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¹Plant Sciences Department, North Dakota State University and the University of
Minnesota, Fargo, ND 58105 and ²Northwest Experiment Station, University of
Minnesota, Crookston, MN 56716. **Weed control in Roundup Ready and Liberty
Link sugarbeet.**

The objective of these experiments was to collect information that will assist in establishing weed control systems using Liberty on Liberty Link sugarbeet and Roundup on Roundup Ready sugarbeet. The experiments were not designed to compare Liberty Link varieties to Roundup Ready varieties. Yield comparisons between Liberty Link and Roundup Ready varieties are not valid. The results reported in this paper are only from 1998. Results from 1997 were published in the 1997 Sugarbeet Research and Extension Reports, volume 28, pages 82-87 (<http://www.sbreb.org>).

An experiment designed to determine the optimum timing of the first application of Liberty and an identical experiment with Roundup were established at Fargo and Crookston. The dates and conditions when herbicides were applied are given in Table 1. Herbicides and hand weeding were started at five times during the growing season, on June 5, June 12, June 29, July 8 and July 15 at Crookston and on June 17, June 23, June 30, July 9 and July 14 at Fargo. Each herbicide treatment was applied three times total. Hand weeding was done as needed after the initial hand weeding. The original intent was to start the first application at weekly intervals and to reapply treatments at weekly intervals. The actual intervals were approximately one week except for a 17 day interval between June 12 and June 29 at Crookston caused by excessive rain. Roundup was applied at 1.0, 2.0 and 4.0 pt/A and Liberty was applied at 14, 28 and 55 fl. oz/A. Weed populations were low at both locations and all treatments gave excellent weed control. A few weeds emerged after the last POST treatment in some plots. Weed control data for this experiment will not be presented.

Delaying the first application of Roundup had no significant effect on extractable sucrose per acre at Fargo or Crookston (Table 2). Sugarbeet plant population varied significantly among Roundup treatment start times at Fargo but the reason for the variability is not known.

Delaying the first application of Liberty had no significant effect on extractable sucrose per acre at Fargo or sugarbeet population at either location (Table 3). Delaying Liberty application for three or four weeks after the cotyledon sugarbeet stage resulted in a reduction of extractable sucrose per acre at Crookston. This is similar to results from 1997 at Fargo and Crookston where delaying Liberty application for two weeks or longer after the cotyledon sugarbeet stage resulted in a reduction in extractable sucrose per acre. These results suggest that early herbicide application will be needed to prevent yield loss due to weed competition prior to treatment.

Plots treated with Roundup generally produced extractable sucrose similar to plots that were hand weeded or hand weeded and treated with Roundup at Fargo and Crookston (Table 4). One exception was that plots that were hand weeded and Roundup treated yielded more than plots that were treated with Roundup at 2.0 pt/A. Plots that were hand weeded and Roundup treated did not yield significantly more than hand weeded

plots which does not support the idea that Roundup may act as a growth regulator. In 1997, plots treated with Roundup often yielded more than hand weeded plots.

Plots treated with Liberty produced extractable sucrose similar to plots that were hand weeded or hand weeded and treated with Liberty at Fargo and Crookston (Table 5). These results do not support the idea that Liberty may act as a growth regulator. In 1997, plots treated with Liberty often yielded more than hand weeded plots. Plots treated with Liberty at 55 fl. oz./A yielded less than plots treated with 14 fl. oz./A at Crookston and 28 fl. oz./A at Fargo. This suggest that 55 fl. oz./A of Liberty, double a normal use rate, caused sugarbeet injury and yield loss.

Table 1. Dates and conditions when herbicides were applied to the experiment on timing of first application.

Crookston: Planted May 22							
Date	June 5	June 12	June 29	July 8	July 15	July 21	July 27
Time of day	noon	noon	4:30 pm	2:00 pm	11:00 am	10:30 am	noon
Air temp. (F)	57	69	70	85	73	67	78
6-inch soil temp. (F)	61	68	72	80	78	74	75
Rel. humidity (%)	70	81	77	60	69	85	53
Wind (mph)	10	12	12	2	5	5	3
Cloud cover (%)	85	75	40	50	0	50	20
Soil moisture	good	good	wet	good	wet	good	dry
Sugarbeet stage (v) ^a	1.0-2.0	1.0-3.5	6-13	6-14	10-18	12-20	15-30

Fargo: Planted May 22							
Date	June 17	June 23	June 30	July 9	July 14	July 20	July 27
Time of day	9:00 am	10:00 am	10:00 am	2:30 pm	4:00 pm	2:00 pm	9:00 am
Air temp. (F)	67	72	74	91	91	93	69
6-inch soil temp. (F)	70	64	71	84	84	82	72
Rel. humidity (%)	85	69	70	45	68	63	76
Wind (mph)	2	9	10	0	5	9	4
Cloud cover (%)	100	70	70	20	70	10	0
Soil moisture	good to wet	good to wet	good	good	good	good	dry
Sugarbeet stage (v) ^a	1.0-4.5	3.0-5.7	5.0-9.5	5.0-13.5	10-16	14-17	14.5-26

^av1.0 = cotyledonary sugarbeet, v2.0 = sugarbeet with two unrolled true leaves, v2.5 = sugarbeet with two unrolled true leaves plus a third leaf 50% unrolled. See 1996 Sugarbeet Research and Extension Reports, pp 152-157.

Table 2. Roundup Ready sugarbeet plant population and extractable sucrose per acre averaged over Roundup applied three times at 1.0, 2.0 or 4.0 pt/A.

Weed control start time	Fargo		Crookston	
	Sugb popul. plts/100 ft	Extrac. sucrose lb/A	Sugb popul. plts/100 ft	Extrac. sucrose lb/A
Cotyledon sugarbeet	83	3380	98	7540
+ 1 week	78	3550	94	7830
+ 2 weeks	87	3930	96	7520
+ 3 weeks	85	3720	--	--
+ 4 weeks	78	3580	96	7410
LSD (0.05)	7	NS	NS	NS

Table 3. Liberty Link sugarbeet plant population and extractable sucrose per acre averaged over

Liberty applied three times at 14, 28 or 55 fl. oz./A

Weed control start time	Fargo		Crookston	
	Sugb popul. plts/100 ft	Extrac. sucrose lb/A	Sugb popul. plts/100 ft	Extrac. sucrose lb/A
Cotyledon sugarbeet	77	4000	94	7620
+ 1 week	76	4150	94	7500
+ 2 weeks	78	4130	93	7380
+ 3 weeks	78	4320	98	6860
+ 4 weeks	78	3900	92	6420
LSD (0.05)	NS	NS	NS	510

Table 4. Roundup Ready sugarbeet plant population and extractable sucrose per acre averaged over the first three starting times.

Treatment	Rate pt/A	Fargo		Crookston	
		Sugb popul. plts/100 ft	Extrac. sucrose lb/A	Sugb popul. plts/100 ft	Extrac. sucrose lb/A
Roundup (3 times)	1.0	82	3690	97	7530
	2.0	83	3890	94	7310
	4.0	82	3780	97	8050
Hand weeded		79	3560	93	7580
Hand weeded + Roundup (3 times)	2.0	82	3990	94	7860
LSD (0.05)		NS	NS	NS	480

Table 5. Liberty Link sugarbeet plant population and extractable sucrose per acre averaged over the first three starting times.

Treatment	Rate fl.oz./A	Fargo		Crookston	
		Sugb popul. plts/100 ft	Extrac. sucrose lb/A	Sugb popul. plts/100 ft	Extrac. sucrose lb/A
Liberty (3 times)	14	76	4200	96	7810
	28	81	4290	90	7440
	55	74	3780	96	7240
Hand weeded		73	4100	89	7600
Hand weeded + Liberty (3 times)	28	71	3840	94	7530
LSD (0.05)					510

Plots treated with Roundup yielded more extractable sucrose than plots treated with Betanex + UpBeet + Stinger + Select + MethOil at the micro-rate or plots treated with the micro-rate and hand weeded at Fargo (Table 6) but Roundup treated and micro-rate treated plots yielded similarly at Crookston. The micro-rate treated plots at Fargo had a lower sugarbeet plant population than the Roundup treated plots which probably explains

the lower yield. The reason for the lower plant population in the micro-rate treated plots is not known since no significant sugarbeet injury was observed.

Plots treated with Liberty yielded extractable sucrose similar to plots treated with Betanex + UpBeet + Stinger + Select + MethOil at the micro-rate or plots treated with the micro-rate and hand weeded at Fargo and Crookston (Table 7).

An experiment was conducted at Fargo and St. Thomas, ND where Roundup was applied two or three times and the first Roundup treatment was applied at the cotyledon stage of sugarbeet and at weekly intervals thereafter (Table 8). Delaying the first Roundup application had no effect on extractable sucrose yield at Fargo but extractable sucrose yield at Crookston was less when the first Roundup application was delayed for 3 or 4 weeks after the cotyledon sugarbeet stage. Control of redroot pigweed, wild mustard, kochia, green foxtail and yellow foxtail was nearly total. The observed sugarbeet injury was not due to damage from the herbicide but was sugarbeet stunting from weed competition prior to the first application of Roundup.

Table 6. Roundup Ready sugarbeet plant population and extractable sucrose per acre averaged over the first two starting times.

Treatment	Rate	Fargo		Crookston	
		Sugb popul plts/100 ft	Extrac. sucrose lb/A	Sugb popul plts/100 ft	Extrac. sucrose lb/A
Roundup (3 times)	2 pt/A	81	3760	94	7270
Betanex + UpBeet + Stinger + Select + MethOil (3 times)	micro-rate ¹	72	2970	97	7240
Hand weeded + Betanex+UpBeet +Stinger+Select+MethOil (3 times)	micro-rate ¹	73	3100	94	7050
LSD (0.05)		5	540	NS	NS

¹Micro-rate = Betanex at 0.5 pt/A + UpBeet at 0.125 oz/A + Stinger at 1.3 fl. oz./A + Select at 2 fl.oz./A + MethOil at 1.5% v/v.

Table 7. Liberty Link sugarbeet plant population and extractable sucrose per acre averaged over the first two starting times.

Treatment	Rate	Fargo		Crookston	
		Sugb popul plts/100 ft	Extrac. sucrose lb/A	Sugb popul plts/100 ft	Extrac. sucrose lb/A
Liberty (3 times)	28 fl.oz./A	82	4220	92	7400
Betanex + UpBeet + Stinger + Select + MethOil (3 times)	micro-rate ¹	71	3760	93	7470
Hand weeded + Betanex+UpBeet +Stinger+Select+ MethOil (3 times)	micro-rate ¹	76	3810	96	7790
LSD (0.05)		NS	NS	NS	NS

¹Micro-rate = Betanex at 0.5 pt/A + UpBeet at 0.125 oz/A + Stinger at 1.3 fl. oz./A + Select at 2 fl.oz./A + MethOil at 1.5% v/v.

The experiment at Fargo and St. Thomas had various dates that the last Roundup treatment was applied (Table 9). Volunteer wheat germinated and emerged over a long period and volunteer wheat was present in plots where the last Roundup application was June 22 or earlier. This illustrates that Roundup must be applied until weeds quit emerging for complete weed control.

An experiment was conducted at Fargo and St. Thomas, ND where Liberty was applied whenever weeds were 1 inch tall or whenever weeds were 4 inches tall (Table 10). Spraying 1-inch weeds resulted in three herbicide treatments at Fargo and four treatments at St. Thomas. Spraying 4-inch weeds resulted in two herbicide treatments at both locations. Sugarbeet injury, weed control and extractable sucrose per acre were all similar between the two treatment regimes averaged over herbicide rates and with or without ammonium sulfate. Ammonium sulfate had no significant effect on weed control from Liberty and this data is not presented. Volunteer wheat control was slightly less with two treatments than with four treatments at St. Thomas. The first Liberty treatment to 4-inch weeds was applied two weeks after the cotyledon

Table 8. Yield of Roundup Ready sugarbeet, sugarbeet injury rating and weed control after two or three applications of Roundup at 1 qt/A at Fargo and St. Thomas.

Timing of first Roundup application	Fargo	St. Thomas	Fargo St.Thom.	St.Thom.	St.Thom.	Fargo St.Thom.
	Extrac. sucrose lb/A	Extrac. sucrose lb/A	Rrpw ¹ cntl %	Wimu ¹ Kochia cntl %	Gr & Yeft ¹ cntl %	Sugb ¹ inj %
Cotyledon sugarbeet	4800	5820	100	100	98	3
Cotyledon + 1 week	4270	5630	100	100	99	2
Cotyledon + 2 weeks	4250	5620	100	99	100	6
Cotyledon + 3 weeks	4225	4880	100	100	100	13
Cotyledon + 4 weeks	4190	4430	100	100	100	14
LSD (0.05)	NS	720	NS	NS	NS	10

¹Rrpw = redroot pigweed, Wimu = wild mustard, Gr & Yeft = mixed population of green and yellow foxtail, sugb = sugarbeet.

Table 9. Volunteer wheat control at St. Thomas.

Date of last Roundup application	Vowh ¹ control %
June 16	82
June 22	94
July 2	100
July 8	100
July 14	100
July 21	100

¹Vowh = volunteer wheat

sugarbeet growth stage. The results with Roundup at St. Thomas showed that delaying the first application for only 2 weeks after the cotyledon sugarbeet stage did not result in yield loss (Table 8). So the Liberty results in Table 10 are in agreement with the Roundup results.

Plots that were cultivated yielded less than uncultivated plots where Roundup or Liberty were used to provide nearly total weed control in 1997 (Table 11). The experiment was repeated in 1998 at Fargo and Crookston. The results were not the same in 1998 as in 1997. Cultivation had no significant effect on sugarbeet yield in the absence of weeds in 1998.

Table 10. Yield of Liberty Link sugarbeet, sugarbeet injury rating and weed control after Liberty application averaged over 21 and 27 fl.oz./A; with and without ammonium sulfate; and Fargo and St. Thomas

Herbicide timing	Extrac. sucrose lb/A	Sugb inj %	Rrpw cntl %	St. Thomas	Fargo
				Vowh cntl %	Gr & Yeft cntl %
Spray when weeds were 1 inch tall (Four treatments at St. Thomas, three at Fargo)	4350	0	100	100	96
Spray when weeds were 4 inches tall (Two treatments)	4310	0	99	95	

Table 11. Influence of cultivation on yield of Liberty treated Liberty Link and Roundup treated Roundup Ready sugarbeet averaged over Fargo and Crookston

Number of cultivations	Liberty Link		Roundup Ready	
	1997	1998	1997	1998
----- Extractable sucrose, lb/A -----				
None	5060	6270	6200	6260
Two	4540	6610	5930	6710
Five	4500	6810	5520	6460
LSD (0.05)	350	NS	370	NS

Summary

The results obtained with Roundup on Roundup Ready and Liberty on Liberty Link sugarbeet in 1998 did not always agree with results obtained in 1997. Several of the experiments will be repeated in 1999. Results to date suggest that Roundup and Liberty will need to be applied two or three weeks after the cotyledon sugarbeet stage or earlier to avoid yield loss due to early season weed competition. Weed populations and relative competitive ability of various weed species will influence the optimum time of first treatment. The last application of Roundup and Liberty should be after late weeds have emerged since neither herbicide has any soil residual. Results in 1997 suggested that Roundup and Liberty were stimulating sugarbeet yield but 1998 results do not give strong support for that conclusion. Cultivation reduced sugarbeet yield in 1997 but cultivation had no significant effect on yield in 1998.