters, 2 to 6 inch waterhemp, and 2 to 3 inch redroot pigweed on July 21 with 82°F, 77% humidity, 75% cloud cover, 8 mph wind at 135°, and dry soil at 76°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	6/26 popul.	7/7 popul.	7/12 vigor	7/12 inj	7/12 wahe	7/12 colq	7/12 corw	7/24 cover
	oz/A	pl/2 m	pl/2 m	%	%	%	%	%	%
Glyphosate[a]	12	27	24	60	10	97	93	95	28
Glyphosate+ALB5000	12+16	24	23	70	0	94	91	93	28
CV		23	30	9	0	3	4	5	10
LSD P=.05		13	16	10	.	7	8	10	6

Treatment	Rate	7/25 vigor	7/25 inj	7/25 wahe	7/25 colq	7/25 corw	8/31 height	10/9 yield
	oz/A	%	%	%	%	%	cm	bu/A
Glyphosate	12	68	23	92	97	84	34	11
Glyphosate+ALB5000	12+16	70	4	92	91	83	37	8
CV		5	17	20	3	2	13	36
LSD P=.05		8	5	10	6	4	10	8

[a] Glyphosate formulation was GlyStar Plus from Albaugh, LLC.

Redroot pigweed was completely controlled by both treatments. Weed control was similar between the treatments.

Dry weather resulted in poor plant establishment and growth. ALB5000 resulted in slightly better soybean growth early in the season; however, no difference was detected July 25. Soybean injury was less with the addition of ALB5000. Injury manifested as puckered leaves and restricted leaf development with less intense green color on newer tissue. The cause of this could not be determined. The injury did not appear on border plants and intensity was much greater with glyphosate alone.

On August 31, distance between lowest and highest pod on the stem was 34 cm in plots where glyphosate was applied alone and 37 cm with the addition of ALB5000. Yield was affected by dry weather in the area as bulk field areas on the farm produced about 18 bu/A. This trial was later maturing and was targeted by jackrabbits for much of the season, especially once other food sources senesced. This further reduced yield and resulted in more variance within treatment.

Genetic enhancer with Dicamba. Dr. Howatt, Mettler, and Harrington. 'AG09X6' soybean was seeded near Fargo on May 19. Preemergence treatments of metolachlor&metribuzin at 2.4 pounds per A was applied May 19 with 61°F, 28% relative humidity, 60% cloud cover, 6 mph wind velocity at 90° and dry soil at 58°F. Post treatments were applied to 2 to 3 trifoliolate soybean, 6 inch common lambsquarters, 4 inch common ragweed, and 5 inch redroot pigweed and waterhemp on June 26 with 68°F, 34% relative humidity, and 0% cloud cover, 2 to 4 mph wind velocity at 315° and dry soil at 64°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 compete block design with four replicates.

Treatment	Rate	6/26 popul.	7/7 popul.	7/12 vigor	7/12 inj	7/12 wahe	7/12 colq	7/12 corw
	oz/A	pl/2 m	pl/2 m	%	%	%	%	%
Dicamba[a]	8	32	26	63	5	86	84	86
Dicamba+ALB5000	8+16	29	27	60	5	85	85	85
Dicamba+ALB5000	8+24	33	28	60	5	85	84	85
CV		19	16	9	0	1	3	2
LSD P=.05		10	8	10	.	2	4	2

Treatment	Rate	7/24 cover	7/24 vigor	7/24 wahe	7/24 colq	7/24 corw	8/31 height	10/9 yield
	oz/A	%	%	%	%	%	cm	bu/A
Dicamba	8	37	77	96	92	97	50	19
Dicamba+ALB5000	8+16	25	70	89	85	90	56	17
Dicamba+ALB5000	8+24	30	75	89	80	94	48	15
CV		13	7	3	2	4	12	20
LSD P=.05		7	9	5	3	6	10	6

[a] Dicamba formulation was Xtendimax from Monsanto Company.

Redroot pigweed was completely controlled by all treatments. Weed control was similar among the treatments on July 12. But on July 24, weed control was less when ALB5000 was included compared with dicamba alone.

Dry weather resulted in poor plant establishment and growth. ALB5000 tended to promote slightly better soybean growth. Minor soybean injury was observed July 12 but not later in the season. This injury was not affected by addition of ALB5000. Injury manifested as slight paler green color. The cause of this could not be determined. The injury did not appear on border plants.

On August 31, distance between lowest and highest pod on the stem was 50 cm in plots where dicamba was applied alone, 56 cm with addition of 16 oz ALB5000, and 48 cm with 24 oz ALB5000. Yield was affected by dry weather in the area as bulk field areas on the farm produced about 18 bu/A. This trial also suffered jackrabbits feeding damage for much of the season, especially once other food sources senesced. This resulted in more variance within treatment.

Genetic enhancer effect on competition between soybean and weeds. Dr. Howatt, Mettler, and Harrington. RR2X 'ND12-24081' soybean was seeded near Fargo on May 19. The first application of treatments was applied to 2 to 3 trifoliolate soybeans, 4 inch common lambsquarters, 2 inch common ragweed, and 2 to 5 inch redroot pigweed and waterhemp on June 26 with 68°F, 34% relative humidity 0% cloud cover, 2 mph wind velocity at 315° and dry soil at 64°F. The second application was applied to 6 inch common lambsquarters, 2 to 6 inch waterhemp, and 2 to 3 inch redroot pigweed on July 21 with 82°F, 77% relative humidity, 75% cloud cover, 7 mph wind velocity at 135° and dry soil at 76°F. Treatments were applied with a backpack sprayer delivering 8.5 gpa at 40 psi through TT11001 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	6/26 popul.	7/7 popul.	7/12 vigor	7/12 inj.	7/12 wahe	7/12 colq	7/12 corw
	oz/A	pl/ 2 m	pl/2 m	%	%	%	%	%
Handweeded Check	0	23	26	70	0	100	100	100
Glyt/Glyt[a]	12/12	24	24	70	8	90	93	93
Glyt+ALB5000/Glyt+ALB5000	12+16/12+16	20	22	70	7	85	89	89
Untreated Check	0	21	22	60	2	0	0	0
CV		24	14	11	89	6	3	2
LSD P=.05		6	4	10	4	5	3	2

Treatment	Rate	7/24 cover	7/24 vigor	7/24 inj	7/24 wahe	7/24 colq	8/31 height	10/9 yield
	oz/A	%	%	%	%	%	cm	bu/A
Handweeded Check	0	25	67	0	100	100	30	6
Glyt/Glyt	12/12	18	62	16	70	95	30	8
Glyt+ALB5000/Glyt+ALB5000	12+16/12+16	20	56	5	74	83	30	5
Untreated Check	0	10	37	0	0	0	7	0
		16	24	75	20	5	14	44
		4	16	5	15	4	4	4

[a] Glyphosate formulation was GlyStar Plus from Albaugh, LLC.

Redroot pigweed was completely controlled by both treatments. Weed control on July 12 was slightly better with glyphosate alone than when ALB5000 was added. This was more evident with common lambsquarters on July 24 with a difference in control of 12 percentage points.

Dry weather resulted in poor plant establishment and growth. No difference in vigor was detected among hand weeded, glyphosate, and glyphosate plus ALB5000 treatments. Soybean injury was present in herbicide-treated plots. Injury was much less on July 24 with the addition of ALB5000. Injury manifested as puckered leaves and restricted leaf development with less intense green color on newer tissue. The cause of this could not be determined. The injury did not appear on plants in the hand weeded check.

On August 31, distance between lowest and highest pod on the stem was 30 cm in the hand weeded check, 30 cm in plots where glyphosate was applied alone, 30 cm with the addition of ALB5000, and 7 cm in the untreated check. Yield was affected by dry weather in the area as bulk field areas on the farm produced about 18 bu/A. This trial was later maturing and was targeted by jackrabbits for much of the season, especially once other food sources senesced. This further reduced yield and resulted in more variance within treatment.