KOCHIA CONTROL WITH PREEMERGENCE NORTRON® IN STANDARD AND MICRO-RATE HERBICIDE PROGRAMS

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Introduction

The distribution of kochia resistant to UpBeet (triflusulfuron) herbicide and other acetolactate synthase (ALS) inhibitors (i.e., sulfonylureas, imidazolinones, and triazolopyrimidines) has increased in recent years and poses a serious problem in sugar beet production, as none of the currently registered postemergence herbicides effectively control ALS-resistant kochia. In these trials, Nortron (ethofumesate) was evaluated for preemergence control of kochia in sugar beet. Nortron is a soil-active herbicide used preemergence or early postemergence to control annual grasses and broadleaf weeds.

Methods

This trial was established at the Malheur Experiment Station under furrow irrigation on April 4, 2003. Sugar beets (Hilleshog 'PM-21') were planted in 22-inch rows at a 2-inch seed spacing. On April 3, kochia seed was spread over the entire experimental area to promote an even weed distribution. After planting, 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 13 and 14. Plots were sidedressed on June 3 with 176 lb nitrogen (urea), 96 lb phosphate, 100 lb potash, 38 lb sulfates, 62 lb elemental sulfur, 2 lb zinc, and 1 lb/acre boron. All plots were treated with Roundup (0.75 lb ai/acre) on April 11 prior to sugar beet emergence. On May 16, Temik 15G (14 lb/acre) was applied for sugar beet root maggot control. For powdery mildew control, Headline (12 fl oz/acre) was applied on June 17 and again on July 2 with Super Six liquid sulfur (16 pt/acre). Topsin M (0.5 lb/acre) was applied on August 4. 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 four rows wide and 27 ft long and treatments were arranged in a randomized complete block design with four replicates.

The treatments in this trial consisted of both standard and micro-rate postemergence weed control programs applied with or without a preemergence application of Nortron at either 16.0, 24.0, or 32.0 oz ai/acre with and without postemergence UpBeet. UpBeet was omitted from selected treatments to simulate ALS resistance and to better evaluate preemergence Nortron efficacy on kochia. Nortron was applied preemergence on April 11. The standard rate program included three applications with the first applied to full

cotyledon sugar beets on April 23, the second to 2-leaf sugar beets on April 30, and the third application to 10-leaf sugar beets on May 16. Progress (ethofumesate + phenmedipham + desmedipham) was applied at 4.0, 5.4, and 6.75 oz ai/acre in the first, second, and third applications, respectively. UpBeet was applied at 0.25 oz ai/acre in all three applications except those treatments where UpBeet was omitted. Stinger (clopyralid) was applied in the second and third applications at 1.5 oz ai/acre. The micro-rate program consisted of four applications with the first applied to cotyledon sugar beets on April 19, the second to cotyledon to 2-leaf sugar beets on April 26, the third applied to 2- to 4-leaf sugar beets on May 1, and the fourth to 10-leaf sugar beets on May 16. In the micro-rate program, Progress was applied at 1.28 oz ai/acre in the first two applications and at 2.0 oz ai/acre in the last two applications. All four micro-rate applications included UpBeet at 0.08 oz ai/acre (excluding treatments where UpBeet was omitted), Stinger at 0.5 oz ai/acre, and a methylated seed oil (MSO) at 1.5 percent v/v.

Sugar beet injury and weed control were evaluated throughout the season. 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 Hilleshog Mono-Hy 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

Kochia control with the standard rate and micro-rate programs without preemergence Nortron was 97 and 96 percent, respectively (Table 1). All treatments including both preemergence Nortron and postemergence UpBeet provided 100 percent control of kochia 66 days after treatment (DAT) on July 21. Kochia control with standard rate treatments without UpBeet gave 92-98 percent control and did not improve with increasing Nortron rates. Applying Nortron preemergence at 16, 24, or 32 oz ai/acre followed by the standard rate program minus UpBeet gave similar kochia control compared with the standard treatment with UpBeet. The micro-rate program minus UpBeet gave 85, 89, and 93 percent kochia control with preemergence Nortron at 16, 24, and 32 oz ai/acre, respectively. When Nortron was applied prior to the micro-rate treatment minus UpBeet only, the 32 oz ai/acre rate provided similar kochia control compared to the micro-rate with UpBeet. Results from previous trials at the Malheur Experiment Station showed that Nortron applied preemergence at 48 oz ai/acre as part of a standard or micro-rate program minus UpBeet provided kochia control similar to both standard and micro-rate programs with UpBeet. The kochia population in this year's trial was less than in previous years and control obtained with Nortron at the evaluated rates may not hold up under greater kochia pressure. These data suggest that in field situations where ALS-resistant kochia is present, preemergence Nortron

can improve control. Higher Nortron rates are required when using a micro-rate versus a standard rate program.

All herbicide treatments gave 100 percent control of common lambsquarters and hairy nightshade. Pigweed control (i.e., Powell amaranth and redroot pigweed) was good to excellent (92-100 percent) with all treatments. The removal of UpBeet from the micro-rate program resulted in a significant decrease in barnyardgrass control compared to the micro-rate treatments with or without preemergence Nortron. The standard rate program with UpBeet following Nortron at 16 oz ai/acre provided 45 percent greater barnyardgrass control than the same treatment without UpBeet. Increasing the preemergence Nortron rate from 16 to 24 oz ai/acre and from 16 to 32 oz ai/acre in the standard rate program without UpBeet resulted in 33 and 40 percent greater barnyardgrass control, respectively.

Sugar beet injury on May 5, 4 days after the third micro-rate application and 5 days after the second standard rate application, ranged from 25 to 33 percent with the micro-rate treatments and from 15 to 19 percent with the standard rate treatments (Table 2). By June 2, 17 days after the last application, sugar beet injury was similar among all treatments. Sugar beet injury was not related to increasing Nortron rates. Sugar beet root yields ranged from 44.8 to 49.7 tons/acre in herbicide-treated plots (Table 2). Nortron applied at 16 oz ai/acre followed by the micro-rate without UpBeet produced 44.8 tons/acre root yield, which was significantly less than Nortron at 32 oz ai/acre followed by the standard with UpBeet and Nortron at 24 oz ai/acre followed by the micro-rate with UpBeet, both of which produced root yields of 49.7 tons/acre. These treatments represent the only significant differences in root yield among all herbicide treatments. The herbicide treatment with the lowest root yield, as mentioned above, also provided the lowest kochia control of any treatment at 85 percent. In this trial, each additional 5 percent increase in kochia control resulted in a sugar beet root yield increase of 1.56 tons/acre. When we combined data from the last 3 years of kochia control trials at the Malheur Experiment Station, there is an increase in root yield of 1.7 tons/acre with each additional 5 percent kochia control (Fig. 1).

There were no differences among treatments with regard to percent sucrose content or percent extraction (Table 2). Estimated recoverable sucrose (ERS) yields ranged from 11,514 to 13,648 lbs/acre in herbicide-treated plots (Table 2). Nortron at 24 oz ai/acre preceding the standard program with UpBeet resulted in a significantly higher ERS yield than the total postemergence standard rate treatment with UpBeet. Nortron applied at 16 oz ai/acre followed by the micro-rate with UpBeet resulted in 1,932 and 1,972 lbs/acre greater ERS than Nortron applied at either 16 or 24 oz ai/acre followed by the micro-rate without UpBeet.

Table 1. Kochia control in sugar beets with preemergence Nortron in standard and micro-rate herbicide programs, Malheur Experiment Station, Oregon State University, Ontario, OR, 2003.

			Weed control‡					
			Kochia		Pigweed spp.§	Lambs-quarters	Hairy Nightshade	Barnyard-grass
Treatment*	Rate	Timing†	6-16	7-21	7-21	7-21	7-21	6-16
	oz ai/acre		%					
Untreated control	--	--	--	--	--	--	--	--
Standard Rate Program								
Progress + UpBeet	4.0 + 0.25	3	100	97	93	100	100	89
Progress + UpBeet + Stinger	5.4 + 0.25 + 1.5	5						
Progress + UpBeet + Stinger	6.7 + 0.25 + 1.5	7						
Micro-Rate Program								
Progress + UpBeet + Stinger + MSO	1.28 + 0.083 + 0.5 + 1.5% v/v	2, 4	98	96	98	100	100	94
Progress + UpBeet + Stinger + MSO	1.95 + 0.083 + 0.5 + 1.5% v/v	6, 7						
Nortron fb	16.0	1	100	100	100	100	100	86
Standard with UpBeet	--	3,5,7						
Nortron fb	24.0	1	100	100	100	100	100	90
Standard with UpBeet	--	3,5,7						
Nortron fb	32.0	1	100	100	100	100	100	93
Standard with UpBeet	--	3,5,7						
Nortron fb	16.0	1	98	98	98	100	100	41
Standard w/out UpBeet	--	3,5,7						
Nortron fb	24.0	1	98	92	100	100	100	74
Standard w/out UpBeet	--	3,5,7						
Nortron fb	32.0	1	100	96	100	100	100	81
Standard w/out UpBeet	--	3,5,7						
Nortron fb	16.0	1	100	100	99	100	100	97
Micro with UpBeet	--	2,4,6,7						
Nortron fb	24.0	1	100	100	98	100	100	95
Micro with UpBeet	--	2,4,6,7						
Nortron fb	32.0	1	100	100	100	100	100	98
Micro with UpBeet	--	2,4,6,7						
Nortron fb	16.0	1	90	85	98	100	100	67
Micro w/out UpBeet	--	2,4,6,7						
Nortron fb	24.0	1	86	89	92	100	100	73
Micro w/out UpBeet	--	2,4,6,7						
Nortron fb	32.0	1	91	93	96	100	100	68
Micro w/out UpBeet	--	2,4,6,7						
LSD (0.05)			7	8	NS	NS	NS	25

*fb = Followed by.

†Application timings were (1) April 11 preemergence, (2) April 19 to cotyledon beets, (3) April 23 to full cotyledon beets, (4) April 26 to cotyledon to 2-leaf beets, (5) April 30 to 2-leaf beets, (6) May 1 to 2- to 4-leaf beets, and (7) May 16 to 10-leaf beets.

‡The untreated control was not included in the weed control analysis.

§Pigweed species included Powell amaranth and redroot pigweed.

Table 2. Sugar beet injury and yield with preemergence Nortron in standard and micro-rate herbicide programs, Malheur Experiment Station, Oregon State University, Ontario, OR, 2003.

			Sugar beet					
			Injury‡		Yield			
Treatment*	Rate	Timing†	5-5	6-2	Root yield	Sucrose	Extraction	ERS§
	oz ai/acre		------- % -------		ton/acre	---------- % ----------		lb/acre
Untreated control	--	--	--	--	20.4	14.6	91.7	4,810
Standard Rate Program								
Progress + UpBeet	4.0 + 0.25	3	17	11	47.0	13.4	90.8	11,523
Progress + UpBeet + Stinger	5.4 + 0.25 + 1.5	5						
Progress + UpBeet + Stinger	6.7 + 0.25 + 1.5	7						
Micro-Rate Program								
Progress + UpBeet + Stinger + MSO	1.28 + 0.083 + 0.5 + 1.5% v/v	2, 4	25	10	47.7	15.0	92.1	13,125
Progress + UpBeet + Stinger + MSO	1.95 + 0.083 + 0.5 + 1.5% v/v	6, 7						
Nortron fb	16.0	1	19	13	48.9	14.5	91.4	12,970
Standard with UpBeet	--	3,5,7						
Nortron fb	24.0	1	17	16	49.1	15.1	92.0	13,648
Standard with UpBeet	--	3,5,7						
Nortron fb	32.0	1	15	14	49.7	14.6	91.6	13,306
Standard with UpBeet	--	3,5,7						
Nortron fb	16.0	1	15	14	45.8	14.1	91.7	11,819
Standard w/out UpBeet	--	3,5,7						
Nortron fb	24.0	1	15	15	47.5	14.7	91.8	12,815
Standard w/out UpBeet	--	3,5,7						
Nortron fb	32.0	1	19	15	48.9	14.0	91.4	12,495
Standard w/out UpBeet	--	3,5,7						
Nortron fb	16.0	1	33	12	48.8	15.1	91.6	13,513
Micro with UpBeet	--	2,4,6,7						
Nortron fb	24.0	1	29	9	49.7	14.4	91.8	13,127
Micro with UpBeet	--	2,4,6,7						
Nortron fb	32.0	1	27	11	48.5	14.4	91.8	12,892
Micro with UpBeet	--	2,4,6,7						
Nortron fb	16.0	1	30	13	44.8	14.0	91.7	11,581
Micro w/out UpBeet	--	2,4,6,7						
Nortron fb	24.0	1	25	13	45.7	13.6	91.6	11,514
Micro w/out UpBeet	--	2,4,6,7						
Nortron fb	32.0	1	29	8	46.8	14.0	91.7	11,991
Micro w/out UpBeet	--	2,4,6,7						
LSD (0.05)			6	NS	3.3	NS	NS	1,833

*fb = Followed by.

†Application timings were (1) April 11 preemergence, (2) April 19 to cotyledon beets, (3) April 23 to full cotyledon beets, (4) April 26 to cotyledon to 2-leaf beets, (5) April 30 to 2-leaf beets, (6) May 1 to 2- to 4-leaf beets, and (7) May 16 to 10-leaf beets.

‡The untreated control was not included in the sugar beet injury analysis.

§ ERS = Estimated recoverable sucrose.

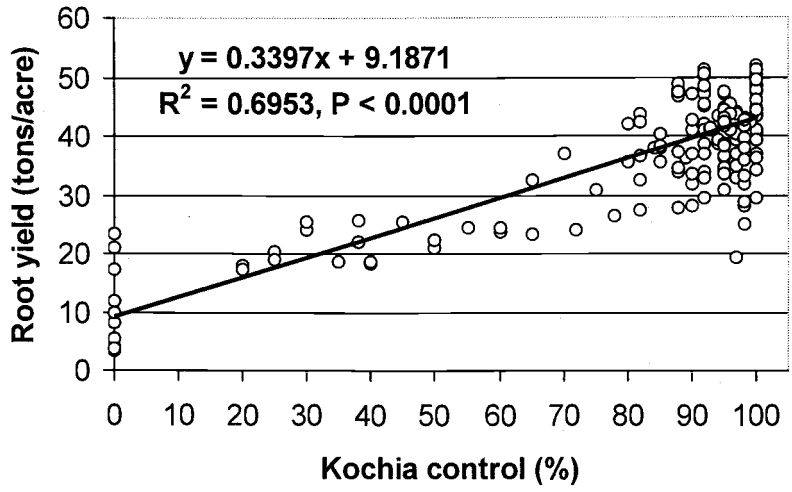

Figure 1. Response of sugar beet root yields to percent kochia control combined over a 3-year period from 2001 to 2003, Malheur Experiment Station, Oregon State University, Ontario, OR.