

# KOCHIA CONTROL WITH VARIABLE NORTRON® RATES IN STANDARD AND MICRO-RATE HERBICIDE PROGRAMS

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## Introduction

The distribution of kochia resistant to acetolactate synthase (ALS) inhibitors (i.e., sulfonyleureas, 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 was evaluated for preemergence and postemergence 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 8, 2002. Sugar beets (Hilleshog 'PM-21') were planted in 22-inch rows at a 2-inch seed spacing. On April 8, kochia seed was spread over the entire experimental area to provide an even weed distribution. After planting, the trial area 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 spacings on May 6 and 7. Plots were sidedressed on May 22 with 150 lb N/acre as urea. All plots were treated with Roundup (0.75 lb ai/acre) prior to sugar beet emergence. On May 13, Temik 15G (10 lb/acre) was applied for sugar beet root maggot control. For powdery mildew control, Super-Six liquid sulfur was applied on June 20 and August 14, sulfur dust (30 lb/acre) was applied July 23, and Laredo fungicide was applied on July 11. All fungicide treatments were applied by air. Herbicide treatments were broadcast applied with a CO<sub>2</sub>-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.

UpBeet herbicide was omitted from selected treatments to simulate ALS resistance and to better evaluate Nortron efficacy on kochia. Nortron was applied preemergence at 48 oz ai/acre with selected standard treatments and postemergence in various tank-mix combinations at 1.0 or 1.5 oz ai/acre included in a micro-rate program and 3.0 oz ai/acre as part of a standard program on sugar beets ranging from cotyledon up to the six-leaf stage. Standard rate treatments consisted of various combinations of Progress (4.0, 5.4, or 6.7 oz ai/acre), UpBeet (0.25, 0.37, or 0.5 oz ai/acre), and Stinger (1.68 oz ai/acre) applied three times at 7- to 10-day intervals. Micro-rate treatments consisted of

various combinations of Progress (1.28 or 1.95 oz ai/acre), UpBeet (0.083 oz ai/acre), Stinger (0.5 oz ai/acre), and methylated seed oil (MSO) (1.5 percent v/v), with and without Nortron, applied a total of four times at 7-day intervals.

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 8 and 9. 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 ( $P = 0.05$ ).

### Results and Discussion

On June 24, 42 days after treatment (DAT), common lambsquarters control was greater than 90 percent for all treatments except for the standard treatment including UpBeet with Nortron (3.0 oz ai/acre) in applications 1 and 2 (Table 1). Hairy nightshade control was similar among all herbicide treatments on June 24. Control of pigweed species (i.e., Powell amaranth and redroot pigweed) was significantly less on June 24 and July 15 with the micro-rate without UpBeet but with Nortron (1.0 oz ai/acre in applications 1 and 2 and 1.5 oz ai/acre in applications 3 and 4) than with either the micro-rate with UpBeet or the micro-rate with UpBeet and Nortron. The standard program plus Outlook (10.5 oz ai/acre) applied in application 3 increased Powell amaranth and redroot pigweed control by 15 percent compared to the standard program alone on July 15 (63 DAT). The addition of Outlook to applications 3 and 4 of the micro-rate program did not increase control for any of the weed species evaluated compared to the micro-rate program alone. Weed control was similar with the addition of Nortron (3.0 oz ai/acre) to the first two applications of the standard program including UpBeet compared to the standard program without Nortron. Kochia control on June 24 was excellent (90 to 100 percent) with all treatments including UpBeet or a preemergence application of Nortron (48 oz ai/acre). Kochia control was significantly less on June 24 and July 15 with the micro-rate without UpBeet but with Nortron (1.0 oz ai/acre in applications 1 and 2 and 1.5 oz ai/acre in applications 3 and 4) than either the micro-rate with UpBeet or the micro-rate with UpBeet and Nortron. The linear relationship between kochia control and sugar beet root yield suggests that every 5 percent increase in kochia control results in an additional 1.5 tons of sugar beet produced per acre (Fig. 1).

Table 1. Weed control with standard and micro-rate treatments with and without various Nortron rates, Malheur Experiment Station, Oregon State University, Ontario, OR, 2002.

Treatment	Rate	Timing*	Weed control							
			Pigweed spp.†		H. nightshade		Kochia		Lambsquarters	
			6-24	7-15	6-24	7-15	6-24	7-15	6-24†	7-15
Untreated check	--	--	0	0	0	0	0	0	0 d	0
Progress + UpBeet + Stinger + MSO	1.28 + 0.083 + 0.5 + 1.5%	2, 3	93	80	93	90	93	91	96 ab	95
Progress + UpBeet + Stinger + MSO	1.95 + 0.083 + 0.5 + 1.5%	5, 6								
Progress + UpBeet + Stinger + Nortron + MSO	1.28 + 0.083 + 0.5 + 1.04 + 1.5%	2, 3	91	83	94	89	95	95	97 ab	91
Progress + UpBeet + Stinger + Nortron + MSO	1.95 + 0.083 + 0.5 + 1.5 + 1.5%	5, 6								
Progress + UpBeet + Stinger + MSO	1.28 + 0.083 + 0.5 + 1.5%	2, 3	90	85	87	70	86	85	98 a	96
Progress + UpBeet + Stinger + Outlook + MSO	1.95 + 0.083 + 0.5 + 10.5 + 1.5%	5, 6								
Progress + UpBeet + Stinger + Nortron + MSO	1.28 + 0.083 + 0.5 + 1.0 + 1.5%	2, 3	91	80	91	83	91	89	98 a	96
Progress + UpBeet + Stinger + Outlook + MSO	1.95 + 0.083 + 0.5 + 10.5 + 1.5%	5, 6								
Progress + UpBeet	4.05 + 0.25	2	84	70	84	66	96	96	95 ab	81
Progress + UpBeet + Stinger	5.4 + 0.25 + 1.68	4								
Progress + UpBeet + Stinger	6.74 + 0.25 + 1.68	6								
Progress + UpBeet	4.0 + 0.25	2	91	85	91	86	96	96	97 ab	90
Progress + UpBeet + Stinger	5.4 + 0.25 + 1.68	4								
Progress + UpBeet + Stinger + Outlook	6.74 + 0.25 + 1.68 + 10.5	6								
Progress + UpBeet + Nortron	4.0 + 0.25 + 3.0	2	91	90	88	72	98	99	97 ab	98
Progress + UpBeet + Stinger + Nortron	5.4 + 0.25 + 1.68 + 3.0	4								
Progress + UpBeet + Stinger + Outlook	6.74 + 0.25 + 1.68 + 10.5	6								
Nortron	48.0	1	93	88	92	87	98	98	98 a	98
Progress	4.0	2								
Progress + Stinger	5.4 + 1.68	4								
Progress + Stinger	6.7 + 1.68	6								
Progress	4.0	2	81	73	84	78	70	53	94 ab	89
Progress + Stinger	4.05 + 1.68	4								
Progress + Stinger	4.05 + 1.68	6								
Nortron	48.0	1	90	84	86	77	98	98	96 ab	94
Progress + UpBeet	4.0 + 0.25	2								
Progress + UpBeet + Stinger	5.4 + 0.25 + 1.68	4								
Progress + UpBeet + Stinger	6.74 + 0.25 + 1.68	6								

Table 1. (continued) Weed control with standard and micro-rate treatments with and without various Nortron rates, Malheur Experiment Station, Oregon State University, Ontario, OR, 2002.

Treatment	Rate	Timing*	Weed control							
			Pigweed spp.†		H. nightshade		Kochia		Lambsquarters	
			6-24	7-15	6-24	7-15	6-24	7-15	6-24‡	7-15
	oz ai/acre % v/v		-----%							
Progress + Stinger + Nortron + MSO	1.28 + 0.5 + 1.04 + 1.5%	2, 3	63	52	84	79	44	30	98 a	91
Progress + Stinger + Nortron + MSO	1.95 + 0.5 + 1.5 + 1.5%	5, 6								
Progress + UpBeet	4.0 + 0.25	2	83	67	90	74	94	90	91 bc	81
Progress + UpBeet + Stinger	5.4 + 0.37 + 1.68	4								
Progress + UpBeet + Stinger	6.74 + 0.5 + 1.68	6								
Progress + UpBeet + Nortron	4.0 + 0.25 + 3.0	2	84	73	88	82	97	94	87 c	81
Progress + UpBeet + Stinger + Nortron	5.4 + 0.25 + 1.68 + 3.0	4								
Progress + UpBeet + Stinger	6.74 + 0.25 + 1.68	6								
Nortron	48.0	1	89	82	93	93	89	89	98 a	95
Progress + Stinger	4.0 + 1.68	2								
Progress + Stinger	5.4 + 1.68	4								
Progress + Stinger	6.7 + 1.68	6								
LSD (0.05)			10	14	12	26	14	15	--	12

\*Application timings were (1) April 9 preemergence, (2) April 22 to cotyledon sugar beets, (3) April 29 to two-leaf sugar beets, (4) May 2 to two-leaf sugar beets, (5) May 4 to two-leaf sugar beets, and (6) May 13 to four-leaf sugar beets.

†Pigweed species were predominantly Powell amaranth mixed with some redroot pigweed.

‡Where letter designations occur the ANOVA was performed on arcsine square root percent transformed data. Transformed mean separation applied to non-transformed data.

Table 2. Sugar beet injury and yield with standard and micro-rate treatments with and without various Nortron rates, Malheur Experiment Station, Oregon State University, Ontario, OR, 2002.

Treatment	Rate oz ai/acre % v/v	Timing*	Injury			Sugar beet			ERS† lb/acre
			5-10	6-01	6-24	Root yield ton/acre	Sucrose Extraction -----%-----		
Untreated check	--	--	0	0	0	4.1	17.7	93.5	893
Progress + UpBeet + Stinger + MSO	1.28 + 0.083 + 0.5 + 1.5%	2, 3	16	6	0	35.8	17.6	93.2	11,704
Progress + UpBeet + Stinger + MSO	1.95 + 0.083 + 0.5 + 1.5%	5, 6							
Progress + UpBeet + Stinger + Nortron + MSO	1.28 + 0.083 + 0.5 + 1.04 + 1.5%	2, 3	20	5	3	36.2	17.4	93.0	11,714
Progress + UpBeet + Stinger + Nortron + MSO	1.95 + 0.083 + 0.5 + 1.5 + 1.5%	5, 6							
Progress + UpBeet + Stinger + MSO	1.28 + 0.083 + 0.5 + 1.5%	2, 3	26	9	7	34.6	16.8	92.9	10,784
Progress + UpBeet + Stinger + Outlook + MSO	1.95 + 0.083 + 0.5 + 10.5 + 1.5%	5, 6							
Progress + UpBeet + Stinger + Nortron + MSO	1.28 + 0.083 + 0.5 + 1.0 + 1.5%	2, 3	27	7	3	38.1	17.2	93.1	8,817
Progress + UpBeet + Stinger + Outlook + MSO	1.95 + 0.083 + 0.5 + 10.5 + 1.5%	5, 6							
Progress + UpBeet	4.0 + 0.25	2	33	20	4	32.1	17.0	93.1	7,631
Progress + UpBeet + Stinger	5.4 + 0.25 + 1.68	4							
Progress + UpBeet + Stinger	6.74 + 0.25 + 1.68	6							
Progress + UpBeet	4.0 + 0.25	2	41	25	11	36.1	17.2	93.1	11,547
Progress + UpBeet + Stinger	5.4 + 0.25 + 1.68	4							
Progress + UpBeet + Stinger + Outlook	6.74 + 0.25 + 1.68 + 10.5	6							
Progress + UpBeet + Nortron	4.0 + 0.25 + 3.0	2	45	29	16	35.4	16.8	93.0	11,067
Progress + UpBeet + Stinger + Nortron	5.4 + 0.25 + 1.68 + 3.0	4							
Progress + UpBeet + Stinger + Outlook	6.74 + 0.25 + 1.68 + 10.5	6							
Nortron	48.0	1	26	12	9	39.7	16.8	93.0	12,442
Progress	4.0	2							
Progress + Stinger	5.4 + 1.68	4							
Progress + Stinger	6.7 + 1.68	6							
Progress	4.0	2	23	14	6	27.0	16.8	93.3	8,469
Progress + Stinger	4.0 + 1.68	4							
Progress + Stinger	4.0 + 1.68	6							
Nortron	48.0	1	35	20	15	34.2	16.7	93.2	10,656
Progress + UpBeet	4.0 + 0.25	2							
Progress + UpBeet + Stinger	5.4 + 0.25 + 1.68	4							
Progress + UpBeet + Stinger	6.74 + 0.25 + 1.68	6							

Table 2 (continued). Sugar beet injury and yield with standard and micro-rate treatments with and without various Nortron rates, Malheur Experiment Station, Oregon State University, Ontario, OR, 2002.

Treatment	Rate oz ai/acre % v/v	Timing*	Injury			Sugar beet			ERS† lb/acre
			5-20	6-01	6-24	Root yield ton/acre	Sucrose Extraction -----%-----		
Progress + Stinger + Nortron + MSO	1.28 + 0.5 + 1.04 + 1.5%	2, 3	15	11	0	20.4	17.7	93.2	6,754
Progress + Stinger + Nortron + MSO	1.95 + 0.5 + 1.5 + 1.5%	5, 6							
Progress + UpBeet	4.0 + 0.25	2	39	28	16	29.4	17.1	92.8	7,093
Progress + UpBeet + Stinger	5.4 + 0.37 + 1.68	4							
Progress + UpBeet + Stinger	6.74 + 0.5 + 1.68	6							
Progress + UpBeet + Nortron	4.0 + 0.25 + 3.0	2	34	21	14	30.8	17.3	93.0	7,228
Progress + UpBeet + Stinger + Nortron	5.4 + 0.25 + 1.68 + 3.0	4							
Progress + UpBeet + Stinger	6.74 + 0.25 + 1.68	6							
Nortron	48.0	1	25	16	11	35.9	16.9	92.8	11,255
Progress + Stinger	4.0 + 1.68	2							
Progress + Stinger	5.4 + 1.68	4							
Progress + Stinger	6.7 + 1.68	6							
LSD (0.05)			7	12	10	6.9	NS	NS	4,503

\*Application timings were (1) April 9 preemergence, (2) April 22 to cotyledon sugar beets, (3) April 29 to two-leaf sugar beets, (4) May 2 to two-leaf sugar beets, (5) May 4 to two-leaf sugar beets, and (6) May 13 to four-leaf sugar beets.

†ERS = estimated recoverable sucrose.

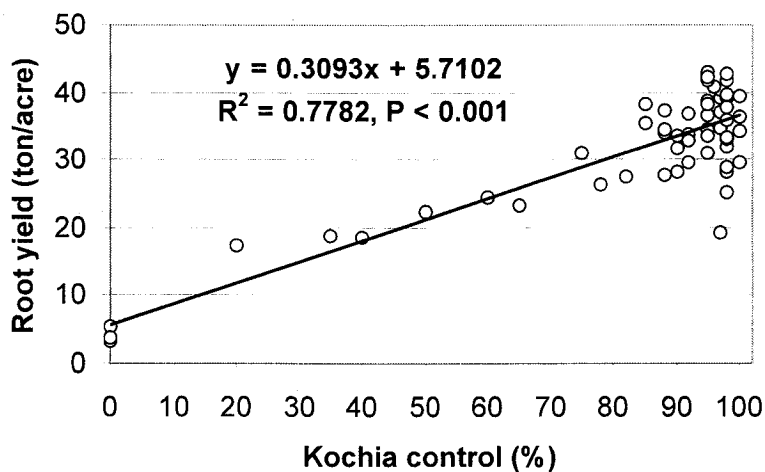


Figure 1. Response of sugar beet root yields to percent kochia control, Malheur Experiment Station, Oregon State University, Ontario, OR, 2002.