CONTINUED REFINEMENT OF THE WATERHEMP CONTROL STRATEGY IN SUGARBEET

Thomas J. Peters[1], Andrew Lueck[2], David Mettler[3] and Cody Groen[4]

[1]Extension Sugarbeet Agronomist and Weed Control Specialist and [2]Research Technician North Dakota State University and the University of Minnesota, Fargo, ND and Research Agronomist and [4]Production Agronomist, Southern Minnesota Beet Sugar Cooperative, Renville, MN

SUMMARY

1. Chloroacetamide herbicide application timing tended to have a greater effect on waterhemp control than choice of chloroacetamide herbicide.
2. Split application of chloroacetamide herbicides improved waterhemp control compared to a single chloroacetamide herbicide application.
3. Applying Dual Magnum preemergence (PRE) fb a chloroacetamide herbicide lay-by improved waterhemp control compared to chloroacetamide alone.
4. Lambsquarters control from glyphosate + ethofumesate was not affected by chloroacetamide herbicide applied with glyphosate and ethofumesate (data not presented).

INTRODUCTION

Survey data indicates waterhemp is the primary weed control challenge in sugarbeet fields in Southern Minnesota Beet Sugar Cooperative, in Minn-Dak Farmers' Cooperative, and in fields south of Grand Forks in American Crystal Sugar Cooperative. Waterhemp populations are a mixture of glyphosate susceptible and resistant biotypes. Roundup PowerMax at 28 fl oz/A controlled 78% of the first flush of emerged waterhemp based on waterhemp counts taken immediately prior to and 9 days following application (Peters, 2015). However, control does not improve by increasing the glyphosate rate or with repeat glyphosate applications. Early-season weed escapes cause late-season weed control failures and weed disasters at harvest. There are no effective POST herbicide options for rescue control of resistant biotypes, especially when waterhemp is greater than 4-inches tall.

Ethofumesate or Ro-Neet provide effective early-season waterhemp control but are expensive or do not provide full-season control (Peters, 2016). Use of site of action (SOA) 15 herbicides (chloroacetamides) applied early postemergence (EPOST) provide the most effective and consistent waterhemp control (Peters, 2015; Peters, 2016; Peters, 2017). However, several important statements should be made about chloroacetamide herbicides and waterhemp control. First, sugarbeet must reach the 2-leaf stage before chloroacetamides can be applied. Thus, planting date influences how and when they can be applied. Second, chloroacetamides need to be activated by timely precipitation in order to control waterhemp. Third, waterhemp seems to be emerging earlier in the spring. Are we selecting for earlier germinating biotypes or have we improved awareness and identification? Maybe some of both. Finally, sugarbeet grower surveys indicate approximately 85% satisfaction (excellent or good response) with current waterhemp control strategies. How can we improve satisfaction to 90% or 95%?

Waterhemp control in soybean was improved using repeat application of chloroacetamide herbicides; a practice referred to as 'layering' (Steckel, 2002). Sugarbeet experiments conducted at Herman and Moorhead, MN in 2015 investigate repeat applications of chloroacetamide herbicides in sugarbeet. Dual Magnum (s-metolachlor) at 0.5 pt/A was applied PRE followed by glyphosate + ethofumesate plus either S-metolachlor, Warrant or Outlook at 2-lf sugarbeet stage. Waterhemp control averaged greater than 90% using the layering strategy compared to S-metolachlor, Warrant, or Outlook applied EPOST (Figure 1).

Outlook often is split-applied at 12 fl oz/A at the 2-leaf sugarbeet stage followed by 12 fl oz/A at the 6-leaf stage. This practice is common when glyphosate plus Outlook is tank-mixed with an insecticide for black cutworm control since there is a concern that applying multiple products formulated as emulsifiable concentrates may injury sugarbeet, especially under cold and wet spring environmental conditions. Split application can also improve waterhemp control consistency (conversation with Jim Radermacher, 2015). Split lay-by application buffers against the possibility of inadequate or untimely precipitation since the first application in May is followed by a second application, 14 to 21 days later, in June.

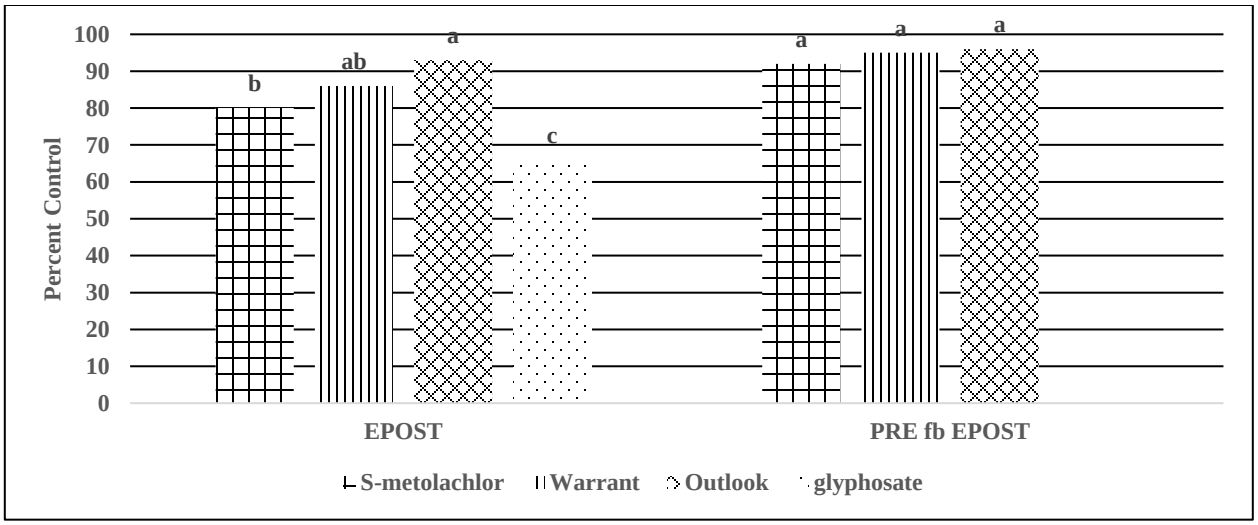

Figure 1. Waterhemp control from soil-residual herbicides applied early postemergence (EPOST) or S-Metolachlor at 0.5 pt/A preemergence (PRE) followed by soil-residual herbicides applied EPOST, averaged across Herman and Moorhead, MN, 2015.

Following successes with Outlook, sugarbeet growers and Agriculturalists have asked if Warrant and S-metolachlor should also be split-applied. The objectives of 2016 and 2017 experiments were to evaluate sugarbeet safety and waterhemp control at multiple locations from: a) Dual Magnum PRE-followed by S-metolachlor, Warrant, or Outlook EPOST in single or multiple applications and; b) S-metolachlor, Warrant, or Outlook EPOST in single or multiple applications. This report summarizes experiments conducted at Roseland, MN in 2016 and Lake Lillian, MN, and Galchutt, ND in 2017.

MATERIALS AND METHODS

Experiments were conducted on natural populations of waterhemp near Moorhead, MN in 2016 and Lake Lillian, MN and Galchutt, ND in 2017. Experimental area was prepared using a field cultivator prior to planting. 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 0.5 inches deep in 22 inch rows at 62,100 seeds per acre on May 8, 2017 at Lake Lillian, MN. 'HM4022RR' 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 9, 2017 at Galchutt.

Table 1. 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 inch	1-3 inch

Herbicide treatments were applied at Moorhead on May 16, June 6, and June 20, 2016; May 11, June 1, and June 16, 2017 at Lake Lillian, and May 9, June 1, and June 20, 2017 at Galchutt. 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 United. 'Destiny HC' high surfactant methylated oil concentrate (HSMOC) was also used and is a product from Winfield United.

Table 2. Application information for sugarbeet trial near Lake Lillian, MN in 2017.

Application code	A	B	C
Date	May 11	June 1	June 16
Time of Day	9:00 AM	9:00 AM	9:00 AM
Air Temperature (F)	58	70	79
Relative Humidity (%)	27	27	42
Wind Velocity (mph)	12	3	5-10
Wind Direction	NNW	SSW	SSE
Soil Temp. (F at 6")	68	70	-
Soil Moisture	Good	Good	Good
Cloud Cover (%)	-	-	Partly Cloudy
Sugarbeet stage (avg)	PRE	2-4 lf	6-8 lf
Waterhemp	-	0.5 inch	1-3 inch

Sugarbeet injury was evaluated June 24 and July 22, 2016 at Moorhead, June 6, June 26 and July 6, 2017 at Lake Lillian, and June 16, 2017 at Galchutt. Waterhemp control was evaluated June 24, June 28, July 22, and August 24, 2016 at Moorhead, June 15, June 26 and July 6, 2017 at Lake Lillian and June 16, July 5, and July 24, 2017 at Galchutt. Common lambsquarters and redroot pigweed control also was evaluated at each location, but data are not included in this report since glyphosate provided complete or near complete control of both species. 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 2017.4 software package.

Table 3. Application information for sugarbeet trial near Galchutt, ND in 2017.

Application code	A	B	C
Date	May 9	June 1	June 20
Time of Day	12:00 PM	9:00 AM	12:00 PM
Air Temperature (F)	64	70	68
Relative Humidity (%)	37	32	47
Wind Velocity (mph)	10	3	6
Wind Direction	NW	S	NW
Soil Temp. (F at 6")	54	59	64
Soil Moisture	Good	Good	Good
Cloud Cover (%)	50	10	10
Sugarbeet stage (avg)	PRE	2-lf	8-10 lf
Waterhemp	-	1 inch	2 inch

RESULTS

Waterhemp control was influenced by herbicide and application timing at Moorhead in 2016 and Lake Lillian and Galchutt in 2017 (Figure 2, Figure 3, Figure 4). In general, application timing had greater influence on waterhemp control than chloroacetamide herbicide.

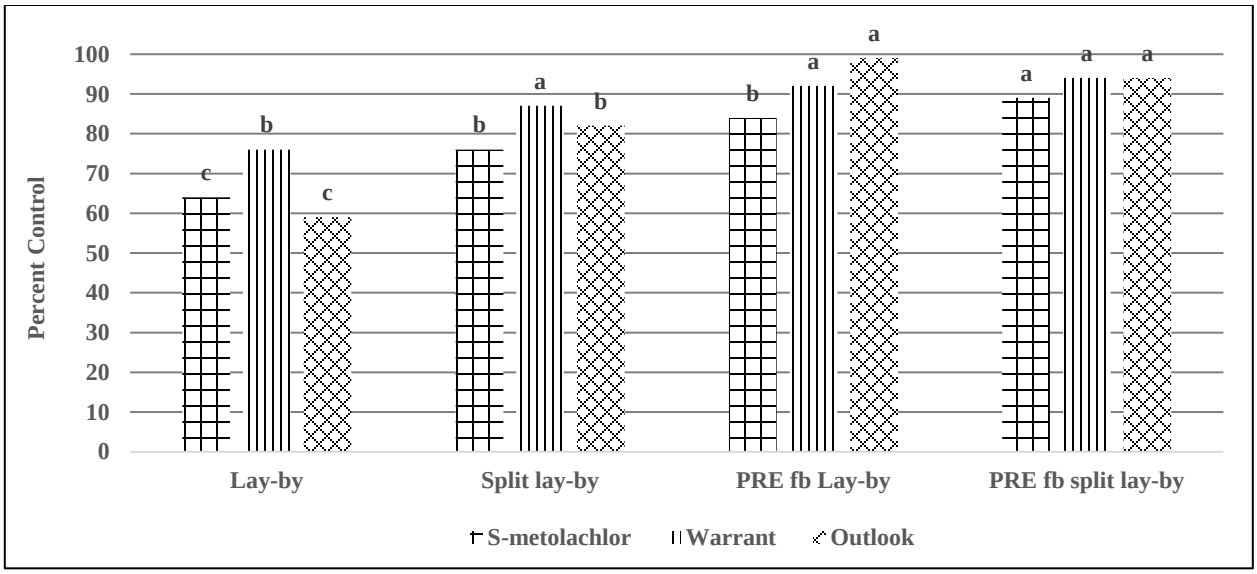

Figure 2. Waterhemp control from single lay-by or split lay-by herbicide applications and S-metolachlor preemergence (PRE) followed by lay-by or split lay-by herbicide applications, Moorhead, MN in 2016, average of July 22 and August 24 evaluation.

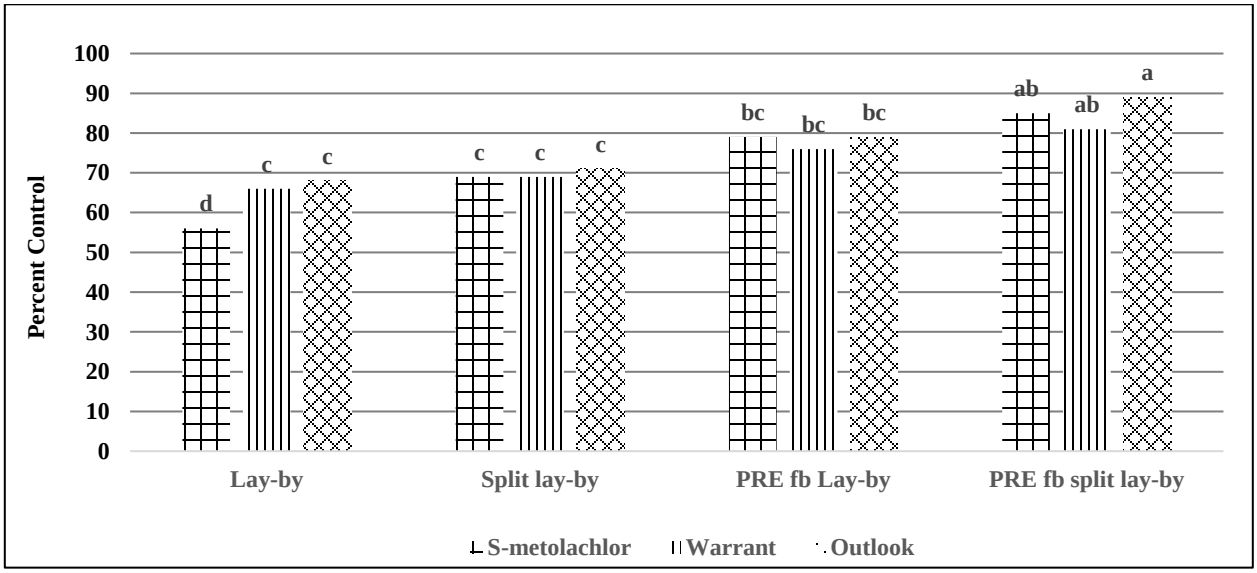

Figure 3. Waterhemp control from single lay-by or split lay-by herbicide applications and S-metolachlor preemergence (PRE) followed by lay-by or split lay-by herbicide applications, Lake Lillian, MN, 2017, July 6 evaluation.

There are several factors to consider when selecting a chloroacetamide herbicide for waterhemp control aside from relationships with a company or company representatives. Warrant costs less per acre on a rate basis than Outlook or S-metolachlor. Outlook is more water soluble than either S-metolachlor or Warrant and requires less precipitation for activation. Once activated, Warrant has longer residual than Outlook or S-metolachlor. Outlook and Warrant have a broader weed control spectrum than S-metolachlor. However, sugarbeet can be planted directly into S-metolachlor residues in the event of replant whereas three to four weeks' time is required before residue levels of Outlook and Warrant will allow sugarbeet replanting. Finally, S-metolachlor and Warrant are safer on sugarbeet than Outlook although injury generally is negligible with all chloroacetamide herbicides. Most of the factors to consider when selecting a chloroacetamide herbicide are based more around risk of sugarbeet injury than level of waterhemp control.

Waterhemp control from chloroacetamide herbicides was evaluated across locations in 2014 to 2017. Precipitation followed within 7-days of chloroacetamide activation in 2014 and 2015. However, timely precipitation did not occur in 2016 or 2017. 2016 was a dry spring, creating erratic germination and emergence patterns in experiments and in grower fields. Early postemergence chloroacetamide application was delayed five days to account for erratic emergence at the Moorhead location. Likewise, precipitation was spotty and possibly up to 24 days between the precipitation event that activated PRE herbicides and precipitation events to activate lay-by herbicides in 2017 at Lake Lillian. These climate phenomena partially explain waterhemp control observations in fields in 2016 and 2017 (Figure 2 and Figure 3).

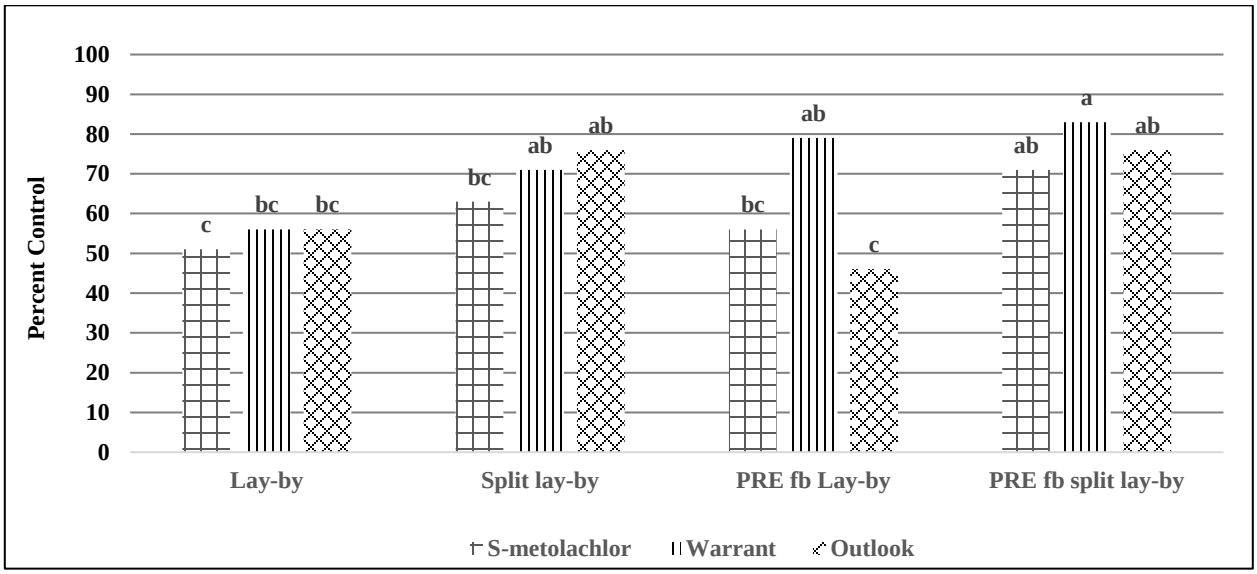

Figure 4. Waterhemp control from single lay-by or split lay-by herbicide applications and S-metolachlor preemergence (PRE) followed by lay-by or split lay-by herbicide applications, Galchutt, ND, 2017, July 25 evaluation.

The Galchutt, ND location received timely precipitation for activation of herbicides in 2017 (Figure 4). However, there was significant sugarbeet stand loss caused by rhizoctonia root rot, possibly caused by above average precipitation in June and July. Stand loss created an open canopy suitable for waterhemp germination and emergence well into July. Under these conditions, split application of chloroacetamide herbicides (EPOST fb POST) or PRE followed by split applications of chloroacetamide herbicides tended to provide better waterhemp control than single lay-by application of chloroacetamide herbicide alone or following PRE S-metolachlor.

At each of the three locations, 12 different treatment combinations of herbicide (S-metolachlor, Warrant, and Outlook) and timing (lay-by, split lay-by, PRE fb lay-by, and PRE fb split lay-by) were tested for a total of 36 observable treatments. In an effort to compare these treatments and determine which method of application resulted in the greatest and most constant control across locations, the following steps were taken. At each evaluation from each location, waterhemp control data was ranked in numerical order from greatest control to least control based upon the least significant difference (LSD). Herbicide treatments that were statistically the same as the best treatment at each evaluation timing from each location were grouped into a cluster and labeled ‘good’. The remaining treatments were once again ranked and grouped into a second and third cluster based on LSD value and labeled ‘fair’ and ‘poor’, respectively. Clusters were titled ‘good’, ‘fair’ and ‘poor’ since treatments in the good cluster generally corresponded to 80% or greater waterhemp control, the fair cluster corresponded to 80 to 65% waterhemp control, and the poor cluster corresponded to 65 to 40% waterhemp control. Chloroacetamide herbicides were combined and were grouped by application timing into four classes: lay-by, split lay-by, PRE fb lay-by, and PRE fb split lay-by. The number of observations corresponding to each cluster (good, fair, or poor) were summed and are presented in Figure 5. Data indicates PRE fb lay-by and PRE fb split lay-by application methods provided the most consistent waterhemp control across locations and years.

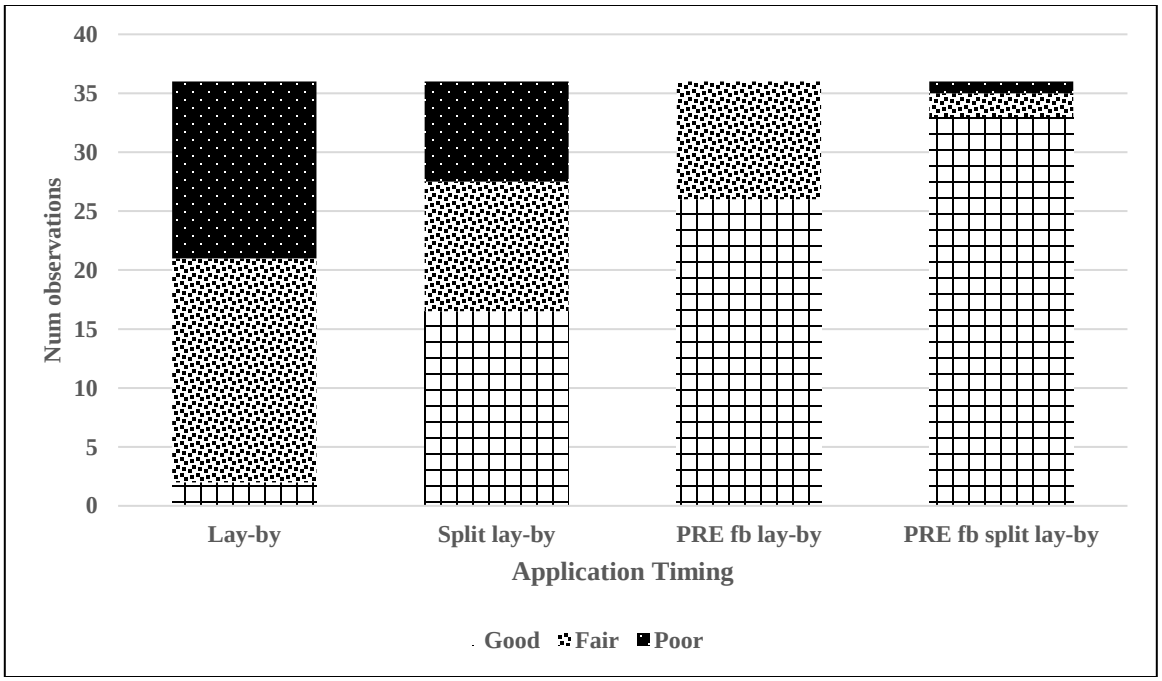

Figure 5. Number of good, fair, and poor estimates of waterhemp control across herbicides and application timing, summed across evaluations, locations, and years

CONCLUSIONS

Sugarbeet planting date is likely the most important factor to consider for herbicide selection and application timing for waterhemp control (Table 4). Split lay-by application of chloroacetamide herbicides is the preferred approach for waterhemp control for early planted sugarbeet. However, PRE followed by a split lay-by application buffers risk against early germinating weeds or uncertainty of when precipitation will occur to activate lay-by herbicides, even in early planted sugarbeet.

Late planted sugarbeet may not reach the sugarbeet 2-lf stage by May 15 (date when the growing degree day model typically forecasts waterhemp germination and emergence). Thus, Dual Magnum and/or ethofumesate should be applied PRE followed by split lay-by application of chloroacetamide herbicides. Timing of the lay-by applications 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 or cultivation are recommended for POST waterhemp control. Apply in combination with HSMOC adjuvant 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
	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
	Single lay-by application when sugarbeet is at the 2-lf stage or greater
Plant Sugarbeet in May	Dual Magnum and/or ethofumesate PRE followed by a split lay-by
Either	Continue to scout fields for late germinating waterhemp in late June and July
Either	Be prepared to rescue with Betamix + ethofumesate, UpBeet + ethofumesate or Betamix + UpBeet (be aware of resistant biotypes)

LITERATURE CITED

1. Peters, TJ, Carlson AL (2015) Controlling Waterhemp in Fields Planted to Sugarbeet. Sugarbeet Res. Ext. Rept. 45: 29-35.
2. Peters, TJ, Lueck AB, Radermacher J (2016) A Strategy for Managing Waterhemp in Sugarbeet. Sugarbeet Res. Ext. Rept. 46: 22-30.
3. Peters, TJ, Lueck AB, Groen C (2017) Continued Evaluation of the Strategy for Managing Waterhemp in Sugarbeet. Sugarbeet Res. Ext. Rept. 47: 30-38.
4. Steckel, LE, Sprague CL, Hager AG (2002) Common Waterhemp (*Amaranthus rudis*) Conrol in Corn (*Zea mays*) with Single Preemergence and Sequential Applications of Residual Herbicides. Weed Technology. 16:755-761.

ACKNOWLEDGMENTS

We implemented an ambitious research program in 2017. We were mostly successful in spite of dry conditions at our Prosper and Moorhead locations. We are thankful to the following for contributing to our successes:

- The Sugarbeet Research and Education Board, and SBARE (ND-State Board of Agricultural Research and Education) for funding portions of this research in 2017
- Our industry partners, BASF, Bayer CropSciences, Dow AgroSciences, Monsanto Company, Syngenta, Winfield United, and UPI
- The Sugarbeet Cooperatives, American Crystal Sugar, Minn-Dak Farmers' Cooperative and Southern Minnesota Beet Sugar Cooperative for collaborating with field research. Aaron Carlson, KayJay Ag Services, for assisting with technical report writing
- Our grower cooperators: Tim and Michael Backman (Herman), James Bergman (Oslo), Glenn and Danny Brandt (Ada), Frank Mataczjek (Grand Forks), Pinta Brothers (Minto), American Crystal Sugar (Moorhead), Chris and Brian Schlegel (Lake Lillian), Jeff Schmoll (Lake Lillian), Brent Torkleson (Foxhome), Larry Wold (Galchutt)
- North Dakota State University Experiment Station and University of Minnesota, Northwest Research and Outreach Center
- Research Specialist Andrew Lueck, graduate students, Alexa Lystad and Nathan Haugrud and summer student employee Bethany Christensen.
- North Dakota State University Experiment Station and University of Minnesota Crookston Research and Outreach Center