

ALS-Resistant Kochia Management in a Corn - Sugarbeet Rotation 2005 to 2006 and 2007 to 2008.

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A field study was initiated in 2005 near Scottsbluff, Nebraska to evaluate the effectiveness of controlling ALS-resistant kochia in sugarbeets by using various degrees of kochia control in corn the previous year. The experimental design was a split block with main blocks, varying degrees of weed control in corn in 2005 and seven sugarbeet weed control programs in 2006 as subplots with four replications. Main plots were 77 ft wide by 65 ft long and were located on a sandy loam soil with an organic matter content of 0.8% and pH of 8.3. Corn, 'DeKalb 47-10', was planted on May 6. Herbicides were applied postemergence on June 16, 2005 and June 22, 2005 (Table 1.). Herbicides were applied with a tractor-mounted sprayer calibrated to deliver 20 gallons of water per acre at 32-psi pressure with Spraying Systems 11002 VS nozzles. The environmental conditions at the time of spraying are given in Table 1.

Weed density in corn averaged 1.5 weeds per square foot in 2005. Weeds remaining after cultivation were hairy nightshade, redroot pigweed, common lambsquarters, and kochia at densities of 31, 208, 189, and 7 plants per 275 sq ft, respectively. The best kochia control of 99% was achieved from two applications of Roundup UltraMax, followed by 85% control from Distinct plus Basis followed 2 weeks later with Roundup UltraMax, and 71% control with a single application of Distinct plus Basis (Table 2). Distinct plus Basis provided 89, 99, and 97% control of hairy nightshade, redroot pigweed, and common lambsquarters, respectively. A combination of Distinct plus Basis followed 2 weeks later with Roundup UltraMax provided excellent control of hairy nightshade, redroot pigweed, and common lambsquarters. Corn yields were responsive to weed control with the greatest corn yield of 179.6 bu/acre achieved with Distinct plus Basis early postemergence followed by Roundup UltraMax 2 weeks later and the lowest yield of 77.6 bu/acre with only cultivation. Corn weed control programs achieved in 2005 provided a range of weed densities in sugarbeets in 2006.

In mid-April the plot area was rototilled twice and then roller-harrowed to firm the soil. Sugarbeets 'Beta 9302GR5' were planted on May 2, 2006.

Herbicides were applied preemergence on May 3 and incorporated with 0.5 inch of water applied with an overhead irrigation system. Herbicides were applied postemergence starting May 19 when sugarbeets were in the cotyledon growth stage and ended on June 19 when the crop was in the 8 true-leaf growth stage. Herbicides were applied with a tractor-mounted sprayer calibrated to deliver 20 gallons of water per acre at 32-psi pressure with Spraying Systems 11002 VS nozzles. The environmental conditions at the time of spraying are given in Table 3. Weed control treatments applied to sugarbeets are described in Table 4.

Kochia density in sugarbeets in the no herbicide/cultivated plots ranged from 4 to 33 plants/92 sq ft. The greatest density of 33 plants/92 sq ft was recorded in main plots where 50% kochia control was obtained in corn in 2005. The lowest kochia density of 4 plants/92 sq ft was observed in main plots where 99% kochia control was obtained in corn in 2005. A preemergence application of Nortron followed postemergence by the Half-Rate in sugarbeets did not control kochia at any level in main plots where 50% kochia control was obtained in corn in 2005. In contrast, the same treatment applied to sugarbeets in main plots where 99% kochia control was obtained (in corn) provided 90% kochia control (in sugarbeets). It was estimated that a majority of the kochia in the field was ALS-resistant and therefore Upbeet in herbicide mixtures would not be effective for kochia control. Two postemergence applications of Roundup in sugarbeets controlled 99% of the kochia in all plots.

Common lambsquarters was present at the greatest density in sugarbeets and when lambsquarters was suppressed it seemed to release kochia (Table 5). For example, in main plots where 30 and 50% control of common lambsquarters and kochia, respectively, was achieved in corn, the next year in sugarbeets in the same plots the density of common lambsquarters and kochia was 415 and 33 plants/92 sq ft. Excellent common lambsquarters control was achieved with Nortron preemergence followed postemergence with the Half-Rate and lambsquarters density was reduced to 2 plants but in contrast kochia density increased to 84 plants/92 sq ft. This suggests that common lambsquarters was dominate over kochia and when lambsquarters was suppressed, kochia was released.

The results of the first 2 years of study clearly demonstrate the benefit of excellent weed control in corn and how it will carryover the next year in sugarbeets and make the job of weed management much easier.

The experiment was repeated in 2007 by planting corn, 'DKC 46-60', on May 3. Corn herbicides were applied on May 24 and June 11 in 2007. The environmental conditions at the time of spraying are given in Table 6. Weed density in corn averaged 2.2 weeds per square foot in 2007. Weeds remaining after cultivation were common lambsquarters, redroot pigweed, hairy nightshade, kochia, green foxtail, and stinkgrass at densities of 268, 64, 247, 1, 2, and 10 plants per 275 sq ft, respectively. The greatest reduction in weed density of 98% was achieved from an early postemergence treatment with Distinct plus Basis followed 2 weeks later with Roundup UltraMax (Table 7). A single early postemergence treatment with Distinct plus Basis provided an 86% reduction in weed density. Corn grain yields were responsive to weed control with the lowest corn yield of 108 bu/acre achieved with cultivation and corn seed yields of 214 to 222 bu/acre where 86 to 98% weed control was obtained.

Table 1. Environmental Conditions at the Time of Herbicide Application in Corn in 2005.

Date	Air temperature	Humidity	Wind speed & direction	Time of day	Corn stage of growth	Weed heights			
	(F)					(%)	(mph)	Colq	Kocz
						----- (inches) -----			
June 6	86	26	7 SE	1:30 pm	V3	3.5	2	4	3.5
June 22	83	36	1 SE	9:00 am	V6	16	10	12	6

Rainfall and irrigation following herbicide application.

Date	Amount	Date	Amount	Date	Amount
	- (inches) -		- (inches) -		- (inches) -
June 1 to 2	0.21	June 10	0.62	June 13	0.46
June 3	0.77	June 11	0.14	June 27	0.20
June 4	0.95	June 12	0.86		

Table 2. ALS-Resistant Kochia Management in Corn in 2005.

Main blocks ¹	Rate	Time of application	Percent weed control ²					Corn	
			Hans	Rrpw	Colq	Kocz	Avg of all weeds	Stand 7/8	Seed yield 11/8
	(lb/acre)		----- (%) -----					(plants/acre)	(bu/acre)
Cultivation no herbicide	—	8 in corn	40	40	30	50	40	34300	77.6
Roundup UltraMax + AMS	0.75	4 in corn	98	99	89	99	94	37200	173.7
Roundup UltraMax + AMS	0.75	2 wks later							
Distinct + Basis + X77 + UAN	0.175 + 0.015	4 in corn	89	99	97	71	91	35600	160.8
Distinct + Basis + X77 + UAN	0.175 + 0.015	4 in corn	99	99	99	85	97	35700	179.6
Roundup UltraMax + AMS	0.75	2 wks later							
LSD at 5%			16	5	8	37	7	NS	36

¹ Spray additives were applied at the following concentrations: ammonium sulfate (AMS) at 2 lbs/acre, surfactant X77, at 0.25% per volume of carrier and liquid nitrogen (UAN) at 1.5 pints/acre.

² Percent weed control calculated from weed counts taken on July 6, 2005. Weed abbreviations: hairy nightshade (Hans), redroot pigweed (Rrpw), common lambsquarters (Colq), and kochia (Kocz).

Table 3. Environmental Conditions at the Time of Herbicide Application in Sugarbeets in 2006.

Date	Air temperature (F)	Humidity (%)	Wind speed & direction (mph)	Time of day	Sugarbeet growth stage	Weed heights (inches)					
						Hans	Rrpw	Colq	Kocz		
May 3	46	56	6 NW	8:00 am	Preemergence	----- no weeds -----					
May 19	86	19	2 W	11:00 am	Cotyledon	0	.5	0	.5	1	0.75
May 24	65	40	14 W	9:00 am	2 true leaves	1	1	1.5	1.5		
June 1	58	69	2 E	9:00 am	4 true leaves	1	2	2	.5	4	
June 14	83	48	2 E	10:00 am	6 true leaves	4	6	8	8		
June 19	76	41	9 SE	11:00 am	8 true leaves	8	12	13	11		

Rainfall and irrigation before and after herbicide application:

Date	Amount - (inches) -	Date	Amount - (inches) -	Date	Amount - (inches) -
May 3 (irrigation)	0.5	May 23	0.20	June 9	0.18
May 4	0.17	May 25 (irrigation)	1.0	June 10	0.29
May 5	0.04	May 28	0.1	June 11	0.90
May 8	0.07	May 30	0.52	June 20 (irrigation)	1.0
May 9 (irrigation)	0.49	June 5	0.07	June 22	1.21
May 12 (irrigation)	0.25	June 6 (irrigation)	1.0		
May 15 (irrigation)	0.25	June 8	1.21		

Table 4. Weed Control Treatments in Sugarbeets in 2006.

Treatment ¹	Rate (lb/acre)	Sugarbeet growth stage	Abbreviation for treatment
No herbicide, cultivation cultivation	—	2 true leaves 6 true leaves	No herbicide/cultivation
Nortron	1.0	Preemergence	
Betamix + Upbeet + Stinger + Scoil	0.16 + 0.008 + 0.04	2 true leaves	
Betamix + Upbeet + Stinger + Scoil	0.16 + 0.008 + 0.04	4 true leaves	
Betamix + Upbeet + Stinger + Scoil	0.16 + 0.008 + 0.04	6 true leaves	Nortron/Half-Rate
Nortron	1.0	Preemergence	
Betamix + Upbeet + Stinger + Scoil	0.08 + 0.004 + 0.02	2 true leaves	
Betamix + Upbeet + Stinger + Scoil	0.08 + 0.004 + 0.02	4 true leaves	
Betamix + Upbeet + Stinger + Scoil	0.08 + 0.004 + 0.02	6 true leaves	Nortron/Micro-Rate
Betamix + Upbeet + Stinger + Scoil	0.33 + 0.016 + 0.09	2 true leaves	
Betamix + Upbeet + Stinger + Scoil	0.33 + 0.016 + 0.09	4 true leaves	
Betamix + Upbeet + Stinger + Scoil	0.33 + 0.016 + 0.09	6 true leaves	Full-Rate
Betamix + Upbeet + Stinger + Scoil	0.16 + 0.008 + 0.04	2 true leaves	
Betamix + Upbeet + Stinger + Scoil	0.16 + 0.008 + 0.04	4 true leaves	
Betamix + Upbeet + Stinger + Scoil	0.16 + 0.008 + 0.04	6 true leaves	Half-Rate
Roundup UltraMax II + AMS	0.75	4 true leaves	
Roundup UltraMax II + AMS	0.75	8 true leaves	Roundup

¹ The spray additive ammonium sulfate (AMS) was added at 1% v/v and methylated seed oil (MSO) at 1.5% v/v.

Table 5. ALS-Resistant Kochia Management in a Corn-Sugarbeet Rotation at Scottsbluff, NE during the 2005/2006 Growing Seasons.

Weed control treatment in corn in 2005	Weed density in corn - July 6, 2005					Weed control treatment in sugarbeet in 2006	Weed density in sugarbeet -June 27, 2006				
	Hans	Rrpw	Colq	Kocz	Avg		Hans	Rrpw	Colq	Kocz	Percent Kochia control
	----- (%) -----						----- (plants/92 sq ft) -----				
No herbicide/cultivation	40	40	30	50	40	No herbicide/cultivation	8	27	415	33	0
						Nortron/Half-Rate	0	0	2	84	0
						Nortron/Micro-Rate	0	0	12	33	39
						Full-Rate	0	0	0	29	12
						Half-Rate	0	3	8	79	0
						Roundup	0	0	2	0	99
Roundup UltraMax II	98	99	89	99	94	No herbicide/cultivation	50	34	300	4	87
Roundup UltraMax II						Nortron/Half-Rate	0	0	0	3	90
						Nortron/Micro-Rate	1	2	11	15	54
						Full-Rate	0	0	0	6	81
						Half-Rate	0	6	3	13	60
						Roundup	0	0	0	0	99
Distinct + Basis	89	99	97	71	91	No herbicide/cultivation	23	49	212	7	0
						Nortron/Half-Rate	0	0	0	23	30
						Nortron/Micro-Rate	0	1	20	31	6
						Full-Rate	0	0	0	33	0
						Half-Rate	0	6	4	31	6
						Roundup	0	2	0	0	99
Distinct + Basis	99	99	99	85	97	No herbicide/cultivation	32	38	252	5	84
Roundup UltraMax II						Nortron/Half-Rate	0	1	0	4	87
						Nortron/Micro-Rate	0	0	5	6	81
						Full-Rate	0	0	0	19	42
						Half-Rate	0	2	2	22	33
						Roundup	0	0	0	0	99
LSD at 5%	16	5	8	37	7		14	10	43	34	

Table 6. Environmental Conditions at the Time of Herbicide Application in Corn in 2007.

Date	Air temperature (F)	Humidity (%)	Wind speed & direction (mph)	Time of day	Corn stage of growth	Weed heights					
						Colq	Rrpw	Hans	Kocz	Grft	Stgr
May 24	58	30	2 SE	11:00 am	4 in corn	2	3	2	2	2	0
June 11	80	42	5 SE	10:30 am	14 in corn	12	5	9	11	5	1

Rainfall and irrigation following herbicide application:

Date	Amount	Date	Amount	Date	Amount	Date	Amount	Date	Amount
	- (inches) -		- (inches) -		- (inches) -		- (inches) -		- (inches) -
May 22	0.75	May 29	0.23	June 6	0.75	June 7	0.08	June 18	0.85

Table 7. ALS-Resistant Kochia Management in Corn in 2007.

Main blocks ¹	Rate (lb/acre)	Time of application	Percent weed control ²							Corn	
			Colq	Rrpw	Hans	Kocz	Grft	Stgr	Avg	Stand 6/28 (plants/acre)	Seed yield 10/23 (bu/acre)
Cultivation - no herbicide	—	8 in corn	0	0	0	0	0	0	0	30600	108.1
Roundup UltraMax + AMS	0.75	4 in corn									
Roundup UltraMax + AMS	0.75	2 wks later	87	93	97	99	87	65	88	30600	219.4
Distinct + Basis + X77 + UAN	0.175 + 0.015	4 in corn	96	99	99	99	62	62	86	32600	222.3
Distinct + Basis + X77 + UAN	0.175 + 0.015	4 in corn									
Roundup UltraMax + AMS	0.75	2 wks later	96	99	99	99	99	97	98	32600	214.4
LSD at 5%	—	—	6	4	2	1	37	57	10	NS	37

¹ Spray additives were applied at the following concentrations: ammonium sulfate (AMS) at 2 lbs/acre, surfactant X77, at 0.25% per volume of carrier and liquid nitrogen (UAN) at 1.5 pints/acre.

² Percent weed control calculated from weed counts taken on June 28, 2007. Weed abbreviations: common lambsquarters (Colq), redroot pigweed (Rrpw), hairy nightshade (Hans), kochia (Kocz) green foxtail (Grft), and stinkgrass (Stgr).