WATERHEMP CONTROL IN SUGARBEET IN 2020

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Summary

1. Ethofumesate provided partial waterhemp control at 1.5 pt/A, even when activating rainfall was 21 day after treatment (DAT). However, ethofumesate at rates less than 6 pt/A provided less than 85% waterhemp control. Ethofumesate at greater than 6 to 7.5 pt/A provided 36 or 54 days, respectively, of greater than 85% waterhemp control.
2. Preemergence herbicides are effective for controlling early germinating waterhemp. Waterhemp control was similar with ethofumesate at 2 pt/A and Dual Magnum at 0.75 pt/A but was less than waterhemp control from ethofumesate at 4 pt/A.
3. Herbicide, herbicide rate, or timing of herbicide application did not influence waterhemp control from treatments applied layby.
4. Inter-row cultivation or Liberty applied through a hooded sprayer controlled escaped waterhemp.

Introduction

A survey conducted at the 2020 winter Sugarbeet Growers Seminars indicated waterhemp is the primary weed control challenge in sugarbeet fields in Southern Minnesota Beet Sugar Cooperative, Minn-Dak Farmers' Cooperative, and American Crystal Sugar Cooperative. Early-season weed escapes turn into late-season weed control failures which can lead to weed issues at harvest. There are minimal effective POST herbicide options for rescue control of glyphosate-resistant biotypes, especially when waterhemp is greater than 4-inches tall. Three experiments were conducted in 2020 to evaluate herbicide treatments, timing of herbicide application, and methods of herbicide application to create an effective weed management program.

Objective

The objective of these studies was to understand the weed control methods available and how to best to combine them into a weed control program to control waterhemp in sugarbeet.

Materials and Methods

Experiment 1

Experiments were conducted on natural weed populations near Moorhead, MN and Blomkest, MN in 2020 to evaluate waterhemp control and wheat nurse-crop tolerance to ethofumesate preemergence (PRE) at multiple rates. The experimental area was prepared for planting by applying the appropriate fertilizer and tillage. Spring wheat at 0.75 bu/A was evenly spread throughout the plot area and incorporated with shallow tillage before ethofumesate application. Sugarbeet was seeded in rows spaced 22 inches apart at approximately 62,000 seeds/A or approximately 4.6 inch spacing between seeds along the row in the experiment at Blomkest, MN but sugarbeet was not planted in the experiment at Moorhead, MN.

Herbicide treatments were applied PRE after planting with a bicycle wheel sprayer in 17 gpa spray solution through 8002 XR flat fan nozzles pressurized with CO_2 at 40 psi to the center of the 11 by 40 feet long plots. Treatments consisted of one application of ethofumesate at 0, 1.5, 3.0, 4.5, 6.0 and 7.5 pt/A

Wheat injury and waterhemp control were evaluated visually, beginning approximately twenty-three days after ethofumesate application. Additional waterhemp control was evaluated 43, 56, and 62 DAP (days after planting) at Moorhead and 36, 44, 58, and 77 DAP at Blomkest. All evaluations were a visual estimate of control in the treated area compared to the adjacent untreated strip. Experimental design was randomized complete block with four replications. Data were analyzed with the ANOVA procedure of ARM, version 2020.2 software package.

Experiment 2

Experiments were conducted on natural weed populations near Hickson, ND and Blomkest, MN in 2020 to consider sugarbeet tolerance and waterhemp control from preemergence and postemergence herbicides. The experimental

area was prepared for planting by applying the appropriate fertilizer and tillage. Sugarbeet was seeded in rows spaced 22 inches apart at approximately 62,000 seeds/A or approximately 4.6 inch spacing between seeds along the row.

Herbicide treatments were applied on April 27, May 27, and June 12 at Hickson and Blomkest with a bicycle wheel sprayer in 17 gpa spray solution through 8002 XR flat fan nozzles pressurized with CO_2. Treatment list for Hickson and Blomkest can be found in Table 1 and 2, respectively.

Table 1. Herbicide treatment, rate, and application timing at Hickson, ND in 2020.

Preemergence Herbicide	PRE Rate	Lay-by Herbicide	Lay-by Rate	Stage
	(pt/A)		(fl oz/A)	(lvs)
–	–	–[1]	–[1]	4 / 8
–	–	Dual Magnum[2]	18	4
–	–	Dual Magnum	18	8
–	–	Dual Magnum / Dual Magnum	18 / 18	4 / 8
Dual Magnum	0.75	–	–	4 / 8
Dual Magnum	0.75	Dual Magnum	18	4
Dual Magnum	0.75	Dual Magnum	18	8
Dual Magnum	0.75	Dual Magnum / Dual Magnum	18 / 18	4 / 8
Ethofumesate 4SC	2	–	–	4 / 8
Ethofumesate 4SC	2	Dual Magnum	18	4
Ethofumesate 4SC	2	Dual Magnum	18	8
Ethofumesate 4SC	2	Dual Magnum / Dual Magnum	18 / 18	4 / 8
Ethofumesate 4SC	4	–	–	4 / 8
Ethofumesate 4SC	4	Dual Magnum	18	4
Ethofumesate 4SC	4	Dual Magnum	18	8
Ethofumesate 4SC	4	Dual Magnum / Dual Magnum	18 / 18	4 / 8

[1] – indicates that no lay-by herbicide was applied but that applications of Roundup PowerMax at 28 fl oz/A + Prefer 90 NIS at 0.25% v/v + N-Pak Liquid AMS at 2.5% v/v were applied at the leaf stage shown.

[2]All POST treatments of Dual Magnum also included Roundup PowerMax at 28 fl oz/A + HSMOC at 1.5 pt/A + AMS 2.5% v/v.

Table 2. Herbicide treatment, rate, and application timing at Blomkest, MN in 2020.

Preemergence Herbicide	PRE Rate	Lay-by Herbicide	Lay-by Rate	POST Stage
	(pt/A)		(fl oz/A)	(lvs)
–	–	–[1]	–[1]	4 / 8
–	–	Warrant[2]	48	4
–	–	Warrant	48	8
–	–	Outlook / Outlook	12 / 12	4 / 8
–	–	Warrant / Warrant	48 / 48	4 / 8
–	–	Outlook / Warrant	12 / 48	4 / 8
Ethofumesate 4SC	2	–	–	4 / 8
Ethofumesate 4SC	2	Warrant	48	4
Ethofumesate 4SC	2	Warrant	48	8
Ethofumesate 4SC	2	Outlook / Outlook	12 / 12	4 / 8
Ethofumesate 4SC	2	Warrant / Warrant	48 / 48	4 / 8
Ethofumesate 4SC	2	Outlook / Warrant	12 / 48	4 / 8
Ethofumesate 4SC	4	–	–	4 / 8
Ethofumesate 4SC	4	Warrant	48	4
Ethofumesate 4SC	4	Warrant	48	8
Ethofumesate 4SC	4	Outlook / Outlook	12 / 12	4 / 8
Ethofumesate 4SC	4	Warrant / Warrant	48 / 48	4 / 8
Ethofumesate 4SC	4	Outlook / Warrant	12 / 48	4 / 8

[1] – indicates that no lay-by herbicide was applied but that applications of Roundup PowerMax at 28 fl oz/A + Prefer 90 NIS at 0.25 % v/v + N-Pak Liquid AMS at 2.5% v/v were applied at the leaf stage shown.
[2]All POST treatments of Warrant and Outlook also included Roundup PowerMax at 28 fl oz/A + HSMOC at 1.5 pt/A + AMS at 2.5% v/v.

Sugarbeet tolerance and waterhemp control were evaluated. All evaluations were a visual estimate of control in the four treated rows compared to the adjacent untreated strip. Experimental design was randomized complete block with four replications. Data were analyzed with the ANOVA procedure of ARM, version 2020.2 software package.

Experiment 3

Experiments were conducted on natural weed populations near Moorhead, MN and Blomkest, MN in 2020 investigating waterhemp control and sugarbeet tolerance from a program approach. The program utilized PRE ethofumesate (either broadcast or in a band) followed by POST herbicides (with or without lay-by herbicides or lay-by timed to different sugarbeet growth stage) and followed by inter-row weed control from either Liberty (glufosinate) (applied through a hooded sprayer) or from inter-cultivation. The experimental area was prepared for planting by applying the appropriate fertilizer and tillage. Sugarbeet was seeded in rows spaced 22 inches apart at approximately 62,000 seeds/A or approximately 4.6 inch spacing between seeds along the row.

Preemergence ethofumesate was applied at 6 pt/A. Banded treatments of ethofumesate were applied at 6 pt/A broadcast equivalent in an 11-inch band. Herbicide treatments were applied on May 2, June 1, June 11, and June 17 at Moorhead and April 27, May 27, June 9 and June 16 at Blomkest with a CO_2-pressurized bicycle-wheel sprayer in 17 gpa spray solution. Preemergence treatments were made using TeeJet TP4002E flat fan nozzles and EPOST, POST, and LPOST treatments were broadcast using 8002 XR flat fan nozzles. Liberty treatments were banded between rows using a hooded sprayer at 22 gpa spray solution through TP4002E nozzles pressurized with CO_2 at 35 psi. The treatment list can be found in Table 3.

Table 3. Treatment, application method, and herbicide rate at Moorhead and Blomkest, MN in 2020.

Preemergence Herbicide[1]	Application Method (broadcast or band)	EPOST[2] / POST Herbicide	Rate (fl oz/A)	Stage (lvs)	LPOST[4] Treatment	Rate (fl oz/A)
Ethofumesate 4SC	broadcast	RUPM[4] / RUPM[4]	28 / 28	4 / 8	RUPM[4]	22
Ethofumesate 4SC	band	RUPM[4] / RUPM[4]	28 / 28	4 / 8	RUPM[4]	22
Ethofumesate 4SC	band	RUPM[5] + Dual Magnum	32 + 16	4	Liberty	32
Ethofumesate 4SC	band	RUPM[3] + Dual Magnum	32 + 16	8	Liberty	32
Ethofumesate 4SC	band	RUPM[3] + Dual Magnum	32 + 16	4	cultivation	–
Ethofumesate 4SC	band	RUPM[3] + Dual Magnum	32 + 16	8	cultivation	–

[1]Preemerge ethofumesate was applied at 6 pt/A broadcast or equivalent (3 pt/A in 11 inch band)
[2]EPOST = early postemergence at 4 lf-stage; POST = postemergence at 8-lf state; LPOST = late postemergence at 12-lf stage
[3]LPOST treatments were applied as follows: RUPM + N-Pak Liquid AMS at 2.5% v/v was broadcast, Liberty + dry AMS at 3 lb/A was applied to inter-row areas with a hooded sprayer, cultivation was directed to inter-row areas.
[4]RUPM = Roundup PowerMax applied with Ethofumesate at 4 fl oz/A + HSMOC at 1.5 pt/A + N-Pak Liquid AMS at 2.5% v/v.
[5]RUPM = Roundup PowerMax applied with Ethofumesate at 12 fl oz/A + HSMOC at 1.5 pt/A + N-Pak Liquid AMS at 2.5% v/v.

Sugarbeet tolerance and waterhemp control were evaluated. All evaluations were a visual estimate of control in the four treated rows compared to the adjacent untreated strip. Experimental design was randomized complete block with four replications. Data were analyzed with the ANOVA procedure of ARM, version 2020.2 software package.

Results

Experiment 1. Ethofumesate requires rainfall for activation. The experimental area near Moorhead, MN received 0.4- and 0.5-inch rains 48 and 72 hours, respectively, after ethofumesate application on May 2. Rain fell on the experiment near Blomkest, MN 1 and 9 days after ethofumesate application. However, these rain events did not provide sufficient moisture (0.7-inch rainfall or greater) to activate ethofumesate and activating rainfall did not occur until 21 days after application. Ethofumesate at 4.5 pt/A or greater reduced wheat stand by more than 50% at 23 and 43 DAT. Wheat ground cover loss was negligible at Blomkest, even at the 7.5 pt/A rate.

Growers frequently ask if ethofumesate can be used in concert with a nurse crop to reduce effect of blowing soil on sugarbeet. Our research indicates that oat tolerates soil residual herbicides better than wheat or barley and S-metolachlor is safer on nurse crops than ethofumesate. However, our data from 2020 clearly demonstrated nurse crop survival if offered the opportunity to achieve a head-start before activation of soil applied herbicides.

Waterhemp control was dependent on ethofumesate rate and evaluation timing (Figure 1). Waterhemp control of 85% or greater was seen from ethofumesate at 7.5 pt/A, only as far as 54 days after application, indicating ethofumesate at the full rate does not provide season long waterhemp control. Ethofumesate at 6 pt/A provided greater than 90% control but only for 36 days after planting. Eighty percent or greater waterhemp control was accomplished with ethofumesate at 7.5 pt/A, 6 pt/A, and 4.5 pt/A at 79, 56, and 36 DAP, respectively.

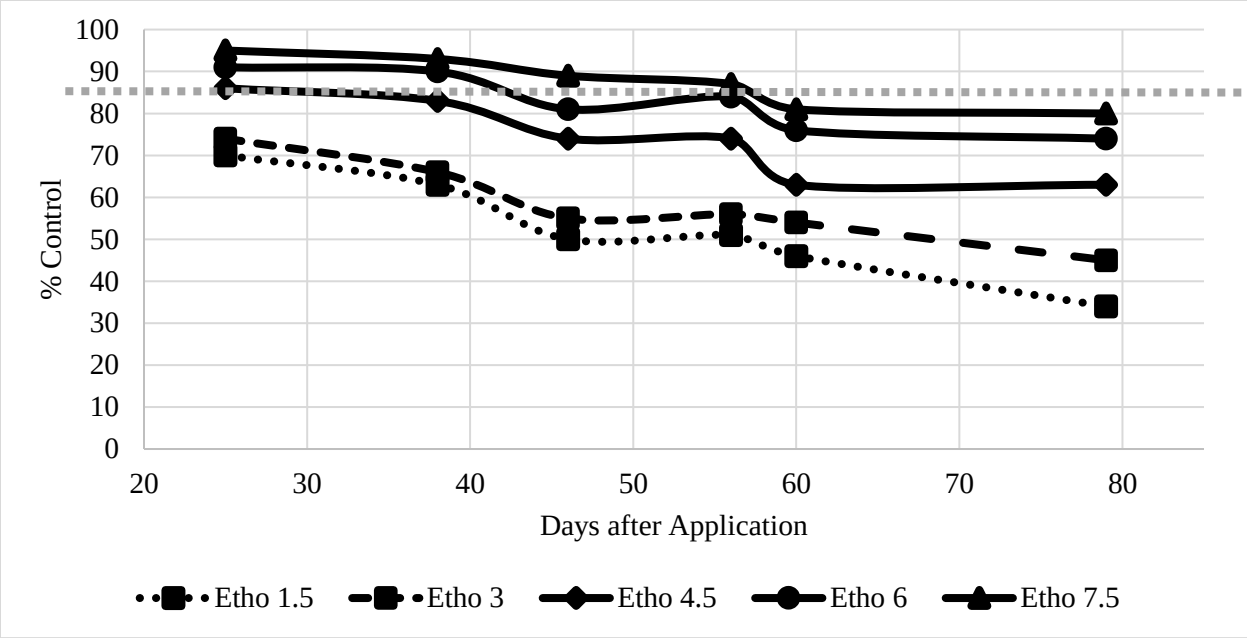

Figure 1. Waterhemp control from increasing ethofumesate rates at Blomkest in 2020.

These spring wheat and waterhemp data suggest we did not properly activate ethofumesate in either experiment in 2020. In addition, waterhemp emergence was much earlier than normal in 2020 than in previous years. An early germinating seed bank means there is less time for herbicide activation before waterhemp emergence.

Experiment 2. This experiment considered a weed management program including preemergence, early postemergence and postemergence herbicides for season-long waterhemp control. Waterhemp control 25 to 28 DAP was dependent on location (Table 4). At Hickson, ND, waterhemp control from ethofumesate at 4 pt/A provided greater waterhemp control than ethofumesate at 2 pt/A or Dual Magnum at 0.75 pt/A. However, at Blomkest, MN, preemergence herbicides did not influence waterhemp control. Preemergence control was influenced by waterhemp emergence date. Waterhemp emergence was documented near Fargo, ND on May 1 and near Mapleton, ND on May 2 (communication with Dr. Joe Ikley, NDSU and Mr. Greg Krause, Minn-Dak Farmers Cooperative) and waterhemp was a uniform and heavy infestation from cotyledon to 2-lf stage on May 28 at Hickson. The waterhemp infestation at Blomkest was sporadic across the experimental area, probably related to dry surface moisture conditions in April and May. Thus, waterhemp PRE control at Blomkest was an estimate of ground cover since the running checks were unreliable due to a light and uneven waterhemp infestation.

Waterhemp control was evaluated 14, 28 and 42 days (+/- 3 days) after POST application at Hickson and 14 days (+/- 3 days) after POST application at Blomkest. Waterhemp control at Hickson will not be presented since there was a tremendous amount of plot to plot variation in POST waterhemp control in the experiment. At Blomkest, waterhemp control from POST herbicide treatments tended to be greatest following ethofumesate at 4 pt/A PRE (Table 5). POST herbicide treatments generally provided similar waterhemp control within PRE treatment.

Table 4. Waterhemp control from the main effect of preemergence herbicide treatment when averaged across postemergence herbicide treatment, 28 DAP at Hickson, ND and 25 DAP at Blomkest, MN in 2020.[1]

Treatment	Rate	Hickson	Blomkest
	--pt/A--	---%---	---%---
No PRE		27 c	81
Dual Magnum	0.75	86 b	–[2]
Ethofumesate	2	85 b	87
Ethofumesate	4	91 a	87
P-value		0.0001	0.1917

[1]Means not sharing any letter are significantly different by t-test at the 5% level of significance.
[2]- treatment was not part of the trial at Blomkest.

Table 5. Waterhemp control 14 days after POST application from PRE, EPOST and POST herbicides at Blomkest in 2020.[1]

Lay-by Treatment[2]	Rate	Timing[3]	No Preemergence Herbicide	Ethofumesate 2 pt/A	Ethofumesate 4 pt/A
	---pt/A---	--lf stage--	----------%----------		
Warrant	3	4	73 bc	83 ab	90 ab
Warrant	3	8	76 abc	86 ab	89 ab
Outlook/Outlook	0.75 / 0.75	4/8	64 c	79 abc	89 ab
Warrant/Warrant	3 / 3	4/8	76 abc	83 abc	92 a
Outlook/Warrant	0.75 / 3	4/8	72 bc	88 ab	90 ab

[1]Means not sharing any letter are significantly different by t-test at the 20% level of significance.
[2]All POST treatments of Warrant and Outlook also included Roundup PowerMax at 28 fl oz/A + HSMOC at 1.5 pt/A + AMS at 2.5% v/v.
[3]Timing=Sugarbeet leaf stage.

Experiment 3. Grower survey results indicated escaped waterhemp occurred following PRE, EPOST, and POST herbicide treatments. Band applying ethofumesate was a common grower practice before the development of Roundup Ready (RR) sugarbeet. Ethofumesate at 6-pt/A broadcast PRE followed by repeat applications of Roundup PowerMax + ethofumesate controlled waterhemp better than ethofumesate at 6-pt per treated acre (band applied) followed by repeat applications of Roundup PowerMax + ethofumesate (Table 6). Improved control from broadcast applied ethofumesate was most likely due to complete soil coverage as compared with only 11-inches of soil coverage from ethofumesate banded over the sugarbeet row. Waterhemp that emerged between the ethofumesate bands were only partially controlled due to the presence of glyphosate-resistant biotypes. Waterhemp control was improved in treatments where ethofumesate was banded by including Dual Magnum (S-metolachlor) and ethofumesate with Roundup PowerMax applied POST and followed with either inter-row cultivation or an inter-row application of Liberty through a hooded sprayer at the 12 leaf, LPOST, stage.

Table 6. Waterhemp control and recoverable sucrose in response to preemergence and postemergence herbicide treatment, Blomkest and Moorhead, 2020.[1]

Herbicide Treatment	Rate	Blomkest, MN		Moorhead, MN	
		58 DAP[2]	67 DAP	62 DAP	Rec. Suc.[3]
	----fl oz/A----	----------%----------			--lb/A--
Ethofumesate / RUPM[4] / RUPM[4] / RUPM[4]	96 / 28 / 28 / 22	99 a	99 a	84 b	6,555
Etho (band) / RUPM[4] / RUPM[4] / RUPM[4]	48 / 28 / 28 / 22	69 b	79 c	76 bc	6,796
Etho (band) / Dual Mag + RUPM[5] + Etho / Liberty (hood)	48 / 16 + 32 + 12 / 32 (hood)	93 a	91 abc	68 c	6,777
Etho (band) / Dual Mag + RUPM[5] + Etho / Inter-row cultivation	48 / 16 + 32 + 12 / (cold hard steel)	100 a	99 ab	99 a	6,952
P value		0.0001	0.0201	0.0001	0.6013

[1]Means not sharing any letter are significantly different by t-test at the 5% level of significance.
[2]DAP=Days after planting.
[3]Rec. Suc. = Recoverable Sucrose.
[4]RUPM = Roundup PowerMax applied with Ethofumesate at 4 fl oz/A + HSMOC at 1.5 pt/A + NPak Liquid AMS at 2.5% v/v.
[5]RUPM = Roundup PowerMax applied with Ethofumesate at 12 fl oz/A + HSMOC at 1.5 pt/A + NPak Liquid AMS at 2.5% v/v.

Summary
Waterhemp control in sugarbeet has been our most important weed management challenge since the beginning of my tenure in 2014. Our research in creating a waterhemp control strategy is based on results from 86 sugarbeet tolerance and waterhemp control experiments since 2014 and has been successfully implemented on over 373,064 acres, where producers identify waterhemp as their most important weed management challenge (according to the 2020 Turning Point survey). The foundation for the program is use of chloroacetamide herbicides (SOA15) early postemergence (EPOST) and postemergence (POST) and in combination with glyphosate and ethofumesate in sugarbeet.

We observed integrating a PRE herbicide into the management plan improved waterhemp control, especially when sugarbeet emergence or timely rainfall to activate chloroacetamide herbicides is delayed (Figure 2). Growers planting after April 20 were encouraged to use a PRE since waterhemp emergence may occur before chloroacetamide herbicide activation. However, 2020 research and commercial experience indicates a PRE should be used regardless of plant date.

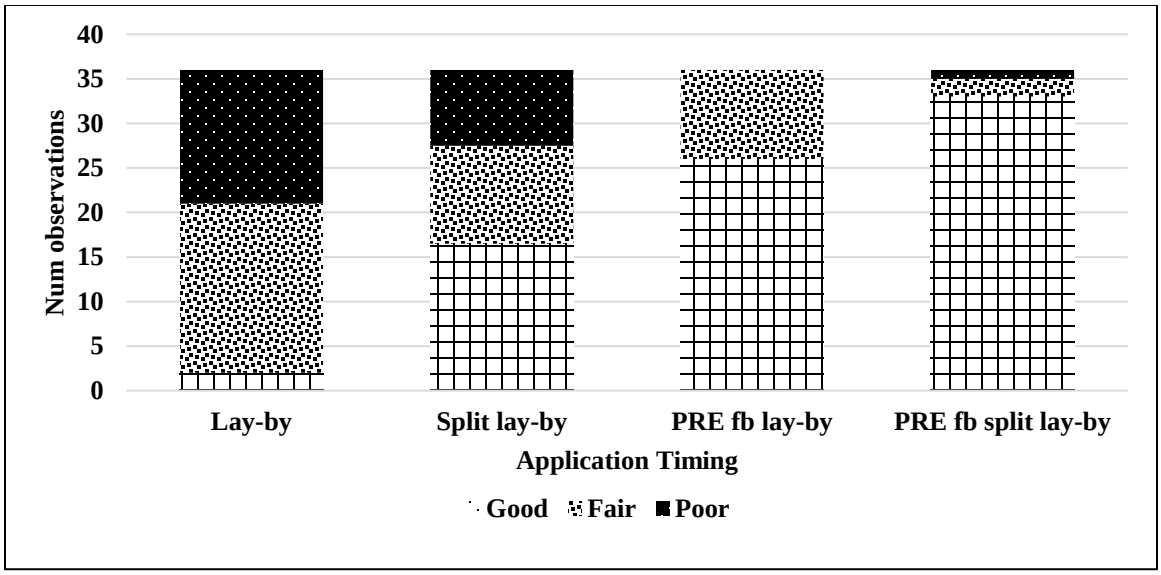

Figure 2. Number of good, fair, and poor estimates of waterhemp control across herbicides and application timing, summed across evaluations, locations, and years.

Surveyed growers attending the 2020 SMBSC seminar in Willmar indicated waterhemp control following PRE and layby application in 2019 did not meet their expectations (31% and 24% of respondents, respectively). POST control of escapes is difficult due to widespread ALS inhibitor (SOA 2) resistance biotypes and depleting Betamix inventories. In 2020, we observed escaped waterhemp can be controlled using inter-row cultivation or by the use of inter-row application of Liberty through a hooded sprayer. BASF Corp is drafting a 24c local needs label for Minnesota and North Dakota for 2021 to allow for this type of application.

Acknowledgements
We wish to thank the Sugarbeet Research and Education Board for funding this research in 2020. Thank you to our cooperators, Vince Ulstad, Hickson, ND and Youngkrantz Family Farms, Blomkest, MN. We also want to thank the Sugarbeet Cooperatives, American Crystal Sugar, Minn-Dak Farmers Cooperative, and Southern Minnesota Beet Sugar Cooperative for collaborating with field research. We also thank our summer student employees Ryan Borgen and Brad Stewart along with other NDSU colleagues for their contributions.