SOME EFFECTS OF SEVERAL PRE-EMERGENCE HERBICIDES ON HAIRY AND SMOOTH CRABGRASS AND THE CULTIVATED STRAWBERRY

by

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INTRODUCTION

A great amount of labor is required to control weeds in strawberries and other row crops. Since 1947 much attention has been given to the control of weeds by the use of chemicals. Carlson (5) was the first to show that 2,4-dichlorophenoxyacetic acid could be used effectively to control weeds in strawberries under certain conditions.

Since the first experiments with 2,4-D sprays for weed control in strawberries, many new herbicides have been developed and proven, while many others are still in the experimental phase.

A herbicide used in strawberry plantings must control certain weed species and also not have a detrimental effect on the strawberry plants under varying climatic conditions.

Irrigation has been widely utilized in recent years in strawberry production in Kansas. Consequently some weed pests have increased in importance. Hairy crabgrass, (Digitaria sanguinalis) has become a most serious problem in irrigated strawberry plantings. The growth of smooth crabgrass, (Digitaria ischaemum) also is encouraged by irrigation.

This study was undertaken to test certain herbicides in order to determine (1) their effectiveness as pre-emergence herbicides in controlling crabgrass in established strawberry plantings, (2) their comparitive effectiveness in the control of smooth and hairy crabgrass and (3) their effect on the growth and vigor of the strawberry plants.

METHODS AND MATERIALS

Pre-emergence Field Tests

On June 3, 1956 a two year old planting of the Blakemore strawberry

variety was completely renovated. In 1955 this planting had been heavily infested with hairy crabgrass, which had been permitted to reseed. Renovation was accomplished by cultivating with a three-foot rototiller to a depth of six inches. The original plant rows had been set four feet apart. After renovation each matted row was reduced to a width of 12 inches. Chemical treatments were made to the plant row and a three-foot renovated area adjacent to the row. All materials were applied as pre-emergence sprays to test their effectiveness in the control of common crabgrass.

Five herbicides were applied each to treatment blocks (Plate II) consisting of four 25 foot replications. Each replication was subdivided into three subplots of eight feet four inches each.

On June 25, the first chemical applications were made to each entire replication. This application was made 22 days after renovation and included the following treatments: 1-N-butyl-3-(3,4-dichlorophenyl) 1-methylurea (neburon) at four pounds per acre, granular 2,4-dichlorophenoxyethanol (ACP-M85) at two pounds per acre, sodium 2,4-dichlorophenoxyethyl sulfate (sesone) at three pounds per acre, triethanolamine salt of 2,4-D at one pound per acre, 2,4-dichlorophenoxyacetamide (Emid) at two pounds per acre and the untreated check. All rates given are expressed in the amount of active ingredient of each chemical used.

Liberal applications of water by irrigation were made to all the strawberry plantings as needed, thus insuring ideal conditions for the germination and growth of crabgrass.

The treatments were applied with a 3-gallon compressed air type sprayer. The granular M-85 was applied with a small lawn type fertilizer spreader, using 10 pounds of light sand as a diluent for the chemical added to each 25 foot replication.

Three applications were made during the summer. The dates of those applications were June 25, July 16, and August 23, 1956. The first application covered each entire treatment block, the second, two-thirds of the subplots, and the third, one-third of the subplots. This was done to test for any possible post-emergence qualities of the herbicide and also to measure the residual properties of each material.

Approximately one month after each spraying, counts were taken in each subplot of each replication. All crabgrass plants within an area four feet square selected equidistant from the ends and sides of each subplot were counted.

Pre-emergence Greenhouse Tests

This phase of the study was conducted in a greenhouse to compare the effects of some herbicides on germinating seeds of hairy and smooth crabgrass. One hundred seeds each of hairy and smooth crabgrass were planted in six inch pots. The crabgrass seed had been collected in 1955 and stored at 44°F. To prevent the moving of seeds in the pots during watering, a piece of cheesecloth six inches in diameter was placed over the soil.

Five chemical treatments each were applied to four single pot replications. For each species the following materials were applied to the pots prior to germination: sesone at the rate of three pounds per acre, Endid at the rate of two pounds per acre, neburon at the rate of four pounds per acre, N-1-Naphthyl phthalamic acid (Alanap 1) at the rate of three pounds per acre and the untreated check. The materials mixed in water were spread uniformly over the surfaces of the pots with a pipette. These materials were applied to pots on each June 25, July 17, and August 2, 1956. In the tests initiated on August 2, tris (2,4-dichlorophenoxyethyl) phosphite (3T9) was included at

the rate of two pounds per acre. All pots were watered regularly and temperature data was recorded. Counts were taken 18 days after treatments were made.

The method of statistical analysis used in both the field test and the greenhouse pre-emergence tests, was the square root transformation method (Snedecor, 54). This involved using the square root of the original count plus one instead of the original count figure. Counts of zero could be worked into the analysis to show their relationship and significance when this method was used.

Greenhouse Treated Strawberry Plant Tests

A study was made to determine the effect of some promising herbicides on strawberry plants. Forty-eight Blakemore strawberry plants were planted in the greenhouse in six inch pots on February 14, 1957. Eighteen days later on March 4, these pots were arranged in eight blocks of six pots each and the following materials were applied: neburon at the rate of four pounds per acre, sesone at the rate of three pounds per acre, Alanap 1 at the rate of three pounds per acre, 3Y9 at the rate of two pounds per acre, Emid at the rate of two pounds per acre, granular M-83 at the rate of two pounds per acre and 2,4-D amine at the rate of one pound per acre, and the untreated check. With the exception of M-83 all materials were mixed in water and applied with a pipette to the strawberry plant and soil. The granular M-83 was applied with sand as a spreader over both the foliage and the soil. All pots were watered regularly. Temperature recordings were kept and observations made daily.

REVIEW OF LITERATURE

Carlson (5) stated that 2,4-D amine applied to strawberry plants at the

rate of two pounds per acre caused young roots to swell double their normal size. These sprays caused plants to become severely stunted three weeks later. By the end of the season all plants appeared fully recovered. Carlson also noted that 2,4-D inhibited flower production in strawberries.

Viehmeyer (37) showed that strawberry varieties differ in tolerance to 2,4-D amine and other formulations of 2,4-D. It was pointed out that these differences were not important at the rates necessary for weed control.

King (21) found that sesone, (formerly known as Experimental Herbicide 1, EH-1, Crag Herbicide 1 and SES) at three pounds per acre applied in a spray to cultivated soil killed germinating seed of crabgrass, purslane, carpet weed, lambquarter and ragweed. In tests of sterilized and unsterilized soil he reported that the conversion of the chemical to a highly active form is caused by soil microorganisms. Peabody, et al. (29) showed that sesone was effective under certain conditions. High soil moisture and high temperatures (24-30°C) were necessary for conversion to the active form. There was little or no herbicidal activity at low temperatures of 0°C.

Since sesone is primarily a pre-emergence herbicide, it is therefore necessary to first prepare the soil and spray the area prior to the germination of the weed seeds.

Kays and Keck (20) found that sesone applied at the rate of 8 and 10 pounds per acre gave 40 and 50.8 quarts of strawberries as compared to 50.2 quarts in the untreated check. Total number of rooted runner plants were reduced at both rates.

Campbell (4), in recent studies has shown that sesone at two and four pounds per acre applied in three applications during the summer significantly reduced the total number of runner plants produced, without reducing the yield.

In tests conducted by Denisen (10) sesone at the rate of four pounds per acre controlled 76 per cent of the annual grasses and broad leaved weeds. Denisen also showed that there was little difference in the weed control when sesone was applied at four, six and eight pound rates. Treatment of Robinson and Dunlap varieties with sesone at four pounds per acre gave no significant reduction in yields.

Carlson (7) and Childs (8) found that sesone will give the most effective control of weeds at three pounds per acre in sandy soils and at six pounds per acre in heavy soils. Carlson (7) stated that since sesone is not converted to active 2,4-D in dry soils, it will be most effective if applied following rain or irrigation.

Much work has been done with neburon in the past four years on different agronomic and horticultural crops (12, 19, 23).

Herron and Chaplin (19) treated Tennessee Beauty strawberry plants with neburon at two, four and eight pounds per acre. Spray application was made over a two foot band on rows four feet apart. Plants were set on April 14, 1956 and spray treatments were made on April 25, June 18 and August 9. The results were variable. As the rates of application increased, both weed control and plant injury resulted. At 8 pounds per acre, the plants were severely injured. At four pounds per acre some injury resulted and at the two pounds per acre rate, light chlorosis occurred.

Alanap is a trade name of a new group of growth regulating chemicals, first described by Hoffman and Smith in 1949. Alanap 1 has a formulation of N-1-naphthyl phthalamic acid and is wettable powder that is non-corrosive to spray equipment. Alanap 1 is also a germination toxicant. Under good conditions, this herbicide will give good weed control from 3 to 8 weeks when applied to freshly cultivated soil (13).

Denisen (11) found that Alanap 1 applied at six pounds per acre to spring planted strawberries, under dry conditions, gave poor weed control. In similar tests conducted later in the same season, excellent weed control was obtained, however, some damage to the leaves was noted.

Hemphill (17) reported that Alanap 1 was applied at the rate of four pounds per acre to squash, cucumbers, watermelons and cantaloupes. Application was made three days after planting. Weed counts taken one month after treatment indicated only 50 per cent control. Weeds were surpressed enough to allow the vegetable plants considerable growth. Normal yields resulted when compared to checks. The primary weeds were crabgrass, pigweed and foxtail.

Mohr (22) also tested the effects on Alanap 1 on cantaloupes. He used rates of four and eight pounds per acre on a sandy loam soil where crabgrass was the predominant weed. In the treated plots, Alanap 1 gave higher yields than check plots from which the weeds had been removed by hand.

Nylund (24) tested Alanap 1 for crabgrass control in bluegrass turf. In these tests, Alanap 1 was applied at four pounds per acre as a pre-emergence application to grass that had been cut to one and one half inches the day before. About one inch of irrigation water was applied one day later. In this test, crabgrass was reduced 75 per cent and only temporary discoloration to the bluegrass was observed.

Warren (38) applied Alanap 1 at eight pounds per acre in 60 gallons of water to lima beans one day after planting. Crabgrass was reduced from 60 to 70 per cent in counts made 25 days after treatment. Slight injury resulted to the lima beans, but this was found not to be significant.

Experimental herbicide 3Y9 has been field tested throughout the United States by numerous research workers (1, 12, 14, 31, 35). 3Y9 or tris (2,4-dichlorophenoxyethyl) phosphite, is a viscous non volatile liquid, which is

prepared as a two pound active gallon with the emulsifying agent included in the formulation. It was developed as a pre-emergence herbicide for the control of annual broadleaf weeds and grasses (14).

Sweet, et al. (35) applied 3Y9 at four pounds per acre in sweet corn trials and found that the control of crabgrass was not significantly better than the checks. In a comparison of post-emergence applications of the herbicides on sweet corn, Rice and Grigsby (31) obtained better crabgrass control with 3Y9 at the rate of two pounds per acre than with the standard application of DNBP on a sandy loam. They found that the improvement in crabgrass control was due to the residual effects rather than the initial kill.

Alban (1) applied 3Y9 at two pounds per acre as a pre-emergence treatment four days after planting to lima beans, and did not get satisfactory control of weeds, including crabgrass.

Hemphill (18) in tests conducted at Columbia Missouri used 3Y9 at six pounds per acre on the green bean variety Top Crop. Applications made one day after planting was found to give satisfactory weed control, but serious damage to the green beans occurred.

Denisen (12) applied 3Y9 at four pounds per acre to spring planted strawberries on July 19, 1956. As severe drought conditions prevailed during and following application, one-fourth inch of irrigation was applied. Denisen (12), found that excellent pigweed control was obtained and 70 per cent control of purslane resulted. Grasses were least effectively controlled. Runner production was reduced in both test and check plots. Drought conditions were believed to cause poor grass control and reduction in runners.

Denisen (12), applied ACP-M83 to spring planted strawberries at two and three pounds per acre on July 19, 1956. Severe drought conditions prevailed during the summer and irrigation was used to supplement the moisture deficiency.

Grasses were found to be poorly controlled by M83 and reduced runner production resulted. These results were also believed to be influenced by the drought conditions.

Nylund and Nelson (26), used ACP-M83 at four pounds per acre on number 39 canning peas. On May 17, 1956, three days after seeding, the treatments were applied. The principal weed problem was foxtail (Sertaria sp.). At the time of application the soil surface was dry, the temperature was 66°F, and weeds had emerged. It was found that under these conditions, ACP-M83 did not satisfactorily control the grasses in the treated plots.

Emid is the American Chemical Paint Company's trade name for a wettable powder containing 75 per cent by weight of 2,4-dichlorophenoxyacetamide. This chemical forms a good suspension in water and has practically no biological volatility. It has recently been found to be effective during both dry and rainy periods in controlling annual grasses and broadleaf weeds (2).

Ries (30), in 1956 tested Emid at two pounds per acre on the Tendermost sweet corn variety in a sandy loam soil. Treatment was made five days after planting on June 4. Two weed control ratings were made on June 13, and August 16, and the corn was harvested on August 14. The weed population consisted of pigweed, purslane, foxtail, and crabgrass. Excellent weed control was observed on June 13, of all species, but after harvest, it was not good. Maturity, weight and number of ears was not effected by Emid at the rates used.

In tests on annual grass control in corn, Bondarenko and Willard (3), sowed German millet into K-62 corn plots which also had a natural infestation of red root pigweed. Plots were sprayed with Emid at the rate of two pounds per acre. At the rate used, Emid gave good control of the red root pigweed, but control of the millet was not satisfactory.

Toole and Toole (36), in using daily temperature alterations of 20 and 40, 20 and 35, 20 and 30, and 15 and 25°C, found that it required 196 days for complete germination of freshly harvested crabgrass seed. One year old seed was found to germinate in 14 days or less at the foregoing temperatures. Prechilling and abrasion also induced germination. Gianfagna and Pridham (15) found that permeability of the seed coat to water is not a major factor in the dormancy of crabgrass seed.

RESULTS

Pre-emergence Field Studies

Following each application of the herbicides to the strawberry plots in the field, regular observations were made to note the effects of these treatments on crabgrass and the strawberry plants. The average number of hairy crabgrass seedlings per sampling area are shown in Table 1. Daily maximum and minimum temperatures and rainfall data are presented in Table 2.

Table 1. Average number of hairy crabgrass seedlings in sampling areas of 4 square feet.

Material	Mean No. Seedlings			
	July 13	August 20	September 15	Combined Dates
Neburon	6.25	2.25	3.00	3.83
Sesone	43.50	26.00	18.00	29.16
Emid	11.75	10.75	7.75	10.08
ACP-M-83	12.75	8.00	12.00	10.91
2,4-D amine	15.2	13.75	29.25	19.40
Check	35.50	83.50	104.00	74.33

It can be seen from Table 1 that the materials varied considerably in

Table 2. Temperature and rainfall data recorded at Kansas State College Horticultural Farm for the period June 1 - September 15, 1956.

Date June	Maximum Temp.	Minimum Temp.	Rainfall	Date July	Maximum Temp.	Minimum Temp.	Rainfall
1	71	42		1	109	77	
2	71	49		2	99	70	
3	79	56		3	88	65	1.95
4	83	61	.13	4	88	67	.45
5	81	65		5	85	66	
6	83	65	.26	6	89	66	
7	82	61	.21	7	92	73	
8	87	56	.58	8	96	64	
9	81	56		9	85	57	
10	88	61		10	81	55	
11	89	61		11	92	64	
12	89	68		12	94	64	.94
13	95	68		13	87	68	.73
14	92	66		14	90	72	
15	87	62		15	96	73	.12
16	86	67		16	100	70	.12
17	87	64	1.45	17	90	63	
18	87	65		18	85	66	
19	95	70		19	90	66	
20	98	73		20	84	58	
21	99	74		21	84	58	.22
22	102	71		22	85	62	
23	83	63	.43	23	85	64	.31
24	94	67	.65	24	83	65	
25	93	69		25	98	63	
26	92	65	.03	26	93	71	
27	89	64		27	105	78	
28	93	62	.10	28	105	77	
29	87	63		29	104	71	.24
30	96	65		30	91	69	
				31	101	74	

Average maximum temperature 88 degrees
Average minimum temperature 63.3 degrees
Total rainfall 3.84 inches

Average maximum temperature 92.1 degrees
Average minimum temperature 67.0 degrees
Total rainfall 5.07 inches

Table 2. (Concl.)

Date August	Maximum Temp.	Minimum Temp.	Rainfall	Date September	Maximum Temp.	Minimum Temp.	Rainfall
1	102	69	.03	1	79	47	
2	98	69	.77	2	90	55	
3	96	73		3	101	69	
4	101	78		4	101	60	
5	104	72		5	98	60	.04
6	102	72		6	78	41	.07
7	96	68		7	69	38	
8	94	69	.08	8	71	41	
9	97	65	1.65	9	80	44	
10	87	65	.68	10	88	61	
11	79	65	.31	11	98	63	
12	82	66	.09	12	106	65	
13	99	69		13	108	69	
14	89	63		14	101	66	
15	94	70		15	85	57	
16	99	76					
17	105	76					
18	98	72					
19	85	57					
20	71	50					
21	76	45					
22	83	50					
23	98	60					
24	98	68					
25	86	62					
26	99	64					
27	100	74					
28	98	71					
29	99	72					
30	91	72					
31	96	68					

Average Maximum Temperature 93.6 degrees
Average Minimum Temperature 66.8 degrees
Total rainfall 3.61 inches

Average Maximum Temperature 90.2 degrees
Average Minimum Temperature 56.4 degrees
Total rainfall .11 inches

Table 3. Total counts of crabgrass seedlings in an area of 4 square feet in field plots receiving spray applications at three dates, 1956.

Treatment		Date of Application		
		June 25	July 18	August 25
Neburon	Block 1	plot 1 19	plot 2 6	plot 3 6
"	Block 2	plot 1 1	plot 2 0	plot 3 0
"	Block 3	plot 1 2	plot 2 2	plot 3 6
"	Block 4	plot 1 3	plot 2 1	plot 3 0
Crag	Block 1	plot 1 7	plot 2 48	plot 3 15
"	Block 2	plot 1 37	plot 2 5	plot 3 3
"	Block 3	plot 1 83	plot 2 24	plot 3 37
"	Block 4	plot 1 47	plot 2 27	plot 3 17
Enid	Block 1	plot 1 6	plot 2 8	plot 3 6
"	Block 2	plot 1 26	plot 2 9	plot 3 10
"	Block 3	plot 1 5	plot 2 10	plot 3 0
"	Block 4	plot 1 10	plot 2 16	plot 3 15
ACP-MBS	Block 1	plot 1 13	plot 2 10	plot 3 3
"	Block 2	plot 1 4	plot 2 2	plot 3 0
"	Block 3	plot 1 18	plot 2 8	plot 3 12
"	Block 4	plot 1 16	plot 2 12	plot 3 33
2,4-D (amine)	Block 1	plot 1 9	plot 2 2	plot 3 23
"	Block 2	plot 1 9	plot 2 1	plot 3 9
"	Block 3	plot 1 1	plot 2 11	plot 3 11
"	Block 4	plot 1 43	plot 2 41	plot 3 74
Check	Block 1	plot 1 42	plot 2 160	plot 3 210
"	Block 2	plot 1 39	plot 2 90	plot 3 117
"	Block 3	plot 1 47	plot 2 47	plot 3 25
"	Block 4	plot 1 14	plot 2 37	plot 3 66

their inhibition of germinating crabgrass seedlings. The seedling counts for the three dates showed the mean number of seedlings for each experimental block to be as follows: neburon 3.83, Emid 10.08, ACP-M83 10.91, 2,4-D amine 19.40, sesone 29.16 and the control 74.33. The crabgrass counts for all the plots are recorded in Table 3. An analysis of variance was made of these data to compare the effectiveness of each herbicide with the other materials in inhibiting germination of crabgrass. Also the number of seedlings in the chemical treated block were compared with the unsprayed control blocks.

Values for the F ratio were obtained by five orthogonal comparisons to get individual degrees of freedom for the sum of squares. The F ratio for the five orthogonal comparisons is shown in the following table.

Table 4. Orthogonal comparison of the inhibition of crabgrass seedlings by five herbicides tested in the field at the Kansas State College Horticultural Farm from June 23 to September 15, 1956.

Comparison	F Ratio
Check vs. all Herbicides	22.79 **
neburon vs. 2,4-D type herbicides	4.57 *
ACP-M-83 vs. Emid, sesone, 2,4-D (amine)	.91
2,4-D (amine) vs. sesone, Emid	.03
sesone vs. Emid	2.93

* Significant
** Very Significant

Table 4 shows that the reduction in the number of crabgrass seedlings by all herbicides was highly significant when compared to the check. Neburon, which is a methylurea type herbicide, caused a significantly greater reduction in the number of seedlings than did the 2,4-D type herbicides. This analysis indicated that there were no significant differences between the various 2,4-D type herbicides in effectiveness of seedling inhibition.

Examinations of the strawberry foliage were made following each spray

application. Following the first neburon spray treatment on June 25, the leaves of some sprayed plants showed a slight chlorosis. The plants resumed their normal appearance within two weeks. The neburon sprays applied July 18, did not noticeably affect the foliage. Following the neburon application on August 23, severe chlorosis was induced on several leaves. The chlorotic condition had disappeared 18 days after spray treatment. It is likely that the injury that was observed at this date was favored by the high daily temperatures after spraying. The average daily maximum temperature for the six day period following spraying was 97°F.

Some wilting of the plants was observed after the application of Emid sprays on June 25. The margins of a few of the leaves turned brown and dried up. At the end of the summer, little damage of the plants could be observed and plant vigor of Emid sprayed plants compared favorably with that of the check plants. None of the plants receiving the other herbicides showed injurious effects from the spray treatments.

Plates I through V show a comparison of the effect of the herbicides on the growth of hairy crabgrass.

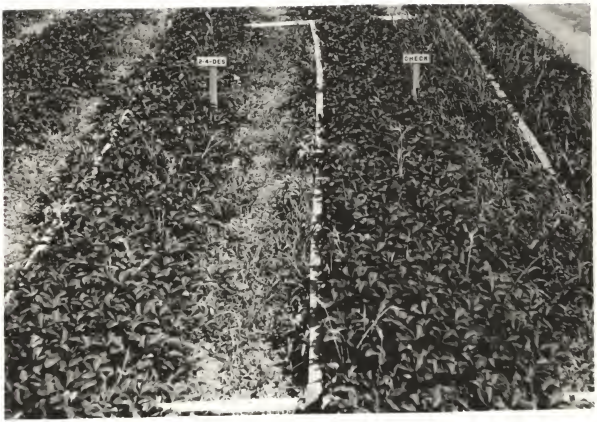
Pre-emergence Greenhouse Studies

At the time of the first herbicidal application on June 23, the maximum daily temperatures were above 95°F and continued high until July 1, at which time they dropped to a maximum of 86°F. These temperatures are recorded in Table 5. Observations were made daily after the sprays were applied to the pots in which 100 crabgrass seeds had been placed. Comparisons were made of the effect of five herbicides on the inhibition of germination of smooth and hairy crabgrass seedlings. It was noted that the seeds to which neburon mixtures were applied turned a pale yellowish green color. These young

EXPLANATION OF PLATE I

Plot at left shows the extent of crabgrass control of sesone applied at the rate of 3 pounds per acre, as compared to untreated check at right, five weeks after application.

PLATE I



EXPLANATION OF PLATE II

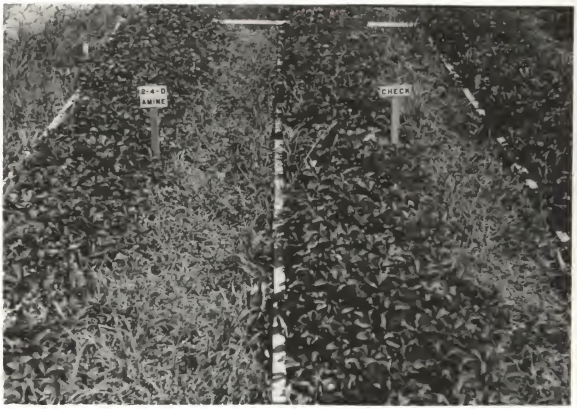
Plot at left shows extent of crabgrass control of neburon applied at the rate of 4 pounds per acre as compared to untreated check at right, five weeks after application.

PLATE II

EXPLANATION OF PLATE III

Plot at left shows extent of crabgrass control of 2,4-D amine applied at the rate of 1 pound per acre as compared to the untreated check at right, five weeks after application.

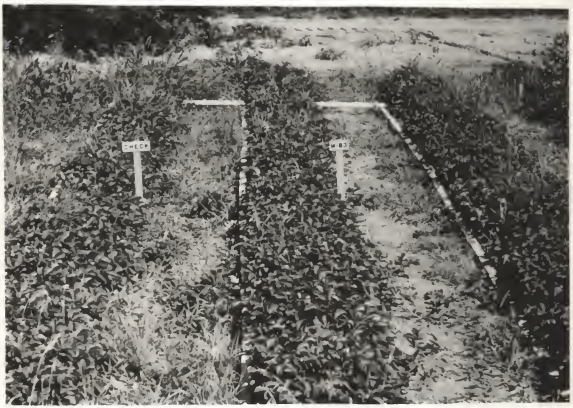
PLATE III



EXPLANATION OF PLATE IV

Plot at right shows extent of crabgrass control of ACP-M83 applied at the rate of 2 pounds per acre as compared to the untreated check at left, five weeks after application.

PLATE IV



EXPLANATION OF PLATE V

Plot at right shows extent of crabgrass control of Emid applied at the rate of 2 pounds per acre, as compared with the untreated check at left, five weeks after application.

PLATE V

Table 5. Maximum and Minimum Temperature recordings in the greenhouse at Kansas State College during pre-emergence tests on crabgrass June 1 - August 31, 1956.

Date	Maximum Temp.	Minimum Temp.	Date	Maximum Temp.	Minimum Temp.	Date	Maximum Temp.	Minimum Temp.
June 23	95	64	July 17	92	65	August 10	82	65
24	95	67	18	86	62	11	84	65
25	93	71	19	85	57	12	100	68
26	90	66	20	85	58	13	91	68
27	93	63	21	87	63	14	96	61
28	88	61	22	85	64	15	101	72
29	96	63	23	99	65	16	107	77
30	109	65	24	95	63	17	100	74
July 1	100	78	25	106	72	18	87	71
2	88	65	26	106	79	19	73	57
3	89	68	27	105	76	20	76	50
4	85	69	28	93	71	21	84	44
5	89	67	29	103	69	22	99	58
6	92	66	30	103	75	23	99	58
7	98	74	31	100	70	24	86	63
8	90	64	August 1	97	72	25	99	60
9	82	57	2	101	76	26	99	74
10	92	54	3	104	78	27	99	75
11	95	70	4	104	70	28	101	72
12	91	64	5	98	72	29	92	73
13	92	68	6	95	69	30	99	72
14	98	72	7	97	71	31	84	63
15	101	73	8	89	66			
16	92	64	9	82	85			

seedlings continued to grow in a fine wiry prostrate growth pattern until they reached about one inch in length. At this time, which was five days after germination, all seedlings which had become badly twisted died. The same effect was noted in each of the tests on both species of crabgrass to which neburon was applied. In all tests conducted neburon inhibited both smooth and hairy crabgrass germination 100 per cent. In the pots receiving the other chemicals, when the seedlings were killed the lethal effects were observed during the process of germination, before much growth had taken place.

Twenty days after germination was first noted, seedling counts were made of all treated pots. These counts are recorded in Table 7. Plate VI shows a typical arrangement of one of the replications used in these tests.

A separate analysis was conducted on the pots treated with Alanap 1 at all three dates because only partial control resulted in each test (Table 6). An analysis of the other chemicals was made only in the tests where partial control resulted. These analyses are presented later.

Table 6. Combined analysis of variance indicating the effectiveness of Alanap 1 vs. check in preventing germination of smooth and hairy crabgrass seeds. The chemical was applied in the greenhouse on July 23, August 2, and August 17.

Source of Variation	Degree of Freedom	Sum of Squares	Variance	F Ratio
Varieties	1	61.1106	61.1106	84.28***
Treatment	1	3.8307	3.8307	5.28*
Replications	2	13.2837	6.6418	9.16***
Treat. X Var.	1	.8748	.8748	1.21 N.S.
Treat. X Rep.	2	6.2436	3.1218	4.30*
Var. X Rep.	2	3.8815	1.9408	2.68 N.S.
Treat. X Var. X Rep.	2	15.0164	7.5082	10.35***
Pots within Treat. X Var. X Rep.	36	26.1128	.7254	
Total	47	130.3541		
Error of hairy crabgrass	18		1.1383	
Error of smooth crabgrass	18		.9235	

* Significant
** Very significant
*** Highly significant

Table 7. Seedling counts made in pre-emergence crabgrass tests in greenhouse. Each pot contained 100 crabgrass seeds. All counts were taken 20 days after chemicals were applied.

Treatment	Date Applied	Total Count (4 pots)	Date Applied	Total Count (4 pots)	Date Applied	Total Count (4 pots)
			Hairy Crabgrass (Digitaria sanguinalis)			
Check	July 23	44	August 2	62	August 17	14
Crag	July 23	1	August 2	20	August 17	0
Enid	July 23	2	August 2	26	August 17	0
Neburon	July 23	0	August 2	0	August 17	0
Alanap	July 23	32	August 2	13	August 17	38
3Y9	July 23	Not tested	August 2	Not tested	August 17	6
			Smooth Crabgrass (Digitaria ischaemum)			
Check	July 23	143	August 2	147	August 17	79
Crag	July 23	1	August 2	52	August 17	0
Enid	July 23	7	August 2	26	August 17	1
Neburon	July 23	0	August 2	0	August 17	1
Alanap	July 23	130	August 2	13	August 17	53
3Y9	July 23	Not tested	August 2	Not tested	August 17	33

EXPLANATION OF PLATE VI

Eight pots at right show treated (below) and untreated pots of hairy crabgrass (above). Eight pots at left show treated (below) and untreated pots (above) of smooth crabgrass. Alanap 1, at the rate of 5 pounds per acre was applied to all treated pots.

PLATE VI

The analysis was conducted to determine whether there was a significant difference in the reduction of crabgrass seedlings when Alanap 1 was applied on the three replicated dates. When the F Table was referred to, probability at the 5 per cent level showed that the variation of inhibition of germination between varieties was highly significant and between treatments was significant. That there was a highly significant variation between replications can be partially attributed to the different rates of germination on the three different dates (Table 7), possibly caused by the temperature flutuations on the dates of application (Table 5).

Since the variation between replications was highly significant, the interaction of treatments X replications showed significance. The mean number of seedlings of the replications treated with Alanap 1 on July 23 and August 2, differed significantly at the 1 per cent level between smooth and hairy crabgrass (Table 8).

Table 8. A comparison of the effect of Alanap 1 on the germination of smooth and hairy crabgrass. A total of three tests were made with the chemical being applied at the rate of 3 pounds per acre to pots in the greenhouse. Counts were made of germinated seedlings.

Treatment and Replication Date	Smooth		Hairy	
	Mean Square Root Trans.	Mean Count	Mean Square Root Trans.	Mean Count
Alanap 1 July 23	5.72	32.50	2.68	8.00
Check July 23	6.01	35.75	3.45	11.00
Alanap 1 Aug. 2	4.78	22.50	1.97	3.20
Check Aug. 2	6.13	36.75	3.65	15.50
Alanap 1 Aug. 17	3.56	13.25	3.20	9.50
Check Aug. 17	4.42	19.75	1.88	3.50

L.S.D. between replications of smooth and hairy crabgrass.
5 per cent .681
1 per cent 1.06
L.S.D. within smooth crabgrass replications.
5 per cent 1.42
1 per cent 1.90
L.S.D. within hairy crabgrass replications.
5 per cent 1.58
1 per cent 2.11

The reason the replications treated on August 17, did not show a significant difference in germination inhibition could possibly be due to the comparatively lower temperatures following this application (Table 5).

When comparisons between replications of each species of crabgrass were made, the mean number of hairy crabgrass seedlings on August 2, was significantly less than the counts taken on July 23 and August 17. No other significant differences were noted. It must be pointed out, that for some unknown reason, germination in the hairy crabgrass check on August 17, was less than in the pots treated with Alanap 1.

When the results of the applications of sesone, Rmid and Alanap 1 to smooth and hairy crabgrass were compared, significant differences in germination inhibition were found. All of the sprays significantly reduced the number of germinating seedlings of smooth crabgrass when compared to the unsprayed controls (Table 9).

Table 9. Comparisons between treatments of sesone, Rmid, Alanap 1 and neburon showing their relative effectiveness on the inhibition of smooth and hairy crabgrass seedlings. Chemicals were applied on August 2, 1956.

Treatment	Smooth		Hairy	
	Mean Square Root Trans.	Mean Count	Mean Square Root Trans.	Mean Count
Partial Control				
Alanap 1	4.78	22.50	1.93	3.25
sesone	3.80	13.00	3.42	13.00
Rmid	3.10	8.75	2.66	6.50
Check	6.13	56.75	3.65	15.50
Complete Control				
neburon	1.00	.00	1.00	.00

L.S.D. between species partially controlled by treatments.
Significant at 5 per cent .97
Significant at 1 per cent 1.31
L.S.D. within species partially controlled by treatments.
Smooth crabgrass
Significant at 5 per cent .98
Significant at 1 per cent 1.39
Hairy crabgrass
Significant at 5 per cent 1.79
Significant at 1 per cent 2.55

Further, the sesone and Emid treatments significantly reduced the average number of smooth crabgrass seedlings when compared to the pots receiving the Alanap 1 treatments.

Alanap 1 and Emid significantly reduced the number of hairy crabgrass seedlings when compared with the checks. The pots receiving the Alanap 1 treatment had significantly fewer hairy crabgrass seedlings than did the pots receiving the sesone treatments.

Comparisons of the effects of the same sprays on the two species of crabgrass revealed that the average number of seedlings of hairy crabgrass in the pots receiving the Alanap 1 treatment were significantly less than that of the smooth crabgrass pots receiving the same treatment. There were no other significant differences between the two species as a result of the other chemical treatments. However the average number of germinating seedlings of the smooth crabgrass checks was highly significantly greater than the average germinated seedlings of the hairy species.

This analysis suggests that any differences in response to chemical treatments between the two species are quite small. It is possible that these differences were due to failure of the seeds of the hairy crabgrass to germinate as well as the seeds of the smooth crabgrass under the conditions of these experiments.

In the tests conducted on August 17, USR-3Y9 was included. The applications of neburon, Emid and sesone gave 100 per cent control of both smooth and hairy crabgrass. An analysis was then made to determine if the number of germinated seedlings in the pots receiving applications of Alanap 1 and USR-3Y9 were significantly different from the checks (Table 10).

The same pattern of results described previously continued in this test. Both chemicals significantly reduced the number of seedlings of both crabgrass

Table 10. The effect of Alanap 1 and USR-3Y9 on the germination of smooth and hairy crabgrass seedlings applied August 17, to pots in the greenhouse.

Treatment	Smooth		Hairy	
	Mean Square Root Trans.	Mean Count	Mean Square Root Trans.	Mean Count
Partial Control				
Alanap 1	3.56 *	13.25	3.20	9.50
USR-3Y9	2.91 **	8.25	1.53	1.50
Check	4.42	19.75	2.38	3.50
Complete Control				
neburon	1.00	.00	1.00	.00
Emid	1.00	.00	1.00	.00
sesone	1.00	.00	1.00	.00

L.S.D. between species of partially controlled treatments.
* Significant at 5 per cent .368
** Significant at 1 per cent .518

species when compared with the checks (Table 10). Also within species, USR-3Y9 treatments significantly reduced the number of seedlings when compared with the Alanap 1 treatments. When the species were compared it was seen that the number of hairy crabgrass seedlings were significantly less than the smooth ones as a result of treatments with both chemicals. There were significantly fewer hairy crabgrass seedlings than smooth in the checks, emphasizing that under the conditions of this experiment the hairy crabgrass seedlings failed to germinate as well as the seeds of the smooth species.

Greenhouse Studies of Treated Strawberry Plants

Daily observations were made from March 4, to April 4, to determine the effects of seven herbicides on the growth and development of treated strawberry plants growing in the greenhouse. Daily temperatures for this period are shown in Table 11.

Strawberry plants treated with sesone at the rate of three pounds per acre showed signs of slight wilting two days following application. The

Table 11. Daily temperature recordings taken in the greenhouse at Kansas State College during the study of the effects of certain herbicides on the leaves and crowns of Blakemore strawberry plants for the period March 4 - April 4, 1957.

Date	Maximum Temp.	Minimum Temp.	Average Daily Temp.	Date	Maximum Temp.	Minimum Temp.	Average Daily Temp.
March 4	61	52	55	March 20	80	51	58
5	89	46	61	21	52	46	49
6	75	42	56	22	64	46	50
7	84	38	53	23	56	48	50
8	79	39	50	24	54	47	58
9	85	39	64	25	76	48	60
10	98	51	69	26	80	48	56
11	84	50	68	27	82	44	62
12	98	50	65	28	85	50	61
13	93	58	72	29	84	48	67
14	74	46	54	30	94	51	55
15	82	38	56	31	57	52	58
16	91	48	64	April 1	60	52	51
17	86	57	64	2	57	46	50
18	85	48	58	3	54	48	52
19	95	44	61	4	64	52	56

Average Maximum Temperature 77 degrees
Average Minimum Temperature 47 degrees
Average Daily Temperature 59 degrees

wilted condition persisted until March 11, at which time the plants showed the first signs of recovery. All plants appeared entirely recovered on March 15. Normal development of the plants including vegetative growth and flower formation continued to the end of the test. Plate VII shows plants treated with sesone.

Neburon applied at the rate of four pounds per acre showed no signs of damaging the plants until four days after application on March 8. At this time browning around the leaf edges and chlorosis of the leaves was recorded in 50 per cent of the plants. By March 15, the young growth and flowers forming on the crowns of the chlorotic plants appeared brown and dying. Twelve days after this condition was noted, new growth began to appear in the affected crowns and at the close of the test on April 4, many new leaf and flower buds had been produced. This type of injury can be seen in Plate VIII.

Of the six plants treated with 2,4-D amine at the rate of one pound per acre, no damage was noted until March 9, when slight wilting and tip burn was first observed. Throughout the remainder of the test period no changes were noted in damage to the plants. At the conclusion of the test on April 4, all plants appeared retarded, with little new growth and few flowers, when compared to the check. Plate IX shows plants treated with 2,4-D amine.

Applications of Emid at the rate of two pounds per acre to the plants resulted in wilting of the leaves two days after the applications were made. This wilted condition persisted until March 20, when all plants were considered dead. Plate X shows injury caused by Emid.

USR-5Y9 at the rate of two pounds per acre caused slight leaf curl and tip burn of the leaves eight days after the applications were made. All plants gradually recovered and in a comparison with the checks at the close of the test, only slight differences in vigor of the plants could be noted.

EXPLANATION OF PLATE VII

Treated plants at right show damage caused by sesone applied at the rate of 3 pounds per acre as compared to untreated checks at left, eleven days after treatment.

PLATE VII

EXPLANATION OF PLATE VIII

Treated plants at right show damage caused by Neburon applied at the rate of 4 pounds per acre as compared to untreated checks at left, eleven days after treatments.

PLATE VIII

EXPLANATION OF PLATE IX

Treated plants at right show damage caused by 2,4-D amine applied at the rate of 1 pound per acre, as compared to untreated checks at left, eleven days after treatment.

PLATE IX

EXPLANATION OF PLATE X

Treated plants at right show damage caused by Emid applied at the rate of 2 pounds per acre as compared to untreated checks at left, eleven days after treatment.

PLATE X

Plate XI shows this damage clearly.

Alanap 1 applied at the rate of three pounds per acre caused visible injury to the plants five days after treatment was made. The plants showed slight chlorosis around the edges of the leaves and some temporary wilting and curling of the leaves. Flowers appeared not to have pollinated and were undeveloped on March 20. Curling of the leaves continued thru March 24, and by April 1, the plants were twisted and retarded. At close of the test on April 4, all plants were chlorotic, twisted and had curled leaves. Flowers and small fruits were not developed normally. Compared to the check, all plants were smaller in size and retarded. Plants treated with Alanap 1 are shown on Plate XII.

Slight browning around the leaf edges was first noted on plants treated with ACP-MS3 at the rate of two pounds per acre on March 8. On March 18, all plants were noted to be retarded as compared to the check. At the close of the test the plants varied in the degree of damage caused by the treatment. Three plants appeared normal, one very weak and retarded and two with intermediate vigor. Plants treated with ACP-MS3 are shown in Plate XIII.

DISCUSSION

The inhibition of germinating crabgrass seedlings varied considerably between chemical treatments applied to an established Blakemore variety strawberry planting in the field as shown in Table 1. The statistical analysis of these data showed that plots receiving chemical treatments had significantly fewer crabgrass seedlings than the check plots (Table 4). It was found that neburon gave significantly better control of germinating crabgrass than did the 2,4-D type herbicides tested. Due to the temperatures in excess of 90°F that prevailed following the applications and the drought

EXPLANATION OF PLATE XI

Treated plants at right show damage caused by 3Y9 applied at the rate of 2 pounds per acre as compared to untreated check at left, eleven days after treatment.

PLATE XI

EXPLANATION OF PLATE XII

Treated plants at right show damage caused by Alanap 1 applied at the rate of 3 pounds per acre as compared to untreated checks at left, eleven days after treatment.

PLATE XII

EXPLANATION OF PLATE XIII

Treated plants at right show damage caused by ACP-M53 applied at the rate of 2 pounds per acre as compared to untreated check at left, eleven days after treatment.

PLATE XIII

conditions that persisted during these field tests, it is believed that possibly all the chemicals did not react as they would have under more normal climatic conditions.

Peabody, et al. (29) have shown that sesone will give best results under moist conditions where soil microorganisms are present to convert it to toxic form. Robbins, et al. (32) have further pointed out that 2,4-D tends to break down at temperatures above 90°F.

Table 2 shows that both of these conditions existed during the field tests. It is therefore suggested that additional tests should be conducted under more normal climatic conditions to determine if these high temperatures and dry conditions had a significant effect on the results of these tests.

When pre-emergence applications were made to crabgrass seed in the greenhouse, it was found that neburon gave 100 per cent control of both smooth and hairy crabgrass germination on all dates tested.

Alanap 1 significantly reduced crabgrass germination of both species on July 23 and August 2 as compared with the checks. It was also found that Alanap 1 gave significantly better control of smooth crabgrass germination on these two dates compared to the checks. Germination was higher in the Alanap 1 treated pots on August 17 than in the check pots for some unknown reason. This may have been possibly caused by an average maximum temperature for the six day period following application of 86°F for the August 17 treatment as compared with the average maximum temperature of 100°F for the same period following the treatments made on July 23 and August 2. Comparison of the replications of each species of crabgrass treated with Alanap 1 showed that the mean number of hairy crabgrass seedlings on August 2 was significantly less than the counts taken on July 23 and August 17. These differences may also have been affected by the temperature differences at the time of

application as mentioned above.

The July 23 and August 17 applications of Emid and sesone gave nearly complete inhibition of the crabgrass seedlings. Comparisons of Emid, Alanap 1 and sesone were made on August 2 when these treatments gave partial control of germination. It was found that Alanap 1 applications significantly reduced the number of hairy crabgrass seedlings when compared to the pots with smooth crabgrass seedlings receiving the same material. This was probably due to the lower germination rate of hairy crabgrass seeds as indicated by the checks (Table 9). All three chemical treatments gave a significant reduction in smooth crabgrass seedlings when compared to the checks on August 2. No significant difference was shown in germination inhibition between chemicals applied to hairy crabgrass and the check pots, except for those treated with Alanap 1. Had a larger number of seeds germinated in the check pots at this time, these results may have been different.

Neburon, sesone and Emid all gave 100 per cent inhibition of germination of both crabgrass species in the August 17 test. A comparison of Alanap 1 and USR-3Y9 treated pots revealed only partial control on this date. Both chemicals significantly reduced germination of crabgrass as compared with the checks. Further, USR-3Y9 gave significantly better inhibition of germination of both crabgrass species than did Alanap 1 on this test date.

As pointed out in the discussion of the field tests, 2,4-D is most effective at temperatures of 70 and 80°F and tends to break down above 95°F. It is therefore reasonable to assume that other chemicals may differ in their effectiveness in response to varying temperatures. Results of these tests may possibly have been different had the temperatures following each application been simular. It is apparent that under the conditions of this experiment that there was a considerably higher per cent of germination in the

smooth than in the hairy crabgrass seeds.

In greenhouse tests conducted to determine the effects of the herbicides on strawberry plants, sesone treated plants showed signs of wilting two days after application was made. This wilting was only temporary as the plants recovered one week later. These results compare with those reported by Denisen (11).

Plants treated with Enid were all dead two weeks following date of application. USR-5Y9 treated plants showed slight wilting and tip burn eight days after application, but resumed normal growth by the close of the test one month after application. ACP-MB3 gave various degrees of plant damage. These treated plants showed lack of vigor and were retarded in general as compared to the checks. Since these three chemicals are still experimental materials, little information on their effects on strawberries is available. Denisen (11) in field tests conducted at Ames, Iowa in the summer of 1956, states that reduced vigor of strawberry plants and runner production resulted from applications of USR-5Y9 at the rate of four pounds per acre and ACP-MB3 at the rate of three pounds per acre. It was pointed out by Denisen (11) however, that these results were possibly affected by the extreme drought conditions that existed during the summer of 1956.

Alanap 1 applied at the rate of three pounds per acre to strawberry plants caused wilting, twisting and curling of the leaves five days after application was made. Uneven fruit development also occurred. One month after the chemical applications, all treated plants were twisted and retarded as compared with the checks. Denisen (10) reported similar results to these from applications of Alanap 1 at the rate of six pounds per acre.

Applications of 2,4-D amine at the rate of one pound per acre caused temporary wilting and a retarded effect on plant growth and flower development

as compared with the checks.

Neburon applied to strawberry plants at the rate of four pounds per acre caused chlorosis of the leaves and damage to the plant crowns. All plants recovered from this damage two weeks after application. These results are similar to those obtained by Herron and Chaplin (19).

It can be concluded from these tests that the damage caused by sesone, neburon and USR-5Y9 was only temporary at the rates used. Further, these greenhouse tests indicated that considerable damage was caused to the plants by ACP-MS3, Alanap 1 and 2,4-D amine, while in the field ACP-MS3 and 2,4-D amine applications resulted in no evident injury to the plants. The results of these tests also showed that greenhouse strawberry plants treated with Emid were all killed. It was found that the damage to strawberry plants in the field treated with Emid at the same rate was only temporary.

Carlson (6) stated that strawberry plants do not respond satisfactorily to the artificial conditions of a greenhouse. It is believed that the chemicals used in these tests may have had a different effect on plants growing in the greenhouse than on plants growing in the field. In the summer it is difficult to prevent daily maximum temperatures in the greenhouse from becoming abnormally high. Further, night temperatures do not drop as low as outside temperatures. These higher temperatures plus extreme low relative humidity likely contributed to the greater phytotoxicity of the chemicals when applied in the greenhouse.

SUMMARY

Several pre-emergence herbicides were tested in the field and greenhouse to determine their effectiveness in inhibiting germination of crabgrass and to note their effects on the growth and vigor of the strawberry plants. Both

smooth and hairy crabgrass were tested and Blakemore variety strawberry plants were used in all tests.

All chemicals tested in the field significantly reduced the germination of crabgrass when compared with the check. Blocks treated with neburon gave significantly better control of crabgrass germination than did the blocks treated with the 2,4-D type herbicides. There were no significant differences in the control of crabgrass germination between the materials Emid, sesone, ACP-M83 and 2,4-D amine. Emid and neburon caused some leaf injury in the field, but the plants recovered satisfactorily.

In the greenhouse tests on smooth and hairy crabgrass, neburon gave 100 per cent germination inhibition of both crabgrass species on all three replicated dates when pre-emergence applications were made.

Alanap 1 significantly reduced the germination of both species of crabgrass in tests made on July 23 and August 2. In the test conducted on August 17, the check pots had a lower rate of germination than did the Alanap 1 treated pots. It was further found that Alanap 1 gave significantly better control of smooth crabgrass germination on July 23 and August 2 than on August 17. Significantly better control of hairy crabgrass germination was obtained on August 2 than on the other two dates.

Sesone and Emid gave complete control of both smooth and hairy crabgrass germination on July 23 and August 17. The partial control of smooth crabgrass germination that resulted from the August 2 application of these two chemicals was found to be significant as compared with the check. Neither chemicals significantly inhibited hairy crabgrass germination on this date as compared with the check.

USR-5Y9 significantly reduced the number of seedlings of both crabgrass species on August 17 as compared with the check. It was also found that

USR-3Y9 reduced germination of hairy crabgrass significantly greater than it did smooth crabgrass. USR-3Y9 was only tested on August 17. It must be pointed out that there were significantly fewer germinated seedlings in the hairy crabgrass checks than in the smooth crabgrass checks in this test. This was possibly caused by the lower maximum daily temperatures that followed the August 17 application as compared to the maximum daily temperatures following the July 23 and August 2 applications.

Strawberry plants treated with Enid in the greenhouse were all killed. Plants treated with USR-3Y9 and sesone were temporarily damaged, but recovered satisfactorily. Neburon applied to strawberry plants in the greenhouse caused damage to the crown and chlorosis in some leaves, but later recovered. Alanap 1, ACP-MB3 and 2,4-D amine showed various degrees of plant damage and did not show satisfactory recovery at the close of the test one month after applications were made.

Since strawberry plants respond differently to greenhouse culture than field conditions, it is believed that possibly some of the plant damage may be attributed to this difference.

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SOME EFFECTS OF SEVERAL PRE-EMERGENCE HERBICIDES ON HAIRY AND SMOOTH CRABGRASS AND THE CULTIVATED STRAWBERRY

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Several pre-emergence herbicides were tested in the field and the greenhouse to determine their effectiveness as pre-emergence herbicides in controlling crabgrass in established strawberry plantings, to observe their comparatative effectiveness in the control of smooth and hairy crabgrass and to note their effects on the growth and vigor of strawberry plants. Three separate experiments were conducted.

A second year planting of Blakemore variety strawberry plants was sprayed with the following chemicals to control crabgrass germination: 1-N-butyl-3 (3,4 dichlorophenyl) 1-methylurea (neburon), at the rate of four pounds per acre, granular 2,4-dichlorophenoxyethanol (ACP-M83), at the rate of two pounds per acre, sodium 2,4-dichlorophenoxyethyl sulfate (sesone), at the rate of three pounds per acre, 2,4-dichlorophenoxyacetamide (Emid), at the rate of two pounds per acre, and the triethanolamine salt of 2,4-D, at the rate of one pound per acre. Applications were made at three different dates during the summer of 1956. All treatments gave significant control of crabgrass germination as compared to the checks. Neburon gave significantly better control of crabgrass germination than did the 2,4-D type herbicides. There were no significant differences in the control of crabgrass germination between the 2,4-D type herbicides. Neburon and Emid were the only chemicals that showed signs of strawberry plant damage in these field tests. This damage was not severe and all affected plants recovered.

The chemicals sesone, Emid, neburon, N-1-Naphtyl phthalamic acid (Alanap 1), at the rate of three pounds per acre and tris (2,4-dichlorophenoxyethyl) phosphite (USR 3Y9), at the rate of two pounds per acre, were applied to pots in the greenhouse containing 100 seeds each of smooth and hairy crabgrass. Three replicated tests were conducted on different dates during the summer. Neburon gave 100 per cent control of both smooth and hairy crabgrass

germination. Alanap 1 gave only partial control of germination in each test. Emid and sesone gave complete control of crabgrass germination on two dates and only partial control on the other. USR-3Y9 gave only partial control of crabgrass germination on the one day it was tested. Some difference in the inhibition of germination between smooth and hairy crabgrass was noted in some of the tests where Alanap 1, Emid, sesone and USR-3Y9 were applied. Germination was higher in the check pots of the smooth crabgrass, in all of the tests.

Emid, sesone, Alanap 1, neburon, USR-3Y9, ACP-M85 and 2,4-D amine were applied to Blakemore variety strawberry plants in the greenhouse on March 4, 1957. All plants treated with Emid were killed. Plants receiving applications of sesone and USR-3Y9 recovered from temporary wilting and leaf injury. Neburon treated plants showed signs of chlorosis in the leaves and crown damage, but recovered by April 4, at the close of the test. Plants treated with Alanap 1, ACP-M85 and 2,4-D amine had wilted and burned leaves and were somewhat stunted.

Since strawberry plants respond differently to greenhouse culture than field conditions, it is believed that possibly some of the plant damage which occurred in the greenhouse may be attributed to this difference.