INTEGRATING HERBICIDES AND INTER-ROW CULTIVATION

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Introduction

The spread of glyphosate resistant waterhemp in Minnesota and North Dakota has sugarbeet growers looking into weed control methods that will supplement chemical control.

Materials and Methods

An experiment was conducted on common lambsquarters and waterhemp near Moorhead, MN in 2019. The trial site was prepared for planting using a Kongskilde s-tine field cultivator on May 9, 2019. 'CR 355' sugarbeet was planted in 22-inch rows at 61,500 seeds per acre on May 10 with a six-row planter. Preemergence (PRE) treatments were applied May 10. Postemergence (POST) treatments were applied June 6 and 19. 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 30 feet in length. A maintenance application of Roundup PowerMax at 22 fl oz/A was applied to the entire trial site on June 13 to reduce competition from common lambsquarters and allow waterhemp emergence. Cultivation treatment was applied June 25 to the center 4 rows of appropriate plots. The cultivator was operated at 4 mph, set 1 to 1.5 inches deep, and equipped with sweeps that tilled 15 inches of soil surface between rows. Sugarbeet injury and common lambsquarters control were evaluated June 6, 26, July 15, and August 9, 2019. Waterhemp control was evaluated June 26, July 15, and August 9. Sugarbeet were harvested September 20 by defoliating the center 4 rows of 30' long plots and harvesting the center 2 rows with a two-row sugarbeet harvester. Sugarbeets were weighed and a subsample of about 25 lbs. of normal, representative roots from each plot were collected and taken to the American Crystal Tare Lab in East Grand Forks, MN for quality analysis.

Table 1. Application Information – Moorhead, MN 2019

Application	A	B	C	Cultivation
Date	May 10	June 6	June 19	June 25
Time of Day	6:00 PM	9:00 AM	12:30 PM	
Air Temperature (F)	64	77	76	
Relative Humidity (%)	26	42	44	
Wind Velocity (mph)	10	2	2	
Wind Direction	SW	NW	SE	
Soil Temp. (F at 6")	50	68	66	
Soil Moisture	Good	Good	Good	Sli Wet
Cloud Cover (%)	80	0	0	
Sugarbeet Stage	PRE	2-lf	8-lf	12-lf
Common Lambsquarters	PRE	1 in	3 in	
Waterhemp	PRE	0 in	3 in	

All sugarbeet 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. The experiment was a 2x4 factorial split-block arrangement in a randomized complete block design with 4 replications. Each replication (block) was "grid split" where the factor A was cultivation at two levels and the factor B was herbicide at four levels. Data were analyzed with the ANOVA procedure of ARM, version 2019.4, software package.

Results

Cultivation (factor A) had no impact on sugarbeet injury at either evaluation (Table 2). Herbicide (factor B) had no impact on sugarbeet injury at either evaluation.

Table 2. Sugarbeet Injury at Moorhead, MN, 2019.

Treatment	Rate	Timing[3]	Percent Sugarbeet Injury	
	(fl oz/A)		June 6	June 26
FACTOR A - Cultivation				
NO Cultivation	-	-	9	8
Cultivation	-	Cultivation	8	7
FACTOR A LSD (0.05)			**NS**	**NS**
FACTOR B - Herbicide				
Dual Magnum	8	A	7	3
Dual Magnum fb	8 fb	A fb		
POST[1] + Outlook fb	1x[2] + 18 fb	B fb	8	8
POST	1x	C		
Dual Magnum fb	8 fb	A fb		
POST fb	1x fb	B fb	13	9
POST + Outlook	1x + 18	C		
Dual Magnum fb	8 fb	A fb		
POST + Outlook fb	1x + 12 fb	B fb	7	11
POST + Outlook	1x + 12	C		
FACTOR B LSD (0.05)			**NS**	**NS**

[1] POST = Roundup PowerMax @ 28 fl oz/A + Ethofumesate 4SC @ 6 fl oz/A + Destiny HC @ 1.5 pt/A + NPak AMS at 2.5% v/v

[2] 1x = rates specified in footnote 1.

[3] Timing refers to application timings in Table 1.

Cultivation (factor A) had no significant impact on common lambsquarters control at any evaluation timing (Table 3). Herbicide (factor B) significantly impacted common lambsquarters control at all evaluations taken after all herbicide application timings were completed. Dual Magnum at 0.5 pt/A was applied PRE on all plots and gave 68% to 78% control of common lambsquarters. Plots receiving two applications of POST herbicides following PRE Dual Magnum showed 97% to 99% lambsquarters control later in the season compared to 38% to 70% control in plots receiving only PRE Dual Magnum. Cultivation did not impact common lambsquarters control when POST herbicides were applied (data not shown), but PRE Dual Magnum followed by cultivation tended to give 15% to 20% greater common lambsquarters control compared to PRE Dual Magnum without cultivation (data not shown).

Table 3. Common Lambsquarters Control at Moorhead, MN, 2019.

Treatment	Rate	Timing[3]	Percent Common Lambsquarters Control			
	(fl oz/A)		June 6	June 26	July 15	August 8
FACTOR A - Cultivation						
NO Cultivation	-	-	72	85	88	86
Cultivation	-	Cultivation	70	81	94	90
FACTOR A LSD (0.05)			**NS**	**NS**	**NS**	**NS**
FACTOR B - Herbicide						
Dual Magnum	8	A	68	38	70	55
Dual Magnum fb	8 fb	A fb				
POST[1] + Outlook fb	1x[2] + 18 fb	B fb	78	99	98	99
POST	1x	C				
Dual Magnum fb	8 fb	A fb				
POST fb	1x fb	B fb	69	97	97	99
POST + Outlook	1x + 18	C				
Dual Magnum fb	8 fb	A fb				
POST + Outlook fb	1x + 12 fb	B fb	70	99	99	99
POST + Outlook	1x + 12	C				
FACTOR B LSD (0.05)			**NS**	**11**	**11**	**8**

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[2] 1x = rates specified in footnote 1.

[3] Timing refers to application timings in Table 1.

Cultivation (factor A) had no significant impact on waterhemp control at June and July evaluation timings (Table 4). The August evaluation showed cultivation gave an improvement in waterhemp control compared to no cultivation, though the difference was slight. Herbicide (factor B) significantly impacted waterhemp control at all evaluations. Dual Magnum at 0.5 pt/A was applied PRE and gave 41% to 74% control of wtaerhemp. Plots receiving two applications of POST herbicides following PRE Dual Magnum showed 96% to 99% waterhemp control. Cultivation did not impact waterhemp control when POST herbicides were applied (data not shown), but PRE Dual Magnum followed by cultivation tended to give 10% to 15% greater waterhemp control compared to PRE Dual Magnum without cultivation (data not shown).

Table 4. Waterhemp Control at Moorhead, MN, 2019.

Treatment	Rate	Timing[3]	Percent Waterhemp Control		
	(fl oz/A)		June 26	July 15	August 8
FACTOR A - Cultivation					
NO Cultivation	-	-	85	89	87
Cultivation	-	Cultivation	82	95	91
FACTOR A LSD (0.05)			**NS**	**NS**	**3.3**
FACTOR B - Herbicide					
Dual Magnum	8	A	41	74	62
Dual Magnum fb	8 fb	A fb			
POST[1] + Outlook fb	1x[2] + 18 fb	B fb	96	99	98
POST	1x	C			
Dual Magnum fb	8 fb	A fb			
POST fb	1x fb	B fb	98	97	99
POST + Outlook	1x + 18	C			
Dual Magnum fb	8 fb	A fb			
POST + Outlook fb	1x + 12 fb	B fb	99	99	99
POST + Outlook	1x + 12	C			
FACTOR B LSD (0.05)			**16**	**10**	**7**

[1] POST = Roundup PowerMax @ 28 fl oz/A + Ethofumesate 4SC @ 6 fl oz/A + Destiny HC @ 1.5 pt/A + NPak AMS at 2.5% v/v

[2] 1x = rates specified in footnote 1.

[3] Timing refers to application timings in Table 1.

Impacts of cultivation and herbicide on yield followed a very similar trend as has been discussed with respect to weed control. Cultivation (factor A) had no significant impact on yield parameters (Table 5). There is a slight numeric trend towards greater root yield (1.3 ton/A) and greater extractable sucrose (353 lb/A) from cultivation, but the impact was not statistically significant. Herbicide (factor B) significantly impacted root yield, but did not impact sugar percentage or extractable sucrose per acre. Dual Magnum at 0.5 pt/A applied PRE gave 27.0 ton/A root yield, while plots receiving two applications of POST herbicides following PRE Dual Magnum gave 29.9 to 31.3 tons/A. Cultivation did not impact root yield or extractable sucrose when POST herbicides were applied (data not shown), but PRE Dual Magnum followed by cultivation gave 6.2 tons/A greater root yield and 1,200 lbs/A greater extractable sucrose compared to PRE Dual Magnum without cultivation (data not shown).

Conclusions

Common lambsquarters was very dense in this trial in late May and early June and was actually suppressing waterhemp germination. Waterhemp started to emerge following an across trial application of Roundup PowerMax at 22 fl oz/A on June 13. The main influence on weed control as the season progressed was not cultivation, but rather Outlook herbicide. For both common lambsquarters and waterhemp, the greatest control was observed when Outlook was applied early POST (2 leaf), late POST (8 leaf), or as a split application at both timings. Due to the early season interference from common lambsquarters, waterhemp emergence was delayed and both POST timings of Outlook were effective at controlling waterhemp. The broadcast application of Roundup PowerMax at 22 fl oz/A allowed us to observe the PRE followed by a single POST application system. This system was not effective at controlling either waterhemp or common lambsquarters under very dense weed pressure. Higher rates of Roundup may have improved common lambsquarters control, but increased rates of POST applied glyphosate would not have improved control of the glyphosate-resistant waterhemp.

Table 5. Yield Impacts from cultivation and herbicide at Moorhead, MN, 2019.

Treatment	Rate	Timing[3]	Yield	Sugar	Ext. Sucrose
	(fl oz/A)		Ton/A	%	Lb/A
FACTOR A - Cultivation					
NO Cultivation	-	-	29.1	13.7	7,154
Cultivation	-	Cultivation	30.4	13.7	7,507
FACTOR A LSD (0.05)			**NS**	**NS**	**NS**
FACTOR B - Herbicide					
Dual Magnum	8	A	27.0	13.7	6,679
Dual Magnum fb	8 fb	A fb			
POST[1] + Outlook fb	1x[2] + 18 fb	B fb	30.7	13.6	7,485
POST	1x	C			
Dual Magnum fb	8 fb	A fb			
POST fb	1x fb	B fb	29.9	13.9	7,485
POST + Outlook	1x + 18	C			
Dual Magnum fb	8 fb	A fb			
POST + Outlook fb	1x + 12 fb	B fb	31.3	13.7	7,673
POST + Outlook	1x + 12	C			
FACTOR B LSD (0.05)			**3.5**	**NS**	**NS**

[1] POST = Roundup PowerMax @ 28 fl oz/A + Ethofumesate 4SC @ 6 fl oz/A + Destiny HC @ 1.5 pt/A + NPak AMS at 2.5% v/v

[2] 1x = rates specified in footnote 1.

[3] Timing refers to application timings in Table 1.

The impact of cultivation on weed control was skewed in this trial. In the plots that received only Dual Magnum PRE, weed pressure was quite heavy. It was in these weedy plots that we observed the greatest impact from cultivation on weed control. This observation is logical and supports what we've known for many years: cultivation in weedy fields generally helps eliminate some weeds and typically improves overall weed control. The weed pressure was lighter in the plots that received POST herbicides and there was less benefit from cultivation. However, no negative effects from cultivation such as increased root disease was observed. Likewise, cultivation did not negatively affect Outlook, which to be effective, must be evenly distributed in the top inch of the soil horizon for weeds to absorb the herbicide and to be controlled.