Effectiveness of PEBC, DATC, and Endothall for Controlling Weeds in Sugar Beets in Western Nebraska[1]

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Introduction

One of the first selective herbicides used on sugar beets was a concentrated salt solution by Bakke (3)[3] in 1947; since then many chemicals have been tried to selectively remove weeds from sugar beets (4,9,11). Dalapon (2,2-dichloropropronic acid) has been consistently effective in the control of annual grasses in sugar beets while 3,6-endoxohexahydrophthalic acid (endothall) and trichloroacetic acid (TCA) have given variable control on annual grasses and broadleaf weeds (1,4). Propyl ethyl-n-butyl-thiolcarbamate (PEBC) has given acceptable weed control in California, Colorado, Wyoming and Montana (2,5,8). Another chemical 2,3-dichloroallyl diisopropylthiolcarbamate (DATC) has proven to be an excellent herbicide for wild oat control (9).

Experiments were initiated in western Nebraska at Hershey, Mitchell, and North Platte, Nebraska, to determine suitable herbicides for controlling weeds in sugar beets.

Material and Methods

In 1961, endothal at 2, 4, 6, and 8 lb/A, PEBC at 2, 4, and 8 lb/A tert-butyl di-n-propylthiolcarbamate (R-1856) at 2.5, 5.0, and 10.0 lb/A, and DATC at 1, 2, and 4 lb/A were applied preplant as broadcast treatments and immediately incorporated on April 12 and 13, April 14 and 15, and April 25 at Mitchell, Hershey, and North Platte, Nebraska, respectively. Sugar beets were planted April 13, 15, and 26 at these particular locations. In 1962, endothall at 2, 4, and 8 lb/A, PEBC at 2, 4, and 8 lb/A and DATC at 1, 2, and 4 lb/A were applied preplant and soil incorporated as broadcast treatments April 12 and 13 at Mitchell, and April 31 and May 1 at North Platte. Sugar beets were planted April 13 and May 4 at the respective locations. Incorporation to a depth of 2 to 3 inches was accomplished within one minute after spraying in 1961, and within five minutes after spraying in 1962, by a power-driven rotary tiller mounted on a Gravely garden tractor.

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[3] Numbers in parentheses refer to literature cited.

Endothall was applied preemergence in 1961 at rates of 2, 4, and 8 lb/A April 13, 19, and 27, respectively, at Mitchell, Hershey, and North Platte. In addition endothall was applied postemergence 26, 44, and 33 days after planting at the respective locations. Sugar beets were in the 4- to 6-leaf stage at the time of the postemergence spraying.

Handweeding at weekly intervals and check (no weed control) were used as treatments in 1961 and 1962. Weeds were removed from the no weed control plots following weed harvest. In 1961 the cultural practice of the cooperating farmer was included as a treatment. The farmer's operations at Mitchell included two cultivations; at Hershey endothall was applied and soil incorporated in a band ahead of the planter and the sugar beets were cultivated five times. The North Platte location included preplant and soil incorporated application of endothall and two cultivations. The farmer's practices at the three locations were handweeded and thinned by Mexican laborers.

A randomized block design with four replications was used at each location in 1961 and a split-plot design with five replications was used at each location in 1962. In the split-plot design, one-half of each main plot received the first cultivation at the time the surrounding field was cultivated and the other half received all cultivations except the first. The plots that received the first cultivation are referred to as normal, the others are called delayed. The farmer's treatments in 1961 were composed of three strips six rows wide, one on each side and one down the middle of the experimental area. Plots to be included in the experiment were selected at random from the strips.

In 1961, visual notes were taken 43, 47, and 38 days after planting at Mitchell, Hershey, and North Platte, respectively. In 1962, counts were taken from two permanently marked areas, 1 ft by 9 ft, directly over the sugar beet row, 36 and 53 days after planting at Mitchell and 36 days after at North Platte. Also an area .5 ft by 18 ft (9 sq ft) was counted over the row at Mitchell 68 days after planting. The latter count occurred 5 days after beets were thinned once by mechanical thinner. A dry seedbed prevented sugar beet seed germination so they were irrigated the first week of May at Mitchell. Rain on May 13 was sufficient for sugar beet seed germination at North Platte.

Weed yields were obtained in 1961 and 1962 by harvesting above ground portions from 6.5, 9, and 18 square feet. Weed harvest occurred 69, 65, and 58 days after planting, respectively, at Mitchell, Hershey and North Platte in 1961. The 1962 harvest occurred 83 and 59 to 60 days after planting, respectively, at Mitchell and North Platte. Weeds were separated as to grasses

and broadleaf weeds in 1961, and in 1962 they were seperated by species at weed harvest. Weeds were oven-dried and reported as pounds per acre. A transformation of log $(x + 1)$ was used on weed counts and weed weights. The data were analyzed and expressed as geometric means. In 1962 weeds were harvested only from the delayed cultivated plots. All plots were weeded following weed harvest and kept weed-free the rest of the season. The normal cultivated plots were weeded at the time of the first cultivation.

In 1961 plots were located on the following soil types: Bridgeport loam at North Platte and Mitchell, and Bridgeport sandy clay loam at Hershey. The 1962 plots were located on the following soil types: Bridgeport loam at Mitchell, and Hall loam at North Platte.

Results

Climatology

The soil temperature (depth—three inches) at the time of application and incorporation of the preplant treatments in 1961 was 45°F at Mitchell, 49-61°F at Hershey, and 54-58°F at North Platte. The soil temperature in 1962 at the time of application and incorporation of the preplant treatments was 44-56° F at Mitchell and 46-58°F at North Platte.

The soil moisture in the top three inches of the soil at the time preplant treatments were made in 1961 was 17.4% at Mitchell, 17.9% at Hershey, and 19.7% at North Platte. The soil moisture in 1962 at the time of the preplant treatments was 12.2% at Mitchell and 9.8% at North Platte.

Table 1.—Accumulative precipitation in inches for 42 days following planting of sugar beets at experimental locations in 1961 and 1962.

Number of days after planting	1961			1962	
	Mitchell	Hershey	North Platte	Mitchell	North Platte
1	0.17	0.00	0.08	0.00	0.00
2	0.17	0.00	0.08	0.00	0.00
3	0.17	0.00	0.08	0.00	0.00
4	0.17	0.00	0.68	0.00	0.00
5	0.17	0.00	0.68	0.00	0.00
6	0.17	0.00	1.48	0.00	0.00
7	0.17	0.00	1.50	0.00	0.00
8	0.17	0.00	1.50	0.00	0.00
9	0.17	0.00	1.99	0.00	1.09
10	0.17	0.00	2.20	0.00	1.09
11	0.17	0.00	2.21	0.00	2.35
12	0.17	0.05	2.43	0.00	3.95
13	0.17	0.05	2.43	0.00	4.12
14	0.32	0.05	2.43	0.00	4.12
21	0.57	2.22	4.43	0.00	4.48
28	0.66	2.47	5.43	0.01	8.33
35	3.74	5.09	6.35	1.62	10.88
42	5.04	5.79	6.79	3.88	11.47

The average minimum and maximum air temperatures for one and two weeks after planting, respectively, in 1961 were 28-58°F and 31-61°F at Mitchell, 33-65°F and 34-63°F at Hershey, and 34-58°F and 40-56°F at North Platte. The average minimum and maximum air temperatures in 1962 for one and two weeks after planting, respectively, were 37-75°F and 41-74°F at Mitchell and 54-88°F and 53-78°F at North Platte.

The precipitation data, from planting to 42 days later, are presented in Table 1 for 1961 and 1962.

Effect on prethinning sugar beet stands

In 1961 PEBC at 4 and 8 lb/A reduced sugar beet stands below the check by 20 and 39%. DATC at 2 and 4 lb/A reduced stands by 17 and 33%. Stand losses on plots treated with R-1856 at 5 and 10 lb/A were 5 and 11%. Endothall applied preplant at 4 and 8 lb/A reduced stands by 5 and 17%; all methods of application were about the same. In 1962 plots treated with PEBC at 4 and 8 lb/A lost 19 and 52% of the pre-thinning stand, DATC at 2 and 4 lb/A lost 11 and 27% and stand loss on the endothall at 8 lb/A plots was 10%.

Annual grass control

The annual grasses in 1961 and 1962 were predominately *Setaria* spp. Visual ratings taken in 1961 are shown in Table 2. Visual control with PEBC at the three locations ranged from 75 to 94% with 2 lb/A, 95 to 100% with 4 lb/A, and 100% with 8 lb/A. Percent control with DATC ranged from 32 to 82% with 1 lb/A, 65 to 95% for 2 lb/A, and 98 to 100% for 4 lb/A. Control obtained with R-1856 was as follows: 35 to 68% with 2.5 lb/A, 72 to 99% with 5.0 lb/A, and 92 to 98% for 10.0 lb/A.

Visual control with endothall applied preplant was as follows: 0 to 92% for 2 lb/A, 15 to 98% for 4 lb/A, 28 to 98% for 6 lb/A, and 22 to 100% for 8 lb/A. Results at Mitchell were excellent, at Hershey control was fair; at North Platte, it was poor.

Control with endothall applied preemergence ranged from 0 to 58% for 2 lb/A, 15 to 74% for 4 lb/A, and 70 to 88% for 8 lb/A. There was little difference between control at Mitchell and Hershey, at North Platte it was poor, excluding the 8 lb/A rate.

The postemergence treatment of endothall gave control of 5 to 55% at 2 lb/A, 48 to 80% for 4 lb/A, and 70 to 98% for 8 lb/A. Except for the low rates at North Platte, control was about the same for the three locations.

The grass yields at the three locations (Table 2) showed that several treatments compared favorably to handweeding at week-

Table 2.—The effect of various herbicides on annual grasses as measured by visual estimations and oven dry weights at Mitchell, Hershey, and North Platte, Nebraska in 1961.

Treatments	lb/A	Visual estimations Percent of check				Oven-dry weed yields in lb/A			
		43[1] Mit.	47 Her.	38 N.P.	Loc. mean	69[1] Mitchell	65 Hershey	58 North Platte	Loc. mean
Handweed	—	100	100	100	100	22 fghi	0 k	35 efg	13 fg
Check	—	0	5	5	3	414 a	316 a[2]	438 ab	381 a
Farmer's pract.	—	0	82	0	27	2 j	12 gh	309 abc	28 ef
Preplant soil incorporated									
PEBC	2	82	95	75	84	38 defg	4 hijk	114 bcdef	31 ef
PEBC	4	95	99	100	98	14 ghij	11 ghij	17 gh	14 fg
PEBC	8	100	100	100	100	6 ij	1 jk	0 i	2 h
R-1856	2.5	60	68	35	54	29 fgh	54 bcdef	60 defg	46 e
R-1856	5.0	95	99	72	89	4 ij	23 fg	62 defg	21 f
R-1856	10.0	92	98	92	94	2 j	9 ghij	4 hi	5 gh
DATC	1	82	68	32	61	27 fgh	32 defg	135 abcde	49 de
DATC	2	65	95	95	85	11 ghij	12 ghi	14 gh	12 fg
DATC	4	100	100	98	99	2 j	0 k	27 fgh	5 gh
Endothall	2	92	52	0	48	163 abc	135 abc	390 abc	202 ab
Endothall	4	98	50	15	54	163 abc	158 ab	372 abc	212 ab
Endothall	6	98	55	28	60	105 bcde	96 bcd	449 ab	167 b
Endothall	8	100	58	22	60	114 bcde	87 bcde	302 abc	145 b
Preemergence									
Endothall	2	58	50	0	36	135 abcd	79 bcde	504 a	175 b
Endothall	4	74	65	15	51	188 abc	59 bcdef	244 abcd	142 b
Endothall	8	88	72	70	77	250 ab	49 cdef	111 bcdef	111 bc
Postemergence									
Endothall	2	55	52	5	37	138 abcd	32 defg	217 abcd	101 bcd
Endothall	4	80	74	48	67	59 cdef	24 fg	106 bcdef	53 cde
Endothall	8	98	98	70	89	14 ghij	9 ghij	94 cdef	25 ef

[1] Number of days after planting.

[2] Numbers followed by the same letter do not differ significantly at the 5 percent level using Duncan's multiple range tests.

ly intervals. These were: 2, 4, and 8 lb/A of PEBC, 5.0 and 10.0 lb/A of R-1856, 2 and 4 lb/A of DATC, and postemergence treatment of endothall at 8 lb/A.

Grass counts and yields for 1962 are presented in Table 3. Counts 36 days after planting at Mitchell show that there was no significant reduction in the number of annual grasses by PEBC and DATC treatments. Counts taken 53 days after planting showed significantly fewer plants on the DATC at 2 and 4 lb/A and 2, 4, and 8 lb/A of PEBC than on the check. Grass yields on the DATC and PEBC treatments were equal to or lower than the handweed treatment.

At North Platte when counts were taken 36 days after planting PEBC and DATC had eliminated significantly more annual grasses than the check. Control was still effective 60 days after planting.

Results with endothall were outstanding from the first reading at Mitchell, but by the second reading there was an increase in plant number so that there was no significant difference between endothall treatments and the check. The North Platte counts show no difference between check and any endothall treatment. There was no significant difference between check and endothall treatments in the grass yields harvested 83 to 60 days after planting at Mitchell and North Platte, respectively.

Grass yields for locations show that all rates of DATC and PEBC were similar to the handweed treatment. There was a highly significant location $\times$ treatment interaction caused by better performance of endothall at Mitchell.

Broadleaf weed control

Principle broadleaf species in 1961 were: kochia (*Kochia scoparia* L.) and rough pigweed (*Amaranthus retroflexus* L.). Kochia was predominate at Mitchell and North Platte, and rough pigweed at Hershey. In 1962, kochia and rough pigweed were the predominate broadleaf weeds at Mitchell and North Platte. Seedling alfalfa was present in sufficient quantity to count. Black nightshade (*Solanum nigraum* L.) was present at the North Platte site.

Visual ratings were taken in 1961 and results are shown in Table 4. PEBC at 2 lb/A controlled 30 to 95%, 4 lb/A controlled 88 to 98%, and 8 lb/A controlled 92 to 100%. Control with R-1856 ranged from 0 to 18% for 2.5 lb/A, 0 to 62% for 5.0, and 25 and 81% for 10 lb/A. Control for DATC ranged from 0 to 45% for 1 lb/A, 20 to 65% for 2 lb/A, and 52 to 94% for 4 lb/A. Only PEBC at 8 lb/A was equal to hand-weeding at weekly intervals for broadleaf weed control.

Table 3.—The effect of various herbicides on annual grasses as measured by plant counts and oven-dry weights at Mitchell, and North Platte, Nebraska in 1962.

	Rate:	Mitchell		No. Platte	Mitchell[1]			North Platte[1]		lb/A
		Plants per 18 sq ft (12" wide)			Number (6" wide)		lb/A	Number	lb/A	Loc.
	lb/A	36 da.	53 da.	36 da.	Normal	Delayed	Delayed	Delayed	Delayed	mean
Check	—	21 a[2]	46 a	194 a	13 a	26 a	290 a	116 a	368 a	326 a
Handweed	—	21 a	7 f	92 ab	3 bcd	11 abc	35 cde	0 c	0 d	11 bcd
Endothall	2	5 b	34 ab	147 a	10 ab	18 ab	121 abc	68 a	477 a	239 a
Endothall	4	1 c	44 a	119 ab	12 a	23 ab	143 ab	71 a	297 a	207 a
Endothall	8	1 c	32 abc	150 a	12 a	18 ab	96 abc	92 a	245 a	155 a
DATC	1	22 a	29 abc	61 bc	7 abc	10 abc	74 bcd	18 b	12 bcd	33 b
DATC	2	21 a	20 bcd	65 bc	1 de	4 cd	33 cde	6 b	7 bcd	17 bc
DATC	4	11 ab	12 def	21 de	0 e	33 cd	15 def	7 b	4 cd	1 cd
PEBC	2	12 ab	20 bcd	40 cd	2 cde	8 bcd	33 cde	11 b	27 b	29 bc
PEBC	4	8 ab	18 cde	39 cd	2 cde	5 cd	7 ef	8 b	18 bc	12 bcd
PEBC	8	8 ab	10 ef	16 e	1 de	2 d	1 f	1 c	0 d	0 d

[1] A nine square foot area was harvested, counted and over-dried 83 days after planting at Mitchell and 60 days after at North Platte for the delayed cultivation. Normal was counted 68 days after planting.

[2] Numbers followed by the same letter do not differ significantly at the 5 percent level using Duncan's multiple range tests.

Table 4.—The effect of various herbicides on broadleaf weeds as measured by visual estimations and oven-dry weights at Mitchell, Hershey, and North Platte, Nebraska, in 1961.

Treatments	Rate: lb/A	Visual estimations Percent of check				Oven-dried weed yields lb/A			
		43[1] Mit.	47 Her.	38 N. P.	Loc. mean	69[1] Mitchell	65 Hershey	58 No. Platte	Loc. mean
Handweed	—	100	100	100	100	18 d[2]	0 f	32 d	12 d
Check	—	0	0	0	0	297 abc	175 a	748 a	339 a
Farmer's pract.	—	0	70	0	23	0 e	9 ef	81 bcd	13 d
Preplant soil incorporated									
PEBC	2	30	95	38	54	281 abc	30 bcde	193 abcd	120 ab
PEBC	4	88	89	88	88	94 abc	29 bcde	541 ab	117 ab
PEBC	8	99	100	92	97	79 bcd	8 ef	39 cd	32 cd
R-1856	2.5	18	12	0	10	390 a	117 ab	275 abc	233 a
R-1856	5.0	0	62	5	22	324 ab	129 ab	381 ab	250 a
R-1856	10.0	68	81	25	58	160 abc	68 abcd	59 ab	193 a
DATC	1	32	45	0	26	111 abc	33 bcde	731 a	142 ab
DATC	2	20	65	42	42	175 abc	59 abcd	880 a	212 a
DATC	4	90	94	52	79	20 d	42 abcde	152 abcd	52 bc
Endothall	2	91	48	0	46	142 abc	81 abcd	541 ab	184 a
Endothall	4	98	42	12	51	67 cd	94 abc	316 abc	126 ab
Endothall	6	100	50	18	56	156 abc	67 abcd	295 abc	145 ab
Endothall	8	98	50	38	59	145 abc	53 abcd	364 ab	142 ab
Preemergence									
Endothall	2	49	32	10	30	309 ab	99 ab	516 ab	250 a
Endothall	4	72	48	8	43	142 abc	70 abcd	528 ab	175 a
Endothall	8	90	48	40	59	175 abc	126 ab	275 abc	180 a
Postemergence									
Endothall	2	10	45	0	18	180 abc	38 bcde	171 abcd	106 ab
Endothall	4	60	58	0	39	347 a	19 de	766 a	180 a
Endothall	8	69	92	12	58	167 abc	20 cde	880 a	148 ab

[1] Number of days after planting.

[2] Numbers followed by the same letter do not differ significantly at the 5 percent level using Duncan's multiple range tests.

Endothall applied preplant and soil incorporated, controlled 0 to 91% for 2 lb/A, 12 to 98% for 4 lb/A, 18 to 100% for 6 lb/A, and 38 to 98% for 8 lb/A. Preemergence applications of endothall controlled 10 to 49% for 2 lb/A, 8 to 72% for 4 lb/A, and 40 to 90% for 8 lb/A. Postemergence applications of endothall controlled 0 to 45% for 2 lb/A, 0 to 60% for 4 lb/A, and 12 to 92% for 8 lb/A. The preplant soil incorporated and the preemergence method of applying endothall performed best at Mitchell but the postemergence treatment was best at Hershey. The weed yields show that the only striking results with endothall were with the postemergence treatments at Hershey.

Table 5 shows the data taken on rough pigweed at Mitchell and North Platte in 1962. PEBC was more effective by the second counting and all rates were significantly better than any other treatment. The two areas counted over the row at Mitchell 53 and 68 days after planting responded similarly. The North Platte counts showed PEBC to be the outstanding herbicide for control of rough pigweed. Weed yields were comparable to the handweed treatment at both locations. PEBC at 4 and 8 lb/A were superior to handweeding at weekly intervals measured by Duncan's multiple range tests on location means.

Counts and weed weights taken at both locations indicate that DATC was ineffective in controlling rough pigweed.

Endothall at 8 lb/A was very effective in controlling rough pigweed at the first observation at Mitchell. There was no significant difference by the second reading between the check and the endothall treatments on the 12-inch wide area over the row. There was a significant difference between the check and endothall treatments on the 6-inch wide area. Weed yields on the 4 lb/A plots were significantly less than the check. The endothall treatments at North Platte were not significantly different than the check at any time. Most of the highly significant location $\times$ treatment interaction was caused by better endothall performance at Mitchell.

Table 6 shows the data taken on kochia at Mitchell and North Platte in 1962. PEBC and DATC did not control kochia at either location. Endothall gave good control of kochia at Mitchell as indicated by the first weed counts, and by the counts and weed weights 83 days after planting. The second reading did not appear as good as the first or that taken 15 days later on the 6-inch area. Control of kochia at North Platte with endothall was poor, although there was a significant reduction in weed weights but none for counts. Again the highly significant location $\times$ treatment interaction was due to better endothall performance at Mitchell.

Table 5.—Effect of various herbicides on rough pigweed as measured by plant counts and oven-dry weights at Mitchell and North Platte, Nebraska in 1962.

	Rate:	Mitchell		No. Platte	Mitchell[1]			North Platte[1]		lb/A
		Plants per 18 sq ft (12" wide)			Number (6" wide)		lb/A	Number	lb/A	Loc.
	lb/A	36 da.	53 da.	36 da.	Normal	Delayed	Delayed	Delayed	Delayed	mean
Check	—	147 ab[2]	92 a	218 a	27 a	44 ab	1600 ab	75 ab	663 ab	1030 a
Handweed	—	177 a	16 bc	134 ab	3 def	13 cd	203 de	0 d	0 c	37 c
Endothall	2	53 abc	46 ab	239 a	6 bcd	19 bc	587 abcd	50 b	940 a	745 a
Endothall	4	33 abcd	48 ab	137 ab	8 bcd	21 bc	437 cd	75 ab	985 a	663 a
Endothall	8	7 d	42 ab	198 a	4 cde	21 bc	523 bcd	77 ab	1210 a	799 a
DATC	1	90 abc	58 a	262 a	17 ab	53 a	1760 a	114 ab	679 ab	1100 a
DATC	2	144 ab	59 a	250 a	17 ab	40 ab	1238 abc	134 a	1240 a	1240 a
DATC	4	77 abc	42 ab	140 ab	12 abc	29 abc	1400 ab	109 ab	663 ab	962 a
PEBC	2	22 bcd	13 cd	61 bc	0 f	7 de	85 e	17 c	257 b	150 b
PEBC	4	21 cd	6 cd	38 c	1 ef	3 ef	0 f	1 d	12 c	6 d
PEBC	8	31 abcd	5 d	9 d	0 f	1 f	11 f	0 d	0 c	4 d

[1] A nine square foot area was harvested, counted and oven-dried 83 days after planting at Mitchell and 60 days after at North Platte for the delayed cultivation. Normal was counted 68 days after planting.

[2] Numbers followed by the same letter do not differ significantly at the 5 percent level using Duncan's multiple range tests.

Table 6.—Effect of various herbicides on kochia as measured by plant counts and oven-dry weights at Mitchell and North Platte, Nebraska in 1962.

	Rate: lb/A	Mitchell Plants per 18 sq ft (12" wide) 36 da.	Mitchell 53 da.	No. Platte 36 da.	Mitchell[1] Number (6" wide) Normal	Mitchell[1] Delayed	Mitchell[1] lb A Delayed	North Platte[1] Number Delayed	North Platte[1] lb/A Delayed	lb A Loc. mean
Check	—	194 ab[2]	140 ab	104 a	40 a	32 a	1460 a	90 abc	2670 a	1970 a
Handweed	—	190 ab	8 d	64 a	0 c	2 d	14 d	0 d	0 c	5 d
Endothall	2	80 bc	61 bc	80 a	4 b	11 bc	312 b	34 c	940 b	537 b
Endothall	4	42 c	55 bc	47 a	3 b	12 b	326 b	40 c	780 b	512 b
Endothall	8	7 d	25 c	94 a	4 b	4 cd	68 c	45 bc	762 b	234 c
DATC	1	131 ab	86 ab	92 a	18 a	49 a	2490 a	82 bc	1890 a	2170 a
DATC	2	218 ab	122 ab	116 a	31 a	43 a	1800 a	64 bc	1980 a	1890 a
DATC	4	154 ab	122 ab	104 a	24 a	44 a	2020 a	92 abc	1930 a	1980 a
PEBC	2	128 ab	88 ab	75 a	31 a	54 a	2800 a	71 bc	2490 a	2610 a
PEBC	4	131 ab	111 ab	147 a	18 a	34 a	1530 a	114 ab	3000 a	2170 a
PEBC	8	233 a	151 a	161 a	34 a	46 a	2020 a	244 a	2930 a	2430 a

[1] A nine square foot area was harvested, counted and oven-dried 83 days after planting at Mitchell and 60 days after at North Platte for the delayed cultivation. Normal was counted 68 days after planting.

[2] Numbers followed by the same letter do not differ significantly at the 5 percent level using Duncan's multiple range tests.

Table 7.—Effect of various herbicides on seedling alfalfa and black nightshade as measured by plant counts at Mitchell and North Platte, Nebraska in 1962.

	Rate: lb/A	Alfalfa			black nightshade
		Plants per 18 sq ft			
		Mitchell		North Platte	North Platte
		36 days	53 days	36 days	36 days
Check	—	15 a[1]	19 a	25 a	61 a
Handweed	—	15 a	2 bc	12 abc	53 a
Endothall	2	1 b	3 bc	11 abc	70 a
Endothall	4	0 b	1 c	7 c	25 a
Endothall	8	0 b	1 c	7 c	45 a
DATC	1	12 a	7 ab	22 a	25 a
DATC	2	16 a	19 a	26 a	44 a
DATC	4	10 a	14 a	16 abc	14 a
PEBC	2	12 a	16 a	18 ab	45 a
PEBC	4	8 a	15 a	13 abc	54 a
PEBC	8	12 a	14 a	9 bc	6 a

[1]Numbers followed by the same letter do not differ significantly at the 5 percent level using Duncan's multiple range tests.

Seedling alfalfa counts are presented in Table 7 for both locations. The endothall treatments at Mitchell eliminated the alfalfa. The alfalfa was not affected by DATC and PEBC. Endothall treatments at North Platte killed many seedling alfalfa. Number of alfalfa on the 4 and 8 lb/A rates was significantly less than the check. DATC at 4 lb/A and the PEBC treatments reduced alfalfa stands, but 8 lb/A of PEBC was the only treatment that was significantly less than the check.

Counts taken on black nightshade at North Platte are given in Table 7. No significant difference was noted between treatments.

Discussion

Endothall's poor performance is related to the rainfall pattern, as amount of rainfall increases results become poorer. In 1961 it was 30 days after planting before an inch of rain was received at Mitchell. Weed notes were taken 43 days after planting. At Hershey it was 17 days after planting before an inch of rain was received; visual notes were taken 47 days after planting. At North Platte it was 5 days after planting before an inch of rain fell; visual notes were taken 38 days after planting. It is presumed that endothall was leached or had dissipated from the upper surface of the soil after an inch of rain. Comes *et al.* (6) have found that endothall was leached to a depth of three inches in sandy loam, sandy clay loam and clay loam soils with two inches of water. Endothall dissipated quicker in the sandy loam

and sandy clay loam than the clay loam soil. They also found that temperature influenced the breakdown of endothall. Extended temperatures of 68°F and above hastened dissipation. Other workers (4,10) have reported poor control with endothall.

There was little difference between the preplant and the preemergence applications of endothall in weed yields, although there was some advantage in the preplant treatment by visual observations. Possibly weed yields were taken too late to show this difference. The postemergence treatment response was variable. At Hershey control was much better than at Mitchell and North Platte. This is probably due to differences in weed species present and stage of development at time of spraying.

In 1962 it was 34 and 9 days after planting before an inch of rain was received at Mitchell and North Platte. Apparently, the rain at North Platte leached endothall below the zone of germinating weeds so few weeds were killed. Furrow irrigation at Mitchell was early enough to germinate most weeds. The weeds were killed before the rain leached the endothall too deep. This would account for the significant location $\times$ treatment interaction.

The furrows that were made for irrigation caused differences in control which were noticeable in the endothall treatments. This is indicated by a significant difference in broadleaf weed counts between the endothall treatments and the check on the 6-inch strip but not on the 12-inch strip. The 12-inch strip included a portion of the soil moved from the furrow. It is assumed that the endothall was either moved closer to the row or had dissipated from the furrow edges.

PEBC was effective in controlling grasses and rough pigweed in both years at all locations under extremely variable climatic conditions. It did not control kochia or nightshade. Kochia has been reported to have been controlled by PEBC (7). Either the kochia in western Nebraska is resistant to PEBC or conditions existed that allowed the kochia to germinate and develop fast enough so that PEBC was ineffective. For example, the PEBC could have dissipated from the upper quarter inch of soil and the kochia germinated in this area. Then the small root grew through the treated area of PEBC. PEBC was much more effective on broadleaf weeds than R-1856.

DATC gave excellent control of annual grasses both years. Two year's data indicate that broadleaf weeds controlled with DATC is not adequate. This agrees with other research work (9,10).

Summary

1. In western Nebraska endothall, DATC, and PEBC were applied preplant and soil incorporated to a depth of 2 to 3 inches in 1961 and 1962; R-1856 was applied in a similar manner in 1961. Endothall was also applied preemergence and postemergence in 1961. Results from three locations in 1961 and two locations in 1962 are reported.
2. PEBC was the outstanding herbicide tried in this study, although it did not control kochia or black nightshade. The control of annual grasses and rough pigweed by PEBC was comparable to handweeding at weekly intervals.
3. DATC gave acceptable control of grass but not broadleaf weeds.
4. Endothall did not give consistant weed control under the conditions of this study.
5. PEBC, R-1856 and DATC were less affected by precipitation than endothall. Soil moistures between 9.8 and 19.7% at incorporation time had little affect on the control of annual grasses and rough pigweed obtained by PEBC in this study.

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