

CRITICAL PERIOD OF WEED CONTROL IN ROUNDUP READY® SUGAR BEETS

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Introduction

Knowledge of the critical weed-free period is important in order to ensure timely weed management and to maximize profit. Timely application also contributes to judicious use of herbicides and builds positively to environmental stewardship. The critical period of weed control consists of two complementary events that lead to a necessary weed-free period during the crop growth cycle.

The first component of this study examines the effect of weeds that emerge with the crop and then are removed after a set time. The second component examines the effect of weeds that emerge sometime after crop emergence and remain until crop harvest. Once these events are combined, a specific critical weed-free period can be identified for the crop growth cycle.

Materials and Methods

A field experiment was conducted at the Malheur Experiment Station near Ontario, Oregon to determine the critical period of weed control using Roundup OriginalMax® on Roundup Ready® (RR) sugar beet. Growing degree days after emergence (GDDAE) were calculated using the formula

$$GDD = \frac{Temp(High) + Temp(Low)}{2}$$

Where Temp (High) = daily high temperature in °F, Temp (Low) = daily low temperature in °F. For sugar beets, if daily low temp was less than 34°F, 34°F was used as the low temperature. Similarly, if the daily high was over 86°F, 86°F was used as the high temperature.

The first Roundup OriginalMax ("Roundup" hereafter) application was made when sugar beets were at the cotyledon stage for the weed-free treatment, and subsequent applications were made every 150 growing degree days. Roundup was applied at different times depending on the treatment, from 150 until 900 GDDAE.

The first set of treatments established 6 levels of increasing duration of weed interference by delaying weed control from the time of crop emergence up to a pre-determined crop growth stage (150, 300, 450, 600, 750, and 900 GDDAE), at which weed control was initiated and maintained for the remainder of the growing season.

The second set of treatments established 6 levels of increasing length of the weed-free period by maintaining weed control from the time of crop planting to 150, 300, 450, 600, 750, and 900 GDDAE and subsequent emerging weeds were left uncontrolled for the remainder of the season. In addition, season-long weedy and weed-free controls were included.

The study was laid out in a randomized complete block design with four replications, and individual plots were four rows wide by 30 ft long. The soil type was Owyhee silt loam with a pH of 7.6, 2.08 percent organic matter, and the CEC (cation exchange capacity) of 18.5 meq/100 g soil. The sugar beet variety 'BTSCT01RR07' was planted on April 19, 2007 in 22-inch rows 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 were thinned on May 16, 2007 to 8-inch spacing between plants within a row. Thick planting and thinning to 8 inches between plants within the row provided a uniform plant population and a fair way to evaluate different weed control treatments.

The predominant weeds in the field were kochia, common lambsquarters, pigweed species, hairy nightshade, lady's thumb, and barnyardgrass. Herbicides were broadcast applied using a pressurized CO₂ sprayer calibrated to deliver 20 gal/acre using EVS 8002 nozzles. Evaluations to assess crop injury and weed control were done using a visual scale of 0-100 percent (0 = no injury or no weed control and 100 percent = total crop kill or complete weed control).

The two center rows of each plot were harvested at maturity for root yield and beet samples were transported to the Snake River Sugar factory to determine sugar content and other variables. The data were subjected to analysis of variance to determine treatment variations and means compared using Least Significant Difference (LSD) at the 5 percent level of significance.

Results

The level of weed control at sugar beet maturity varied among Roundup application timings (Table 1). Control of kochia, redroot pigweed, common lambsquarters, lady's thumb, hairy nightshade, and barnyardgrass was 99 percent for the applications starting at 50, 150, 300, 450, 600, 750, and 900 GDDAE. Weed control was generally reduced when Roundup was sprayed only up to 150, 300, 450, and 600 GDDAE. Kochia control was lowest when Roundup was applied once at 150 GDDAE or with two applications up to 300 and three times up to 450 GDDAE, and ranged from 88 to 90 percent. Kochia control improved to 99 percent when Roundup application was extended to 750 and 900 GDDAE.

Redroot pigweed control was lowest (22.5 percent) when Roundup was applied once at 150 GDDAE. Applying Roundup twice up to 300 GDDAE or three times up to 600 GDDAE did not improve redroot pigweed control. However, extending Roundup

applications up to 750 and 900 GDDAE provided 99 percent control for redroot pigweed, common lambsquarters, lady's thumb, hairy nightshade, and barnyardgrass. Common lambsquarters and hairy nightshade control was reduced to 59, 60, and 70 percent when Roundup was applied once at 150 GDDAE, twice up to 300 GDDAE, and three times up to 450 GDDAE, respectively. The level of control for lady's thumb followed the same trend as kochia. Barnyardgrass control was reduced for Roundup applications between 150 GDDAE and 600 GDDAE and ranged between 36 and 66 percent, respectively.

Sugar beet root yield was 56.7 and 9.9 tons/acre for the weed-free treatment and the untreated control, respectively (Table 2). The root yield for different Roundup application timings ranged from 51.7 to 58.9 tons/acre. The estimated recoverable sugar ranged from 14,523 to 17,230 lb/acre and the untreated control had the lowest at 2,850 lb/acre. Root yield and estimated recoverable sugar yield followed the same trend as the level of weed control for different Roundup application timings. The results suggest that two to three Roundup applications will be required to control weeds in Roundup Ready sugar beets. The initial application should be done soon after sugar beet emergence and the last one just before sugar beet row closure.

Table 1. Average weed control on October 11, 2007 in Roundup Ready sugar beets (var BTSCT01RR07) in response to different Roundup OriginalMax application timings at Malheur Experiment Station, Oregon State University, Ontario, OR, 2007

Treatment ^a	Rate/acre	Application dates	Kochia	Redroot pigweed	Common lambsquarters	Lady's thumb	Hairy nightshade	Barnyard grass
			Control (0-100%)					
1 Weed free start at 50 GDD Roundup OriginalMax	22.0 fl oz	5/4; 5/15; 5/31; 6/18	99.0	99.0	99.0	99.0	99.0	99.0
2 Start at 150 GDD Roundup OriginalMax	22.0 fl oz	5/6; 5/25; 6/18	99.0	99.0	99.0	99.0	99.0	98.0
3 Start at 300 GDD Roundup OriginalMax	22.0 fl oz	5/11; 5/25; 6/18	99.0	99.0	99.0	99.0	99.0	99.0
4 Start at 450 GDD Roundup OriginalMax	32.0 fl oz	5/15; 5/25; 6/18	99.0	99.0	99.0	99.0	99.0	99.0
5 Start at 600 GDD Roundup OriginalMax	32.0 fl oz	5/23; 5/31; 6/18	99.0	96.8	99.0	96.8	99.0	99.0
6 Start at 750 GDD Roundup OriginalMax	32.0 fl oz	5/26; 6/18	99.0	99.0	99.0	99.0	99.0	99.0
7 Start at 900 GDD Roundup OriginalMax	32.0 fl oz	5/31; 6/18	99.0	99.0	99.0	99.0	99.0	99.0
8 Untreated control	---	--	0.0	0.0	0.0	0.0	0.0	0.0
9 Spray only at 150 GDD Roundup OriginalMax	22.0 fl oz	5/6	87.5	22.5	58.8	88.8	58.8	36.3
10 Spray only up to 300 GDD Roundup OriginalMax	22.0 fl oz	5/6; 5/11;	90.0	38.8	60.0	90.0	60.0	62.5
11 Spray only up to 450 GDD Roundup OriginalMax	32.0 fl oz	5/6; 5/11; 5/15;	90.0	36.3	70.0	91.3	70.0	60.0
12 Only up to 600 GDD Roundup OriginalMax	32.0 fl oz	5/6; 5/11; 5/23;	91.3	67.5	90.0	95.8	90.0	66.3
13 Only up to 750 GDD Roundup OriginalMax	32.0 fl oz	5/6; 5/11; 5/26;	99.0	99.0	99.0	99.0	99.0	99.0
14 Only up to 900 GDD Roundup OriginalMax	32.0 fl oz	5/6; 5/11; 5/31	99.0	99.0	99.0	99.0	99.0	99.0
LSD ($P = 0.05$)			1.4	17.1	17.6	2.8	17.6	17.3
CV			1.1	15.9	14.8	2.2	14.8	15.2

^aRoundup applications included ammonium sulfate (AMS) at 2% v/v.

Table 2. Average root yield, sugar content, conductivity, gross sugar, percent extraction, and estimated recoverable sugar of Roundup Ready sugar beet (var BTSCT01RR07) following application of Roundup OriginalMax at different timings at Malheur Experiment Station, Oregon State University, Ontario, OR, 2007.

Treatment ^a	Rate/acre	Application dates	Root	Sugar	Conduc-	Gross	Sugar	Estimated reco-	
			yield	content	tivity	sugar	Extraction	verable sugar	
			ton/acre	%	mmho	lb/acre	%	lb/ton	lb/acre
1 Weed free start at 50 GDD Roundup OriginalMax	22.0 fl oz	5/4; 5/15; 5/31; 6/18	56.7	16.9	0.768	19,211.0	84.7	287	16,277
2 Start at 150 GDD Roundup OriginalMax	22.0 fl oz	5/6; 5/25; 6/18	51.7	17.4	0.745	17,989.5	85.1	296	15,312
3 Start at 300 GDD Roundup OriginalMax	22.0 fl oz	5/11; 5/25; 6/18	57.8	17.2	0.805	19,824.5	84.3	289	16,712
4 Start at 450 GDD Roundup OriginalMax	32.0 fl oz	5/15; 5/25; 6/18	57.9	17.1	0.830	19,769.0	83.9	287	16,595
5 Start at 600 GDD Roundup OriginalMax	32.0 fl oz	5/23; 5/31; 6/18	57.6	17.3	0.755	19,942.0	85.0	294	16,947
6 Start at 750 GDD Roundup OriginalMax	32.0 fl oz	5/26; 6/18	55.5	17.1	0.840	18,964.8	83.8	287	15,894
7 Start at 900 GDD Roundup OriginalMax	32.0 fl oz	5/31; 6/18	55.1	16.8	0.863	18,555.0	83.5	281	15,482
8 Untreated control	--	--	9.9	16.9	0.768	3,361.0	84.7	287	2,850
9 Spray only at 150 GDD Roundup OriginalMax	22.0 fl oz	5/6	53.6	17.0	0.743	18,239.8	85.1	290	15,526
10 Spray only up to 300 GDD Roundup OriginalMax	22.0 fl oz	5/6; 5/11;	56.1	16.9	0.778	18,979.8	84.6	286	16,060
11 Spray only up to 450 GDD Roundup OriginalMax	32.0 fl oz	5/6; 5/11; 5/15;	52.1	16.6	0.833	17,322.3	83.8	279	14,523
12 Only up to 600 GDD Roundup OriginalMax	32.0 fl oz	5/6; 5/11; 5/23;	53.8	17.1	0.815	18,436.5	84.2	288	15,518
13 Only up to 750 GDD Roundup OriginalMax	32.0 fl oz	5/6; 5/11; 5/26;	57.6	17.0	0.848	19,587.8	83.7	285	16,394
14 Only up to 900 GDD Roundup OriginalMax	32.0 fl oz	5/6; 5/11; 5/31	58.9	17.2	0.760	20,288.5	84.9	292	17,230
LSD ($P = 0.05$)			4.4	0.8	0.101	1,593.8	1.4	17	1,398
CV			5.9	3.1	8.9	6.2	1.2	4	7

^aRoundup applications included ammonium sulfate (AMS) at 2% v/v.