Weed control in Clearfield corn and canola. Zollinger, Richard K. and Jerry L. Ries. An experiment was conducted near Casselton, ND, to evaluate crop response and weed efficacy in Clearfield canola. Pioneer '39D85' corn, 'Glenn' wheat, 'Drummond' barley, and Pioneer '46A76' Clearfield canola, and 'Morton' oat were planted perpendicular to each plot length on June 8, 2006. POST treatments were applied on June 26 at 10:15 am with 78 F air, 83 F soil surface, 36% relative humidity, 0% cloud cover, 5 to 10 mph S wind, moist soil surface and subsoil, excellent vigor, and no dew present. Species stages at time of application were: V2 (3 to 7/ft^2) corn, 3 to 5 inch (20 to 30/ft^2) wheat; 3 to 6 inch (15 to 25/ft^2) barley; V1 to V2 (25 to 35/ft^2) canola, 3 to 6 inch (15 to 25/ft^2) oat, and 2 to 5 inch (1 to 3/yd^2) common cocklebur. 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 flat-fan nozzles. The experiment had randomized complete block design with three replicates per treatment.

This experiment was conducted to test adjuvants overcoming hard water antagonism and enhance weed control of Beyond, Poast, and Assure II. All treatments were applied in water containing 837 ppm calsium ($CaCl_2$). A reduced herbicide rate was used to measure adjuvant effects. Adjuvant rates were used to provide equivalent of 8.5 lb/100 gallon of water. At 28 DAT, AMS generally provided equal or greater adjuvant enhancement of herbicides compared to Bronc Max and Cut-Rate. (Dept. of Plant Sciences, North Dakota State University, Fargo).

Table. Weed control in Clearfield corn and canola (Zollinger and Ries).

		14 DAT						28 DAT					
Treatment[1]	Rate	Corn[2]	Canola[3]	Wheat	Barley	Oat	Cocb	Corn	Canola	Wheat	Barley	Oat	Cocb
	(product/A)	% control						% control					
Beyond +	2 fl oz +	0	0	43	42	43	23	0	0	47	43	62	23
Bronc Max	0.5% v/v	0	0	67	67	68	60	0	0	77	60	75	60
Cut-Rate	4lb/100gal	0	0	58	63	67	57	0	0	60	52	52	57
AMS	8.5lb/100gal	0	0	63	62	65	72	0	0	82	58	83	72
Poast +	0.5 pt +	43	0	53	55	57	0	32	0	60	45	99	0
Bronc Max	0.5% v/v	65	0	75	75	72	0	55	0	85	85	99	0
Cut-Rate	4lb/100gal	53	0	68	73	72	0	48	0	90	89	99	0
AMS	8.5lb/100gal	62	0	66	77	77	0	52	0	90	80	99	0
Assure II +	4 fl oz +	47	0	75	68	77	0	45	0	78	78	99	0
Bronc Max	0.5% v/v	84	0	84	81	86	0	82	0	95	95	99	0
Cut-Rate	4lb/100gal	61	0	73	72	75	0	55	0	92	92	99	0
AMS	8.5lb/100gal	60	0	70	73	73	0	50	0	93	92	99	0
LSD (0.05)		7	NS	9	8	6	4	5	NS	9	7	3	4

[1]Bronc Max and Cut-Rate = water conditioning agents; AMS = ammonium sulfate.
[2]Corn = Roundup Ready/Liberty Link stacked corn.
[3]Canola = Clearfield canola.

Controlling grass species with Section. Zollinger, Richard K. and Jerry L. Ries. An experiment was conducted near Casselton, ND, to evaluate grass control. Dekalb 'DKC35-51' corn, 'Drummond' barley, and 'Briggs' wheat were planted perpendicular to each plot length on May 30, 2006. POST treatments were applied on June 26 at 9:00 am with 71 F air, 84 F soil surface, 54% relative humidity, 30% cloud cover, 2 to 5 mph W wind, moist soil surface and subsoil, excellent vigor, and light dew present. Species stages at time of application were: V4 to V5 (3 to 7/ft^2) corn; 8 to 12 inch (20 to 40/ft^2) barley; 8 to 12 inch (20 to 40/ft^2) wheat. 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 flat-fan nozzles. The experiment had randomized complete block design with three replicates per treatment.

Most treatments controlled over 90% of the wheat and barley. There was more treatment separation with corn than wheat and barley. Treatments that controlled more than 90% of the corn was Roundup Original Max + Destiny + AMS, and experimental adjuvant AG 05006. Increased control from glyphosate + Destiny is an example of how oil adjuvants can be used with glyphosate only when good emulsifiers/surfactants are in the oil adjuvant formulation. (Dept. of Plant Sciences, North Dakota State University, Fargo).

Table. Controlling grass species with Section (Zollinger and Ries).

		14 DAT			28 DAT		
Treatment[2]	Rate	Wheat	Barley	Corn[2]	Wheat	Barley	Corn
	(product/A)	------ % control ------			------ % control ------		
Roundup Original Max+Section +	11fl oz+2fl oz +	90	90	61	99	99	72
N-Pac AMS	2.5% v/v	90	94	58	99	94	68
Destiny+N-Pac AMS	1% v/v+2.5% v/v	98	96	93	99	99	94
ClassAct Next Generation	2.5% v/v	98	95	74	99	96	72
Preference+N-Pac AMS	0.25% v/v+2.5% v/v	96	96	83	99	99	84
Superb HC+N-Pac AMS	0.5% v/v+2.5% v/v	98	96	86	99	99	83
Superb HC+Alliance	0.5% v/v+1.25% v/v	99	97	88	99	99	86
AG 05055	1.5% v/v	99	99	84	99	99	89
AG 05055	2.5% v/v	99	97	91	99	98	93
AG 05006+N-Pac AMS	0.5% v/v+2.5% v/v	98	98	92	99	99	96
AG 05006+Alliance	0.5% v/v+1.25% v/v	97	97	95	97	95	94
AG 03002	0.5% v/v+2.5% v/v	97	95	84	99	99	93
AG 06072+N-Pac AMS	0.5% v/v+2.5% v/v	96	95	83	96	97	84
Roundup Original Max +	11fl oz +						
N-Tense	0.5% v/v	99	97	0	98	99	0
N-Tense	0.75% v/v	98	96	0	97	99	0
Trophy Gold	0.5% v/v	97	93	0	96	98	0
N-Tense+Trophy Gold	0.25% v/v+0.25% v/v	97	94	0	97	97	0
LSD (0.05)		2	4	4	2	2	3

[1]N-Pac AMS = liquid AMS, Destiny = methylated seed oil, ClassAct Next Generation = surfactants + fertilizers; Preference = nonionic surfactant; Superb HC = high surfactant oil concentrate; Alliance = water conditioning agents; AG compounds = proprietary experimental adjuvants from Agriliance; N-Tense = water conditioning agents + surfactants; Trophy Gold = oil based surfactant.

[2]Corn = Roundup Ready corn.

Volunteer corn control with Gramoxone tank-mixes. Zollinger, Richard K. and Jerry L. Ries. An experiment was conducted near Casselton, ND, to evaluate volunteer corn efficacy in a late re-crop planting situation. DeKalb 'DKC35-51' was planted on June 8, 2006. Study treatments were sprayed with Buctil at 0.5 pt/A + 2 pt/A Scoil to simulate a frost or hail event five to seven days before EPOST and POST applications.

EPOST treatments were over-sprayed with Buctril to stimulate injury on June 22 at 10:40 am with 64 F air, 81 F soil surface, 40% relative humidity, 80% cloud cover, 3 to 5 mph NE wind, dry soil surface, moist subsoil, excellent crop vigor, and no dew present to V1 to V2 (1 to 4 inch) corn. EPOST treatments were applied on June 27 at 12:30 pm with 82 F air, 91 F soil surface, 27% relative humidity, 0% cloud cover, 9 to 12 mph S wind, dry soil surface, moist subsoil, excellent crop vigor, and no dew present to V3 to V4 (6 to 10 inch) corn.

POST treatments were over-sprayed with Buctril to stimulate injury on June 26 at 10:45 am with 82 F air, 91 F soil surface, 27% relative humidity, 10% cloud cover, 3 to 6 mph W wind, moist soil surface, moist subsoil, and excellent crop vigor and no dew present to V2 to V3 (4 to 7 inch) corn. POST treatments were applied on July 3 at 10:00 am with 74 F air, 94 F soil surface, 48% relative humidity, 0% cloud cover, 5 to 8 mph N wind, dry soil surface, moist subsoil, excellent crop vigor, and no dew present to V3 to V4 (8 to 14 inch) corn.

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 flat-fan nozzles. The experiment had randomized complete block design with three replicates per treatment. (Dept. of Plant Sciences, North Dakota State University, Fargo).

Table. Volunteer corn control with Gramoxone tank-mixes (Zollinger and Ries).

		July 13			July 20			July 27		
Treatment[1]	Rate	Corn	Corn	Corn	Corn	Corn	Corn	Corn	Corn	Corn
	(product/A)	% chlorotic	% necrotic	# dead	% chlorotic	% necrotic	# dead	% chlorotic	% necrotic	# dead
EPOST										
Liberty+AMS	32.2fl oz+3lb	0	0	0	0	0	0			
Gramoxone Max+Herbimax	24fl oz+1% v/v	38	47	273	23	67	285			
Gramoxone Max+Herbimax	12fl oz+1% v/v	27	23	9	17	20	22			
Gramoxone Max+Sencor+Herbimax	12fl oz+3oz+1% v/v	27	57	320	22	43	308			
Gramoxone Max+Sencor+Herbimax	24fl oz+3oz+1% v/v	7	90	463	5	83	463			
Gramoxone Max+Lorox+Herbimax	12fl oz+1lb+1% v/v	23	70	323	18	62	315			
Gramoxone Max+Lorox+Herbimax	24fl oz+1lb+1% v/v	6	92	448	5	87	298			
POST										
Liberty+AMS	32.2fl oz+3lb				0	0	0	0	0	0
Gramoxone Max+Herbimax	24fl oz+1% v/v				33	73	365	18	73	365
Gramoxone Max+Herbimax	12fl oz+1% v/v				23	27	75	0	27	75
Gramoxone Max+Sencor+Herbimax	12fl oz+3oz+1% v/v				37	32	215	17	32	215
Gramoxone Max+Sencor+Herbimax	24fl oz+3oz+1% v/v				15	83	430	3	86	430
Gramoxone Max+Lorox+Herbimax	12fl oz+1lb+1% v/v				18	30	161	0	30	161
Gramoxone Max+Lorox+Herbimax	24fl oz+1lb+1% v/v				23	72	330	12	73	330
LSD (0.05)		4	6	27	5	6	127	5	5	91

[1]AMS = ammonium sulfate; Herbimax = petroleum oil concentrate.

Overcoming dicamba salt antagonism. Zollinger, Richard K. and Jerry L. Ries. An experiment was conducted near Alice, ND, to evaluate Dicamba tank-mixes with AMS replacement adjuvants. Post treatments were applied on June 11, 2006 at 11:30 am with 70-72 F air, 75-77 F soil surface, 48-49 % relative humidity, 30% cloud cover, 2 to 6 mph SE wind, moist soil surface, moist subsoil, and no dew present to non-cropland. Weed species present were: 2 to 14 inch (20 to 75/ft^2) common lambsquarters. 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 flat-fan nozzles. The experiment had randomized complete block design with three replicates per treatment.

In general, water conditioners do not enhance dicamba control in the presence of hard water salts as effectively as adjuvants containing AMS, 28% N, basic pH blend (Quad 7), and MSO. Adjuvants containing AMS overcome Ca/Mg antagonism while adjuvants containing 28% overcome Na antagonism.
(Dept of Plant Sciences, North Dakota State University, Fargo).

Table. Overcoming dicamba salt antagonism (Zollinger and Ries).

		Colq control - 14 DAT		
		2005	2006	2006
Treatment[1]	Rate	500 ppm Ca+Mg	523 ppm Ca	625 ppm Na
	(product/A)	% control		
Dicamba +	2fl oz +	5	0	17
R-11	0.25% v.v	42	67	43
AMS	8.5lb/100gal	25	60	35
28% N	2.5% v/v	7	50	52
R-11+AMS	0.25% v/v+8.5lb/100gal	53	77	48
R-11+28% N	0.25% v/v+2.5% v/v	35	61	73
ClassAct Next Generation	2.5% v/v	52	80	47
Surfate	1% v/v	43	68	43
Alliance+Preference	1.25% v/v+0.25% v/v	42	48	37
Choice+Liberate	0.5% v/v+0.25% v/v	3	40	40
Quest+Preference	0.5% v/v+0.25% v/v	42	33	37
Cayuse Plus	0.75% v/v	35	40	38
Citron+Preference	2.2lb/100gal+0.25% v/v	41	37	42
Herbolyte	1% v/v	10	25	13
N-Tense	0.75% v/v	48	76	69
Reddy IT	0.25% v/v	35	58	47
Quad 7	1% v/v	73	62	75
Scoil+AMS	1.5pt+8.5lb/100gal	73	73	62
Z-64	1.5pt	70	72	72
Renegade	1.5pt	74	73	68
LSD (0.05)		6	7	8

[1]R-11, Preference, Liberate = nonionic surfactant; AMS = ammonium sulfate; 28% N = 28-0-0; ClassAct Next Generation and Surfate = surfactants + fertilizers; Alliance, Choice, and and Quest = water conditioning agents; Cayuse Plus = AMS + nonionic surfactant; Herbolyte = a proprietary compound from ProfitPro, LLC; N-Tense = water conditioning agents + surfactants; Reddy IT = MSO complex surfactant blend; Quad 7 = basic pH blend; Scoil = methylated seed oil; Z-64 and Renegade = MSO basic pH blend.

AMS replacement adjuvants with Poast. Zollinger, Richard K. and Jerry L. Ries. An experiment was conducted near Casselton, ND, to evaluate species efficacy of AMS replacement type adjuvants with Poast. Pioneer '36D85' corn, 'Briggs' wheat, and 'Drummond' barley, were planted perpendicular to each plot length on June 8, 2006. POST treatments were applied on July 7 at 8:30 am with 78 F air, 85 F soil surface, 49% relative humidity, 25% cloud cover, 7 to 12 mph S wind, dry soil surface and subsoil, excellent vigor, and no dew present. Species stages at time of application were: V3 to V6 (1 to 7/ft^2) corn; 8 to 14 inch (25 to 30/ft^2) wheat; and 6 to 12 inch (25 to 40/ft^2) 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 flat-fan nozzles. The experiment had randomized complete block design with three replicates per treatment.

Treatments were applied with water containing 625 ppm Na hardness ($NaHCO_3$). Poast was optimized greater by AMS + oil adjuvants. (Dept. of Plant Sciences, North Dakota State University, Fargo).

Table. AMS replacement adjuvants with Poast (Zollinger and Ries).

		14 DAT			28 DAT		
Treatment[1]	Rate	Wheat	Barley	Corn[2]	Wheat	Barley	Corn
	(product/A)	-------- % control --------			-------- % control --------		
Poast +	0.5 pt +	20	20	13	20	27	13
PO	1qt	27	22	17	27	32	17
AMS	8.5lb/100gal	67	53	42	67	50	32
28% N	2.5% v/v	63	47	40	63	43	37
PO+AMS	1qt+8.5lb/100gal	73	63	81	73	83	81
PO+28% N	1qt+2.5% v/v	75	68	71	75	68	71
ClassAct Next Generation	2.5% v/v	60	50	47	40	33	27
Surfate	1% v/v	60	50	45	40	40	25
Alliance+PO	1.25% v/v+1qt	62	60	72	62	60	72
Choice+PO	0.5% v/v+1qt	47	52	45	47	52	42
Quest+PO	0.5% v/v+1qt	62	60	74	62	60	74
Cayuse Plus	0.75% v/v	50	50	23	50	50	23
Citron+PO	2.2lb/100gal+1qt	62	60	67	72	60	65
Herbolyte	1% v/v	17	17	10	17	17	10
N-Tense	0.75% v/v	58	48	37	58	48	33
Reddy It	0.25% v/v	13	13	0	13	13	0
Quad 7	1% v/v	63	63	60	63	53	50
Scoil+AMS	1.5pt+8.5lb/100gal	76	69	82	83	69	82
Z-64	1.5pt	75	69	83	73	68	80
Renegade	1.5pt	78	71	72	78	71	72
LSD (0.05)		7	5	8	7	6	8

[1]PO = petroleum oil concentrate = Herbimax; AMS = ammonium sulfate; 28% N = 28-0-0; ClassAct Next Generation, Surfate, and Cayuse Plus = surfactants + fertilizers; Alliance, Choice, Citron, and Quest = water conditioning agents; Herbolyte = a proprietary adjuvant from ProfitPro, LLC; N-Tense = water conditioning agents + surfactants; Reddy IT = MSO complex surfactant blend; Quad 7 = basic pH blend; Scoil = methylated seed oil; Z-64 and Renegade = MSO basic pH Blend;

[2]Corn = Roundup Ready/Liberty Link stacked corn.

AMS replacement adjuvants with Raptor. Zollinger, Richard K. and Jerry L. Ries. An experiment was conducted near Casselton, ND, to evaluate species efficacy of AMS replacement type adjuvants with Raptor. 'Carter' flax, 'Steele' wheat, Pioneer '63M80' sunflower, Pioneer '39F27' corn, 'Quinoa'(*Chenopodium quinoa*), and 'Plainsman' amaranth were planted perpendicular to each plot length on May 30, 2006. POST treatments were applied on June 22 at 9:30 am with 64 F air, 75 F soil surface, 58% relative humidity, 100% cloud cover, 0 to 3 mph NE wind, dry soil surface, moist subsoil, excellent vigor, and no dew present. Species stages at time of application were: 1 to 4 inch (15 to 30/ft^2) flax; 2 to 7 inch (15 to 40/ft^2) wheat; 3 to 8 inch (10 to 20/ft^2) sunflower; V2 to V3, 4 to 12 inch (2 to 5/ft^2) corn; 2 to 5 inch (15 to 30/ft^2) quinoa; and 2 to 4 inch (20 to 50 /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 flat-fan nozzles. The experiment had randomized complete block design with three replicates per treatment.

Treatments were applied with water containing 625 ppm hardness of $NaHCO_3$. Treatment containing N-Tense, Quad 7, MSO, or Basis blend + MSO adjuvants had the greatest species control. Water conditioners did not provide adequate control. (Dept. of Plant Sciences, North Dakota State University, Fargo).

Table. AMS replacement adjuvants with Raptor (Zollinger and Ries).

		14 DAT						28 DAT					
Treatment[1]	Rate	Wheat	Corn[2]	Flax	Quinoa	Amar[3]	Snfl[4]	Wheat	Corn	Flax	Quinoa	Amar	Snfl
	(product/A)	% control						% control					
Raptor +	2 fl oz +	15	7	0	0	40	28	13	10	0	0	43	27
R-11	0.25% v/v	79	40	22	52	60	60	93	37	22	55	65	62
AMS	8.5lb/100gal	35	20	7	17	52	64	32	20	7	50	52	68
28% N	2.5% v/v	72	57	20	23	70	63	83	58	32	32	83	73
R-11+AMS	0.25% v/v+8.5lb/100gal	94	93	47	84	93	92	94	93	43	86	93	80
R-11+28% N	0.25% v/v+ 2.5% v/v	95	94	62	79	90	92	95	94	62	83	90	92
ClassAct Next Generation	2.5% v/v	84	67	30	63	70	76	85	67	27	67	74	78
Surfate	1% v/v	81	53	20	40	67	65	81	45	20	33	67	65
Alliance+Preference	1.25% v/v+0.25% v/v	83	73	25	64	65	90	81	80	28	64	65	70
Choice+Liberate	0.5% v/v+0.25% v/v	68	40	27	40	53	63	70	33	27	32	50	61
Quest+Preference	0.5% v/v+0.25% v/v	91	78	15	66	64	88	91	80	18	69	63	85
Cayuse Plus	0.75% v/v	73	37	13	30	62	71	72	35	17	22	62	62
Citron+Preference	2.2lb/100gal+0.25% v/v	90	78	27	60	66	76	92	86	28	63	68	79
Herbolyte	1% v/v	25	15	8	20	40	50	25	13	7	20	40	50
N-Tense	0.75% v/v	93	82	47	69	87	70	93	90	53	92	96	77
Reddy IT	0.25% v/v	70	17	17	53	61	73	75	15	20	50	61	70
Quad 7	1% v/v	85	92	40	81	93	91	95	96	42	96	95	96
Scoil+AMS	1.5pt+8.5lb/100gal	96	96	49	87	93	96	97	96	53	94	95	96
Z-64	1.5pt	96	93	61	83	90	94	97	94	63	95	94	95
Renegade	1.5pt	92	88	54	80	88	87	97	94	52	93	95	95
WC052	1% v/v	77	50	40	60	80	80	83	50	40	57	85	83
LSD (0.05)		7	9	10	9	6	5	5	7	7	5	5	6

[1]R-11, Preference, and Liberate = nonionic surfactants; AMS = ammonium sulfate; 28% N = 28-0-0; ClassAct Next Generation, Surfate, and Cayuse Plus = surfactants + fertilizer; Alliance, Choice, Quest, and Citron = water conditioning agents; Herbolyte = a proprietary adjuvant from ProfitPro, LLC; N-Tense = water conditioning agents + surfactants; Reddy IT = MSO complex surfactant blend; Quad 7 = basic pH blend; Scoil = methylated seed oil; Z-64 and Renegade = MSO basic pH Blend; WC052 = a proprietary adjuvant from West Central.

[2]Corn = conventional corn, [3]Amar = amaranth, [4]Snfl = sunflower.

AMS replacement adjuvants with Steadfast. Zollinger, Richard K. and Jerry L. Ries. An experiment was conducted near Casselton, ND, to evaluate species efficacy of AMS replacement type adjuvants with Steadfast. 'Briggs' wheat, 'Drummond' barley, and 'Quinoa' (*Chenopodium quinoa*) were planted perpendicular to each plot length on June 8, 2006. POST treatments were applied on June 23 at 8:45 am with 72 F air, 74 F soil surface, 42% relative humidity, 0% cloud cover, 0 to 2 mph NE wind, dry soil surface, moist subsoil, good vigor, and no dew present. Species stages at the time of application were: 3 to 5 inch (15 to 25/ft^2) wheat; 3 to 4 inch (20 to 30/ft^2) barley; 1 to 1.5 (5 to 30/ft^2) quinoa; and 2 to 10 inch (5 to 25/yd^2) redroot pigweed. 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 flat-fan nozzles. The experiment had randomized complete block design with three replicates per treatment.

Treatments were applied with water containing 625 ppm hardness of $NaHCO_3$ .Treatment containing surfactant + AMS, N-Tense, Quad 7, MSO, or Basis blend + MSO adjuvants had the greatest species control. Water conditioners did not provide adequate species control. (Dept. of Plant Sciences, North Dakota State University, Fargo). Treatments

Table. AMS replacement adjuvants with Steadfast (Zollinger and Ries).

		14 DAT			28 DAT			
Treatment[1]	Rate	Wheat	Barley	Quinoa	Wheat	Barley	Quinoa	Rrpw
	(product/A)	------- % control -------			---------- % control ----------			
Steadfast +	0.75 oz +	48	43	7	55	50	7	0
R-11	0.25% v/v	72	62	50	78	63	43	70
AMS	8.5lb/100gal	57	47	25	70	77	25	72
28% N	2.5% v/v	76	71	30	88	93	47	92
R-11+AMS	0.25% v/v+8.5lb/100gal	94	94	96	83	88	90	91
R-11+28% N	0.25% v/v+ 2.5% v/v	93	95	96	95	97	94	96
ClassAct Next Generation	2.5% v/v	85	92	77	90	92	83	91
Surfate	1% v/v	83	84	68	91	92	80	92
Alliance+Preference	1.25% v/v+0.25% v/v	72	78	60	74	82	68	82
Choice+Liberate	0.5% v/v+0.25% v/v	72	72	63	73	75	63	73
Quest+Preference	0.5% v/v+0.25% v/v	82	85	85	82	87	88	86
Cayuse Plus	0.75% v/v	79	80	50	79	83	50	79
Citron+Preference	2.2lb/100gal+0.25% v/v	79	79	72	85	87	84	87
Herbolyte	1% v/v	56	53	25	56	53	25	63
N-Tense	0.75% v/v	92	92	89	95	96	92	94
Reddy IT	0.25% v/v	84	79	62	87	79	65	83
Quad 7	1% v/v	96	96	96	97	96	96	96
Scoil+AMS	1.5pt+8.5lb/100gal	97	97	97	97	97	97	99
Z-64	1.5pt	96	96	96	97	97	97	99
Renegade	1.5pt	96	96	96	97	97	97	99
WC052	1% v/v	83	86	82	87	96	85	87
LSD (0.05)		6	8	9	5	6	7	3

[1]R-11, Preference, and Liberate = nonionic surfactants; AMS = ammonium sulfate; 28% N = 28-0-0; ClassAct Next Generation, Surfate, and Cayuse Plus = surfactants + fertilizer; Alliance, Choice, Quest, and Citron = water conditioning agents; Herbolyte = a proprietary adjuvant from ProfitPro, LLC; N-Tense = water conditioning agents + surfactants; Reddy IT = MSO complex surfactant blend; Quad 7 = basic pH blend; Scoil = methylated seed oil; Z-64 and Renegade = MSO basic pH Blend; WC052 = a proprietary adjuvant from West Central.

Adjuvants with Steadfast plus Callisto. Zollinger, Richard K. and Jerry L. Ries. An experiment was conducted near Casselton, ND, to evaluate efficacy from tank-mixes of Steadfast and Callisto with adjuvants. 'Steele' wheat, 'Carter' flax, Pioneer '63M80' sunflower, 'Plainsman' amaranth, and 'Quinoa' (*Chenopodium quinoa*) species were planted perpendicular to each plot length on May 30, 2006. POST treatments were applied on June 20 at 7:00 pm with 81 F air, 85 F soil surface, 48% relative humidity, 0% cloud cover, dry soil surface, moist subsoil, excellent vigor, and no dew present. Species stages at time of application were: 4 to 6 inch (10 to 25/ft^2) wheat; 1 to 3 inch (25 to 50/ft^2) flax; V3 to V5 (3 to 7/ft^2) sunflower; 1 to 3 inch (20 to 30/ft^2) amaranth; and (10 to 20/ft^2) quinoa. 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 flat-fan nozzles. The experiment had randomized complete block design with three replicates per treatment.

Plant species respond differently to herbicide + adjuvant combinations. (Dept of Plant Sciences, North Dakota State University, Fargo).

Table. Adjuvants with Steadfast plus Callisto (Zollinger and Ries).

		14 DAT					28 DAT				
Treatment[1]	Rate	Wheat	Flax	Quinoa	Amar[2]	Snfl[3]	Wheat	Flax	Quinoa	Amar	Snfl
	(product/A)	% control					% control				
Steadfast+Callisto +	0.5oz+2fl oz +										
Premium COC+Premium AMS	1% v/v+3lb	82	37	82	86	69	80	40	80	85	68
Premium COC+N-Tense	1% v/v+0.5% v/v	96	68	99	89	82	91	68	99	88	90
Trophy Gold+Premium AMS	0.25% v/v+8.5lb/100gal	70	65	99	71	71	68	62	99	68	69
Trophy Gold+N-Tense	0.25% v/v+0.5% v/v	92	53	99	99	91	93	57	99	99	92
Base+N-Tense	1% v/v+0.5% v/v	96	65	99	91	95	91	63	99	90	93
Destiny+28% N	1% v/v+2.5% v/v	94	91	99	84	94	95	94	99	90	96
Prime Oil+28% N	1% v/v+2.5% v/v	83	74	99	86	92	80	72	99	85	91
Superb HC+28% N	0.5% v/v+2.5% v/v	78	72	94	71	95	75	69	94	67	94
Newtone	1% v/v	89	79	99	90	95	91	87	99	87	96
AG 06072+28% N	0.5% v/v+2.5% v/v	73	68	92	77	89	70	68	92	68	90
AG 05006+28% N	0.5% v/v+2.5% v/v	94	89	99	95	97	93	89	99	86	92
AG 05006+28% N	1% v/v+2.5% v/v	92	96	99	92	97	83	91	99	83	97
AG 05055+28% N	1.5% v/v+2.5% v/v	92	91	99	87	96	84	86	99	84	96
AG 05055+28% N	2.5% v/v+2.5% v/v	92	91	99	89	96	80	93	99	86	96
AG 06051+28% N	1% v/v+2.5% v/v	88	67	99	80	90	93	63	99	68	87
AG 06050+AG 05006	0.5% v/v+0.5% v/v	82	63	93	61	74	92	66	93	62	77
AG 06051+AG 05006	1% v/v+0.5% v/v	78	65	99	83	95	78	66	99	77	90
Destiny+AG 02013+28% N	1% v/v+4fl oz+2.5% v/v	78	13	90	70	73	83	13	90	60	70
AG 06022+28% N	0.5% v/v+2.5% v/v	92	94	99	99	97	95	92	99	99	99
AG 06023+28% N	0.5% v/v+2.5% v/v	92	69	99	92	95	92	69	99	94	95
LSD (0.05)		6	7	6	6	4	5	5	6	6	6

[1]Premium COC and Prime Oil, Superb HC = high surfactant oil concentrate; Premium AMS = ammonium sulfate; N-Tense = water conditioning agents + fertilizers; Trophy Gold = oil based surfactant; Base = MSO basic pH blend; Destiny = methylated seed oil; 28% N = 28-0-0; Newtone = basic pH blend; AG compounds = proprietary adjuvants from Agriliance.
[2]Amar = amaranth.
[3]Snfl = sunflower.

Adjusting spray solution pH. Zollinger, Richard K. and Jerry L. Ries. An experiment was conducted near Casselton, ND, to evaluate the affects of pH adjusted carrier solutions on efficacy. 'Briggs' wheat, 'Drummond' barley, and 'Quinoa' (*Chenopodium quinoa*) were planted perpendicular to each plot length on June 8, 2006. POST treatments were applied on June 23 at 9:30 am with 76 F air, 86 F soil surface, 32% relative humidity, 0% cloud cover, 0 to 2 mph, dry soil surface, moist subsoil, good vigor, and no dew present. Species stages at time of application were: 3 to 5 inch (15 to 25/ft^2) wheat; 3 to 4 inch (20 to 30/ft^2) barley; 1 to 1.5 inch (5 to 30/ft^2) quinoa. 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 flat-fan nozzles. The experiment had randomized complete block design with three replicates per treatment.

This experiment was conducted to test herbicide efficacy by adjusting spray solution pH. The pH of the spray solution was adjusted to a pH of 5 or 7 by using Tri-Fol before herbicide treatments were mixed. The solubility of Accent and Option increase as spray solution pH increase. Quad 7 and Renegade adjuvants are designed to increase spray solution pH, increase the herbicide solubility, and increase weed control. When the spray solution is adjusted to pH 5, which is near the pKa of these herbicides, they may not interact with hard water salts and result in antagonism while treatments at pH 7 will allow herbicides to interact with salts. At 28 DAT, generally weed control was near complete and treatment separation could not be made. However, weed control from Accent was greater when applied with MSO-type oil adjuvant compared to the non-oil adjuvant of Quad 7 or Renegade (MSO + Quad 7) in pH 5 or 7 spray solution. (Dept. of Plant Sciences, North Dakota State University, Fargo).

Table. Adjusting spray solution pH (Zollinger and Ries).

		14 DAT			28 DAT		
Treatment[1]	Rate	Wheat	Barley	Quinoa	Wheat	Barley	Quinoa
	(product/A)	------- % control -------			------- % control -------		
Spray Solution - pH 5							
Accent+SS MSO+28% N	0.33oz+1qt+2qt	92	92	93	99	99	96
Accent+Renegade	0.33oz+1.75pt	85	85	71	99	99	74
Accent+Quad 7	0.33oz+1% v/v	86	87	72	99	99	75
Option+SS MSO+28% N	1.5oz+1qt+2qt	91	92	93	99	99	96
Option+Renegade	1.5oz+1.75pt	92	90	90	96	99	93
Option+Quad 7	1.5oz+1% v/v	88	88	89	99	99	95
Spray Solution - pH 7							
Accent+SS MSO+28% N	0.33oz+1qt+2qt	95	94	93	99	99	93
Accent+Renegade	0.33oz+1.75pt	87	78	70	99	99	74
Accent+Quad 7	0.33oz+1% v/v	90	92	81	99	99	80
Option+SS MSO+28% N	1.5oz+1qt+2qt	96	96	94	99	99	98
Option+Renegade	1.5oz+1.75pt	92	92	93	99	99	97
Option+Quad 7	1.5oz+1% v/v	91	92	92	99	99	98
LSD (0.05)		4	5	3	2	0	2

[1]SS MSO = SuperSpread MSO; 28% N = 28-0-0; Renegade = MSO Basic pH Blend; Quad 7 = basic pH blend.

Spray solution pH adjusting adjuvants. Zollinger, Richard K. and Jerry L. Ries. An experiment was conducted near Casselton, ND, to evaluate the affects of pH adjusted carrier solutions on efficacy. 'Steele' wheat, 'Carter' flax, Pioneer '63M80' sunflower, Pioneer '39F27' corn, 'Plainsman' amaranth, and 'Quinoa' (*Chenopodium quinoa*) were planted perpendicular to each plot length on May 30, 2006. POST treatments were applied on June 20 at 7:45 pm with 79 F air, 83 F soil surface, 46% relative humidity, 0% cloud cover, dry soil surface, moist soil surface, excellent vigor, and no dew present. Species stages at time of application were: 4 to 6 inch (10 to 25/ft^2) wheat; 1 to 3 inch (25 to 50/ft^2) flax; V3 to V5 (3 to 7/ft^2) sunflower; V3 (3 to 5/ft^2) corn, 1 to 3 inch (20 to 30/ft^2) amaranth; and 1 to 2 inch (10 to 20/ft^2) quinoa. 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 flat-fan nozzles. The experiment had randomized complete block design with three replicates per treatment.

This experiment was conducted to test herbicide efficacy by adjusting spray solution pH before and after adding herbicides to the spray mixture. All treatments were applied in water containing 443 ppm Ca ($CaCl_2$). The solubility of Accent, Distinct, and Impact increases as spray solution pH increases. Adjuvants that are designed to increase spray solution pH were added to the water before herbicides to increase the water pH to highly alkaline. After the herbicides were added and allowed to equilibrate Tri-fol was added to reduce the spray solution pH to approximately 5 which near the pKa of the herbicide. (Dept of Plant Sciences, North Dakota State University, Fargo).

Table. Spray solution pH adjusting adjuvants (Zollinger and Ries).

		14 DAT						28 DAT					
Treatment[1]	Rate	Wheat	Flax	Quinoa	Amar[2]	Snfl[3]	Corn[4]	Wheat	Flax	Quinoa	Amar	Snfl	Corn
	(product/A)	% control						% control					
Accent +	0.33oz +												
Super Spread MSO+28% N	1qt+2qt	96	70	84	99	57	0	97	70	84	83	86	0
WE 6060	1.75pt	94	62	67	99	52	0	93	60	67	86	43	0
WE 6061	1.75pt	89	80	47	95	32	0	89	50	43	92	30	0
WE 6061AVC	1.75pt	94	62	67	99	54	0	96	63	86	88	52	0
WE 6064	1.75pt	96	60	59	95	30	0	93	65	59	91	30	0
Distinct +	3oz +												
R-11+28% N	0.25% v/v+1.25% v/v	53	57	88	74	75	0	63	55	99	99	91	0
WE 6060	1.75pt	48	50	90	70	75	0	42	50	93	90	84	0
WE 6061	1.75pt	40	42	87	71	66	0	37	42	95	92	81	0
WE 6061AVC	1.75pt	53	57	91	63	67	0	50	58	96	90	73	0
WE 6064	1.75pt	45	50	87	60	68	0	42	43	95	56	80	0
Impact +	0.5fl oz +												
Super Spread MSO+28% N	1% v/v+2.5% v/v	61	10	99	73	68	0	55	20	99	70	73	0
WE 6060	1.75pt	50	7	99	68	73	0	42	13	99	62	83	0
WE 6061	1.75pt	68	17	98	92	83	0	53	17	98	77	78	0
WE 6061AVC	1.75pt	68	17	99	84	88	0	58	17	99	78	87	0
WE 6064	1.75pt	58	8	90	73	68	0	55	8	91	65	66	0
LSD (0.05)		8	7	6	7	8	0	4	7	5	18	7	0

[1]Super Spread MSO = methylated seed oil; 28% N = 28-0-0; R-11 = nonionic surfactant; WE compounds = proprietary compounds from Wilbur-Ellis.
[2]Amar = amaranth. [3]Snfl = sunflower. [4]Corn = conventional corn.

Adjuvants with glyphosate-tolerant corn. Zollinger, Richard K. and Jerry L. Ries. An experiment was conducted near Casselton, ND, to evaluate weed species efficacy with adjuvants. Pioneer '63M80' sunflower, DeKalb 'DKC35-51' corn, 'Carter' flax, 'Briggs' wheat, 'Plainsman' amaranth, and 'Quinoa' (*Chenopodium quinoa*) were planted perpendicular to each plot length on June 8, 2006. POST treatments were applied on June 23, at 10:45 am with 79 F air, 94 F soil surface, 32% relative humidity, 30% cloud cover, 1 to 3 mph SW wind, dry soil surface, moist subsoil, excellent vigor, and no dew present. Species stages at time of application were: 1 to 3 inch, V2 (1 to 5/ft^2) sunflower; V1 to V2, 3 to 4 inch (3 to 5/ft^2) corn; 0.5 to 1.5 inch (25 to 40/ft^2) flax; 3 to 5 inch (10 to 30/ft^2) wheat; 1 to 1.5 inch (25 to 40/ft^2) amaranth; and 1 to 2 inch (10 to 25/ft^2) quinoa. 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 flat-fan nozzles. The experiment had randomized complete block design with three replicates per treatment.

Plant species respond differently to herbicide + adjuvant combinations. (Dept. of Plant Sciences, North Dakota State University, Fargo).

Table. Aduvants with glyphosate-tolerant corn (Zollinger and Ries).

		14 DAT						28 DAT					
Treatment[1]	Rate	Wheat	Flax	Amar[2]	Quinoa	Snfl[3]	Corn[4]	Wheat	Flax	Amar	Quinoa	Snfl	Corn
	(product/A)	% control						% control					
RoundUp Original Max +	11fl oz +	90	82	75	84	90	0	93	84	58	58	80	0
Premium AMS	8.5lb/100gal	98	96	89	86	96	0	98	98	63	82	91	0
N-Tense	0.5% v/v	99	96	92	92	95	0	99	96	88	91	95	0
Establish+N-Tense	10fl oz+0.5% v/v	99	97	96	95	97	0	99	97	88	95	97	0
Atrazine+N-Tense	0.56lb+0.5% v/v	99	96	96	96	98	0	99	84	71	96	98	0
Option +	1.5oz +												
Distinct+Soy-Stik+Premium AMS	4oz+1.5pt+1.5lb	89	68	90	95	91	0	96	62	65	92	88	0
Distinct+Soy-Stik+N-Tense	4oz+1.5pt+0.5% v/v	87	60	87	88	89	0	99	82	82	98	96	0
Distinct+Base+N-Tense	4oz+1.5pt+0.5% v/v	96	79	98	98	96	0	99	80	89	99	98	0
Distinct+Trophy Gold+Premium AMS	4oz+0.25% v/v+1.5lb	96	70	88	88	81	0	98	73	88	95	90	0
Distinct+Quad 7	4oz+1% v/v	88	68	91	96	95	0	95	69	82	99	96	0
Distinct+WC052	4oz+1% v/v	90	47	82	75	73	0	90	43	70	96	82	0
LSD (0.05)		5	3	4	4	2	NS	2	5	13	5	4	NS

[1]Premium AMS = ammonium sulfate; N-Tense = water conditioning agents + surfactants; Soy-Stik = methylated seed oil; Base = MSO basic pH blend; Tropy Gold = oil based surfactant; Quad 7 = basic pH blend; WCO52 = a proprietary adjuvant from West Central.
[2]Amar = amaranth.
[3]Snfl = sunflower.
[4]Corn = glyphosate-tolerant corn.

AMS replacement adjuvants with RT 3. Zollinger, Richard K. and Jerry L. Ries. An experiment was conducted near Casselton, ND, to evaluate weed efficacy from RT3 treatments with adjuvants. 'Steele' wheat, 'Carter' flax, Pioneer '63M80' sunflower, Pioneer '39F27' corn, 'Quinoa' (*Chenopodium quinoa*), and 'Plainsman' amaranth were planted perpendicular to each plot length on May 30, 2006. POST treatments were applied on June 28 at 9:35 am with 75 F air, 86 F soil surface, 35% relative humidity, 0% cloud cover, 0 to 3 mph E wind, dry soil surface, moist subsoil, excellent vigor, and no dew present. Species stages at time of application were: 6 to 12 inch (20 to 30/ft^2) wheat; 2 to 6 inch (25 to 40/ft^2) flax; V6 to V8 (5 to 10/ft^2) sunflower; V4 to V5 (4 to 7/yd^2) corn; 2 to 6 inch (25 to 40/ft^2) quinoa; and V6 to V8 (5 to 10/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 flat-fan nozzles. The experiment had RCB design with 3 replicates per treatment.

RT 3 is a Monsanto branded potassium salt glyphosate. Treatments were applied with water containing 525 ppm hardness of $CaCl_2$. At 28 DAT, most treatments gave greater than 90% weed control. Of all the adjuvants used, at least Superb HC is an oil based adjuvant. Oil adjuvants antagonize glyphosate. However this is an example of where an oil adjuvant with a high surfactant load can enhance glyphosate which is a water soluble herbicide. The AMS was still needed to overcome the antagonism from calcium. (Dept. of Plant Sciences, North Dakota State University, Fargo).

Table. AMS replacement adjuvants with RT 3 (Zollinger and Ries).

		14 DAT						28 DAT					
Treatment[1]	Rate	Wheat	Flax	Amar[2]	Quinoa	Snfl[3]	Corn[4]	Wheat	Flax	Amar	Quinoa	Snfl	Corn
	(product/A)	% control						% control					
RT 3 +	8fl oz +	90	69	67	50	57	60	95	90	47	70	82	73
AMS	8.5lb/100gal	99	93	85	92	92	96	99	99	96	99	99	96
Bronc Max	0.5% v/v	99	88	72	77	73	80	99	99	86	99	99	97
Bronc Max EDT	0.5% v/v	99	85	70	86	73	70	99	95	80	99	83	85
Bronc Max EDT Dry	10lb/100gal	99	95	82	95	96	96	99	99	92	99	98	99
Cut-Rate	3lb/100gal	99	91	78	78	84	74	99	99	88	86	94	87
Cut-Rate	4lb/100gal	99	89	75	73	75	70	99	96	83	93	92	90
AMS	8.5lb/100gal	99	96	89	90	92	92	99	99	95	98	99	98
WECO 5074-3	0.5% v/v	99	99	98	98	95	98	99	99	96	99	96	99
N-Pac AMS	5% v/v	99	99	90	93	88	96	99	99	90	99	96	99
ClassAct NG	2.5% v/v	99	99	99	99	96	97	99	99	99	99	99	97
Alliance	0.75% v/v	99	84	75	84	84	86	99	99	85	95	94	95
AG 03019	0.5% v/v	99	82	72	78	70	69	99	92	75	96	82	82
AG 03019	1% v/v	99	86	67	87	87	73	99	89	90	99	90	91
N-Tense	0.5% v/v	99	88	75	92	85	77	99	96	93	99	94	87
Superb HC+AMS	0.5% v/v+8.5lb/100gal	99	99	76	86	87	90	99	99	90	96	99	92
Superb HC+Alliance	0.5% v/v+1.25% v/v	99	86	85	93	86	88	99	99	96	99	99	96
Superb HC+Alliance	0.5% v/v+1.5% v/v	99	99	94	94	94	96	99	99	94	95	99	94
Superb HC+Alliance	0.5% v/v+2% v/v	99	97	95	94	90	96	99	99	95	99	95	95
Superb HC+ClassAct NG	0.5% v/v+2.5% v/v	99	99	99	99	97	98	99	99	99	99	99	99
LSD (0.05)		0	4	6	4	6	5	1	1	4	2	4	5

[1]AMS = ammonium sulfate; Bronc Max, Cut-Rate, and Alliance = water conditioning agents; Bronc Max EDT/Dry = AMS + deposition + water conditioner; WECO 5074-3 = a proprietary adjuvant from Wilbur-Ellis; N-Pac AMS = liquid AMS; ClassAct NG = ClassAct Next Generation = surfactants + fertilizer; AG 03019 = a proprietary adjuvant form Agriliance; Superb HC = high surfactant oil concentrate.
[2]Amar = amaranth, [3]Snfl = sunflower, [4]Corn = conventional corn.

Glyphosate formulations. Zollinger, Richard K. and Jerry L. Ries. An experiment was conducted near Casselton, ND, to evaluate weed efficacy from glyphosate formulations. 'Briggs' wheat, 'Carter' flax, 'Plainsman' amaranth, 'Quinoa' (*Chenopodium quinoa*), Pioneer '63M80' sunflower, and DeKalb 'DCK35-51' corn were planted perpendicular to each plot length on June 8, 2006. POST treatments were applied on July 11 at 9:00 am with 77 F air, 78 F soil surface, 62% relative humidity, 10% cloud cover, 6 to 10 mph SE wind, dry soil surface and subsoil, and no dew present. Species stages at the time of applications were: 8 to 14 inch (20 to 30/ft^2) wheat; 2 to 5 inch (15 to 30/ft^2) flax; 6 to 12 inch (25 to 40/ft^2) amaranth; 6 to 18 inch (20 to 30/ft^2) quinoa; 20 to 30 inch ,V10 to V14, (5 to 10/ft^2) sunflower; and 24 to 32 inch, V4 to V6 (3 to 7/ft^2) corn. 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 flat-fan nozzles. The experiment had randomized complete block design with three replicates per treatment.

Glyphosate in RU WeatherMax, Mirage, or LI experimental formulations were applied at full 0.75 lb ae/A labeled rates. There was no visible RR corn injury. (Dept. of Plant Sciences, North Dakota State University, Fargo).

Table. Glyphosate formulations (Zollinger and Ries).

		14 DAT						28 DAT					
Treatment[1]	Rate	Wheat	Flax	Amar[2]	Quinoa	Snfl[3]	Corn[4]	Wheat	Flax	Amar	Quinoa	Snfl	Corn
	(product/A)	% control						% control					
RUWM+Choice WeatherMaster	22fl oz+0.5% v/v	99	99	96	99	70	0	99	99	87	99	82	0
Mirage Plus+Choice WeatherMaster	1qt+0.5% v/v	99	99	95	99	86	0	99	99	87	99	93	0
LI 6130+Choice WeatherMaster	1qt+0.5% v/v	99	93	98	99	82	0	99	95	86	99	93	0
LI 6173+Choice WeatherMaster	1qt+0.5% v/v	99	99	96	99	78	0	99	99	93	99	89	0
Mirage+LI 700+Choice WeatherMaster	1qt+0.25% v/v+0.5% v/v	99	99	94	99	75	0	99	99	87	99	87	0
LI 6171+Choice WeatherMaster	1qt+0.5% v/v	99	96	85	92	75	0	99	99	83	99	88	0
LI 6139+Choice WeatherMaster	22fl oz+0.5% v/v	99	87	86	90	69	0	99	97	86	99	83	0
LI 6139+LI 700+Choice WeatherMaster	22fl oz+0.25% v/v+0.5% v/v	99	89	86	91	72	0	99	97	88	99	86	0
LI 6139+LI 700+Choice WeatherMaster	22fl oz+0.5% v/v+0.5% v/v	99	82	80	90	74	0	99	91	91	99	87	0
Mirage+Flame	1qt+0.25% v/v	99	99	99	99	88	0	99	99	99	99	97	0
Mirage+Flame	1qt+0.5% v/v	99	99	99	99	85	0	99	99	99	99	94	0
Mirage+Activator 90+AMS	1qt+0.25% v/v+17lb/100gal	99	99	99	99	92	0	99	99	99	99	99	0
LSD (0.05)		0	4	6	3	5	0	0	2	7	0	4	0

[1]RUWM = Roundup WeatherMax; Choice WeatherMaster = water conditioning agents; LI compounds = proprietary herbicides from UAP; LI 700 = acidifying agents; Flame = water conditioning agents + surfactants; Activator 90 = nonionic surfactant; AMS = ammonium sulfate.
[2]Amar = amaranth.
[3]Snfl = sunflower.
[4]Corn = glyphosate-tolerant corn.

Nonionic surfactants with RT 3. Zollinger, Richard K. and Jerry L. Ries. An experiment was conducted near Casselton, ND, to evaluate species efficacy. Pioneer '39F27' corn, Pioneer '63M80' sunflower, 'Carter' flax, 'Steele' wheat, 'Quinoa' (*Chenopodium quinoa*), and 'Plainsman' amaranth were planted perpendicular to each plot length on May 30, 2006. POST treatments were applied on June 27 at 9:35 am with 68 F air, 78 F soil surface, 52% relative humidity, 0% cloud cover, 4 to 7 mph NE wind, dry soil surface, moist subsoil, excellent crop vigor, and no dew present. Species stages at time of application were: V3 to V4 (5 to 10/ft^2) corn; V4 to V8 (3 to 5/ft^2) sunflower; 2 to 5 inch (20 to 30/ft^2) flax; 6 to 8 inch (15 to 30/ft^2) wheat; 3 to 8 inch (15 to 30/ft^2) quinoa; and 3 to 8 inch (20 to 40/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 flat-fan nozzles. The experiment had randomized complete block design with three replicates per treatment.

RT 3 is a Monsanto branded potassium salt glyphosate with a more aggressive adjuvant formulation than other products and is not labeled on RR crops. A reduced rate of RT 3 was used for treatment separation. The AG coded adjuvant are experimental and branded single and mixture adjuvants from Agriliance. Initially, AG 03019 controlled more weeds than other adjuvants but by 28 DAT several other adjuvants gave similar control. This study shows plant species respond differently to herbicide + adjuvant combinations. (Dept. of Plant Sciences, North Dakota State University, Fargo).

Table. Nonionic surfactants with RT 3 (Zollinger and Ries).

		14 DAT						28 DAT					
Treatment[1]	Rate	Wheat	Flax	Amar[2]	Quinoa	Snfl[3]	Corn[4]	Wheat	Flax	Amar	Quinoa	Snfl	Corn
	(product/A)	% control						% control					
RT 3 +	8fl oz +	85	58	73	85	78	67	89	86	76	87	86	88
Preference	0.25% v/v	95	90	78	87	82	72	96	95	82	92	90	82
AG 03019	0.25% v/v	97	94	88	96	91	85	99	99	87	98	94	96
AG 03037	0.25% v/v	90	84	80	85	83	70	99	96	90	99	99	88
AG 04021	0.25% v/v	90	70	73	73	72	63	99	85	85	90	93	89
AG 06001	0.25% v/v	95	82	70	82	77	70	99	96	77	99	96	90
AG 06011	5fl oz	90	67	78	87	76	68	99	89	79	90	73	83
AG 06013	0.25% v/v	90	70	60	83	73	60	99	99	67	92	91	91
AG 06015	5fl oz	95	68	75	88	72	63	99	68	75	88	72	72
AG 06038	0.25% v/v	95	70	58	73	63	53	99	82	55	85	75	88
LSD (0.05)		1	14	9	6	9	10	1	4	9	4	10	4

[1]Preference = nonionic surfactant; AG compounds = experimental proprietary adjuvants from Agriliance.
[2]Amar = amaranth.
[3]Snfl = sunflower.
[4]Corn = conventional corn.

Glyphosate performance with adjuvants. Zollinger, Richard K. and Gregory J. Endres. An experiment was conducted near Carrington, ND, to evaluate glyphosate enhancement with adjuvant tank-mixes. POST treatments were applied on June 16 at 6:30 am with 64 F air, 93% relative humidity, 100% cloud cover, 5 to 6 mph wind, wet soil surface, and a light dew present. Species at time of application were: 2 to 24 inch common lambsquarters; and vining wild buckwheat. Treatments were applied to the center 6.7 feet of the 10 by 30 foot plots with a backpack-type plot sprayer delivering 8.5 gpa at 35 psi through 8001 TeeJet flat-fan nozzles. The experiment had randomized complete block design with three replicates per treatment.

NIS adjuvants are not created equal. The greatest weed control resulted from AMS + NIS adjuvants. Water conditioner adjuvants generally do not enhance glyphosate as much as AMS + NIS. (Dept of Plant Sciences, North Dakota State University, Fargo).

Table. Glyphosate performance with adjuvants (Zollinger and Endres).

Treatment[1]	Rate	21 DAT	
		Colq	Wibw
	(product/A)	% control	
Roundup Original Max+	8fl oz+		
AMS	8.5lb/100gal	78	55
R-11	0.5% v/v	93	50
Preference	0.5% v/v	83	57
Liberate	0.5% v/v	67	35
APSA-80	0.5% v/v	85	48
Purity 100	0.5% v/v	81	32
Cornbelt Premier 90	0.5% v/v	80	50
Wet-Sol 99	0.5% v/v	77	52
ClassAct Next Generation	2.5% v/v	83	60
Surfate	1% v/v	78	63
Alliance+Preference	1.25% v/v+0.5% v/v	66	47
Choice+Liberate	0.5% v/v+0.5% v/v	78	37
Bronc Max+R-11	0.5% v/v+0.5% v/v	88	64
Quest+Preference	0.5% v/v+0.5% v/v	70	43
Citron+Preference	2.2lb/100gal+0.5% v/v	78	62
N-Tense	0.5% v/v	67	47
Herbolyte	1% v/v	53	37
R-11+AMS	0.5% v/v+8.5lb/100gal	92	73
LSD (0.05)		7	9

[1]AMS = ammonium sulfate; R-11, Preference, Liberate, APSA-80, Purity 100, Cornbelt Premier 90, and Wet-Sol 99 = nonionic surfactants; ClassAct Next Generation and Surfate = sufactants + fertilizer; Alliance, Choice, Citron, and Quest = water conditioning agents; Bronc Max and N-Tense = water conditioning agents + surfactants; Herbolyte = a proprietary adjuvant from ProfitPro, LLC.
[2]Amar = amaranth.
[3]Snfl = sunflower.
[4]Corn = conventional corn.

Glyphosate performance with adjuvants, Langdon. Lukach, John and Rich Zollinger. An experiment was conducted near Langdon, ND, to evaluate glyphosate enhancement with adjuvant tank-mixes. POST treatments ere applied on June 22, 2006 at 9:30 to 11:00 am with 56 F air, 80% relative humidity, 50% cloud cover, 8 mph SW wind, damp surface, moist subsoil, excellent vigor, and dew present. Species at time of application were: 5 to 7 leaf (1/ft^2) wild oat; 5-leaf (2/yd^2) barnyardgrass; 3 to 5 inch (5/ft^2) redroot pigweed; and 3 to 5 inch (1/ft^2) common lambsquarters. Treatments were applied to the center 6.7 feet of the 10 by 40 foot plots with a tractor 3-point mounted plot sprayer delivering 8.5 gpa at 40 psi through 8001 flat-fan nozzles. The experiment had randomized complete block design with four replicates per treatment.

NIS adjuvants are not created equal. Generally, the greatest weed control resulted from AMS + NIS adjuvants. Water conditioner adjuvants generally do not enhance glyphosate as compared to AMS + NIS. (Dept of Plant Sciences, North Dakota State University, Fargo).

Table. Glyphosate performance with adjuvants, Langdon (Lukach and Zollinger).

		14 DAT				28 DAT				
Treatment[1]	Rate	Bygr[2]	Wioa[3]	Colq[4]	Wibw[5]	Bygr	Wioa	Rrpw[6]	Colq	Wibw
	(product/A)	- - - - - - - % control - - - - - - -				- - - - - - - - % control - - - - - - - -				
Roundup Original Max+	8fl oz+									
AMS	8.5lb/100gal	92	99	89	20	99	99	99	98	97
R-11	0.5% v/v	92	98	93	23	99	99	97	96	65
Preference	0.5% v/v	87	92	80	9	97	99	97	91	62
Liberate	0.5% v/v	86	99	66	10	99	99	99	86	58
APSA-80	0.5% v/v	90	98	97	5	99	99	99	98	48
Purity 100	0.5% v/v	83	97	86	5	99	99	98	98	55
Cornbelt Premier 90	0.5% v/v	87	97	84	5	97	99	99	95	46
Wet-Sol 99	0.5% v/v	97	99	88	9	95	99	92	98	79
ClassAct Next Generation	2.5% v/v	96	99	94	13	99	99	99	98	77
Surfate	1% v/v	95	99	80	5	99	99	98	94	78
Alliance+Preference	1.25% v/v+0.5% v/v	92	99	86	10	95	99	97	94	70
Choice+Liberate	0.5% v/v+0.5% v/v	80	97	77	6	95	99	98	94	63
Bronc Max+R-11	0.5% v/v+0.5% v/v	86	99	90	6	99	99	98	97	75
Quest+Preference	0.5% v/v+0.5% v/v	94	99	96	9	97	99	98	97	63
Citron+Preference	2.2lb/100gal+0.5% v/v	92	99	88	8	97	99	95	97	65
N-Tense	0.5% v/v	95	99	95	14	97	99	97	99	70
Herbolyte	1% v/v	84	88	60	9	97	99	92	86	48
R-11+AMS	0.5% v/v+8.5lb/100gal	95	98	95	23	99	99	98	99	91
LSD (0.05)		6	3	7	5	2	NA	2	3	8

[1]AMS = ammonium sulfate; R-11, Preference, Liberate, APSA-80, Purity 100, Cornbelt Premier 90, and Wet- Sol 99 = nonionic surfactants; ClassAct Next Generation and Surfate = sufactants + fertilizer; Alliance, Choice, Citron, and Quest = water conditioning agents; Bronc Max, N-Tense = water conditioning agents + surfactants; Herbolyte = a proprietary adjuvant from ProfitPro, LLC.
[2]Bygr = barnyardgrass,
[3]Wioa = wild oat,
[4]Colq = common lambquarters,
[5]Wibw = wild buckwheat,
[6]Rrpw = redroot pigweed.

2006 Adjuvants with glyphosate at Hettinger, Eriksmoen, Eric and Rich Zollinger.
Treatments were applied on May 25 to 4 leaf wheat, heading downy brome (dobr), 9" tall blooming tansy mustard (tamu) and to 6" long field bindweed (fibw) with 67° F, 52% RH, sunny sky and NW wind at 4 mph. Treatments were applied with a tractor mounted CO_2 propelled plot sprayer delivering 10 gpa at 30 psi to 5 foot wide by 20 foot long plots. Weed populations per ft^2 were 2.5 for wheat, 15 for downy brome, 2.75 for tansy mustard and 1.5 for field bindweed. The experiment was a randomized complete block design with four replications. Plots were evaluated for weed control on June 7 and on June 23.

	Treatment	Rate	June 7				June 23			
			hrsw	dobr	tamu	fibw	hrsw	dobr	tamu	fibw
	R'up Origional Max +	% of solution	% Control							
1	alone	4 oz/A	90	94	18	7	86	97	32	8
2	AMS	1	95	98	50	10	94	99	70	30
3	R-11	0.5	90	94	25	5	91	97	30	30
4	Preference	0.5	85	92	12	5	72	99	20	11
5	Liberate	0.5	69	94	22	8	64	96	38	11
6	APSA-80	0.5	85	91	15	3	85	97	30	32
7	Purity 100	0.5	84	94	15	5	80	97	30	28
8	Premier 90	0.5	74	94	10	3	68	97	22	11
9	Wet-Sol	0.5	69	92	22	8	62	97	32	9
10	Class Act NG	2.5	92	98	35	5	95	99	80	32
11	Surfate	1	92	98	25	3	91	99	70	40
12	Alliance + Preference	1.25 + 0.5	94	98	22	3	91	99	32	32
13	Choice + Liberate	0.5 + 0.5	92	94	14	12	75	99	20	22
14	BroncMax + R-11	0.5 + 0.5	92	96	20	3	89	94	32	30
15	Quest + Preference	0.5 + 0.5	92	96	30	11	74	97	45	20
16	Citron + Preference	2.2 lbs + 0.5	93	98	27	2	94	98	53	15
17	N-Tense	0.5	96	96	32	5	97	98	50	24
18	Herbolyte	1	80	98	12	8	81	98	25	12
19	R-11 + AMS	0.5 + 1	92	98	40	16	92	99	66	52
20	Dispatch AMS	2.5	95	98	31	12	94	99	70	55
21	Weather Guard	0.25	92	94	18	3	60	98	25	12
22	Flame	0.25	65	95	19	5	62	98	22	9
	C.V. %		9.0	3.1	33.4	71.5	13.0	3.2	30.6	43.4
	LSD .05		8	4	6	7	9	NS	8	11

Hrsw = hard red spring wheat, dobr = downy brome, tamu = tansy mustard, fibw = field bindweed.

Summary

Liberate, Premier 90, Wet-Sol and Flame adjuvants with glyphosate appear to be antagonistic for hrsw control. Downy brome control was excellent and adjuvants did not significantly enhance or decrease control. In general, adjuvants containing ammonium sulfate (AMS) tended to significantly enhance tansy mustard and field bindweed control, while non-AMS containing adjuvants tended to be less efficacious on these broadleaf weeds.

Glyphosate performance with adjuvants, Casselton. Zollinger, Richard K. and Jerry L. Ries. An experiment was conducted near Casselton, ND, to evaluate glyphosate enhancement with adjuvant tank-mixes. 'Steele' wheat, 'Carter' flax, Pioneer '63M80' sunflower, Pioneer '39F27' corn, 'Plainsman' amaranth, and 'Quinoa' (*Chenopodium quinoa*) species were planted perpendicular to each plot length on May 30, 2006. POST treatments were applied on June 28 at 8:30 am with 76 F air, 89 F soil surface, 30% relative humidity, 0% cloud cover, 5 to 8 mph S wind, dry soil surface, moist subsoil, excellent vigor, and no dew present. Species at time of application were: 6 to 12 inch (25 to 30/ft^2) wheat; 3 to 6 inch (25 to 40/ft^2) flax; V6 to V8 (3 to 7/ft^2) sunflower; V4 to V5 (4 to 7/yd^2) corn; 4 to 7 inch (30 to 40/ft^2) amaranth; and 4 to 10 inch (10 to 20/ft^2) 'Quinoa' (*Chenopodium quinoa*). 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 flat-fan nozzles. The experiment had randomized complete block design with three replicates per treatment.

NIS adjuvants are not created equal. The greatest weed control resulted from AMS + NIS adjuvants. Water conditioner adjuvants generally do not enhance glyphosate as AMS + NIS. (Dept of Plant Sciences, North Dakota State University, Fargo).

Table. Glyphosate performance with adjuvants, Casselton (Zollinger and Ries).

		14 DAT						28 DAT					
Treatment[1]	Rate	Wheat	Flax	Amar[2]	Quinoa	Snfl[3]	Corn[4]	Wheat	Flax	Amar	Quinoa	Snfl	Corn
	(product/A)	% control						% control					
Roundup Original Max+	8fl oz+												
AMS	8.5lb/100gal	99	92	82	96	93	94	69	96	91	98	96	98
R-11	0.5% v/v	99	89	71	96	83	85	99	93	82	97	92	94
Preference	0.5% v/v	99	78	72	95	77	77	99	81	73	95	80	73
Liberate	0.5% v/v	91	68	50	83	73	72	91	72	53	87	77	73
APSA-80	0.5% v/v	98	92	60	90	79	87	98	94	72	90	81	85
Purity 100	0.5% v/v	99	88	70	93	74	89	99	89	75	94	83	93
Cornbelt Premier 90	0.5% v/v	99	64	63	89	69	73	99	67	63	90	73	85
Wet-Sol 99	0.5% v/v	96	77	72	91	68	87	98	82	73	91	80	87
ClassAct Next Generation	2.5% v/v	99	96	97	99	97	97	99	99	95	99	97	97
Surfate	1% v/v	99	95	88	98	94	93	99	99	94	99	96	96
Alliance+Preference	1.25% v/v+0.5% v/v	96	84	80	94	83	88	97	92	80	94	87	90
Choice+Liberate	0.5% v/v+0.5% v/v	94	84	70	81	75	80	96	92	75	89	85	87
Bronc Max+R-11	0.5% v/v+0.5% v/v	99	92	94	98	95	92	99	97	97	99	92	98
Quest+Preference	0.5% v/v+0.5% v/v	99	80	78	93	72	81	99	93	87	99	85	81
Citron+Preference	2.2lb/100gal+0.5% v/v	99	82	80	95	88	81	99	99	80	99	98	97
N-Tense	0.5% v/v	99	91	70	96	75	96	99	91	70	96	75	96
Herbolyte	1% v/v	92	77	73	92	68	82	93	78	74	94	78	89
R-11+AMS	0.5% v/v+8.5lb/100gal	99	94	95	99	95	96	99	99	96	99	99	99
LSD (0.05)		3	6	5	5	7	5	3	4	5	3	6	5

[1]AMS = ammonium sulfate; R-11, Preference, Liberate, APSA-80, Purity 100, Cornbelt Premier 90, and Wet- Sol 99 = nonionic surfactants; ClassAct Next Generation and Surfate = sufactants + fertilizer; Alliance, Choice, Citron, and Quest = water conditioning agents; Bronc Max, N-Tense = water conditioning agents + surfactants; Herbolyte = a proprietary adjuvant from ProfitPro, LLC.

[2]Amar = amaranth.

[3]Snfl = sunflower.

[4]Corn = conventional corn.

AMS replacement with Roundup Original Max. Zollinger, Richard K. and Jerry L. Ries. An experiment was conducted near Casselton, ND, to evaluate weed efficacy from glyphosate and adjuvants. Pioneer '39F27' corn, 'Pioneer '63M80' sunflower, 'Carter' flax, 'Steele' wheat, 'Plainsman' amaranth, and Quinoa (*Chenopodium quinoa*) species were planted perpendicular to the each plot length on May 30, 2006. POST treatments were applied on June 27 at 9:00 am with 65 F air, 71 F soil surface, 50% relative humidity, 0% cloud cover, 0 to 2 mph NE wind, dry soil surface, moist subsoil, excellent crop vigor, and no dew present. Species at time of application were: V3 to V4 (5 to 10/ft^2) corn; V4 to V8 (3 to 5/ft^2) sunflower; 2 to 5 inch (20 to 30/ft^2) flax; 6 to 8 inch (15 to 30/ft^2) wheat; 3 to 8 inch (20 to 40/ft^2) amaranth; and 3 to 8 inch (15 to 30/ft^2) quinoa. 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 flat-fan nozzles. The experiment had randomized complete block design with three replicates per treatment.

All treatments were applied in water containing 523 ppm Ca ($CaCl_2$). Treatments containing AMS and AMS + surfactant (R+11+ AMS, Class Act NG, Surfate) resulted in greater weed control than water conditioners. (Dept of Plant Sciences, North Dakota State University, Fargo).

Table. AMS replacement adjuvants with Roundup Original Max (Zollinger and Ries).

		14 DAT						28 DAT					
Treatment[1]	Rate	Wheat	Flax	Amar[2]	Quinoa	Snfl[3]	Corn[4]	Wheat	Flax	Amar	Quinoa	Snfl	Corn
	(product/A)	% Control						% Control					
Roundup Original Max+	8fl oz+	85	72	70	80	72	67	93	82	72	83	83	77
R-11	0.5% v/v	90	79	77	86	76	78	92	85	85	88	76	85
AMS	8.5lb/100gal	97	99	94	95	95	95	97	95	94	95	94	90
R-11+AMS	0.25% v/v+17lb/100gal	99	97	93	96	94	94	99	99	96	99	94	94
ClassAct Next Generation	2.5% v/v	99	99	91	96	96	95	99	99	95	99	99	99
Surfate	1% v/v	99	96	96	94	88	88	99	94	95	99	93	92
Alliance+Preference	1.25% v/v+0.5% v/v	98	95	88	93	88	88	98	96	90	95	90	92
Choice+Liberate	0.5% v/v+0.5% v/v	90	80	70	78	72	70	95	90	70	85	77	75
Quest+Preference	0.5% v/v+0.5% v/v	95	81	75	85	77	70	95	88	51	85	87	84
Bronc Max+R-11	0.5% v/v+0.5% v/v	97	87	70	86	78	77	99	94	78	97	88	87
Citron+Preference	2.2lb/100gal+0.5% v/v	99	88	63	81	70	68	99	88	67	90	83	78
Herbolyte	1% v/v	85	72	63	62	63	66	91	73	63	82	83	73
LoadOut	0.5% v/v	95	90	77	78	78	68	95	90	72	88	88	78
Full Load HWP	0.5% v/v	95	85	72	72	70	73	99	92	75	90	86	88
Arrow Four	0.5% v/v	95	80	68	73	73	67	95	90	65	87	83	87
Bronc Max EDT	0.5% v/v	92	73	68	57	63	63	87	99	82	87	83	89
N-Tense	0.5% v/v	97	96	81	75	73	78	99	99	84	96	87	96
N-Tank	0.5% v/v	97	95	81	73	68	77	99	99	82	95	92	90
LSD (0.05)		3	6	9	7	8	6	7	4	9	5	6	6

[1]R-11, Preference, and Liberate = nonionic surfactants; AMS = ammonium sulfate; ClassAct Next Generation and Surfate = surfactants + fertilizers; Alliance, Choice, Citron, and Quest = water conditioning agents; Bronc Max and N-Tense = water conditioning agents + surfactants; Herbolyte is a proprietary adjuvant from ProfitPro, LLC; Full Load HWP = is a proprietary adjuvant from AgraSyst; Arrow Four = AMS + water conditioning + deposition + defoamer; Bronc Max EDT = AMS + deposition + retention + water conditioning; N-Tank = a proprietary adjuvant from Adjuvants Plus.
[2]Amar = amaranth, [3]Snfl = sunflower, [4]Corn = conventional corn.

Glyphosate with micronutrients. Zollinger, Richard K. and Jerry L. Ries. An experiment was conducted near Casselton, ND, to evaluate species efficacy with tank-mixes of micronutrients and glyphosate. 'Steele' wheat, Pioneer '39F27' corn, Pioneer '63M80' sunflower,'Carter' flax, 'Plainsman' amaranth, and 'Quinoa' (*Chenopodium quinoa*) were planted perpendicular to each plot length on May 30, 2006. POST treatments were applied on July 3 at 11:00 am with 78 F air, 87 F soil surface, 26% relative humidity, 0% cloud cover, dry soil surface, moist subsoil, excellent vigor, and no dew present. Species stage at time of application were: 12 to 18 inch (25 to 30/ft^2) wheat; V4 to V6 (3 to 7/ft^2) corn; V8 to V12 (5 to7/ft^2) sunflower; 6 to 10 inch (20 to 30/ft^2) flax; 6 to 12 inch (30 to 40/ft^2) amaranth; and 6 to 16 inch (10 to 20/ft^2) quinoa. 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 flat-fan nozzles. The experiment had randomized complete block design with three replicates per treatment.

See footnotes below for a description of the micronutrient formulations. Mn Sulfate did not completely go into solution prior to application. The desired rate of Mn EDTA was 1 lb ai/A (2 gallons/product/A). Due to a limited supply, the Mn micronutrient was applied at 0.43 lb ai/A (0.86 gallon/A). This resulted in less glyphosate antagonism than if applied at 1 lb/A. Fe caused more glyphosate antagonism than Mn micronutrient. AMS and WE 5052A did not fully overcome the antagonism. (Dept. of Plant Sciences, North Dakota State University, Fargo).

Table. Glyphosate with micronutrients (Zollinger and Ries).

		14 DAT						28 DAT					
Treatment	Rate	Wheat	Flax	Amar[1]	Quinoa[2]	Snfl[3]	Corn[4]	Wheat	Flax	Amar	Quinoa	Snfl	Corn
	(product/A)	% control						% control					
Roundup Original Max +	16fl oz +	99	96	99	99	97	99	99	88	99	99	96	99
WE 5052A[5]	4.0oz	99	95	99	99	96	99	99	90	96	96	83	90
AMS[6]	17lb/100gal	99	99	99	99	96	99	99	85	95	95	89	92
Manganese (Mn) Sulfate[7]	1lb	94	38	68	70	90	65	90	38	68	57	75	58
Mn Sulfate+WE 5052A	1lb+4.0oz	99	48	77	67	82	70	99	48	77	60	70	50
Mn Sulfate+AMS	1lb+17lb/100gal	96	43	78	73	92	80	95	53	85	70	73	70
Mn Lignosulfate[8]	2gal	90	30	55	60	90	72	87	30	48	37	67	45
Mn Lignosulfate+WE 5052A	2gal+4oz	95	33	55	92	80	60	89	47	52	45	70	57
Mn Lignosulfate+AMS	2gal+17lb/100gal	95	37	65	72	92	68	88	53	64	72	73	68
Mn EDTA[9]	0.86gal	99	94	89	85	92	90	99	73	86	82	77	72
Mn EDTA+WE 5052A	0.86gal+4oz	99	92	91	82	95	92	99	73	91	75	82	72
Mn EDTA+AMS	0.86gal+17lb/100gal	99	90	96	94	90	94	99	87	95	92	87	83
$FeSO_4$[10]	0.4lb	0	0	0	0	0	0	0	0	0	0	0	0
$FeSO_4$+WE 5052A	0.4lb+4oz	0	0	0	0	0	0	0	0	0	0	0	0
$FeSO_4$+AMS	0.4lb+17lb/100gal	22	23	22	25	30	27	22	22	22	25	30	27
FeHEDTA[11]	2gal	95	68	58	58	40	52	93	62	48	58	45	52
FeHEDTA+WE 5052A	2gal+4oz	90	50	60	48	45	55	90	50	57	45	45	55
FeHEDTA+AMS	2gal+17lb/100gal	90	50	30	27	32	33	90	50	30	27	32	33
LSD (0.05)		3	7	7	10	10	6	6	7	8	10	9	8

[1]Amar = amaranth.
[2]Quinoa = chenopodium species.
[3]Snfl = sunflower.
[4]Corn = conventional corn.
[5]WE 5052A = proprietary adjuvant from Wilbur-Ellis.
[6]AMS = ammonium sulfate.
[7]Mn Sulfate = Mn Sulfate Monohydrate, 32% Mn.
[8]Mn Lignosulfate = RSA Mn Lignosulfate 5%.
[9]Mn EDTA = Mn 5% IDS/EDTA, Mn Chelate 5%.
[10]$FeSO_4$ = Ferrous Sulfate Heptahydrate, 20% Fe.
[11]FeHEDTA = RSA Platinum, 4.3% Fe HEDTA.

Liberty plus Impact plus adjuvants. Zollinger, Richard K. and Jerry L. Ries. An experiment was conducted near Casselton, ND, to evaluate weed species efficacy from tank-mixes. Pioneer '39F27' corn, Pioneer '63M80' sunflower, 'Steele' wheat, 'Carter' flax, 'Plainsman' amaranth, and 'Quinoa' (*Chenopodium quinoa*) species were planted perpendicular to each plot length on May 30, 2006. POST treatments were applied on June 22 at 9:10 am with 63 F air, 67 F soil surface, 76% relative humidity, 100% cloud cover, 0 to 3 mph E wind, dry soil surface, moist subsoil, excellent vigor, and no dew present. Species stages at time of application were: 4 to 12 inch, V2 to V4 (2 to 5/ft^2) corn; 1 to 6 inch, V2 to V4 (2 to 5/ft^2) sunflower; 2 to 8 inch (15 to 40/ft^2) wheat; 1 to 4 inch (5 to 30/ft^2) flax; 1 to 4 inch (25 to 50/ft^2) amaranth; and 1 to 4 inch (10 to 25/ft^2) quinoa. 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 flat-fan nozzles. The experiment had randomized complete block design with three replicates per treatment.

Impact is a new foliar, systemic, HPPD inhibitor mode of action applied at 0.5 to 0.75 fl oz/A for grass and broadleaf weed control in corn. This data shows the contact action of Liberty antagonizes the systemic action of Impact. Impact at 0.5 fl oz should provide near complete redroot pigweed, lambsquarters, and sunflower control when applied alone. At 28 DAT, weed control from Liberty + Impact is generally similar to Liberty applied alone.
(Dept. of Plant Sciences, North Dakota State University, Fargo).

Table. Liberty plus Impact plus adjuvants (Zollinger and Ries).

		14 DAT						28 DAT					
Treatment[1]	Rate	Wheat	Corn[2]	Flax	Amar[3]	Quinoa	Snfl[4]	Wheat	Corn	Flax	Amar	Quinoa	Snfl
	(product/A)	% control						% control					
Liberty +	20fl oz +	55	42	88	50	70	70	55	88	47	70	70	40
AMS	3lb	77	78	87	74	90	91	83	96	62	92	89	72
ClassAct Next Generation	2.5% v/v	75	57	94	52	83	87	78	95	73	83	83	48
ClassAct NG+AG 02013	2.5% v/v+4 oz	77	64	94	63	91	90	73	94	50	91	89	58
Liberty+Impact +	20fl oz+0.5fl oz +												
AG 05006+ClassAct NG	0.5% v/v+2.5% v/v	85	63	93	76	95	93	85	96	68	96	89	57
AG 05055	2.5% v/v	85	47	91	92	95	97	84	93	62	95	82	50
Superb HC+ClassAct NG	0.5% v/v+2.5% v/v	72	67	96	77	92	95	72	96	70	92	80	67
AG 03002	2.5% v/v	76	63	93	84	97	98	72	95	63	97	83	51
LSD (0.05)		10	8	5	7	3	3	7	4	4	3	3	6

[1]AMS = ammonium sulfate; ClassAct Next Generation (NG) = surfactants + fertilizers; AG adjuvants = proprietary compounds from Agriliance; Superb HC = high surfactant oil concentrate.
[2]Corn = conventional corn.
[3]Amar = amaranth.
[4]Snfl = sunflower.

Adjuvants with Liberty. Zollinger, Richard K. and Jerry L. Ries. An experiment was conducted near Casselton, ND, to evaluate species efficacy and crop response. 'Phoenix' Liberty-Link canola, 'Carter' flax, 'Glenn' wheat, Pioneer '37J99' Liberty-Link corn, 'Quinoa' (*Chenopodium quinoa*), and 'Plainsman' amaranth were planted perpendicular to each plot length on June 8, 2006. POST treatments were applied on June 23 at 10:00 am with 81 F air, 89 F soil surface, 26% relative humidity, 10% cloud cover, 1 to 3 mph SW wind, dry soil surface, moist subsoil, good vigor, and no dew present. Species at time of application were: emergence to 1 inch (15 to 30/ft^2) canola; 1 to 2 inch (15 to 50/ft^2) flax; 3 to 5 inch (20 to 40/ft^2) wheat; 3 to 5 inch (5 to 12/ft^2) corn; 1 to 2 inch (15 to 30/ft^2) quinoa; and 1 to 2 inch (40 to 70/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 flat-fan nozzles. The experiment had randomized complete block design with three replicates per treatment.

This experiment was conducted to test adjuvant enhancement of Liberty and adjuvants overcoming hard water antagonism. The treatments indicated were applied in water containing 443 ppm Ca ($CaCl_2$). A reduced herbicide rate was used to measure adjuvant effects. Bronc Max, Cut Rate, Renegade, and AMS were added to water before the herbicide was added. In-Place was premixed with Liberty and then added to the spray solution. WE 5079 and WE 5045 was added last. In treatments without hard-water salts, N-tense enhanced Liberty more compared to other adjuvants used except for flax control where AMS was greater. This is an example where plant species respond differently to herbicide + adjuvant combinations. In hard water, adding In-Place increased weed control more than doubling the Bronc Max rate but did not increase weed control when applied with Renegade or AMS. Applying twice the rate of Cut-Rate or AMS did not increase weed control. (Dept. of Plant Sciences, North Dakota State University, Fargo).

Table. Adjuvants with Liberty (Zollinger and Ries).

		28 DAT					
Treatment[1]	Rate	Corn[2]	Canola[3]	Amar[4]	Quinoa	Flax	Wheat
	(product/A)	% control					
Liberty +	20 fl oz +	0	0	23	23	22	22
AMS	3lb	0	0	32	47	79	42
N-Tense	0.75% v/v	0	0	72	83	67	53
ClassAct Next Generation	2.5% v/v	0	0	65	53	69	52
ClassAct Next Generation+AG 02013	2.5% v/v+4oz	0	0	45	44	64	30
Liberty +	32 fl oz +						
AMS	3lb	0	0	45	50	81	65
N-Tense	0.75% v/v	0	0	60	70	66	68
Treatments with 443 ppm Ca water hardess							
Liberty +	20 fl oz +	0	0	22	20	20	20
Bronc Max	0.5% v/v	0	0	20	20	22	20
Bronc Max+In-Place	0.5% v/v+3.5fl oz	0	0	37	55	58	58
Bronc Max	1% v/v	0	0	25	33	53	33
Cut-Rate	3lb/100gal	0	0	30	30	28	27
Cut-Rate	4lb/100gal	0	0	23	20	23	20
Renegade	1.75pt	0	0	43	38	39	53
Renegade+In-Place	1.75pt+3.5fl oz	0	0	30	23	29	30
AMS	17lb/100gal	0	0	32	28	43	35
AMS	8.5lb/100gal	0	0	28	23	42	32
AMS+In-Place	8.5lb/100gal+3.5 fl oz	0	0	28	23	38	28
AMS+WE 5079	8.5lb/100gal+1qt	0	0	27	22	23	25
AMS+WE 5045	8.5lb/100gal+4fl oz	0	0	53	27	35	32
LSD (0.05)		NS	NS	11	10	8	6

[1]AMS = ammonium sulfate; N-Tense = water conditioning agents + surfactants; ClassAct Next Generation = surfactants + fertilizers; AG 02013 = a proprietary experimental adjuvant from Agriliance; Bronc Max and Cut-Rate = water conditioning agents; In-Place = deposition and retention agent; WE 5079 and 5045 = proprietary adjuvants from Wilbur-Ellis.
[2]Corn = Liberty-Link corn.
[3]Canola = Liberty-Link canola.
[4]Amar = amaranth.