Glyphosate with adjuvants. Zollinger, Richard K., Jerry L. Ries, and Angela J. Kazmierczak. An experiment was conducted near Mapleton, ND to evaluate weed efficacy with glyphosate and various adjuvants. Pioneer '39D81' conventional corn, Pioneer '63M80' conventional sunflower, tame buckwheat, 'Golden' flax, 'quinoa' (*Chenopodium quinoa*) and 'Plainsman' amaranth were planted perpendicular to each plot length on May 20, 2008. POST treatments were applied on July 14, at 10:00 am with 80 F air, 86 F soil surface, 44% relative humidity, 0% cloud cover, 3 to 8 mph S wind, dry soil surface, moist subsoil, good crop vigor, and no dew present. Species stages at time of application were: 20 to 28 inch (V6 to V7, 1 to 5/ft^2) corn; 24 to 30 inch (V10 to V14, 1 to 5/ft^2) sunflower; 8 to 16 inch (10 to 25/ft^2) tame buckwheat; 8 to 20 inch (10 to 30/ft^2) flax; 6 to 24 inch (1 to 10/ft^2) quinoa; and 6 to 14 inch (5 to 20/ft^2) amaranth. 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 through11001 Turbo TeeJet nozzles. The experiment had a randomized complete block design with three replicates per treatment.

This study was designed to test several products that have been identified as being used in ND with many different herbicides. Some adjuvants have been reported to replace or enhance herbicide activity comparable to AMS. The objectives of this study was to use these adjuvants with glyphosate, without and with hard water. The leading practices of overcoming hard water herbicide antagonism involves at least 3 theories.
1. Sequestration - The sulfate (SO_3) from AMS sequester and precipitate antagonistic Ca, Mg, and others salts. Citric acid is another substance thought to sequester ions.

2. Chelation - the EDTA used in micronutrient solutions also is used in adjuvants.

3. pKa - lowering the pH of spray water below the important pKa values of herbicides by which the herbicide is changed to its acid form and is mostly non-reactive with unintentional ions.

Many adjuvants are classified as AMS replacement (Water Conditioners) or having ingredients that give these properties. To date there are no adjuvants of this type that nullify antagonistic ions and provide the same level of herbicide enhancement as AMS. Most adjuvants used in this study use one of these theories described above.

R-11 + AMS, Class Act NG, and UltraSurf AMS all contain the equivalent of 8.5 lb/100 gal AMS + NIS and are used as the standard to which the other adjuvants are compared.

Helm-Ade is an NIS by Helm-Agro and enhanced glyphosate without hard water which is expected as it contains no AMS. It has been used as an AMS replacement.

H_2O_2 (hydrogen peroxide) at 1 qt/A has been used with many herbicides labeled in cereal, corn, soybeans and others, used with sugarbeet micro-rates, with fungicides, and to prevent algae buildup in water tanks. Without hard water and for most species tested it did not perform better than no adjuvant and did not overcome hard water antagonism. One might wonder about the mode of action of H_2O_2 but effect on spray solution pH, herbicide interaction, leaf cuticular wax, nor the affect inside the plant is not known .

Monty's Fertilizer (MF) is labeled as an adjuvant (appears mostly as an NIS) for burn down weed control and for herbicide applications. It contains 8-16-8 and is used at 8 and 16 fl oz/100 gallon of water. The label refers to reducing surface tension and to act as a rapid transport vehicle to aid in systemic translocation. The adjuvant provided some enhancement to glyphosate without hard water but did not overcome hard water antagonism. This is not surprising as the sulfate in AMS is just as important as the NH_4 which Monty's Fertilizer does not have.

Synurgize contains AMS "salts" and NIS and may contain substances that act as AMS replacements and as a drift retardant. Synurgize partially enhanced the activity of glyphosate and did not overcome hard water antagonsim. The rate of Class Act NG and UltraSurf applied at 2.5% v/v gives 8.5 lb/100 gal water but the recommended and comparably lower rate of Synurgize at 1.5 and 2% would contain less AMS. Perhaps better results would occur if the rate was increased to 2.5% v/v.

DRA-10 contains 0.96% polyoxyethylene (ethylene oxide is what makes surfactants mix in water) and 99.04% not active ingredients and the distributing company reported this product is a new concept additive that maximizes glyphosate intake into weeds despite spray water pH, dust on weeds, and time-of-day application that supports reduced glyphosate rates during usual accepted conditions. Tests have been conducted comparing DRA-10 to other NIS and has been used as an AMS replacement. Another description of ingredients was provided as potable water interblended with 1% resins having (OCH2CG)2-nOH structure producing undamaged linear homopolymer chains which carry zero surface charge (nonionic) capability. The poly (ethylene oxide) may be considered a polymer by EPA. Without hard water and for most species tested it did not perform better than no adjuvant and did not overcome hard water antagonism.

Citron is mostly citric acid and recommends no NIS with partial or full load glyphosate solutions. Citron partially overcame hard water antagonism but did not optimize weed control.

Merge is an oil based adjuvant used in Canada and is similar to Dash used with Poast herbicide. It has been reported in Canada that Merge is the only adjuvant needed with glyphosate and will supply the deposition and absorption properties of NIS and sequestration properties of AMS. Merge is the only adjuvant needed with glyphosate. Previous research shows some oil adjuvants antagonize the activity of glyphosate because glyphosate is a water soluble herbicide. Merge did not provide the enhancement of NIS as compared to other NIS based adjuvants and did not overcome hard water antagonism.

AMADS contains monocarbamide dihydrogen sulfate (urea + sulfuric acid) and is the substance in many newly released adjuvants such as, Import (Precision Labs), Cut-Rate (Wilbur-Ellis, ET-4000 MK Ag Service, Hell-Fire (Helena), N-Tank (Adjuvants Plus). AMADS was formulated in a commercial glyphosate formulation and sold as Engame by UAP several years ago. AMADS enhanced glyphosate especially in controlling drought stressed weeds. Engame was discontinued because of very low acid pH (battery acid), applicator exposure, and corrosion to spray equipment. ET-4000 reduces spray solution pH but reportedly contains detoxified sulfuric acid which lessens the risk of human exposure to those mixing and applying. AMADS reduces the spray solution to pH 2 or lower which is below the 3 pKa values of glyphosate (pKa 1 - 2.2 to 2.6, pKa 2 - 5.5 to 5.9, pKa 3 - 10.1-10.9). Reducing the spray solution pH also converts glyphosate to the acid form and makes glyphosate mostly non-reactive with antagonistic ions. AMADS and ET-4000 partially overcame hard water antagonism but not optimize glyphosate activity to the level of AMS + NIS adjuvants.

In summary, no adjuvant tested enhanced and optimized the activity of glyphosate nor overcame hard water antagonism to the same level as AMS + NIS adjuvants.
(Department of Plant Sciences, North Dakota State University, Fargo).

Table. Glyphosate with adjuvants (Zollinger, Ries, Kazmierczak).

Treatment	Rate	DW*	HW**	14 DAT					
				Corn	Sunflower	Tabw[1]	Flax	Quinoa	Amaranth
	(product/A)			% control					
RU PowerMax+	8fl oz+	x		60	50	45	43	99	99
			x	45	40	29	30	53	99
R-11+AMS	0.25%v/v+1lb	x		90	82	86	93	99	99
			x	90	88	89	92	96	99
Class Act NG	2.5% v/v	x		93	84	93	97	99	99
			x	94	89	92	87	96	99
UltraSurf AMS	2.5% v/v	x		85	78	90	82	99	99
			x	83	80	85	87	93	99
Helm-Ade	0.25% v/v	x		60	72	68	42	99	99
			x	50	62	45	30	70	99
Helm-Ade	0.5% v/v	x		67	73	75	43	99	99
			x	50	70	45	32	70	99
H202	1 pt	x		65	70	38	48	99	99
			x	32	53	23	25	60	99
Monty's Fertilizer	0.5 pt	x		60	70	50	66	99	99
			x	30	60	30	32	60	99
Monty's Fertilizer	1 pt	x		62	77	62	75	99	99
			x	32	62	32	35	60	99
Synurgize	1.5 qt	x		60	67	55	65	99	99
			x	45	60	37	40	60	99
Synurgize	2 qt	x		63	70	58	73	99	99
			x	53	67	45	47	73	99
DRA-10	0.5fl oz/gal	x		57	70	42	37	99	99
			x	33	60	30	33	65	99
DRA-10	1fl oz/gal	x		62	70	42	43	99	99
			x	47	65	38	42	70	99
Citron	2.2lb/100 gal	x		60	73	50	45	99	99
			x	43	73	47	47	73	99
Merge	0.5% v/v	x		50	67	43	45	99	99
			x	42	62	38	40	65	99
ET 4000	1% v/v	x		82	82	67	75	99	99
			x	80	75	63	71	83	99
AMADS	0.5% v/v	x		91	78	83	92	99	99
			x	84	77	78	82	96	99
LSD (0.05)				5	6	8	8	5	NS

*DW = Treatments applied with distilled water.
**HW = Treatments were applied with water containing 194 ppm calcium and 302 ppm magnesium.

AMS replacements with hard water. Zollinger, Richard K., Jerry L. Ries, and Angela J. Kazmierczak. An experiment was conducted near Mapleton, ND, to evaluate weed efficacy with various ammonium sulfate replacements and hard water. Pioneer '39D81' conventional corn, Pioneer '63M80' conventional sunflower, tame buckwheat, 'Golden' flax, 'quinoa' (*Chenopodium quinoa*) and 'Plainsman' amaranth were planted perpendicular to each plot length on May 20, 2008. POST treatments were applied on July 15, at 9:10 am with 72 F air, 76 F soil surface, 50% relative humidity, 0% cloud cover, 0 wind, dry soil surface, moist subsoil, good crop vigor, and no dew present. Species stages at time of application were: 20 to 30 inch (V6 to V7, 3 to 5/ft^2) corn; 20 to 32 inch (V12 to V14, 5 to 10/ft^2) sunflower; 10 to 20 inch (10 to 20/ft^2) tame buckwheat; 12 to15 inch (10 to 30/ft^2) flax; 10 to 24 inch (5 to 25/yd^2) quinoa; and 6 to 18 inch (10 to 25/ft^2) amaranth. 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.

Treatments were applied at 500 ppm hard water, a natural North Dakota water source. (Department of Plant Sciences, North Dakota State University, Fargo).

Table. AMS replacements with hard water (Zollinger, Ries, and Kazmierczak).

		14 DAT					
Treatment[1]	Rate	Corn	Sunflower	Tabw[1]	Flax	Quinoa	Amaranth
	(product/A)	% control					
Buccaneer Plus+	1pt+	65	63	57	57	73	82
N-Pac AMS	5% v/v	95	87	89	93	99	99
Class Act NG	2.5% v/v	90	88	90	93	99	99
Alliance	1.25% v/v	82	77	73	84	98	96
AG 07046	2.5% v/v	90	78	89	89	99	99
AG 07046	1.25% v/v	73	68	62	82	92	92
Placement Propak	1% v/v	68	67	60	67	85	82
AG 07043	1% v/v	65	65	60	57	83	83
AG 07089	1% v/v	57	65	43	42	78	78
AG 07090	1% v/v	53	67	53	50	80	80
AG 03019	0.5% v/v	62	73	47	55	80	82
AG 08040	0.5% v/v	70	72	69	73	90	92
LSD (0.05)		6	7	8	7	4	5

[1]AG = proprietary compounds from Winfield Solutions.
[2]Tabw = Tame buckwheat.

Buccaneer plus adjuvants. Zollinger, Richard K., Jerry L. Ries, and Angela J. Kazmierczak. An experiment was conducted near Mapleton, ND, to evaluate weed efficacy with Buccaneer and various adjuvants. Four rows of DeKalb 'DKC38-92' corn were planted to each plot length. Asgrow 'AG0604' soybean, 'Cavalier' conventional soybean, tame buckwheat, 'Golden' flax, 'Beach' oat, 'Siberian' foxtail millet, and 'Westford' forage barley were planted perpendicular to each plot length on June 19, 2008. POST treatments were applied on July 31, at 9:55 am with 77 F air, 83 F soil surface, 68% relative humidity, 10% cloud cover, 1 to 3 mph N wind, wet soil surface, wet subsoil, excellent crop vigor, and no dew present to 24 to 36 inch corn. Species stages present at time of application were: 12 to 18 inch soybean; 12 to 20 inch (V4 to V7, R1, 3 to 10/ft^2) conventional soybean; 12 to 30 inch (15 to 25/ft^2) tame buckwheat; 12 to 24 inch (20 to 30/ft^2) flax; 20 to 24 inch (20 to 30/ft^2) oat; 18 to 24 inch (15 to 25/ft^2) foxtail millet; and 12 to 18 inch (15 to 25/ft^2) forage barley. 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.

All adjuvants enhanced the glyphosate + oil soluble herbicide mixtures generally similar. (Department of Plant Sciences, North Dakota State University, Fargo).

Table. Buccaneer plus adjuvants (Zollinger, Ries, and Kazmierczak).

		14 DAT							
Treatment	Rate	Soybean	Tabw[1]	Flax	Oat	Fomi[2]	Foba[3]	RR soy	RR corn
	(product/A)	% control							
Buccaneer Plus+	16fl oz+	52	43	53	80	99	74	0	0
Premium AMS	1lb	85	60	70	96	99	96	0	0
Laudis+Premium AMS	2fl oz+1lb	95	72	67	93	99	95	43	0
Laudis+N-Tense	2fl oz+0.5% v/v	85	67	67	94	99	96	47	0
Laudis+WC 073	2fl oz+0.75% v/v	88	67	70	96	99	93	43	0
Laudis+N-Tense+Trophy Gold	2fl oz+0.25% v/v+0.25% v/v	90	63	67	98	99	96	58	0
Laudis+Destiny HC	2fl oz+1.5pt	87	63	55	96	99	91	50	0
Imapct+N-Tense	0.33fl oz+0.5% v/v	85	63	57	90	99	96	40	0
Imapct+N-Tense	0.5fl oz+0.5% v/v	82	70	72	90	99	95	43	0
Impact+Destiny HC	0.5fl oz+1.5pt	87	65	57	95	98	93	40	0
Callisto+N-Tense	2fl oz+0.5% v/v	93	70	77	96	99	97	30	0
LSD (0.05)		8	9	9	8	1	5	13	NS

[1]Tabw = Tame buckwheat.

[2]Fomi = Foxtail millet.

[3]Foba = Forage barley.

[4]RR soy = Roundup Ready soybean.

[5]RR corn = Roundup Ready .

Volunteer corn control. Zollinger, Richard K. and Jerry L. Ries. An experiment was conducted near Casselton, ND, to evaluate volunteer corn control. Four rows per plot of DeKalb 'DKC38-92' Roundup Ready volunteer corn was planted on May 9, 2008. POST applications were applied on June 30 at 12:45 pm with 84 F air, 87 F soil surface, 37% relative humidity, 15% clouds, 3 to 7 mph SW wind, moist soil surface and wet subsoil, good crop vigor, and no dew present to V5 to V7 (18 to 24 inch) corn. Weed species present at the time of POST applications were: cotyledon to 20 inch (5 to 20/yd^2) common lambsquarters; and 12 to 18 inch diameter (5 to 15/yd^2) wild buckwheat. Treatments were applied to the center 6.7 feet of the 10 by 40 foot plot 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.

Roundup Ready corn was planted so only Section herbicide had activity on corn. Glyphosate showed activity on broadleaf weeds. Petroleum oil antagonized weed control. (Dept of Plant Sciences, North Dakota State University, Fargo).

Table. Volunteer corn control (Zollinger and Ries).

		14 DAT			28 DAT		
Treatment[1]	Rate	Colq	Wibw	Corn	Colq	Wibw	Corn
	(product/A)	----- % control -----			----- % control -----		
TD HiTech+Section	11fl oz+3fl oz	48	27	35	52	30	35
TD HiTech+Section+N-Pac AMS	11fl oz+3fl oz+2.5% v/v	68	43	49	68	43	52
TD HiTech+Section+Preference+ N-Pac AMS	11fl oz+3fl oz+0.25% v/v+ 2.5% v/v	88	74	74	88	75	77
TD HiTech+Section+Preference+ PrimeOil+N-Pac AMS	11fl oz+3fl oz+0.25% v/v+ 0.25% v/v+2.5% v/v	79	65	68	56	65	72
Section+Superb HC+N-Pac AMS	3fl oz+0.5% v/v+2.5% v/v	0	0	72	0	0	92
Section+AG 05006+N-Pac AMS	3fl oz+0.5% v/v+2.5% v/v	0	0	68	0	0	93
LSD (0.05)		3	6	11	11	8	9

[1]TD HiTech = Touchdown HiTech; AG 05006 = a proprietary product from Winfield Solutions.

Glyphosate with NIS. Zollinger, Richard K., Jerry L. Ries, and Angela J. Kazmierczak. An experiment was conducted near Mapleton, ND, to evaluate weed efficacy with glyphosate various NIS formulations. Pioneer '39D81' conventional corn, Pioneer '63M80' conventional sunflower, tame buckwheat, 'Golden' flax, 'quinoa' (*Chenopodium quinoa*) and 'Plainsman' amaranth were planted perpendicular to each plot length on May 20, 2008. POST treatments were applied on July 15, at 9:20 am with 73 F air, 76 F soil surface, 51% relative humidity, 0% cloud cover, 0 wind, dry soil surface, moist subsoil, good crop vigor, and no dew present. Species stages at time of application were: 20 to 30 inch (V6 to V7, 3 to 5/ft^2) corn; 20 to 32 inch (V12 to V14, 5 to 10/ft^2) sunflower; 10 to 20 inch (10 to 20/ft^2) tame buckwheat; 12 to15 inch (10 to 30/ft^2) flax; 10 to 24 inch (5 to 25/yd^2) quinoa; and 6 to 18 inch (10 to 25/ft^2) amaranth. 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.

Generally, the better adjuvants were AG 5045 = AG 6001 > AG 3019. All other adjuvants were inferior. (Department of Plant Sciences, North Dakota State University, Fargo).

Table. Glyphosate with NIS (Zollinger, Ries, and Kazmierczak).

		14 DAT					
Treatment[1]	Rate	Corn	Sunflower	Tabw[2]	Flax	Quinoa	Amaranth
	(product/A)	- - - - - - - - - - - - - - - - - - % control - - - - - - - - - - - - - - - - - -					
Buccaneer Plus+	12fl oz+	55	60	47	58	67	63
AG 03019	0.25% v/v	75	77	65	79	88	85
AG 03037	0.25% v/v	70	78	72	72	82	80
AG 05045	0.25% v/v	76	75	75	87	92	85
AG 06001	0.25% v/v	75	75	81	82	92	70
AG 06011	5fl oz	68	67	70	77	73	70
AG 06099	0.25% v/v	70	72	63	72	82	80
AG 07008	0.25% v/v	65	70	63	68	78	82
AG 08005	0.5% v/v	65	68	62	65	75	77
LSD (0.05)		7	7	8	8	5	7

[1]AG = proprietary compounds from Winfield Solutions.
[2]Tabw = Tame buckwheat.

Controlling volunteer corn with Buccaneer Plus and adjuvants. Zollinger, Richard K. and Jerry L. Ries. An experiment was conducted near Casselton, ND, to evaluate volunteer corn control. Four rows per plot of DeKalb 'DKC38-92' Roundup Ready volunteer corn was planted on May 9, 2008. POST applications were applied on June 30 at 12:30 pm with 84 F air, 87 F soil surface, 32% relative humidity, 15% clouds, 3 to 7 mph SW wind, moist soil surface and wet subsoil, good crop vigor, and no dew present to V5 to V7 (18 to 24 inch) corn. Weed species present at the time of POST applications were: cotyledon to 3 inch (10 to 30/yd^2) venice mallow; and 12 to 18 inch diameter (5 to 15/yd^2) wild buckwheat. Treatments were applied to the center 6.7 feet of the 10 by 40 foot plot 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.

Generally, weed control increased as adjuvant concentration increased. (Dept of Plant Sciences, North Dakota State University, Fargo).

Table. Controlling volunteer corn with Buccaneer Plus and adjuvants (Zollinger and Ries).

		14 DAT			28 DAT		
Treatment	Rate	Vema	Wibw	Corn	Vema	Wibw	Corn
	(product/A)	----- % control -----			----- % control -----		
Buccaneer Plus +	16 fl oz +	43	33	0	53	42	0
Premium AMS	1lb	45	45	0	88	89	0
N-Tense	0.25% v/v	53	48	0	72	62	0
N-Tense	0.5% v/v	55	55	0	77	75	0
Veracity	0.5% v/v	37	35	0	47	42	0
Veracity	0.75% v/v	65	67	0	78	68	0
Veracity	1% v/v	68	68	0	85	83	0
Volunteer+N-Tense	3fl oz+0.5% v/v	52	47	69	62	58	88
Volunteer+Veracity	3fl oz+0.75% v/v	47	33	74	58	45	83
Volunteer+N-Tense+Trophy Gold	3fl oz+0.25% v/v+0.25% v/v	57	43	73	57	47	75
Volunteer+Premium COC+Premium AMS	3fl oz+0.5% v/v+1lb	60	45	70	63	52	90
LSD (0.05)		9	8	5	7	7	4

Glyphosate + oil adjuvants. Zollinger, Richard K., Jerry L. Ries, and Angela J. Kazmierczak. An experiment was conducted near Mapleton, ND, to evaluate weed efficacy with glyphosate and various oil adjuvants. 'Cavalier' conventional soybean, tame buckwheat, 'Golden' flax, 'Beach' oat, 'Siberian' foxtail millet, and 'Westford' forage barley were planted perpendicular to each plot length on June 19, 2008. POST treatments were applied on July 30, at 8:10 am with 68 F air, 70 F soil surface, 82% relative humidity, 0% cloud cover, 0 to 3 mph NW wind, dry soil surface, moist subsoil, excellent crop vigor, and no dew present. Species stages at time of application were: 8 to 14 inch (V6 to V8, 5 to 15/ft^2) soybean; 14 to 18 inch (10 to 20/ft^2) tame buckwheat; 10 to 18 inch (10 to 25/ft^2) flax; 18 to 24 inch (10 to 20/ft^2) oat; 18 to 24 inch (10 to 20/ft^2) foxtail millet; and 8 to 12 inch (5 to 15/ft^2) forage barley. 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.

Class Act NG enhanced weed control the most. Prime Oil (petroleum oil) antagonized glyphosate while Superb HC (high surfactant petroleum oil concentrate) and Destiny HC (high surfactant methylated seed oil concentrate) overcame some of the antagonism. (Department of Plant Sciences, North Dakota State University, Fargo).

Table. Glyphosate + oil adjuvants (Zollinger, Ries, and Kazmierczak).

		14 DAT					
Treatment[1]	Rate	Soybean	Tabw[2]	Flax	Oat	Fomi[3]	Foba[4]
	(product/A)	% control					
TD Hi-Tech+Laudis+	6.4fl oz+1fl oz+	18	18	18	13	63	18
N-Pac AMS	2.5% v/v	28	32	23	43	89	35
Class Act NG	2.5% v/v	88	52	62	88	96	78
Prime Oil+N-Pac AMS	1% v/v+2.5% v/v	22	22	13	25	72	28
Superb HC+N-Pac AMS	0.5% v/v+2.5% v/v	67	35	37	73	90	49
Destiny+N-Pac AMS	1% v/v+2.5% v/v	50	26	33	58	82	37
Destiny HC+N-Pac AMS	0.5% v/v+2.5% v/v	71	42	37	73	90	52
Destiny HC+N-Pac AMS	1% v/v+2.5% v/v	80	43	37	77	90	53
Alliance+AG 02013	1.25% v/v+4fl oz	57	37	32	67	88	43
Newtone	1% v/v	30	28	28	53	83	23
AG 07042+N-Pac AMS	0.5% v/v+2.5% v/v	72	22	33	70	90	50
AG 08040	1.5% v/v	35	28	25	57	91	58
AG 08005	1.5% v/v	37	27	29	50	85	33
AG 08005+N-Pac AMS	0.5% v/v+2.5% v/v	58	38	27	75	90	40
TD Hi-Tech+AG 02013+	6.4fl oz+4fl oz+						
Status+Superb HC+Alliance	2 oz+0.5% v/v+1.25% v/v	63	40	50	60	90	37
Status+Destiny HC+Alliance	2 oz+0.5% v/v+1.25% v/v	77	47	58	67	92	48
Superb HC+Alliance	0.5% v/v+1.25% v/v	73	38	47	83	93	60
AG 05006+Alliance	0.5% v/v+1.25% v/v	45	28	28	78	91	52
LSD (0.05)		7	8	6	10	6	8

[1]TD Hi-Tech =Touchdown Hi-Tech, AG = proprietary compounds from Winfield Solutions.
[2]Tabw = Tame buckwheat.
[3]Fomi = Foxtail millet.
[4]Foba = Forage barley.

UAP glyphosate formulations. Zollinger, Richard K., Jerry L. Ries, and Angela J. Kazmierczak. An experiment was conducted near Mapleton, ND, to evaluate weed efficacy with various glyphosate formulations. Pioneer '39D81' conventional corn, Pioneer '63M80' conventional sunflower, tame buckwheat, 'Golden' flax, 'quinoa' (*Chenopodium quinoa*) and 'Plainsman' amaranth were planted perpendicular to each plot length on May 20, 2008. POST treatments were applied on July 17, at 9:30 am with 63 F air, 66 F soil surface, 100% relative humidity, 100% cloud cover, 6 to 10 mph N wind, wet soil surface, wet subsoil, excellent crop vigor, and no dew present. Species stages at time of application were: 24 to 32 inch (V6 to V8, 3 to 5/ft^2) corn; 20 to 36 inch (V14 to V16, 5 to 10/ft^2) sunflower; 14 to 20 inch (10 to 20/ft^2) tame buckwheat; 18 to 24 inch (15 to 30/ft^2) flax; 8 to 24 inch (5 to 20/yd^2) quinoa; and 10 to 22 inch (1 to 20/ft^2) amaranth. 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. (Department of Plant Sciences, North Dakota State University, Fargo).

Table. UAP glyphosate formulations (Zollinger, Ries, and Kazmierczak).

		14 DAT					
Treatment[1]	Rate	Corn	Sunflower	Tabw[2]	Flax	Quinoa	Amaranth
	(product/A)	% control					
LI 6130	12fl oz	57	58	57	60	99	83
LI 6130+Choice Weathermaster	12fl oz+0.5% v/v	72	63	50	73	99	90
LI 6130+Choice Weathermaster	22fl oz+0.5% v/v	86	73	82	85	99	99
LI 6130+Choice Weathermaster	32fl oz+0.5% v/v	95	86	94	95	99	99
LI 6269	12fl oz	67	63	72	65	98	96
LI 6269+Choice Weathermaster	12fl oz+0.5% v/v	72	67	65	77	99	96
LI 6269+Choice Weathermaster	22fl oz+0.5% v/v	83	80	83	92	99	98
LI 6269+Choice Weathermaster	32fl oz+0.5% v/v	91	87	93	95	99	99
LSD (0.05)		5	7	8	5	2	7

[1]LI compounds = proprietary products from UAP.
[2]Tabw = Tame buckwheat.

Mad Dog with adjuvants. Zollinger, Richard K., Jerry L. Ries, and Angela J. Kazmierczak. An experiment was conducted near Mapleton, ND, to evaluate weed efficacy with Mad Dog and various adjuvants. Asgrow 'AG0604' Roundup Ready soybean, Pioneer '39D81' conventional corn, Pioneer '63M80' conventional sunflower, tame buckwheat, 'Golden' flax, 'quinoa' (*Chenopodium quinoa*) and 'Plainsman' amaranth were planted perpendicular to each plot length on May 20, 2008. POST treatments were applied on July 15 at 9:00 am with 72 F air, 76 F soil surface, 53% relative humidity, 0% cloud cover, 0 wind, dry soil surface, moist subsoil, good crop vigor, and no dew present. Species stages at time of application were: 20 to 24 inch (R1 to R2) soybean; 20 to 24 inch (V6 to V7, 3 to 5/ft^2) corn; 24 to 30 inch (V12 to V14, 5 to 10/ft^2) sunflower; 12 to 20 inch (10 to 20/ft^2) tame buckwheat; 14 to 20 inch (10 to 30/ft^2) flax; 6 to 24 inch (5 to 20/yd^2) quinoa; and 6 to 24 inch (5 to 20/ft^2) amaranth. 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.

Activity of glyphosate was greatest with adjuvants containing AMS at 8.5 lb/100 gal water, Class Act NG, Surfate at 2%, Powerhouse at 2.5%, and R-11 + AMS. There was little difference in affect from order of mixing In-Place. No crop injury was observed on soybean. (Department of Plant Sciences, North Dakota State University, Fargo).

Table. Mad Dog with adjuvants (Zollinger, Ries, and Kazmierczak).

Treatment	Rate	14 DAT						21 DAT					
		Corn	Snfl[1]	Tabw[2]	Flax	Quinoa	Amar[3]	Corn	Snfl	Tabw	Flax	Quinoa	Amar
	(product/A)	% control						% control					
Mad Dog+	12fl oz+	60	60	47	47	90	72	60	60	47	47	90	72
Alliance	1.125% v/v	70	60	70	68	99	90	70	60	70	77	99	90
Class Act NG	2.5% v/v	92	73	83	85	99	93	92	73	83	85	99	93
Surfate	1% v/v	72	72	63	63	99	67	72	72	65	68	99	62
Surfate	2% v/v	92	73	73	80	99	93	92	73	75	87	99	93
Powerhouse	1.125% v/v	81	65	62	67	99	83	81	65	65	77	99	83
Powerhouse	2.5% v/v	92	73	78	72	99	93	92	73	78	75	99	93
Helm-Ade	0.5% v/v	62	67	60	55	99	73	62	67	60	53	99	73
R-11+AMS	0.25% v/v+8.5lb/100 gal	95	72	80	88	99	94	95	72	83	86	99	94
Makaze+	32fl oz+												
Choice WeatherMaster+ InPlace+ZN EDTA 9%[4]	0.5% v/v+8fl oz+32fl oz	95	80	89	92	99	95	95	80	92	92	99	95
Choice WeatherMaster+ InPlace+ZN EDTA 9%[5]	0.5% v/v+2fl oz+32fl oz	95	80	95	95	99	93	95	80	95	95	99	93
Choice WeatherMaster+ InPlace+ZN EDTA 9%+In-Place[6]	0.5% v/v+8fl oz+32fl oz+2fl oz	95	62	95	96	99	95	95	82	95	96	99	95
LSD (0.05)		4	6	6	8	3	4	4	6	7	7	3	4

[1] Snfl = Sunflower.
[2] Tabw = Tame buckwheat.
[3] Amar = Amaranth.
[4] In-Place added to Makaze.
[5] In-Place added to ZN EDTA 9%.
[6] In-Place added to Makaze and ZN EDTA 9%.

Glyphosate formulations. Zollinger, Richard K., Jerry L. Ries, Angela J. Kazmierczak. An experiment was conducted near Mapleton, ND, to evaluate weed efficacy with various glyphosate formulations. Pioneer '39D81' conventional corn, Pioneer '63M80' conventional sunflower, tame buckwheat, 'Golden' flax, 'quinoa' (*Chenopodium quinoa*) and 'Plainsman' amaranth were planted perpendicular to each plot length on May 20, 2008. POST treatments were applied on July 17, at 9:00 am with 63 F air, 66 F soil surface, 100% relative humidity, 100% cloud cover, 6 to 10 mph N wind, wet soil surface, wet subsoil, excellent crop vigor, and no dew present. Species stages at time of application were: 24 to 32 inch (V6 to V8, 3 to 5/ft^2) corn; 20 to 36 inch (V14 to V16, 5 to 10/ft^2) sunflower; 14 to 20 inch (10 to 20/ft^2) tame buckwheat; 18 to 24 inch (15 to 30/ft^2) flax; 8 to 24 inch (5 to 20/yd^2) quinoa; and 10 to 22 inch (1 to 20/ft^2) amaranth. 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.

Of the coded glyphosate formulations, MON 76237 generally gave the highest weed control of those applied at higher rates. Durango and Buccaneer + R-11 generally gave the highest weed control of the disclosed formulations. (Department of Plant Sciences, North Dakota State University, Fargo).

Table. Glyphosate formulations (Zollinger, Ries, and Kazmierczak).

Treatment[1]	Rate	14 DAT						21 DAT					
		Corn	Snfl[2]	Tabw[3]	Flax	Quinoa	Amar[4]	Corn	Snfl	Tabw	Flax	Quinoa	Amar
	(product/A)	% control						% control					
MON 76238	8fl oz	50	62	57	65	96	73	50	62	57	65	96	73
MON 76237	8fl oz	57	63	58	52	93	75	57	63	58	52	93	75
MON 76790	8fl oz	57	60	67	62	98	70	57	60	67	62	98	70
MON 76301	8fl oz	70	60	70	63	88	81	70	60	70	67	88	81
MON 76410	8fl oz	73	60	43	58	83	80	73	60	43	58	83	80
MON 76186	8fl oz	60	58	47	53	83	82	60	58	47	53	83	82
MON 79415	8fl oz	70	70	67	73	96	83	70	70	67	73	96	83
MON 76238	10.8fl oz	68	67	73	77	90	87	68	67	78	82	92	87
MON 76237	10.8fl oz	75	70	75	85	93	88	77	75	77	80	96	92
MON 79790	10.8fl oz	75	67	67	65	95	78	75	67	72	72	95	78
MON 76301	10.8fl oz	70	70	72	77	96	85	70	70	72	73	96	85
MON 76410	10.8fl oz	73	75	67	75	90	83	73	75	67	72	90	83
MON 76186	10.8fl oz	73	73	57	53	93	86	73	73	57	53	93	86
MON 76415	10.8fl oz	60	62	50	60	91	85	60	62	50	60	91	85
Touchdown Total	11.6fl oz	57	62	43	47	87	82	57	62	43	47	87	82
TD Hi-Tech+LI-700	6.7fl oz+0.25% v/v	60	63	53	37	90	80	60	63	53	37	90	80
Glyphomax XRT	12.2fl oz	75	60	57	43	90	77	75	60	68	57	90	77
Durango DMA	12.2fl oz	72	73	85	87	96	95	72	73	85	88	96	95
Buccaneer Plus+R-11	16.2fl oz+0.25% v/v	72	72	78	83	95	93	72	72	82	88	95	93
Helostate 70	9.7fl oz	73	70	75	83	96	96	73	70	78	85	96	96
LSD (0.05)		8	5	13	11	7	8	8	5	12	9	6	7

[1]MON = proprietary products from Monsanto; TD Hi-Tech = Touchdown Hi-Tech.
[2]Snfl = Sunflower.
[3]Tabw = Tame buckwheat.
[4]Amar = Amaranth.

Glyphosate + herbicides with pH. Zollinger, Richard K., Jerry L. Ries, and Angela J. Kazmierczak. An experiment was conducted near Mapleton, ND, to evaluate weed efficacy with glyphosate with herbicides and adjuvants at various pH levels. 'Cavalier' conventional soybean, tame buckwheat, 'Golden' flax, 'quinoa (*Chenopodium quinoa*), 'Siberian' foxtail millet, and 'Westford' forage barley were planted perpendicular to each plot length on June 19, 2008. POST treatments were applied on July 31 at 10:35 am with 77 F air, 83 F soil surface, 72% relative humidity, 0% cloud cover, 3 to 6 mph N wind, dry soil surface, moist subsoil, excellent crop vigor, and no dew present. Species stages at time of application were: 12 to 20 inch (V4 to V7, R1, 3 to 10/ft^2) soybean; 12 to 30 inch (15 to 25/ft^2) tame buckwheat; 12 to 24 inch (20 to 30/ft^2) flax; 12 to 30 inch (5 to 10/ft^2) quinoa; 18 to 24 inch (15 to 25/ft^2) foxtail millet; and 12 to 18 inch (15 to 25/ft^2) forage barley. 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 with nitrogen gas through 11001 Turbo TeeJet nozzles. The experiment had a randomized complete block design with three replicates per treatment.

The objective was observe the affect of spray solution pH on weed control by using adjuvants to produce a desired spray solution pH: Surfate = pH 8; ClassAct = pH 6.5; AMADS = pH 2. For most bioassay species there was little affect. However, soybean control was greatest at more neutral pH of 6.5. Laudis activity was least at the lowest pH of 2 which supports water solubility physical characteristics of Laudis where solubility increases as pH increases. (Department of Plant Sciences, North Dakota State University, Fargo).

Table. Glyphosate + herbicides with pH (Zollinger, Ries, and Kazmierczak).

		14 DAT					
Treatment	Rate	Soybean	Tabw[1]	Flax	Quinoa	Fomi[2]	Foba[3]
	(product/A)	% control					
RU PowerMax+AMS	7.1fl oz+8.5lb/100 gal	37	53	60	92	99	98
Accent+NIS+AMS	0.33oz+0.25% v/v+8.5lb/100 gal	7	20	10	5	50	22
FirstRate+NIS+AMS	0.1oz+0.25%+8.5lb/100 gal	0	20	8	10	5	5
Laudis+Destiny HC+AMS	1fl oz+0.5pt+8.5lb/100 gal	2	0	12	0	0	0
RU PowerMax+	7.1fl oz+						
Accent+Surfate	0.33oz+2.5% v/v	86	67	62	93	99	98
Accent+Class Act NG	0.33oz+2.5% v/v	93	65	57	96	99	95
Accent+NIS+AMADS	0.33oz+0.25% v/v+0.5% v/v	57	57	58	92	99	95
FirstRate+Surfate	0.1oz+2.5% v/v	60	62	53	87	99	93
FirstRate+Class Act NG	0.1oz+2.5% v/v	78	60	68	93	99	95
FirstRate+NIS+AMADS	0.1oz+0.25% v/v+0.5% v/v	27	57	62	93	99	96
Laudis+Destiny HC+Surfate	1fl oz+0.5pt+2.5% v/v	92	72	72	95	99	96
Laudis+Destiny HC+Class Act NG	1fl oz+0.5pt+2.5% v/v	93	53	48	92	99	95
Laudis+Destiny HC+AMADS	1fl oz+0.5pt+0.5% v/v	73	62	62	87	99	96
LSD (0.05)		9	10	9	8	4	6

[1]Tabw = Tame buckwheat.
[2]Fomi = Foxtail millet.
[3]Foba = Forage barley.

Ignite with AMS. Zollinger, Richard K., Jerry L. Ries, and Angela J. Kazmierczak. An experiment was conducted near Mapleton, ND, to evaluate weed efficacy with Ignite and various AMS rates and water quality. Pioneer '39D81' conventional corn, Pioneer '63M80' sunflower, 'quinoa' (*Chenopodium quinoa*), 'Plainsman' amaranth 'Siberian' foxtail millet, and 'Westford' forage barley were planted perpendicular to each plot length on June 19, 2008. POST treatments were applied on July 21 at 10:15 am with 76 F air, 79 F soil surface, 65% relative humidity, 0% cloud cover, 3 to 7 mph NW wind, dry soil surface, moist subsoil, excellent crop vigor, and no dew present. Species stages at time of application were: 8 to 20 inch (V3 to V6, 3 to 6/ft^2) corn; 10 to 26 inch (V8 to V12, 3 to 5/ft^2) sunflower; 4 to 14 inch (15 to 40/yd^2) quinoa; 4 to12 inch (5 to 20/ft^2) amaranth; 6 to 12 inch (15 to 30/ft^2) foxtail millet; and 6 to 14 inch (15 to 30/ft^2) forage barley. 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.

In is not known why control from AMS at 8.5 lb/100 gallon water was lower than at 4.25 or 17 lb/100 gallon water. (Department of Plant Sciences, North Dakota State University, Fargo).

Table. Ignite with AMS (Zollinger, Ries, and Kazmierczak).

		14 DAT					
Treatment	Rate	Corn	Sunflower	Quinoa	Amaranth	Foxtail millet	Forage barley
	(product/A)	% control					
0 ppm							
Ignite+	8fl oz+	20	30	37	23	93	17
AMS	4.25lb/100 gal	50	73	73	66	95	40
AMS	8.5lb/100 gal	50	53	43	35	94	27
AMS	17lb/100 gal	70	88	73	75	99	45
500 ppm of a natural water source containing 194 ppm calcium and 302 ppm magnesium.							
Ignite+	8fl oz+	28	40	57	29	96	22
AMS	4.25lb/100 gal	66	73	68	53	99	27
AMS	8.5lb/100 gal	77	63	48	50	93	38
AMS	17lb/100 gal	73	82	84	72	99	33
1000 ppm of a natural water source containing 388 ppm calcium and 604 ppm magnesium.							
Ignite+	8fl oz+	37	48	60	23	83	23
AMS	4.25lb/100 gal	45	73	67	47	95	45
AMS	8.5lb/100 gal	67	60	65	33	99	33
AMS	17lb/100 gal	67	86	73	69	99	52
LSD (0.05)		9	10	8	8	6	7

Ignite with adjuvants. Zollinger, Richard K., Jerry L. Ries and Angela J. Kazmierczak. An experiment was conducted near Mapleton, ND, to evaluate weed efficacy with Ignite and adjuvants. Pioneer '39D81' conventional corn, Pioneer '63M80' conventional sunflower, 'quinoa' (*Chenopodium quinoa*), 'Plainsman' amaranth 'Siberian' foxtail millet, and 'Westford' forage barley were planted perpendicular to each plot length on June 19, 2008. POST treatments were applied on July 22 at 9:40 am with 75 F air, 84 F soil surface, 60% relative humidity, 0% cloud cover, 5 to 8 mph SE wind, dry soil surface, moist subsoil, excellent crop vigor, and no dew present. Species stages at time of application were: 14 to 30 inch (V5 to V7, 1 to 5/ft^2) corn; 28 to 30 inch (V12 to V14, 5 to 8/ft^2) sunflower; 6 to 18 inch (5 to 40/yd^2) quinoa; 6 to16 inch (5 to 15/ft^2) amaranth; 10 to 16 inch (20 to 30/ft^2) foxtail millet; and 10 to 14 inch (15 to 30/ft^2) forage barley. 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.

Adjuvants that gave the higher herbicide enhancement was AMS at 8.5 lb/100 gallons water, Class Act NG, UltraSurf AMS, and WE-5078/5070. (Department of Plant Sciences, North Dakota State University, Fargo).

Table. Ignite with adjuvants (Zollinger, Ries, and Kazmierczak).

		14 DAT					
Treatment[1]	Rate	Corn	Sunflower	Quinoa	Amaranth	Fomi[2]	Foba[3]
	(product/A)	% control					
0 ppm							
Ignite+	8fl oz+	23	40	27	27	83	10
AMS	4.25lb/100 gal	48	52	57	52	94	30
AMS	8.5lb/100 gal	57	73	74	57	92	37
500 ppm of a natural water source containing 194 ppm calcium and 302 ppm magnesium.							
Ignite+	8fl oz+	25	63	43	30	96	20
AMS	4.25lb/100 gal	40	62	60	43	96	32
AMS	8.5lb/100 gal	57	62	68	65	96	30
Class Act NG	2.5% v/v	58	73	73	63	97	37
AG 07046	2.5% v/v	57	70	64	50	93	33
Surfate	1% v/v	32	53	42	40	89	32
Weather Gard Complete	0.5% v/v	27	50	25	29	87	10
Speedway	0.25% v/v	47	52	58	32	89	26
UltraSurf AMS	2.5% v/v	57	70	80	58	95	36
Border	2.5% v/v	50	55	50	38	83	30
Import	0.5% v/v	55	53	63	43	92	30
N-Tense	0.75% v/v	58	47	43	40	91	27
Veracity	0.75% v/v	47	52	53	47	90	28
WE-5078	10lb/100 gal	48	67	53	50	90	32
WE-5070	3qt/100 gal	38	65	70	54	95	27
Helm-Ade	0.25% v/v	27	35	33	30	87	13
Helm-Ade	0.5% v/v	25	43	33	37	92	20
LSD (0.05)		10	9	8	9	5	8

[1]AG 07046 = proprietary product from Winfield Solutions; WE 5078 and 5070 = proprietary products from Wilbur-Ellis; Helm-Ade = product from Helm Agro.
[2] Fomi = Foxtail millet.
[3] Foba = Forage barley.

Ignite at different gpa. Zollinger, Richard K., Jerry L. Ries, and Angela J. Kazmierczak. An experiment was conducted near Mapleton, ND, to evaluate weed efficacy with Ignite, AMS, NIS, and MSO at various application rates. Pioneer '39D81' conventional corn, Pioneer '63M80' conventional sunflower, 'quinoa' (*Chenopodium quinoa*), 'Plainsman' amaranth 'Siberian' foxtail millet, and 'Westford' forage barley were planted perpendicular to each plot length on June 19, 2008. POST treatments were applied on July 23 at 9:25 am with 71 F air, 76 F soil surface, 82% relative humidity, 100% cloud cover, 10 to 13 mph SE wind, dry soil surface, moist subsoil, excellent crop vigor, and no dew present. Species stages at time of application were: 14 to 28 inch (V4 to V6, 3 to 5/ft^2) corn; 18 to 32 inch (V8 to V12, 5 to10/ft^2) sunflower; 4 to 16 inch (5 to 50/yd^2) quinoa; 6 to18 inch (5 to 20/ft^2) amaranth; 8 to 14 inch (10 to 25/ft^2) foxtail millet; and 8 to 14 inch (10 to 25/ft^2) forage barley. Treatments were applied to the center 6.7 feet of the 10 by 40 foot plots with a ATV plot sprayer at 28 psi through 8002 and 8004 Turbo TeeJet nozzles. The experiment had a randomized complete block design with three replicates per treatment.

Generally, NIS + AMS gave greater control than AMS alone or MSO + AMS. 20 gpa gave greater control than 10 or 5 gpa. The same is true with speed of travel where greatest control occurs from slower speeds. 20 gpa with 8004 nozzles (larger droplets) gave greater control than 8002 nozzles. Control at 10 gpa from 8002 or 8004 nozzles was different depending on adjuvant. Control at 5 gpa was greatest with NIS + AMS. Control at 20 gpa was greater with 8004 nozzles at 5 mph than at 2.5 mph. The same is true where doubling the nozzle size (8002 to 8004) gives greater control even though speed is doubled. (Department of Plant Sciences, North Dakota State University, Fargo).

Table. Ignite at different gpa (Zollinger, Ries, and Kazmierczak).

		14 DAT					
Treatment	Rate	Corn	Sunflower	Quinoa	Amaranth	Fomi[2]	Foba[2]
	(product/A)	% control					
Ignite+AMS	8fl oz+8.5lb/100 gal						
8002/2.5 mph = 20 gpa		65	78	58	62	89	32
8002/5 mph = 10 gpa		37	33	28	35	74	10
8002/10 mph = 5 gpa		23	17	10	12	38	5
8004/5 mph = 20 gpa		76	84	76	67	90	34
8004/10 mph = 10 gpa		52	50	30	35	74	20
Ignite+NIS+AMS	8fl oz+0.25% v/v+8.5lb/100 gal						
8002/2.5 mph = 20 gpa		69	71	48	55	89	30
8002/5 mph = 10 gpa		57	60	40	38	79	21
8002/10 mph = 5 gpa		43	27	22	17	47	15
8004/5 mph = 20 gpa		72	78	65	66	90	30
8004/10 mph = 10 gpa		47	58	35	32	78	17
Ignite+MSO+AMS	8fl oz+1.2pt+8.5lb/100 gal						
8002/2.5 mph = 20 gpa		57	77	27	38	86	20
8002/5 mph = 10 gpa		32	35	15	23	64	13
8002/10 mph = 5 gpa		23	22	8	10	45	7
8004/5 mph = 20 gpa		78	82	30	53	90	23
8004/10 mph = 10 gpa		43	40	22	28	65	21
LSD (0.05)		7	5	5	6	7	5

[1] Fomi = Foxtaill millet.
[2] Foba = Forage barley.

Ignite with pH. Zollinger, Richard K., Jerry L. Ries, and Angela J. Kazmierczak. An experiment was conducted near Mapleton, ND, to evaluate weed efficacy with Ignite and adjuvants. Pioneer '39D81' conventional corn, Pioneer '63M80' conventional sunflower, 'quinoa' *(Chenopodium quinoa)*, 'Plainsman' amaranth 'Siberian' foxtail millet, and 'Westford' forage barley were planted perpendicular to each plot length on June 19, 2008. POST treatments were applied on July 21 at 10:00 am with 74 F air, 78 F soil surface, 65% relative humidity, 10% cloud cover, 3 to 6 mph NW wind, dry soil surface, moist subsoil, excellent crop vigor, and no dew present. Species stages at time of application were: 12 to 24 inch (V5 to V7, 3 to 6/ft^2) corn; 28 to 30 inch (V12 to V14, 3 to 5/ft^2) sunflower; 6 to 14 inch (15 to 40/yd^2) quinoa; 6 to12 inch (5 to 20/ft^2) amaranth; 8 to 12 inch (20 to 30/ft^2) foxtail millet; and 8 to 14 inch (20 to 30/ft^2) forage barley. 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 with nitrogen gas through 11001 Turbo TeeJet nozzles. The experiment had a randomized complete block design with three replicates per treatment.

Surfate, Class Act NG, and AMADS adjuvants were used to adjust spray solution pH of approximately 8, 6.5, and 2, respectively to test affect of pH on Ignite performance. Generally, control increased as pH decreased. (Department of Plant Sciences, North Dakota State University, Fargo).

Table. Ignite with pH (Zollinger, Ries, and Kazmierczak).

			14 DAT					
Treatment		Rate	Corn	Sunflower	Quinoa	Amaranth	Fomi[1]	Foba[2]
	Spray solution pH	(product/A)	% control					
0 ppm								
Ignite+		8fl oz+	28	30	37	23	93	17
AMS		8fl oz+	50	53	43	35	94	27
NIS+AMS	6.8	0.25% v/v+8.5lb/ 100 gal	69	53	67	47	93	30
Surfate	8.0	2.5% v/v	42	55	62	33	95	28
Class Act NG	6.3	2.5% v/v	57	58	70	38	98	37
NIS+AMADS	2.1	0.25% v/v/+0.5% v/v	65	72	76	38	98	40
500 ppm of a natural water source containing 194 ppm calcium and 302 ppm magnesium.								
Ignite+		8fl oz+	20	40	57	29	96	22
AMS		8fl oz+	66	63	58	50	98	38
NIS+AMS	6.7	0.25% v/v+8.5lb/ 100 gal	67	63	67	47	95	39
Surfate	8.0	2.5% v/v	52	75	63	37	91	22
Class Act NG	7.0	2.5% v/v	65	63	60	43	96	23
NIS+AMADS	2.1	0.25% v/v/+0.5% v/v	62	74	72	46	97	28
LSD (0.05)			10	10	8	9	6	6

[1] Fomi = Foxtail millet.
[2] Foba = Forage barley.

Laudis with AMS and hard water. Zollinger, Richard K., Jerry L. Ries, and Angela J. Kazmierczak. An experiment was conducted near Mapleton, ND, to evaluate weed efficacy with Laudis and various AMS rates. 'Cavalier' conventional soybean, tame buckwheat, 'Golden' flax, 'Beach' oat, 'Siberian' foxtail millet, and 'Westford' forage barley were planted perpendicular to each plot length on June 19, 2008. POST treatments were applied on July 28, at 10:25 am with 77 F air, 82 F soil surface, 82% relative humidity, 75% cloud cover, 6 to 10 mph SE wind, dry soil surface, moist subsoil, good crop vigor, and no dew present. Species stages at time of application were: 8 to 16 inch (V6 to R1, 5 to 20/ft^2) soybean; 18 to 26 inch (10 to 20/ft^2) tame buckwheat; 10 to 18 inch (10 to 25/ft^2) flax; 15 to 20 inch (10 to 20/ft^2) oat; 15 to 20 inch (10 to 20/ft^2) foxtail millet; and 8 to 14 inch (10 to 20/ft^2) forage barley. 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.

Bioassay species were chosen with anticipation of response; however flax and oat showed no response. Weed control from Laudis was antagonized with hard water. Without hardwater AMS at 4.25 lb/100 gallon water was the optimum rate with higher AMS rates showing less enhancement of Laudis. In the presence of hardwater AMS was able to overcome antagonism from hard water and weed control from Laudis increased as AMS rates increased. (Department of Plant Sciences, North Dakota State University, Fargo).

Table. Laudis with AMS and hard water (Zollinger, Ries, and Kazmierczak).

		14 DAT			
Treatment	Rate	Soybean	Tame buckwheat	Foxtail Millet	Forage Barley
	(product/A)	% control			
0 ppm					
Laudis+MSO	1fl oz+1.2pt+	40	30	40	20
AMS	4.25lb/100 gal	40	50	63	20
AMS	8.5lb/100 gal	40	40	47	20
AMS	17lb/100 gal	40	42	53	20
250 ppm of a natural water source containing 194 ppm calcium and 302 ppm magnesium.					
Laudis+MSO	1fl oz+1.2pt+	40	13	22	20
AMS	4.25lb/100 gal	40	37	43	20
AMS	8.5lb/100 gal	40	43	70	20
AMS	17lb/100 gal	40	55	70	20
500 ppm of a natural water source containing 194 ppm calcium and 302 ppm magnesium.					
Laudis+MSO	1fl oz+1.2pt+	40	15	22	20
AMS	4.25lb/100 gal	40	42	40	20
AMS	8.5lb/100 gal	40	40	57	20
AMS	17lb/100 gal	40	55	67	20
LSD (0.05)		NS	7	9	NS

Laudis with oil concentrations. Zollinger, Richard K., Jerry L. Ries, and Angela J. Kazmierczak. An experiment was conducted near Mapleton, ND, to evaluate weed efficacy with Laudis and various MSO rates. 'Cavalier' conventional soybean, tame buckwheat, 'Golden' flax, 'Beach' oat, 'Siberian' foxtail millet, and 'Westford' forage barley were planted perpendicular to each plot length on June 19, 2008. POST treatments were applied on July 28, at 10:40 am with 77 F air, 82 F soil surface, 82% relative humidity, 75% cloud cover, 6 to 10 mph SE wind, dry soil surface, moist subsoil, good crop vigor, and no dew present. Species stages at time of application were: 12 to 18 inch (V6 to R1, 10 to 20/ft^2) soybean; 20 to 28 inch (10 to 20/ft^2) tame buckwheat; 14 to 20 inch (10 to 25/ft^2) flax; 16 to 22 inch (15 to 25/ft^2) oat; 16 to 22 inch (15 to 25/ft^2) foxtail millet; and 12 to 16 inch (10 to 20/ft^2) forage barley. 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, 17, and 34 gpa at 40 psi through 8001, 8002, and 8004 Turbo TeeJet nozzles. The experiment had a randomized complete block design with three replicates per treatment.

All treatments were applied at 1000 ppm water hardness. Bioassay species was chosen with anticipation of response; however soybean, flax, barley, and oat showed no response. The optimum spray volume + MSO concentration was 8.5 gpa + 1.5 pt/A which supports the "pile theory" developed by John Nalewaja which term describes highly concentrated spray droplets with low water volume providing a better retention of spray droplets, a better deposit in the droplet giving a more affective interface between the active ingredient and the leaf surface, all resulting in more absorption of the active ingredient and greater weed control. (Department of Plant Sciences, North Dakota State University, Fargo).

Table. Laudis with oil concentrations (Zollinger, Ries, and Kazmierczak).

Treatment[1]	Herbicide rate	MSO oil rate	14 DAT	
			Tame buckwheat	Foxtail millet
	(product/A)	(product/A)	% control	
8001 at 40 psi = 8.5 gpa				
Laudis+	1fl oz+			
MSO	0.25% v/v	0.16 pt/A	13	17
MSO	0.50% v/v	0.3 pt/A	20	25
MSO	1% v/v	0.6 pt/A	30	40
MSO	2% v/v	1.5 pt/A	38	60
8002 at 40 psi = 17 gpa				
Laudis+	1fl oz+		15	22
MSO	0.25% v/v	0.3 pt/A	15	22
MSO	0.50% v/v	0.6 pt/A	13	27
MSO	1% v/v	1.5 pt/A	10	42
MSO	2% v/v	3 pt/A	18	47
8004 at 40 psi = 34 gpa				
Laudis+	1fl oz+			
MSO	0.25% v/v	0.6 pt/A	7	5
MSO	0.50% v/v	1.5 pt/A	13	10
MSO	1% v/v	3 pt/A	13	17
MSO	2% v/v	6 pt/A	12	17
LSD (0.05)			6	8

[1]MSO = Scoil.

Laudis with silicone surfactants. Zollinger, Richard K., Jerry L. Ries, and Angela J. Kazmierczak. An experiment was conducted near Mapleton, ND, to evaluate weed efficacy with Laudis and silicone adjuvants. 'Cavalier' conventional soybean, tame buckwheat, 'Golden' flax, 'Beach' oat, 'Siberian' foxtail millet, and 'Westford' forage barley were planted perpendicular to each plot length on June 19, 2008. POST treatments were applied on July 29, at 8:35 am with 68 F air, 70 F soil surface, 74% relative humidity, 0% cloud cover, 6 to 12 mph W wind, dry soil surface, moist subsoil, excellent crop vigor, and no dew present. Species stages at time of application were: 8 to 14 inch (V6 to R1, 10 to 20/ft^2) soybean; 14 to 22 inch (10 to 25/ft^2) tame buckwheat; 10 to 18 inch (15 to 25/ft^2) flax; 16 to 22 inch (15 to 25/ft^2) oat; 16 to 22 inch (15 to 25/ft^2) foxtail millet; and 8 to 14 inch (10 to 20/ft^2) forage barley. 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.
(Department of Plant Sciences, North Dakota State University, Fargo).

Table. Laudis with silicone adjuvants (Zollinger, Ries, and Kazmierczak).

Treatment[1]	Rate	14 DAT						28 DAT					
		Soybean	Tabw[2]	Flax	Oat	Fomi[3]	Foba[4]	Soybean	Tabw	Flax	Oat	Fomi	Foba
	(product/A)	% control						% control					
Laudis+	1fl oz+												
MSO+OE 444	0.75pt/A+0.12 oz/A	43	25	0	0	33	38	42	22	0	0	32	37
MSO+OE 440	0.75pt/A+0.12 oz/A	40	20	0	0	27	23	40	20	0	0	25	22
MSO+OE 444	0.75pt/A+0.24 oz/A	40	20	0	0	24	12	40	20	0	0	23	8
MSO+OE 440	0.75pt/A+0.24 oz/A	40	13	0	0	23	37	40	12	0	0	22	35
MSO	0.75pt/A	45	20	0	0	38	18	42	10	0	0	36	18
MSO	1.5pt/A	38	12	0	0	27	15	38	12	0	0	23	13
Aerosurf 8-190	0.1% v/v	27	10	0	0	17	12	25	10	0	0	15	10
Aerosurf 8-190	0.25% v/v	38	13	0	0	28	13	37	12	0	0	27	12
Aerosurf 8-190	0.5% v/v	43	32	0	0	38	27	42	30	0	0	37	23
Tego Wet 510	0.1% v/v	12	2	0	0	5	20	10	0	0	0	5	18
Tego Wet 510	0.25% v/v	17	7	0	0	10	22	15	3	0	0	10	18
Tego Wet 510	0.5% v/v	20	17	0	0	10	23	20	15	0	0	10	22
Break-Thru S 240	0.1% v/v	35	35	0	0	32	20	33	32	0	0	30	20
LSD (0.05)		6	5	NS	NS	6	8	3	4	NS	NS	5	5

[1]MSO = methylated seed oil = Scoil; OE, Aerosurf 8-190, Tego Wet 510, and BreakThru S 240 = proprietary compounds from Evonik.
[2]Tabw = Tame buckwheat.
[3]Fomi = Foxtail millet.
[4]Foba = Forage barley.

Accent with silicone adjuvants. Zollinger, Richard K.Jerry L. Ries, and Angela J. Kazmierczak. An experiment was conducted near Mapleton, ND, to evaluate weed efficacy with Accent and various silicone adjuvants. 'Cavalier' conventional soybean, tame buckwheat, 'Golden' flax, 'Beach' oat, 'Siberian' foxtail millet, and 'Westford' forage barley were planted perpendicular to each plot length on June 19, 2008. POST treatments were applied on July 17, at 1:00 pm with 71 F air, 80 F soil surface, 72% relative humidity, 75% cloud cover, 6 to 11 mph N wind, moist soil surface, wet subsoil, excellent crop vigor, and no dew present. Species stages at time of application were: 4 to 8 inch (V1 to V4, 10 to 25/yd^2) soybean; 4 to 14 inch (15 to 20/ft^2) tame buckwheat; 4 to 8 inch (15 to 30/ft^2) flax; 4 to 12 inch (10 to 30/ft^2) oat; 4 to 12 inch (10 to 35/ft^2) foxtail millet; and 3 to 10 inch (10 to 25/ft^2) forage barley. 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.
(Department of Plant Sciences, North Dakota State University, Fargo).

Table. Accent with silicone adjuvants (Zollinger, Ries, and Kazmierczak).

Treatment	Rate	14 DAT						28 DAT					
		Soybean	Tabw[1]	Flax	Oat	Fomi[2]	Foba[3]	Soybean	Tabw	Flax	Oat	Fomi	Foba
	(product/A)	% control						% control					
Accent+	0.67 oz+												
MSO+OE 444	0.75pt/A+0.12 oz/A	53	40	57	45	50	67	60	52	42	88	68	94
MSO+OE 440	0.75pt/A+0.12 oz/A	65	43	66	38	43	67	69	43	72	79	60	93
MSO+OE 444	0.75pt/A+0.24 oz/A	55	40	52	32	53	53	55	40	52	82	80	80
MSO+OE 440	0.75pt/A+0.24 oz/A	60	47	57	37	55	58	60	48	62	82	55	82
MSO	0.75pt/A	50	40	43	30	60	43	52	42	40	70	72	72
MSO	1.5pt/A	68	43	57	37	65	65	68	48	50	62	63	90
Aerosurf 8-190	0.1% v/v	23	27	13	22	23	40	23	25	13	50	28	68
Aerosurf 8-190	0.25% v/v	40	33	27	30	40	47	40	33	27	50	40	74
Aerosurf 8-190	0.5% v/v	60	37	38	38	53	53	60	45	37	75	62	83
Tego Wet 510	0.1% v/v	17	32	13	25	25	33	15	32	13	72	27	62
Tego Wet 510	0.25% v/v	30	37	3	32	32	47	30	40	3	70	30	93
Tego Wet 510	0.5% v/v	35	47	8	32	52	33	37	50	8	80	50	62
Break-Thru S 240	0.1% v/v	30	38	12	32	53	37	30	40	12	70	58	62
LSD (0.05)		6	6	7	7	9	7	4	5	16	3	6	6

[1]Tabw = Tame buckwheat.
[2]Fomi = Foxtail millet.
[3]Foba = Forage barley.

Milestone with AMS. Zollinger, Richard K., Jerry L. Ries, and Angela J. Kazmierczak. An experiment was conducted near Mapleton, ND, to evaluate weed efficacy with various Milestone and AMS rates. Pioneer '63M80' conventional sunflower, tame buckwheat, 'Golden' flax, 'Hudson' conventional canola, 'quinoa' (*Chenopodium quinoa*) and 'Plainsman' amaranth were planted perpendicular to each plot length on May 20, 2008. POST treatments were applied on July 9, at 8:20 am with 65 F air, 66 F soil surface, 70% relative humidity, 0% cloud cover, 6 to 8 mph W wind, dry soil surface, moist subsoil, good crop vigor, and no dew present. Species stages at time of application were: 14 to 30 inch (V10 to V14, 3 to 5/ft^2) sunflower; 6 to 14 inch (10 to 25/ft^2) tame buckwheat; 8 to 18 inch (10 to 30/ft^2) flax; 4 to 24 inch (5 to 25/ft^2) canola; 6 to 20 inch (5 to 40/yd^2) quinoa; and 4 to 12 inch (5 to 50 /yd^2) amaranth. 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.

We attempted to use bioassay species that had some susceptibility to Milestone, however, only sunflower showed any visible response. Milestone activity increases as AMS rate increases independent hard water level. (Department of Plant Sciences, North Dakota State University, Fargo).

Table. Milestone with AMS (Zollinger, Ries, and Kazmierczak).

		14 DAT	
Treatment	Rate	Sunflower	Sunflower
	(product/A)	- - - - inches - - - -	- - - - % control - - - -
0 ppm			
Milestone +	0.5fl oz +	44	10
AMS	4.25lb/100gal	34	23
AMS	8.5lb/100gal	30	28
AMS	17lb/100gal	25	38
250 ppm of a natural water source containing 194 ppm calcium and 302 ppm magnesium.			
Milestone +	0.5fl oz +	41	13
AMS	4.25lb/100gal	28	37
AMS	8.5lb/100gal	26	40
AMS	17lb/100gal	23	43
500 ppm of a natural water source containing 194 ppm calcium and 302 ppm magnesium.			
Milestone +	0.5fl oz +	31	28
AMS	4.25lb/100gal	30	30
AMS	8.5lb/100gal	29	37
AMS	17lb/100gal	23	47
LSD (0.05)		3	6

Status with adjuvant and AMS. Zollinger, Richard K., Jerry L. Ries, and Angela J. Kazmierczak. An experiment was conducted near Mapleton, ND, to evaluate weed efficacy with various Status and AMS rates. Pioneer '63M80' conventional sunflower, tame buckwheat, 'Golden' flax, 'Hudson' conventional canola, 'quinoa' (*Chenopodium quinoa*) and 'Plainsman' amaranth were planted perpendicular to each plot length on May 20, 2008. POST treatments were applied on July 9, at 8:40 am with 65 F air, 66 F soil surface, 70% relative humidity, 0% cloud cover, 6 to 8 mph W wind, dry soil surface, moist subsoil, good crop vigor, and no dew present. Species stages at time of application were: 24 to 30 inch (3 to 5/ft^2) sunflower; 8 to 16 inch (10 to 25/ft^2) tame buckwheat; 8 to 14 inch (10 to 30/ft^2) flax; 8 to 20 inch (5 to 25/ft^2) canola; 6 to 20 inch (5 to 40/^{2}) quinoa; and 4 to 12 inch (1 to 20/ft^2) amaranth. 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.

The data is complex with many interactions.
Generally:
- Order of herbicide enhancement was MSO>NIS>AMS
- 4.25 and 8.5 lb/100 gallons AMS was sufficient to maximize weed control
- 17 lb/100 occasionally antagonized Status as compared to 8.5 lb/100 AMS.
- Weed control was antagonized as water hardness increased.
- AMS overcame hard water antagonism and enhanced weed control from Status.

(Department of Plant Sciences, North Dakota State University, Fargo).

Table. Status with adjuvants and AMS (Zollinger, Ries, and Kazmierczak).

Treatment	Rate	14 DAT					
		Sunflower	Tabw[1]	Flax	Canola	Amaranth	Sunflower
	(product/A)	% control					inches
0 ppm							
Status+	2 oz+	20	18	0	27	22	40
AMS	4.25lb/100 gal	32	27	10	47	30	32
AMS	8.5lb/100 gal	32	38	20	32	33	31
AMS	17lb/100 gal	37	40	25	27	28	31
Status+R-11+	2 oz+0.25pt+	28	23	10	-	-	38
AMS	4.25lb/100 gal	33	30	30	-	-	30
AMS	8.5lb/100 gal	42	37	42	-	-	31
AMS	17lb/100 gal	38	30	22	-	-	26
Status+Scoil+	2 oz+1% v/v+	36	42	-	42	42	26
AMS	4.25lb/100 gal	53	50	-	50	50	28
AMS	8.5lb/100 gal	47	70	-	70	70	27
AMS	17lb/100 gal	55	57	-	57	57	27
250 ppm of a natural water source containing 194 ppm calcium and 302 ppm magnesium.							
Status+	2 oz+	17	15	-	22	15	39
AMS	4.25lb/100 gal	22	23	-	26	27	33
AMS	8.5lb/100 gal	30	32	-	38	28	29
AMS	17lb/100 gal	40	40	-	43	40	28
Status+R-11+	2 oz+0.25pt+	22	17	12	-	-	34
AMS	4.25lb/100 gal	40	38	22	-	-	30
AMS	8.5lb/100 gal	43	40	30	-	-	31
AMS	17lb/100 gal	48	45	50	-	-	26
Status+Scoil+	2 oz+1% v/v+	30	30	-	30	30	26
AMS	4.25lb/100 gal	43	65	-	65	65	25
AMS	8.5lb/100 gal	65	70	-	70	70	22
AMS	17lb/100 gal	55	63	-	63	63	25
500 ppm of a natural water source containing 194 ppm calcium and 302 ppm magnesium.							
Status+	2 oz+	15	15	-	23	10	36
AMS	4.25lb/100 gal	25	27	-	32	25	31
AMS	8.5lb/100 gal	30	28	-	43	27	32
AMS	17lb/100 gal	42	30	-	27	30	28
Status+R-11+	2 oz+0.25pt+	18	17	12	-	-	33
AMS	4.25lb/100 gal	30	28	15	-	-	27
AMS	8.5lb/100 gal	35	42	32	-	-	25
AMS	17lb/100 gal	47	45	40	-	-	29
Status+Scoil+	2 oz+1% v/v+	28	22	-	22	22	25
AMS	4.25lb/100 gal	45	60	-	60	60	21
AMS	8.5lb/100 gal	60	72	-	72	72	22
AMS	17lb/100 gal	58	60	-	60	60	22
Untreated - AMS series		0	0	0	0	0	50
Untreated - NIS series		0	0	0	0	0	55
Untreated - MSO series		0	0	0	0	0	56
LSD (0.05)		5	5	3	6	5	8

[1] Tabw = Tame buckwheat

Impact Carryover and pH interactions. Zollinger, Richard K. and Jerry L. Ries. An experiment was conducted near Buffalo, and Valley City,ND, to evaluate bioassay species one year after Impact treatment applications at two different soil types and pH levels. At Buffalo, POST treatments were applied on June 20, 2007 at 11:00 am with 76 F air, 71 F soil surface, 40% relative humidity, 0% cloud cover, 0 to 3 mph SW wind, dry soil surface, and moist subsoil to V4 (10 to 14 inch corn. Soil characteristics were: 40.6% sand, 43.5% silt, 15.9% clay, loam texture, 4.1% OM, and 7.9 pH. At Valley City, POST treatments were applied on June 20, 2007 at 9:45 am with 75 F air, 65 F soil surface, 61% relative humidity, 0% cloud cover, 3 to 5 mph SW wind, dry soil surface, and moist subsoil to V2 to V4 sunflower. Soil characteristics were: 72.2% sand, 20.8% silt, 1.9% clay, sandy loam texture, 1.9% OM, and 5.9 pH. At both locations, treatments were applied to the entire 20 feet of the 20 by 40 foot plots with a bicycle-type sprayer delivering 8.5 gpa at 40 psi through 11001 Turbo TeeJet flat-fan nozzles. The experiment had randomized compete block design with three replicates per treatment. At both locations, the objective was to spray the Impact treatments at a normal application timing with some amount of crop canopy to intercept some of the spray. The intention was not to spray the treatments to bare ground. The cooperator at each location harvested the crop as usual in the fall of 2007. A light tillage was then done to loosen the soil. On May 14, 2008, both locations were lightly cultivated to prepare the seedbed before planting followed by the planting of the following bioassy species perpendicular to each plot: 'Hudson' conventional canola; 'Golden' type flax; 'Cavalier' conventional soybean; 'Buster' pinto bean; Crystal 'R308' sugarbeet; and 'Ensign' navy bean.

At both locations applications were made not to bare soil but at sites with normal crop foliage that would be present in May or early June. At the research site of soil pH 5.9 volunteer sunflower emerged which gave another crop to evaluate for crop tolerance. Impact was applied at 0.5 fl oz/A (X rate for northern climates), 0.75 fl oz/A (X rate for mid-west), 1 fl oz/A (2X for northern climate), and 1.5 fl oz/A (2X for mid-west). At study site with soil pH 5.9 there was no soybean, pinto dry bean, navy dry bean, or flax injury at any Impact rate. Impact residue at 1 and 1.5 fl oz/A caused 5 and 7% sugarbeet, 13 and 20% canola, and 53 and 70% sunflower injury at 12 months after application (MAA) but by 13 MAA sugarbeet injury was 5%, canola injury was 7%, and sunflower injury was 47% at the highest rate. At study site with soil pH 7.9 there was no crop injury at any Impact rate at 12 MAA. At 12.5 MAA 7% sugarbeet injury at the highest Impact rate of 1.5 fl oz/A was the only injury observed. At 13 MAA there was no crop injury from Impact residue at 0.5, 0.75, and 1 fl oz/A and canola and flax was unaffected at all rates. However, injury to soybean, pinto dry bean, navy dry bean, and sugarbeet from the highest Impact rate of 1.5 fl oz/A was 15%, 23%, 7%, and 13%, respectively. Since the solubility of topramezone increases as pH increases it was thought that soil pH may affect rate of breakdown. The current crop rotation for soybean, dry bean, canola, sugarbeet in parts of the northern great plains including North Dakota is 18 months after Impact application. This data may help support a reduced crop rotation of 9 months when Impact is used at 0.5 fl oz/A. (Dept of Plant Sciences, North Dakota State University, Fargo).

Table. Impact carryover in high pH, Buffalo (Zollinger and Ries).

Treatment	Rate	12 MAT						12.5 MAT						13 MAT					
		Soyb[1]	Pinto	Navy	Sgbt[2]	Cano[3]	Flax	Soyb	Pinto	Navy	Sgbt	Cano	Flax	Soyb	Pinto	Navy	Sgbt	Cano	Flax
	(product/A)	% control						% control						% control					
Impact	0.5fl oz	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Impact	0.75fl oz	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Impact	1fl oz	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Impact	1.5fl oz	0	0	0	2	0	0	0	17	0	7	0	0	15	23	7	13	0	0
Untreated		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LDS (0.05)		NS	NS	NS	2	NS	NS	NS	9	NS	2	NS	NS	7	4	5	2	NS	NS

[1]Soyb = soybean.
[2]Sgbt = surgarbeet.
[3]Cano = canola.

Table. Impact carryover in low pH, Valley City (Zollinger and Ries).

Treatment	Rate	July 3, 2007		12 MAT							12.5 MAT							13 MAT						
		Snfl[1]	Wibw	Soyb[2]	Pinto	Navy	Sgbt[3]	Cano[4]	Flax	V Snfl[5]	Soyb	Pinto	Navy	Sgbt	Cano	Flax	V Snfl	Soyb	Pinto	Navy	Sgbt	Cano	Flax	V Snfl
	(product/A)	% control		% control							% control							% control						
Impact	0.5fl oz	13	53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Impact	0.75fl oz	37	58	0	0	0	0	0	0	7	0	0	0	0	0	0	7	0	0	0	0	0	0	7
Impact	1fl oz	63	70	0	0	0	5	13	0	53	0	0	0	0	2	0	22	0	0	0	0	2	0	22
Impact	1.5fl oz	72	80	0	0	0	7	20	0	70	0	0	0	3	7	0	47	0	0	0	5	7	0	47
Untreated				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LDS (0.05)		8	15	NS	NS	NS	5	6	NS	6	NS	NS	NS	2	5	NS	7	NS	NS	NS	4	5	NS	7

[1]Snfl = sunflower injury in 2007.
[2]Soyb = soybean.
[3]Sgbt = surgarbeet.
[4]Cano = canola.
[5]V Snfl = volunteer sunflower.

Helmosate plus fluroxypyr in corn. Zollinger, Richard K. and Jerry L. Ries. An experiment was conducted near Prosper, ND, to evaulate Helm Agro Company corn treatments applied POST. DeKalb 'DKC38-92' Roundup Ready corn corn was planted on May 8, 2008. POST treatments were applied on June 17 at 10:30 am with 76 F air, 77 F soil surface, 36% relative humidity, 0% clouds, 2 to 6 mph NW wind, moist soil surface, wet subsoil, good crop vigor, and no dew present to V2 to V4 (4 to 7 inch) corn. Weeds species at the time of POST applications were: emergence to 2 inch (1 to 5/yd^2) redroot pigweed; cotyledon to 3 inch (1 to 10/yd^2) common lambsquarters; cotyledon to 3 inch (1 to 5/yd^2) hairy nightshade; cotyledon to 2 inch (1/yd^2) wild mustard; cotyledon to 3 inch (1 to 10/yd^2) common ragweed; 2 to 6 inch (< 1/yd^2) common cocklebur; and 0.5 to 4 inch (20 to 100/ft^2) yellow foxtail. Treatments were applied to the center 6.7 feet of the 10 by 40 foot plot with a backpack-type plot sprayer delivering and 8.5 gpa at 40 psi through 11001 Turbo TeeJet nozzles for POST treatments. The experiment had a randomized complete block design with three replicates per treatment.

Cool, dry conditions slowed growth in the spring. 99% control of wild mustard at 14 and 28 DAT.

(Dept of Plant Sciences, North Dakota State University, Fargo).

Table. Helmosate plus fluroxypyr in corn (Zollinger and Ries).

		14 DAT							28 DAT						
Treatment	Rate	Yeft	Rrpw	Colq	Hans	Wibw	Corw	Cocb	Yeft	Rrpw	Colq	Hans	Wibw	Corw	Cocb
	(product/A)	% control							% control						
Roundup PowerMax	11fl oz	72	72	70	72	62	62	86	72	78	80	72	62	62	86
Helosate Plus	1 pt	86	88	80	80	71	70	92	83	88	80	80	71	70	92
Helosate Plus+Helm Fluroxypyr	1pt+10.66fl oz	85	83	78	99	84	95	95	87	85	80	99	88	97	99
Helosate Plus+Starane	1pt+10.66fl oz	90	85	80	99	85	95	97	82	88	90	99	88	97	99
Helosate Plus+Dicamba	1pt+4fl oz	82	91	91	99	92	99	99	83	94	94	99	95	99	99
Steadfast+Dicamba+ Scoil+28% N	0.75oz+4fl oz+ 1.25pt+1.5qt	75	91	91	91	88	99	99	75	94	94	95	88	99	99
Callisto+Atrazine+Herbimax	3fl oz+0.42lb+1qt	72	99	99	99	99	99	99	77	99	99	99	99	99	99
Helosate Plus+Harness+Helm Nico+ R-11+28% N	1pt+1.75pt+0.5oz+ 0.25% v/v+1.5qt	97	96	96	96	77	93	99	97	99	99	99	77	99	99
Harness+Helm Nico+Dicamba R-11+28% N	1.75pt+0.75oz+4fl oz 0.25% v/v+1.5qt	96	99	96	99	83	99	99	99	99	99	99	92	99	99
Laudis+Atrazine+Scoil+28% N	3fl oz+0.42lb+1.25pt+1.5qt	88	99	99	99	95	99	95	93	99	99	99	98	99	99
Option+Dicamba+Scoil+28% N	1.5oz+4fl oz+1.25pt+1.5qt	83	99	99	99	85	87	87	85	99	99	99	87	88	87
Helosate Plus+ WideMatch	1pt+0.75pt	85	98	96	96	96	96	99	87	98	96	97	97	99	99
LSD (0.05)		6	4	4	5	6	4	3	5	3	4	4	5	4	2

Foliar zinc formulations with glyphosate. Zollinger, Richard K. and Jerry L. Ries. An experiment was conducted near Casselton, ND, to evaluate weed control and yield from POST applied tank-mixes of micro-nutrients with Makaze (glyphosate). DeKalb 'DKC38-92' Roundup Ready corn was planted on May 9, 2008 followed by the application of PRE application of 4 pt/A of Lumax across the entire plot area at 9:45 am with 51 F air, 44 F soil at a four inch depth, 43% relative humidity, 65% cloud cover, 5 to 8 mph NE wind, dry soil surface and moist subsoil. Soil characteristics were: 9.1% sand, 56% silt, 34.9% clay, silty clay loam texture, 5.4% OM, and 7.8 pH. POST treatments were applied on June 20 at 12:00 pm with with 80 F air, 87 F soil surface, 23% relative humidity, 0% clouds, 5 to 8 mph NW wind, moist soil surface, wet subsoil, good crop vigor and no dew present to V4 (8 to 12 inch) corn. Weed species present at the time of POST applications were: 1 to 5 inch (1 to 20/yd^2) common lambsquarters; cotyledon to 6 inch (1/yd^2) wild mustard; 1 to 4 inch (1 to 10/yd^2) yellow and green foxtail; 1 to 3 inch (1/yd^2) common cocklebur, emergence to 1 inch (1 to 2/yd^2) redroot pigweed, 2 to 4 inch diameter (1 to 20/yd^2) wild buckwheat; and emergence to 1 inch (5 to 20/yd^2) venice mallow. Treatments were applied to the center 6.7 feet of the 10 by 40 foot plot 8.5 gpa at 40 psi through 11001 Turbo TeeJet nozzles for POST treatments. The experiment had a randomized complete block design with three replicates per treatment.

The month of May was dry and cold delaying emergence. Warmer weather and effective precipitation did not occur until beginning of June. Weed control was not an objective of this study as Lumax was applied to the entire study with a bicycle-type plot sprayer with an attached 10 foot boom delivering 17 gpa at 40 psi through 11002 Turbo TeeJet nozzles right after planting. Zn products were added to water first. (Dept of Plant Sciences, North Dakota State University, Fargo).

Table. Foliar zinc formulations with glyphosate (Zollinger and Ries).

		56 and 76 DAT							Corn
Treatment[1]	Rate	Fxtl[2]	Wimu	Rrpw	Colq	Vema	Wibw	Cocb	Yield
	(product/A)	- - - - - - - - - - - - - - % control - - - - - - - - - - - - - -							- bu/A -
Makaze +	32fl oz +								
Choice WM	0.5% v/v	99	99	99	99	99	99	99	82.4
LI 6222+Choice WM	5fl oz+0.5% v/v	99	99	99	99	99	99	99	107.2
LI 6222+Choice WM	10fl oz+0.5% v/v	99	99	99	99	99	99	99	99.6
CitraPlex Zn+Choice WM	1lb+0.5% v/v	99	99	99	99	99	99	99	94.8
Awaken+Choice WM	48fl oz+0.5% v/v	99	99	99	99	99	99	99	108.7
LI 6263+Choice WM	16fl oz+0.5% v/v	99	99	99	99	99	99	99	100.5
LI 6263+Choice WM	32fl oz+0.5% v/v	99	99	99	99	99	99	99	91.6
Zn EDTA 9%+Choice WM	32fl oz+0.5% v/v	99	99	99	99	99	99	99	106.0
LI 6264+Choice WM	16fl oz+0.5% v/v	99	99	99	99	99	99	99	89.4
LSD (0.05)		N/S	N/S	N/S	N/S	N/S	N/S	N/S	43.2

[1]Choice WM = Choice WeatherMaster; LI compounds are proprietary products from UAP.
[2]Fxtl = green and yellow foxtail.