Blue Section: Weed control in corn and soybean

Weed Control in Corn with Topramezone. Dr. Howatt, Mettler, and Harrington. 'DKC38-04RIB' Corn was seeded near Fargo on May 15. PRE treatments were applied on May 16 with 78°F, 45% relative humidity, clear sky, 6.5 mph wind velocity at 270°, and dry soil at 70°. Pigweed (0.5 inch tall) was present at preemergence with 1 to 3 plants per plot. Post treatments were applied to 2 leaf corn, 1 inch Venice mallow with 10 to 15 plants per square foot, 1 inch redroot pigweed and common lambsquarters with 5 plants per square foot, and 4 inch wild buckwheat with 1 plant per square foot on June 7 with 68°F, 48% relative humidity, 40% cloud cover, 5.8 mph wind velocity at 135°, and dry soil at 68°F. The 4 leaf treatments were applied to 4 leaf corn and 1 to 12 inch pigweed and common lambsquarters with 15 to 20 plants per square meter and 1 to 4 inch Venice mallow with 15 to 25 per square meter on June 19, with 82°F, 41% relative humidity, 70% cloud cover, 8 mph wind at 60° and dry soil at 80°F. All treatments were applied with a backpack sprayer delivering 17 gpa at 40 psi through 11002 TT nozzles to a 7 foot wide area the length of 10 by 30 foot plots. The experiment was a randomized complete block design with four replicates.

Treatment	Rate	Appl Code	6/5 Corn	6/5 Pgwd	6/5 Colq	6/5 Vema	6/5 Wibw	6/20 Corn	6/20 Pgwd	6/20 Colq	6/20 Vema
	oz ai/A		%	%	%	%	%	%	%	%	%
Untreated Check	0		0	0	0	0	0	0	0	0	0
Acet&Atra-5.6	40	PRE	0	96	91	87	93	0	97	93	85
Acet&Atra-5.6/Topr&Atra+MSO+AMS-L	40/5.7+1%+2.5%	PRE/ 4L	0	98	94	88	89	0	98	95	85
Acet&Atra-5.6/ Topr&Atra+Glyt-4.5+MSO+AMS-L	40/ 4.3+18+0.5%+2.5%	PRE/ 4L	0	97	94	87	91	0	97	94	81
Acet&Atra-5.6/Topr&Atra+Gluf+AMS-L	40/4.3+9.4+2.5%	PRE/ 4L	0	97	93	89	87	0	97	95	82
Acet-H+Topr+Atra-L+MSO+AMS-L	26+0.35+8+0.25%+2.5%	2L	0	0	0	0	0	4	99	99	99
Acet-H+Topr+Glyt-4.5+Atra-L+MSO+AMS-L	26+.26+18+8+0.25%+2.5%	2L	0	0	0	0	0	0	99	99	98
Mest&Glyt&Meto+Atra-L+NIS+AMS-L	32+8+0.25+2.5	2L	0	0	0	0	0	0	99	99	98
CV			0	2	5	5	5	189	1	4	4
LSD P=0.5			.	1	3	3	3	1	1	4	5

Treatment	Rate	Appl Code	6/20 Wibw	7/5 Corn	7/5 Pgwd	7/5 Colq	7/5 Vema	7/5 Wibw	7/16 Corn	7/16 Weeds	8/14 Weeds
	oz ai/A		%	%	%	%	%	%	%		%
Untreated Check	0		0	42	0	0	0	0	57		0
Acet&Atra-5.6	40	PRE	93	10	95	95	79	89	0		95
Acet&Atra-5.6/Topr&Atra+MSO+AMS-L	40/5.7+1%+2.5%	PRE/ 4L	93	0	96	96	90	91	0		95
Acet&Atra-5.6/ Topr&Atra+Glyt-4.5+MSO+AMS-L	40/ 4.3+18+0.5%+2.5%	PRE/ 4L	91	0	99	99	97	97	0		99
Acet&Atra-5.6/Topr&Atra+Gluf+AMS-L	40/4.3+9.4+2.5%	PRE/ 4L	92	0	99	99	99	98	0		99
Acet-H+Topr+Atra-L+MSO+AMS-L	26+0.35+8+0.25%+2.5%	2L	99	0	98	99	98	97	0		99
Acet-H+Topr+Glyt-4.5+Atra-L+MSO+AMS-L	26+.26+18+8+0.25%+2.5%	2L	98	0	99	99	99	99	0		99
Mest&Glyt&Meto+Atra-L+NIS+AMS-L	32+8+0.25+2.5	2L	98	0	99	99	98	97	0		99
CV			3	57	1	1	2	2.	47		1
LSD P=0.5			4	6	1	1	3	3	5		1

No new emergence

The treatment with topramezone at 0.36 oz ai/A applied to 2 leaf corn resulted in injury in three of the four replicates, but response was not detected 2 weeks after application. Weed competition greatly limited corn growth in July. All treatments effectively managed weeds, especially with the help of vigorous corn canopy. In August, Venice mallow was the primary weed remaining in plots treated with herbicide.

Waterhemp Control in Corn. Dr. Howatt, Mettler, and Harrington. 'DKC38-04 RIB' corn was seeded near Fargo on May 15. Preemergence (PRE) treatments were applied May 16 with 79°F 45% relative humidity, clear sky, 6.5 mph wind velocity at 270°, and dry soil at 70°. POST treatments were applied to V4 corn, 1 to 14 inch pigweed, and 1 to 3 inch wild buckwheat on June 19 with 82°F, 41% relative humidity 70% cloud cover, 8.2 mph wind velocity and dry soil at 80°F. All treatments were applied with a backpack sprayer delivering 17 gpa at 40 psi through 11002 TT nozzles to a 7 foot wide area the length of 10 by 30 foot plots. The experiment was a randomized complete block design with four replicates.

Treatment	Rate	Growth Stage	6/5 Corn	6/5 Pgwd	6/5 Colq	6/5 Vema	6/5 Wibw	6/20 Corn	6/20 Pgwd	6/20 Colq	6/20 Vema	6/20 Wibw
	oz ai/A		%	%	%	%	%	%	%	%	%	%
Untreated Check			0	0	0	0	0	0	0	0	0.0	0
Isft+Atra-L	1.37+8	PRE	0	98	99	98	88	0	98	99	98	86
Isft/ Thcz&Temb+Atra-L+Glyt-4.5+PO+AMS	1/ 1.3+8+18+1%+20	PRE/ V4	0	95	98	94	82	0	93	98	95	90
Thcz&Temb+Atra-L+Glyt-4.5+PO+AMS	1.3+8+18+1%+20	V4	0	0	0	0	0	0	20	0	0	0
Thcz&Temb+Atra-L+Glyt-4.5+ Dica-DF+PO+AMS	1.3+8+18+ 3.8+1%+20	V4	0	0	0	0	0	0	47	50	40	42
Isft/ Atra-L+Temb+Dica&Temb+ Glyt-4.5+MSO+AMS	1/ 8+0.44+6.4+ 18+1%+20	PRE/ V4	0	93	97	92	82	0	98	99	95	85
Atra-L+Temb+Dica&Temb+ Glyt-4.5+MSO+AMS	8+0.44+6.4+ 18+1%+20	V4	0	0	0	0	0	0	50	52	42	47
Dica&Difl+Atra-L+Glyt-4.5+AMS	1.8+8+18+20	V4	0	0	0	0	0	0	52	52	45	47
Meto&Mest&Bcpy	22.8		0	98	99	95	90	0	98	98	95	91
CV			0	3	2	3	6	0	6	6	7	8
LSD P=0.5			.	2	1	2	3	.	6	6	6	6

Treatment	Rate	Growth Stage	6/27 Corn	6/27 Pgwd	6/27 Colq	6/27 Vema	6/27 Wibw	7/16 Corn	7/16 Pgwd	7/16 Colq	7/16 Vema	7/16 Wibw	8/14 Weeds
Untreated Check			22	0	0	0	0	55	0	0	0	0	0
Isft+Atra-L	1.37+8	PRE	1	98	98	98	84	0	98	98	96	88	99
Isft/ Thcz&Temb+Atra-L+Glyt-4.5+PO+AMS	1/ 1.3+8+18+1%+20	PRE/ V4	0	98	99	98	95	2	98	99	98	97	99
Thcz&Temb+Atra-L+Glyt-4.5+PO+AMS	1.3+8+18+1%+20	V4	20	95	88	85	85	22	97	96	93	94	97
Thcz&Temb+Atra-L+Glyt-4.5+ Dica-DF+PO+AMS	1.3+8+18+ 3.8+1%+20	V4	21	95	88	84	84	30	97	97	95	95	97
Isft/ Atra-L+Temb+Dica&Temb+ Glyt-4.5+MSO+AMS	1/ 8+0.44+6.4+ 18+1%+20	PRE/ V4	0	98	99	98	96	2	99	99	99	98	99
Atra-L+Temb+Dica&Temb+ Glyt-4.5+MSO+AMS	8+0.44+6.4+ 18+1%+20	V4	14	94	92	89	87	17	98	98	94	95	97
Dica&Difl+Atra-L+Glyt-4.5+AMS	1.8+8+18+20	V4	14	95	91	90	89	17	96	97	94	93	97
Meto&Mest&Bcpy	22.8		0	97	98	96	82	5	97	98	94	88	97
CV			31	1	3	3	4	38	1	1	3	3	0
LSD P=0.5			5	2	3	4	5	9	2	2	3	4	.

Herbicides did not elicit response in corn, but corn showed stunting and chlorosis by June 27 due to weed competition. Removal of weeds and establishment of vigorous crop canopy prevented mid-season weed establishment.

Volunteer Canola Control. Devin A Wirth. An experiment was conducted near Hillsboro, ND to evaluate volunteer canola control from PRE, Pre-Bolt, and Post-Bolt applications. Canola was seeded on May 31, 2018. PRE treatments were applied on May 31, 2018 at 10:00 AM with 77 F air, 63 F soil, 56% RH, 10% cloud cover, 8-10 mph N wind, and dry soil moisture. Pre-Bolt treatments were applied on June 21, 2018 at 2:30 PM with 84 F air, 68 F soil, 48% RH, 30% cloud cover, 2-4 mph NE wind, and adequate soil moisture. Canola at the time of Pre-Bolt application was 2-4 leaf at 6-8/ft2. Post-Bolt treatments were applied on July 5, 2018 at 1:00 PM with 74 F air, 70 F soil, 60% RH, 0% cloud cover, 2-4 mph N wind, and adequate soil moisture. Canola at the time of Post-Bolt application was 32-36" bolt at 6-8/ft2. Soil characteristics were: 46.7% sand, 43.2% silt, 10.1% clay, Loam, 3.3% OM, and 8.1 pH. Treatments were applied to the center 6.7 feet of the 10 by 40 foot plots with a backpack-type plot sprayer delivering 17 gpa through 11002 TTI nozzles for PRE applications and 8.5 gpa through 11001 TT nozzles for Pre-Bolt and Post-Bolt applications all at 40 psi. The experiment had a randomized complete block design with three replicates per treatment.

All PRE and Pre-Bolt herbicides provided excellent volunteer canola control. After canola bolted, control decreased dramatically. Only Acuron at 1.5 qt/A and Acuron Flexi at 2qt/A provided excellent control after canola bolt.

Table. Volunteer Canola Control (Wirth).

Treatment	Rate	Prior to Pre-Bolt Canola	Prior to Post-Bolt Canola	14 DA Post-Bolt Canola	28 DA Post-Bolt Canola
	(Product/A)	% control			
(PRE) Resicore+Atrazine	2.25qt+0.75lb	99	99	99	99
(PRE) Lumax EZ	2.7qt	99	99	99	99
(PRE) Acuron	1.5qt	99	99	99	99
(PRE) Acuron Flexi	2 qt	99	99	99	99
(Pre-Bolt) Resicore	1.25qt	99	99	99	99
(Pre-Bolt) Acuron	1.5qt	0	99	99	99
(Pre-Bolt) Acuron Flexi	2qt	0	99	99	99
(Post-Bolt) Resicore	1.25qt	0	0	30	37
(Post-Bolt) Resicore	1.5qt	0	0	30	57
(Post-Bolt) Acuron	1.5qt	0	0	62	90
(Post-Bolt) Acuron Flexi	2qt	0	0	70	95
(Post-Bolt) Callisto	3floz	0	0	30	50
LSD		0	0	1	4

PRE Followed by POST Applications in Corn. Devin A Wirth. An experiment was conducted near Prosper, ND to evaluate weed control and corn damage from PRE and POST herbicides. Corn was seeded on May 15, 2018. PRE treatments were applied on May 16, 2018 at 11:30 AM with 85 F air, 57 F soil, 22% RH, 10% cloud cover, 8-10 mph W wind, and dry soil moisture. Immediately following PRE applications rain accumulations of 1.25" followed which adequately activated PREs. POST treatments were applied June 13, 2018 at 10:20 AM with 83 F air, 69 F soil, 14% RH, 15% cloud cover, 6-8 mph SW wind, and moist soil. Weeds present at POST applications were: snfl 3-5" at 1-2/ft2, cocb 3-5" at 1-2/ft2, colq 1-2" at 1-2/yd2, hans 1-2" at 1-2/yd2, corw 1-2" at 1-2/yd2, yeft 3-5" at 2-4/ft2, rrpw 1-2" at 1-2/ft2, and wibw 1-2" at 1-2/yd2. Soil characteristics were: 24.7% sand, 53.3% silt, 22% clay, Silt Loam, 4% OM, and 8.2 pH. Treatments were applied to the center 6.7 feet of the 10 by 40 foot plots with a backpack-type plot sprayer delivering 17 gpa through 11002 TTI nozzles for PRE herbicides and 17 gpa through 11002 TT nozzles for POST applications all at 40 psi. The experiment had a randomized complete block design with three replicates per treatment.

Above average growing conditions in 2018 resulted in earlier canopying of the corn crop. PRE herbicides alone provided fair to excellent control of weeds for most of the season. Treatments including a POST application resulted in excellent control the rest of the season.

Table. PRE followed by POST applications in corn (Wirth).

		Prior to POST									14, 28 & 56 DA EPOST								
Treatment[1]	Rate	corn	yeft	rrpw	colq	hans	wibw	corw	cocb	snfl	corn	yeft	rrpw	colq	hans	wibw	corw	cocb	snfl
	(Product/A)	-% inj-	----------% control----------								-% inj-	----------% control----------							
Untreated		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(PRE) Acuron	1.5qt																		
(POST) Acuron Flexi+RUPM+AMS	2.25pt+32floz+8.5lb/100gal	0	85	99	99	99	99	99	80	80	0	99	99	99	99	99	99	90	95
(PRE) Acuron	1.5qt																		
(POST) Halex GT+NIS+AMS	3.6pt+0.25%v/v+8.5lb/100gal	0	85	99	99	99	99	99	78	78	0	99	99	99	99	99	99	95	99
(PRE) Lumax EZ	1.7qt																		
(POST) Acuron Flexi+RUPM+AMS	2.25pt+32floz+8.5lb/100gal	0	90	99	99	99	99	99	78	78	0	99	99	99	99	99	99	95	99
(PRE) Lumax EZ	1.7qt																		
(POST) Halex GT+NIS+AMS	3.6pt+0.25%v/v+8.5lb/100gal	0	90	99	99	99	99	99	80	80	0	99	99	99	99	99	99	90	99
(PRE) SureStart II	1.75pt																		
(POST) Resicore+RUPM	2.5pt+32floz	0	85	99	99	99	99	80	73	82	0	99	99	99	99	99	99	95	99
+NIS+AMS	+0.25%v/v+8.5lb/100gal																		
(PRE) Harness Max	40floz																		
(POST) Impact+RUPM+AMS	0.5floz+32floz+8.5lb/100gal	0	85	99	99	99	99	99	80	85	0	99	99	99	99	99	99	85	99
(PRE) Verdict	14floz																		
(POST) Armezon Pro+RUPM+AMS	14floz+32floz+8.5lb/100gal	0	90	99	96	99	99	99	90	90	0	99	99	99	99	99	99	99	99
LSD		0	0	0	3	0	0	0	5	3	0	0	0	0	0	0	0	0	0

[1] RUPM = Roundup Powermax

PRE and POST Programs in Corn 1. Devin A Wirth. An experiment was conducted near Prosper, ND to evaluate weed control and corn damage from PRE and POST herbicides. Corn was seeded on May 15, 2018. PRE treatments were applied on May 16, 2018 at 11:30 AM with 85 F air, 57 F soil, 22% RH, 10% cloud cover, 8-10 mph W wind, and dry soil moisture. Immediately following PRE applications rain accumulations of 1.25" followed which adequately activated PREs. EPOST treatments were applied on June 7, 2018 at 1:30 PM with 75 F air, 69 F soil, 36% RH, 100% cloud cover, 6-8 mph N wind, and moist soil. Weeds present at EPOST applications were: snfl 2-4" at 4-6/ft2, cocb 2-4" at 4-6/ft2, colq 1-2" at 1-2/ft2, rrpw 1-2" at 1-2/ft2, hans 1-2" at 1-2/ft2, corw 1-2" at 1-2/ft2, wibw 1-2" at 1-2/ft2, and yeft 1-2" at 1-2/ft2. LPOST treatments were applied June 13, 2018 at 10:30 AM with 83 F air, 69 F soil, 14% RH, 15% cloud cover, 6-8 mph SW wind, and moist soil. Weeds present at LPOST applications were: snfl 3-5" at 1-2/ft2, cocb 3-5" at 1-2/ft2, colq 1-2" at 1-2/yd2, hans 1-2" at 1-2/yd2, corw 1-2" at 1-2/yd2, and yeft 3-5" at 2-4/ft2. Soil characteristics were: 24.7% sand, 53.3% silt, 22% clay, Silt Loam, 4% OM, and 8.2 pH. Treatments were applied to the center 6.7 feet of the 10 by 40 foot plots with a backpack-type plot sprayer delivering 17 gpa through 11002 TTI nozzles for PRE herbicides and 17 gpa through 11002 TT nozzles for EPOST and LPOST herbicides all at 40 psi. The experiment had a randomized complete block design with three replicates per treatment.

Above average growing conditions in 2018 resulted in earlier canopying of the corn crop. PRE herbicides alone provided fair to excellent control of weeds for most of the season. Treatments including a LPOST application resulted in excellent control the rest of the season. EPOST treatments at the also provided excellent of all weeds after 28 DAA.

Table. PRE and POST Programs in Corn 1 (Wirth).

		Prior to LPOST									28 & 56 DA EPOST								
Treatment[1]	Rate	corn	yeft	rrpw	colq	hans	wibw	corw	cocb	snfl	corn	yeft	rrpw	colq	hans	wibw	corw	cocb	snfl
	(Product/A)	-% inj-	----------% control----------								-% inj-	----------% control----------							
Untreated		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(PRE) Acuron Flexi	56floz	0	80	99	99	99	99	99	90	95	0	63	78	72	63	77	62	62	55
(PRE) Balance Flexx+Atrazine	5.5floz+1pt	0	78	99	99	99	99	98	85	88	0	73	80	72	70	70	63	65	72
(PRE) Balance Flexx	4floz																		
(LPOST) Capreno+RUWM+Atrazine	3floz+32floz+1pt	0	70	99	99	99	99	99	82	90	0	99	99	99	99	99	99	99	99
+COC+AMS	+1%v/v+8.5lb/100gal																		
(PRE) Balance Flexx	4floz																		
(LPOST) DiFlexx DUO+Laudis+RUWM	24floz+1floz+32floz	0	67	99	99	99	99	99	82	87	0	99	99	99	99	99	99	99	99
+ Atrazine+MSO+AMS	+1pt+1%v/v+8.5lb/100gal																		
(EPOST) Capreno+RUWM+Atrazine	3floz+32floz+1pt																		
+COC+AMS	+1%v/v+8.5lb/100gal	0	90	99	99	95	99	99	95	95	0	99	99	99	99	99	99	99	99
(EPOST) Capreno+RUWM+DiFlexx	3floz+32floz+7.5floz																		
+Atrazine+COC+AMS	+1pt+1%v/v+8.5lb/100gal	0	95	99	99	99	99	99	95	95	0	99	99	99	99	99	99	99	99
(EPOST) DiFlexx DUO+Laudis+RUWM	24floz+1floz+32floz																		
+Atrazine+MSO+AMS	+1pt+1%v/v+8.5lb/100gal	0	95	99	99	99	99	99	95	95	0	99	99	99	99	99	99	99	99
(EPOST) Status+Atrazine+RUWM	3oz+1pt+32floz																		
+AMS	+8.5lb/100gal	0	85	99	99	99	99	99	95	95	0	99	99	99	99	99	99	99	99
LSD		0	8	0	0	0	0	1	5	4	0	2	2	2	2	2	5	2	2

[1] RUWM = Roundup Weathermax

POST Applications in Corn. Devin A Wirth. An experiment was conducted near Fargo, ND to evaluate weed control and corn damage from POST herbicides. Corn was seeded on May 15, 2018. POST treatments were applied on June 7, 2018 at 3:10 PM with 80 F air, 66 F soil, 24% RH, 100% cloud cover, 6-8 mph SE wind, and moist soil. Weeds present were: vema 1-2" at 6-8/ft2, colq 1-3" at 2-4/ft2, rrpw 1-3" at 2-4/ft2, wimu 3-5" at 2-4/yd2, corw 1-3" at 1-2ft2, and yeft 1-2" at 1-2/ft2. Soil characteristics were: 3.1% sand, 43.5% silt, 53.4% clay, Silty Clay, 5.6% OM, and 7.1 pH. Treatments were applied to the center 6.7 feet of the 10 by 40 foot plots with a backpack-type plot sprayer delivering 17 gpa through 11002 TTI nozzles for POST herbicides. The experiment had a randomized complete block design with three replicates per treatment.

All treatments provided excellent weed control.

Table. POST Applications in Corn (Wirth).

		14, 28, & 42 DAA							
POST Treatments[1]	Rate	corn	yeft	vema	corw	rrpw	wibw	wimu	colq
	(Product/A)	-% inj-	----------% control----------						
Untreated		0	0	0	0	0	0	0	0
DiFlexx DUO+RUWM+Atrazine +MSO+AMS	32floz+32floz+16floz +1%v/v+8.5lb/100gal	0	99	99	99	99	99	99	99
DiFlexx DUO+RUWM+Atrazine +MSO+AMS	24floz+32floz+16floz +1%v/v+8.5lb/100gal	0	99	99	99	99	99	99	99
DiFlexx DUO+Liberty+Atrazine +AMS	24floz+32floz+16floz +8.5lb/100gal	0	99	99	99	99	99	99	99
Capreno+RUWM+Atrazine +COC+AMS	3floz+32floz+16floz +1%v/v+8.5lb/100gal	0	95	90	99	99	98	99	99
Halex GT+Atrazine +NIS+AMS	57.6floz+16floz +0.25%v/v+8.5lb/100gal	0	99	96	99	99	99	99	99
Armezon Pro+RUWM+Atrazine +AMS	16floz+32floz+16floz 8.5lb/100gal	0	99	95	99	99	99	99	99
Armezon Pro+Status+RUWM +Atrazine+AMS	16floz+5oz+32floz +16floz+8.5lb/100gal	0	99	98	99	99	99	99	99
DiFlexx DUO+Laudis+RUWM +Atrazine+MSO+AMS	24floz+1floz+32floz 16floz+1%v/v+8.5lb/100gal	0	99	99	99	99	99	99	99
DiFlexx DUO+RUWM+Atrazine +AMS	24floz+32floz+16floz +8.5lb/100gal	0	99	96	99	99	99	99	99
LSD		0	0	2	0	0	1	0	0

[1] RUWM = Roundup Weathermax

PRE and POST Programs in Corn 2. Devin A Wirth. An experiment was conducted near Prosper, ND to evaluate weed control and corn damage from PRE and POST herbicides. Corn was seeded on May 15, 2018. PRE treatments were applied on May 16, 2018 at 11:30 AM with 85 F air, 57 F soil, 22% RH, 10% cloud cover, 8-10 mph W wind, and dry soil moisture. Immediately following PRE applications rain accumulations of 1.25" followed which adequately activated PREs. EPOST treatments were applied on June 7, 2018 at 1:30 PM with 75 F air, 69 F soil, 36% RH, 100% cloud cover, 6-8 mph N wind, and moist soil. Weeds present at EPOST applications were: snfl 2-4" at 4-6/ft2, cocb 2-4" at 4-6/ft2, colq 1-2" at 1-2/ft2, rrpw 1-2" at 1-2/ft2, hans 1-2" at 1-2/ft2, corw 1-2" at 1-2/ft2, wibw 1-2" at 1-2/ft2, and yeft 1-2" at 1-2/ft2. LPOST treatments were applied June 13, 2018 at 10:30 AM with 83 F air, 69 F soil, 14% RH, 15% cloud cover, 6-8 mph SW wind, and moist soil. Weeds present at LPOST applications were: snfl 3-5" at 1-2/ft2, cocb 3-5" at 1-2/ft2, colq 1-2" at 1-2/yd2, hans 1-2" at 1-2/yd2, corw 1-2" at 1-2/yd2, and yeft 3-5" at 2-4/ft2. Soil characteristics were: 24.7% sand, 53.3% silt, 22% clay, Silt Loam, 4% OM, and 8.2 pH. Treatments were applied to the center 6.7 feet of the 10 by 40 foot plots with a backpack-type plot sprayer delivering 17 gpa through 11002 TTI nozzles for PRE herbicides and 17 gpa through 11002 TT nozzles for EPOST and LPOST herbicides all at 40 psi. The experiment had a randomized complete block design with three replicates per treatment.

Above average growing conditions in 2018 resulted in earlier canopying of the corn crop. PRE herbicides alone provided good to excellent control of small seeded broadleaf weeds, but poor to good control of common cocklebur and common sunflower. Treatments including a PRE followed by a POST application resulted in excellent control the rest of the season. EPOST treatments alone also provided excellent of all weeds after 14 DAA.

Table. PRE and POST Programs in Corn 2 (Wirth).

		Prior to EPOST									14, 28 & 56 DA EPOST								
Treatment[1]	Rate	corn	yeft	rrpw	colq	hans	wibw	corw	cocb	snfl	corn	yeft	rrpw	colq	hans	wibw	corw	cocb	snfl
	(Product/A)	-% inj-				-% control-					-% inj-				-% control-				
Untreated		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(PRE) Anthem Maxx+Atra	4floz+16floz																		
(LPOST) Callisto+Atra+RUPM	3.5floz+8floz+22floz	0	92	99	93	96	96	80	37	53	0	99	99	99	99	99	80	70	70
+COC+AMS	+1%v/v+8.5lb/100gal																		
(PRE) Anthem Maxx+Callist+Atra	4floz+5floz+16floz																		
(LPOST) Status+Atra+RUPM	3oz+8floz+22floz	0	85	99	99	99	99	87	73	82	0	95	99	99	99	99	99	90	95
+COC+AMS	+1%v/v+8.5lb/100gal																		
(PRE) Corvus+Atra	5.6floz+16floz																		
(LPOST) RUPM	32floz	0	98	99	99	99	99	99	82	87	0	99	99	99	99	99	99	85	90
+NIS+AMS	+0.25%v/v+8.5lb/100gal																		
(PRE) Acuron	2.5qt																		
(LPOST) RUPM	32floz	0	99	99	99	99	99	98	90	90	0	99	99	99	99	99	99	95	95
+NIS+AMS	+0.25%v/v+8.5lb/100gal																		
(PRE) Resicore	2.5qt																		
(LPOST) RUPM	32floz	0	99	99	99	99	99	99	95	99	0	99	99	99	99	99	99	90	99
+NIS+AMS	+0.25%v/v+8.5lb/100gal																		
(PRE) SureStart II	2pt																		
(LPOST) Realm Q+Durango DMA+AMS	4oz+1qt+8.5lb/100gal	0	96	99	99	99	99	85	77	82	0	99	99	99	99	99	99	80	90
(PRE) Resicore	2qt																		
(LPOST) Realm Q+Durango DMA	4oz+1qt	0	99	99	99	99	99	99	90	95	0	99	99	99	99	99	99	95	99
+COC+AMS	+0.5%v/v+8.5lb/100gal																		

Treatment[1]	Rate	Prior to EPOST									14, 28 & 56 DA EPOST								
		corn	yeft	rrpw	colq	hans	wibw	corw	cocb	snfl	corn	yeft	rrpw	colq	hans	wibw	corw	cocb	snfl
	(Product/A)	-% inj-	----------% control----------								-% inj-	----------% control----------							
(PRE) SureStart II	1.75pt																		
(LPOST) Resicore+Atra	1.25qt+0.42lb	0	70	99	99	99	99	85	70	85	0	95	99	99	99	99	99	95	99
+Durango DMA+AMS	+1qt+8.5lb/100gal																		
(PRE) Breakfree NXT ATZ	2qt																		
(LPOST) Realm Q+Durango DMA	4oz+1qt	0	99	99	99	99	99	99	53	63	0	99	99	99	99	99	99	95	95
+COC+AMS	+0.5%v/v+8.5lb/100gal																		
(PRE) Resicore	1.25qt																		
(EPOST) Resicore+Atra	1.25qt+0.42lb	0	80	99	99	99	99	98	83	90	0	99	99	99	99	99	99	95	99
+Durango DMA+AMS	+1qt+8.5lb/100gal																		
(EPOST) Anthem Maxx+Callisto+Atra	4floz+3floz+16floz																		
+RUPM+COC+AMS	22floz+1%v/v+8.5lb/100gal	0	99	99	99	99	99	90	90	90	0	99	99	99	99	99	99	90	95
(EPOST) Acuron Flexi+RUPM+COC	2qt+22floz+1%v/v	0	99	99	99	30	99	40	30	40	0	99	99	99	99	99	99	99	99
(EPOST) SureStart II+Realm Q	2pt+4oz																		
+Durango DMA+AMS	+1qt+8.5lb/100gal	0	90	99	99	30	99	60	85	85	0	99	99	99	99	99	99	99	99
LSD		0	5	0	2	1	1	4	5	4	0	0	0	0	0	0	0	0	0

[1] RUPM = Roundup Powermax, Atra = Atrazine

POST Treatments Including Impact Z (topramazone + atrazine) in Corn. Devin A Wirth. An experiment was conducted near Prosper, ND to evaluate weed control and corn damage from PRE and POST herbicide programs including Impact and Impact Z. Corn was seeded on May 15, 2018. PRE treatments were applied on May 16, 2018 at 11:30 AM with 85 F air, 57 F soil, 22% RH, 10% cloud cover, 8-10 mph W wind, and dry soil moisture. Immediately following PRE applications rain accumulations of 1.25" followed which adequately activated PREs. EPOST treatments were applied on June 7, 2018 at 1:30 PM with 75 F air, 69 F soil, 36% RH, 100% cloud cover, 6-8 mph N wind, and moist soil. Weeds present at EPOST applications were: snfl 2-4" at 4-6/ft2, cocb 2-4" at 4-6/ft2, colq 1-2" at 1-2/ft2, rrpw 1-2" at 1-2/ft2, hans 1-2" at 1-2/ft2, corw 1-2" at 1-2/ft2, wibw 1-2" at 1-2/ft2, and yeft 1-2" at 1-2/ft2. LPOST treatments were applied June 13, 2018 at 10:30 AM with 83 F air, 69 F soil, 14% RH, 15% cloud cover, 6-8 mph SW wind, and moist soil. Weeds present at LPOST applications were: snfl 3-5" at 1-2/ft2, cocb 3-5" at 1-2/ft2, colq 1-2" at 1-2/yd2, hans 1-2" at 1-2/yd2, corw 1-2" at 1-2/yd2, and yeft 3-5" at 2-4/ft2. Soil characteristics were: 24.7% sand, 53.3% silt, 22% clay, Silt Loam, 4% OM, and 8.2 pH. Treatments were applied to the center 6.7 feet of the 10 by 40 foot plots with a backpack-type plot sprayer delivering 17 gpa through 11002 TTI nozzles for PRE herbicides and 17 gpa through 11002 TT nozzles for EPOST and LPOST applications all at 40 psi. The experiment had a randomized complete block design with three replicates per treatment.

Above average growing conditions in 2018 resulted in earlier canopying of the corn crop. PRE herbicides alone provided fair to excellent control of weeds for most of the season. Mild chlorotic and necrotic speckling on lower corn leaves was observed early on. However, due to rapid corn growth, symptoms quickly disappeared 14 DAA. Treatments including a POST application resulted in excellent control of small seeded broadleaf weeds the rest of the season. Warm weather and adequate rainfall also caused multiple flushes of large seeded common cocklebur and common sunflower weeds.

Table. POST Treatments Including Impact Z (topramazone + atrazine) in Corn (Wirth).

		Prior to LPOST									14, 28, 42, & 56 DA LPOST								
Treatment[1]	Rate	corn	yeft	rrpw	colq	hans	wibw	corw	cocb	snfl	corn	yeft	rrpw	colq	hans	wibw	corw	cocb	snfl
	(Product/A)	-% inj-	----------% control----------								-% inj-	----------% control----------							
Untreated		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(PRE) Harness Xtra 5.6	3.6pt	0	99	99	99	99	99	99	40	60	0	99	99	99	99	99	96	99	99
(PRE) Harness Xtra 5.6	3.6pt																		
(LPOST) Impact Z+MSO+N-Pak AMS	10.7floz+1%v/v+2.5%v/v	0	99	99	99	99	99	99	40	60	0	99	99	99	99	99	99	89	93
(PRE) Harness Xtra 5.6	3.6pt																		
(LPOST) Impact Z+RUPM	8floz+32floz																		
+MSO+N-Pak AMS	+0.5%v/v+2.5%v/v	0	99	99	99	99	99	99	40	60	0	99	99	99	99	99	99	94	96
(PRE)Harness Xtra 5.6	3.6pt																		
(LPOST) Impact Z+Liberty+N-Pak AMS	8floz+22floz+2.5%v/v	2	99	99	99	99	99	99	50	68	0	99	99	99	99	99	99	96	98
(EPOST) Harness+Impact+Atrazine	1.87pt+1floz+1pt																		
+MSO+N-Pak AMS	+0.25%v/v+2.5%v/v	15	99	99	90	99	90	85	77	87	0	99	99	99	99	99	99	99	98
(EPOST) Harness+Impact+RUPM	1.87pt+0.75floz+32floz																		
+Atrazine+MSO+N-Pak AMS	+1pt+0.25%v/v+2.5%v/v	3	99	99	99	99	99	99	90	95	0	99	99	99	99	99	99	99	98
(EPOST) Halex GT+Atrazine	3.6pt+1pt																		
+NIS+N-Pak AMS	+0.25%v/v+2.5%v/v	5	95	99	90	99	99	99	83	90	0	99	99	99	99	99	99	98	99
LSD		2	0	0	0	0	0	0	11	6	0	0	0	0	0	0	2	7	4

[1] RUPM = Roundup Powermax

Fall dandelion control with Glyphosate, Valor, and adjuvants. (Minot). The objective of this study was to evaluate fall dandelion control with glyphosate and Valor tank mixes. Treatments were applied September 28, 2017 to a moderate to heavy dandelion population. Glyphosate was applied at 32 fl oz (4.5 lb ae/gal) in all treatments. Valor was applied at 2 or 3 oz with or without MSO. These treatments were compared to Glyphosate alone, Glyphosate + Express or 2,4-D, Foundation (sulfentrazone + triclopyr + dicamba + 2,4-D), and Horsepower (triclopyr + dicamba + MCPA ester).

Glyphosate alone, Glyphosate + Express or 2,4-D, Foundation, and Horsepower provided 88-92% dandelion control at the July evaluation. Treatments containing Valor provided 77-84% dandelion control.

Table. Fall dandelion control with Glyphosate, Valor, and adjuvants. (1803)			Weed Control	
			Dandelion	
Treatment	Rate	Timing	May-18	Jul-18
			-------%-------	
Untreated			0	0
Glyphosate[a]	32 oz	Fall	97	90
Glyphosate + Valor[a]	32 oz + 2 oz	Fall	99	81
Glyphosate + Valor[ab]	32 oz + 2 oz	Fall	98	81
Glyphosate + Valor[a]	32 oz + 3 oz	Fall	98	79
Glyphosate + Valor[ab]	32 oz + 3 oz	Fall	97	77
Glyphosate + Valor + 2,4-D[a]	32 oz + 3 oz + 1 pt	Fall	98	84
Glyphosate + Valor + 2,4-D[ab]	32 oz + 3 oz + 1 pt	Fall	97	82
Glyphosate[a] + Express[c]	32 oz + 0.3 oz	Fall	99	92
Glyphosate[a] + 2,4-D	32 oz + 1 pt	Fall	99	88
Foundation	4 pt	Fall	98	89
Horsepower	3 pt	Fall	97	90
LSD (0.05)			2.2	4.8
[a] *Applied with AMS (2.5 gal)*				
[b] *Applied with MSO (1%)*				
[c] *Applied with NIS (0.25%)*				

Weed Control Programs in Soybean. Devin A Wirth. An experiment was conducted near Prosper, ND to evaluate weed control and soybean damage from PRE and POST herbicides. Soybean was seeded May 15, 2018. PRE treatments were applied on May 16, 2018 at 11:30 AM with 85 F air, 57 F soil, 22% RH, 10% cloud cover, 8-10 mph W wind, and dry soil moisture. POST treatments were applied June 13, 2018 at 10:30 AM with 83 F air, 69 F soil, 14% RH, 15% cloud cover, 6-8 mph SW wind, and moist soil. Weeds present at POST applications were: snfl 3-5" at 1-2/ft2, cocb 3-5" at 1-2/ft2, colq 1-2" at 1-2/yd2, hans 1-2" at 1-2/yd2, corw 1-2" at 1-2/yd2, and yeft 3-5" at 2-4/ft2. Soil characteristics were: 24.7% sand, 53.3% silt, 22% clay, Silt Loam, 4% OM, and 8.2 pH. Treatments were applied using a backpack-type plot sprayer delivering 17 gpa through 11002 TTI nozzles for PREs and 8.5 gpa through 11001 TT nozzles for POSTs at 40 psi.

PRE herbicides alone provided good to excellent control of small seeded broadleaf weeds, but poor to good control of common cocklebur and common sunflower. After POST applications, all treatments provided excellent control the rest of the season.

Table. Weed Control Programs in Soybean (Wirth).

		Prior to POST								14 DA POST							
Treatment	Rate	soy	yeft	rrpw	colq	hans	corw	cocb	snfl	soy	yeft	rrpw	colq	hans	corw	cocb	snfl
	(Product/A)	-% inj-	----------% control----------							-% inj-	----------% control----------						
(PRE) Authority First	4oz																
(POST) Roundup Powermax+AMS	32floz+8.5lb/100gal	0	85	99	99	99	82	90	95	0	95	99	99	99	99	99	99
(PRE) Authority Assist	8floz																
(POST) Roundup Powermax+AMS	32floz+8.5lb/100gal	0	87	99	99	99	99	77	90	0	95	99	99	99	99	99	99
(PRE) Authority Elite	28floz																
(POST) Roundup Powermax+AMS	32floz+8.5lb/100gal	0	85	99	99	99	96	72	82	0	95	99	99	99	99	95	99
(PRE) Authority Supreme	7floz																
(POST) Roundup Powermax+AMS	32floz+8.5lb/100gal	0	85	99	99	99	99	70	80	0	95	99	99	99	99	95	99
(PRE) Authority MTZ	14oz																
(POST) Roundup Powermax+AMS	32floz+8.5lb/100gal	0	75	99	99	93	99	75	80	0	90	99	99	99	99	90	95
(PRE) Authority First+Anthem Maxx	5oz+3floz																
(POST) Roundup Powermax+AMS	32floz+8.5lb/100gal	0	93	99	99	99	93	85	85	0	95	99	99	99	99	95	99
(PRE) Zidua Pro	4.5floz																
(POST) Roundup Powermax+AMS	32floz+8.5lb/100gal	0	92	99	99	99	99	88	92	0	90	99	99	99	99	90	95
(PRE) Fierce	3oz																
(POST) Roundup Powermax+AMS	32floz+8.5lb/100gal	0	95	99	77	99	90	77	82	0	95	99	99	99	99	95	99
(PRE) Boundary	1.8pt																
(POST) Roundup Powermax+AMS	32floz+8.5lb/100gal	0	95	99	95	88	77	78	83	0	95	99	99	99	99	95	99
(PRE) Surveil	2.8oz																
(POST) Durango DMA+AMS	36floz+8.5lb/100gal	0	88	99	99	99	92	87	92	0	95	99	99	99	99	95	99
(PRE) Afforia	2.5oz																
(POST) Durango DMA+AMS	36floz+8.5lb/100gal	0	92	99	77	99	93	77	82	0	90	99	99	99	99	90	95
(PRE) Panther Pro	12floz																
(POST) Credit Xtreme+AMS	32floz+8.5lb/100gal	0	93	99	99	99	96	82	87	0	95	99	99	99	99	95	99
(PRE) Panther MTZ	12floz																
(POST) Credit Xtreme+AMS	32floz+8.5lb/100gal	0	95	99	99	93	85	40	50	0	95	99	99	99	99	95	99
(PRE) Panther MTZ	15floz																
(POST) Credit Xtreme+AMS	32floz+8.5lb/100gal	0	95	99	83	99	90	80	85	0	95	99	99	99	99	95	99
LSD		0	4	0	2	3	3	3	3	0	0	0	0	0	0	0	0

Residual Duration in Soybean. Dr. Howatt, Mettler, and Harrington. 'Xtend AGO8X8' soybean was seeded near Prosper, North Dakota on May 17. Preemergence treatments were applied on May 17 with 58°F, 88% relative humidity, cloud covered sky, 5 mph wind velocity at 165°, moist soil at 59°F. Treatments were applied with a backpack sprayer delivering 17 gpa at 40 psi through 11002 TT nozzles to a 7 foot wide area the length of 10 by 30 foot plots. The experiment was a randomized complete block design with four replicates.

Treatment	Rate	6/8 Sobe	6/8 Colq	6/8 Pgwd	6/8 Corw	6/15 Sobe
	oz ai/A	%	%	%	%	%
Untreated Check	0	0	0	0	0	0
Flumioxazin	1	0	75	80	70	0
Flumioxazin&Pyroxasulfone	2.3	0	84	89	84	0
V-01425-2002	2.3	0	67	66	56	0
V-10425-2078	2.3	0	65	75	61	0
V-10425-2079	2.3	0	80	85	84	0
V-10425-2080	2.3	0	87	90	84	0
Sulfentrazone&Metolachlor	28	0	96	98	66	0
CV		0	8	5	9	0
LSD P=0.5		.	8	6	9	.

Herbicide treatments did not result in injury to soybean. Sulfentrazone and metolachlor provided the best control of common lambsquarters and pigweed species but only gave 66% control of common ragweed. Formulations 2079 or 2080 of V-10425 gave better control of species than formulations 2002 or 2078. Formulations 2079 and 2080 gave similar control to flumioxazin and pyroxasulfone, which was better than control with flumioxazin alone. Additional emergence was not observed on June 15.

Residual Control of Waterhemp. Dr. Howatt, Mettler, and Harrington. 'Xtend AGO8X8' soybean was seeded near Prosper, North Dakota on May 17. Preemergence treatments were applied with 65°F, 53% relative humidity, 100% cloud cover, 5 to 10 mph wind velocity at 70°, and dry soil at 59°F. Post treatments were applied to 2 trifoliolate soybean, 7 inch redroot pigweed and volunteer corn, and 3 inch common lambsquarters and common ragweed on June 13 with 77°F, 50% relative humidity, clear sky, 7 mph wind velocity at 225°, and wet soil at 65°F. Treatments were applied with a backpack sprayer delivering 17 gpa at 40 psi through 11002 TT nozzles to a 7 foot wide area the length of 10 by 30 foot plots to a 7 foot wide area the length of 10 by 30 foot plots. The experiment was a randomized complete block design with four replicates

Treatment	Rate	Growth Stage	6/8 Soy	6/8 Colq	6/8 Pgwd	6/27 Soy	6/27 Colq	6/27 Pgwd	6/27 Corw	6/27 Cocb	7/11 Soy	7/11 Colq	7/11 Pgwd	7/11 Corw	7/11 Cocb	10/2 Yield
	oz ai/A		%	%	%	%	%	%	%	%	%	%	%	%	%	bu/A
Untreated Check	0		1	0	0	0	0	0	0	0	0	0	0	0	0	-
Meto&Metr/ Glyt-4.5+Meto&Dica+CARid+Intact	19.4/ 16+24+1%+0.5%	PRE/ 3"	1	89	94	0	99	99	99	99	0	99	99	99	99	39
Meto&Suen/ Glyt-4.5+Meto&Dica+CARid+Intact	21.9/ 16+24+1%+0.5%	PRE/ 3"	4	96	96	0	99	99	99	99	0	99	99	99	99	37
Meto&Fome/ Glyt-4.5+Meto&Dica+CARid+Intact	21.2/ 16+24+1%+0.5%	PRE/ 3"	4	86	91	0	99	99	99	99	0	99	99	99	99	38
Flum-sx/ Glyt-4.5+Dica-X+CARid+Intact	1/ 16+8+1%+0.5%	PRE/ 3"	4	80	81	0	99	99	99	99	0	99	99	99	99	39
Pxsf&Saff&Imep/ Glyt-4.5+Dica-E+CARid+Intact	2.3/ 16+8+1%+0.5%	PRE/ 3"	6	96	96	0	99	99	99	99	0	99	99	99	99	39
Suen&Chlorimuron/ Glyt-4.5+Dica-X+CARid+Intact	3.5/ 16+8+1%+0.5%	PRE/ 3"	4	97	97	0	99	99	99	99	0	99	99	99	99	39
CV			51	3	3	0	0	0	0	0	0	0	0	0	0	8
LSD P=0.5			3	3	3	.	.	.	.	.	.	.	.	.	.	5

Slight injury of 4 to 6% was observed on soybean with most herbicide treatments on June 8, but this injury was not observed June 27. POST treatments did not introduce more injury. Yield estimate was not possible in the untreated check because of substantial weed biomass.

Several PRE treatments gave greater than 90% control of weeds present. POST treatments all included glyphosate and dicamba and were exceptionally successful. Weeds were not found in any herbicide treatment after the post emergence applications.

Waterhemp Control with Sulfentrazone Premixes. Dr. Howatt, Mettler, and Harrington. 'CZ0201LL' Liberty Link soybean was seeded near Fargo on May 16. Preemergence treatments were applied May 16 with 86°F, 28% relative humidity, clear sky, and 12 mph wind velocity at 225° and dry soil at 64°F. POST treatments were applied to V3 Soybean, 1 to 14 inch pigweed (primarily redroot), 1 to 5 inch common lambsquarters and wild buckwheat, and 4 leaf yellow foxtail on June 19 with 89°F, 32% relative humidity, 90% cloud cover, 6 mph wind velocity at 90°, and dry soil at 80°F. Treatments were applied with a backpack sprayer delivering 17 gpa at 40 psi through 11002 TT nozzles to a 7 foot wide area the length of 10 by 30 foot plots. The experiment was a randomized complete block design. Venice mallow emerged mid-season.

Treatment	Rate	Appl Code	6/5 Sobe	6/5 Yeft	6/5 Pgwd	6/5 Colq	6/5 Wibw
	oz ai/A		%	%	%	%	%
Untreated Check		PRE	0	0	0	0	0
Pxsf&Suen/Gluf+AMS	4.16/9.4+32	PRE/28DAT	0	92	92	94	88
Pxsf&Suen/Gluf+AMS	3.12/9.4+32	PRE/28DAT	0	87	86	92	85
Pxsf&Suen/Pxsf&Flut+MSO	3.12/1.4+20	PRE/28DAT	0	85	87	92	85
Pxsf&Suen+Suen&Carf/Gluf+AMS	3.12+1.75/9.4+32	PRE/28DAT	0	91	94	95	90
Pxsf&Suen+Suen&Carf/Gluf+AMS	3.12+2.6/9.4+32	PRE/28DAT	0	91	94	94	93
Pxsf&Suen+Metr/Gluf+AMS	3.12+4.5/9.4+32	PRE/28DAT	0	89	92	95	89
Pxsf&Saff&Imep/Gluf+AMS	2.3/9.4+32	PRE/28DAT	0	98	98	95	96
Flum&Pxsf+Metr/Gluf+AMS	2.85+4/9.4+32	PRE/28DAT	0	91	82	85	76
Flum&Pxsf/Gluf+AMS	2.85/9.4+32	PRE/28DAT	0	87	90	86	75
Meto&Metr/Gluf+AMS	23.6/9.4+32	PRE/28DAT	0	87	84	89	84
Pxsf&Flut/Gluf+AMS	2.3/9.4+32	PRE/28DAT	0	85	80	82	67
Pxsf&Suen/Gluf+Acet-W+AMS	3.12/9.4+20+32	PRE/28DAT	0	94	89	92	80
CV			0	5	5	5	6
LSD P=0.5			.	6	5	6	7

Treatment	Rate	Appl Code	6/20 Sobe	6/20 Yeft	6/20 Pgwd	6/20 Colq	6/20 Wibw	7/5 Yeft	7/5 Pgwd	7/5 Colq	7/5 Wibw	7/5 Vema
	oz ai/A		%	%	%	%	%	%	%	%	%	%
Untreated Check	0	PRE	0	0	0	0	0	0	0	0	0	0
Pxsf&Suen/Gluf+AMS	4.16/9.4+32	PRE/28DAT	0	81	86	91	77	96	96	98	96	96
Pxsf&Suen/Gluf+AMS	3.12/9.4+32	PRE/28DAT	0	81	86	89	82	97	97	99	96	97
Pxsf&Suen/Pxsf&Flut+MSO	3.12/1.4+20	PRE/28DAT	14	85	95	90	77	82	91	95	89	91
Pxsf&Suen+Suen&Carf/Gluf+AMS	3.12+1.75/9.4+32	PRE/28DAT	0	85	94	94	86	98	99	99	98	99
Pxsf&Suen+Suen&Carf/Gluf+AMS	3.12+2.6/9.4+32	PRE/28DAT	0	88	95	95	79	98	98	99	98	98
Pxsf&Suen+Metr/Gluf+AMS	3.12+4.5/9.4+32	PRE/28DAT	0	84	91	94	84	98	97	98	97	98
Pxsf&Saff&Imep/Gluf+AMS	2.3/9.4+32	PRE/28DAT	0	97	98	98	95	99	98	99	98	99
Flum&Pxsf+Metr/Gluf+AMS	2.85+4/9.4+32	PRE/28DAT	0	81	86	75	85	98	95	96	97	99
Flum&Pxsf/Gluf+AMS	2.85/9.4+32	PRE/28DAT	0	85	89	72	85	97	97	99	98	98
Meto&Metr/Gluf+AMS	23.6/9.4+32	PRE/28DAT	0	85	89	79	84	99	97	98	96	97
Pxsf&Flut/Gluf+AMS	2.3/9.4+32	PRE/28DAT	0	84	85	76	74	98	96	98	89	97
Pxsf&Suen/Gluf+Acet-W+AMS	3.12/9.4+20+32	PRE/28DAT	0	84	90	87	89	99	97	98	98	98
CV			38	3	4	4	6	1	2	1	3	1
LSD P=0.5			1	4	4	4	7	2	2	2	4	2

Pre-emergence herbicide treatments did not cause visible crop response. Postemergence treatment with pyroxasulfone and fluthiacet resulted in 14% damage to foliage that was evident the day after application. The symptoms included chlorotic spots on the foliage consistent with a PPO inhibitor such as fluthiacet. This did not appear to retard growth and the tissue recovered. Symptoms were not observed on July 5 or August 14. Soybean reached full canopy by July 16 which provided substantial shading to the ground with several layers of vegetation.

Pyroxasulfone and saflufenacil and imazethapyr (Zidua Pro) provided exceptional control of all weed speices, 95% or greater, and maintained control throughout the season. There was barely a weed present for the postemergence application of glufosinate to control. Some might have argued that competition from the soybean crop would have been sufficient to prevent negative effect from the few weeds present. However, this treatment carries quite restrictive crop rotation allowances because of the imazethapyr. Pyroxasulfone and sulfentrazone (Authority Supreme) at the higher rate or tankmixed with metribuzin or sulfentrazone and carfentrazone (Spartan Charge) provided essentially 90 to 95% control of species present.

Evaluation on June 12 provided similar control ratings to June 5. On June 20, new emergence was not evident but plants that had established were larger resulting in slightly lower ratings for weed control. On July 5, glufosinate added substantially to control for most treatments resulting in near complete weed removal. Pyroxasulfon and fluthiacet was not as effective but total control was about 90%. These ratings were unchanged on July 16 and August 14.

Layered Residual Herbicide in Soybean. Dr. Howatt, Mettler, and Harrington. 'CZ0201LL' Liberty link soybean was seeded near Fargo on May 16. Preemergence treatments were applied May 16 with 86°F, 28% relative humidity, clear sky, 12 mph wind velocity at 225°, and dry soil at 64°F. Post treatments were applied to V2 soybean (21 DAT), 1 inch common lambsquarters and wild buckwheat, and 2 inch redroot pigweed and yellow foxtail on June 7 with 70°F, 49% relative humidity, 25% cloud cover, 7 mph wind velocity at 135°, and dry soil at 68°F. Treatments were applied with a backpack sprayer delivering 17 gpa at 40 psi through 11002 TT nozzles to a 7 foot wide area the length of 10 by 30 foot plots. The experiment was a randomized complete block design with four replicates.

Treatment	Rate	Appl Code	6/5 Soy	6/5 Yeft	6/5 Pgwd	6/5 Colq	6/5 Wibw	6/15 Soy	6/15 Yeft	6/15 Pgwd
	oz ai/A		%	%	%	%	%	%	%	%
Untreated Check	0		0	0	0	0	0	0	0	0
Meto&Metr/Gluf+AMS	23.4/9.4+1%	PRE/21DAT	0	72	87	76	71	0	99	99
Flumioxazin/Gluf+AMS	1/9.4+1%	PRE/21DAT	0	15	20	5	0	0	99	99
Meto&Suen/Gluf+AMS	21.9/9.4+1%	PRE/21DAT	0	91	95	96	90	0	99	99
Meto&Metr/Meto+Gluf+AMS	23.4/15.2+9.4+1%	PRE/21DAT	0	76	86	85	80	0	99	99
Meto&Suen/Meto+Gluf+AMS	21.9/15.2+9.4+1%	PRE/21DAT	0	92	95	96	93	0	99	99
Meto&Metr/Fome+Gluf+AMS	23.4/2.8+9.4+1%	PRE/21DAT	0	82	89	82	71	0	99	99
Meto&Metr/Meto+Fome+Gluf+AMS	23.4/15.2+2.8+9.4+1%	PRE/21DAT	0	76	82	80	75	0	99	99
CV			0	10	9	8	8	0	87	87
LSD P=0.5			.	9	10	7	7	0	0	0

Treatment	Rate	Appl Code	6/15 Colq	6/15 Wibw	6/20 Soy	6/20 Yeft	6/20 Pgwd	6/20 Colq	6/20 Wibw	10/22 Yield
	oz ai/A		%	%	%	%	%	%	%	bu/A
Untreated Check	0		0	0	0	0	0	0	0	44
Meto&Metr/Gluf+AMS	23.4/9.4+1%	PRE/21DAT	99	99	0	99	99	99	99	41
Flumioxazin/Gluf+AMS	1/9.4+1%	PRE/21DAT	99	99	0	99	99	99	99	46
Meto&Suen/Gluf+AMS	21.9/9.4+1%	PRE/21DAT	99	99	0	99	99	99	99	46
Meto&Metr/Meto+Gluf+AMS	23.4/15.2+9.4+1%	PRE/21DAT	99	99	0	99	99	99	99	46
Meto&Suen/Meto+Gluf+AMS	21.9/15.2+9.4+1%	PRE/21DAT	99	99	0	99	99	99	99	44
Meto&Metr/Fome+Gluf+AMS	23.4/2.8+9.4+1%	PRE/21DAT	99	99	0	99	99	99	99	48
Meto&Metr/Meto+Fome+Gluf+AMS	23.4/15.2+2.8+9.4+1%	PRE/21DAT	99	99	0	99	99	99	99	50
CV			87	87	0	87	87	87	87	10
LSD P=0.5			0	0	0	0	0	0	0	7

Weed emergence was not observed in the untreated on May 23. Evaluation of weed control on June 5 was just before POST application of glufosinate. Metolachlor and sulfentrazone provided the best control of the weed spectrum at more than 90% for each species. Flumioxazin did not give the level of control expected according to previous trials. Glufosinate provided excellent control of existing weeds. Weed control also was evaluated on June 27, August 2, and August 14, but new emergence was not found.

Evaluating the soybean trait stack of LL + RR. Ostlie

Soybean varieties will be available in 2019 that contain both Liberty Link® and RoundUp Ready® traits. This will provide much more flexibility with herbicide programs and should result in cleaner fields when glyphosate-resistant weeds are present. The system will require some additional training. Previous studies have demonstrated antagonism between the two products when tank-mixed. We conducted a study at the CREC last season to test different rates and adjuvants with the two products. Application conditions were designed to optimize the Liberty application since it is the more expensive product (i.e. we used 15 GPA). Here is what we learned (Table 1).

Table 1. RoundUp and Liberty combinations for controlling common ND weeds

Herbicide	Rate	Adjuvant	Yellow Foxtail	Common Lambsquarters	Redroot Pigweed
	oz/a		14 DAT	14 DAT	14 DAT
Check			0.0	0.0	0.0
Liberty	32	AMS	41.7	81.7	86.7
RoundUp Powermax	28	Class Act NG	63.3	81.7	93.3
Liberty + R. Powermax	32 + 28	Class Act NG	56.7	71.7	85.0
Liberty + R. Powermax	43 + 21	Class Act NG	68.3	88.3	88.3
Liberty + R. Powermax	32 + 21	Class Act NG	56.7	80.0	90.0
Liberty + R. Powermax	32 + 21	Class Act Rideon	61.7	78.3	93.3
Liberty + R. Powermax	32 + 21	AMS	68.3	88.3	90.0
LSD (0.05)			8.3	7.9	4.6

Assessments in Table 1 were taken 14 days after the herbicide application. In some cases we did identify antagonism, particularly when using 28 fl oz of RoundUp Powermax. Better weed control was achieved at times by using 21 fl oz of RoundUp Powermax when mixed with Liberty. Even when there was no antagonism between the products, there was never an advantage to mixing the products where the combination performed better than either product alone. Essentially mixing the products would be a waste of money.

Proper stewardship and economics dictate that these two products should be applied separately. Consider the following in-crop sequence for applications: Use Liberty as an early POST treatment to be as effective as possible on small broadleaf weeds (with or without an approved tank-mix partner). Follow-up with a mid-season application of glyphosate (+ tank-mix partner). And of course, your foundation PRE herbicide program will ultimately determine the long-term success of your POST applications.

Weed control in no-till Liberty soybeans. (Minot). The objective of the study was to evaluate weed control in no-till Liberty soybeans with PRE and POST herbicides. Liberty soybeans were planted May 16. PRE treatments were applied on May 22. POST treatments were applied the June 8, June 20, June 27, and July 2.

None of the treatments caused any visible crop injury. All treatments provided excellent control of kochia, lambsquarters, horseweed, and volunteer wheat.

Table. Weed control in no-till Liberty soybeans. (1812)

		Weed Control											
		Kochia			Lambsquarters			Horseweed			Volunteer wheat		
Treatment[c]	Timing	Jun-4	Jun-27	Jul-23	Jun-4	Jun-27	Jul-23	Jun-4	Jun-27	Jul-23	Jun-4	Jun-27	Jul-23
		----------%----------											
Untreated		0	0	0	0	0	0	0	0	0	0	0	0
ZP + Gly[ab] / Lib[b]	May 22 / Jun 27	100	92	100	100	100	100	100	100	100	100	100	100
ZP + Gly[ab] / Lib + Out[b]	May 22 / Jun 27	100	93	100	100	100	100	100	100	100	100	100	100
ZP[ab] + Lib / Lib[b]	May 22 / Jun 27	100	96	100	100	100	100	100	100	100	92	93	100
ZP[ab] + Lib / Liberty + Out[b]	May 22 / Jun 27	100	97	100	100	100	100	100	100	100	89	90	100
Ver + Metri + Gly[ab] / Lib + Out[b]	May 22 / Jun 27	100	99	100	100	100	100	100	100	100	100	100	100
Ver + Metri + Gly[ab] / Lib + Z SC[b]	May 22 / Jun 20	100	100	100	100	100	100	100	100	100	100	100	100
Ver + Gly[ab] + Z SC / Lib + Out[b]	May 22 / Jun 20	100	100	100	100	100	100	100	100	100	100	100	100
Ver + Gly[ab] / Lib[b] / Lib + Out[b]	May 22 / Jun 8 / Jun 27	100	97	100	100	100	100	100	100	100	100	100	100
Ver + Gly[ab] / Lib[b] / Lib[b]	May 22 / Jun 8 / Jul 2	99	100	100	100	100	100	100	100	100	100	100	100
LSD (0.05)		0.9	3.7	0	0	0	0	0	0	0	12.0	10.7	0

[a] Applied with MSO (1%)

[b] Applied with AMS (7.35 gal/100 gal)

[c] ZP=Zidua Pro (4.5 oz); Gly=Roundup PowerMax (32 oz); Out=Outlook (10 oz); Lib=Liberty (32 oz); Z SC= Zidua SC (2 oz); Ver=Verdict (5 oz); Metri=Metribuzin DF (5 oz)

Flumioxazin in LL soybean system. Dr. Howatt, Mettler, and Harrington. 'CZ0201LL' Liberty link soybean was seeded near Prosper, North Dakota on May 17. Preemergence treatments were applied on May 17 with 65°F, 53% relative humidity, 100% cloud cover, 5 to 10 mph wind velocity at 70°, and dry soil at 59°F. Treatment (1inch) was applied to 1 inch soybean and common lambsquarters, and 2 inch redroot pigweed and common ragweed on June 6 with 72°F, 52% relative humidity, clear sky, 9 mph wind velocity at 180°, and wet soil at 71°F. Treatments (2 inch) were applied to 1 trifoliolate soybean, 2 inch common lambsquarters, 3 inch pigweed and common ragweed, and V3 volunteer corn on June 13 with 76°F, 50% relative humidity, clear sky, 7 mph wind velocity at 225°, and wet soil at 65°F. Treatments were applied with a backpack sprayer delivering 17 gpa at 40 psi through 11002 TT nozzles to a 7 foot wide area the length of 10 by 30 foot plots. The experiment was a randomized complete block design with four replicates.

Treatment	Rate	Appl Code	6/8 Soybe	6/8 Colq	6/8 Pgwd	6/8 Corw	6/15 Volunteer corn	6/15 Colq	6/15 Pgwd	6/15 Corw	6/22 Volunteer corn	6/22 Colq
	oz ai/A		%	%	%	%	%	%	%	%	%	%
Untreated Check	0		5	0	0	0	0	0	0	0	0	0
Gluf+AMS/ Gluf+Clet SM+AMS+NIS	8.5+48/ 8.5+0.75+48+0.25%	1"/ 2"	4	81	87	65	60	99	99	99	95	98
Flum&Pxsf/ Gluf+Clet SM+AMS+NIS	2.3/ 8.5+0.75+48+0.25%	Pre/ 2"	6	85	91	85	60	86	92	87	95	93
Meto&Metr/ Gluf+Clet SM+AMS+NIS	26/ 8.5+0.75+48+0.25%	Pre/ 2"	6	91	92	90	60	91	96	92	95	96
Suen&Meto/ Gluf+Clet SM+AMS+NIS	21.9/ 8.5+0.75+48+0.25%	Pre/ 2"	6	97	97	90	60	98	98	89	95	99
Pxsf&Saff&Imep/ Gluf+Clet SM+AMS+NIS	2.3/ 8.5+0.75+48+0.25%	Pre/ 2"	6	97	97	96	60	97	98	98	95	99
Flum&Pxsf&Metr/ Gluf+Clet SM+AMS+NIS	5.28/ 8.5+0.75+48+0.25%	Pre/ 2"	6	84	91	89	60	92	96	94	95	95
Flum&Pxsf/ Gluf+Clet SM+AMS+NIS	2.84/ 8.5+0.75+48+0.25%	Pre/ 2"	4	81	90	79	60	88	96	91	95	94
Pxsf&Suen/ Gluf+Clet SM+AMS+NIS	4/ 8.5+0.75+48+0.25%	Pre/ 2"	6	96	96	87	60	99	98	92	95	99
V10452/ Gluf+Clet SM+AMS+NIS	2.28/ 8.5+0.75+48+0.25%	Pre/ 2"	5	85	91	86	60	88	94	92	95	93
CV			37	6	5	6	0	4	2	4	0	2
LSD P=0.5			3	7	6	7	.	4	2	5	.	3

Treatment	Rate	Appl Code	6/22 Pgwd	6/22 Corw	6/27	7/5 Colq	7/5 Pgwd	7/5 Corw	7/5 Wibw	7/11 Colq	7/11 Pgwd	7/11 Corw
	oz ai/A		%	%		%	%	%	%	%	%	%
Untreated Check	0		0	0		0	0	0	0	0	0	0
Gluf+AMS/ Gluf+Clet SM+AMS+NIS	8.5+48/ 8.5+0.75+48+0.25%	1"/ 2"	99	99		92	94	98	98	92	94	98
Flum&Pxsf/ Gluf+Clet SM+AMS+NIS	2.3/ 8.5+0.75+48+0.25%	Pre/ 2"	98	99		93	94	98	99	93	94	98
Meto&Metr/ Gluf+Clet SM+AMS+NIS	26/ 8.5+0.75+48+0.25%	Pre/ 2"	99	99		92	96	97	98	92	96	97
Suen&Meto/ Gluf+Clet SM+AMS+NIS	21.9/ 8.5+0.75+48+0.25%	Pre/ 2"	99	99		99	98	96	99	99	98	96
Pxsf&Saff&Imep/ Gluf+Clet SM+AMS+NIS	2.3/ 8.5+0.75+48+0.25%	Pre/ 2"	99	99		98	98	99	99	98	98	99
Flum&Pxsf&Metr/ Gluf+Clet SM+AMS+NIS	5.28/ 8.5+0.75+48+0.25%	Pre/ 2"	99	99		92	98	98	97	92	98	98
Flum&Pxsf/ Gluf+Clet SM+AMS+NIS	2.84/ 8.5+0.75+48+0.25%	Pre/ 2"	99	99		87	93	96	95	87	93	96
Pxsf&Suen/ Gluf+Clet SM+AMS+NIS	4/ 8.5+0.75+48+0.25%	Pre/ 2"	99	99		99	99	99	99	99	99	99
V10452/ Gluf+Clet SM+AMS+NIS	2.28/ 8.5+0.75+48+0.25%	Pre/ 2"	98	99		87	95	97	96	87	95	97
CV			1	0.0	.	3	2	1	2	3	2	1
LSD P=0.5			1	.	.	4	3	2	2	4	3	2

No New Emergence

Treatment	Rate	Appl Code	7/11 Wibw	7/23 Colq	7/23 Pgwd	7/23 Corw	7/23 Wibw	8/2 Colq	8/2 Pgwd	8/2 Corw	8/2 Wibw	8/14
	oz ai/A		%	%	%	%	%	%	%	%	%	
Untreated Check	0		0	0	0	0	0	0	0	0	0	
Gluf+AMS/ Gluf+Cleth SM+AMS+NIS	8.5+48/ 8.5+0.75+48+0.25%	1"/ 2"	98	92	94	98	98	92	94	98	98	
Flum&Pxsf/ Gluf+Cleth SM+AMS+NIS	2.3/ 8.5+0.75+48+0.25%	Pre/ 2"	99	93	94	98	99	93	94	98	99	
Meto&Metr/ Gluf+Cleth SM+AMS+NIS	26/ 8.5+0.75+48+0.25%	Pre/ 2"	98	92	96	97	98	92	96	97	98	
Suen&Meto/ Gluf+Cleth SM+AMS+NIS	21.9/ 8.5+0.75+48+0.25%	Pre/ 2"	99	99	98	96	99	99	98	96	99	
Pxsf&Saff&Imep/ Gluf+Cleth SM+AMS+NIS	2.3/ 8.5+0.75+48+0.25%	Pre/ 2"	99	98	98	99	99	98	98	99	99	
Flum&Pxsf&Metr/ Gluf+Cleth SM+AMS+NIS	5.28/ 8.5+0.75+48+0.25%	Pre/ 2"	97	92	98	98	97	92	98	98	97	
Flum&Pxsf/ Gluf+Cleth SM+AMS+NIS	2.84/ 8.5+0.75+48+0.25%	Pre/ 2"	94	87	93	96	94	87	93	96	94	
Pxsf&Suen/ Gluf+Cleth SM+AMS+NIS	4/ 8.5+0.75+48+0.25%	Pre/ 2"	99	99	99	99	99	99	99	99	99	
V10452/ Gluf+Cleth SM+AMS+NIS	2.28/ 8.5+0.75+48+0.25%	Pre/ 2"	96	87	95	97	96	87	95	97	96	
CV			2	3	2	1	2	3	2	1	2	.
LSD P=0.5			2	4	3	2	2	4	3	2	2	.

No new emergence

All herbicide programs provided excellent, full-season control of weeds. Weed control was enhanced by competition from vigorous soybean growth. A full, dense canopy hindered establishment and growth of weeds from about July 11 in 21-inch wide rows.

Soybean row spacing on horseweed growth. Froemke, and Dr. Howatt. 'Xtend AG08X8' soybean was seeded near Sheldon, North Dakota on May 11. Preemergence treatments were applied on May 11 with 58°F, 30% relative humidity, 95% cloud cover, 7 mph wind velocity at 135°, and dry soil at 60°F. Treatments were applied with a backpack sprayer delivering 10 gpa at 40 psi through 11001 TT nozzles to a 7 foot wide area the length of 10 by 30 foot plots. The experiment was a randomized complete block design in split-plot arrangement with four replicates.

Treatment	Rate	Application code	6/1 Horw	6/18 Horw	6/18 Horw	6/18 Horw
	oz ai/A		#	#	Height (in)	Dry Weight (g)
7.5 inch						
Untreated		PRE	16	25	11	17
Dicamba-X	4	PRE	0	7	6	0
Paraquat	5	PRE	9	10	9	56
15 inch						
Untreated		PRE	57	82	12	159
Dicamba-X	4	PRE	0	4	6	2
Paraquat	5	PRE	32	35	10	72
30 inch						
Untreated		PRE	63	63	11	101
Dicamba-X	4	PRE	1	6	6	4
Paraquat	5	PRE	17	20	11	24
CV			94	117	17	109
LSD P=0.05			30	47	2	74

Soybean stage was V1 on June 1. On June 1 horseweed stand counts were collected 3 weeks after herbicide application. The only significance found in the June 1 stand count is when comparing the untreated treatment from the 7.5 to both the 15 and 30 untreated treatments. The stand counts on June 18 revealed significance in the untreated treatment when comparing the 7.5 to the 15 but revealed no significance in all other treatments. Horseweed height did not show any significance with narrower row spacing in all three treatments. The dry weight data showed significance only in the untreated treatment when comparing the 7.5 to both the 15 and 30.

Soybean row spacing on horseweed growth. Froemke, and Dr. Howatt. 'Xtend AG08X8' soybean was seeded near Sheldon, North Dakota on May 10. Preemergence treatments were applied on May 10 with 59°F, 99% relative humidity, 90% cloud cover, 3 mph wind velocity at 35°, and dry soil at 68°F. Treatments were applied with a backpack sprayer delivering 10 gpa at 40 psi through 11001 TT nozzles to a 7 foot wide area the length of 10 by 30 foot plots. The experiment was a randomized complete block design in split-plot arrangement with four replicates.

Treatment	Rate	Application code	6/1 Horw	6/18 Horw	6/18 Horw	6/18 Horw
	oz ai/A		#	#	Height (in)	Dry Weight (g)
7.5 inch						
Untreated		PRE	125	112	10	143
Dicamba-X	4	PRE	6	10	5	3
Paraquat	5	PRE	82	79	9	110
15 inch						
Untreated		PRE	99	77	11	150
Dicamba-X	4	PRE	11	11	5	6
Paraquat	5	PRE	69	59	10	60
30 inch						
Untreated		PRE	163	137	12	144
Dicamba-X	4	PRE	7	12	5	8
Paraquat	5	PRE	140	94	11	96
CV			30	35	12	42
LSD P=0.05			35	32	1	28

Soybean stage was V1 on June 1. On June 1 horseweed stand counts were collected 3 weeks after herbicide application. Both the untreated and paraquat treatments showed significance when comparing the 7.5 and 15-inch row spacings to the 30-inch row spacing, but did not show significance in any treatments when comparing the 7.5 to the 15.

Horseweed height decreased and showed significance with narrower row spacing in both the untreated and paraquat treatments, but did not have significance in the dicamba treatment due to dicambas efficacy on horseweed control and growth regulating aptitude. This change in horseweed height is most likely due to the increase in competitiveness from the closer populated soybean.

The dry weight data showed significance only in the paraquat treatment when comparing the 15 to both the 7.5 and 30-inch row spacings.

Residual herbicide programs (PRE + POST) in distinctive herbicide crop systems for horseweed control in soybean. Froemke, and Dr. Howatt. 'Xtend AG08X8', 'Liberty Link CZ0201LL', and 'Roundup Ready 2 AG0934' soybean was seeded near Sheldon, North Dakota on May 11. Preemergence treatments were applied on May 11 with 60°F, 25.8% relative humidity, 95% cloud cover, 2 mph wind velocity at 65°, and dry soil at 70°F. Treatments (POST) were applied to V4 soybean, 5 to 20 inch horseweed, on June 18 with 78°F, 47% relative humidity, 40% cloud cover, 4 mph wind velocity at 15°, and moist soil at 80°F. Treatments were applied with a backpack sprayer delivering 10 gpa at 40 psi through 110015 TTI and 11001 TT (Dicamba treatments and all other treatments) nozzles to a 7 foot wide area the length of 10 by 30 foot plots. The experiment was a randomized complete block design in nested block arrangement with four replicates.

Treatment	Rate	Application code	6/1 Horw	7/9 Horw	8/6 Horw	6/1 Horw	7/9 Horw	8/6 Horw	8/18 Sobe
	oz ai/A		%	%	%	#	#	#	Seed Weight (g)
Liberty Link									
Parqt/Gluf	8/11.5	PRE/V4	50	99	99	1	0	0	1390
Parqt+Saff/Gluf	8+0.356/11.5	PRE/V4	99	99	99	0	0	0	1562
Parqt+Flum/Gluf	8+1/11.5	PRE/V4	42	99	99	3	0	0	1611
Parqt+Suen/Gluf	8+3/11.5	PRE/V4	73	99	99	2	0	0	1753
Roundup Ready 2									
Glyt/Bent+Glyt	12/80+12	PRE/V4	5	13	13	57	25	33	983
Glyt+Saff/ Bent+Glyt	12+0.356/80+12	PRE/V4	97	80	89	1	4	1	1991
Glyt+Flum/ Bent+Glyt	12+1/80+12	PRE/V4	10	19	20	32	21	21	1321
Glyt+Suen/ Bent+Glyt	12+3/80+12	PRE/V4	8	18	24	28	29	17	1373
Xtend									
Glyt/Dica-X+Glyt	12/8+12	PRE/V4	11	89	99	30	0	0	2011
Glyt+Dica-X+Saff/Dica-X+Glyt	12+8+0.356/8+12	PRE/V4	99	99	99	0	0	0	1907
Glyt+Dica-X+Flum/Dica-X+Glyt	12+8+1/8+12	PRE/V4	99	99	99	0	0	0	2200
Glyt+Dica-X+Suen/Dica-X+Glyt	12+8+3/8+12	PRE/V4	99	99	99	0	0	0	2061
CV			33	5	4	95	128	49	17
LSD P=0.5			28	6	5	17	12	4	403

Soybean stage was V1 on June 1. The addition of saflufenacil applied preemergence drastically increased the percent control of horseweed in the Liberty Link and Roundup Ready 2 soybean systems. Due to dicambas effectiveness on horseweed, there were no visible benefits from the addition of the saflufenacil, flumioxazin, or sulfentrazone in that system. Glyphosate and paraquat applied preemergence had little to no effect on horseweed control which leads us to believe the horseweed population is highly tolerant or resistant to the EPSP synthase and PSI sites of action.

Glufosinate and dicamba applied postemergence were both very effective treatments and provided greater than 89% control of horseweed. The horseweed population in this site was less condensed which allowed the glufosinate to penetrate further into to canopy resulting in an increased percent control. Bentazon applied postemergence had very little effect on horseweed which leads us to believe the horseweed population is also very tolerant, if not resistant, to the PSII site of action as well. The effectiveness of saflufenacil applied preemergence carried over into the postemergence, July 9 and August 6, evaluations as we can see in the Roundup Ready 2 system.

The efficacy of the saflufenacil was also demonstrated in the horseweed stand counts in the Roundup Ready 2 system. The soybean seed weight also increased with the addition of the saflufenacil in the Roundup Ready 2 system. The increase in horseweed control allowed the soybean to grow in a less competitive environment than the other three treatments, which resulted in higher soybean yield.

Residual herbicide programs (PRE + POST) in distinctive herbicide crop systems for horseweed control in soybean. Froemke, and Dr. Howatt. 'Xtend AG08X8', 'Liberty Link CZ0201LL', and 'Roundup Ready 2 AG0934' soybean was seeded near Sheldon, North Dakota on May 10. Preemergence treatments were applied on May 10 with 57°F, 99% relative humidity, 95% cloud cover, 6 mph wind velocity at 35°, and dry soil at 68°F. Treatments (POST) were applied to V4 soybean, 5 to 20 inch horseweed, on June 18 with 80°F, 40% relative humidity, 50% cloud cover, 4 mph wind velocity at 0°, and dry soil at 83°F. Treatments were applied with a backpack sprayer delivering 10 gpa at 40 psi through 110015 TTI and 11001 TT (Dicamba treatments and all other treatments) nozzles to a 7 foot wide area the length of 10 by 30 foot plots. The experiment was a randomized complete block design in nested block arrangement with four replicates.

Treatment	Rate	Application code	6/1 Horw	7/9 Horw	8/6 Horw	6/1 Horw	7/9 Horw	8/6 Horw	8/18 Sobe
	oz ai/A		%	%	%	#	#	#	Seed Weight (g)
Liberty Link									
Parqt/Gluf	8/11.5	PRE/V4	6	74	82	59	9	12	1280
Parqt+Saff/Gluf	8+0.356/11.5	PRE/V4	45	84	92	32	1	3	1488
Parqt+Flum/Gluf	8+1/11.5	PRE/V4	8	75	86	79	12	10	1397
Parqt+Suen/Gluf	8+3/11.5	PRE/V4	13	80	85	88	4	9	1440
Roundup Ready 2									
Glyt/Bent+Glyt	12/80+12	PRE/V4	5	11	5	86	102	126	622
Glyt+Saff/ Bent+Glyt	12+0.356/80+12	PRE/V4	55	68	68	15	13	21	1342
Glyt+Flum/ Bent+Glyt	12+1/80+12	PRE/V4	6	11	5	85	83	114	595
Glyt+Suen/ Bent+Glyt	12+3/80+12	PRE/V4	6	11	5	92	101	115	466
Xtend									
Glyt/Dica-X+Glyt	12/8+12	PRE/V4	5	85	99	100	0	0	1584
Glyt+Dica-X+Saff/Dica-X+Glyt	12+8+0.356/8+12	PRE/V4	99	99	99	0	0	0	1746
Glyt+Dica-X+Flum/Dica-X+Glyt	12+8+1/8+12	PRE/V4	99	99	99	0	0	0	1613
Glyt+Dica-X+Suen/Dica-X+Glyt	12+8+3/8+12	PRE/V4	99	99	99	0	0	0	1673
CV			13	5	10	67	56	32	30
LSD P=0.5			7	5	10	51	22	16	540

Soybean stage was V1 on June 1. The addition of saflufenacil applied preemergence drastically increased the percent control of horseweed in the Liberty Link and Roundup Ready 2 soybean systems. Due to dicambas effectiveness on horseweed, there were no visible benefits from the addition of the saflufenacil, flumioxazin, or sulfentrazone in that system. Glyphosate and paraquat applied preemergence had little to no effect on horseweed control which leads us to believe the horseweed population is highly tolerant or resistant to the EPSP synthase and PSI sites of action.

Glufosinate and dicamba applied postemergence were both very effective treatments and provided greater than 74% control of horseweed. Since glufosinate is a contact herbicide, it was not able to provide control further into the horseweed canopy due to the very high horseweed population. Bentazon applied postemergence had very little effect on horseweed which leads us to believe the horseweed population is also very tolerant, if not resistant, to the PSII site of action as well. The effectiveness of saflufenacil applied preemergence carried over into the postemergence, July 9 and August 6, evaluations as we can see in the Liberty Link and Roundup Ready 2 systems.

The efficacy of the saflufenacil was also demonstrated in the horseweed stand counts especially in the Roundup Ready 2 system. The soybean seed weight also increased with the addition of the saflufenacil in all three systems. The increase in horseweed control allowed the soybean to grow in a less competitive environment than the other three treatments.

Preemergence Herbicide Options to Dicamba in Soybean. Dr. Howatt, Mettler, and Harrington. 'Xtend AG08X8' soybean was seeded near Prosper, North Dakota on May 17. Preemergence treatments were applied on May 17 with 58°F, 88% relative humidity, 100% cloud cover, 5 mph wind velocity at 165°, and moist soil at 59°F. Treatments (V2-V3) were applied to V3 soybean, 1 to 14 inch pigweed (primarily redroot), and 1 to 12 inch common lambsquarters and common cocklebur on June 19 with 79°F, 56% relative humidity, 90% cloud cover, 3 mph wind velocity at 30°, and dry soil at 76°F. Treatments were applied with a backpack sprayer delivering 17 gpa at 40 psi through 11002 TT nozzles to a 7 foot wide area the length of 10 by 30 foot plots. The experiment was a randomized complete block design with four replicates.

Treatment	Rate	Application code	6/8 Sobe	6/8 Colq	6/8 Pgwd	6/8 Corw	6/8 Hans	6/22 Sobe	7/5 Sobe	7/5 Colq	7/5 Pgwd	7/5 Corw	7/5 Cocb
	oz ai/A		%	%	%	%	%	%	%	%	%	%	%
Untreated Check			0	0	0	0	0	0	0	0	0	0	0
Pxsf&Flut/Glyt-4.5	1.9/18	PRE/V2-3	0	79	85	74	85	0	0	98	98	95	99
Pxsf&Flut/Glyt-4.5	2.3/18	PRE/V2-3	0	85	87	84	86	0	0	96	96	96	97
Pxsf&Flut+Metr/Glyt-4.5	1.9+4.5/18	PRE/V2-3	0	86	91	81	84	0	0	98	96	96	97
Pxsf&Flut+Metr/Glyt-4.5	2.3+4.5/18	PRE/V2-3	0	91	95	86	91	0	0	98	97	97	98
Pxsf&Flut/Pxsf&Flut+MSO	1.9/1.9+20	PRE/V2-3	0	86	90	84	89	25	0	84	89	76	69
Meto&Metr/Glyt-4.5	23.6/18	PRE/V2-3	0	82	89	72	82	0	0	98	98	93	98
Pxsf&Saff&Imep/Glyt-4.5	2.3/18	PRE/V2-3	0	97	98	82	95	0	0	99	99	97	98
Meto&Fmsf/Glyt-4.5	21.2/18	PRE/V2-3	0	86	91	85	90	0	0	98	98	98	99
Dime-p/Glyt-4.5	12/18	PRE/V2-3	0	84	91	81	89	0	0	97	98	95	98
Acetochlor-W/Glyt-4.5	18/18	PRE/V2-3	0	27	27	27	27	0	0	93	96	92	98
Metr/Glyt-4.5	4.5/18	PRE/V2-3	0	86	84	74	80	0	0	98	95	96	97
Suen&Clsm/Glyt-4.5	4.5/18	PRE/V2-3	0	97	98	96	97	0	0	99	98	98	99
Dicamba-X/Glyt-4.5	8/18	PRE/V2-3	0	86	89	87	89	0	0	98	95	97	99
CV			0	5	4	5	4	61	0	2	2	3	2
LSD P=0.5			.	6	5	6	5	2	.	3	2	3	2

Soybean stage was V1 on June 8. PRE herbicide treatments did not result in visible soybean response. Soybean stage was predominantly V4 on June 22. Pyroxasulfone and fluthiacet (Anthem Max) applied postemergence resulted in soybean injury of 25%. This likely resulted from the fluthiacet because symptoms were chlorotic spots on leaves consistent with a PPO herbicide. Soybean continued to grow and injury diminished over time so that plants did not show irregularity on July 5. At this date, soybean had begun reproductive stage and there was no delay associated with the previous response.

Sulfentrazone and chloransulam (Authority First/Sonic) was a very effective treatment and provided greater than 95% control of each species present. The chloransulam, however, greatly restricts rotational crops for the next 2 to 3 years. Pyroxasulfone and saflufenacil and imazethapyr (Zidua Pro) also performed quite well but did not control common cocklebur quite as well as the other species and crop rotation still must be considered because of the imazethapyr. Pyroxasulfone and fluthiacet (at the higher rate or mixed with metribuzin) or metolachlor and fomesafen (Prefix) gave similar control across species to dicamba (Engenia/FeXapan/Xtend) of 85 to 90% without as much concern for rotational crop as chloransulam or imazethapyr.

By July 5, canopy was about 60% of surface area with several foliar layers which aided weed control by inhibiting new emergence and restricting growth of treatment escapes. Nightshade did not remain in any herbicide treatment. Weeds did not emerge mid-season in any of the herbicide treatments, or at least didn't survive under the soybean canopy. Postemergence glyphosate controlled most weeds with a few plants lingering because of large size at application and somewhat shielded from spray by soybean canopy. Soybean reached full canopy before August 14 but individual weeds remained resulting in control rating similar to July 5.

Water Conditioner with Fomesafen. Dr. Howatt, Mettler, and Harrington. 'Xtend AGO8X8' soybean was seeded near Fargo on May 16. Treatments (preemergence) were applied on May 16 with 88°F, 18% relative humidity, clear sky, 8 mph wind velocity at 225°, and dry soil at 70°F. Treatments (3 inch) were applied to V3 soybean, 1 to 10 inch pigweed, and 1 to 4 inch common lambsquarters and Venice mallow on June 19 with 84°F, 37% relative humidity, 80% cloud cover, 2 mph wind velocity at 70°, and dry soil at 79°F. Treatments (10DAT) were applied on June 28 with 86°F, 60% relative humidity, cloudy sky, 6 mph wind velocity at 225°, and dry soil at 80°F. All treatments were applied with a backpack sprayer delivering 8.5 gpa at 40 psi through 11001 TT nozzles to a 7 foot wide area the length of 10 by 30 foot plots. The experiment was a randomized complete block design with four replicates.

Treatment	Rate	Appl Code	6/22 Soy	6/27 Soy	6/27 Pgwd	6/27 Colq	6/27 Vema	7/5 Soy	7/5 Pgwd	7/5 Colq	7/5 Vema
	oz ai/A		%	%	%	%	%	%	%	%	%
ET4000+Glyt-dma+Fome-S+Meto-M+NIS/ ET4000+Glyt-dma+Fome-S+Meto-M+NIS	0.75%+6.7+1.5+11.4+0.25/ 0.75%+6.7+1.5+11.4+0.25%	3"/ 10DAT	8	12	93	96	85	5	98	96	95
ET4000+Glyt-dma+Fome-S+Meto-M+Glacier/ ET4000+Glyt-dma+Fome-S+Meto-M+Glacier	0.75%+6.7+1.5+11.4+6/ 0.75%+6.7+1.5+11.4+6	3"/ 10DAT	7	9	94	94	86	6	98	96	95
ET4000+Glyt-dma+Fome-S+Meto-M+NIS/ ET4000+Glyt-dma+Fome-S+Meto-M+NIS	1.25%+6.7+1.5+11.4+0.25%/ 1.25%+6.7+1.5+11.4+0.25%	3"/ 10DAT	8	9	94	95	86	6	99	98	96
ET4000+Glyt-dma+Fome-S+Meto-M+Glacier/ ET4000+Glyt-dma+Fome-S+Meto-M+Glacier	1.25%+6.7+1.5+11.4+6/ 1.25%+6.7+1.5+11.4+6	3"/ 10DAT	8	11	93	96	86	7	99	98	98
ET4000+Glyt-dma+Fome-S+Meto-M+Glacier/ ET4000+Glyt-dma+Fome-S+Meto-M+Glacier	1.25%+6.7+1.5+11.4+12/ 1.25%+6.7+1.5+11.4+12	3"/ 10DAT	13	13	92	96	85	8	98	96	96
AMS-L+Glyt-dma+Fome-S+Meto-M+Glacier/ AMS-L+Glyt-dma+Fome-S+Meto-M+Glacier	2.5%+6.7+1.5+11.4+12/ 2.5%+6.7+1.5+11.4+12	3"/ 10DAT	13	14	93	95	86	8	98	97	95
Zaar+Glyt-dma+Fome-S+Meto-M/ Zaar+Glyt-dma+Fome-S+Meto-M	16+6.7+1.5+11.4/ 16+6.7+1.5+11.4	3"/ 10DAT	19	20	96	96	91	9	98	97	96
AMS-L+Glyt-dma+Fome-S+Meto-M+NIS/ AMS-L+Glyt-dma+Fome-S+Meto-M+NIS	3%+6.7+1.5+11.4+0.25%/ 3%+6.7+1.5+11.4+0.25%	3"/ 10DAT	6	6	94	96	86	5	99	98	96
CV			18	14	1	1	2	27	1	1	1
LSD P=0.5			3	2	2	2	2	2	1	2	1

Table continued

Treatment	Rate	Appl Code	7/12 Soy	7/12 Pgwd	7/12 Colq	7/12 Vema	7/23 Soy	7/23 Pgwd	7/23 Colq	7/23 Vema
	oz ai/A		%	%	%	%	%	%	%	%
ET4000+Glyt-dma+Fome-S+Meto-M+NIS/ ET4000+Glyt-dma+Fome-S+Meto-M+NIS	0.75%+6.7+1.5+11.4+0.25/ 0.75%+6.7+1.5+11.4+0.25%	3"/ 10DAT	5	98	96	95	5	98	96	95
ET4000+Glyt-dma+Fome-S+Meto-M+Glacier/ ET4000+Glyt-dma+Fome-S+Meto-M+Glacier	0.75%+6.7+1.5+11.4+6/ 0.75%+6.7+1.5+11.4+6	3"/ 10DAT	6	98	96	95	6	98	96	95
ET4000+Glyt-dma+Fome-S+Meto-M+NIS/ ET4000+Glyt-dma+Fome-S+Meto-M+NIS	1.25%+6.7+1.5+11.4+0.25%/ 1.25%+6.7+1.5+11.4+0.25%	3"/ 10DAT	6	99	98	96	6	99	98	96
ET4000+Glyt-dma+Fome-S+Meto-M+Glacier/ ET4000+Glyt-dma+Fome-S+Meto-M+Glacier	1.25%+6.7+1.5+11.4+6/ 1.25%+6.7+1.5+11.4+6	3"/ 10DAT	7	99	98	98	7	99	98	98
ET4000+Glyt-dma+Fome-S+Meto-M+Glacier/ ET4000+Glyt-dma+Fome-S+Meto-M+Glacier	1.25%+6.7+1.5+11.4+12/ 1.25%+6.7+1.5+11.4+12	3"/ 10DAT	8	98	96	96	8	98	96	96
AMS-L+Glyt-dma+Fome-S+Meto-M+Glacier/ AMS-L+Glyt-dma+Fome-S+Meto-M+Glacier	2.5%+6.7+1.5+11.4+12/ 2.5%+6.7+1.5+11.4+12	3"/ 10DAT	8	98	97	95	8	98	97	95
Zaar+Glyt-dma+Fome-S+Meto-M/ Zaar+Glyt-dma+Fome-S+Meto-M	16+6.7+1.5+11.4/ 16+6.7+1.5+11.4	3"/ 10DAT	9	98	97	96	9	98	97	96
AMS-L+Glyt-dma+Fome-S+Meto-M+NIS/ AMS-L+Glyt-dma+Fome-S+Meto-M+NIS	3%+6.7+1.5+11.4+0.25%/ 3%+6.7+1.5+11.4+0.25%	3"/ 10DAT	5	99	98	96	5	99	98	96
CV			27	1	1	1	27	1	1	1
LSD P=0.5			3	1	2	1	3	1	2	1

Water conditioner and adjuvant treatments had little effect on weed control as all treatments provided excellent control of species present. Injury was observed as necrotic lesions on the most exposed leaf tissue during application. The treatment that included AMS and NIS resulted in 6% injury. Treatments that included Glacier at 12 oz/A or Zaar adjuvants resulted in more injury than the standard. Injury with these treatments was elevated during all evaluations as the necrotic tissue did not recover. However, detrimental effect on soybean development was not observed and effect on yield was not anticipated.

Volunteer Corn Control in the Roundup and Roundup Xtend Systems. Devin A Wirth. An experiment was conducted near Prosper, ND to evaluate weed and volunteer corn control from PRE and POST herbicides. Soybean was seeded on May 15, 2018. PRE treatments were applied on May 16, 2018 at 11:30 AM with 85 F air, 57 F soil, 22% RH, 10% cloud cover, 8-10 mph W wind, and dry soil moisture. Immediately following PRE applications rain accumulations of 1.25" followed which adequately activated PREs. POST treatments were applied on June 19, 2018 at 10:20 AM with 87 F air, 74 F soil, 36% RH, 95% cloud cover, 2-4 mph E wind, and adequate soil moisture. Weeds present at POST applications were: snfl 8-10" at 1-2/ft2, cocb 8-10" at 1-2/ft2, colq 6-8" at 2-4/ft2, rrpw 6-8" at 2-4/ft2, hans 6-8" at 2-4/ft2, corw 6-8" at 4-6/ft2, yeft 8-10" at 6-8/ft2, and volunteer corn at 30-36" at 2-4/ft2. Soil characteristics were: 24.7% sand, 53.3% silt, 22% clay, Silt Loam, 4% OM, and 8.2 pH. Treatments were applied to the center 6.7 feet of the 10 by 40 foot plots with a backpack-type plot sprayer delivering 17 gpa through 11002 TTI nozzles for PRE herbicides and 17 gpa through 11002 TT nozzles for POST at 40 psi. The experiment had a randomized complete block design with three replicates per treatment.

Weed control was 99% across all weed species after POST was applied. Prior to POST applications, Broadaxe XC provided fair to excellent control in every treatment. There was no significant difference in volunteer corn control between the additions of either fusilade DX (fluazifop) or Select Max (clethodim) to Roundup or Roundup + Xtendimax. However, trends indicated that volunteer corn control increased with the addition of Fusilade DX more than Select Max. Also, antagonism may have been observed when Xtendimax (dicamba) was included in the tankmix.

Table. Volunteer Corn Control in the Roundup and Roundup Xtend Systems (Wirth).

Treatment[1]	Rate	7 DA POST Vol Corn	14 DA POST Vol Corn	21 DA POST Vol Corn	28 DA POST Vol Corn
	(Product/A)	% control			
Untreated		0	0	0	0
(PRE) Broadaxe XC	28floz				
(POST) RUPM+Fusilade DX+CA Rid	32floz+6floz+1%v/v	53	98	96	93
(PRE) Broadaxe XC	28floz				
(POST) RUPM+Select Max+CA Rid	32floz+6floz+1%v/v	73	82	82	75
(PRE) Broadaxe XC	28floz				
(POST) RUPM+Xtendimax +Fusilade DX+CA Rid	32floz+22floz +6floz+1%v/v	40	87	83	75
(PRE) Broadaxe XC	28floz				
(POST) RUPM+Xtendimax +Select Max+CA Rid	32floz+22floz +6floz+1%v/v	43	73	72	67
LSD		15	21	21	22

[1] CA Rid = Class Act Ridion

Control of volunteer corn with herbicide plus dicamba. Dr. Howatt and Mettler. 'DKC38-04RIB' corn was seeded to simulate a volunteer corn situation in soybean near Fargo on June 1. Soybean was not seeded. Treatments were applied to volunteer corn on July 2 with 72°F, 73% relative humidity, clear sky, 3 mph wind at 225°, and dry soil at 76°F. Treatments were applied with a backpack sprayer delivering 17 gpa at 40 psi through 11002 TT nozzles to a 7 foot wide area the length of 10 by 30 foot plots. The experiment was a randomized complete block design with four replicates.

Treatment	Rate	7/16 Volunteer Corn
	oz ai/A	%
Quiz+HSOC	0.35+20	99
Quiz+Dica-X+HSOC	0.35+8+20	96
Quiz+Dica-X+HSOC	0.5+8+20	98
Quiz+Dica-X+HSOC	0.9+8+20	99
Seth+HSOC	1.2+20	29
Seth+Dica-X+HSOC	1.2+8+20	2
Seth+Dica-X+HSOC	2+8+20	20
Seth+Dica-X+HSOC	3+8+20	42
CletSM+HSOC	0.75+20	97
Clet-SM+Dica-X+HSOC	0.75+8+20	88
Clet-SM+Dica-X+HSOC	1+8+20	95
Clet-SM+Dica-X+HSOC	1.5+8+20	98
CV		5
LSD P=.05		6

Quizalofop provided the best control of volunteer corn averaged across treatments, 98%. There was not enough difference to identify antagonism of dicamba to quizalofop activity, but quizalofop plus dicamba gave numerically less control than quizalofop alone.

Sethoxydim was not a good corn mamagement tool atonly 29% control. This activity was antagonized with addition of dicamba and resulted in symptoms that were barely discernable from the untreated. With inclusion of dicamba, twice as much sethoxydim was needed to re-establish control.

Clethodim at 0.75 oz ai/A provided 97% control of volunteer corn. Addition of dicamba resulted in only 88% control with clethodim. Similar level of control to clethodim alone was obtained by raising the rate of clethodim to 1 oz ai/A when dicamba was included.

Control of Volunteer Corn with Herbicide plus 2,4-D. Dr. Howatt and Mettler. 'DKC38-04RIB' corn was seeded to simulate a volunteer corn situation in soybean near Fargo on June 1. Soybean was not seeded into this study. Treatments were applied to volunteer corn on July 2 with 72°F, 73% relative humidity, clear sky, 3 mph wind at 225°, and dry soil at 76°F. Treatments were applied with a backpack sprayer delivering 17 gpa at 40 psi through 11002 TT nozzles to a 7 foot wide area the length of 10 by 30 foot plots. The experiment was a randomized complete block design with four replicats.

Treatment	Rate	7/16 Volunteer Corn
	oz ai/A	%
Quiz+HSOC	0.35+20	99
Quiz+2,4-D-CH+HSOC	0.35+16+20	30
Quiz+2,4-D-CH+HSOC	0.5+16+20	57
Quiz+2,4-D-CH+HSOC	0.9+16+20	98
Seth+HSOC	1.2+20	36
Seth+2,4-D-CH+HSOC	1.2+16+20	10
Seth+2,4-D-CH+HSOC	2+16+20	25
Seth+2,4-D-CH+HSOC	3+16+20	37
Clet SM+HSOC	0.75+20	97
Clet SM+2,4-D-CH+HSOC	0.75+16+20	89
Clet SM+2,4-D-CH+HSOC	1+16+20	96
Clet SM+2,4-D-CH+HSOC	1.5+16+20	96
CV		8
LSD P=.05		7

All three grass herbicides were antagonized by 2,4-D. Quizalofop alone provided 99% control. Addition of 2,4-D resulted in only 30% control. Quizalofop rate had to be 0.9 oz ai/A when 2,4-D was included to reach similar control to quizalofop alone at 0.35 oz ai/A.

Sethoxydim alone gave 36% control of corn. Addition of 2,4-D limited activity to 10% control. Sethoxydim at 3 oz/A with 2,4-D gave similar control to sethoxydim alone at 1.2 oz/A.

Slight antagonism of clethodim occurred with addition of 2,4-D. Level of control with clethodim alone was achieved by raising the rate of clethodim from 0.75 to 1 oz ai/A.

Weed control in soybeans with Engenia applied PRE vs. early POST. (Minot). The objective of the study was to evaluate weed control with Engenia applied PRE and POST. Soybean was planted May 22. PRE treatments were applied after planting on May 22. POST treatments were applied at emerging to unifoliate stage (June 6), 3rd trifoliate stage (June 27), and 5th trifoliate stage (July 2).

Flexstar GT was the only treatment that caused visible crop injury. Any treatment that contained Engenia + Glyphosate PRE or very early POST provided excellent control of all weeds at the June 27 evaluation. Zidua Pro + Glyphosate applied PRE did not adequately control kochia or horseweed. However, POST treatments of Engenia + Glyphosate effectively controlled any weeds that escaped the early treatments.

Table. Weed control in soybeans with Engenia applied PRE vs early POST. (1811)

		Injury				Weed Control											
		Soybean				Kochia			Lambsquarters			Horseweed			Volunteer wheat		
Treatment[f]	Timing	Jun-6	Jun-27	Jul-13	Jul-23	Jun-6	Jun-27	Jul-23	Jun-6	Jun-27	Jul-23	Jun-6	Jun-27	Jul-23	Jun-6	Jun-27	Jul-23
		--------%--------				----------%----------											
Untreated		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eng + Zidua + Gly[a]	Em-Unifol	0	0	0	0	-	100	100	-	100	100	-	98	100	-	100	100
Eng + Zidua + Gly[a] / Flex GT[bc]	Em-Unifol / 5th trifol	0	0	28	18	-	100	100	-	100	100	-	96	100	-	100	100
Eng + Zidua + Gly[a] / Flex GT + Outlook[bc]	Em-Unifol / 5th trifol	0	0	28	18	-	100	100	-	100	100	-	96	100	-	100	100
Eng + Zidua + Gly[a] / Gly[c]	Em-Unifol / 5th trifol	0	0	0	0	-	100	100	-	100	100	-	97	100	-	100	100
Eng + Zidua + Gly[a] / Gly + Outlook[c]	Em-Unifol / 5th trifol	0	0	0	0	-	100	100	-	100	100	-	98	100	-	100	100
ZP + Eng + Gly[de] / Eng + Gly[a]	PRE / 3rd trifol	0	0	0	0	99	98	100	100	100	100	98	98	100	100	100	100
ZP + Eng + Gly[de] / Eng + Zidua + Gly[a]	PRE / 3rd trifol	0	0	0	0	99	100	100	100	100	100	100	100	100	100	100	100
ZP + Gly[cd] / Eng + Gly[a]	PRE / 3rd trifol	0	0	0	0	81	62	100	100	100	100	87	74	100	100	100	100
ZP + Gly[cd] / Eng + Zidua + Gly[a]	PRE / 3rd trifol	0	0	0	0	77	52	100	100	100	100	89	74	100	100	100	100
Eng + Zidua + Gly[a] / Eng + Zidua + Gly[a]	Em-Unifol / 3rd trifol	0	0	0	0	-	100	100	-	100	100	-	97	100	-	100	100
LSD (0.05)		NS	NS	0	0	8.0	8.2	0	0	0	0	5.4	7.3	0	0	0	0

[a] *Applied with Induce (0.25%)*

[b] *Applied with Agri-Dex (1%)*

[c] *Applied with AMS (5.3 gal/100 gal)*

[d] *Applied with MSO (16 oz)*

[e] *Applied with Intact (0.5%)*

[f] *Eng=Engenia (12.8 oz); Zidua (1.33 oz); Gly=Roundup PowerMax (32 oz); ZP=Zidua Pro (4.5 oz); Flex GT=Flexstar GT (56 oz); Out=Outlook (10 oz)*

Weed control in soybeans with Engenia + Zidua. (Minot). The objective of the study was to evaluate weed control in soybeans with Engenia + Zidua compared to other soybean herbicides. Dicamba-tolerant soybean was planted May 22. Preemergence (PRE) herbicides were applied after planting on May 22. Postemergence (POST) herbicides were applied 24 days after planting (June 15) and at the 3rd trifoliate stage (June 27).

All treatments provided excellent control of all weeds (kochia, lambsquarters, horseweed, and volunteer wheat). No crop injury was observed with any treatment.

Table. Weed control in soybeans with Engenia + Zidua. (1809)

		Weed Control							
		Kochia		Lambsquarters		Horseweed		Volunteer wheat	
Treatment[c]	Timing	Jun-8	Jul-23	Jun-8	Jul-23	Jun-8	Jul-23	Jun-8	Jul-23
		----------%----------							
Untreated		0	0	0	0	0	0	0	0
Engenia + Zidua + Gly[a] / Engenia + Gly[a]	PRE / 24 DAP	99	100	100	100	100	100	100	100
Engenia + Zidua + Gly[a] / Engenia + Zidua + Gly[a]	PRE / 24 DAP	97	100	100	100	100	100	100	100
Engenia + Zidua + Gly[a] / Engenia + Zidua + Gly[a]	PRE / 3rd Trifoliate	99	100	100	100	100	100	100	100
Zidua Pro + Gly[b] / Engenia + Zidua + Gly[a]	PRE / 24 DAP	81	100	100	100	93	100	100	100
Verdict + Gly[b] / Engenia + Zidua + Gly	PRE / 24 DAP	77	100	100	100	93	100	100	100
Xtend + Dual + Gly[a] / Xtend + Gly[a]	PRE / 24 DAP	99	100	100	100	100	100	100	100
Xtend + Dual + Gly[a] / Xtend + Dual + Gly[a]	PRE / 24 DAP	96	100	100	100	100	100	100	100
Xtend + Warrant + Gly[a] / Xtend + Gly[a]	PRE / 24 DAP	99	100	100	100	100	100	100	100
Xtend+ Warrant + Gly[a] / Xtend + Warrant + Gly[a]	PRE / 24 DAP	97	100	100	100	100	100	100	100
LSD (0.05)		4.9	0	0	0	10	0	0	0

[a]Applied with Induce (0.25%)

[b]Applied with MSO (16 oz)

[c]Engenia (12.8 oz); Zidua (1.33 oz); Gly=Roundup PowerMax (22 oz); Dual=Dual Magnum (16 oz); Xtend=Xtendimax (22 oz); Zidua Pro (4.5 oz); Verdict (5 oz); Warrant (48 oz)

Weed control in dicamba-tolerant soybean, Carrington, 2018. Greg Endres and Mike Ostlie. The trial was conducted at the NDSU Carrington Research Extension Center in cooperation with BASF to evaluate dicamba-tolerant soybean weed control with PRE followed by POST or sequential POST treatments utilizing Engenia and Engenia Pro. Experimental design was a randomized complete block with three replicates. The field trial was established on a conventionally-tilled Heimdal-Emrick loam soil. Asgrow 'AG05X8' dicamba-tolerant soybean were planted on May 16 in 22-inch rows. A hand-held boom sprayer was used delivering 17 gpa at 35 psi through turbo TeeJet TTI11002 nozzles to the center 6.7 ft of 10- by 30-ft plots. PRE treatments were applied on May 30 with 82 F, 28% RH, and 15 MPH wind. Following PRE herbicide application, 0.7 inch of rain occurred on May 18. POST1 treatments were applied on May 30 with 69 F, 73% RH, and 1 mph wind to unifoliate (VC) stage soybean, 3-leaf green and yellow foxtail, 0.5- to 1-inch tall common lambsquarters, and 0.5- to 1-inch tall redroot and prostrate pigweed. POST2 treatments were applied on June 15 with 67 F, 59% RH, and 5 mph wind to 2- to 3-trifoliate (V2-3) stage soybean, 0.5- to 6-inch tall foxtail, 0.5- to 3-inch tall common lambsquarters, and 0.5- to 3-inch tall pigweed. POST3 treatments were applied on June 28 with 87 F, 57% RH, and 4 mph wind to 6-trifoliate (V6) stage soybean, 12-inch tall foxtail, 2- to 3-inch tall common lambsquarters, and 2- to 3-inch tall pigweed.

No soybean injury was noted during visual evaluation of weed control. Use of PRE treatments (7-10) provided 92-99% weed control about two wk after application (Table). Grass weeds generally were suppressed (57-71% control) with POST1 treatments (2-6, and 11) when evaluated about two and four wk after application. Broadleaf weed control was excellent (97-99%) with POST1 and PRE followed by POST2 treatments when evaluated about two and four wk after application. Generally, all treatments provided excellent weed control when evaluated in mid July.

Table.

Herbicide				Weed control (%)[1]											
Treatment[2]		Rate	Application	29-May			15-Jun			28-Jun			13-Jul		
no.	description	fl oz product/A	timing[3]	fota	colq	piwe	fota	colq	piwe	grass	colq	piwe	grass	colq	piwe
1	untreated check	x	x	0	0	0	0	0	0	0	0	0	0	0	0
2	Engenia Pro	16	POST1	x	x	x	63	98	99	60	98	99	48	98	98
	Engenia Pro	16	POST1												
	Flexstar GT	56													
3	Destiny HC	1% v/v	POST3	x	x	x	68	99	99	67	98	99	96	99	99
	Engenia Pro	16	POST1												
	Flexstar GT	56													
	Outlook	10													
4	Destiny HC	1% v/v	POST3	x	x	x	62	99	99	57	99	99	93	99	99
	Engenia Pro	16	POST1												
5	RPM	32	POST3	x	x	x	71	99	98	65	98	98	98	99	99
	Engenia Pro	16	POST1												
	RPM	32													
6	Outlook	10	POST3	x	x	x	62	99	98	59	97	98	98	99	99
	Zidua Pro	4.5	PRE	92	99	99									
	Engenia Pro	16													
7	RPM	32	POST2	x	x	x	84	95	99	99	99	99	98	99	99
	Zidua Pro	4.5	PRE	94	99	99									
	Engenia	12.8													
8	RPM	32	POST2	x	x	x	88	97	99	97	99	99	99	99	99
	Zidua Pro	4.5													
	Engenia	12.8	PRE	93	99	99									
	RPM	32													
9	Outlook	1o	POST2	x	x	x	89	99	99	98	99	99	99	99	99
	Engenia	12.8													
	Pursuit	3													
	Zidua	3.3	PRE	98	99	99									
	RPM	32													
10	Outlook	10	POST2	x	x	x	98	99	99	99	99	99	99	99	99
	Engenia Pro	16	POST1												
	Engenia Pro	16													
11	RPM	32	POST3	x	x	x	68	99	99	70	98	99	96	99	99
C.V. (%)				3.4	0.3	0.3	17.2	1.7	0.8	14.1	1.2	1.3	15.4	0.5	0.4
LSD (0.05)				5	1	1	20	3	1	17	2	1	22	1	1

[1]fota=primarily yellow foxtail, and green foxtail; colq=common lambsquarters; piwe=redroot and prostrate pigweed; grass=fota and barnyardgrass.

[2]RPM=Roundup PowerMax. All treatments including application timings include Class Act Ridion at 2% v/v except PRE no. 7 and 8.

[3]PRE=May 16; POST1=May 30; POST2=June 15; POST3=June 28.

Paraquat with Growth Regulators Used as Post-Harvest Burndowns. Devin A Wirth. Devin A Wirth. An experiment was conducted near Prosper, ND to evaluate Post-harvest weed control using paraquat, atrazine, and growth regulator herbicides. POST treatments were applied June 19, 2018 at 10:30 AM with 87 F air, 74 F soil, 36% RH, 95% cloud cover, 2-4 mph E wind, and adequate soil moisture. Weeds present at POST applications were: snfl 8-10" at 1-2/ft2, cocb 8-10" at 1-2/ft2, colq 6-8" at 2-4/ft2, hans 6-8" at 2-4/ft2, corw 6-8" at 4-6/ft2, wibw 4-6" at 1-2/yd2, rrpw 6-8" at 2-4/ft2, and yeft 8-10" at 6-8/ft2. Soil characteristics were: 24.7% sand, 53.3% silt, 22% clay, Silt Loam, 4% OM, and 8.2 pH. Treatments were applied to the center 6.7 feet of the 10 by 40 foot plots with a backpack-type plot sprayer delivering 8.5 gpa through 11001 XR nozzles at 40 psi. The experiment had a randomized complete block design with three replicates per treatment.

The addition of a growth regulator to parazone mostly increased broadleaf and yeft control. The addition of atrazine alone to parazone provided the most yeft and broadleaf weed control overall. However, when parazone was tankmixed with either growth regulator AND atrazine, weed control decreased. The addition of atrazine and either growth regulator to parazone likely caused antagonism.

Table. Paraquat with Growth Regulators Used as Post-Harvest Burndowns (Wirth).

		7 DAA								14 & 28 DAA							
POST Treatments	Rate	yeft	rrpw	colq	hans	wibw	corw	cocb	snfl	yeft	rrpw	colq	hans	wibw	corw	cocb	snfl
	(Product/A)	----------% control----------								----------% control----------							
Untreated		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Parazone+NIS	2pt+0.25%v/v	75	90	87	85	92	87	92	96	75	95	92	85	96	93	96	99
Parazone+2,4-D Ester+COC	2pt+1pt+1%v/v	90	95	93	93	95	93	95	95	90	99	98	98	99	98	98	98
Parazone+Clarity+COC	2pt+0.5pt+1%v/v	75	87	85	85	87	85	85	83	85	96	99	99	96	95	95	95
Parazone+Atrazine+COC	2pt+1.5pt+1%v/v	98	99	99	99	98	99	99	99	98	99	99	99	98	99	99	99
Parazone+2,4-D+Atrazine+COC	2pt+1pt+1.5pt+1%v/v	85	70	68	70	70	72	77	77	85	95	93	80	96	63	99	99
Parazone+Clarity+Atrazine+COC	2pt+0.5pt+1.5pt+1%v/v	70	58	53	55	58	55	57	53	75	88	88	85	98	70	93	93
LSD		1	3	2	1	3	2	3	3	1	3	2	1	4	3	3	3

Simulated dicamba drift to soybeans

Mike Ostlie and Paulo Flores

A simulated dicamba drift trial was established in Carrington in 2018. The goals of the study were to identify yield impacting doses of dicamba and determine if remote sensing could be a viable means of scouting for drift injury. Treatments were applied at the onset of the R1 growth stage. Clarity was the dicamba and RoundUp Powermax was the glyphosate formulation used. Soybean variety was ND Bison. Severe drought conditions heavily influenced soybean yields in this trial, and may have exacerbated injury symptoms compared to previous seasons.

Table 1. Soybean performance as a result of sub-lethal doses of dicamba and glyphosate.

Treatment	Rate	Injury	Injury	injuy	pm	pod ht	plant ht	Moisture	Tstwght	Yield
	fl oz/a	10 DAT	20 DAT	30 DAT	days	cm	cm	%	lb/bu	bu/a
Check		0.0	0.0	0.0	106.8	11.5	59.5	13.7	54.8	24.3
Dicamba R1 fb R2	0.14	25.0	26.3	23.8	107.0	8.5	48.0	13.5	56.3	23.5
Dicamba R1 fb R2 fb R3	0.14	26.3	27.5	25.0	106.8	8.0	42.5	12.9	54.4	21.4
Dicamba + Class Act Rideon	0.14	35.0	30.0	27.5	107.0	10.0	45.0	13.6	56.5	22.8
Dicamba	0.014	5.0	6.3	5.0	106.8	10.0	57.5	12.1	56.1	23.6
Dicamba	0.14	27.5	28.8	25.0	106.8	8.3	44.0	13.7	55.2	22.9
Dicamba	1.4	46.3	58.8	62.5	129.0	7.3	32.0	11.5	.	9.7
Glyphosate + dicamba	0.025 + 0.014	12.5	16.3	13.8	106.8	9.8	51.5	13.0	56.8	22.0
Glyphosate + dicamba	0.25 + 0.14	33.8	30.0	28.8	107.0	9.0	42.5	14.1	56.2	20.7
Glyphosate + dicamba	2.5 + 1.4	61.3	68.8	71.3	129.0	6.0	30.0	.	.	7.2
LSD (0.05)		4.3	4.1	4.8	0.6	3.0	7.0	1.3	NS	4.5

Visual injury was very evident at all doses of dicamba in this study, contrary to previous versions of this study, including at 0.014 oz/a of clarity. Injury symptoms for all treatments did not diminish throughout the growing season, and in some cases appear to have increased. Dicamba injury was largely in the form of stunted plant growth and leaf cupping for medium and high dicamba doses, and all treatments (except the check) having the 'alligator skin' appearance. The highest dose of dicamba also caused growing point necrosis. Maturity was substantially delayed by the highest dose of dicamba, and affected plants showed few signs of maturity when a killing frost terminated the plants, similar to previous years. Plant height data correlated well with injury data. Yield was only reduced by the highest dicamba rates, similar to previous years. Adding glyphosate to dicamba increased visual injury compared to dicamba alone, but yield was similar with both treatments.

Several vegetation indices were collected within 24 hours of each visual injury rating. Images were collected using UAV-mounted multi-spectral and RGB cameras. Excess Green (ExGr), Normalized Difference Vegetation Index (NDVI), Normalized Difference Red Edge (NDRE), and Green Normalized Difference Vegetation Index (GNDVI) were all evaluated against yield and injury. Only the relationship 30 days after application was plotted for this article, though all dates are expected to show a similar response. All indices had a similar trend across the yield and injury ranges in the study (Figures 1 and 2). Excess Green and NRDE provided substantially lower values than the other two indices, but in all cases the relationships were very strong. The relationships between visual injury and indices were particularly strong, providing evidence that remote sensing could be developed into a dicamba injury scouting tool. The relationship between vegetation index and yield is somewhat lower. This could be attributed to the grouping of majority of points toward one end of the chart, due to the limited or absent yield response

of many of the dicamba treatments. In both cases, dicamba plus glyphosate provided the lowest index values and dicamba alone was the second lowest. The relationships between indices and soybean response were on par with visual rating of soybean injury compared to yield (Figure 3), further substantiating utility of remote sensing as an aid to measure the extent of drift injury in a field.

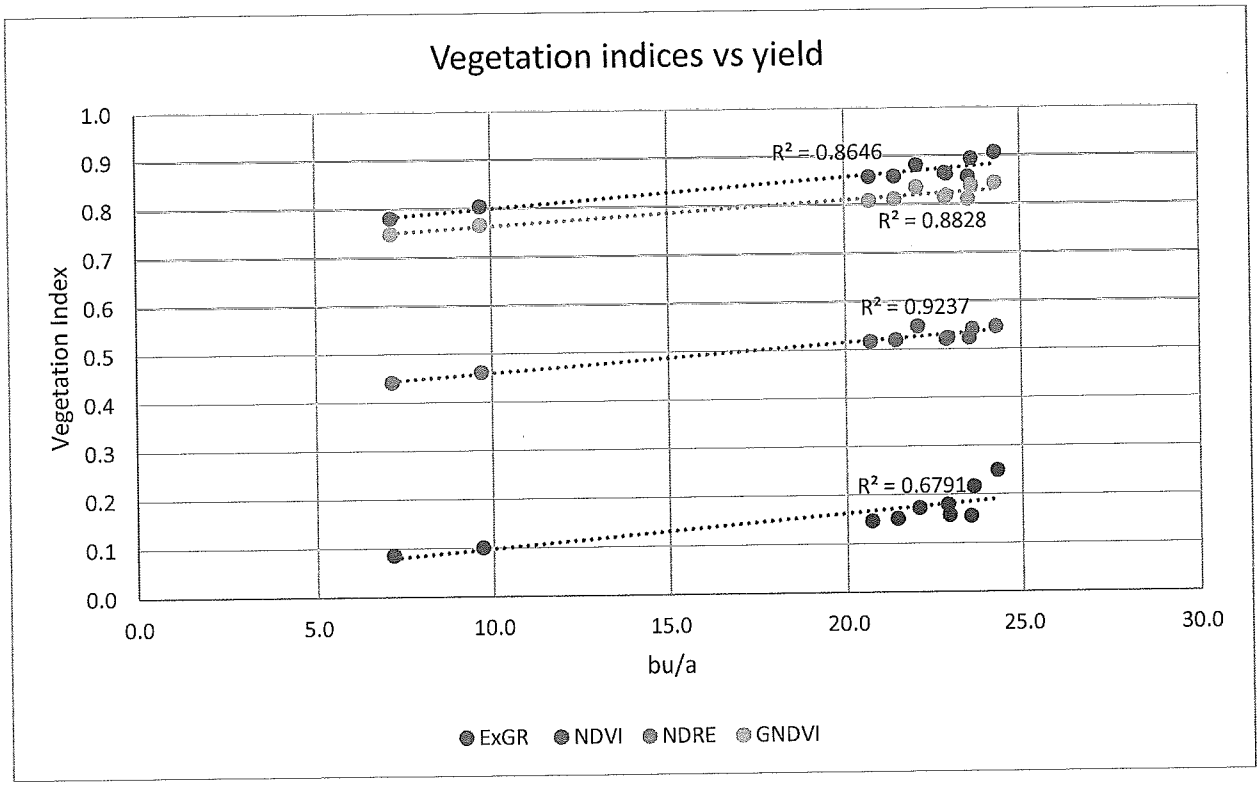

Figure 1. Comparison of various vegetation indices to soybean yield.

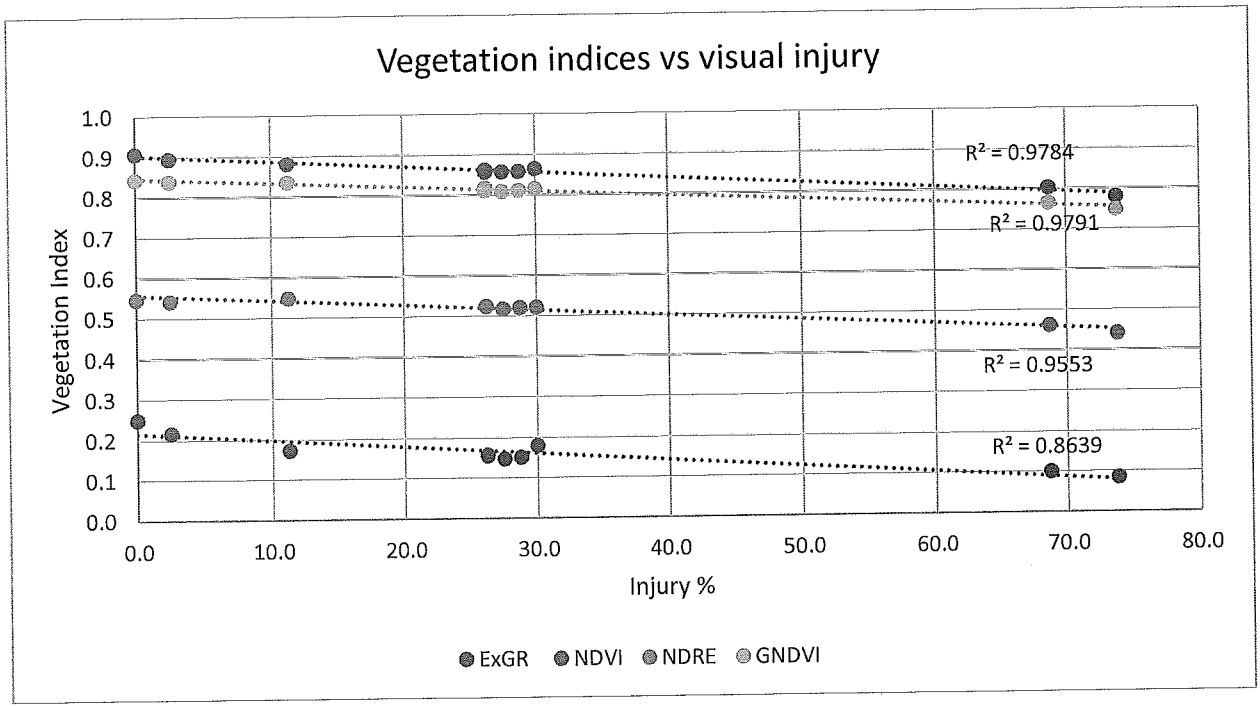

Figure 2. Comparison of various vegetation indices to recorded visual injury

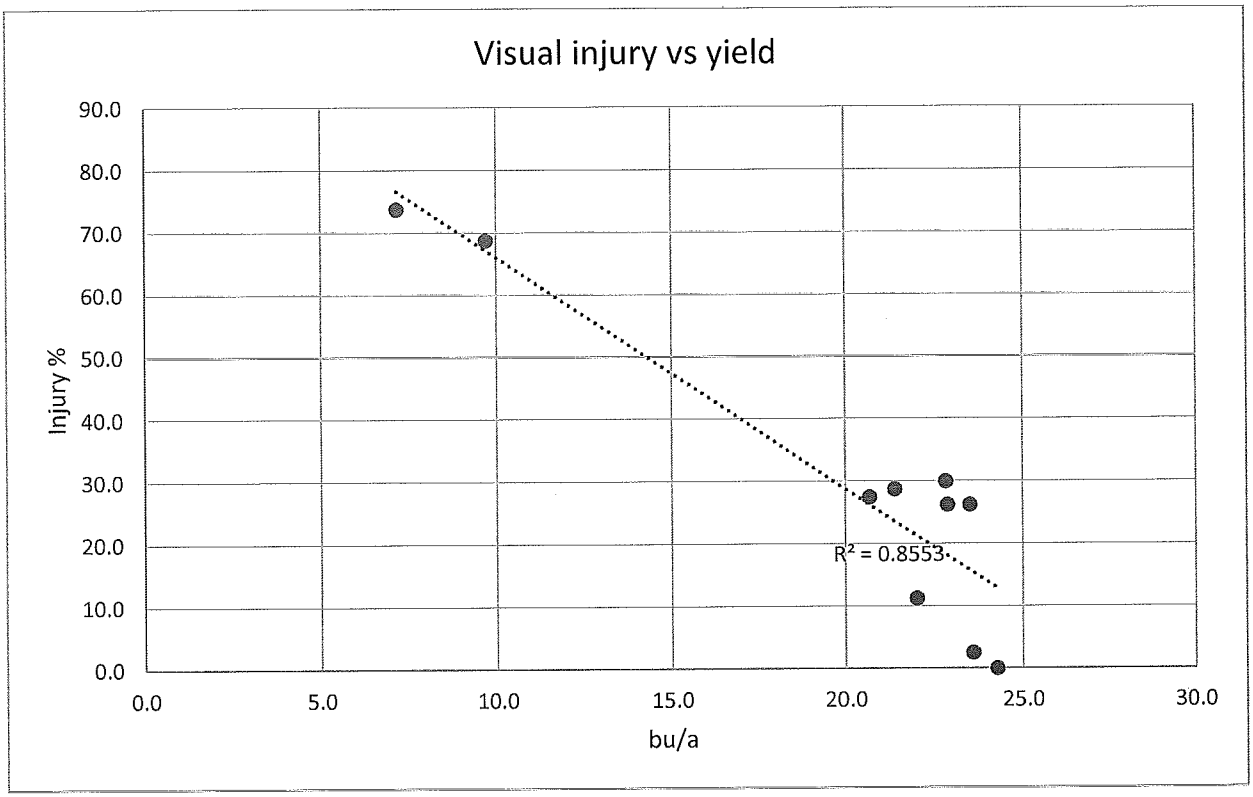

Figure 3. Comparison of recorded injury to soybean yield.

Soybean response to dicamba and glyphosate. Dr. Howatt, Mettler, and Harrington. 'Bison' soybean were seeded near Fargo on May 22. Treatments were applied as follows:

Sobean stage	Colq	Vema	Date	Air °F	RH %	Cloud cover	Wind velocity	Wind direction	Soil moisture	Soil °F
V2	NA	NA	June 20	77	56	20	5.7	45	Dry	74
R1	NA	NA	July 2	68	73	0	1.5	315	Dry	76
R2	10 inch	NA	July 16	68	66	100	4.4	360	Dry	72
R3	NA	NA	July 24	78	49	5	3	2.70	Dry	76

Plots were hand weeded and hoed for better soybean contact. Treatments were applied with a backpack sprayer delivering 8.5 gpa at 40 psi through 11001 TT nozzles to a 7 foot wide area the length of 10 by 30 foot plots. Plant tissue was sampled from each plot 10 days after application. The sample consisted of the top 2 inches of main stem and associated leaves. Samples were frozen and retained until all samples could be sent to lab for analysis. The experiment was a randomized complete block design with four replicates.

Treatment	Rate	Timing	6/29 SOBE	7/12 SOBE	8/3 SOBE	Dicamba	Glyphosate
	oz ai/A		%	%	%	PPB	PPB
Untreated Check	0		0	0	2	4	5
Dica-C/Dica-C	0.07/0.07	R1/R2	0	12	32	4	236
Dica-C/Dica-C/Dica-C	0.07/0.07/0.07	R1/R2/R3	0	14	37	494	75
Dica-C	0.07	June 20	21	31	9	109	299
Dica-C	0.007	R1	0	3	6	23	364
Dica-C	0.07	R1	0	16	26	4	218
Dica-C	0.7	R1	0	40	50	21	330
Glyt-4.5+Dica-C	0.014+0.007	R1	0	6	9	188	166
Glyt-4.5+Dica-C	0.14+0.07	R1	0	19	34	6	76
Glyt-4.5+Dica-C	1.4+0.7	R1	0	55	60	18	187
CV			37	19	17	60	60
LSD P=.05			1	5	7	64	193

Soybean demonstrated strong response to dose for rates of dicamba or dicamba and glyphosate. Concentration of dicamba was greatest following three applications, but concentrations did not appear to correlate with dose or number of applications. Glyphosate quantification raised question because presence was greater in plots treated only with dicamba than plots treated with dicamba and glyphosate. In addition, the sample from dicamba plot treated on June 20 was collected a few days before glyphosate was applied in this study.

Dicamba effect in soybean seed. Howatt, Mettler, Harrington.

Introduction:

Broadscale damage to soybean occurred in North Dakota in 2017 that was consistent with symptoms of exposure to dicamba. Dicamba was used on an estimated 5 to 6 times as much land in North Dakota in 2017 than previous years because of the adoption of dicamba-resistant soybean (Xtend technology). Also, the use rate of dicamba for this additional area was more than twice that which is typically used in corn and wheat in North Dakota.

Several individuals have expressed concern over potential effects of dicamba to soybean that could limit seed yield. While reduced seed production would have direct, economic impact, other indirect losses could occur. Seed produced on damaged plants could exceed residue tolerance limits and be condemned. Or within the seed industry, presence of dicamba in seed could affect the germination or vigor of progeny.

Preliminary observations of soybean grown from seed of dicamba-injured plants indicated reduced germination and vigor was possible in progeny. This research was conducted to evaluate dicamba concentration, seed characteristics, and seedling vigor of soybean seed developed under exposure to off-target dicamba movement.

Materials and Methods:

A drift trial was conducted near Casselton, ND, to evaluate the benefit of various drift reducing adjuvants to limit off-target movement of dicamba to non-Xtend soybean. Conventional 'RG 607' soybean was seeded on May 15, 2016, to an area approximately 5 ha. Corn was seeded in plots measuring 3 by 15 m within the soybean field. The experiment was a randomized complete block design with four replicates. Replicates were separated by 23 m and plots within replicate were separated by 60 m because of prevailing wind direction perpendicular to plot length.

A tarp measuring 9 by 12 m was placed on soybean adjacent and downwind from the plot during treatment application. The tarp was intended to protect soybean from spray particle impingement but would not prevent secondary movement due to volatilization of dicamba from the treated plot area. The tarp was removed after spray particles settled. Dicamba at 8 oz ae/A was applied to corn when surrounding soybean had four to six trifoliolate leaves on June 29, 2016. Treatments were applied with a boom mounted on a 4-wheeler and wind speed was 3 to 4 km/h. Treatments were applied to the entire corn plot area and nearest soybean was within 1 m around the perimeter of each plot.

Injury was rated on August 11, 2016. Seed harvest was on September 28. Only seed from around the untreated and dicamba without drift-reducing adjuvant were included for characterization of seed and progeny plants. Soybean seed samples were collected from six areas near each plot and kept separate: adjacent upwind, adjacent downwind, adjacent downwind under tarp during application, 9 m downwind under tarp during application, 9 m downwind, and 21 m downwind.

Subsamples of each seed collection were provided to the North Dakota State Seed Laboratory (1313 18th St. N., PO Box 5252, Fargo, ND 58105) for evaluation of germination and vigor under their standard protocols. Number of seeds included in germination tests for each sample were 100 per area for each replicate. Vigor was tested in an accelerated aging protocol with 50 seeds per area for each replicate. A subsample of each seed collection was sent to South Dakota Agriculture Laboratories (1006 32nd Ave, #103/#105, Brookings, SD 57006) for determination of dicamba and metabolite concentrations in soybean seed. Subsamples also were sent to the Forage Project (NDSU, Dept. 7670, PO Box 6050, Fargo, ND 58108-6050) for oil and protein content of seed.

Seed sizing and a greenhouse experiment were conducted with remaining seed samples. Weight per 200 seeds was recorded for the bulk sample. Then, seed size fractions were separated with sieve plates. Fractions included seed retained over size 18/64, seed passing a size 18/64 but retained on size

15/64, seed passing size 15/64 but retained on size 12/64, and seed passing size 12/64 but retained on size 10/64. Each fraction was weighed to determine percent of sample by weight. Twenty-five seeds of each fraction were weighed to determine weight per seed, and these seeds were used in a greenhouse experiment to investigate the effect of seed size on germination and growth rate.

Each set of 25 seeds was grown in peat-based growing media (Sunshine Mix #1, Sun Gro Horticulture, 770 Silver St., Agawam, MA 01001) spread in a flat 30 by 30 by 5 cm deep. Flats were watered daily on drying. The greenhouse temperature was 20 to 24C and natural light was supplemented with metal halide lamps set to 16 hour photoperiod. Number of established plants were counted. Development stage and height of plants in the flat, on average, were recorded 3 weeks after emergence.

Response of soybean to dicamba in the field and soybean seed yield were subjected to analysis of variance in Agricultural Research Manager, version 2018.2 3rd edition. Means were separated with Fisher's protected LSD with $\alpha = 0.05$. Remaining data were subjected to analysis in Excel. Pairs of means within harvest area were compared by t-test with $\alpha = 0.05$.

Results and Discussion:

Soybean in the field expressed mild to severe leaf cupping and apical meristem damage depending on the proximity to dicamba application and whether the plants were covered by tarp (Table 1). Although treatment effect resulted in wide variance when comparing most areas, increased symptom expression was associated with less yield. It is worth noting that the treatments were applied before the R1 stage of soybean which is the labeled cut off for this dicamba treatment in dicamba-resistant soybean. Although not showing flower buds, the treatment occurred about a week after the astrological initiation of reproductive stage in soybean, summer solstice on June 20. Exposure to particle drift was a substantial cause of soybean response and reduced yield; however, injury and yield loss occurred downwind under the tarp where exposure due to droplet movement was greatly restricted.

Table 1. Injury and yield of soybean exposed to dicamba in areas surrounding dicamba-treated plot.

	Injury						Seed yield					
Dicamba	A[a]	B	C	D	E	F	A	B	C	D	E	F
	0=no symptom : 9=dead						bu/A					
Untreated	0	0	0	0	0	0	36	36	36	39	35	32
Treated	1	5	3	0	3	1	32	18	21	28	27	24
LSD =0.05	1	1	1	0	1	1	10	10	12	12	12	5

[a] Letters indicate sample area: A was adjacent upwind, B was adjacent downwind, C was adjacent downwind under tarp during application, D was 9 m downwind under tarp during application, E was 9 m downwind, and F was 21 m downwind.

Weight of 200 seeds was less from around treated areas or near plots under the tarp (Table 2). This was clarified in the seed fractions. Even without a difference in 200 seed weight, less large seed (greater than 18/64 size) tended to be produced around dicamba treated plots regardless of sample area. In these areas, more seed tended to be retained between the 12/64 and 15/64 sizes. Weight per seed was similar between treatments within a size category, which indicated density of the seed was not affected. Oil content was only greater 9 m downwind from the dicamba treated plot. Absolute value difference was less than 1 percentage point but in most cases dicamba was associated with the greater value. Protein was very similar and variable in rank between the untreated and treated at each location.

Dicamba concentration was highly variable which precluded separation even when means differed by factors greater than 10 (Table 2). Dicamba concentration in seed from around untreated plots ranged from 0.3 ppb to nearly 8 ppb while the range around treated plots was about 2.5 to 17 ppb. This was well below the residue tolerance for dicamba in soybean seed of 10 ppm as published in the Federal Register as of December 2016.

Table 2. Seed characteristics of progeny from plants exposed to dicamba[a].

	Seed weight by % of sample				Weight per seed				Weight per 200 seeds all sizes included	Oil content	Protein content	Dicamba concentration[b]
	No. of sieve size				No. of sieve size							
Dicamba	<12 >10	<15 >12	<18 >15	> 18	<12 >10	<15 >12	<18 >15	> 18				
	%				g				g	%	%	ppb
	Adjacent Upwind											
Untreated	0.0	2.4	84.2	13.0	0.047	0.108	0.168	0.201	34.9	20.9	39.1	2.39
Treated	0.0	4.5	89.9	5.5	0.041	0.109	0.160	0.201	32.3	21.4	38.6	3.50
	Adjacent Downwind											
Untreated	*0.0	2.3	82.2	15.5	0.041	0.104	0.164	0.199	*35.7	20.7	39.2	3.43
Treated	*0.1	12.6	82.8	4.5	0.062	0.111	0.173	0.202	*31.2	20.5	39.7	17.15
	Adjacent Downwind under Tarp											
Untreated	0.0	2.6	84.1	*13.3	0.043	0.109	0.171	0.202	*35.1	20.8	39.1	7.96
Treated	0.1	13.1	83.7	*3.1	0.049	0.108	0.170	0.178	*30.1	21.2	39.0	7.15
	9 m Downwind under Tarp											
Untreated	0.0	2.5	83.4	*14.0	0.047	0.102	0.159	0.193	34.9	20.7	39.3	2.80
Treated	0.1	8.4	85.3	*6.2	0.045	0.111	0.167	0.191	31.7	21.6	38.5	2.54
	9 m Downwind											
Untreated	0.0	2.4	81.4	*16.2	0.048	0.120	0.174	0.204	*34.8	*20.9	39.0	0.30
Treated	0.0	9.5	86.9	*3.6	0.042	0.102	0.153	0.192	*30.0	*21.5	38.4	9.68
	21 m Downwind											
Untreated	0.0	2.2	83.9	13.8	0.049	0.116	0.170	0.204	34.8	21.1	38.5	0.67
Treated	0.1	8.6	85.4	5.9	0.040	0.115	0.159	0.201	32.5	21.4	38.5	8.42

[a] An asterisk (*) was used to denote difference between the untreated and treated within a location as identified in t-test with α=0.05.

[b] Dicamba residue tolerance as listed in the Federal Register for soybean seed is 10 ppm (10,000 ppb).

Germination tended to be less and hard seed more prevalent for seed from near treated plots, although differences were not identified (Table 3). Plant establishment in the greenhouse within seed size was generally variable for treatment rank and only four comparisons were different. Dicamba exposure was only identified in two instances to result in less soybean plant establishment than the untreated. Height and growth stage (data not shown) of progeny grown in the greenhouse were very similar within size category. Growth stage was the same across all plants regardless of seed size. Plants from larger seed seemed to be taller than plants from small seed. The preliminary observation of poor vigor of progeny when exposed to dicamba could have been observation of small seed effect. The effect of dicamba on seed size still holds, but at least these results do not indicate presence of or effect of dicamba within the seed.

Table 3. Plant characteristics of progeny from plants exposed to dicamba[a].

	ND State Seed Lab results				Greenhouse Experiment - Established				Greenhouse Experiment - Height			
Dicamba	**Normal**	**Abnormal**	**Hard**	**Accel. aging**	**<12 >10**	**<15 >12**	**<18 >15**	**> 18**	**<12 >10**	**<15 >12**	**<18 >15**	**> 18**
	%				%				cm			
Adjacent Upwind												
Untreated	95.3	4.5	0.3	67.5	39.8	*98.0	96.0	98.0	4.9	7.3	10.3	11.4
Treated	93.5	4.8	1.8	66.5	28.8	*93.0	98.0	98.0	5.3	8.1	9.7	11.6
Adjacent Downwind												
Untreated	96.0	3.5	0.5	56.0	*31.3	91.0	98.0	96.0	4.8	8.4	11.1	10.2
Treated	88.8	6.0	5.3	69.8	*65.8	96.0	97.8	99.0	5.2	8.1	11.0	11.3
Adjacent Downwind under Tarp												
Untreated	94.0	5.3	0.8	61.0	23.5	94.0	96.0	98.0	5.0	7.5	10.0	11.3
Treated	88.5	6.5	5.0	52.0	51.0	91.3	100.0	97.0	5.5	8.0	9.5	10.6
9 m Downwind under Tarp												
Untreated	94.3	5.5	0.3	*78.0	29.8	*98.0	96.0	97.0	5.1	7.6	10.1	10.5
Treated	92.8	4.3	3.0	*46.3	38.0	*85.8	98.0	99.0	5.0	7.5	9.8	10.7
9 m Downwind												
Untreated	95.5	4.0	0.5	*79.5	32.3	93.0	98.0	95.0	5.2	7.9	10.8	10.5
Treated	92.3	5.5	2.0	*45.0	37.3	96.0	100.0	98.0	5.1	7.6	9.5	11.1
21 m Downwind												
Untreated	94.5	5.0	0.3	80.0	26.5	96.0	98.0	*94.0	5.1	7.9	*10.9	10.6
Treated	93.8	4.5	1.8	47.3	48.0	92.0	97.0	*98.0	5.3	7.5	*9.5	10.6

[a] An asterisk (*) was used to denote difference between the untreated and treated within a location as identified in t-test with α=0.05.

Summary:
Dicamba at low dose can cause adverse effect to non-dicamba-resistant soybean. Injury can result in yield loss even when plants only show leaf cupping. Seed that was produced generally was reduced in size but oil and protein content were not adversely affected. Dicamba concentration in seed did not exceed 50 ppb for an individual replicate sample and most samples were less than 10 ppb, substantially less than the residue tolerance limit of 10 ppm in soybean seed. Soybean exposure to dicamba can have economic implications because of lost commodity sales, but this research indicated dicamba does not accumulate appreciably in soybean seed so exceeding the tolerance limit is unlikely. And oil and protein contents generally were unaffected in seed produced by plants injured with dicamba. There was a reduction in overall seed size with exposure to dicamba, which could affect the growth rate of young seedlings because of seed size not due to dicamba in the seed. Therefore, seed from damaged field areas can still be used for seed production with the standard size screening methods already used by some in the seed industry. In conclusion, soybean harvested from fields with dicamba damage could be used for the intended purpose of that production without adverse complications.