COMPARISON OF CALENDAR DAYS AND GROWING DEGREE DAYS FOR SCHEDULING HERBICIDE APPLICATIONS IN SUGAR BEET

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Introduction

Timely herbicide applications are critical to achieve effective weed control in sugar beet. Often, the amount of time between sequential herbicide applications is based on a given number of calendar days since the prior herbicide application. Under most circumstances this approach works well. When spring weather is cooler than normal, applying herbicides on a calendar day schedule may result in applications too close together. This can result in greater injury to the beets or herbicides being applied before they are needed. Since weed and beet growth depend on temperature, it is logical that using accumulated growing degree days (GDD) to schedule herbicide applications may be superior to calendar days. GDD accounts for variations in the weather and gives a more accurate idea of how fast plants are growing. If the weather is ideal for weed and beet growth, herbicide applications are made closer together; if the weather is cool, then applications are spaced further apart. Evaluation of a GDD model for timing herbicide applications may provide producers with a tool to improve the efficacy of the herbicides they are using.

Materials and Methods

This trial was established at the Malheur Experiment Station under furrow irrigation on April 6, 2005. Sugar beets (Hilleshog 'PM-90') were planted in 22-inch rows at a 2-inch seed spacing. On April 7, the trial was corrugated and Counter 20 CR® was applied in a 7-inch band over the row at 6 oz/1,000 ft of row. Sugar beets were thinned to 8-inch spacing on May 12 and 13. Plots were sidedressed on June 8 with 150 lb nitrogen (urea), 50 lb phosphate (P), 30 lb potash (K_2O), 30 lb sulfates (SO_4), 5 lb manganese (Mn),8 lb zinc (Zn), 1 lb copper (Cu), and 2 lb/acre boron (B). All plots were treated with Roundup® (0.75 lb ai/acre) on April 11 prior to sugar beet emergence. On April 28, Temik 15G® (14 lb prod/acre) was applied for sugar beet root maggot control. For powdery mildew control, Headline® (12 fl oz/acre) was applied on June 14, Dithane® (2 lb prod/acre) plus sulfur (6 lb/acre) were applied June 28, sulfur (6 lb/acre) was applied August 20, and Gem® (7 fl oz/acre) was applied August 25. All fungicide treatments were applied by air. Herbicide treatments were broadcast-applied with a CO_2-pressurized backpack sprayer calibrated to deliver 20 gal/acre at 30 psi. Plots were 4 rows wide and 27 ft long and treatments were arranged in a randomized complete block design with 4 replicates.

Standard rate, high rate, and micro-rate treatments were compared when applied on fixed calendar day schedules or when applied on different GDD accumulation schedules. The standard and high rate treatments were applied every 7 or 10 days and these timings were compared to applications at 150, 175, or 225 accumulated GDD since the previous application. The micro-rate treatments were applied on a 5- or 7-day schedule or at 150, 175, or 225 GDD since the previous application. Growing degree days were calculated on a base of 34°F using the equation GDD = [(daily high temperature – daily low temperature)/2] – 34. GDD were calculated beginning the day after each herbicide application. Herbicide application dates and GDD measured between applications are shown in Table 1.

Table 1. Application dates for herbicide treatments applied to sugar beet on calendar day or growing degree day (GDD) schedules, Malheur Experiment Station, Ontario, OR, 2005.

		Application				
Treatment*	Timing†	PRE	1st	2nd	3rd	4th
		Calendar date (GDD since previous application)				
Standard/High Rate	7 Day	4/11	4/22	4/29	5/7	--
Standard/High Rate	10 Day	4/11	4/22	5/2	5/12	--
Standard/High Rate	150 GDD	4/11	4/22	4/29 (144)	5/7 (165)	--
Standard/ High Rate	175 GDD	4/11	4/22	4/30 (161)	5/10 (213)	--
Standard/High Rate	225 GDD	4/11	4/22	5/3 (223)	5/14 (231)	--
Micro-rate	5 Day	4/11	4/22	4/27	5/2	5/7
Micro-rate	7 Day	4/11	4/22	4/29	5/7	5/12
Micro-rate	150 GDD	4/11	4/22	4/29 (144)	5/7 (165)	5/17 (207)
Micro-rate	175 GDD	4/11	4/22	4/30 (161)	5/10 (213)	5/17 (153)
Micro-rate	225 GDD	4/11	4/22	5/3 (223)	5/14 (231)	5/25 (238)

*Standard and high rate treatments were applied on the same dates.
†Application timing based on GDD were determined by calculating the number of GDD beginning the day after the previous application, using the equation GDD = [(daily high temperature – daily low temperature)/2] – 34.

Sugar beet injury was evaluated on May 12 and 23, and weed control was evaluated on August 18. Sugar beet yields were determined by harvesting the center two rows of each plot on October 6 and 7. Root yields were adjusted to account for a 5 percent tare. One sample of 16 beets was taken from each plot for quality analysis. The samples were coded and sent to Syngenta Seeds Research Station in Nyssa, Oregon to determine beet pulp sucrose content and purity. Sucrose content and recoverable sucrose were estimated using empirical equations. Data were analyzed using analysis of variance procedures and means were separated using protected LSD at the 95 percent confidence interval (P = 0.05). The untreated control was not included in the analysis of variance for weed control or crop response.

Results and Discussion

For the standard and high rate herbicide treatments, the number of days between herbicide applications was the same for the 7-day schedule and the 150-GDD schedule. Applications on the 10-day schedule were between the 175-GDD and 225 GDD timing schedules. The final application of the standard and high rate herbicide treatments varied by as much as 7 days between application schedules. For micro-rate treatments, the 5- and 7-day application schedules were shorter than all application schedules based on GDD. The final application date among the different application schedules varied by as much as 18 days. The 7-day application schedule would have been similar to the 150-GDD schedule except weather delayed the last application of the micro-rate on the 150-GDD schedule.

Pigweed control was reduced when the standard or high rate treatments were applied on 225-GDD intervals compared to all other application timings (Table 2). Increasing the herbicide rate of standard treatments did not compensate for the long period between applications. Pigweed control was least when the micro-rate treatment was applied at 225-GDD. Reduced pigweed control was also observed when the micro-rate was applied at the 150-GDD timing as compared to 175-GDD or 5- or 7-day intervals. The micro-rate applied on 5-day intervals provided less kochia control than all other treatments and timings, suggesting that some of the kochia may have germinated after the spray program was completed.

On May 12, injury from the standard or high rate treatments was among the greatest with the exception of the 225-GDD application timing, which had not yet received the third application (Table 3). By May 23, there were no differences in sugar beet injury between any of the herbicide treatments or application timings. All herbicide treatments increased sugar beet root yield and estimated recoverable sugar compared to the untreated check (Table 3). There were no differences in percent extraction or sugar content for any treatment. Root yields were reduced by the micro-rate applied on 225-GDD intervals compared to all other treatments and timings because of poor pigweed control. Estimated recoverable sugar was also reduced with the micro-rate applied on a 225-GDD interval compared to all other treatments except the micro-rate applied on a 175-GDD interval.

This year applications spaced too far apart resulted in poor pigweed control. With the micro-rate, making applications too close together reduced kochia control, suggesting that some kochia emerged late this year. The use of GDD to assist in timing herbicide applications appears to provide an advantage over calendar days because the GDD model is able to account for slow weed growth during cold weather and application timings are adjusted to compensate for the less favorable growing conditions. Weather conditions make applying herbicides on a set schedule difficult. Growers have to be flexible in making herbicide applications when they are needed and when the weather allows.

Table 2. Weed control in sugar beet with standard rate, high rate, and micro-rate herbicide treatments applied on a calendar day schedule or at different growing degree day (GDD) intervals, Malheur Experiment Station, Ontario, OR, 2005.

			Weed control‡				
Treatment*	Rate	Timing†	Pigweed spp.	Common lambsquarters	Hairy nightshade	Kochia	Barnyard-grass
	oz ai/acre or % v/v	--	----------%----------				
Standard Rate							
Progress + UpBeet	4.0 + 0.25	7 Day	100	100	100	98	99
Progress + UpBeet + Stinger	5.4 + 0.25 + 1.5						
Progress + UpBeet + Stinger	5.4 + 0.25 + 1.5						
Standard Rate	Same as above	10 Day	100	100	100	100	100
Standard Rate	Same as above	150 GDD	100	100	100	100	96
Standard Rate	Same as above	175 GDD	100	100	98	98	97
Standard Rate	Same as above	225 GDD	86	100	100	98	98
Micro-Rate							
Progress + UpBeet + Stinger + MSO	1.3 + 0.08 + 0.5 + 1.5% v/v	5 Day	95	100	98	88	99
Progress + UpBeet + Stinger + MSO	1.3 + 0.08 + 0.5 + 1.5% v/v						
Progress + UpBeet + Stinger + MSO	2.0 + 0.08 + 0.5 + 1.5% v/v						
Progress + UpBeet + Stinger + MSO	2.0 + 0.08 + 0.5 + 1.5% v/v						
Micro-Rate	Same as above	7 Day	92	100	100	96	97
Micro-Rate	Same as above	150 GDD	76	100	100	96	98
Micro-Rate	Same as above	175 GDD	86	99	100	95	100
Micro-Rate	Same as above	225 GDD	51	100	100	94	97
High Rate							
Progress + UpBeet	4.0 + 0.25	7 Day	99	100	100	100	99
Progress + UpBeet + Stinger	6.7 + 0.37 + 1.5						
Progress + UpBeet + Stinger	8.1 + 0.5 + 1.5						
High Rate	Same as above	10 Day	100	100	100	99	98
High Rate	Same as above	150 GDD	100	100	100	100	96
High Rate	Same as above	175 GDD	100	100	100	99	98
High Rate	Same as above	225 GDD	85	99	99	98	100
LSD (P = 0.05)	--		9.0	NS	NS	5.7	NS

*Standard and high-standard-rate treatments were applied on the same dates.
†Application timing based on GDD were determined by calculating the number of GDD beginning the day after the previous application using the equation GDD = [(daily high temperature – daily low temperature)/2] – 34.
‡Weed control was evaluated August 18. Pigweed species are a mixture of redroot pigweed and Powell amaranth.

Table 3. Sugar beet injury and yield with standard rate, high-standard-rate, and micro-rate herbicide treatments applied on a calendar day schedule or at different growing degree day (GDD) intervals, Malheur Experiment Station, Ontario, OR, 2005.

			Sugar beet‡					
			Injury		Yield			
Treatment*	Rate	Timing†	5-12	5-23	Root yield	Extraction	Sucrose	ERS¶
--	oz ai/acre or % v/v	--	---- % ----		ton/acre	---------- % ----------		lbs/acre
Untreated control	--	--	--	--	13.0	92.7	15.6	3,760
Standard Rate						92.0	15.4	14,638
Progress + UpBeet	4.0 + 0.25	7 Day	27	16	51.5			
Progress + UpBeet + Stinger	5.4 + 0.25 + 1.5							
Progress + UpBeet + Stinger	5.4 + 0.25 + 1.5							
Standard Rate	Same as above	10 Day	25	20	50.2	91.9	15.4	14,179
Standard Rate	Same as above	150 GDD	24	18	50.6	91.8	15.3	14,217
Standard Rate	Same as above	175 GDD	18	18	51.0	92.0	15.4	14,454
Standard Rate	Same as above	225 GDD	13	13	49.4	92.1	15.6	14,179
Micro-Rate						91.9	15.4	14,132
Progress + UpBeet + Stinger + MSO	1.3 + 0.08 + 0.5 + 1.5% v/v	5 Day	24	15	50.0			
Progress + UpBeet + Stinger + MSO	1.3 + 0.08 + 0.5 + 1.5% v/v							
Progress + UpBeet + Stinger + MSO	2.0 + 0.08 + 0.5 + 1.5% v/v							
Progress + UpBeet + Stinger + MSO	2.0 + 0.08 + 0.5 + 1.5% v/v							
Micro-Rate	Same as above	7 Day	19	18	51.6	92.0	15.3	14,506
Micro-Rate	Same as above	150 GDD	17	16	50.0	92.0	15.7	14,387
Micro-Rate	Same as above	175 GDD	16	16	47.9	91.9	15.1	13,358
Micro-Rate	Same as above	225 GDD	12	16	45.0	92.1	15.3	12,639
High Rate						92.2	15.7	14,289
Progress + UpBeet	4.0 + 0.25	7 Day	29	19	49.5			
Progress + UpBeet + Stinger	6.7 + 0.37 + 1.5							
Progress + UpBeet + Stinger	8.1 + 0.5 + 1.5							
High Rate	Same as above	10 Day	27	21	49.1	92.2	15.6	14,102
High Rate	Same as above	150 GDD	32	21	49.9	92.0	15.7	14,411
High Rate	Same as above	175 GDD	29	21	49.6	92.2	15.4	14,107
High Rate	Same as above	225 GDD	11	17	50.2	92.0	15.7	14,458
LSD (P = 0.05)	--		5.59	NS	3.27	NS	NS	1,204

*Standard and high-standard-rate treatments were applied on the same dates.
†Application timing based on GDD were determined by calculating the number of GDD beginning the day after the previous application using the equation GDD = [(daily high temperature – daily low temperature)/2] – 34.
‡Sugar beets were harvested October 6 and 7.
¶ERS = estimated recoverable sucrose.