EFFECT OF SEQUENTIAL PREEMERGENCE AND POSTEMERGENCE HERBICIDE TREATMENTS ON WEED CONTROL AND SUGARBEET PERFORMANCE

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Herbicides applied preplant incorporated in spring or alternately as layered treatments in conjunction with fall-ridging have been effective for the control of weeds in sugarbeets in semi-arid southern Alberta. Earlier experiments with preemergence application of herbicides gave inconsistent results and consequently their use was commercially unacceptable. This paper presents the summarized results from several recent experiments conducted over a period of three years to re-evaluate the potential usefulness of preemergence herbicides in this semi-arid beet growing area.

1. 1987 - 88 experiments: The first experiments were initiated in the fall of 1987 at two sites. One was on the A.S.C. research farm and one on the farm of a cooperator, Megyes. The A.S.C. site was fall-plowed and prepared in the usual manner and fall-ridged. The Megyes site was not moldboard plowed. After combining, the straw was spread with a crazy-harrow. This was followed by deep chisel plowing twice and one discing. Fertilizer was broadcast and incorporated with a vibrashank cultivator. The site was then ridged in the usual manner in preparation for beets in 1988.

The plots were two rows wide and 7.62 meters long. A modified Latin Square design with 24 treatments and 12 replications was used at each site. The herbicides used in the study were Nortron (ethofumesate), Pyramin (pyrazon), Ro-Neet (cycloate), and Betamix (a 1:1 mix of phenmedipham and desmedipham). Following are several of the selected treatments included in these experiments.

Trt. No.	Herbicide	Formulation	Method of Appl'n	Rate of Application kg/ha a.i.	Spray sol'n Litres/ha	Band Width cm***
1.	Check	N.A.*	N.A.	N.A.	N.A.	N.A.
2.	Betamix	15EC	Post-E	0.4 (0.8)	400	18
3.	Betamix	15EC	Post-E	0.4 (0.8)	400	18
	Betamix	15EC	Post-E	0.4 (o.8)	400	18
4.	Nortron	18EC	Pre-E	3.5	5490	10
5.	Nortron	18EC	Pre-E	3.5	5490	10
	Betamix	15EC	Post-E	0.4 (0.8)	400	18
6.	Nortron	18EC	Pre-E	3.5	5490	10
	Betamix	15EC	Post-E	0.4 (0.8)	400	18
	Betamix	15EC	Post-E	0.4 (0.8)	400	18

7.	Pyramin	50SU	Pre-E	4.5	4650	10
8.	Pyramin	50SU	Pre-E	4.5	4650	10
	Betamix	15EC	Post-E	0.4 (0.8)	400	18
9.	Pyramin	50SU	Pre-E	4.5	4650	10
	Betamix	15EC	Post-E	0.4 (0.8)	400	18
	Betamix	15EC	Post-E	0.4 (0.8)	400	18

* - N.A. = not applicable.
** - ( ) = rate in brackets applied at Megyes site.
*** - beet rows were spaced 56 cm apart.

Because of the very dry winter and spring, both sites were sprinkler irrigated before de-ridging in preparation for planting. Normal inter-row cultivations were performed at both sites. A 6.5 cm wide band, centred over the row, remained uncultivated. The data reported for this experiment was obtained by counting all the weeds in each plot remaining in this uncultivated band. All beets were harvested to determine sugar yield. The beets at the A.S.C. site were in the cotyledon stage when the first application of Betamix was made on May 24. The postemergence Betamix should have been applied at the Megyes site on June 1, but was delayed by wet soil from irrigation and subsequent rains. When the ground was dry enough the weeds were large and the sugarbeets were in the 4- to 6-leaf stage. For this reason the Betamix rates were doubled at this site.

Pertinent data for the two sites is as follows:

	A.S.C.	Megyes
Clay % (0 - 30 cm)	20	23
Silt % (0 - 30 cm)	20	24
Sand % (0 - 30 cm)	60	53
O.M. % (0 - 30 cm)	2.4	2.35
E. C. (0 - 30 cm)	1	0.7
pH (0 - 30 cm)	8.1	8.1
Planted	May 6	May 11
Preemergence	May 9	May 12
Postemergence	May 24	June 14
	June 1	June 20
Moisture received (after application of pre-emergence)		May 18 10 mm irr.
	May 31 6 mm rain	May 22 18 mm irr.
	June 4 4 mm rain	May 28 18 mm irr.
	June 5 5 mm rain	May 29 8 mm rain
	June 7 12 mm rain	June 7 15 mm rain
	June 8 32 mm rain	June 8 48 mm
Weed counts	June 17 - 21	June 27 - 30
Weed Control Rating	Sept. 9	Sept. 1
Harvest	Sept. 26 & 27	Sept. 30 & Oct. 1

Results:

The results from the A.S.C. and Megyes sites are given in tables 1 and 2 respectively. The number of weeds per square meter is equivalent to the number of weeds per 50 feet of row. A weed control score of 9 represents complete absence of weeds, whereas, a score of 7 is considered the minimum commercially acceptable level of control.

Table 1. Effect of preemergence and postemergence herbicides on weeds and sugarbeets. A.S.C. 1988.

Pre-emerge May 9	Post-emerge May 24	Post-emerge June 1	Total weeds	Red-root pigweed	Lambs-quarter	Weed score Sept. 9	Sugar (kg/ha)
ooooo	ooooo	ooooo	44.4	2.2	2.3	3.8	6,595
ooooo	BETAMIX	ooooo	37.9	0.9	2.6	4.7	7,400
ooooo	BETAMIX	BETAMIX	26.6	0.8	1.5	4.3	6,921
NORTRON	ooooo	ooooo	28.4	0.9	1.9	5.4	7,034
NORTRON	BETAMIX	ooooo	17.9	0.3	0.5	5.8	7,713
NORTRON	BETAMIX	BETAMIX	6.7	0.1	0.0	6.6	8,139
PYRAMIN	ooooo	ooooo	23.4	1.4	1.9	5.1	7,335
PYRAMIN	BETAMIX	ooooo	17.9	0.5	0.3	5.8	7,929
PYRAMIN	BETAMIX	BETAMIX	7.8	0.1	0.2	6.3	7,887
L.S.D. P = 0.05			12.5	1.1	1.0	1.2	966

Table 2. Effect of preemergence and postemergence herbicides on weeds and sugarbeet performance. Megyes. 1988.

Pre-emerge May 11	Post-emerge June 14	Post-emerge June 20	Total weeds	Red-root pigweed	Lambs-quarter	Weed score Sept. 1	Sugar yield (kg/ha)
ooooo	ooooo	ooooo	71.2	62.1	3.6	2.3	4,784
ooooo	BETAMIX	ooooo	67.8	61.3	3.3	4.3	5,755
ooooo	BETAMIX	BETAMIX	66.9	62.9	0.7	5.5	5,656
NORTRON	ooooo	ooooo	13.4	8.3	0.8	7.3	6,529
NORTRON	BETAMIX	ooooo	7.5	4.5	0.8	7.6	6,440
NORTRON	BETAMIX	BETAMIX	3.5	3.3	0.1	8.6	6,555
PYRAMIN	ooooo	ooooo	12.7	10.0	0.4	7.3	6,592
PYRAMIN	BETAMIX	ooooo	5.2	4.2	0.1	8.7	6,928
PYRAMIN	BETAMIX	BETAMIX	3.8	3.3	0.0	8.7	7,041
L.S.D. P = 0.05			18.5	17.2	1.3	1.2	1,055

Effect of postemergence treatments alone: Single applications of Betamix to plots with no prior herbicide treatment resulted in modest weed control and increases in yield of sugar. Repeat applications of low rates increased weed control particularly when the first application had been applied when the beets were in the cotyledon stage of growth (as at the A.S.C. site). Betamix applications to larger weeds, even at higher rates, failed to significantly reduce the number (Megyes site). Although the applications of Betamix increased the yield of sugar, these increases were not statistically significant.

Effect of preemergence herbicides alone: The preemergence applied herbicides, Pyramin and Nortron, were essentially equal in overall weed control. Pyramin and Nortron provided overall weed control of 47% and 36% respectively and resulted in increases in sugar yield of 11% and 7% respectively at the A.S.C. site. At the Megyes site the weed control was 82% and 81% respectively and the yield increases were 38% and 36% respectively. The effect on weed control was significant at both sites, although greater weed control was obtained at the Megyes site. The increase in sugar yield was statistically significant only at the Megyes site. This was most likely due to the application of a light sprinkler irrigation within a week of the preemergence herbicide treatment.

Effect of preemergence plus postemergence treatments: At the Megyes site the preemergence application of either Nortron or Pyramin resulted in significant increases in weed control and sugar yield. One or two sequential Betamix applications tended to further improve weed control, but none of these increases were significant. Likewise, sequential Betamix treatments failed to consistently increase sugar yield. Apparently the application of water within one week of preemergence treatment had been very effective in removing weed competition so that further herbicide treatments were at best of only marginal benefit.

At the A.S.C. site moisture was delayed 22 days. Although the preemergence treatments of Nortron or Pyramin improved the weed control significantly, the level of control was lower than at the Megyes site. The preemergence applications alone failed to significantly increase the sugar yield. Sequential applications of Betamix resulted in significantly improved weed control and consistent increases in sugar yield. After one or two applications of Betamix sugar yields were significantly greater than the check treatment. Treatments with Betamix only failed to significantly increase sugar yield. Therefore, when sequential treatments are used, preemergence applications are very useful even when their initial efficacy is reduced by a delay in rainfall or irrigation.

2. Experiment: Effect of water volume on the efficacy of Nortron, 1990.

The purpose of this experiment was to determine whether the volume of spray solution would affect the efficacy of Nortron when applied to very dry soil. The top 30 cm of soil contained 64% sand, 19% silt, 17% clay, 2.5% organic matter, a pH of 8.1 and an EC of 2.35.

One rate of Nortron (3.5 kg/ha) was used with three volumes of water. All Nortron treatments were applied using a constant dilution of 355 L/ha. Additional water, as required, was applied simultaneously using a separate sprayer. The preplant fall-layered Nortron treatments were applied to powder dry soil on October 12, 1989. All treatments were applied to an 18 cm wide band and the soil ridged immediately. Winter snow resulted in a very moist seedbed.

The plots were de-ridged, planted and the preemergence treatments applied on May 2, 1990. The surface soil was very moist. Rainfall after application of the preemergence treatments consisted of 0.5 mm on May 8, 2 mm on May 11, 18 mm on May 19, and 23 mm on May 24. The plots were 6 rows wide trimmed to 3.05 m long. Sugarbeet seeds were planted to stand with 6.56 seeds/m of row. Redroot pigweed and Lambsquarter were planted into rows 4 and 5 respectively at 32.8 seeds/m of row. The seeds were placed above the beet seeds into the depression formed by the single-rib presswheel. These seeds were lightly covered with soil by the tine harrows attached for this purpose. Kochia infestations resulted from natural seeding. Betamix was applied at 4:45 pm on June 4 when the air temperature was 18 C. At this date the sugarbeets ranged in size from cotyledon to very early 4-leaf. The Redroot pigweed and Lambsquarter were in the cotyledon stage.

Results:

The results are given in table 3.

Table 3. Effect of water volume on efficacy of Nortron PPF-L and preemergence, with and without sequential Betamix on the number of weeds per square meter. 1990.

Application & Soil	Nortron only			Nortron + Betamix		
	355	1020	1685	355	1020	1685
	-----L/ha---------			-----L/ha---------		
Redroot pigweed						
PPF-L, dry soil	13	15	8	0	0	0.2
PRE, moist soil	0	0	0	0	0	0
L.S.D. (0.05) = 6						
Lambsquarter						
PPF-L, dry soil	5	5	5	0.2	0.4	0.7
PRE, moist soil	0.2	0	0.2	0.2	0.2	0
L.S.D. (0.05) = 2						
Kochia						
PPF-L, dry soil	77	85	47	40	37	30
PRE, moist soil	17	23	20	10	7	8
L.S.D. (0.05) = 32						

Increasing the water volume from 355 to 1020 L/ha failed to improve the control of any of the weeds. However, applying 1685 L/ha resulted in significantly better control of Kochia and Redroot pigweed than with 1020 L/ha, but not Lambsquarter. This difference in weed control due to water volumes used with the fall-layered treatments largely disappeared after one postemergence application of Betamix.

Nortron applied preemergence to a moist soil surface resulted in significantly better weed control than the fall-layered treatments made to powder dry soil. Fall-layered Nortron applied to dry ground with a sequential postemergence Betamix provided weed control almost equal to preemergence Nortron onto moist soil followed with Betamix.

3. Experiments conducted in 1989 and 1990.

Results from experiments conducted in 1988 suggested that weed control with preemergence herbicides was enhanced when moisture was received soon after application. However, a sequence of preemergence and postemergence treatments resulted in much better weed control than was obtained with preemergence or postemergence treatments alone. The objective of the following experiments, was to obtain additional information on the efficacy of several preemergence treatments compared with comparable fall-layered treatments. Previous research, which was followed by many years of commercial success, has shown that excellent control of a broad-spectrum of broadleaved weeds could be obtained by using a combination of Ro-Neet + Nortron applied as a fall-layered treatment followed with one or two postemergence treatments with Betamix. Therefore this treatment was used as the standard in the following experiments.

The experiments were initiated in the fall of 1988 and 1989 on two sites each year. One site was on the A.S.C. Research Farm and the other on the farm of a commercial producer, Oudman. Both sites were prepared in the traditional manner with moldboard plowing followed by levelling.
The soil analysis and other pertinent information is given below:

	A.S.C.	OUDMAN
Clay % (0 - 30 cm)	20	26
Silt % (0 - 30 cm)	26	40
Sand % (0 - 30 cm)	54	34
O.M. % (0 - 30 cm)	1.33	2.04
E. C. (0 - 30 cm)	5.86	1.69
pH (0 - 30 cm)	7.7	7.6

A modified Latin Square design with twenty-four treatments and twelve replications was used. The plots were 2 rows wide and 9.14 meters long, with rows 56 cm apart. Each row was trimmed to 7.62 meters. Below is a list of some of the treatments evaluated. With fall-layered treatments each herbicide was applied from a separate spray tank. Where two herbicides were applied to the same plot they were dispensed simultaneously from separate sprayers. When two herbicides were applied preemergence they were applied as a tank-mix. The first significant rainfall after the application of the preemergence treatments was 7 mm after 4 days, 9 mm after 6 days, 16 mm after 14 days, and 10 mm after 20 days for experiments 1, 2, 3, and 4 respectively.

Experimental Treatments:

Trt. No.	Herbicide	Formulation	Method of Appl'n	Rate of Appl'n kg/ha ai	Spray sol'n Litres/ha B.C.basis	Band Width cm
1.	Ro-Neet	E.C.	Fall-L	2.8	700	18
	Nortron	E.C.	Fall-L	2.3	675	18
	Betamix	E.C.	Post-E	0.375	500	18
2.	Nortron	E.C.	Fall-L	3.5	1030	18
	Betamix	E.C.	Post-E	0.375	500	18

3.	Nortron	E.C.	Pre-E	3.5	6150	10
	Betamix	E.C.	Post-E	0.375	500	18
4.	Pyramin	SU	Fall-L	2.25	520	18
	Nortron	E.C.	Fall-L	1.75	515	18
	Betamix	E.C.	Post-E	0.375	500	18
5.	Pyramin	SU	Pre-E	2.25	6150	10
	Nortron	E.C.	Pre-E	1.75	tm *	10
	Betamix	E.C.	Post-E	0.375	500	18

* - tank-mix

The weed counts included all living weeds present and did not distinguish apparently healthy weeds from those displaying varying degrees of stunting caused by the herbicide treatments. The weed data was obtained from the 6.5 cm wide uncultivated portion of each of the two rows. The weed score was taken late in summer and represents overall visual weed control. A score of 9 represents complete absence of weeds. A score of 7 is deemed the minimum level of weed control that would be considered commercially acceptable.

Results:

The summarized results of four selected treatments included in the four experiments are given in table 4. Weeds number is reported per 2 sq m. This is equivalent to weeds per 100 feet of row. On the average there was not much difference between one or two Betamix treatments when these followed a soil applied herbicide, so these are averaged for this summary.

Table 4. Summary of results from selected treatments from 1989 and 1990 experiments at A.S.C. and Oudman.

Expt.	Precip.	Weeds/2 sq m June**		Weed score September		Sugar yield*	
		PPF-L	Pre	PPF-L	Pre	PPF-L	Pre
	delay & amount						
Nortron @ 3.5 kg/ha plus Betamix							
1.	4 days, 7 mm	8	2	8.5	8.4	100	105
2.	6 days, 9 mm	3	2	8.5	8.8	105	107
3.	14 days, 16 mm	1	8	8.9	8.7	102	107
4.	20 days, 10 mm	44	36	8.7	7.8	102	99
Nortron @ 1.75 + Pyramin @ 2.25 kg/ha plus Betamix							
1.	4 days, 7 mm	6	5	7.8	7.8	97	102
2.	6 days, 9 mm	7	1	8.1	8.7	111	111
3.	14 days, 16 mm	2	11	8.9	8.9	109	112
4.	20 days, 10 mm	33	69	8.1	8.0	99	98

* in % of PPF-L Nortron + Ro-Neet plus Betamix

** number of weeds in poorest treatment included in each of the respective experiments were: 82 in Expt. 1; 28 in Expt. 2; 51 in Expt 3; and 98 in Expt. 4.

Effect on weed control and sugar yield: When the preemergence Nortron or the mix of Nortron + Pyramin received a sequential postemergence Betamix, the overall weed control and sugar yield were comparable to similar sequential treatments using fall-layered treatments. The relative performance of PPF-L and preemergence treatments remained consistent even when rainfall was delayed up to 20 days after the application of the preemergence herbicides.

CONCLUSION

1. A moist surface soil at time of application or precipitation soon after application was required for satisfactory weed control from preemergence herbicides used alone.

2. When a preemergence application of Nortron, Pyramin, or a tank-mix of Nortron plus Pyramin were followed with postemergence Betamix excellent overall control of a broad-spectrum of broad-leaf weeds was obtained even when precipitation was delayed up to 3 weeks.