CONTROL OF KOCHIA WITH REGISTERED HERBICIDES

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Kochia biotypes that are resistant to ALS inhibiting herbicides, such as UpBeet, have become very common in the Red River Valley in North Dakota and Minnesota. Kochia was named as "worst weed" by 43% of the sugarbeet growers responding to the annual survey in 2000. This compares to 1997, when only 3% of the respondents named kochia as worst weed. The objective of this experiment was to evaluate control of ALS resistant kochia using herbicides presently registered for sugarbeet.

'Beta 6600' sugarbeet was seeded May 14 at Felton, MN and May 15 at St. Thomas, ND. 'Crystal 817' sugarbeet was seeded May 18 at Manvel, ND and May 18 at Glasston, ND. Sugarbeet was seeded 1.25 inches deep in 22-inch rows and Counter 15G insecticide at 12 lb product per acre was applied modified in-furrow at planting. Application dates and conditions are given in Table 1. Herbicides were applied in 17 gpa water at 40 psi through 8002 nozzles at 3 mph to the center four rows of six-row plots. PRE and PPI herbicides were applied May 14, 15 or 18. The Eptam + Ro-Neet was incorporated immediately after application with a rototiller operated 4 inches deep. Plots treated three times with POST herbicides were treated on the first three listed postemergence dates and plots treated four times with POST herbicides were treated on all four listed postemergence dates.

Kochia control was evaluated three or four times at Felton, Manvel and Glasston. St. Thomas was hand weeded throughout the season so weed control was not evaluated at St. Thomas. A dense population of cutworms destroyed the sugarbeet stand in a short time at Glasston and Lorsban was applied to kill the cutworms and save the kochia. Sugarbeet injury was evaluated three or four times at Felton, Manvel and St. Thomas. Sugarbeet was harvested September 25 at St. Thomas.

The results from the four locations are summarized in Table 2. The following discussion is from Table 2 but some of the comparisons and Table 3 were generated by averaging over treatments listed in Table 2. In the discussion, micro-rate treatments are those with Progress or Betamix at rates of 5.7 fl oz/A or 0.5 pt/A. Conventional rate treatments are those with Progress or Betamix at rates of 1.1 pt/A and higher or 1.5 pt/A and higher. The rates of Progress and Betamix on an active ingredient per acre basis were identical but the ai per gallon for Progress is greater than for Betamix so less product per acre of Progress was applied.

The greatest sugarbeet injury was in plots treated with Eptam + Ro-Neet (Table 2). The micro-rate following Eptam + Ro-Neet gave less sugarbeet injury than the conventional rate following Eptam + Ro-Neet. The conventional rate of Progress and Betamix in this experiment was selected intentionally as an agressive rate and sugarbeet injury may be greater with these rates than was observed at these locations if the environment at application is more favorable for high phytotoxicity. A sudden change from cool, cloudy and wet to hot and sunny often will cause excessive sugarbeet injury from Betanex, Betamix or Progress applied near the time that the weather change occurs. The sugarbeet yield in extractable sucrose per acre was similar among all treatments in the hand weeded sugarbeet at St. Thomas suggesting that even the most injured sugarbeet recovered from the injury with no significant effect on yield. Sugarbeet injury from herbicides can cause significant yield loss but yield loss was not observed in this experiment at St. Thomas.

Kochia control evaluated 8 to 14 days after the last herbicide treatment was greater than kochia control averaged over all dates of evaluation indicating that kochia recovered from the initial herbicidal injury (Table 2). Also, kochia plants germinated and emerged for at least 2 months after planting so some of the loss in control could have been from kochia that emerged after the last herbicide treatment. The discussion on kochia control will be based on the early evaluation of control.

A high proportion of the kochia was resistant to UpBeet. The conventional rate without UpBeet gave 76% control while the conventional rate with UpBeet gave 82% control averaged over locations and extra Nortron

treatments. UpBeet normally gives nearly 100% control of non-resistant kochia so the observed kochia control was from the Progress, not from the UpBeet. Herbicide combinations that included Stinger gave kochia control similar to combinations that were identical except without the Stinger. Stinger had no effect on kochia control. However, the micro-rate plus Stinger gave 94% control of common lambsquarters while the micro-rate without Stinger gave only 85% control.

Kochia control was improved by adding Nortron to the micro-rate or the conventional rate (Table 3). Please remember that Table 3 was derived from the data presented in Table 2. Nortron at 4 fluid ounces/A in the first two postemergence treatments tended to give better kochia control than 2 fluid ounces in each treatment or 8 fluid ounces in the first treatment. Common lambsquarters control was improved by adding Nortron to the micro-rate but common lambsquarters control from the conventional rate was not improved by additional Nortron. Redroot pigweed control was not improved by additional Nortron. The conventional rate alone gave slightly more sugarbeet injury than the micro-rate alone but additional Nortron did not significantly increase sugarbeet injury. The micro-rate alone gave 50% kochia control while the micro-rate plus Nortron gave 71% control. Kochia control was 75% with the conventional rate alone and 83% with the conventional rate plus Nortron. While this increase is not large and the overall control level is considerably less than the desired 100%, any increase in kochia control can be quite valuable in a field with a dense population of kochia. The conventional rate applied three times gave better kochia control than the micro-rate applied four times even when Nortron was added to the micro-rate.

Progress applied three times at 1.1/1.5/2.2 pt/A in combination with UpBeet, Stinger and Select gave 80% kochia control. Progress at 1.1 pt/A applied three times in combination with UpBeet, Stinger, Select and Scoil gave 55% kochia control (Table 2). This suggests that control of ALS resistant kochia increases as the rate of Progress increases. However, the risk of yield-reducing sugarbeet injury and the cost per acre also increase as the Progress rate increases.

The best kochia control in the experiment was from Eptam + Ro-Neet (PPI) or Nortron (PRE) followed by the conventional rate (POST) applied three times (Table 2). Part of the benefit from the Eptam + Ro-Neet was the rototiller incorporation which killed emerged weeds more effectively than the seedbed preparation tillage with a 10-foot wide triple-K field cultivator. Roundup at 1 qt /A was applied four days after planting at Glasston to control weeds that were not controlled by seedbed preparation tillage. The other sites were not treated with preemergence Roundup and the incorporated plots had fewer weeds that survived seedbed preparation tillage. The surviving weeds were larger and more difficult to control with postemergence treatments than weeds that germinated and emerged after planting. Nortron (PRE) followed by the conventional rate (POST) would cost $277/A broadcast or $88/A in a 7-inch band on 22-inch rows. Eptam + Ro-Neet (PPI) followed by the conventional rate (POST) would cost $164/A broadcast or $68/A with broadcast Eptam + Ro-Neet and the conventional rate in a 7-inch band on 22-inch rows.

Cutworm at Glasston eliminated the sugarbeet and thereby eliminated sugarbeet competition with the kochia. Felton had excellent population of sugarbeet that competed vigorously with the kochia. Kochia control from Nortron (PRE) followed by the conventional rate (POST) was 93% at Glasston and 98% at Felton at the first evaluation 9 to 14 days after the last treatment at Glasston and 34 days after the last treatment at Felton (data not shown). Kochia control at Felton declined from 98% to 90% in the 20 days between evaluations while kochia control at Glasston declined from 93% to 59% in the 12 days between evaluations. The population of kochia and late emergence of kochia were much greater at Glasston than at Felton but the lack of a good sugarbeet population also contributed to the lesser kochia control at Glasston.

Adequate control of Kochia resistant to ALS inhibitor herbicides in sugarbeet often will require the use of all available applicable weed control tools. Some weed control tools to consider are listed.

1. Obtain kochia control as near 100% as possible in all crops in the rotation. Kochia seed is short lived in the soil so excellent control for even one year can reduce kochia populations by over 90% and two years of excellent control can reduce populations by 98%. Many kochia populations are resistant to ALS inhibiting herbicides so use non-ALS herbicides in combination or in rotation. Starane, bromoxynil, Aim, Roundup, Liberty, dicamba, and Flexstar are non-ALS herbicides that can provide excellent kochia control when

used properly.

2. Kochia generally germinates early in the spring although recent field observations suggest that kochia is germinating later into the season than in the past. Regardless, control of one or more flushes of kochia prior to planting will reduce the infestation in the crop. Any field known to be severely infested with kochia should be planted last to allow as much kochia as possible to germinate and emerge before seedbed preparation. Seedbed preparation tillage should be thorough enough to kill all emerged kochia or Roundup should be applied after planting but before any sugarbeet emerges. Time between sugarbeet planting and emergence varies with soil temperature and moisture so observe fields carefully to be sure the Roundup is applied before any sugarbeet plants emerge.

3. Eptam + Ro-Neet (PPI) or Nortron (PRE) followed by postemergence herbicides will give better kochia control than postemergence herbicides alone. Both Nortron and Eptam + Ro-Neet have some disadvantages but they may be needed to obtain adequate kochia control in severely infested fields.

4. Uniformly high populations of sugarbeet improve overall weed control by increasing the ability of the sugarbeet to compete with the weeds. Use plenty of seed to obtain a high sugarbeet population.

5. Kochia control was increased by adding Nortron to the micro-rate or the conventional rate of postemergence herbicides in the 2001 experiment reported in this paper. Nortron at 4 fl oz/A applied twice would cost about $11/A broadcast.

6. Herbicides alone are unlikely to provide adequate control of ALS resistant kochia if the kochia population is moderate to high. Row crop cultivation, rotary hoeing and harrowing will reduce kochia populations. Hand labor for weeding may be needed in some fields.

7. Prevent kochia from producing seed and, if kochia does produce seed, prevent the kochia plants from spreading seed by rolling in the wind. Hand labor to control a few surviving kochia plants probably will not increase crop yield but prevention of seed production may be worth the hand weeding cost or effort. Kochia growing in field margins or along tree rows should be controlled before they produce seed. Kochia in these “waste” areas that produce seed should be chopped before they have the opportunity to break off and spread seed by rolling in the wind. Unharvested patches of kochia in small grain fields should be tilled or chopped before the plants move in the wind.

Table 1. Conditions when herbicides were applied, 2001.

FELTON					
Date	May 14	May 29	June 5	June 15	June 21
Time of day	4:30 pm	11:00 am	9:30 am	10:00 am	9:50 am
Air temp. (F)	82	71	59	70	75
Relative humidity (%)	50	42	26	40	37
6-inch soil temp (F)	56	58	60	63	69
Soil moisture	good	good	good	good	good
Sugarbeet	-	cotyl	2 leaf	4-6 leaf	8-10 leaf
Kochia (height)	-	0.5-1 inch	0.5-1.5 inch	2.5 inch	2-6 inch
Redroot pigweed	-	cotyl	cot-2 lf	4 leaf	cot-6 lf
MANVEL					
Date	May 18	June 7	June 14	June 22	June 28
Time of day	6 pm	10:50 am	4:45 pm	9:30 am	9:45 am
Air temp. (F)	83	79	64	82	79
Relative humidity (%)	25	39	60	28	31
6-inch soil temp (F)	52	63	62	71	70
Soil moisture	good	good	good	good	good
Sugarbeet	-	cotyl	2 leaf	4-6 leaf	8-10 leaf
Kochia (height)	-	cot-3 inch	3 inch	4 inch	6 inch
Common lambsquarters (height)	-	2 lf-4 inch	6-8 inch	10 inch	12-14 inch
Wild mustard	-	cot-2 lf	6 inch	10 inch	blooming
GLASSTON					
Date	May 18	June 4	June 12	June 20	June 26
Time of day	1:15 pm	1:40 pm	2:00 pm	1:15 pm	10:20 am
Air temp. (F)	83	73	79	68	70
Relative humidity (%)	25	25	27	40	32
6-inch soil temp. (F)	52	60	64	60	64
Soil moisture	good	good	good	good	good
Sugarbeet	-	cotyl	2-lf	4 lf	6-8 lf
Kochia (height)	-	0.5 inch	1.0 inch	2.0 inch	4.0 inch
ST. THOMAS					
Date	May 15	May 30	June 6	June 12	June 22
Time of day	5:00 pm	11:00 am	10:00 am	3:30 pm	9:30 am
Air temp. (F)	70	70	62	82	70
Relative humidity (%)	73	58	58	37	48
6-inch soil temp. (F)	61	57	58	69	59
Soil moisture	good	good	good	good	good
Sugarbeet	-	cotyl	2-4 leaf	4-6 leaf	8-10 leaf

Table 2. Kochia control at Felton, Manvel and Glasston and sugarbeet injury at Felton, Manvel and St. Thomas.

Treatment - Rate in Product/A	3 loc[a] 8-14 DALT Sugb. inj	3 loc.[a] 8-14 DALT Kochia cntl	3 loc.[a] all eval. Kochia cntl	Felton[a] 14 DALT Rrpw cntl	Manvel[a] 8 DALT Colq cntl	St. Thom. Extrac. sucrose
	%	%	%	%	%	lb/A
Progress + UpBeet + Stinger + Select + Scoil 5.7 fl oz + 1/8 oz + 1.3 + 2 fl oz + 1.5% (4x)	13	55	46	90	89	7110
Betamix + UpBeet + Stinger + Select + Scoil 0.5 pt + 1/8 oz + 1.3 + 2 fl oz + 1.5% (4x)	15	66	58	94	91	7370
Prog + UpB + Sting + Sel + Nortron + Scoil 5.7 fl oz + 1/8 oz + 1.3 + 2 + 2 fl oz + 1.5% (4x)	12	66	56	95	96	6440
Prog + UpB + Sting + Sel + Nortron + Scoil 5.7 fl oz + 1/8 oz + 1.3 + 2 + 4 fl oz + 1.5% (2x) 5.7 fl oz + 1/8 oz + 1.3 + 2 + 0 fl oz + 1.5% (2x)	10	75	61	91	97	6625
Prog + UpB + Sting + Sel + Nortron + Scoil 5.7 fl oz + 1/8 oz + 1.3 + 2 + 8 fl oz + 1.5% (1x) 5.7 fl oz + 1/8 oz + 1.3 + 2 + 0 fl oz + 1.5% (3x)	10	66	57	96	96	6415
Progress + Select 1.1 pt + 2.6 fl oz/1.5 pt + sm[a]/2.2 pt + sm	15	70	63	85	94	6680
Progress + UpBeet + Stinger + Select 1.1 pt + 1/4 oz + 2.0 + 2.6 fl oz (3x)	9	62	47	88	92	6670
Progress + UpBeet + Select 1.1 pt + 1/4 oz + 2.6 fl oz/1.5 pt + sm/2.2 pt + sm	14	74	69	94	97	6930
Prog + UpB + Sting + Select 1.1 pt + 1/4 oz + 2.0 + 2.6 fl oz/1.5 pt + sm/2.2 pt + sm	13	80	73	89	99	6940
Betamix + UpB + Select 1.5 pt + 1/4 oz + 2.6 fl oz/2.0 pt + sm/3.0 pt + sm	14	82	70	93	98	6640
Prog + Select + Nortron 1.1 pt + 2.6 + 2 fl oz/1.5 pt + sm/2.2 pt + sm	13	80	72	97	98	5970
Prog + Select + Nortron 1.1 pt + 2.6 + 4 fl oz/1.5 pt + sm/ 2.2 pt + 2.6 + 0 fl oz	14	81	71	96	97	6480
Prog + Sel + Nortron/Prog + Select 1.1 pt + 2.6 + 8 fl oz/1.5 pt + 2.6 fl oz/2.2 pt + sm	14	74	63	92	97	6720
Prog + UpB + Select 1.1 pt + 1/2 oz + 2.6 fl oz/1.5 pt + sm/2.2 pt + sm	15	80	70	97	98	6840
Prog + UpB + Sel + Nort 1.1 pt + 1/2 oz + 2.6 + 2 fl oz/1.5 pt + sm/2.2 pt + sm	14	81	69	95	98	6600
Prog + UpB + Sel + Nort 1.1 pt + 1/2 oz + 2.6 + 4 fl oz/1.5 pt +sm/ 2.2 pt + 1/2 oz + 2.6 + 0 fl oz	15	85	75	91	99	7190

Prog + UpB + Sel + Nort/Prog + UpB + Sel 1.1 pt + 1/2 oz + 2.6 + 8 fl oz/1.5 pt + 1/2 oz + 2.6 fl oz/ 2.2 pt + 1/2 oz + 2.6 fl oz	13	81	76	94	97	6530

(continued)

Table 2. (continued)

Treatment - Rate in Product/A	3 loc[a] 8-14 DALT Sugb. inj	3 loc.[a] 8-14 DALT Kochia cntl	3 loc.[a] all eval. Kochia cntl	Felton[a] 14 DALT Rrpw cntl	Manvel[a] 8 DALT Colq cntl	St. Thom. Extrac. sucrose
	%	%	%	%	%	lb/A
Prog + UpB + Sel + Scoil 5.7 fl oz + 1/8 oz + 2 fl oz + 1.5 % (4x)	8	61	56	93	79	6680
Prog + UpB + Sel + Nortron + Scoil 5.7 fl oz + 1/8 oz + 2 + 2 fl oz + Scoil (4x)	11	68	59	87	85	7430
Prog + UpB + Sel + Nortron + Scoil 5.7 fl oz + 1/8 oz + 2 + 4 fl oz + 1.5% (2x) 5.7 fl oz + 1/8 oz + 2 + 0 fl oz + 1.5% (2x)	11	67	57	93	90	7040
Prog + UpB + Sel + Nortron + Scoil 5.7 fl oz + 1/8 oz + 2 + 8 fl oz + 1.5% (1x) 5.7 fl oz + 1/8 oz + 2 + 0 fl oz + 1.5% (3x)	10	69	57	93	87	6500
Prog + UpB + Sting + Sel + Scoil 5.7 fl oz + 1/8 oz + 1.3 + 2 fl oz + 1.5% (1x) 8.5 fl oz + sm (3x)	12	59	52	93	94	6210
Nortron (PRE) 3 qt Prog + UpB + Sting + Sel + Scoil 5.7 fl oz + 1/8 oz + 1.3 + 2 fl oz + 1.5% (4x)	11	83	75	99	99	6100
Eptam + Ro-Neet (PPI) 1.1 + 2.67 pt Prog + UpB + Sting + Sel + Scoil 5.7 fl oz + 1/8 oz + 1.3 + 2 fl oz + 1.5% (4x)	21	83	69	97	99	6000
Nortron (PRE) 3 qt Prog + UpB + Select 1.1 pt + 1/4 oz + 2.6 fl oz/1.5 pt + sm/2.2 pt + sm	13	90	84	99	99	6840
Eptam + Ro-Neet (PPI) 1.1 + 2.67 pt Prog + UpB + Select 1.1 pt + 1/4 oz + 2.6 fl oz/1.5 pt + sm/2.2 pt + sm	30	94	86	96	100	6470
LSD (0.05)	5	8	8	7	6	NS

[a]3 loc = averaged over three locations, DALT = days after last treatment, sugb inj = sugarbeet injury, all eval. = averaged over all dates of evaluation, Rrpw cntl = redroot pigweed control, Colq cntl = common lambsquarters control, sm = same rate as in previous treatment.

Table 3. Weed control and sugarbeet injury from additional Nortron averaged over treatments in Table 2.

Treatment	3 loc Kochia cntl	1 loc Colq cntl	1 loc Rrpw cntl	3 loc Sugb inj	BC cost
	%	%	%	%	$/A
Micro-Rate (4x)	58	84	92	10	84
M-R + Nortron 2 fl oz (4x)	67	90	91	13	95
M-R +Nortron 4 fl oz (2x)/M-R (2x)	71	94	92	12	95
M-R +Nortron 8 fl oz (1x)/M-R (3x)	67	91	94	10	95
Conventional Rate (3x)	75	96	91	15	140
CR + Nortron 2 fl oz (3x)	81	98	96	14	148
CR + Nortron 4 fl oz (2x)/CR (1x)	83	98	94	14	151
CR + Nortron 8 fl oz (1x)/CR (2x)	78	97	93	14	151
LSD (0.05)	6	4	NS	4	