

# RESPONSE OF TRANSGENIC SUGARBEET TO POSTEMERGENCE LIBERTY TREATMENTS

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## INTRODUCTION

Despite many efforts to improve current weed control options for maximizing yield, weeds remain a costly problem as revealed by surveyed sugarbeet growers in eastern North Dakota and Minnesota. Sugarbeet growers would greatly benefit from improved weed control systems that are aimed to increase herbicide efficacy and crop safety, provide more flexibility, and reduce production inputs. Transgenic herbicide-resistant sugarbeet allows the use of excellent broadspectrum non-selective herbicides such as Liberty postemergence (POST) to kill weeds at any growth stage. This new technology offers the potential to overcome limitations of current weed control systems with commonly used sugarbeet herbicides including the lack of crop selectivity, narrow weed spectrum, precise timing of sequential POST herbicide applications for effective weed control, and occurrence of herbicide-resistant weed biotypes. To improve information available for weed management decision making, the objectives of this research were to determine the response of Liberty resistant sugarbeet to various Liberty rates and timings.

## MATERIALS AND METHODS

Field studies during 2000 were conducted at St. Thomas, ND and Crookston, MN. 'Beta 2012 Liberty Link' sugarbeet was seeded in 22-inch rows on April 27 at St. Thomas and May 2 at Crookston. Counter 15G insecticide was applied modified-in-furrow at 12 lb/A with planting at both locations. Sugarbeet was hand thinned in each experiment. Liberty treatments were applied to the center four rows of six row plots in 17 gal/A at 40 psi through 8002 flat fan nozzles using a CO<sub>2</sub> pressurized bicycle-wheel-type sprayer. Liberty was applied to sugarbeet four times at a seven day interval beginning at either one, three or four weeks after the cotyledon stage of sugarbeet. Dates, environmental conditions, and crop size when herbicides were applied are presented in [Table 1](#). One-time Liberty treatments started six or seven weeks after sugarbeet was in the cotyledon stage. Each treatment was tested for Liberty at the recommended rate of 28 fl oz/A, half and twice the normal rate at 14 or 55 fl oz/A, respectively. All plots were handweeded prior the first herbicide application so that competition from growing weeds would not interfere with sugarbeet yield. The corresponding check plots used for yield and injury comparisons with the plots to which Liberty was applied starting at either three or six weeks after the cotyledon stage of sugarbeet were handweeded throughout the season until six weeks after the cotyledon stage of sugarbeet. Respectively, plots treated with Liberty beginning four or seven weeks after the cotyledon sugarbeet stage were compared to check plots that were handweeded as needed until seven weeks after the sugarbeet cotyledon stage. Plots were evaluated for visible sugarbeet injury from Liberty at seven and 14 days after the last herbicide application. The two center 30-foot long rows of each plot were harvested on September 28 at St. Thomas and October 3 at Crookston.

## RESULTS AND DISCUSSION

Averaged over all starting times, plots treated with Liberty at 55 fl oz/A yielded significantly less extractable sucrose than plots that were sprayed with Liberty at either 28 or 14 fl oz/A ([Table 2](#)). Sugarbeet root yield was reduced as a result of Liberty at double the normal use rate as compared to the normal or half the normal recommended rate. Visible sugarbeet injury ratings from either the first or the second evaluation increased as the rate of Liberty increased and were highest with 55 fl oz/A of the herbicide applied. This suggests that, averaged over all application starting times, Liberty at 55 fl oz/A caused significant crop injury and yield loss.

Table 1. Dates, conditions and sugarbeet leaf stage at the time of the first Liberty applications.

Crookston	C+1 <sup>a</sup>	C+3	C+4	C+6	C+7
Date	May 26	June 9	June 19	July 3	July 10
Time of day	9:30 am	12:30 pm	3:00 pm	11:00 am	2:30 pm
Air temp. (F)	63	92	69	81	87
6" soil temp. (F)	59	69	66	69	72
Rel. Humidity (%)	65	26	100	80	58
Wind (mph)	4	5	10	2	2
Wind direction	SE	SE	SE	SW	N
Cloud cover (%)	20	10	100	75	30
Soil moisture	Dry	Dry	Good	Good	Wet
Sugarbeet.stage (v) <sup>b</sup>	2-3	3-6	9.75-13.5	8.75-18.75	9.5-19.75

  

St. Thomas					
Date	May 24	June 7	June 16	June 29	July 6
Time of day	2:30 pm	10:30 pm	4:00 pm	2:00 pm	12:15 pm
Air temp. (F)	71	76	54	81	74
6" soil temp. (F)	60	64	60	65	68
Rel. Humidity (%)	38	56	88	55	78
Wind (mph)	19	3	8	9	0
Wind direction	NW	S	NW	W	NE
Cloud cover (%)	50	45	100	5	130
Soil moisture	Dry	Dry	Wet	Dry	Good
Sugarbeet.stage (v) <sup>b</sup>	1-2	2-7.75	5.5-10.75	7.5-14.75	10.5-18.75

<sup>a</sup> C+1 = Sugarbeet cotyledon stage plus 1 wk.

<sup>b</sup> v1.0 = Cotyledonary sugarbeet, v2.0 = sugarbeet with two unrolled true leaves, v2.5 = sugarbeet with two unrolled true leaves plus a third leaf 50% unrolled.

Table 2. Response of Liberty Link sugarbeet to various rates of Liberty averaged over all starting timings.

Rate	Crookston/St. Thomas				
	Harvest Plant	Root Yield	Extractable	Sugarbeet Injury	
	Population		Sucrose	7 DAT <sup>a</sup>	21 DAT
fl oz/A	plants/60 ft	T/A	lb/A	%	
14	80	25.0	8171	7	5
28	80	24.5	8062	12	10
55	83	23.4	7808	22	17
LSD (0.05)	NS	0.9	256	3	2

<sup>a</sup> DAT = Days after the last treatment.

Liberty at twice the normal rate applied four times and starting when sugarbeet was in the 7-leaf stage (C+3 treatment) or the 10-leaf stage (C+4 treatment) gave similar extractable sucrose compared to plots that were treated with the same rate of Liberty applied four times but starting at the 2-leaf stage (C+1 treatment) (Table 3). Plots that were treated one time at either six or seven weeks after the cotyledonary sugarbeet stage yielded the same as plots treated four times. Handweeded check plots did not yield more than the Liberty-treated plots at any tested starting times. Visible herbicide-induced sugarbeet injury from Liberty treatments at 55 fl oz/A sprayed three weeks after the cotyledon sugarbeet stage or

later had no effect on yield when compared to the results from the early Liberty application and the handweeded check plots. This indicates that the yield loss from Liberty applications delayed for three or four weeks after the cotyledon sugarbeet stage as observed in field experiments during 1998 (published in the 1998 Sugarbeet Research and Extension Reports, volume 29, pages 76-81) and 1999 (data unpublished) was due to the weed competition prior the first herbicide application rather than caused by herbicide injury.

Table 3. Liberty applied at 55 fl oz/A.

Treatment	Crookston/St. Thomas					
	Sgbt stage at last application	Harvest Plant Population plants/60 ft	Root Yield T/A	Extractable Sucrose lb/A	Sugarbeet Injury	
					7 DAT	21 DAT
					%	
C+1 (4x)	9-11	83	23.5	7871	4	3
C+3 (4x)	12-14	86	23.2	7696	22	16
C+4 (4x)	14-17	86	23.8	7894	42	29
C+6 (1x)	12-14	80	23.9	8003	16	13
C+7 (1x)	14-17	79	22.6	7577	26	27
HW (C+6) <sup>a</sup>	12-14	82	23.6	8037	3	0
HW (C+7) <sup>b</sup>	14-17	82	24.2	8022	2	0
LSD (0.05)	-	NS	NS	NS	6	5

<sup>a</sup> HW (C+6) = Handweeded throughout the season until C+6; used to compare to C+3 and C+6 treatments.

<sup>b</sup> HW (C+7) = Handweeded throughout the season until C+7; used to compare to C+4 and C+7 treatments.

The number of Liberty applications, averaged over all herbicide rates did not influence extractable sucrose yield (Table 4). Plots that were treated four times and received four times the amount of the tested rate produced similar extractable sucrose as plots treated only once at the tested rate of Liberty. However, a significantly lower root yield was observed from plots treated once as compared to plots receiving four sequential Liberty applications. Plots that were sprayed only once as opposed to four times were handweeded over a longer period of time, with the last handweeding occurring when sugarbeet had 12 to 14 leaves or 14 to 17 leaves for the C+6 and C+7 treatments, respectively. The longer period of handweeding may have caused more physical damage to the sugarbeet plants, which may explain the root yield loss. The lower harvest sugarbeet population in plots treated only once could be also an indication of handweeding damage. Herbicide injury ratings at seven days after the last treatment were slightly but significantly greater with Liberty applied four times as compared to single treatments. At 21 days after the last treatment, sugarbeet had partially recovered from Liberty-induced injury and injury ratings were similar for sugarbeet treated once or four times.

Table 4. Yield as affected by Liberty applied one time versus four times, averaged over rates.

Rate	Crookston/St. Thomas					
	Harvest Plant Population plants/60 ft	Root Yield T/A	Extractable Sucrose lb/A	Sugarbeet Injury		
				7 DAT	21 DAT	
					%	
C+3, C+4 (4x)	83	24.8	8116	19	14	
C+6, C+7 (1x)	79	23.8	7921	13	13	
LSD (0.05)	3	0.8	NS	3	NS	

## **CONCLUSIONS**

Sugarbeet was injured and yield was reduced by Liberty at 55 fl oz/A or twice the normal use rate, averaged over all starting times as compared to sugarbeet treated with Liberty at 14 or 28 fl oz/A. Early or late applications of Liberty at 55 fl oz/A gave yield similar to handweeded plots despite the significantly greater crop injury in plots that were treated later than one week after the cotyledon sugarbeet stage. However, late Liberty applications resulted in yield loss if weeds were allowed to compete prior the first herbicide application. No cumulative phytotoxic effect on extractable sucrose yield was observed from Liberty applied four times compared to Liberty sprayed only once at the same tested rate. Possibly, greater damage from prolonged handweeding in plots treated once with Liberty caused the observed reduced root yield.

## **ACKNOWLEDGEMENTS**

I would like to thank Dr. Dexter and Lenny Luecke for their guidance, assistance and field help with this research and also the Sugarbeet Research and Education Board of Minnesota and North Dakota for providing research funds.