WEED CONTROL IN ROUNDUP READY® SUGAR BEETS WITH ROUNDUP® PLUS SOIL-RESIDUAL HERBICIDES

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Introduction

Weed competition is one of the yield-limiting factors in most crop production systems. Weeds compete with sugar beets for light, nutrients, and water. Sugar beets are especially vulnerable to weeds because of their poor competitiveness at the early growth stage and before canopy closure. Sugar beet tolerance of weeds will vary depending on the predominant weed species, planting date, time of weed emergence relative to the crop, and environmental conditions. Newly emerged sugar beet seedlings are small, lack vigor, and take about 60-90 days for total canopy closure. Dawson (1977) reported that annual weeds that germinate within 2 weeks after planting or in a 4-week period after the two-leaf stage can reduce sugar beet root yield by 26 to 100 percent. Sugar beet growers have traditionally used preplant or pre-emergence (PRE) herbicides to control weeds that emerge together with the crop.

The introduction of Roundup Ready® (RR) sugar beets presents an opportunity for growers to employ a total postemergence (POST) weed management program. If root yields are to be maximized, the total POST weed management program will require diligent monitoring of weed cohorts that emerge in succession. Some argue that use of soil-applied herbicides is a sound way to minimize weed biotype selection and a viable practice to provide sustainable weed control. A field study was conducted at the Malheur Experiment Station in Ontario, Oregon to determine crop response to herbicide tank-mixtures of soil-residual herbicides in combination with RoundUp PowerMax® to control weeds in RR sugar beets.

Materials and Methods

A study was established during 2008 in a field that had been ripped, moldboard plowed, and disked several times to create a seedbed favorable for sugar beet growth. The field was well drained and had been planted to wheat the previous year. The predominant soil was an Owyhee silt loam with 1.9 percent organic matter, a pH of 7.2, and a cation exchange capacity of 11 meq/g of soil. The study was a randomized complete block design with four replications. Individual plots were 7.33 ft wide (4 rows) by 25 ft long. Roundup Ready sugar beet variety 'BTSCT02RR08' was planted on April 11, 2008, using tractor-mounted flexi-planter units with double-disc furrow openers and cone seeders fed from a spinner divider that uniformly distributed the seeds within the row. Sugar beet seeds were dropped at the rate of 8 seeds/ft of row and later thinned to 8-

inch spacing between plants within a row. Counter® 15G (7.4 lb/acre) was applied on April 12, 2008 and Temik® 15G (10 lb/acre) on June 3. Sugar beets were fertilized on June 13 using a special blend fertilizer to supply 180 lb nitrogen, 20 lb potassium, and 3 lb zinc. The study was irrigated on a calendar schedule to maintain moisture in the top 12 inches of the soil profile. Herbicide treatments were applied using a CO_2-pressurized backpack sprayer equipped with a boom fitted with four 8002EVS Teejet nozzles calibrated to deliver 12 gal/acre at 40 psi at 3 mph. Early POST treatments (2-leaf stage) were applied on May 13, while POST treatments (4-leaf stage) on June 5 were followed by a second POST application (8-leaf stage) on June 23. Plants within each plot were visually evaluated for crop injury and weed control at 9 and 24 days after the last POST herbicide application on July 2 and July 17, respectively, using 0 percent (no crop injury or no weed control) to 100 percent (complete crop kill or complete weed control) scale. Sugar beets were harvested on October 16 from 25 ft of the two center rows using a beet harvester. Sugar beet weight from each plot was multiplied by a factor of 0.90 to correct for tare. Sugar content and other sugar yield variables were determined in a laboratory at the Amalgamated Sugar Factory in Nampa, Idaho. Sugar concentrations were determined by multiplying measured sucrose by 0.98 to estimate the sugar that would have been lost to respiration if the beets had been stored in a pile. The percent sugar extraction was calculated using the formula:

$$Ext = \frac{250 + [(1{,}255.2 * Cond) - (15{,}000 * Sug) - 6{,}185]}{Sug * (98.66 - 7.845 * Cond)}$$

Where *Ext* is percent sugar extraction, *Cond* is the electrical conductivity in mmho, and *Sug* is the percent sucrose concentration.

The data were subjected to analysis of variance and treatment means compared using the least significant difference (LSD, $P = 0.05$).

Results

There was no injury observed on sugar beet plants from the herbicides used in this study. Kochia, common lambsquarters, pigweed species, common barnyardgrass, and hairy nightshade control at 7 and 24 DAT was 99 percent across treatments (Tables 1 and 2). The sugar beet plants were severely outcompeted by weeds in the untreated control plots. Consequently, the untreated control had the lowest yield (4.9 tons/acre) in the study (Table 3). Root yield for different herbicide treatments ranged from 45 to 48 tons/acre. The estimated recoverable sugar (lb/acre) varied among treatments. The root yield was relatively highest when early POST (2-leaf stage) of Roundup PowerMax at 22 fl oz/acre plus Upbeet® at 0.5 oz/acre was followed by two sequential applications of Roundup PowerMax at 22 fl oz/acre at the 4- and 8-leaf stage, compared to treatments that included Stinger® at 10.7 fl oz/acre at either 4- or 8-leaf stage. The untreated control treatment had the lowest estimated recoverable sugar (1,215 lb/acre) whereas that for the herbicide treatments ranged from 11,108 to 12,591 lb/acre. The results suggest that while inclusion of soil-residual herbicides provided season-long weed control, it was not different from the control provided by Roundup PowerMax alone.

Further studies are needed to evaluate the possibility of using soil-residual herbicides to reduce the number of Roundup PowerMax stand-alone sequential applications from three to one or two per season.

References

Dawson, J. H. 1977. Competition of late-emerging weeds with sugar beets. Weed Science 25:168–170.

Table 1. Weed control ratings at 9 days (7/2/2008) after the last POST herbicide application on Roundup Ready® sugar beets at Malheur Experiment Station, Oregon State University, Ontario, OR, 2008.

	Treatment	Rate	unit	Application timing	Crop injury‡	Weed control†				
						Kochia	Lambs-quarters	Pigweed spp.	Barnyard-grass	Hairy nightshade
					%	%				
1	Untreated Check				51 a	0 b	0 b	0 c	0 b	0 b
2	Roundup PowerMax	21.3	FL OZ/A	2 leaf	0 b	99 a	99 a	99 a	99 a	99 a
	Roundup PowerMax	21.3	FL OZ/A	4 leaf						
	Roundup PowerMax	21.3	FL OZ/A	8 leaf						
3	Roundup PowerMax	21.3	FL OZ/A	2 leaf	0 b	99 a	99 a	99 a	99 a	99 a
	Upbeet	0.5	OZ/A	2 leaf						
	Roundup PowerMax	21.3	FL OZ/A	4 leaf						
	Roundup PowerMax	21.3	FL OZ/A	8 leaf						
4	Roundup PowerMax	21.3	FL OZ/A	2 leaf	0 b	99 a	99 a	99 a	99 a	99 a
	Upbeet	0.5	OZ/A	2 leaf						
	Crop Oil Concentrate	0.8	PT/A	2 leaf						
	Roundup PowerMax	21.3	FL OZ/A	4 leaf						
	Roundup PowerMax	21.3	FL OZ/A	8 leaf						
5	Roundup PowerMax	21.3	FL OZ/A	2 leaf	0 b	99 a	99 a	99 a	99 a	99 a
	Roundup PowerMax	21.3	FL OZ/A	4 leaf						
	Stinger	10.7	FL OZ/A	4 leaf						
	Roundup PowerMax	21.3	FL OZ/A	8 leaf						
6	Roundup PowerMax	21.3	FL OZ/A	2 leaf	0 b	99 a	99 a	99 a	99 a	99 a
	Roundup PowerMax	21.3	FL OZ/A	4 leaf						
	Roundup PowerMax	21.3	FL OZ/A	8 leaf						
	Stinger	10.7	FL OZ/A	8 leaf						
7	Roundup PowerMax	21.3	FL OZ/A	2 leaf	0 b	99 a	99 a	99 a	99 a	99 a
	Roundup PowerMax	21.3	FL OZ/A	4 leaf						
	Selectmax	9.2	FL OZ/A	4 leaf						
	Roundup PowerMax	21.3	FL OZ/A	8 leaf						
8	Roundup PowerMax	21.3	FL OZ/A	2 leaf	0 b	99 a	99 a	97 b	99 a	99 a
	Nortron	2.88	FL OZ/A	2 leaf						
	Roundup PowerMax	21.3	FL OZ/A	4 leaf						
	Roundup PowerMax	21.3	FL OZ/A	8 leaf						
9	Roundup PowerMax	21.3	FL OZ/A	2 leaf	0 b	99 a	99 a	99 a	99 a	99 a
	Progress Ultra	17.2	FL OZ/A	2 leaf						
	Roundup PowerMax	21.3	FL OZ/A	4 leaf						
	Roundup PowerMax	21.3	FL OZ/A	8 leaf						
10	Roundup PowerMax	21.3	FL OZ/A	2 leaf	0 b	99 a	99 a	99 a	99 a	99 a
	Roundup PowerMax	21.3	FL OZ/A	4 leaf						
	Dual Magnum	1.31	PT/A	4 leaf						
	Roundup PowerMax	21.3	FL OZ/A	8 leaf						
11	Roundup PowerMax	21.3	FL OZ/A	2 leaf	0 b	99 a	99 a	99 a	99 a	99 a
	Roundup PowerMax	21.3	FL OZ/A	4 leaf						
	Roundup PowerMax	21.3	FL OZ/A	8 leaf						
	Dual Magnum	1.31	PT/A	8 leaf						
12	Roundup PowerMax	21.3	FL OZ/A	2 leaf	0 b	99 a	99 a	99 a	99 a	99 a
	Roundup PowerMax	21.3	FL OZ/A	4 leaf						
	Outlook	21	OZ/A	4 leaf						
	Roundup PowerMax	21.3	FL OZ/A	8 leaf						
13	Roundup PowerMax	21.3	FL OZ/A	2 leaf	0 b	99 a	99 a	99 a	99 a	99 a
	Roundup PowerMax	21.3	FL OZ/A	4 leaf						
	Roundup PowerMax	21.3	FL OZ/A	8 leaf						
	Outlook	21	OZ/A	8 leaf						
14	Roundup PowerMax	21.3	FL OZ/A	2 leaf	0 b	99 a	99 a	99 a	99 a	99 a
	Roundup PowerMax	21.3	FL OZ/A	8 leaf						
	Outlook	21	FL OZ/A	8 leaf						

‡Means within a column followed by the same letter are not significantly different (LSD, $P = 0.05$).
† All treatments and each application timing included ammonium sulfate (5 gal/100gal).

Table 2. Weed control ratings at 24 days (7/17/2008) after POST herbicide application on Roundup Ready® sugar beets at Malheur Experiment Station, Oregon State University, Ontario, OR, 2008.

	Treatment	Rate	unit	Application timing	Crop injury‡	Weed control†				
						Kochia	Lambs-quarters	Pigweed spp.	Barnyard-grass	Hairy nightshade
					%	%				
1	Untreated Check				75 a	0 b	0 c	0 b	0 b	0 b
2	Roundup PowerMax	21.3	FL OZ/A	2 leaf						
	Roundup PowerMax	21.3	FL OZ/A	4 leaf						
	Roundup PowerMax	21.3	FL OZ/A	8 leaf						
3	Roundup PowerMax	21.3	FL OZ/A	2 leaf	0 b	99 a	99 a	99 a	99 a	99 a
	Upbeet	0.5	OZ/A	2 leaf						
	Roundup PowerMax	21.3	FL OZ/A	4 leaf						
	Roundup PowerMax	21.3	FL OZ/A	8 leaf						
4	Roundup PowerMax	21.3	FL OZ/A	2 leaf	0 b	99 a	99 a	99 a	99 a	99 a
	Upbeet	0.5	OZ/A	2 leaf						
	Crop Oil Concentrate	0.8	PT/A	2 leaf						
	Roundup PowerMax	21.3	FL OZ/A	4 leaf						
	Roundup PowerMax	21.3	FL OZ/A	8 leaf						
5	Roundup PowerMax	21.3	FL OZ/A	2 leaf	0 b	99 a	99 a	99 a	99 a	99 a
	Roundup PowerMax	21.3	FL OZ/A	4 leaf						
	Stinger	10.7	FL OZ/A	4 leaf						
	Roundup PowerMax	21.3	FL OZ/A	8 leaf						
6	Roundup PowerMax	21.3	FL OZ/A	2 leaf	0 b	99 a	98 a	99 a	99 a	99 a
	Roundup PowerMax	21.3	FL OZ/A	4 leaf						
	Roundup PowerMax	21.3	FL OZ/A	8 leaf						
	Stinger	10.7	FL OZ/A	8 leaf						
7	Roundup PowerMax	21.3	FL OZ/A	2 leaf	0 b	99 a	99 a	99 a	99 a	99 a
	Roundup PowerMax	21.3	FL OZ/A	4 leaf						
	Selectmax	9.2	FL OZ/A	4 leaf						
	Roundup PowerMax	21.3	FL OZ/A	8 leaf						
8	Roundup PowerMax	21.3	FL OZ/A	2 leaf	0 b	99 a	99 a	99 a	99 a	99 a
	Nortron	2.88	FL OZ/A	2 leaf						
	Roundup PowerMax	21.3	FL OZ/A	4 leaf						
	Roundup PowerMax	21.3	FL OZ/A	8 leaf						
9	Roundup PowerMax	21.3	FL OZ/A	2 leaf	0 b	99 a	99 a	99 a	99 a	99 a
	Progress Ultra	17.2	FL OZ/A	2 leaf						
	Roundup PowerMax	21.3	FL OZ/A	4 leaf						
	Roundup PowerMax	21.3	FL OZ/A	8 leaf						
10	Roundup PowerMax	21.3	FL OZ/A	2 leaf	0 b	99 a	99 a	99 a	99 a	99 a
	Roundup PowerMax	21.3	FL OZ/A	4 leaf						
	Dual Magnum	1.31	PT/A	4 leaf						
	Roundup PowerMax	21.3	FL OZ/A	8 leaf						
11	Roundup PowerMax	21.3	FL OZ/A	2 leaf	0 b	99 a	99 a	99 a	99 a	99 a
	Roundup PowerMax	21.3	FL OZ/A	4 leaf						
	Roundup PowerMax	21.3	FL OZ/A	8 leaf						
	Dual Magnum	1.31	PT/A	8 leaf						
12	Roundup PowerMax	21.3	FL OZ/A	2 leaf	0 b	99 a	99 a	99 a	99 a	99 a
	Roundup PowerMax	21.3	FL OZ/A	4 leaf						
	Outlook	21	OZ/A	4 leaf						
	Roundup PowerMax	21.3	FL OZ/A	8 leaf						
13	Roundup PowerMax	21.3	FL OZ/A	2 leaf	0 b	99 a	99 a	99 a	99 a	99 a
	Roundup PowerMax	21.3	FL OZ/A	4 leaf						
	Roundup PowerMax	21.3	FL OZ/A	8 leaf						
	Outlook	21	OZ/A	8 leaf						
14	Roundup PowerMax	21.3	FL OZ/A	2 leaf	0 b	99 a	99 a	99 a	99 a	99 a
	Roundup PowerMax	21.3	FL OZ/A	8 leaf						
	Outlook	21	FL OZ/A	8 leaf						

‡Means within a column followed by the same letter are not significantly different (LSD, $P = 0.05$).
†All treatments and each application timing included ammonium sulfate (5 gal/100gal).

Table 3. Sugar content (%), sugar beet root yield, and recoverable sucrose estimates at Malheur Experiment Station, Oregon State University, Ontario, OR, 2008.

	Treatment[†]	Rate	unit	Application timing	Sugar beet yield[‡]				
					Sugar content	Root yield	Extractable sugar	Estimated recoverable sugar	Estimated recoverable sugar
					%	ton/acre	%	lb/acre	lb/ton
1	Untreated Check				15 a	4.9 b	83.2 a	1,215 c	250 a
2	Roundup PowerMax	21.3	FL OZ/A	2 leaf	16 a	45.4 a	83.4 a	11,769 ab	260 a
	Roundup PowerMax	21.3	FL OZ/A	4 leaf					
	Roundup PowerMax	21.3	FL OZ/A	8 leaf					
3	Roundup PowerMax	21.3	FL OZ/A	2 leaf	16 a	48.0 a	83.2 a	12,591 a	262 a
	Upbeet	0.5	OZ/A	2 leaf					
	Roundup PowerMax	21.3	FL OZ/A	4 leaf					
	Roundup PowerMax	21.3	FL OZ/A	8 leaf					
4	Roundup PowerMax	21.3	FL OZ/A	2 leaf	15 a	45.0 a	83.2 a	11,300 ab	254 a
	Upbeet	0.5	OZ/A	2 leaf					
	Crop Oil Concentrate	0.8	PT/A	2 leaf					
	Roundup PowerMax	21.3	FL OZ/A	4 leaf					
	Roundup PowerMax	21.3	FL OZ/A	8 leaf					
5	Roundup PowerMax	21.3	FL OZ/A	2 leaf	15 a	45.0 a	82.6 a	11,108 b	248 a
	Roundup PowerMax	21.3	FL OZ/A	4 leaf					
	Stinger	10.7	FL OZ/A	4 leaf					
	Roundup PowerMax	21.3	FL OZ/A	8 leaf					
6	Roundup PowerMax	21.3	FL OZ/A	2 leaf	15 a	44.9 a	81.8 a	11,143 b	248 a
	Roundup PowerMax	21.3	FL OZ/A	4 leaf					
	Roundup PowerMax	21.3	FL OZ/A	8 leaf					
	Stinger	10.7	FL OZ/A	8 leaf					
7	Roundup PowerMax	21.3	FL OZ/A	2 leaf	16 a	46.4 a	84.2 a	12,387 ab	268 a
	Roundup PowerMax	21.3	FL OZ/A	4 leaf					
	Selectmax	9.2	FL OZ/A	4 leaf					
	Roundup PowerMax	21.3	FL OZ/A	8 leaf					
8	Roundup PowerMax	21.3	FL OZ/A	2 leaf	16 a	47.0 a	83.4 a	12,163 ab	259 a
	Nortron	2.88	FL OZ/A	2 leaf					
	Roundup PowerMax	21.3	FL OZ/A	4 leaf					
	Roundup PowerMax	21.3	FL OZ/A	8 leaf					
9	Roundup PowerMax	21.3	FL OZ/A	2 leaf	15 a	47.2 a	83.0 a	11,937 ab	254 a
	Progress Ultra	17.2	FL OZ/A	2 leaf					
	Roundup PowerMax	21.3	FL OZ/A	4 leaf					
	Roundup PowerMax	21.3	FL OZ/A	8 leaf					
10	Roundup PowerMax	21.3	FL OZ/A	2 leaf	15 a	46.8 a	82.1 a	11,761 ab	251 a
	Roundup PowerMax	21.3	FL OZ/A	4 leaf					
	Dual Magnum	1.31	PT/A	4 leaf					
	Roundup PowerMax	21.3	FL OZ/A	8 leaf					
11	Roundup PowerMax	21.3	FL OZ/A	2 leaf	15 a	46.4 a	81.7 a	11,649 ab	252 a
	Roundup PowerMax	21.3	FL OZ/A	4 leaf					
	Roundup PowerMax	21.3	FL OZ/A	8 leaf					
	Dual Magnum	1.31	PT/A	8 leaf					
12	Roundup PowerMax	21.3	FL OZ/A	2 leaf	15 a	47.4 a	81.7 a	11,589 ab	245 a
	Roundup PowerMax	21.3	FL OZ/A	4 leaf					
	Outlook	21	OZ/A	4 leaf					
	Roundup PowerMax	21.3	FL OZ/A	8 leaf					
13	Roundup PowerMax	21.3	FL OZ/A	2 leaf	15 a	48.4 a	82.1 a	11,925 ab	246 a
	Roundup PowerMax	21.3	FL OZ/A	4 leaf					
	Roundup PowerMax	21.3	FL OZ/A	8 leaf					
	Outlook	21	OZ/A	8 leaf					
14	Roundup PowerMax	21.3	FL OZ/A	2 leaf	15 a	47.5 a	82.7 a	12,129 ab	256 a
	Roundup PowerMax	21.3	FL OZ/A	8 leaf					
	Outlook	21	FL OZ/A	8 leaf					

[†] All treatments and each application timing included ammonium sulfate (5 gal/100gal).

[‡] Means within a column followed by the same letter are not significantly different (LSD, $P = 0.05$).