Gold Section: Sugarbeet Weed Control

COMPARISONS OF ETHOTRON, NORTRON, AND ETHOFUMESATE 4SC APPLIED PREPLANT INCORPORATED, PREEMERGENCE, AND POSTEMERGENCE IN 2016

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The objective of this study was to compare sugarbeet crop safety along with grass and small seeded broadleaf weed control from Ethotron, Nortron, and Ethofumesate 4SC in Roundup Ready (RR) sugarbeet.

MATERIALS AND METHODS

An experiment was conducted near Hickson, ND in 2016. The trial site was prepared using a Kongskilde 's-tine' field cultivator with rolling baskets on May 20, 2016. Preplant-incorporated (PPI) treatments were applied prior to seeding and incorporated with a 7' Frontier rototiller. All plots were rototilled to remove tillage variability among plots. Bioassay strips of quinoa, common lambsquarters, redroot pigweed, foxtail millet, and oat were established by spreading seeds by hand perpendicular to herbicide treatments and then harrow incorporating the seeds. 'SV36272RR' sugarbeet, treated with NipsIt Suite, Tachigaren at 45g per unit, and Kabina at 7g per unit, was seeded in 22-inch rows at 60,560 seeds per acre on June 8 with a John Deere 1700XP 6-row planter. Preemergence (PRE) treatments were applied immediately after seeding. Postemergence (POST) treatments were applied June 16. All herbicide treatments were applied with a bicycle sprayer in 17 gpa spray solution through 8002 XR flat fan nozzles pressurized with CO2 at 40 psi to the center four rows of six row plots 30 feet in length. Weed control was evaluated June 9, 15, and 22. Sugarbeet injury was evaluated June 9, 15, 22, and 28.

All evaluations were a visual estimate of percent fresh weight reduction in the four treated rows compared to the adjacent untreated strip. Experimental design was randomized complete block with 4 replications for each trial. Data were analyzed with the ANOVA procedure of ARM, version 2016.4 software package.

Table 1. Application Information – Hickson, ND 2016

	Application Timing		
	A – Preplant Incorporated	B – Preemergence	C - Postemergence
Date	20 May	20 May	16 June
Time of Day	10:00 AM	10:30 AM	8:00 AM
Air Temperature (F)	65	66	65
Relative Humidity (%)	48	48	75
Wind Velocity (mph)	10	10	6
Wind Direction	S	S	E
Soil Temp. (F at 6")	56	56	63
Soil Moisture	Dry	Dry	Good
Cloud Cover (%)	25	25	0
Date of next rainfall	May 25 (0.44")	May 25 (0.44")	June 18 (0.9")
Sugarbeet stage (avg)	-	-	4-6 leaf
quinoa	-	-	3 inch
common lambsquarters	-	-	1.5 inch
foxtail millet	-	-	2 inch
oat	-	-	3 inch
redroot pigweed	-	-	2 inch

SUMMARY

Sugarbeet injury from PPI treatments (Table 2) was significantly greater than from PRE or POST treatments at the June 15 evaluation. Injury was similar among Nortron, Ethotron, or Ethofumesate 4SC applied PPI and ranged from 20% to 30%. However, the sugarbeet injury observed on June 15 was short lived as no significant injury was observed from any treatment at the June 22 evaluation. While ethofumesate products may provide some early season injury when applied PPI or PRE, they are generally safe for use in sugarbeet. Nortron, Ethotron, and Ethofumesate 4SC showed excellent crop safety at the June 22 evaluation when applied POST at labeled rates in sugarbeet.

Nortron, Ethotron, and Ethofumesate 4SC applied PPI or PRE significantly improved weed control at the June 15 evaluation compared to when no soil herbicide was applied. Common lambsquarters and redroot pigweed control tended to be greater from products applied PPI compared to the same products applied PRE. Quinoa, foxtail millet, and oat control was similar among products applied PPI or PRE. No significant differences in sugarbeet injury or weed control were observed among Nortron, Ethotron, or Ethofumesate 4SC when applied in the same manner, whether PPI or PRE. However, PRE applied Nortron tended to show greater activity on sugarbeet and all weed species except quinoa compared to Ethotron or Ethofumesate 4SC at the June 15 evaluation.

Nortron, Ethotron, and Ethofumesate 4SC applied POST showed similar weed control among all species evaluated on June 22. The application of PowerMax following PPI or PRE ethofumesate products gave similar weed control compared to PowerMax alone as observed June 22.

Table 2. Sugarbeet Injury and weed control from Nortron, Ethotron, and Ethofumesate 4SC applied at different timings in sugarbeet at Hickson, ND in 2016.

			----------15 – June----------						----------22 – June----------					
Treatment[1]	Rate	Appl[2]	sgbt[3]	quin	colq	rrpw	fxmi	oat	sgbt	quin	colq	rrpw	fxmi	oat
			% inj	---------% control---------					% inj	---------% control---------				
Nortron	6 pt/a	A	20	59	75	91	96	89	1	99	99	100	100	100
Ethotron	6 pt/a	A	30	58	79	95	94	93	0	96	98	100	100	100
Ethofumesate 4SC	6 pt/a	A	25	58	79	90	93	89	3	99	100	100	100	100
Nortron	6 pt/a	B	10	55	71	78	94	95	0	96	100	100	100	100
Ethotron	6 pt/a	B	0	58	63	68	89	89	0	99	100	100	100	99
Ethofumesate 4SC	6 pt/a	B	3	60	63	60	88	91	0	98	98	100	100	100
Nortron	12 fl oz/a	C	0	0	0	0	0	0	4	96	100	100	100	100
Ethotron	12 fl oz/a	C	0	0	0	0	0	0	0	95	100	100	100	100
Ethofumesate 4SC	12 fl oz/a	C	0	0	0	0	0	0	1	100	99	100	100	100
RU PowerMax	12 fl oz/a	C	0	0	0	0	0	0	1	96	98	100	100	100
Untreated Check			0	0	0	0	0	0	0	0	0	0	0	0
LSD (0.05)			**10.1**	**16.1**	**12.6**	**14.6**	**11.6**	**15.2**	**NS**	**9.4**	**2.7**	**1.0**	**1.0**	**1.1**

[1]All treatments applied at either the A or B application timing were treated at the C application timing with Roundup PowerMax at 32 fl oz/A + NIS at 0.25% v/v + AMS at 8.5 lb/100 gal. Treatments applied at the C application timing were tank mixed with Roundup PowerMax at 32 fl oz/A + Destiny HC at 1.5 pt/A + AMS at 8.5 lb/100 gal. Prefer 90 NIS provided by West Central. N-Pak AMS and Destiny HC provided by Winfield.

[2]Appl = application timings listed in Table 1. A=PPI, B=PRE, C= POST

[3]sgbt = sugarbeet, quin = quinoa, colq = common lambsquarters, rrpw = redroot pigweed, fxmi = foxtail millet, inj = injury

CONCLUSION

Lambsquarters and pigweed control tended to be greater from PPI applications of ethofumesate compared to PRE applications. This spring was relatively dry, but this trial received 1.05 inches of rain during the 7 days following planting which was more than adequate to activate PRE applied products. Applying ethofumesate products PPI compared to PRE may improve control of tough weeds like common lambsquarters. Nortron, Ethotron, and Ethofumesate 4SC performed very similar in terms of weed control and crop safety regardless of method of application.

EVALUATION OF ETHOTRON AND STINGER IN SUGARBEET IN 2016

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The objective of this study was to evaluate a weed control systems approach with Ethotron and Stinger in Roundup Ready (RR) sugarbeet.

MATERIALS AND METHODS

An experiment was conducted near Hickson, ND in 2016. The trial site was prepared using a Kongskilde 's-tine' field cultivator with rolling baskets on May 20, 2016. Bioassay strips of quinoa, common lambsquarters, redroot pigweed, foxtail millet, and oat were established by spreading seeds by hand perpendicular to herbicide treatments and then harrow incorporating the seeds. 'SV36272RR' sugarbeet, treated with NipsIt Suite, Tachigaren at 45g per unit, and Kabina at 7g per unit, was seeded in 22-inch rows at 60,560 seeds per acre on June 8 with a John Deere 1700XP 6-row planter. Post emergence (POST) treatments were applied June 16. All herbicide treatments were applied with a bicycle sprayer in 17 gpa spray solution through 8002 XR flat fan nozzles pressurized with CO2 at 40 psi to the center four rows of six row plots 28 feet in length. Sugarbeet injury and weed control were evaluated June 22, 28 and July 19.

All evaluations were a visual estimate of percent fresh weight reduction in the four treated rows compared to the adjacent untreated strip. Experimental design was randomized complete block with 4 replications for each trial. Data were analyzed with the ANOVA procedure of ARM, version 2016.4 software package.

Table 1. Application Information – Hickson, ND 2016

	Post emergence
Date	16 June
Time of Day	8:00 AM
Air Temperature (F)	65
Relative Humidity (%)	75
Wind Velocity (mph)	6
Wind Direction	E
Soil Temp. (F at 6")	63
Soil Moisture	Good
Cloud Cover (%)	0
Next rainfall	June 18 (0.9")
Sugarbeet stage (avg)	4-6 leaf
quinoa	3 inch
common lambsquarters	1.5 inch
foxtail millet	2 inch
oat	3 inch
redroot pigweed	2 inch

SUMMARY

Sugarbeet injury was 20% at 6 days after application (data not shown) in treatments containing Stinger + PowerMax. Injury symptoms were curling of the sugarbeet leaf margins. Applying Stinger + MSO resulted in 15% sugarbeet injury at 6 days after application. Sugarbeet injury declined substantially by the June 28 evaluation (Table 2) from treatments containing Stinger to a maximum of 10% injury. No injury was observed from Stinger containing treatments on July 19. When Stinger was absent from a treatment, no sugarbeet injury was observed at any evaluation timing.

Treatments containing Roundup PowerMax showed greater than 90% control of quinoa, common lambsquarters, redroot pigweed, foxtail millet, and oat throughout the evaluations. There were very little, if any, synergistic or antagonistic effects on weed control when Ethotron or Stinger were added to PowerMax. Stinger plus MSO gave 10% to 20% control of quinoa, but no control of other weed species evaluated. Ethotron plus MSO gave 60% redroot pigweed control at 6 days after application (data not shown), but control declined to 46% and 23% at 12 and 33 days after application (Table 2). Ethotron plus MSO gave 30% to 35% control of common lambsquarters, but virtually no control of emerged grass species.

Table 2. Sugarbeet injury and weed control from Roundup PowerMax, Stinger, and Ethotron applied postemergence to sugarbeet at Hickson, ND in 2016.

		June 28						July 19					
Treatment[1]	Rate	sgbt[2]	quin	rrpw	colq	fxmi	oat	sgbt	quin	rrpw	**colq**	**fxmi**	**oat**
		% inj	---------% control--------					% inj	---------% control---------				
RU PowerMax + AMS + NIS	22 fl oz/a + 8.5 lb ai/100 gal+ 0.25 % v/v	0	100	98	95	100	100	0	96	98	91	100	100
Stinger + MSO	2 fl oz/a + 1.5 pt/a	5	10	0	3	0	0	0	20	0	0	0	0
Ethotron + MSO	12 fl oz/a + 1.5 pt/a	0	33	46	35	18	13	0	33	23	30	0	0
RU PowerMax + Stinger + AMS + HSMOC	22 fl oz/a + 2 fl oz/a + 8.5 lb ai/100 gal + 1.5 pt/a	10	100	96	95	100	100	0	98	96	96	100	100
RU PowerMax + Ethotron + AMS + HSMOC	22 fl oz/a + 12 fl oz/a + 8.5 lb ai/100 gal + 1.5 pt/a	0	100	98	96	100	100	0	96	96	94	100	100
RU PowerMax + Stinger + Ethotron + AMS + HSMOC	22 fl oz/a + 2 fl oz/a + 12 fl oz/a + 8.5 lb ai/100 gal + 1.5 pt/a	10	99	95	95	100	100	0	99	98	94	100	100
Untreated Check		0	0	0	0	0	0	0	0	0	0	0	0
LSD (0.05)		**3.2**	**7.3**	**8.4**	**8.3**	**7.1**	**7.1**	**NS**	**6.5**	**8.1**	**6.1**	**1.0**	**1.0**

[1]RU PowerMax= Roundup PowerMax, AMS = N-Pak AMS from Winfield, NIS = Prefer 90 NIS from West Central, Inc., MSO = Methylated Seed Oil from Loveland, Inc., HSMOC = Destiny HC from Winfield.
[2]sgbt = sugarbeet, quin = quinoa, colq = common lambsquarters, rrpw = redroot pigweed, fxmi = foxtail millet, inj = injury

CONCLUSION

Stinger provides a narrow spectrum of weed control, but combines well with glyphosate or Ethotron plus glyphosate to enhance weed control on species such as lambsquarters, ragweed, and thistle. Stinger caused nominal sugarbeet injury that was unobservable 33 days after application. Sugarbeet injury was similar when Stinger was tank-mixed with glyphosate or Ethotron plus glyphosate.

Postemergence application of Ethotron did not cause sugarbeet injury. Ethotron provided some suppression of common lambsquarters, quinoa, and redroot pigweed when applied alone. Postemergence application of Ethotron did not provide grass weed control. Preplant-incorporated or preemergence applications of Ethotron at 6 to 7 pt/A should be made if grass weed control is desired from this product.

EFFECT OF VOLITILITY REDUCING ADJUVANTS ON WEED CONTROL AND SUGARBEET INJURY FROM RO-NEET SB IN 2016

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The objective of this study was to evaluate the effectiveness of volatility reducing adjuvants applied with Ro-Neet SB by evaluating control of weed indicator species in Roundup Ready (RR) sugarbeet.

MATERIALS AND METHODS

An experiment was conducted near Hickson, ND in 2016. The trial site was prepared using a Kongskilde 's-tine' field cultivator with rolling baskets on May 27, 2016. Preplant-incorporated (PPI) treatments were applied prior to seeding and immediately incorporated 4 inches deep with a 7' Frontier rototiller. All plots were rototilled to remove tillage variability among plots. Bioassay strips of redroot pigweed, foxtail millet, and oat were established by spreading seeds by hand perpendicular to herbicide treatments and then harrow incorporating the seeds. A rain event began as bioassay strips were being harrowed. Rainfall over the next 24 hours totaled 0.47 inches. 'SV36272RR' sugarbeet, treated with NipsIt Suite, Tachigaren at 45g per unit, and Kabina at 7g per unit, was seeded in 22-inch rows at 60,560 seeds per acre on June 8 with a John Deere 1700XP 6-row planter. Pre emergence (PRE) treatments were applied immediately after seeding. A rain event on May 31 totaled 0.39 inches. All herbicide treatments were applied with a bicycle sprayer in 17 gpa spray solution through 8002 XR flat fan nozzles pressurized with CO2 at 40 psi to the center four rows of six row plots 35 feet in length. Sugarbeet injury and weed control were evaluated June 15, 22, 29 and July 5, 13.

All evaluations were a visual estimate of percent fresh weight reduction in the four treated rows compared to the adjacent untreated strip. Experimental design was randomized complete block with 4 replications for each trial. Data were analyzed with the ANOVA procedure of ARM, version 2016.4 software package.

Table 1. Application Information – Hickson, ND 2016

	PPI	PRE
Date	May 27	May 30
Time of Day	3:45 PM	12:00 PM
Air Temperature (F)	70	80
Relative Humidity (%)	65	37
Wind Velocity (mph)	5	8
Wind Direction	E	S
Soil Temp. (F at 6")	60	62
Soil Moisture	Good	Good
Cloud Cover (%)	100	5
Next Rainfal (amount)	May 27 (0.47")	May 31 (0.39")

SUMMARY

Sugarbeet injury from Ro-Neet SB at either 4.5 or 5.36 pt/a applied PPI was less than 5% at evaluations June 22, July 5, and July 13 (Table 2). Sugarbeet injury from Ro-Neet SB at either 4.5 or 5.36 pt/a alone or with an adjuvant was 5% or less when applied PRE. All adjuvants used in this study showed good crop safety when applied with Ro-Neet SB.

Table 2. Sugarbeet injury and weed control from Ro-Neet SB plus volatility reducing adjuvants at Hickson, ND in 2016.

Treatment	Rate		Appl[1]	June 22				July 5				July 13			
				sgbt[2]	fxmi	oat	rrpw	sgbt	fxmi	oat	rrpw	sgbt	fxmi	oat	rrpw
				% inj	-- % control --			% inj	--% control --			% inj	--% control --		
Ro-Neet SB	4.5	pt/a	PPI	5	91	73	76	5	79	53	65	3	75	50	55
Ro-Neet SB	5.36	pt/a	PPI	3	94	83	85	5	84	73	71	5	83	58	65
Ro-Neet SB + Eptam	2.67 2.29	pt/a + pt/a	PPI	33	100	100	99	35	93	93	89	20	94	91	91
Ro-Neet SB + Eptam	4.5 2.29	pt/a + pt/a	PPI	36	98	99	100	35	96	95	93	20	95	95	95
Eptam	3.5	pt/a	PPI	48	100	99	100	40	95	93	94	25	94	94	91
Ro-Neet SB	4.5	pt/a	PRE	0	86	65	64	3	85	48	40	0	85	45	25
Ro-Neet SB	5.36	pt/a	PRE	0	94	74	64	0	88	54	33	0	89	55	25
Ro-Neet SB + AX-1618	4.5 0.5	pt/a + % v/v	PRE	0	88	64	45	0	80	50	33	0	81	38	33
Ro-Neet SB + AX-1618	5.36 0.5	pt/a + % v/v	PRE	0	93	80	71	3	88	63	55	0	90	65	40
Ro-Neet SB + AU-810D	4.5 0.5	pt/a + % v/v	PRE	0	85	45	56	0	76	35	44	0	75	30	41
Ro-Neet SB + AU-810D	5.36 0.5	pt/a + % v/v	PRE	0	94	63	73	5	89	41	50	0	89	43	33
Ro-Neet SB + AU-376	4.5 0.5	pt/a + % v/v	PRE	0	90	34	46	0	76	38	33	0	87	35	30
Ro-Neet SB + AU-376	5.36 0.5	pt/a + % v/v	PRE	0	93	55	45	3	83	46	30	0	84	39	28
Ro-Neet SB + Grounded	4.5 4	pt/a + pt/a	PRE	0	85	51	69	5	73	44	41	0	71	45	33
Ro-Neet SB + Grounded	5.36 4	pt/a + pt/a	PRE	5	89	43	70	4	81	30	51	0	81	23	40
Dual Magnum	12	fl oz/a	PRE	0	75	28	80	5	70	28	65	0	64	28	45
Dual Magnum + Grounded	12 4	fl oz/a+ pt/a	PRE	6	78	30	79	3	73	28	71	0	70	28	56
Nortron	6.5	pt/a	PRE	15	90	84	78	8	73	68	65	0	69	53	48
Untreated Check				0	0	0	0	0	0	0	0	0	0	0	0
LSD (0.05)				**7.6**	**6.5**	**28.0**	**21.1**	**7.1**	**10.7**	**20.8**	**17.3**	**4.8**	**12.8**	**25.9**	**19.7**

[1]Appl = Application information indicated in Table 1.
[2]sgbt = sugarbeet, fxmi = foxtail millet, rrpw = redroot pigweed, inj = injury.

Sugarbeet injury from Eptam at 3.5 pt/a applied PPI was 48% on June 22, but declined to 40% and 25% on July 5 and 13 respectively. Ro-Neet SB at either 2.67 or 4.5 pt/a plus Eptam applied PPI showed a slight improvement in crop safety with 36% sugarbeet injury on June 22, 35% on July 5, and 20% on July 13. Sugarbeet injury with the use of Eptam decreased over time, but was statistically significant and biologically relevant throughout this experiment.

Sugarbeet injury from Nortron applied PRE was 15% on June 22, but declined to zero over time. Sugarbeet injury from Dual Magnum + Grounded was greater than from Dual Magnum alone on June 15 (data not shown), but injury was negligible throughout the remainder of this experiment from Dual Magnum applied alone or with Grounded.

Foxtail millet control from Ro-Neet SB applied PPI declined throughout the season. Ro-Neet SB at 5.36 pt/a PPI tended to give better millet control than Ro-Neet SB at 4.5 pt/a. Millet control from Ro-Neet SB applied PRE generally stayed the same throughout the duration of this trial with Ro-Neet SB at 4.5 pt/A giving 85% to 86% control and Ro-Neet SB at 5.36 pt/A giving 88% to 94% control. None of the tank mixed adjuvants enhanced foxtail millet control compared to

Ro-Neet SB applied PRE alone. Ro-Neet SB applied PRE, whether alone or in combination with an adjuvant gave greater control of foxtail millet than Dual Magnum or Nortron throughout this trial. Eptam, whether alone or tank mixed with Ro-Neet SB, gave the greatest and most consistent control of foxtail millet, ranging from 93% to 100% control over the duration of the trial.

Oat was seemingly more difficult to control than foxtail millet. Ro-Neet SB applied PPI at either 4.5 or 5.36 pt/A gave less than 60% oat control 45 days after application on July 13 and was similar to control from Ro-Neet SB applied PRE. None of the adjuvants applied with Ro-Neet SB statistically improved oat control. However, AX-1618 showed a trend towards enhancing oat control compared to PRE Ro-Neet SB alone or with other adjuvants. Dual Magnum alone or with Grounded gave 28% oat control, and Nortron gave 53% oat control on July 13. All three treatments containing Eptam gave 91% or greater oat control on July 13.

Redroot pigweed control was 55% to 65% from PPI Ro-Neet SB, depending on rate, compared to 25% from PRE Ro-Neet SB on July 13. The addition of a volatility reducing adjuvant to PRE Ro-Neet SB did not significantly improve redroot pigweed control compared to PRE Ro-Neet SB alone. Redroot pigweed control from Dual Magnum, Dual Magnum + Grounded, and Nortron was similar and ranged from 45% to 56% on July 13. All three treatments containing Eptam gave 91% or greater redroot pigweed control on July 13.

CONCLUSION

The PPI application of Eptam alone or Ro-Neet SB plus Eptam gave the most consistent and longest lasting weed control of all the treatments in this experiment. Ro-Neet SB plus Eptam showed slightly improved sugarbeet safety compared to Eptam alone.

Ro-Neet SB, when applied PPI, gave similar, to slightly improved, weed control and sugarbeet safety compared to PRE Nortron or Dual Magnum. Ro-Neet SB applied PRE showed significantly less redroot pigweed control throughout the season compared to PRE Nortron or Dual Magnum.

AX-1618 tended to be the most promising adjuvant for grass and broadleaf weed control when applied PRE with Ro-Neet SB in this experiment. However, neither AX-1618 nor any other adjuvant, significantly improved weed control compared to PRE Ro-Neet SB alone. Rainfall shortly after application may have masked some of the volatility reducing aspects of these adjuvants by quickly incorporating PRE Ro-Neet SB applied alone and not allowing significant volatility to occur. Additional research in an environment where Ro-Neet SB is more prone to volatility may allow significant weed control differences to be observed between Ro-Neet SB and Ro-Neet SB plus volatility reducing adjuvants.

AN EVALUATION OF POTENTIAL HERBICIDES FOR USE IN SUGARBEET IN 2016

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The objective of this study was to evaluate several 'non-sugarbeet' herbicides available from UPI for crop safety in Roundup Ready (RR) sugarbeet.

MATERIALS AND METHODS

An experiment was conducted near Hickson, ND in 2016. Fertilizer was spread April 16 and 2.35 inches of rain over the next seven days incorporated the fertilizer. The trial site was prepared using a Kongskilde 's-tine' field cultivator with rolling baskets on June 8, 2016. 'SV36272RR' sugarbeet, treated with NipsIt Suite, Tachigaren at 45g per unit, and Kabina at 7g per unit, was seeded in 22-inch rows at 60,560 seeds per acre on June 8 with a John Deere 1700XP 6-row planter. Preemergence (PRE) treatments were applied immediately after seeding. Rain events on June 12, 14, and 18 dropped 0.09, 0.25, and 0.90 inches of rain, respectively. Postemergence (POST) treatments were applied June 28. All herbicide treatments were applied with a bicycle sprayer in 17 gpa spray solution through 8002 XR flat fan nozzles pressurized with CO_2 at 40 psi to the center four rows of six row plots 35 feet in length. This trial was maintained weed free by applications of glyphosate on July 1 and August 2 and maintained disease free by applications of fungicide on July 20 (Priaxor), August 2 (Eminent), and August 17 (Headline). Sugarbeet injury was evaluated June 22, 28 and July 5, 13, 19. The trial was harvested September 12. One of the middle two rows, typically row 3, by 27 feet long was defoliated, stand was counted, and a sample of 25 pounds of sugarbeet was collected for quality analysis. The remaining beets in the harvested row were then gathered by hand and weighed.

All sugarbeet injury evaluations were a visual estimate of percent fresh weight reduction in the four treated rows compared to the adjacent untreated strip. Experimental design was randomized complete block with 4 replications for each trial. Data were analyzed with the ANOVA procedure of ARM, version 2016.4 software package.

Table 1. Application Information – Hickson, ND 2016

Date	June 8	June 28
Time of Day	12:30 PM	1:00 PM
Air Temperature (F)	75	79
Relative Humidity (%)	37	32
Wind Velocity (mph)	9	2
Wind Direction	SE	W
Soil Temp. (F at 6")	60	73
Soil Moisture	Good	Fair
Cloud Cover (%)	5	5
Next Rainfall (amount)	June 12 (0.09")	July 7 (0.12")
Sugarbeet Stage	PRE	2-4 leaf

SUMMARY

Sugarbeet injury from herbicides ranged from zero to 85% in this trial (Table 2). Collide, either applied PRE or POST, gave unacceptable sugarbeet injury in this trial ranging from 55% to 85% injury. Stand loss at harvest of 81 fewer plants per 100 feet of row was also observed from PRE Collide compared to the untreated check. Collide applied PRE gave 1.2% less sugar, 1,130 less pounds extractable sucrose per acre, and 2.3% reduced purity compared to the untreated check. Collide applied POST gave 4.5 less tons of root yield, 0.6% less sugar, and 1,366 less pounds per acre extractable sucrose compared to the untreated check.

Table 2. Crop injury and yield response following application of several 'non-sugarbeet' herbicides in sugarbeet near Hickson, ND in 2016.

			6/22	6/28	7/5	7/13	7/19			September 12			
Treatment[1]	Rate	Appl	Injury					Stand	Yield	Sugar	Ext. Sucrose	Ext. Sucrose	Purity
			----------%----------					#/100'	ton/a	%	lb/a	lb/ton	%
Untreated			0	0	0	0	0	227	23.6	15.0	5883	249	88.7
Collide	0.25 lb ai/a	A[2]	85	75	65	55	55	146	21.7	13.8	4752	220	86.4
Collide	0.25 lb ai/a	B	0	0	68	75	70	209	19.1	14.4	4517	238	88.4
Ultra Blazer	0.25 lb ai/a	B	0	0	45	33	33	229	23.3	14.5	5455	234	87.3
Devrinol	1.0 lb ai/a	A	0	0	0	4	0	218	25.1	14.6	5977	238	87.8
Command	0.375 lb ai/a	A	5	8	0	3	5	219	25.7	14.8	6239	244	88.4
Prowl H_2O	0.75 lb ai/a	B	0	0	13	0	4	198	24.8	14.4	5812	235	87.6
LSD (0.05)			**6.8**	**4.7**	**6.0**	**7.8**	**11.1**	**34.6**	**2.11**	**0.57**	**524.9**	**14.3**	**1.26**

[1]Common names are as follows: Ultra Blazer=acifluorfen; Collide=oxyfluorfen; Devrinol=napropamide; Command=clomazone; Prowl H20=pendimethalin

[2]Application information can be found in Table 1. A=PRE on June 8, B=POST on June 28.

Ultra Blazer gave significant sugarbeet injury at all three evaluations following an application to 2 to 4 leaf sugarbeet on June 28. Injury symptoms included growth reduction and leaf necrosis. Injury did marginally decline over evaluation timings from 45% on July 5 to 33% on July 13 and 19. Sugarbeet treated with Ultra Blazer gave 15 less pounds per ton of extractable sucrose and 1.4% reduced percent purity compared to the untreated check and showed a trend toward reduced levels of yield, percent sugar, and pounds per acre extractable sucrose when compared to the untreated check.

Devrinol and Command gave very similar results when applied PRE in sugarbeet. Devrinol gave essentially no visual injury symptoms and gave very similar results for yield and quality parameters compared to the untreated check. Command gave chlorosis and some necrosis of the oldest leaves early in the season, but the injury symptoms diminished as time progressed. Command did not significantly affect any yield or quality parameter compared to the untreated check.

Prowl H_2O gave some sugarbeet injury observed as droopy plants 7 days after application. The injury symptom disappeared as time progressed. Prowl application did not affect any sugarbeet yield or quality parameters compared to the untreated check.

CONCLUSION

Collide is not a suitable herbicide candidate for use in sugarbeet at this time. Collide applied PRE gave significant stand loss and negatively affected yield and quality. Collide applied POST also resulted in significant negative effects on sugarbeet yield and quality. Ultra Blazer showed significant sugarbeet injury in visual evaluations, but the mixed effect of this injury on yield and quality parameters may warrant further study. Devrinol, Command, and Prowl H_2O applied in sugarbeet showed good to excellent crop safety with no adverse effects on sugarbeet yield or quality and should be studied further for sugarbeet crop safety as well as weed control efficacy in the sugarbeet crop.

CONTINUED EVALUATION OF THE STRATEGY FOR MANAGING WATERHEMP IN SUGARBEET

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Summary

1. Chloroacetamide herbicides (S-metolachlor, Warrant, Outlook) applied early postemergence (lay-by) are the most effective waterhemp control strategy in sugarbeet
2. Dual Magnum at 0.5 to 0.75 pt/A, ethofumesate at 1 to 2 pt/A) or Dual Magnum + ethofumesate at 0.5+ 2 pt/A) applied preemergence and followed by split application of S-metolachlor, Warrant or Outlook early postemergence provides the most consistent waterhemp control in sugarbeet.
3. Sugarbeet injury is least when chloroacetamide herbicides are split applied early postemergence and postemergence.

Introduction

Sugarbeet growers across all sugarbeet producing regions in Minnesota and eastern North Dakota should be scouting for waterhemp. Waterhemp is a summer annual weed in the pigweed family that can germinate in mid to late May, June, and July in North Dakota and Minnesota. Waterhemp germinates and emerges from the soil surface to one-half inch deep in the soil and remains viable in soils from four to six years. Waterhemp plants have male and female flowers on separate plants thus increasing the genetic diversity in populations and results in plants that are biologically and morphologically unique. It also has contributed to development of biotypes that are resistant to several herbicide families including ALS inhibitor (SOA2), triazine (SOA5), PPO inhibitor (SOA14), and glyphosate (SOA9) in Minnesota and North Dakota.

Waterhemp germination and emergence is tracked using a growing degree day (GDD) model (base temperature 45F) that calculates GDD accumulation during calendar year. Three hundred fifty units correspondence with waterhemp emergence and generally occurs in mid to late May. However, improved awareness and recognition of waterhemp has challenged the accuracy and utility of the model. Extension personnel will continue to use the model but recognize that local weather conditions and field specific environments ultimate will determine waterhemp emergence date.

Field research conducted at multiple field locations in 2014 and 2015 has concluded the chloroacetamide herbicides (S-metolachlor, Outlook, and Warrant) applied early postemergence (lay-by) with glyphosate and ethofumesate provide the most consistent waterhemp control. Growers enjoyed very favorable conditions for timely sugarbeet planting in 2016. However, several variables including stand uniformity, crop stage of nurse crops, waterhemp germination and emergence, and lack of timely precipitation in May created challenges for execution of the lay-by waterhemp control strategy.

S-metolachlor applied PRE followed by lay-by application improved the consistency and overall waterhemp control in an experiment at Moorhead in 2015. Additional research needs to be conducted to evaluate the PRE fb EPOST concept. Outlook usually is applied split lay-by or 12 fl oz/A fb 12 fl oz/A compared to 18 or 21 fl oz/A. Additional research needs to be conducted to determine if S-metolachlor or Warrant should be split applied. The objectives of 2016 experiments were to evaluate sugarbeet safety and waterhemp control at multiple locations from: a) S-metolachlor applied PRE followed by S-metolachlor, Warrant, or Outlook lay-by in single or multiple application; b) S-metolachlor, Warrant, or Outlook lay-by in a single or multiple application and; c) S-metolachlor, Outlook and Warrant rates lay-by in single or multiple applications. The purpose of this report is to summarize the sugarbeet safety experiment conducted at Roseland, MN and the waterhemp control experiment conducted at Moorhead, MN in 2016.

Materials and Methods

Experiments were conducted on natural populations of waterhemp near Moorhead and Roseland, Minnesota in 2016. Plot area was prepared with a Kongskilde s-tine field cultivator on May 7, 2016 at Moorhead, MN and with a field cultivator with rolling baskets on May 4, 2016 at Roseland, MN. Hilleshog 'HM4302RR' sugarbeet treated with Tachigaren, at 45 grams product, Cruiser Maxx (contains Cruiser 5FS at 60 gram active ingredient (g a.i.), Apron XL at 15 g a.i., and Maxim 4FS at 2.5 g a.i.) and Vibrance at 2g a.i. per 100,000 seeds was seeded 1.25 inches deep in 22 inch rows at 60,825 seeds per acre on May 12, 2016 at Moorhead. Crystal 'M380' sugarbeet treated with Tachigaren and Kabina at 45 g product and 14 g a.i. per 100,000 seeds, respectfully, was seeded 1.25 inches deep in 22 inch rows at 61,000 seeds per acre on May 5, 2016 at Roseland, MN

Herbicide treatments were applied at Moorhead May 16, June 6, and June 20, 2016 and May 5, June 2, and June 17, 2016 at Roseland. All treatments were applied with a bicycle sprayer in 17 gpa spray solution through 8002 XR flat fan nozzles pressurized with CO_2 at 40 psi to the center four rows of six row plots 30 feet in length in fields with moderate to heavy infestations of glyphosate-resistant waterhemp. Ammonium sulfate (AMS) in all treatments was 'N-Pak' AMS, a liquid formulation from Winfield Solutions. Non-ionic surfactant (NIS) was 'Prefer 90', a product from West Central, Inc.

Sugarbeet injury was evaluated June 24 and July 22, 2016 at Moorhead, MN and June 10, June 23, and July 5, 2016 at Roseland, MN. Waterhemp control was evaluated June 24, June 28, July 22, and August 24, 2016 at Moorhead and June 10, June 23, and July 5, 2016 at Roseland. Common lambsquarters and redroot pigweed control also was evaluated at each location but not included in this report since glyphosate provided complete or near complete control. All evaluations were a visual estimate of percent fresh weight reduction in the four treated rows compared to the adjacent untreated strip. Experimental design was randomized complete block with 4 replications. Data were analyzed with the ANOVA procedure of ARM, version 2016.4 software package.

Table 1. Application information for sugarbeet trials near Roseland, MN in 2016.

Application code	A	B	C
Date	May 5	June 2	June 17
Time of Day			
Air Temperature (F)	61	74	70
Relative Humidity (%)	36	40	40
Wind Velocity (mph)	7	4	10
Wind Direction	SW	W	SE
Soil Temp. (F at 6")	-	-	-
Soil Moisture	Good	Fair	Very Wet
Cloud Cover (%)	40	-	-
Sugarbeet stage (avg)	PRE	2-4	8-10
Waterhemp	-	-	-

Table 2. Application information for sugarbeet trial near Moorhead, MN in 2016.

Application code	A	B	C
Date	May 16	June 6	June 20
Time of Day	9:00 AM	2:00 PM	2:30 PM
Air Temperature (F)	51	67	73
Relative Humidity (%)	56	56	37
Wind Velocity (mph)	7	12	10
Wind Direction	N	NW	NW
Soil Temp. (F at 6")	48	62	70
Soil Moisture	Poor	Good	Good
Cloud Cover (%)	80	90	10
Sugarbeet stage (avg)	PRE	4-6 lf	10 lf
Waterhemp	-	0.5"	1-3"

Results and Discussion

2014 and 2015. Lay-by is use of soil residual herbicides after crop emergence but before weed emergence. In sugarbeet, S-metolachlor, Warrant, and Outlook can be applied POST to sugarbeet after sugarbeet have reached the two-leaf stage. Timely precipitation is required for activation since neither S-metolachlor, Warrant, nor Outlook control emerged weeds.

S-metolachlor, Warrant, and Outlook were applied lay-by at multiple locations in 2014 and 2015. Locations represented experiments with early sugarbeet planting (Moorhead, 2015) late sugarbeet planting (Herman, 2014 and Herman, 2015), and an open sugarbeet canopy (Herman, 2015). Glyphosate at 28 fl oz/A + ethofumesate at 4 fl oz/A was applied in combination with lay-by herbicides to control emerged weeds. Waterhemp control tended to be more consistent across locations and years from herbicides applied lay-by (Figure 1) compared to waterhemp control from herbicides applied PRE followed by POST or POST only tank-mixtures (1, 2). Outlook tended to provide more consistent waterhemp control than S-metolachlor or Warrant.

Waterhemp control may be related to herbicide solubility and resultant herbicide activation. Outlook is more water soluble than S-metolachlor or Warrant and thus, more easily activated (3). Warrant is the least water soluble of the chloroacetamide herbicides and thus, most dependent on timely and significant precipitation for activation. Significant precipitation occurred four days after lay-by application and precipitation totals were 1.7 inches, two weeks after lay-by application at Moorhead, 2015. Similar precipitation totals occurred during the two week interval following lay-by application at Herman, 2015 but precipitation was more events and less total precipitation per event. Thus, activation of S-metolachlor and Warrant may not have occurred as quickly or as completely.

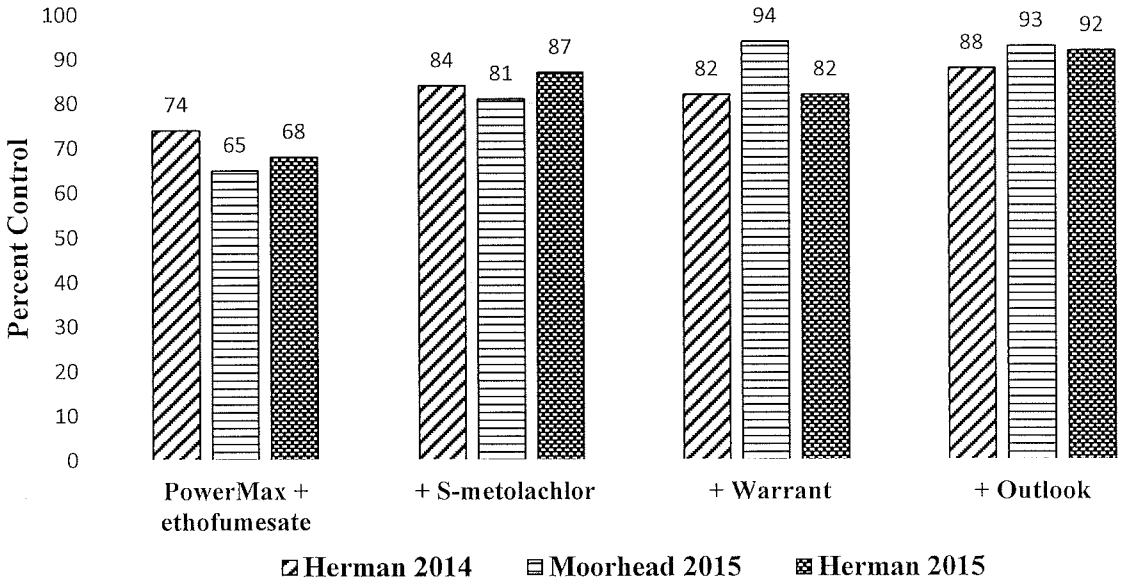

Figure 1. Waterhemp control from glyphosate plus ethofumesate and soil residual herbicides lay-by, across locations in 2014 and 2015.

There is a risk in relying on lay-by applications, that timely precipitation may not occur and thus, not activate herbicide. Preemergence herbicides followed by chloracetamide herbicides lay-by is a systems approach that may provide early-season broadleaf control including lambsquarters and redroot pigweed and available herbicide for waterhemp control until lay-by application is activated by precipitation. PRE fb lay-by may improve consistency of season-long control of waterhemp across environments.

S-metolachlor at 0.5 pt/A applied PRE followed by S-metolachlor, Outlook or Warrant improved the consistency of waterhemp control at Herman and Moorhead in 2015 (Figure 2). Waterhemp control tended to be greater when S-metolachlor was applied PRE fb lay-by, compared to lay-by alone.

Sugarbeet stands at Herman were compromised by a severe rhizoctonia root rot infestation that compromised sugarbeet stand and confounded sugarbeet injury evaluation from herbicide treatments. Sugarbeet safety from glyphosate, lay-by or PRE fb lay-by was negligible at Moorhead.

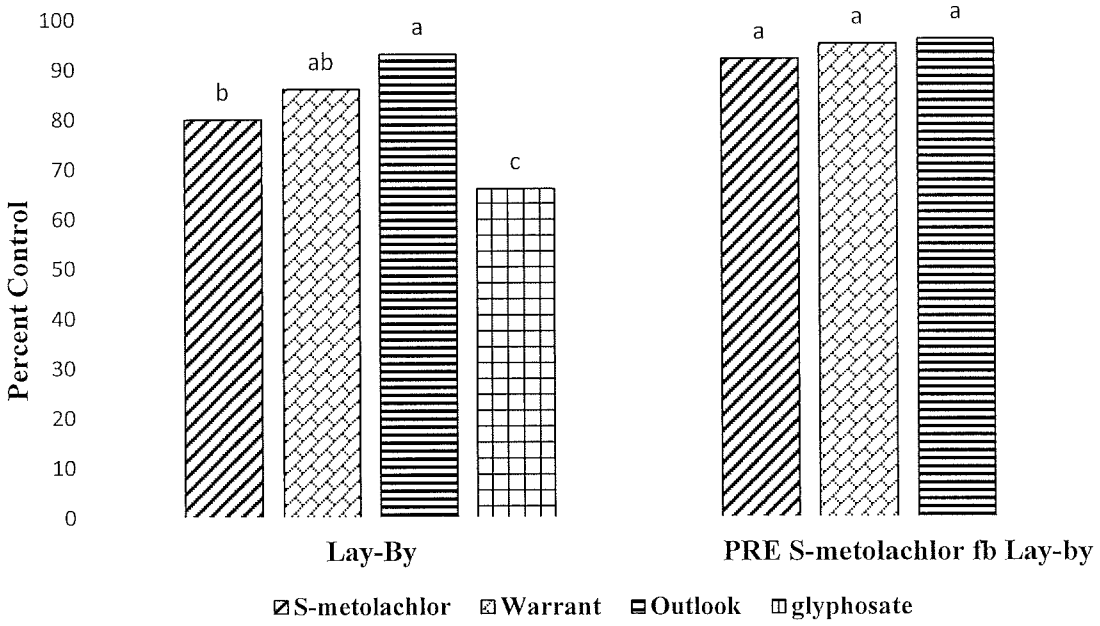

Figure 3. Waterhemp control from soil residual herbicides lay-by or S-metolachlor at 0.5 pt/A PRE followed by lay-by, averaged across Herman, MN and Moorhead, MN in 2015.

2016. Herbicides applied lay-by in single or multiple applications (split-lay-by) or PRE fb lay-by or split lay-by did not injure sugarbeets at Moorhead in 2016 (Table 2). This continues a trend of negligible sugarbeet injury from use of chloroacetamide herbicides alone or tank-mixed with glyphosate + ethofumesate. Lay-by applications were applied later than usual and at a higher growth stage (up to 6-lf sugarbeet) to achieve full stands since germination and emergence was confounded by dry soil conditions.

Waterhemp control was influenced by herbicide and application timing but generally was not influenced by herbicide rate (Table 2, Figure 4). Waterhemp control was best when S-metolachlor was applied PRE and followed by lay-by or split lay-by application. Timing of lay-by application may have impacted these results as the delay in application to achieve desired sugarbeet stage before application provided greater time for waterhemp to germinate and emerge, even though glyphosate + ethofumesate was in the tank-mix for burndown control. Previous experience and data from this experiment indicates glyphosate + ethofumesate alone do not provide sufficient waterhemp control, especially once waterhemp is greater than 1-inch. Splitting the lay-by application tended to improve waterhemp control as compared to a single application. Improvement in waterhemp control tended to occur across chloroacetamide herbicide. Outlook split lay-by at 12+12 fl oz/A is the common application approach by Growers, generally favoring this approach to a single application of 15 to 21 fl oz/A.

Common lambsquarters control was outstanding at Moorhead (data not presented). Control ranged from 95 to 100% across treatments. A uniform infestation of lambsquarters was 2 inches tall at application. Lambsquarters control was evaluated only on June 24 due to magnitude of control and competition from sugarbeet and waterhemp.

There was significant sugarbeet injury at Roselawn (Table 3). Sugarbeet injury was characterized as growth reduction injury, sugarbeet a pale green color compared to untreated sugarbeet, and lack of sugarbeet uniformity within the row. Injury across treatments ranged from 14 to 51% on June 10, from 6 to 30% on June 23, and from 5 to 21% on July 5, 8, 28, and 33 days, respectfully, after the first lay-by application. Average sugarbeet injury across treatments was 29%, 25%, and 14% on June 10, June 23 and July 5, respectfully.

Table 2. Sugarbeet injury and waterhemp control from residual herbicides applied PRE and/or lay-by at Moorhead, MN in 2016.

Treatment[1]	Rate	App. Code[2]	Sugarbeet		Waterhemp		
			Jun 24	Jul 22	Jun 24	Jul 22	Aug 24
	fl oz or pt (p)/A		---% injury---		------% control------		
PMax[3]+Etho / PMax+Etho	28+4 / 28+4	B / C	0	1	0	45	33
PMax+Etho+Dual / PMax+Etho	28+4+1.25p / 28+4	B / C	0	0	71	68	60
PMax+Etho+Dual / PMax+Etho	28+4+1.67p / 28+4	B / C	0	0	74	60	55
PMax+Etho+War / PMax+Etho	28+4+3.25p / 28+4	B / C	0	0	88	78	75
PMax+Etho+War / PMax+Etho	28+4+4p / 28+4	B / C	0	0	90	79	74
PMax+Etho+Out / PMax+Etho	28+4+18 / 28+4	B / C	0	0	78	64	55
PMax+Etho+Out / PMax+Etho	28+4+21 / 28+4	B / C	0	4	81	73	64
PMax+Etho+Dual / PMax+Etho+Dual	28+4+1p / 28+4+1p	B / C	5	0	84	80	71
PMax+Etho+Dual / PMax+Etho+Dual	28+4+1.25p / 28+4+1.25p	B / C	0	3	90	89	85
PMax+Etho+War / PMax+Etho+War	28+4+2.25p / 28+4+2.25p	B / C	0	3	93	88	86
PMax+Etho+War / PMax+Etho+War	28+4+3p / 28+4+3p	B / C	0	3	86	86	85
PMax+Etho+Out / PMax+Etho+Out	28+4+12 / 28+4+12	B / C	0	0	88	86	78
PMax+Etho+Out / PMax+Etho+Out	28+4+15 / 28+4+9	B / C	0	0	83	81	70
Dual / PMax+Etho+Dual / PMax+Etho	0.5p / 28+4+1.25p / 28+4	A / B / C	0	0	90	84	84
Dual / PMax+Etho+War / PMax+Etho	0.5p / 28+4+3.25p / 28+4	A / B / C	0	0	99	93	91
Dual / PMax+Etho+Out / PMax+Etho	0.5p / 28+4+18 / 28+4	A / B / C	0	5	100	98	100
Dual / PMax+Etho+Dual / PMax+Etho+Dual	0.5p / 28+4+1p / 28+4+1p	A / B / C	0	0	91	91	88
Dual / PMax+Etho+War / PMax+Etho+Dual	0.5p / 28+4+2.25p / 28+4+2.25p	A / B / C	0	0	94	95	94
Dual / PMax+Etho+Out / PMax+Etho+Dual	0.5p / 28+4+9 / 28+4+9	A / B / C	0	0	96	94	95
LSD (0.05)			**3**	**4**	**10**	**13**	**13**
CV			**879**	**341**	**8**	**12**	**12**

[1]Treatments of Roundup PowerMax contained Destiny HC at 1.5 pt/A + N-Pak AMS at 2.5% v/v

[2]Application codes refer to the information in Table 1

[3]PMax=Roundup PowerMax; Dual=Dual Magnum; War=Warrant; Out=Outlook; Etho=Ethofumesate 4SC

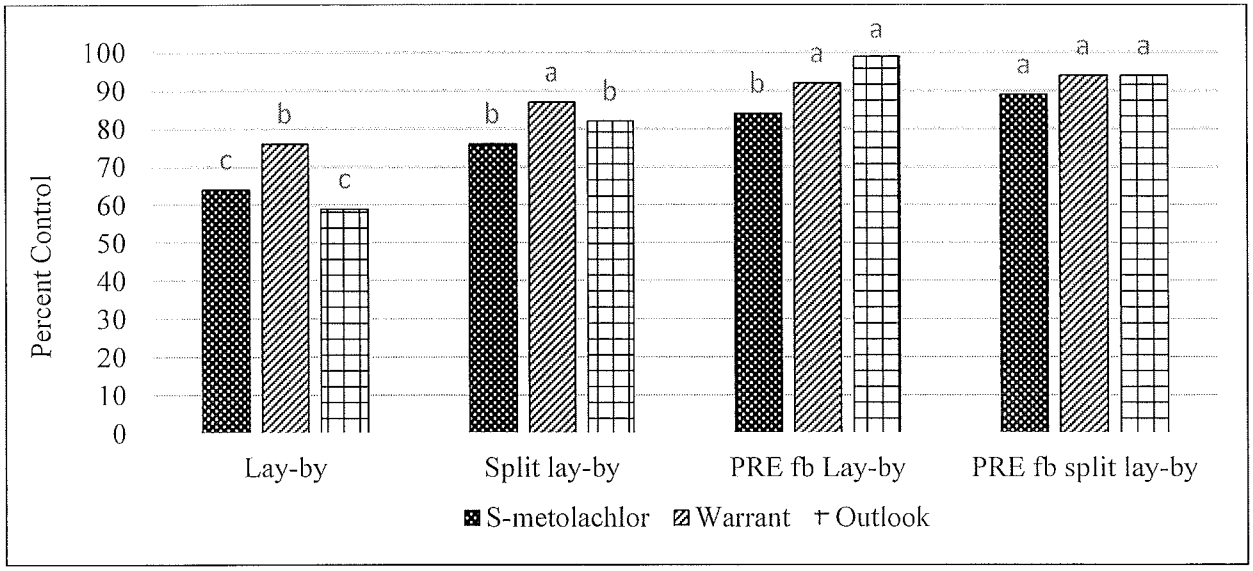

Figure 4. Waterhemp control from single (lay-by) or multiple applications of herbicides applied lay-by (split-lay-by) or S-metolachlor PRE followed by a lay-by or split lay-by, Moorhead, MN in 2016, average of July 22 and August 24 evaluation.

Sugarbeet injury was influenced by herbicide treatment, herbicide rate, timing of treatment application, and evaluation timing. Injury was greatest at the first evaluation timing or 8 days after PRE application. Injury tended to decrease in time from June 10 to July 5, the final evaluation. Injury was most severe from S-metolachlor PRE fb S-metolachlor, Outlook or Warrant lay-by (Figure 5). Splitting the lay-by application or a single lay-by application decreased or tended to decrease sugarbeet injury. Sugarbeet injury from S-metolachlor or Warrant was the same and was less or tended to be less than sugarbeet injury from Outlook. Greater injury from Outlook might be related to the amount and timeliness of precipitation and the solubility of Outook. These data provide good evidence for splitting Outlook lay-by compared to an 18 or 21 fl oz Outlook in a single application lay-by.

Experiment was very unique due to the amount and timeliness of precipitation. It is likely that chloroacetamide herbicide was leached into the seedling zone of actively growing plants. The outcome were plants that were not actively growing; plants that were standing still; plants that were drunk. The experiment received 10.6 inches of precipitation in May and June, the first eight weeks following planting. Over one-inch precipitation occurred in a single rainfall event five days following PRE, 11 days following lay-by and the day following split lay-by application. The experiment was planted into corn stalks residue.

Experiment does not suggest that chloroacetamide herbicides applied PRE and/or lay-by will always cause sugarbeet injury. Rather, the experiment informs its audience that when conditions are appropriate for sugarbeet injury, S-metolachlor PRE fb S-metolachlor, Outlook or Warrant lay-by will cause the greatest sugarbeet injury. It teaches that Outlook has the potential to cause more injury than Dual Magnum or Warrant.

Experiment reinforces our herbicide rate structure. Dual Magnum should be applied at 1.25 pt/a lay-by or 1 pt/a fb 1 pt/a split lay-by; Warrant 3.25 pt/a or 2.25 pt/a fb 2.25 pt/a; and Outlook 18 oz or 12 oz/a fb 12 oz/a split lay-by.

Waterhemp control ranged from 85 to 100% during the June 23 and July 5 evaluations (Table 3). Waterhemp control from lay-by herbicide application was slightly better than split-lay-by herbicide application but was herbicide treatment dependent. S-metolachlor applied PRE tended to improve control provided from lay-by treatments. However, control tended to be greater from lay-by herbicide application than split-lay-by application.

In general, there were no differences across herbicides, herbicide rates or application timing. Lambsquarters control was near perfect there were no observations of treatment differences (data not presented). There was a light infestation of redroot pigweed in the experimental area (data not presented). In general, all entries provided greater than 95% pigweed control. Lay-by tended to provide slightly better control than split-lay-by. PRE fb lay-by or PRE fb split lay-by gave perfect pigweed control.

Table 3. Sugarbeet injury and waterhemp control from residual herbicides applied PRE and/or lay-by at Roseland, MN in 2016.

Treatment[1]	Rate	App. Code[2]	Sugarbeet			Waterhemp	
			Jun 10	Jun 23	Jul 5	Jun 23	Jul 5
	fl oz or pt (p)/A		-------% injury-------			--% control--	
PMax[3]+Etho / PMax+Etho	28+4 / 28+4	B / C	0	0	9	70	64
PMax+Etho+Dual / PMax+Etho	28+4+1.25p / 28+4	B / C	25	5	11	90	65
PMax+Etho+Dual / PMax+Etho	28+4+1.67p / 28+4	B / C	38	20	6	96	93
PMax+Etho+War / PMax+Etho	28+4+3.25p / 28+4	B / C	16	15	5	99	95
PMax+Etho+War / PMax+Etho	28+4+4p / 28+4	B / C	41	14	11	98	95
PMax+Etho+Out / PMax+Etho	28+4+18 / 28+4	B / C	38	8	11	95	93
PMax+Etho+Out / PMax+Etho	28+4+21 / 28+4	B / C	39	23	19	98	96
PMax+Etho+Dual / PMax+Etho+Dual	28+4+1p / 28+4+1p	B / C	18	13	11	88	85
PMax+Etho+Dual / PMax+Etho+Dual	28+4+1.25p / 28+4+1.25p	B / C	21	10	14	95	91
PMax+Etho+War / PMax+Etho+War	28+4+2.25p / 28+4+2.25p	B / C	14	10	11	85	89
PMax+Etho+War / PMax+Etho+War	28+4+3p / 28+4+3p	B / C	35	19	13	98	96
PMax+Etho+Out / PMax+Etho+Out	28+4+12 / 28+4+12	B / C	34	18	18	96	95
PMax+Etho+Out / PMax+Etho+Out	28+4+15 / 28+4+9	B / C	26	6	6	100	100
Dual / PMax+Etho+Dual / PMax+Etho	0.5p / 28+4+1.25p / 28+4	A / B / C	36	15	18	100	100
Dual / PMax+Etho+War / PMax+Etho	0.5p / 28+4+3.25p / 28+4	A / B / C	39	16	18	99	99
Dual / PMax+Etho+Out / PMax+Etho	0.5p / 28+4+18 / 28+4	A / B / C	51	30	21	100	100
Dual / PMax+Etho+Dual / PMax+Etho+Dual	0.5p / 28+4+1p / 28+4+1p	A / B / C	20	19	19	99	93
Dual / PMax+Etho+War / PMax+Etho+Dual	0.5p / 28+4+2.25p / 28+4+2.25p	A / B / C	23	13	15	100	96
Dual / PMax+Etho+Out / PMax+Etho+Dual	0.5p / 28+4+9 / 28+4+9	A / B / C	15	9	13	98	98
LSD (0.05)			**16**	**14**	**9**	**8**	**11**
CV			**40**	**72**	**48**	**6**	**9**

[1]Treatments of Roundup PowerMax contained Destiny HC at 1.5 pt/A + N-Pak AMS at 2.5% v/v
[2]Application codes refer to the information in Table 1
[3]PMax=Roundup PowerMax; Dual=Dual II Magnum; War=Warrant; Out=Outlook; Etho=Ethofumesate 4SC

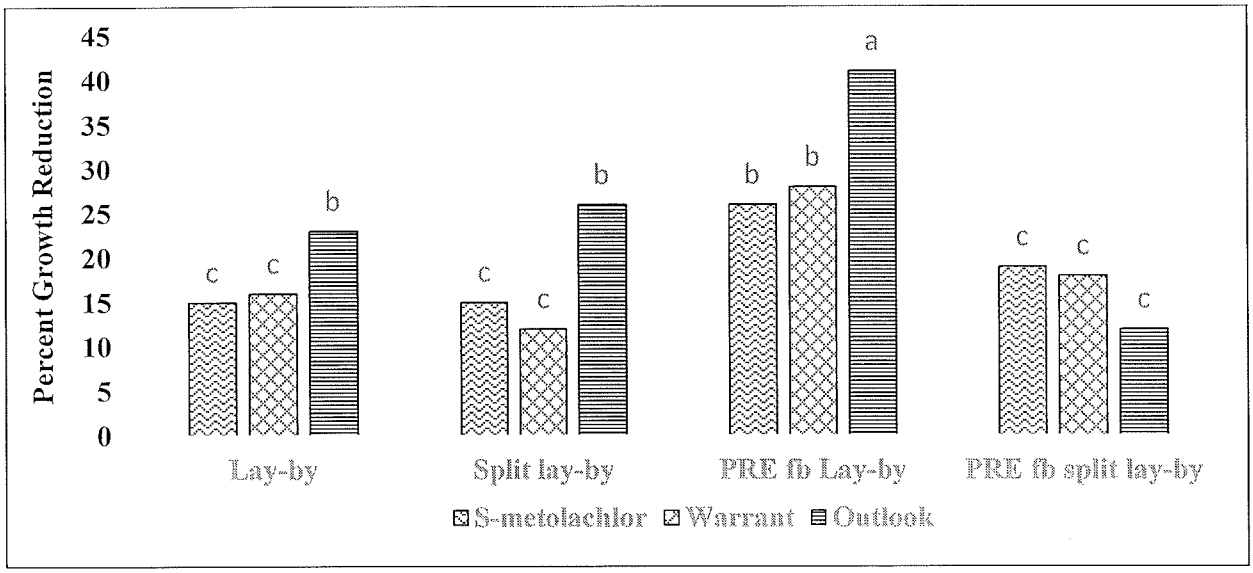

Figure 5. Sugarbeet injury from single (lay-by) or multiple applications of herbicides applied lay-by (split-lay-by) or PRE S-metolachlor followed by a lay-by or split lay-by, Moorhead, MN in 2016, average of June 10 and June 23 evaluation.

Conclusions

Sugarbeet planting date is the first consideration for waterhemp control recommendation (Table 9). Lay-by or split lay-by application of chloroacetamide herbicides is the preferred approach for waterhemp control for early planted sugarbeet. Use PRE followed by a split lay-by application for fields with early germinating weeds or to manage the risk of uncertainty with activation of lay-by herbicide.

Late planted sugarbeet may not reach the sugarbeet 2-lf stage by May 15 or the approximate date for waterhemp germination and emergence and lay-by application of chloroacetamide herbicides. Thus, Dual Magnum or ethofumesate should be applied PRE followed by split lay-by. Timing of lay-by will be dependent on sugarbeet planting date, precipitation to activate PRE, and waterhemp pressure in the field.

Continue to scout sugarbeet fields for waterhemp in July and August. Tank-mixes of Betamix or UpBeet with Roundup plus ethofumesate are recommended for POST waterhemp control. Apply in combination with HSMOC at 1.5 pt/A and AMS at 8.5 to 17 lb/100 gallon water carrier.

Table 4. Recommendation for waterhemp control in sugarbeet, by planting date.

Planting Date	Recommendation
Plant Sugarbeet in April	Split lay-by application (early postemergence / postemergence) of chloroacetamide herbicides applied at 2-lf sugarbeet fb 4 to 6-lf sugarbeet
	Single lay-by application when sugarbeet is at the 2-lf stage or greater
	Dual Magnum and/or ethofumesate PRE followed by a split lay-by application at 2 to 4-lf stage fb 4 to 6-lf stage
Plant Sugarbeet in May	Dual Magnum and/or ethofumesate PRE followed by a split lay-by
Mid Season	Continue to scout fields for late germinating waterhemp
	Be prepared to rescue with Betamix + ethofumesate, UpBeet+ ethofumesate or Betamix + UpBeet

Future Research

Sugarbeet growers have asked about cultivation as an integrated management strategy to achieve the zero tolerance for weed escapes strategy. We need to investigate if cultivation will disrupt the herbicide boundary, allowing new flushes of waterhemp to germination and emerge, thus potentially doing more harm than good. We need to

investigate if cultivation is a method to activate lay-by herbicides when precipitation is not timely. We need to evaluate if Treflan is an effective option for lay-by control of waterhemp in sugarbeet.

We need to continue to evaluate the preemergence component of the systems strategy for waterhemp control. We need to determine if ethofumesate should be utilized in tank-mixtures with Dual Magnum to extend waterhemp control. We need to continue to evaluate formulation technology that may permit preemergence use of Ro-Neet SB in sugarbeet.

ACKNOWLEDGMENTS

We implemented an ambitious research program in 2016. We were mostly successful in spite of a very dry planting season. We are thankful to the following for contributing to our successes:

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A SYSTEMS APPROACH FOR COMMON LAMBSQUARTERS AND KOCHIA CONTROL IN CORN IN A SUGARBEET ROTATION IN 2016 AT BARNEY, ND

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The objective of this study was to demonstrate a weed control system in corn using herbicides with a site of action different than EPSP synthase inhibitor (glyphosate) and have rotation flexibility with sugarbeet as a rotational crop the following season.

MATERIALS AND METHODS

An experiment was conducted near Barney, ND in 2016. The trial site was prepared using a Kongskilde 's-tine' field cultivator with rolling baskets on May 4, 2016. 'DKC38-04 RIB' Dekalb corn was seeded in 22-inch rows at 32,000 seeds per acre on May 4 with a John Deere 1700XP 6-row planter. Preemergence (PRE) treatments were applied May 4. Postemergence (POST) treatments were applied June 2 and 21. All herbicide treatments were applied with a bicycle sprayer in 17 gpa spray solution through 8002 XR flat fan nozzles pressurized with CO_2 at 30 psi to the center four rows of six row plots 30 feet in length. Corn injury and common lambsquarters, kochia, and redroot pigweed control were evaluated June 1, July 1, and September 7.

All corn injury and weed control evaluations were a visual estimate of percent fresh weight reduction in the four treated rows compared to the adjacent untreated strip. Experimental design was randomized complete block with 4 replications for each trial. Data were analyzed with the ANOVA procedure of ARM, version 2016.4 software package.

Table 1. Application Information – Barney, ND 2016

Application	A	B	C
Date	May 4	June 2	June 21
Time of Day	1:00 PM	9:00 AM	3:30 PM
Air Temperature (F)	69	59	83
Relative Humidity (%)	24	60	32
Wind Velocity (mph)	7	6	7
Wind Direction	NNW	NW	W
Soil Temp. (F at 6")	59	54	70
Soil Moisture	Good	Good	Fair
Cloud Cover (%)	0	10	30
Next Rainfall (amount)	May 11	June 3	June 22
Corn Stage	PRE	V6	V8
Common Lambsquarters	-	3 inch	1 inch
Kochia	-	2 inch	3 inch
Redroot Pigweed	-	2 inch	1 inch

SUMMARY

Corn injury from herbicides was generally minimal in this trial (Table 2). All treatments, except three, gave 15% or less corn injury on July 1. The three treatments that gave greater than 15% injury actually showed 30% to 38% injury. These three treatments were PRE Harness+Sharpen, PRE Harness fb Widematch, and PRE Sharpen fb Widematch. This injury may have been more attributed to weed competition rather than herbicide injury. Common lambsquarters control on July 1 for these three treatments ranged from 13% to 35%. The extensive competition from weeds caused the corn to be shorter and thereby appear injured. All herbicides used in these treatments are labeled for use on corn and are generally safe.

Table 2. Corn injury and weed control from herbicides at Barney, ND in 2016.

			June 1	--------July1--------			--------Sept 7---------		
Treatment	Rate	Appl[1]	colq[2]	corn	colq	kocz	colq	rrpw	kocz
			% cntl	% inj	% cntl	% cntl	% cntl	% cntl	% cntl
Harness + Sharpen	32 + 2.5 fl oz + fl oz	A	65	38	13	65	0	0	0
Harness + Clarity	32 + 16 fl oz + fl oz	A	80	5	65	100	60	100	100
Widematch[3]	16 fl oz	B							
Harness + AAtrex	32 + 12 fl oz + fl oz	A	55	5	80	98	80	100	100
Status[4]	3.5 oz	B							
Harness	32 fl oz	A	28	10	80	88	80	98	91
Status[4]	3.5 oz	B							
Harness	32 fl oz	A	38	38	33	100	0	0	0
Widematch[3]	16 fl oz	B							
Harness	32 fl oz	A	30	10	70	78	63	100	90
Buctril[3]	24 fl oz	B							
Sharpen	2.5 fl oz	A	30	8	78	95	80	98	93
Status[4]	3.5 oz	B							
Sharpen	2.5 fl oz	A	43	30	35	95	0	0	0
Widematch[3]	16 fl oz	B							
Verdict + AAtrex	13 + 12 fl oz + fl oz	A	58	8	83	95	86	96	98
Status[4]	3.5 oz	B							
Verdict	13 fl oz	A	70	5	78	93	89	98	93
Status[4]	3.5 oz	B							
Sharpen	2 fl oz	A	33	3	88	93	90	100	95
Warrant + Status +	48 + 3.5 fl oz + oz	B							
RU PowerMax[5]	32 fl oz	B							
Laudis + AAtrex[4]	3 + 12 fl oz + fl oz	B	0	8	75	93	76	98	98
Status+PowerMax[5]	3.5 + 28 oz + fl oz	BC	0	5	95	95	100	100	100
Widematch	16 fl oz	BC	0	15	95	100	100	100	100
Status+PowerMax[5]	3.5 + 28 oz + fl oz	BC							
LSD (0.05)			**16.3**	**10.6**	**7.5**	**15.6**	**7.2**	**4.3**	**9.7**

[1]Appl refers to application information in Table 1. A=PRE, B=POST applied June 14, C=POST applied June 23
[2]colq=common lambsquarters; kocz=kochia; rrpw=redroot pigweed
[3]Indicates addition of Prefer 90 Non-ionic Surfactant (NIS) at 0.25% v/v. Product provided by West Central Inc.
[4]Indicates addition of Methylated Seed Oil (MSO) at 1.5 pt/A. Product provided by Loveland.
[5]Indicates addition of Ammonium Sulfate (AMS) at 8.5 lb/100 gal + High Surfactant Methylated Seed Oil Concentrate (HSMOC) at 1.5 pt/A. N-Pak AMS and Destiny HC (HSMOC) were provided by Winfield.

Common lambsquarters control varied by herbicide treatment and evaluation timing. Lambsquarters control from PRE herbicides was evaluated June 1 and ranged from 28% to 80%. PRE Harness gave 28% to 38% lambsquarters control. PRE Sharpen at 2 or 2.5 fl oz/A gave 30% to 43% lambsquarters control. PRE Verdict gave 70% lambsquarters control. Tank mixing PRE herbicides tended to improve common lambsquarters control. PRE Verdict+AAtrex was an exception to this trend. The addition of AAtrex gave no improvement of lambsquarters control and may have caused slight antagonism. This was also observed at Moorhead in 2016. When only PRE Harness + Sharpen was applied, lambsquarters continue to germinate throughout the season and control dropped from 65% on June 1 to virtually no control on September 7. Widematch applied POST did not provide adequate lambsquarters control, and evaluations taken September

7 reflect only the strength of the PRE herbicide. A single POST application of Laudis+AAtrex gave 76% lambsquarters control at the final evaluation. However, two POST applications of Status+PowerMax or Widematch+Status+ PowerMax gave 100% lambsquarters control on September 7. Only these two treatments, both of which contained Roundup PowerMax, gave 100% lambsquarters control and demonstrate the value of glyphosate at controlling weeds.

The kochia population at this location has been documented to have some level of resistance to glyphosate. However, research at this location conducted over the last 5 years has provided mixed results when glyphosate is applied to kochia. The kochia density has also varied greatly from season to season with the density in 2016 being low to moderate. Kochia control in this trial on July 1 ranged from 65% to 100%. PRE Harness+Sharpen did not provide season-long control of kochia and gave 65% control on July 1 and 0% control on September 7. PRE Harness fb Buctril gave 78% kochia control on July 1 and PRE Harness fb Status gave 88% control. All other treatments gave greater than 90% control on July 1. The September 7 evaluation showed 90% or greater kochia control from most treatments. The three treatments that showed no kochia control were PRE Harness+Sharpen, PRE Harness fb Widematch, and PRE Sharpen fb Widematch. Widematch is usually a very good herbicide for use on kochia. The lack of observed kochia control from the two treatments containing Widematch is probably due to the heavy lambsquarters density at application and late in the season where observations may have been confounded due to the overall lack of lambsquarters control.

Redroot pigweed control was generally excellent in this trial with 11 of 14 treatments giving 96% to 100% pigweed control. The three treatments that gave no pigweed control also gave no lambsquarters or kochia control on September 7. These treatments were PRE Harness+Sharpen, PRE Harness fb Widematch, and PRE Sharpen fb Widematch. While Widematch is usually a very good herbicide for use on kochia, it is not a good herbicide for use on pigweed species. However, Harness is a very good PRE herbicide for use on pigweeds, but will rarely provide season-long control. The heavy lambsquarters density at application and late in the season may have confounded pigweed control evaluation for these three treatments.

CONCLUSIONS

Crop safety from the herbicides applied in this trial was good to excellent. Broad spectrum weed control was best achieved in this trial from two POST applications of Widematch+Status+Roundup PowerMax or Status+Roundup PowerMax. Using a PRE herbicide will generally provide a better foundation for season long weed control and reduce selection pressure on POST herbicides rather than using POST herbicides alone. However, in dry spring conditions as were seen in 2016, PRE herbicides fb a single POST application did not provide acceptable broad spectrum weed control. In these cases, a second POST application may be needed.

A SYSTEMS APPROACH FOR WATERHEMP CONTROL IN CORN IN A SUGARBEET ROTATION IN 2016 AT MOORHEAD, MN

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The objective of this study was to demonstrate a weed control system in corn using herbicides with a site of action different than EPSP synthase inhibitor (glyphosate) and have rotation flexibility with sugarbeet as a rotational crop the following season.

MATERIALS AND METHODS

An experiment was conducted near Moorhead, MN in 2016. The trial site was prepared using a Kongskilde 's-tine' field cultivator with rolling baskets on May 7, 2016. 'DKC38-04 RIB' corn was seeded in 22-inch rows at 32,000 seeds per acre on May 12 with a John Deere 1700XP 6-row planter. Preemergence (PRE) treatments were applied May 16. Postemergence (POST) treatments were applied June 14 and 23. All herbicide treatments were applied with a bicycle sprayer in 17 gpa spray solution through 8002 XR flat fan nozzles pressurized with CO_2 at 30 psi to the center four rows of six row plots 30 feet in length. Corn injury and common lambsquarters and waterhemp control were evaluated June 13, July 8, and August 24.

All corn injury and weed control evaluations were a visual estimate of percent fresh weight reduction in the four treated rows compared to the adjacent untreated strip. Experimental design was randomized complete block with 4 replications for each trial. Data were analyzed with the ANOVA procedure of ARM, version 2016.4 software package.

Table 1. Application Information – Moorhead, MN 2016

Application	A	B	C
Date	May 16	June 14	June 23
Time of Day	9:30 AM	9:30 AM	10:00 AM
Air Temperature (F)	51	65	65
Relative Humidity (%)	56	68	62
Wind Velocity (mph)	47	7	3
Wind Direction	N	SE	NW
Soil Temp. (F at 6")	48	68	64
Soil Moisture	Poor	Poor	Good
Cloud Cover (%)	80	100	0
Next Rainfall (amount)	May 25	June 14	June 29
Corn Stage	PRE	V6	V8
Common Lambsquarters	-	3 inch	4 inch
Waterhemp	-	2 inch	6 inch

SUMMARY

Corn injury from herbicides was minimal in this trial (Table 2). Preemergence Clarity may have slowed corn germination based upon observations from late May and early June. Corn injury observed on July 8 from PRE Harness+Sharpen was 23%, but declined to no visible injury on August 24. The cause of this visual injury on July 8 is unclear. POST applications showed some corn injury on July 8. This injury may be more attributed to weed competition rather than herbicide injury. Observations taken August 24 show little, if any, corn injury from herbicide treatments.

Table 2. Corn injury and weed control from herbicides at Moorhead, MN in 2016.

			------June 13-----			----------July 8----------				----August 24----		
Treatment	Rate	Appl[1]	corn	colq[2]	wahe	corn	colq	wahe	copu	corn	colq	wahe
			% inj	---%cntl---		% inj	-----% cntl-----			% inj	---% cntl---	
Harness + Sharpen	32 + 2.5 fl oz + fl oz	A	5	86	99	23	38	94	93	0	30	75
Harness + Clarity	32 + 16 fl oz + fl oz	A	16	95	99	5	85	93	100	0	83	100
Laudis+AAtrex[3]	3 + 12 fl oz + fl oz	B										
Harness + AAtrex	32 + 12 fl oz + fl oz	A	10	81	99	8	86	95	99	0	93	95
Status[3]	3.5 oz	B										
Harness	32 fl oz	A	0	66	94	0	94	95	100	0	98	96
Status[3]	3.5 oz	B										
Harness	32 fl oz	A	3	64	98	3	94	100	100	3	98	100
Laudis + AAtrex[3]	3 + 12 fl oz + fl oz	B										
Sharpen	2.5 fl oz	A	9	79	70	8	94	69	80	0	97	84
Status[3]	3.5 oz	B										
Sharpen	2.5 fl oz	A	9	81	68	5	95	93	94	0	94	96
Laudis + AAtrex[3]	3 + 12 fl oz + fl oz	B										
Verdict + AAtrex	13 + 12 fl oz + fl oz	A	9	84	89	0	99	89	95	0	98	91
Status[3]	3.5 oz	B										
Verdict	13 fl oz	A	5	83	94	10	99	98	99	3	100	98
Status[3]	3.5 oz	B										
Sharpen	2 fl oz	A	3	66	68	5	96	89	98	0	96	95
Warrant + Status +	48 + 3.5 fl oz + oz	B										
RU PowerMax[4]	28 fl oz	B										
Clarity	16 fl oz	A	11	73	60	0	100	96	100	0	100	99
Outlook + Laudis +	18 + 3 fl oz + fl oz	B										
AAtrex[3]	12 fl oz	B										
Laudis + AAtrex[3]	3 + 12 fl oz + fl oz	B	0	0	0	30	98	63	84	0	89	71
Status+PowerMax[4]	3.5 + 32 oz + fl oz	B	0	0	0	25	96	48	100	0	94	60
Laudis + AAtrex[3]	3 + 12 fl oz + fl oz	B	0	0	0	10	100	100	100	0	100	100
Status+PowerMax[4]	3.5 + 32 oz + fl oz	C										
LSD (0.05)			**NS**	**8.8**	**6.9**	**11.4**	**11.3**	**8.8**	**8.9**	**NS**	**12.3**	**20.1**

[1]Appl refers to application information in Table 1. A=PRE, B=POST applied June 14, C=POST applied June 23
[2]colq=common lambsquarters; wahe=waterhemp; copu=common purselane
[3]Indicates addition of Methylated Seed Oil (MSO) at 1.5 pt/A. Product provided by Loveland.
[4]Indicates addition of Ammonium Sulfate (AMS) at 8.5 lb/100 gal + High Surfactant Methylated Seed Oil Concentrate (HSMOC) at 1.5 pt/A. N-Pak AMS and Destiny HC (HSMOC) were provided by Winfield.

Common purslane was sporadically present in most areas of this trial. Purslane control was evaluated July 8 as 93% to 100% control by all PRE fb POST herbicide treatments except Sharpen fb Status which gave only 80% control. Laudis+AAtrex POST gave 84% purslane control and was the only other treatment to give less than 90% control. POST treatments containing PowerMax gave 98% to 100% purslane control.

Common lambsquarters control varied by herbicide treatment and evaluation timing. Lambsquarters control from PRE herbicides was evaluated June 13 and ranged from 64% to 95%. PRE Harness gave 64% to 66% lambsquarters control. PRE Sharpen at 2.5 fl oz/A gave 79% to 81% control while PRE Sharpen at 2 fl oz/A gave 66% lambsquarters control. PRE Clarity and PRE Verdict gave 73% and 83% lambsquarters control, respectively. PRE Verdict+AAtrex gave similar lambsquarters control to PRE Verdict. When only PRE Harness + Sharpen was applied, lambsquarters continue to germinate throughout the season and control dropped from 86% on June 13 to 30% on August 24. PRE Harness+Clarity gave 95% lambsquarters control on June 13, but control dropped to 83% on August 24 despite a POST application of Laudis+AAtrex. This was the only PRE fb POST treatment to give less than 93% lambsquarters control on August 24. A single POST application of Laudis+AAtrex or Status+Roundup PowerMax resulted in 89% and 94% lambsquarters control at the final evaluation. Dry conditions early in the 2016 growing season may have conditioned lambsquarters to have a thicker waxy cuticle which make herbicide retention and absorption more difficult than under ideal growing conditions. Two POST applications, Laudis+AAtrex fb Status+PowerMax gave 100% lambsquarters control on August 24.

Waterhemp at this location is known to have some level of resistance to glyphosate. Waterhemp control from two or three glyphosate applications ranged from 34% to 66% in trials at this location in 2016. Treatments containing PRE Harness provided excellent waterhemp control ranging from 94% to 99% on June 13. PRE Verdict gave 94% waterhemp control. PRE Sharpen at 2 or 2.5 fl oz/A gave waterhemp control ranging from 68% to 70%, while PRE Clarity gave 60% waterhemp control. PRE Verdict+AAtrex gave similar, to slightly less, waterhemp control than PRE Verdict. Due to the duration of waterhemp germination and emergence, PRE Harness+Sharpen did not provide season long control and gave only 75% waterhemp control by August 24. Sharpen fb Status gave only 84% waterhemp control and was the only PRE fb POST treatment that gave less than 91% waterhemp control at the end of the season. A single POST application of Laudis+AAtrex or Status+PowerMax gave 71% or 60% waterhemp control, respectively, on August 24. However, making sequential applications of Laudis+AAtrex fb Status+PowerMax gave 100% waterhemp control at the end of the season.

CONCLUSIONS

Crop safety from the herbicides applied in this trial was good to excellent. Corn germination may have been slowed by PRE Clarity, but corn outgrew any visual symptoms midway through the growing season. PRE herbicides varied in controlling common lambsquarters early in the season. Verdict gave 83% lambsquarters control prior to any POST herbicide applications followed by Sharpen at 2.5 fl oz/A at 80%, Clarity at 73%, Sharpen at 2 fl oz/A at 66%, and Harness at 65%. However, a PRE tank mix of Harness+Sharpen gave 86% lambsquarters control and Harness+Clarity gave 95% control prior to POST applications. Waterhemp control also varied by PRE herbicide. Harness gave 96% waterhemp control followed by Verdict at 94%, Sharpen at 69%, and Clarity at 60%. Again, a PRE tank mix of Harness+Sharpen or Harness+Clarity gave 99% waterhemp control. Three PRE fb POST treatments gave 98% or greater control of both waterhemp and common lambsquarters. One of these treatments, PRE Clarity fb Outlook+Laudis+AAtrex, included a residual herbicide, Outlook, applied postemergence to the crop, but preemergence to waterhemp. This application can be considered a 'lay-by' application and it proved very effective this season. A single application of POST herbicide gave less than acceptable control of waterhemp at 60% to 71% and good control of common lambsquarters at 89% to 94%. In order to provide excellent control of both weed species, two POST applications of differing herbicides needed to be made. Rotating modes of action will help reduce selection pressure on tough to control weeds, thereby slowing the development of herbicide resistant weeds.

A SYSTEMS APPROACH FOR WATERHEMP CONTROL IN CORN IN A SUGARBEET ROTATION AT WHEATON, MN IN 2016

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The objective of this study was to demonstrate a weed control system in corn using herbicides with a 'site of action' different than EPSP synthase inhibitor (glyphosate) and have rotation flexibility with sugarbeet as a rotational crop the following season.

MATERIALS AND METHODS

An experiment was conducted near Wheaton, MN in 2016. The trial site was prepared by the grower cooperator on May 15, 2016. 'DKC38-04 RIB' Dekalb corn was seeded in 22-inch rows at 32,000 seeds per acre on May 17 with a John Deere 1700XP 6-row planter. Preemergence (PRE) treatments were applied May 18. Postemergence (POST) treatments were applied June 21. All herbicide treatments were applied with a bicycle sprayer in 17 gpa spray solution through 8002 XR flat fan nozzles pressurized with CO_2 at 30 psi to the center four rows of six row plots 30 feet in length. Corn injury and common lambsquarters, redroot pigweed, and waterhemp control were evaluated June 29, July 18, and August 31. Only data from August 31 will be discussed.

All corn injury and weed control evaluations were a visual estimate of percent fresh weight reduction in the four treated rows compared to the adjacent untreated strip. Experimental design was randomized complete block with 4 replications for each trial. Data were analyzed with the ANOVA procedure of ARM, version 2016.4 software package.

Table 1. Application Information – Wheaton, MN 2016

Date	May 18	June 21
Time of Day	12:00 PM	11:00 AM
Air Temperature (F)	72	75
Relative Humidity (%)	27	40
Wind Velocity (mph)	4.5	2
Wind Direction	SE	NW
Soil Temp. (F at 6")	56	70
Soil Moisture	Poor	Poor
Cloud Cover (%)	10	10
Next Rainfall (amount)	May 25	July 10
Corn Stage	PRE	V8 – V10
Common Lambsquarters	-	7 inch
Waterhemp	-	7 inch

SUMMARY

This trial had large amounts of variability throughout the growing season. Corn emergence was variable due to dry conditions at planting. Weed pressure was variable across the trial as well. Due to these inconsistencies, only data from August 31 evaluation (Table 2.) will be discussed. Data should be interpreted with a level of caution due to these variabilities.

Table 2. Corn injury and weed control on August 31, 2016 at Wheaton, MN.

Treatment	Rate/A	Appl[1]	corn	colq[2]	wahe
			% inj	% cntl	% cntl
Harness + Sharpen	32 + 2.5 fl oz + fl oz	PRE	8	75	100
Harness + Clarity	32 + 16 fl oz + fl oz	PRE	5	100	100
Laudis+AAtrex[3]	3 + 12 fl oz + fl oz	post			
Harness + AAtrex	32 + 12 fl oz + fl oz	PRE	10	100	100
Status[3]	3.5 oz	post			
Harness	32 fl oz	PRE	5	100	98
Status[3]	3.5 oz	post			
Harness	32 fl oz	PRE	3	98	100
Laudis + AAtrex[3]	3 + 12 fl oz + fl oz	post			
Sharpen	2.5 fl oz	PRE	0	100	100
Status[3]	3.5 oz	post			
Sharpen	2.5 fl oz	PRE	5	98	100
Laudis + AAtrex[3]	3 + 12 fl oz + fl oz	post			
Verdict + AAtrex	13 + 12 fl oz + fl oz	PRE	0	100	100
Status[3]	3.5 oz	post			
Verdict	13 fl oz	PRE	3	100	99
Status[3]	3.5 oz	post			
Sharpen	2 fl oz	PRE	5	100	100
Warrant + Status +	48 + 3.5 fl oz + oz	post			
RU PowerMax[4]	28 fl oz	post			
Clarity	16 fl oz	PRE	3	85	95
Outlook + Laudis +	18 + 3 fl oz + fl oz	post			
AAtrex[3]	12 fl oz	post			
Laudis + AAtrex[3]	3 + 12 fl oz + fl oz	post	3	90	93
Status + RU PowerMax[4]	3.5 + 32 oz + fl oz	post	0.0	98	88
LSD (0.05)			NS	13.8	7.1

[1]Appl refers to application information in Table 1. PRE herbicides were applied May 18 and post herbicides applied June 21.
[2]colq=common lambsquarters; wahe=waterhemp
[3]Indicates addition of Methylated Seed Oil (MSO) at 1.5 pt/A. Product provided by Loveland.
[4]Indicates addition of Ammonium Sulfate (AMS) at 8.5 lb/100 gal + High Surfactant Methylated Seed Oil Concentrate (HSMOC) at 1.5 pt/A. N-Pak AMS and Destiny HC (HSMOC) were provided by Winfield.

Corn injury was observed in late August as "firing" of lower leaves. Treatments containing a PRE tended to show slightly more firing of lower leaves than treatments without a PRE. However, corn injury was not statistically significantly among treatments.

Common lambsquarters control varied from 75% from PRE Harness+Sharpen to 100% from many treatments. Treatments containing both a PRE and POST herbicide program tended to give greater and more consistent lambsquarters control compared to treatments containing only POST herbicides. The exception to this trend was PRE Clarity at 1 pt/A fb POST Outlook at 18 fl oz + Laudis at 3 fl oz + AAtrex at 12 fl oz + MSO at 1.5 pt/A which gave only 85% lambsquarters control.

Waterhemp control varied from 88% from POST Status at 3.5 oz + PowerMax at 32 fl oz + AMS at 8.5 lb/100 gal + Destiny HC at 1.5 pt to 100% from many treatments. Similarly to lambsquarters, treatments containing a PRE fb POST

program tended to give greater waterhemp control than the POST only program. Harness PRE fb Status POST gave 98% waterhemp control. Verdict PRE fb Status POST gave 99% waterhemp control. Increasing the rate of Status from 3.5 oz/A to 5-10 oz/A would likely improve waterhemp control to 100% from these treatments. Clarity PRE fb Outlook+Laudis+AAtrex+MSO POST gave 95% waterhemp control. Outlook herbicide requires rainfall for activation and provides little, if any, control of emerged waterhemp. The dry spring may account for some reduction in control from this treatment.

CONCLUSIONS

Variability in this study reduced the overall quality of the data. However, a trend was still observed that pointed toward improved weed control from a PRE fb POST weed control system compared to a POST only system. Corn injury from the herbicides used was generally slight and was statistically similar across treatments.

COMMON LAMBSQUARTERS AND KOCHIA CONTROL IN LIBERTY LINK AND XTEND SOYBEAN AS PART OF A SUGARBEET ROTATION IN 2016 AT BARNEY, ND

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The objective of this study was to demonstrate a weed control system in soybean using herbicides with a site of action different than EPSP synthase inhibitor (glyphosate) and have rotation flexibility with sugarbeet as a rotational crop the following season.

MATERIALS AND METHODS

An experiment was conducted near Barney, ND in 2016. The trial site was prepared using a Kongskilde 's-tine' field cultivator with rolling baskets on May 4, 2016. 'L08-14' Liberty Link and '16X07N' Roundup Ready 2Xtend soybean from Peterson Farm Seed was seeded in 22-inch rows at 160,000 seeds per acre on May 4 with a John Deere 1700XP 6-row planter. Liberty Link soybean were seeded in one block that was 7 treatments wide by 4 replications deep and Xtend soybean were seeded in an adjacent block with the same dimensions. Preemergence (PRE) treatments were applied May 4. Postemergence (POST) treatments were applied May 24, June 2, and June 21. All herbicide treatments were applied with a bicycle sprayer in 17 gpa spray solution through 8002 XR flat fan nozzles pressurized with CO_2 at 30 psi to the center four rows of six row plots 30 feet in length. Soybean injury and common lambsquarters and kochia control were evaluated June 1, 22, 29, and September 7. Data from June 22 are not shown in this publication.

All soybean injury and weed control evaluations were a visual estimate of percent fresh weight reduction in the four treated rows compared to the adjacent untreated strip. Experimental design was randomized complete block with 4 replications for each trial. Data were analyzed with the ANOVA procedure of ARM, version 2015.6 software package.

Table 1. Application Information – Barney, ND 2016

Application	A	B	C	D
Date	May 4	May 24	June 2	June 21
Time of Day	1:00 PM	3:00 PM	9:00 AM	3:30 PM
Air Temperature (F)	69	86	59	83
Relative Humidity (%)	24	29	60	32
Wind Velocity (mph)	7	5	6	7
Wind Direction	NNW	SW	NW	W
Soil Temp. (F at 6")	59	70	54	70
Soil Moisture	Good	Fair	Good	Fair
Cloud Cover (%)	0	70	10	30
Next Rainfall (amount)	May 11	May 25	June 3	June 22
Corn Stage	PRE	VC	V2	V4
Common Lambsquarters	-	1 inch	3 inch	1 inch
Kochia	-	1 inch	2 inch	3 inch
Redroot Pigweed	-		2 inch	1 inch

SUMMARY

Xtend soybean are tolerant to both dicamba and glyphosate. Soybean injury was observed from treatments containing Cobra (Table 2) following the first POST application (application B). Injury ranged from 45 to 50% with the greater levels of injury coming from Sharpen PRE fb Cobra. No other treatments caused soybean injury following the first POST application. Injury was observed from other treatments following the second POST application but may be partially attributed to weed competition as Xtend soybean showed 19% injury on June 29 following two applications of Roundup PowerMax.

Table 2. Soybean injury and weed control in Liberty and Xtend soybeans at Barney, ND in 2016.

			-------June 1-------			------June 29-------			---Sept 7---	
Treatment	Rate	Appl[1]	soyb[2]	kocz	colq	soyb	kocz	colq	kocz	colq
			% inj	%cntl	%cntl	% inj	%cntl	%cntl	%cntl	%cntl
Dual Magnum+Sharpen	1.3+1 pt + fl oz	A	0	0	60	11	61	40	17	87
Liberty[3]	29 fl oz	C								
Dual Magnum+Valor SX	1.3+2.5 pt + oz	A	0	0	53	10	49	53	27	75
Liberty[3]	29 fl oz	C								
Sharpen	1 fl oz	A	50	100	84	45	100	61	100	48
Cobra[4]	10 fl oz	B								
Cobra[4]	10 fl oz	D								
Sharpen	1 fl oz	A	0	93	89	14	75	60	45	40
Basagran[5]	0.8 pt	B								
Basagran[5]	0.8 pt	D								
Liberty[3]	29 fl oz	B	0	93	86	14	94	75	82	68
Liberty[3]	29 fl oz	D								
Liberty[3] + Cobra[4]	22 + 8 fl oz+fl oz	B	45	100	90	43	100	76	100	61
Liberty[3] + Cobra[4]	22 + 8 fl oz+fl oz	D								
Liberty[3] + Basagran[5]	22+0.8 fl oz + pt	B	0	95	90	21	89	71	60	53
Liberty[3] + Basagran[5]	22+0.8 fl oz + pt	D								
Warrant + Sharpen	3 + 1 pt + fl oz	A	0	0	38	13	81	79	68	89
Engenia + RU PowerMax[6]	12.8+32 fl oz+fl oz	C								
Warrant	3 pt	A	0	99	96	3	100	96	100	100
Engenia + RU PowerMax[6]	12.8+32 fl oz+fl oz	B								
Engenia + RU PowerMax[6]	12.8+32 fl oz+fl oz	D								
Engenia	25.6 fl oz	A	0	100	98	4	94	99	97	100
Engenia + Warrant	12.8+3 fl oz + pt	B								
RU PowerMax[7]	32 fl oz/a	D								
Sharpen	1 fl oz/a	A	0	98	93	11	88	88	73	98
Engenia + Warrant	12.8+3 fl oz + pt	B								
RU PowerMax[7]	32 fl oz/a	D								
Engenia + RU PowerMax[6]	12.8+28 fl oz+fl oz	B	0	100	95	8	96	98	100	100
Engenia + RU PowerMax[6]	12.8+28 fl oz+fl oz	D								
Engenia + RU PowerMax	12.8+28 fl oz+fl oz	BD								
+Basagran[6]	+0.8 +pt	BD	0	100	98	9	96	99	100	100
RU PowerMax[7]	32 fl oz/a	B	0	60	88	19	32	76	45	88
RU PowerMax[7]	32 fl oz/a	D								
LSD (0.05)			**4.9**	**13.7**	**15.6**	**11.8**	**20.3**	**10.7**	**20.9**	**16.7**

[1]Appl refers to application information in Table 1.
[2]soyb=soybean; kocz=kochia; colq=common lambsquarters
[3]Indicates addition of ammonium sulfate (AMS) at 17 lb/100 gal (5% v/v). N-Pak AMS provided by Winfield.
[4]Indicates addition of crop oil concentrate (COC) at 1.5 pt/A. Cornbelt COC used.
[5]Indicates addition of methylated seed oil (MS) at 1.5 pt/A. MSO provided by Loveland.
[6]Indicates addition of Class Act Ridion at 1 %v/v provided by Winfield.
[7]Indicates addition of ammonium sulfate (AMS) at 8.5 lb/100 gal and non-ionic surfactant (NIS) at 0.25% v/v. N-Pak AMS provided by Winfield and Prefer 90 NIS provided by West Central, Inc.

Common lambsquarters control was generally greater from Roundup PowerMax or Engenia containing treatments than from Liberty containing treatments. The spring of 2016 was relatively dry and activation of PRE herbicides was difficult. Preemergence applications of Dual Magnum+Sharpen, Dual Magnum+Valor, or Warrant+Sharpen provided only 40% to 60% lambsquarters control prior to applying POST herbicides. In the Liberty Link system, the treatments containing a PRE fb Liberty gave the greatest lambsquarters control from 75% to 87%. Preemergence Sharpen fb two applications of Cobra or Basagran gave 48% and 40% lambsquarters control, respectively. Adding Liberty to both applications of Cobra or Basagran tended to increase control compared to Cobra or Basagran alone, but tended to decrease lambsquarters control compared to making two applications of Liberty. In the Xtend system, common lambsquarters control was greatest from treatments containing Engenia, regardless of whether a PRE had been applied or not. Warrant+Sharpen applied PRE fb Engenia+Roundup PowerMax applied June 2 gave 89% lambsquarters control and was similar to control from two applications of Roundup PowerMax which gave 88% control. All other treatments, which contained Engenia, gave 98% to 100% lambsquarters control on September 7.

No kochia control was observed from any PRE treatments prior to the first POST application being made. Sharpen and Valor SX have both shown good kochia control in other trials, but the lack of activating rainfall kept these herbicides from performing up to their potential. Kochia control at the end of the season was less than 30% when Liberty was applied once following a PRE herbicide. Two applications of Liberty with no PRE herbicide gave 82% kochia control on September 7. Basagran, either alone or with Liberty, gave only 45% and 60% kochia control, respectively, at the end of the season. Cobra, however, applied alone or with Liberty gave 100% kochia control at the end of the season. In the Xtend system, treatments containing 2 applications of Engenia, either PRE fb POST or two POST applications gave 97% to 100% kochia control at the end of the season. One application of Engenia, regardless of the PRE herbicide applied, gave 68% to 73% kochia control. Two applications of Roundup PowerMax gave only 45% kochia control and indicates the presence of glyphosate resistant kochia at this location.

CONCLUSIONS

Liberty herbicide, while very effective at controlling many weeds, can have difficulty controlling hard to wet weeds. Achieving good to excellent spray droplet retention on the leaf surfaces of both kochia and common lambsquarters is difficult due to the hairy pubescence of kochia and waxy cuticle of lambsquarters. Since Liberty is only a contact herbicide, spray droplet retention is critical. Environment at, and following, Liberty application is incredibly important to maximize Liberty efficacy. Information regarding Liberty can be found in the North Dakota Weed Control Guide (W-253) in paragraph B9. Kochia control in the Liberty system was 100% from two applications of Cobra, either with or without Liberty. Lambsquarters control was greatest at 87% from PRE Dual Magnum+Sharpen fb Liberty.

Roundup Ready2 Xtend soybean show excellent promise at helping growers control difficult weeds such as lambsquarters and kochia. Two POST applications or a PRE fb POST application of Engenia was needed to achieve 97% to 100% kochia control in this trial. A single application of Engenia, even following a PRE herbicide, gave only 68% to 73% kochia control. Lambsquarters control was greatest from treatments containing two POST applications of at least two different herbicides. Applying herbicides with multiple effective modes of action can greatly increase control of difficult to control weeds such as lambsquarters, even in the Xtend system.

A SYSTEMS APPROACH FOR WEED CONTROL IN SOYBEAN IN A SUGARBEET ROTATION AT MOORHEAD, MN IN 2016

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The objective of this study was to demonstrate a weed control system in soybean using herbicides with a site of action different than EPSP synthase inhibitor (glyphosate) and have rotation flexibility with sugarbeet as a rotational crop the following season.

MATERIALS AND METHODS

An experiment was conducted near Moorhead, MN in 2016. The trial site was prepared using a Kongskilde 's-tine' field cultivator with rolling baskets on May 7, 2016. 'L08-14' Liberty Link soybean from Peterson Farm Seed was seeded in 22-inch rows at 160,000 seeds per acre on May 12 with a John Deere 1700XP 6-row planter. Preemergence (PRE) treatments were applied May 16. Postemergence (POST) treatments were applied June 14 and 23. All herbicide treatments were applied with a bicycle sprayer in 17 gpa spray solution through 8002 XR flat fan nozzles pressurized with CO_2 at 30 psi to the center four rows of six row plots 30 feet in length. Soybean injury and common lambsquarters and waterhemp control were evaluated June 13, July 7, and August 24.

All soybean injury and weed control evaluations were a visual estimate of percent fresh weight reduction in the four treated rows compared to the adjacent untreated strip. Experimental design was randomized complete block with 4 replications for each trial. Data were analyzed with the ANOVA procedure of ARM, version 2016.4 software package.

Table 1. Application Information – Moorhead, MN 2016

Date	May 16	June 14	June 23
Time of Day	1:00 PM	10:00 AM	9:00 AM
Air Temperature (F)	67	67	65
Relative Humidity (%)	32	68	62
Wind Velocity (mph)	8	7	3
Wind Direction	N	SE	NW
Soil Temp. (F at 6")	51	68	64
Soil Moisture	Fair	Poor	Good
Cloud Cover (%)	20	100	0
Next Rainfall (amount)	May 25	June 14	June 29
Soybean Stage	PRE	V1 – V2	V4
Common Lambsquarters	-	2.5 inch	3 inch
Waterhemp	-	3 inch	5 inch

SUMMARY

Under normal planting conditions, crop seeds are planted into soils with some moisture and begin to absorb water and begin the germination and emergence process immediately. Preemergence herbicides can then be applied, but will require rainfall for activation. The 2016 spring conditions at Moorhead were not normal. Soils were very dry at planting and seeds did not begin to absorb water until rainfall occurred. The rainfall began the germination process and activated PRE herbicides at the same time. Soybean injury was observed from treatments containing dimethanamid-P (Outlook and Verdict) and saflufanacil (Sharpen and Verdict) (Table 2). Injury from dimethanamid-P was related to rate. Outlook applied PRE at 14 fl oz/A + Verdict gave 30% injury on June 13 compared to Outlook at 8 fl oz/A + Verdict giving 14% injury. Injury from Sharpen + Warrant tended to be greater than injury from Sharpen alone. Injury from PRE herbicides had generally diminished by the July 7 evaluation. Soybean injury from Cobra observed on July 7 was 30% to 33% and symptoms were leaf necrosis and reduced plant growth. Injury from all treatments had diminished to insignificant levels by August 24.

Table 2. Soybean injury and weed control from herbicides at Moorhead, MN in 2016.

Treatment	Rate	Appl[1]	-------June 13-------			--------July 7--------			---Aug 24---	
			soyb[2]	colq	wahe	soyb	colq	wahe	soyb	colq
			%inj	%cntl	%cntl	%inj	%cntlj	%cntl	%inj	%cntl
Valor SX+Dual Magnum	2+21 oz+fl oz	A	8	79	99	13	71	94	0	43
Liberty[3]	29 fl oz/a	B								
Valor SX+Dual Magnum	2+12 oz+fl oz	A	8	79	86	9	71	93	0	38
Liberty+Dual Magnum[3]	29+12 fl oz+fl oz	B								
Valor SX	2 oz	A	0	61	68	8	61	76	0	13
Liberty+Dual Magnum[3]	29+21 fl oz+fl oz	B								
Verdict+Outlook	5+14 fl oz+fl oz	A	30	79	100	11	69	96	0	40
Liberty[3]	29 fl oz/a	B								
Verdict+Outlook	5+8 fl oz+fl oz	A	14	66	94	11	64	94	0	28
Liberty+Outlook[3]	29+12 fl oz+fl oz	B								
Sharpen	1 fl oz/a	A	13	43	38	11	54	66	0	10
Liberty+Outlook[3]	29+18 fl oz+fl oz	B								
Sharpen+Warrant	1+52 fl oz+fl oz	A	21	74	98	13	73	90	0	30
Liberty[3]	29 fl oz/a	B								
Sharpen+Warrant	1+32 fl oz+fl oz	A	15	63	73	10	55	98	0	5
Liberty+Warrant[3]	29+32 fl oz+fl oz	B								
Sharpen	1 fl oz/a	A	11	54	28	15	35	48	0	3
Liberty+Warrant[3]	29+52 fl oz+fl oz	B								
Liberty[3]	29 fl oz/a	BC	0	0	0	5	84	80	0	75
Liberty+Basagran[3,4]	22+13 fl oz+fl oz	BC	0	0	0	0	96	74	0	53
Liberty+Cobra[3,5]	22+8 fl oz+fl oz	BC	0	0	0	33	79	100	3	40
Basagran+Cobra[4]	13+8 fl oz+fl oz	BC	0	0	0	30	58	94	0	13
LSD (0.05)			**12.2**	**21.4**	**16.1**	**11.8**	**13.5**	**10.1**	**NS**	**26.5**

[1]Appl refers to application information in Table 1.
[2]soyb=soybean; colq=common lambsquarters; wahe=waterhemp
[3]Indicates addition of ammonium sulfate (AMS) at 2.9 lb/A. N-Pak AMS used at 5 %v/v and provided by Winfield.
[4]Indicates addition of methylated seed oil (MSO) at 1.5 pt/A. MSO provided by Loveland.
[5]Indicates addition of crop oil concentrate (COC) at 1.5 pt/A. Cornbelt COC used.

Waterhemp control varied by treatment and evaluation timing. Preemergence herbicides were applied either as an individual product or as a tank-mix. Tank mixtures of PRE herbicides always gave greater waterhemp control than individual PRE herbicides. Applying Dual Magnum as a full rate PRE herbicide, or a split rate PRE fb lay-by herbicide, gave greater waterhemp control than applying Dual Magnum strictly as a full rate lay-by herbicide. The same observation was made with Outlook and Warrant.

This trial had tremendous common lambsquarters density. Lambsquarters control, though poor, was generally greatest from a full rate PRE herbicide tank mix compared to split rate PRE fb lay-by herbicide, or a strict full rate lay-by herbicide. No PRE fb POST treatment gave adequate season-long lambsquarters control. Two applications of Liberty gave the greatest lambsquarters control at 75% on August 24. Two applications of Liberty+Basagran or Liberty+Cobra gave 53% and 40% lambsquarters control, respectively, on August 24.

CONCLUSIONS

Growing conditions in 2016 made weed control in Liberty Link soybeans quite difficult, especially in regard to lambsquarters. Preemergence herbicides provided some early season control of lambsquarters, but dry conditions did not allow for maximum activation and efficacy of these herbicides. When herbicide activation was achieved, soybean seed germination was also just beginning and some injury was observed. Weather conditions at time of application are very important in maximizing Liberty efficacy. The first POST application (application 'B') was made on June 14 when skies were cloudy, air temperature was 67 F, and soils were dry. Achieving good to excellent spray droplet retention on lambsquarters can be difficult in normal growing conditions, but under dry conditions, spray droplet retention is incredibly challenging. These challenging environmental conditions may account for the abnormally poor lambsquarters control observed throughout this trial. Similar environmental conditions at application were recorded in trials at Barney, ND in 2015 and similarly poor lambsquarters control was observed. Maximizing Liberty efficacy is discussed at length in the North Dakota Weed Control Guide (W-253) in paragraph B9.

AN EVALUATION OF WEED CONTROL IN XTEND SOYBEAN AT MOORHEAD, MN IN 2016

Thomas J. Peters[1] and Andrew B. Lueck[2]

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The objective of this study was to evaluate weed control systems options that combine at least two, and preferably three, sites of action for controlling waterhemp in RR2 Xtend soybean in a field in sequence with Roundup Ready sugarbeet.

MATERIALS AND METHODS

An experiment was conducted near Moorhead, MN in 2016. The trial site was prepared using a Kongskilde 's-tine' field cultivator with rolling baskets on May 7, 2016. '16X07N' Roundup Ready 2Xtend soybean from Peterson Farm Seed was seeded in 22-inch rows at 160,000 seeds per acre on May 12 with a John Deere 1700XP 6-row planter. Preemergence (PRE) treatments were applied May 16. Postemergence (POST) treatments were applied June 14 and 23. All herbicide treatments were applied with a bicycle sprayer in 17 gpa spray solution through 8002 XR flat fan nozzles pressurized with CO_2 at 30 psi to the center four rows of six row plots 30 feet in length. Soybean injury along with common lambsquarters and waterhemp control were evaluated June 13, July 7, and August 24.

All soybean injury and weed control evaluations were a visual estimate of percent fresh weight reduction in the four treated rows compared to the adjacent untreated strip. Experimental design was randomized complete block with 4 replications for each trial. Data were analyzed with the ANOVA procedure of ARM, version 2016.4 software package.

Table 1. Application Information – Moorhead, MN 2016

Date	May 16	June 14	June 23
Time of Day	1:00 PM	10:00 AM	9:00 AM
Air Temperature (F)	67	67	65
Relative Humidity (%)	32	68	62
Wind Velocity (mph)	8	7	3
Wind Direction	N	SE	NW
Soil Temp. (F at 6")	51	68	64
Soil Moisture	Fair	Poor	Good
Cloud Cover (%)	20	100	0
Next Rainfall (amount)	May 25	June 14	June 29
Soybean Stage	PRE	V1 – V2	V4
Common Lambsquarters	-	2.5 inch	3 inch
Waterhemp	-	3 inch	5 inch

SUMMARY

Xtend soybeans are tolerant to both dicamba and glyphosate. Crop injury was generally negligible from all treatments evaluated in this trial (Table 2). Slight soybean height reduction was observed on July 7 from POST only applications, but this injury may have been due more to early season weed competition than actual herbicide phytotoxicity. No significant soybean injury was observed at the August 24 evaluation.

Table 2. Soybean injury and weed control in Xtend soybeans at Moorhead, MN in 2016.

			------June 13------			--------July 7--------			-----August 24-----		
Treatment	Rate	Appl[1]	soyb[2]	colq	wahe	soyb	colq	wahe	soyb	colq	wahe
			% inj	%cntl	%cntl	% inj	%cntl	%cntl	% inj	%cntl	%cntl
Warrant	3.25 pt	A	6	70	85	3	99	79	0	98	86
Engenia+PMax[3]	12.8+32 fl oz+fl oz	B									
Warrant+Sharpen	3+1 pt + fl oz	A	0	88	93	3	98	86	5	100	89
Engenia+PMax[3]	12.8+32 fl oz+fl oz	B									
Warrant	3 pt	A	0	64	80	0	100	99	3	100	100
Engenia+PMax[3]	12.8+28 fl oz+fl oz	B									
Engenia+PMax[3]	12.8+28 fl oz+fl oz	C									
Warrant	3.25 pt	A	0	76	84	0	98	80	5	100	93
Engenia	12.8 fl oz	B									
RU PowerMax[4]	32 fl oz	C									
Engenia	25.6 fl oz	A	0	94	81	0	100	81	3	100	91
Engenia+Warrant	12.8+3 fl oz + pt	B									
RU PowerMax[4]	32 fl oz	C									
Sharpen	1 fl oz	A	3	85	41	5	99	68	3	100	70
Engenia+Warrant	12.8+3 fl oz + pt	B									
RU PowerMax[4]	32 fl oz	C									
Warrant	2.25 pt	A	0	53	64	0	96	83	0	100	89
Engenia+Warrant	12.8+2.25 fl oz + pt	B									
RU PowerMax[4]	32 fl oz	C									
Engenia+PMax[3]	12.8+28 fl oz+fl oz	B	0	0	0	13	99	89	10	96	99
Engenia+PMax[3]	12.8+28 fl oz+fl oz	C									
Engenia+PMax	12.8+28 fl oz+fl oz	BC	0	0	0	15	99	90	8	98	99
+Basagran[3]	+12.8 +fl oz	BC									
RU PowerMax[4]	32 fl oz	B	0	0	0	10	100	43	0	100	40
RU PowerMax[4]	32 fl oz	C									
LSD (0.05)			**NS**	**12.2**	**10.7**	**9.7**	**NS**	**13.2**	**NS**	**NS**	**15.1**

[1]Appl refers to application information in Table 1.
[2]soyb=soybean; colq=common lambsquarters; wahe=waterhemp
[3] PMax=Roundup PowerMax and indicates addition of Class Act Ridion at 1 %v/v provided by Winfield.
[4]Indicates addition of ammonium sulfate (AMS) at 8.5 lb/100 gal and non-ionic surfactant (NIS) at 0.25% v/v. N-Pak AMS provided by Winfield and Prefer 90 NIS provided by West Central, Inc.

Common lambsquarters control varied considerably by PRE herbicide early in the season. On June 13, PRE Warrant at 2.25, 3, and 3.25 pt/a gave 53%, 64%, and 73% lambsquarters control, respectively. Preemergence Sharpen at 1 fl oz/A gave 85% lambsquarters control, and a tank-mix of PRE Warrant at 3 pt/a + Sharpen at 1 fl oz/A gave 88% lambsquarters control. Preemergence Enginia at 25.6 fl oz/A gave the greatest lambsquarters control of all PRE herbicides at 94%. All POST applications contained Roundup PowerMax and no significant differences in lambsquarters control were observed among treatments on either July 7 or August 24.

Waterhemp control early in the season also varied considerably by PRE herbicide. Preemergence Warrant at 3 pt/A+Sharpen at 1 fl oz/A gave the greatest waterhemp control on June 13 at 93%. Warrant at 3.25 or 3 pt/A gave 85% and 80% control, respectively, which was similar to 81% control from Enginia at 25.6 fl oz/A. Reducing the Warrant rate to 2.25 pt/A reduced waterhemp control to 64%, and PRE Sharpen at 1 fl oz/A gave only 41% waterhemp control.

Waterhemp control at the end of the season was generally greater from two POST Enginia applications compared to 1 POST Enginia application. Two POST applications of Engina, regardless of whether a PRE herbicide was applied or not, gave 99% to 100% waterhemp control. Where only 1 POST Engina application was made, waterhemp control ranged from 70% to 93% on August 24. The greatest and most consistent waterhemp control throughout the season came from Warrant applied PRE at 3 pt/A fb two POST applications of Engina at 12.8 fl oz/A+Roundup PowerMax at 28 fl oz/A. Two applications of Roundup PowerMax gave only 40% control of waterhemp which indicates the presence of glyphosate resistant waterhemp in this trial.

CONCLUSIONS

Soybean injury was generally negligible in this trial, though some leaf necrosis was observed when Basagran was applied in a tank-mix with Enginia+Roundup PowerMax. Common lambsquarters control was greater than 95% at the end of the season from all treatments. However, early season control did vary by PRE herbicide and Engina at 25.6 fl oz/A, Warrant at 3 pt/A+Sharpen at 1 fl oz/A, and Sharpen at 1 fl oz/A gave 94%, 88%, and 85% lambsquarters control on June 13. The greatest waterhemp control was achieved from two POST applications of Enginia. However, repeated use of the same herbicide is what selects for tolerant biotypes and speeds herbicide resistance development in weeds. Applying PRE Warrant at 3 pt/A gave 80% waterhemp control on June 13 and following Warrant with sequential POST applications of Enginia+Roundup PowerMax gave 100% waterhemp control on August 24.

A SYSTEMS APPROACH FOR WATERHEMP CONTROL IN SOYBEAN IN A SUGARBEET ROTATION AT WHEATON, MN IN 2016

Thomas J. Peters[1] and Andrew B. Lueck[2]

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The objective of this study was to demonstrate a weed control system in soybean using herbicides with a site of action different than EPSP synthase inhibitor (glyphosate) and have rotation flexibility with sugarbeet as a rotational crop the following season.

MATERIALS AND METHODS

An experiment was conducted near Wheaton, MN in 2016. The trial site was prepared by the grower cooperator on May 15, 2016. 'L08-14' Peterson Farm Seed soybean was seeded in 22-inch rows at 160,000 seeds per acre on May 17 with a John Deere 1700XP 6-row planter. Preemergence (PRE) treatments were applied May 18. Postemergence (POST) treatments were applied June 21. All herbicide treatments were applied with a bicycle sprayer in 17 gpa spray solution through 8002 XR flat fan nozzles pressurized with CO_2 at 30 psi to the center four rows of six row plots 30 feet in length. Soybean injury and common lambsquarters, redroot pigweed, and waterhemp control were evaluated June 29, July 18, and August 31.

All soybean injury and weed control evaluations were a visual estimate of percent fresh weight reduction in the four treated rows compared to the adjacent untreated strip. Experimental design was randomized complete block with 4 replications for each trial. Data were analyzed with the ANOVA procedure of ARM, version 2016.4 software package.

Table 1. Application Information – Wheaton, MN 2016

Date	May 18	June 16	June 29
Time of Day	12:00 PM	1:00 PM	11:45 AM
Air Temperature (F)	72	75	77
Relative Humidity (%)	29	66	45
Wind Velocity (mph)	4.5	9	5.5
Wind Direction	SE	SE	SW
Soil Temp. (F at 6")	56	62	72
Soil Moisture	Poor	Good	Poor
Cloud Cover (%)	10	10	20
Next Rainfall (amount)	May 25	June 18	July 9
Soybean Stage	PRE	V1 – V2	V2 – V4
Common Lambsquarters	-	8 inch	8 inch
Waterhemp	-	7 inch	5 inch

SUMMARY

Soybean injury varied among treatments on July 18, but had decreased to non-significant levels by August 31 (Table 2). Treatments containing Cobra showed 10% to 15% greater injury compared to Liberty alone on July 18. Leaf necrosis is common with group 14 PPO inhibiting herbicides.

Table 2. Soybean injury and weed control from herbicides at Wheaton, MN in 2016.

Treatment	Rate	Appl[1]	July 18				August 31		
			soyb[2]	colq	rrpw	wahe	soyb	colq	wahe
			%inj	%cntl	%cntl	%cntl	%inj	%cntl	%cntl
Valor SX+Dual Magnum	2+21 oz+fl oz	A	10	90	98	90	0	88	85
Liberty[3]	29 fl oz/a	B							
Valor SX+Dual Magnum	2+12 oz+fl oz	A	10	91	98	98	5	78	93
Liberty+Dual Magnum[3]	29+12 fl oz+fl oz	B							
Valor SX	2 oz	A	13	80	95	93	3	78	85
Liberty+Dual Magnum[3]	29+21 fl oz+fl oz	B							
Verdict+Outlook	5+14 fl oz+fl oz	A	13	99	100	99	3	100	98
Liberty[3]	29 fl oz/a	B							
Verdict+Outlook	5+8 fl oz+fl oz	A	13	98	100	97	8	98	98
Liberty+Outlook[3]	29+12 fl oz+fl oz	B							
Sharpen	1 fl oz/a	A	15	94	100	98	5	93	95
Liberty+Outlook[3]	29+18 fl oz+fl oz	B							
Sharpen+Warrant	1+52 fl oz+fl oz	A	11	100	100	100	8	100	100
Liberty[3]	29 fl oz/a	B							
Sharpen+Warrant	1+32 fl oz+fl oz	A	18	95	100	100	3	95	100
Liberty+Warrant[3]	29+32 fl oz+fl oz	B							
Sharpen	1 fl oz/a	A	18	93	100	98	5	98	100
Liberty+Warrant[3]	29+52 fl oz+fl oz	B							
Liberty[3]	29 fl oz/a	BC	10	98	98	95	3	95	93
Liberty+Basagran[3,4]	22+13 fl oz+fl oz	BC	15	99	100	98	3	100	95
Liberty+Cobra[3,5]	22+8 fl oz+fl oz	BC	25	94	100	100	5	85	100
Basagran+Cobra[4]	13+8 fl oz+fl oz	BC	20	48	100	98	5	40	90
LSD (0.05)			**8.5**	**12.1**	**NS**	**NS**	**NS**	**16.4**	**NS**

[1]Appl refers to application information in Table 1.
[2]soyb=soybean; colq=common lambsquarters; rrpw=redroot pigweed; wahe=waterhemp
[3]Indicates addition of ammonium sulfate (AMS) at 2.9 lb/A. N-Pak AMS used at 5 %v/v and provided by Winfield.
[4]Indicates addition of methylated seed oil (MSO) at 1.5 pt/A. MSO provided by Loveland.
[5]Indicates addition of crop oil concentrate (COC) at 1.5 pt/A. Cornbelt COC used.

Waterhemp populations were variable in density at this location in 2016. Waterhemp control was similar among all treatments tested at both July 18 and August 31 evaluations. However, waterhemp control seemed to separate by residual herbicide and tended to be greatest from treatments containing Warrant at 98% to 100% control, followed by treatments containing Outlook at 95% to 99%, or treatments containing Dual Magnum at 78% to 93% control. Two POST applications of Liberty, Liberty+Basagran, Liberty+Cobra, or Basagran+Cobra gave 90% to 100% waterhemp control. Redroot pigweed control was 98% or greater and was similar among all treatments tested.

Common lambsquarters control varied among treatments. Two POST applications of Basagran+Cobra gave poor lambsquarters control at 40% to 48% control. Two applications of Liberty+Cobra gave 94% lambsquarters control on July18, but control declined to 85% on August 31. Control from two applications of Liberty or Liberty+Basagran was excellent at 95% to 100%. Three residual herbicides, Dual Magnum, Outlook, and Warrant, were used in a PRE only, PRE fb lay-by, and lay-by only methods along with other herbicides. Dual Magnum gave the least consistent control, despite the other herbicides used. Lambsquarters control ranged from 78% to 91% from treatments containing Dual

Magnum. Treatments utilizing Outlook or Warrant as the main residual herbicide gave lambsquarters control from 93% to 100%.

CONCLUSIONS

Two applications of Liberty gave good, but not exceptional, weed control in this trial. Early dry conditions made lambsquarters control more difficult, and moisture events in July allowed for late season germination of waterhemp. The use of a residual herbicide tended to improve weed control. A program built around Dual Magnum tended to give the least lambsquarters and waterhemp control of treatments evaluated. A program built around Warrant tended to give the greatest waterhemp control. A program built around Outlook tended to give similar lambsquarters control, but slightly less waterhemp control, when comparted to the Warrant program, though no significant differences were detected.

AN EVALUATION OF WEED CONTROL IN XTEND SOYBEAN AT WHEATON, MN IN 2016

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The objective of this study was to evaluate weed control systems options that combine at least two, and preferably three, sites of action for controlling waterhemp in RR2 Xtend soybean in a field in sequence with Roundup Ready sugarbeet.

MATERIALS AND METHODS

An experiment was conducted near Wheaton, MN in 2016. The trial site was prepared by the grower cooperator on May 15, 2016. '16X07N' Roundup Ready 2Xtend soybean from Peterson Farm Seed was seeded in 22-inch rows at 160,000 seeds per acre on May 17 with a John Deere 1700XP 6-row planter. Preemergence (PRE) treatments were applied May 18. Postemergence (POST) treatments were applied June 16 and 29. All herbicide treatments were applied with a bicycle sprayer in 17 gpa spray solution through 8002 XR flat fan nozzles pressurized with CO_2 at 30 psi to the center four rows of six row plots 30 feet in length. Soybean injury and common lambsquarters, redroot pigweed, and waterhemp control were evaluated June 29, July 18, and August 31.

All soybean injury and weed control evaluations were a visual estimate of percent fresh weight reduction in the four treated rows compared to the adjacent untreated strip. Experimental design was randomized complete block with 4 replications for each trial. Data were analyzed with the ANOVA procedure of ARM, version 2016.4 software package.

Table 1. Application Information – Wheaton, MN 2016

Date	May 18	June 16	June 29
Time of Day	12:00 PM	1:00 PM	11:45 AM
Air Temperature (F)	72	75	77
Relative Humidity (%)	29	66	45
Wind Velocity (mph)	4.5	9	5.5
Wind Direction	SE	SE	SW
Soil Temp. (F at 6")	56	62	72
Soil Moisture	Poor	Good	Poor
Cloud Cover (%)	10	10	20
Next Rainfall (amount)	May 25	June 18	July 9
Soybean Stage	PRE	V1 – V2	V2 – V4
Common Lambsquarters	-	8 inch	1 inch
Waterhemp	-	7 inch	1 inch

SUMMARY

Xtend soybeans are tolerant to both dicamba and glyphosate. Soybean injury was non-existent in this trial (Table 2). All products tested at all rates applied gave excellent crop safety.

Weed pressure for this trial was light, to very light, and all herbicide treatments performed well. The June 29 evaluation was taken 13 days after the first POST treatments had been applied, and was the only evaluation where differences could be observed among treatments. Redroot pigweed control ranged from 98% to 100% for all but one treatment. Preemergence Warrant at 3.25 pt/A fb Engenia at 12.8 fl oz/A gave 96% redroot pigweed control. Three treatments showed less common lambsquarters control compared to all other treatments on June 29, but PRE Warrant fb Enginia gave the least control at 89%. Two POST only treatments of Engenia+Roundup PowerMax+ Basagran at 95% and Roundup PowerMax at 94% gave less waterhemp control than other treatments. However, all treatments gave near perfect weed control midway through, and at the end of the season. This trial demonstrated how effective weed management in prior years can contribute to effective weed control from a number of different herbicide options in the current year.

Table 2. Soybean injury and weed control in Xtend soybeans at Wheaton, MN in 2016.

			------June 29------			--------July 18------			-----August 31-----		
Treatment	Rate	Appl[1]	rrpw[2]	colq	wahe	soyb	colq	wahe	soyb	colq	wahe
			%cntl	%cntl	%cntl	% inj	%cntl	%cntl	% inj	%cntl	%cntl
Warrant	3.25 pt	A	100	100	100	1	100	98	0	100	91
Engenia+PMax[3]	12.8+32 fl oz+fl oz	B									
Warrant+Sharpen	3+1 pt + fl oz	A	100	100	100	5	100	100	3	100	100
Engenia+PMax[3]	12.8+32 fl oz+fl oz	B									
Warrant	3 pt	A	100	100	100	3	100	100	0	100	100
Engenia+PMax[3]	12.8+28 fl oz+fl oz	B									
Engenia+PMax[3]	12.8+28 fl oz+fl oz	C									
Warrant	3.25 pt	A	96	89	99	4	100	99	3	100	100
Engenia	12.8 fl oz	B									
RU PowerMax[4]	32 fl oz	C									
Engenia	25.6 fl oz	A	100	99	100	5	100	100	0	100	100
Engenia+Warrant	12.8+3 fl oz + pt	B									
RU PowerMax[4]	32 fl oz	C									
Sharpen	1 fl oz	A	100	98	99	4	100	100	0	100	100
Engenia+Warrant	12.8+3 fl oz + pt	B									
RU PowerMax[4]	32 fl oz	C									
Warrant	2.25 pt	A	100	94	100	3	100	100	0	100	100
Engenia+Warrant	12.8+2.25 fl oz + pt	B									
RU PowerMax[4]	32 fl oz	C									
Engenia+PMax[3]	12.8+28 fl oz+fl oz	B	98	94	96	1	100	100	0	100	100
Engenia+PMax[3]	12.8+28 fl oz+fl oz	C									
Engenia+PMax	12.8+28 fl oz+fl oz	BC	99	98	95	3	100	100	0	100	100
+Basagran[3]	+12.8 +fl oz	BC									
RU PowerMax[4]	32 fl oz	B	99	96	94	5	100	100	0	100	99
RU PowerMax[4]	32 fl oz	C									
LSD (0.05)			**2.4**	**4.9**	**4.0**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

[1]Appl refers to application information in Table 1.
[2]soyb=soybean; colq=common lambsquarters; wahe=waterhemp
[3] PMax=Roundup PowerMax and indicates addition of Class Act Ridion at 1 %v/v provided by Winfield.
[4]Indicates addition of ammonium sulfate (AMS) at 8.5 lb/100 gal and non-ionic surfactant (NIS) at 0.25% v/v. N-Pak AMS provided by Winfield and Prefer 90 NIS provided by West Central, Inc.

WATERHEMP CONTROL IN SOYBEAN AT RENVILLE, MN IN 2016

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The objective of this study was to evaluate control of glyphosate-resistant waterhemp in soybean by using residual herbicides.

MATERIALS AND METHODS

Experiments were conducted on natural populations of waterhemp near Renville, Minnesota in 2016. Plot area was worked by the cooperating farmer with a Demco field cultivator equipped with rolling baskets on May 7, 2016. 'NK 08RR' soybean from Syngenta was seeded 1.25 inches deep in 30 inch rows at 140,000 seeds per acre on May 7. Preemergence (PRE) herbicide treatments were applied May 9 and early-postemergence (EPOST) treatments were applied at soybean first trifoliate on June 8. All treatments were applied with a bicycle sprayer in 17 gpa spray solution through 8002 XR flat fan nozzles pressurized with CO_2 at 30 psi to the center two rows of four row plots 30 feet in length in a field with moderate to heavy levels of glyphosate-resistant waterhemp. Ammonium sulfate (AMS) in all treatments was a liquid formulation from Winfield Solutions called N-Pak AMS. Non-ionic surfactant (NIS) in all treatments was a product from West Central called Prefer 90.

Soybean injury was evaluated June 22. Waterhemp control was evaluated June 8, June 22, and August 8. All evaluations were a visual estimate of percent fresh weight reduction in the two treated rows compared to the adjacent untreated strip. Experimental design was randomized complete block with 4 replications. Data were analyzed with the ANOVA procedure of ARM, version 2016.4 software package.

Table 1. Application information for soybean trial near Renville, MN in 2016.

Application code	A	B
Date	May 9	June 8
Time of Day	9:00 AM	2:15 PM
Air Temperature (F)	57	79
Relative Humidity (%)	61	34
Wind Velocity (mph)	13	6
Wind Direction	SE	SE
Soil Temp. (F at 6")	54	70
Soil Moisture	Good	Good
Cloud Cover (%)	100	75
Sugarbeet stage (avg)	PRE	V1
Waterhemp	-	1-3'

RESULTS AND DISCUSSION

Crop safety evaluations on June 22 indicate slight crop injury, but on August 8 no evidence of injury remain; thus, no further crop safety evaluations were taken. The early season crop injury could be attributed to substantial rainfall (1.41 inches between May 9 and 11) immediately following the application of PRE treatments with increased herbicide in the soil solution which allowed for increased uptake into the soybean.

The field did contain low populations of other weed species such as Eastern Black Nightshade, Venice Mallow, Common Mallow, Lambsquarters, Horseweed, and various grasses, but all treatments were effective in controlling these other species; thus, only waterhemp will be discussed in this article.

Soil-applied herbicides differ in duration of residual activity and can be layered to reduce the emergence of glyphosate-resistant waterhemp. Waterhemp at this location was late to emerge and only plants less than 4 inches tall were present at the time of the EPOST application (Table 1). Waterhemp grew rapidly over the next two months, and plants ten feet in height could be found in the untreated strips by August 8. Preemergence treatments included Authority MTZ at 12 oz, Sharpen + Warrant at 1 fl oz and 24 fl oz, respectfully, Spartan at 8 fl oz, and Verdict at 7.5

fl oz and provided 68, 93, 89, and 73% end of season waterhemp control, respectfully, without an EPOST residual herbicide (Table 2). Dual II Magnum at 27 fl oz, Warrant at 24 fl oz, and Zidua at 2.5 oz were applied EPOST in a tank mix with Roundup PowerMax at 32 fl oz and provided 55, 48, and 50% end of season waterhemp control, respectfully, without a PRE residual herbicide (Table 2). When applied alone, PRE residuals degraded by seasons end and EPOST residuals activated too late and after waterhemp emergence. In both cases, unsatisfactory waterhemp control was attained. Early-postemergence Roundup PowerMax, without a PRE or EPOST residual herbicide, provided only 48% end of season waterhemp control. The individual PRE and EPOST treatments were then factored across each other resulting in 12 additional PRE + EPOST combinations. All PRE treatments fb EPOST Roundup PowerMax at 32 fl oz gave 90 to 100% and 85 to 98% control on June 22 and August 8, respectfully.

Table 2. Soybean injury and waterhemp control from pre emergence and postemergence herbicide applications near Renville, MN in 2016.

Treatment[a]	Rate	App. Code[b]	Sgbt Injury	Waterhemp Control		
			June 22	June 8	June 22	Aug 8
	oz/A* or fl oz/A		----------%----------			
PMax[c]	32	B	1	41	55	48
Authority MTZ / PMax	12* / 32	A / B	3	83	90	68
Authority MTZ / Dual+PMax	12* / 27+32	A / B	20	88	93	88
Authority MTZ / Warrant+PMax	12* / 24+32	A / B	8	97	99	95
Authority MTZ / Zidua+PMax	12* / 2.5*+32	A / B	13	99	98	98
Sharpen+Warrant / PMax	1+24 / 32	A / B	9	99	98	93
Sharpen+Warrant / Dual+PMax	1+24 / 27+32	A / B	10	96	99	93
Sharpen+Warrant / Warrant+PMax	1+24 / 24+32	A / B	11	90	90	85
Sharpen+Warrant / Zidua+PMax	1+24 / 2.5*+32	A / B	20	94	95	91
Spartan / PMax	8 / 32	A / B	3	99	100	89
Spartan / Dual+PMax	8 / 27+32	A / B	18	99	100	95
Spartan / Warrant+PMax	8 / 24+32	A / B	4	99	100	94
Spartan / Zidua+PMax	8 / 2.5*+32	A / B	9	98	100	96
Verdict[d] / PMax	7.5[e] / 32	A / B	14	96	93	73
Verdict / Dual+PMax	7.5 / 27+32	A / B	11	99	100	95
Verdict / Warrant+PMax	7.5 / 24+32	A / B	8	99	100	89
Verdict / Zidua+PMax	7.5 / 2.5*+32	A / B	21	99	100	98
Dual+PMax	27+32	B	14	16	69	55
Warrant+PMax	24+32	B	6	21	74	48
Zidua+PMax	2.5*+32	B	16	20	50	50
Zidua / Warrant+PMax	2.5* / 24+32	A / B	13	97	98	96
LSD (0.05)[e]			**12**	**19**	**18**	**21**

[a]PRE treatment applications contained no additional adjuvants. All EPOST treatments tank mixed with Roundup PowerMax contained Destiny HC at 1.5 pt/A plus N-Pak AMS at 2.5% v/v. The Roundup PowerMax alone treatment contained Prefer 90 NIS at 0.25% v/v plus N-Pak AMS at 2.5% v/v.

[b]Application codes refer to the information in Table 1.

[c]PMax=Roundup PowerMax; Dual=Dual II Magnum.

[d]Off label rate for one-time application; 5 fl oz/A rate per application is the label.

[e]LSD=least significant difference.

CONCLUSION

Overall, a glyphosate alone treatment provided 48% end of season waterhemp control. A PRE alone treatment averaged 81% end of season waterhemp control compared to 51% from EPOST treatments alone. Preemergence + EPOST combination treatments averaged 93% end of season waterhemp control. The results indicate a PRE + EPOST treatments that provides acceptable end of season waterhemp control. Excluding EPOST only treatments, residual herbicides alone, or in combination, applied prior to weed emergence averaged 90% end of season waterhemp control. The use of residual herbicides in soybean will be critical for managing glyphosate resistant waterhemp and other broadleaf weeds in the future. The results suggest that glyphosate as a single mode of action is no longer a viable option in controlling diverse populations of waterhemp, and that independent PRE or EPOST applications of residual herbicides will not provide adequate control of emerged waterhemp and must be layered.

EVALUATION OF ET-4000 ADJUVANT IN CORN IN 2016 AT MOORHEAD, MN

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The objective of this study was to evaluate ET-4000, an acidic AMS replacement adjuvant, for weed control and crop safety when applied with glyphosate and ethofumesate in corn. Ethofumesate is not currently labeled for use in corn.

MATERIALS AND METHODS

An experiment was conducted near Moorhead, MN in 2016. The trial site was prepared using a Kongskilde 's-tine' field cultivator with rolling baskets on May 7, 2016. 'DKC38-04 RIB' Dekalb corn was seeded in 22-inch rows at 32,000 seeds per acre on May 12 with a John Deere 1700XP 6-row planter. Postemergence (POST) treatments were applied June 17. All herbicide treatments were applied with a bicycle sprayer in 17 gpa spray solution through 8002 XR flat fan nozzles pressurized with CO_2 at 30 psi to the center four rows of six row plots 30 feet in length. Corn injury and common lambsquarters and waterhemp control were evaluated June 24 and July 7.

All corn injury and weed control evaluations were a visual estimate of percent fresh weight reduction in the four treated rows compared to the adjacent untreated strip. Experimental design was randomized complete block with 4 replications for each trial. Data were analyzed with the ANOVA procedure of ARM, version 2016.4 software package.

Table 1. Application Information – Moorhead, MN 2016

Date	June 17
Time of Day	1:00 PM
Air Temperature (F)	78
Relative Humidity (%)	65
Wind Velocity (mph)	3
Wind Direction	E
Soil Temp. (F at 6")	69
Soil Moisture	Poor
Cloud Cover (%)	90
Next Rainfall	June 18
Corn Stage	V7
Common Lambsquarters	8 inch
Waterhemp	6 inch

SUMMARY

Ethofumesate is not currently labeled for use in corn. No corn injury was observed in any treatment (Table 2). Ethofumesate, at 4 fl oz/A, appears to be quite safe to corn. ET-4000 also appears to have good crop safety when applied in corn at both 1% and 2% v/v.

Common lambsquarters control on June 24 ranged from 15% from Ethofumesate + MSO + ET-4000 to 97% from treatments containing Roundup PowerMax + Ethofumesate or Roundup PowerMax + ET-4000. Application of Ethofumesate 4SC + AMS gave similar control of lambsquarters to application of Ethofumesate 4SC + ET-4000. Common lambsquarters control ranged from 94% to 97% when treatments contained Roundup PowerMax. July 7 evaluation of common lambsquarters control followed the same patterns as observed on June 24.

Waterhemp control was less than adequate from all treatments at both evaluation dates. Treatments containing Roundup PowerMax gave 20% to 40% greater waterhemp control than treatments without PowerMax. Control was generally greater from all treatments on the June 24 evaluation than at the July 7 evaluation. Weed regrowth and additional waterhemp germination accounted for this decline in control as the season progressed. Application of Ethofumesate 4SC

at 4 fl oz/A provided less than 35% control regardless of the adjuvants used in that application. Waterhemp control from application of Ethofumesate + Roundup PowerMax was greater or tended to be greater than from Ethofmusate or Roundup PowerMax applied individually. The use of ET-4000 at 1% v/v gave similar waterhemp control as N-Pak AMS at 2.5% v/v when applied with Roundup PowerMax + Ethofumesate + Destiny HC. However, increasing the rate of ET-4000 to 2% v/v tended to improve waterhemp control compared to N-Pak AMS or ET-4000 at 1% v/v when applied with the same herbicides.

Table 2. Corn Injury and weed control from herbicides applied on June 17 with AMS or ET-4000 at Moorhead, MN in 2016.

		June 24			July 7	
Treatment[1]	Rate	corn	wahe[2]	colq	wahe	colq
		% inj	% cntl	% cntl	% cntl	% cntl
Ethofumesate 4SC+	4 fl oz/a	0	33	18	5	28
MSO+	1.5 pt/a					
N-Pak AMS	2.5 % v/v					
RU PowerMax+	28 fl oz/a	0	53	94	25	100
Prefer 90 NIS+	0.25 % v/v					
N-Pak AMS	2.5 % v/v					
RU PowerMax+	28 fl oz/a	0	66	97	33	95
Ethofumesate 4SC+	4 fl oz/a					
N-Pak AMS+	2.5 % v/v					
Destiny HC HSMOC	1.5 pt/a					
Ethofumesate 4SC+	4 fl oz/a	0	30	15	13	25
MSO+	1.5 pt/a					
ET-4000	1 % v/v					
RU PowerMax+	28 fl oz/a	0	55	97	38	93
Prefer 90 NIS+	0.25 % v/v					
ET-4000	1 % v/v					
RU PowerMax+	28 fl oz/a	0	63	97	35	93
Ethofumesate 4SC+	4 fl oz/a					
ET-4000+	1 % v/v					
Destiny HC HSMOC	1.5 pt/a					
RU PowerMax+	28 fl oz/a	0	73	97	45	93
Ethofumesate 4SC+	4 fl oz/a					
ET-4000+	2 % v/v					
Destiny HC HSMOC	1.5 pt/a					
LSD (0.05)		**NS**	**18.5**	**5.3**	**18.3**	**12.0**

[1]MSO=Methylated Seed Oil provided by Loveland. N-Pak AMS=ammonium sulfate provided by Winfield. Prefer 90 NIS=nonionic surfactant provided by West Central, Inc. ET-4000=an acidic AMS replacement was produced by Earth Science Laboratories and provided by MK Ag Service, Inc.

[2]wahe=waterhemp; colq=common lambsquarters

CONCLUSIONS

Glyphosate-resistant waterhemp was present at this location. None of the treatments applied provided adequate, season-long, control of waterhemp. Application of glyphosate + ethofumesate gave greater waterhemp control than application of either glyphosate or ethofumesate alone. ET-4000 at 1% v/v performed very similarly to N-Pak AMS at 2.5% v/v. However, increasing the rate of ET-4000 to 2% v/v appeared to provide some improvement of waterhemp control when applied with glyphosate + ethofumesate + Destiny HC. Addition of ET-4000 to the spray tank did not adversely, or positively, affect common lambsquarters control compared to the use of AMS. Even though ethofumesate is not currently labeled for use in corn, all treatments applied showed excellent crop safety.