THE CHEMICAL CONTROL OF CRABGRASS IN STRAWBERRIES

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INTRODUCTION

Crabgrass is one of the most troublesome of all summer weeds in the entire Southwest. In the growing of strawberries, crabgrass is usually an extremely serious problem since it competes for nutrients and moisture in the hot dry part of the summer. This is a critical time for the production of runner plants in strawberries, and any reduction in runner plants usually means reduced yields. Cooper (6) has shown that a smaller number of plants per square foot results in a reduction of marketable and total strawberries the following year until there is an average of at least four and sometimes as many as seven plants per square foot. Shoemaker (39) obtained evidence that the time of runner plant formation was also important since early rooted plants are the most productive.

Another factor of importance in recent years has been the availability and expense of hand labor. Hemphill (26) has stated that the cost of growing an acre of strawberries exclusive of harvesting may vary from less than one hundred dollars up to two hundred and fifty dollars. This variation is determined largely by the amount of hand labor necessary to keep the field free from weeds. It has also been common for new fields to be abandoned because it was not possible or practical to control weeds by hand. Denisen (16) has stated that it is possible to reduce the necessary hand labor

for weeding strawberries by as much as eighty-eight percent with the use of chemical weed killers.

REVIEW OF LITERATURE

Chemical Control of Crabgrass

Chemical weed control has been of some economic importance in this country since the last decade of the nineteenth century, according to Muenscher (33), but little progress was made after that time for almost fifty years. Except for a few selective weed killers developed in the 1920's and 1930's, there was no outstanding progress made until after the discovery of the herbicidal properties of 2,4-D (2,4-dichlorophenoxy-acetic acid) in 1944 according to Ahlgren (1). Since that time there has been a tremendous amount of experimental work undertaken on chemical weed control involving numerous materials.

At first, 2,4-D was thought to be effective only on broad-leaved plants but has more recently been used with success on crabgrass. Danielson (10) found that 2,4-D successfully controlled crabgrass for three to four weeks in field and sweet corn when two pounds of a seventy percent mixture of the sodium salt was applied immediately after planting. Jagoe (31) found 2,4-D to be effective in controlling Digitaria species (crabgrass) on both cultivated and pasture lands. DeFrance (14) found that a mixture of the butyl ester of 2,4-D (1:4000) and PMA (phenyl mercuric acetate) (1:6000) applied at the rate of one gallon per 100 square feet controlled crabgrass in lawns, with little damage to Kentucky Blue Grass, Colonial Bent Grass, and Chewing's Fescue. Wolf (46), Day (12), and Gianfagna (22) found that

2,4-D as a pre-emergence spray, was successful in controlling crabgrass for as long as eight weeks. Kelly (32) sprayed greenhouse grown plants of three species of crabgrass with an aqueous solution of the potassium salt of 2,4-D and held them in chambers at constant temperatures of 5° C., 15° C., and 25° C. and equal light intensities. All were more susceptible at higher than at lower temperatures.

PMA was used mainly as a fungicide until the accidental discovery of its herbicidal properties on crabgrass in connection with experimental work on putting green turfs. DeFrance (14) found that a PMA solution controlled crabgrass in a putting green turf. He recommended a 1:6000 solution with a 1:4000 solution of 2,4-D butyl ester at the rate of ten gallons per 1000 square feet. He also suggested that a 1:10,000 solution of PMA be applied once a month as a preventative against crabgrass. Grigsby (24) found PMA to be effective against crabgrass in lawns. Some injury to perennial grasses followed heavy applications. Nutter (35) found PMA to be one of the best materials to control crabgrass in turf. Wolf (46) found PMA (1½ to 4 pounds per acre) alone, and in combination with 2,4-D controlled crabgrass seedlings in gladiolus with no harmful effect when the gladiolus leaves were five inches high. DeFrance (13, 15), and Nutter (35) have also reported good success in controlling crabgrass with the following commercial preparations of PMA: Puraturf, Puratized 806, PMA--AA, Tat-C-Lect, Puratized 641, and Scutl.

KOCN (potassium cyanate) has been used almost exclusively as a pre-emergence herbicide since it is very toxic to most growing plants; however, the surviving plants are benefitted somewhat as the compound breaks down in the soil since it releases some nitrogen and potassium. DeFrance (15) found that a one percent solution of KOCN gave fairly good control of crabgrass in turf. There was a noticeable discoloration of the turf, but usually no permanent injury resulted. Grigsby (24, 25) found that KOCN at twelve pounds per acre gave good control of crabgrass on golf greens but produced injury that lasted three weeks. Nutter (34, 35) reported that KOCN at twenty-five pounds per acre was one of the four best chemicals for controlling crabgrass in turf and that it had given satisfactory control with as little as eight to sixteen pounds per acre without causing permanent injury to the turf. Wolf (46) reported that KOCN had recently shown promise as a control for crabgrass but that much experimental work remained to be done. Gianfagna (21, 22) found that KOCN was successful in controlling crabgrass for eight weeks when used as a pre-emergence spray. He also reported that KOCN at 75 and 150 pounds per acre controlled crabgrass in gladiolus as a pre-emergence treatment. Injury was avoided when only the bases of the gladiolus plants were sprayed.

Currier (7) found that MH (maleic hydrazide) applied as a 0.2 percent aqueous solution killed grasses other than barley when the plants were young. The plants were killed faster when 0.024 percent Vatsol was used as a spreader for

the MH. Waywell (42) reported that MH was not effective in controlling crabgrass when applied as a pre-emergence spray. Curtis (8) found that MH inhibited the growth of many species of grass two months. Six pounds per acre applied as a ground spray around young apple trees caused no reduction in growth.

DeRose (18) reported that CIPC (O-isopropyl N, 3-chlorophenyl, carbamate) would control crabgrass seedlings in the germinating stage and that it had an inhibitory effect on larger seedlings. It was not harmful to transplanted strawberry plants when the concentration was as low as one mg. per pound of soil (applied in fifty ml. aqueous spray) in flats. Severe stunting, however, was noticed when concentrations of two and five mg. per pound of soil were used. It reduced growth seven times as much as similar compounds. These included IPC (isopropyl N-phenyl carbamate) from which CIPC is derived.

Grigsby (24) found PCP (pentachlorophenate) and NaPCP (sodium pentachlorophenate) gave control of crabgrass seedlings but injury to perennial grasses was noticeable after heavy applications. Gianfagna (21) reported that NaPCP was successful in controlling crabgrass for eight weeks when used as a pre-emergence spray.

Warren (41) reported that N-(1-naphthyl) phthalamide at two and four pounds per acre reduced crabgrass stands a total of forty-five percent to seventy-five percent with the remainder being severely stunted. Feldman (19) suggested that N-(1-naphthyl) phthalamide at five to ten pounds per

acre was an effective pre-emergence weed killer when applied as an aqueous spray.

Runyan (38) reported that dinitro salts were effective against crabgrass seedlings in turfed areas.

Nutter (35) found that EH2 (dichloral urea) gave good control of crabgrass seedlings.

Wolf (46) reported that $CaCN_2$ (calcium cyanamid) gave promise of controlling crabgrass when used as a pre-emergence treatment on maise and potatoes.

Chemical Weed Control in Strawberries

Investigators in chemical weed control have been hindered greatly when working with many crops due to the extreme susceptibility of these crops to various herbicides, but have been more successful with strawberries since this crop is at least moderately resistant to many herbicides.

Wilson (44, 45) found 2,4-D caused injury to transplanted strawberry plants when applied at either two or three pounds per acre. Injury was more severe in plots treated immediately before planting. Very little injury was noted where applications were made as much as two weeks before planting. Symptoms consisted of twisting of petioles, stunting, and some burning of foliage. Two weeks later the symptoms had disappeared. No severe injury was noted when 0.8 pounds of 2,4-D acid equivalent per acre was applied immediately after scraping and strawing in early spring. Preplanting applications of two pounds per acre caused temporary stunting if the

plants were set within one week after application. Carlson (2, 3, 5) found several varieties of strawberries that tolerated pre-planting and post-planting applications of 2,4-D. He also found that strawberry plants which were to be transplanted could be protected from 2,4-D injury by dipping the roots in activated carbon before transplanting, and that runner production was reduced by using 2,4-D. Holm (29) found that as little as one pound of 2,4-D per acre caused temporary wilting of strawberry plants lasting from three to seven days; however, two applications of two pounds each applied just as runner production started and thirty days later only reduced runner plant production twenty percent. Danielson (9) reported that 2,4-D at 1½ and 3 pounds per acre gave the same results when applied in five gallons of water per acre as when applied in 100 gallons of water per acre to both corn and strawberries. Weed kill was not successful when heavy rainfall came a short time after application. Best results were obtained when the soil was rolled to pack it immediately after application. Denisen (17) reported that two applications of two pounds per acre of 2,4-D on Dunlap strawberries in 1950 showed no significant reduction in yield in 1951. In 1951, a two pound rate of application applied twice to Robinson strawberries planted in the spring did not satisfactorily control weeds and gave a sixty-three percent reduction of rooted runner plants. Hemphill (27, 28) states that three applications of 2,4-D at two pounds per acre each applied as a pre-planting, a June, and an August summer foliage spray only reduced runner plant production

five percent, and the following year there was an average increase in yield of thirty-five crates per acre over the check. He also states that with Blakemore strawberries, a three pound pre-planting application of 2,4-D followed by successive 1½ pound foliage applications in June, July, and August reduced runner plants by about thirty-five percent. Weed control was not good due to excessive rain. Howat (30) found that the amine form of 2,4-D was not as effective in controlling weeds as was the nonvolatile ester at the same rate. However, a one pound per acre treatment of the ester, at the end of the spring dormant period, resulted in about ten percent of the flowers being sterile in Dakota and Dunlap strawberries and about twenty percent dried without forming fruit. Nylund (38) reported that nine varieties of strawberries treated with two successive one pound per acre applications of 2,4-D isopropyl ester, soon after planting, gave no difference in yield the following year when compared with the check, furthermore, the varieties did not respond differently to the treatments.

White (43) stated that MH at 1000 to 3000 p.p.m. delayed the blossoming of Bristol black raspberry plants from twenty-four to thirty-eight days, and that fruit maturity was delayed from sixteen to twenty-three days. Vegetative growth which was temporarily inhibited was later followed by normal growth. Foliage was not injured by rates of 1000 and 1500 p.p.m., slightly injured at 2000 p.p.m., and

was severely injured at 3000 p.p.m. Less complete information suggests that early spring applications might also delay the blooming of strawberry plants. Hemphill (28) stated that MH at twelve pounds per acre as a planting application followed by summer foliage sprays of eight pounds each in June and August reduced runner plants to only forty percent of normal and production the following year was decreased by forty-six crates or about twenty-two percent.

DeRose (18) reported that CIPC at low concentrations (up to 1 mg. per pound of soil) had no noticeably harmful effects on strawberries that were transplanted in flats in the greenhouse. Concentrations of two mg. or more per pound of soil caused severe stunting of strawberry plants. Holm (29) found that post-planting applications of ten to fifteen pounds of CIPC per acre severely injured strawberry plants.

Carlson (4) found that ammonium TCA and sodium TCA killed strawberry plants when used in herbicidal concentrations.

Holm (29) reported that EH1 (sodium 2,4-dichlorophenoxyethyl sulfate) at six pounds per acre resulted in a ten percent reduction in runner plants. Carlson (3) also reported that the use of EH1 caused a reduction in the number of runner plants. Hemphill (27, 28) reported that EH1 when used at four pounds per acre as a preplanting application followed by two summer foliage sprays of two pounds

each reduced runner plant production by seventeen percent. However, it resulted in a decrease in production of only seven crates per acre the following year which was not significant. He also reported that in a new planting of Blakemore strawberries, a planting application of four pounds of EH1 followed by three summer foliage sprays of the same amount resulted in an eight percent reduction in runners. Heavier rates of application resulted in a more severe reduction in runner plants. Denisen (16, 17) reported that a four pound application of EH1 just before applying a summer mulch followed by a six pound application four weeks later increased the production of ever-bearing strawberries by an average of 16.2 percent. He also reported that two applications of eight pounds of EH1 on Dunlap strawberries gave no significant reduction in yield. The following year, runner production was reduced by twenty-one percent from a six pound rate of application. Man hours of hoeing were also reduced by seventy-six percent.

Carlson (3) found that EH2 reduced runner production of strawberries when used in herbicidal concentrations. Hemphill (28) reported that EH2 at eight pounds per acre for four applications which was necessary for fairly good weed control resulted in a thirty-five percent reduction in runner plants in Blakemore strawberries.

Davidson (11) reported that DNOSBP (dinitro-O-sec-butyl phenol) at 1.8 pounds per acre gave excellent control of winter growing weeds in strawberries when applied in the

fall. Strawberry leaves were burned to the crown but very little permanent damage could be observed the following spring.

MATERIALS AND METHODS

In this series of tests there were three main divisions:

Greenhouse trials with crabgrass.

Greenhouse trials with strawberries.

Field trials with crabgrass and strawberries.

The following chemicals were used: $CaCN_2$, CIPC, CMU (3-,p-chlorophenyl,-1-1-dimethylurea), DNOSBP, EH1, EH2, kerosene, KOCN, MH, NaPCP, N-(1-naphthyl) phthalamide, PCP, PMA, Scutl, S-2500 (silica floride compound), TCA, and 2,4-D.

Greenhouse Trials with Crabgrass

A supply of crabgrass seed was harvested in the fall of 1951 near the campus of Oklahoma A. and M. College, Stillwater, Oklahoma.

These seed were chilled for seventeen days at thirty-five to forty degrees F. since it had been shown by Toole (40) that this was the most effective method of breaking the rest period on freshly harvested seed.

Twenty-six flats twenty inches long, sixteen inches wide, and three inches deep were filled with a uniform loamy soil that was comparatively free from weed seed and placed on the south bench of the west room of the sash house. Two of these flats were seeded with 2.92 grains (about 300 seed) each on January 14 to act as checks.

After it had been determined that two to four days were required for several seed to germinate (the daily maximum temperature was usually between eighty and ninety degrees F.) the initial two flats were replaced.

The twenty-six flats were then seeded with a like amount of seed on January 18.

Ten other flats of the same size were filled with a fairly uniform heavy textured soil and placed on the south bench of the east room of the sash house where the temperature was about sixty-five degrees F. during the day.

All of these flats were seeded January 21 and were moved to the north bench of the center section of the sash house where the daily maximum temperature was between seventy and eighty degrees F. before there was any evidence of germination.

The seed in each flat were broadcast over the surface of the soil and the flats were watered every one or two days in order to keep the soil surface moist to insure the maximum amount of germination.

Chemicals were applied in each instance as soon as there was evidence of germination of crabgrass.

The following treatments were applied:

In the initial twenty-six flats (January 20)

Scutl - 110 and 220 pounds per acre.

S-2500 - 50, 100, and 150 pounds per acre.

$CaCN_2$ - 50, 100, and 200 pounds per acre (special grade).

NaPCP - five and ten gallons per acre (ten percent active ingredients).

TCA - 50 and 100 pounds per acre (ninety percent active ingredients).

KOCN - eight and sixteen pounds per acre (active ingredients).

CMU - ½ and 1 pound per acre (active ingredients).

2,4-D - one and two pounds per acre (acid equivalent).

PMA - 3½ and 7 quarts per acre (ten percent active ingredients).

N-(1-naphthyl) phthalamide - five and ten pounds per acre (active ingredients).

MH - three and six pounds per acre (active ingredients).

Two check flats.

Scutl, S-2500, and $CaCN_2$ are commercial or experimental preparations in which the percent of active ingredients were not stated.

Scutl, S-2500, and $CaCN_2$ were mixed with sand and applied with a salt shaker. The other materials were applied in water with a small hand sprayer. A cardboard box was placed over each flat as the sprays were being applied to prevent the different materials from contaminating nearby flats.

In the remaining ten flats (January 26)

DNOSBP - 1½ and 3 pints per acre (fifty-four percent active ingredients).

PCP - five and ten gallons per acre (ten percent active ingredients).

CIPC - one and two pints per acre (40.6 percent active ingredients).

Kerosene - fifty-eight gallons per acre.

Three check flats.

All of the materials in this group were applied in ten ml. of kerosene per flat (fifty-eight gallons per acre) except the ten gallon rate of PCP which was applied in twenty ml. of kerosene.

The results of these trials will be found in tables one and two.

Greenhouse Trials with Strawberries and Crabgrass

These tests were conducted in much the same manner as the first trials except that special attention was paid to the effect of the various chemicals upon the growing strawberry plants.

One hundred Blakemore strawberry plants were dug February 21, 1952. They were dug in such a manner that the roots were disturbed very little, and then placed four to a flat on the south bench of the east room of the sash house. The additional soil in the flats was a sandy loam infested with numerous weed seed.

These flats were moved to the south bench of the west room of the sash house on March 4, 1952.

The flats were seeded with approximately 600 crabgrass seed each on March 10.

All flats were fairly uniform and the strawberry plants were making rapid vegetative growth at the time of treatment.

The following treatments were applied on March 13:

S-2500 at the rates of 50, 75, and 100 pounds per acre.

Scutl at the rates of 330 and 440 pounds per acre.

$CaCN_2$ at the rates of 400 and 600 pounds per acre.

KOCN at the rates of twenty-four and thirty-two pounds per acre.

EH1 at the rate of four pounds per acre (active ingredients).

CMU at the rates of 1/2 and 3/4 pounds per acre.

2,4-D at the rates of 1, 1½, and 2 pounds per acre.

EH2 at the rate of 5.1 pounds per acre (active ingredients).

NaTCA at the rates of twenty-five and fifty pounds per acre.

CIPC at the rates of two and four pints per acre.

DNOSBP at the rates of two and four pints per acre.

NaPCP at the rates of five and eight gallons per acre.

Two check flats.

Supplemental trials with applications made on April 14 and 15 included:

Scutl at the rate of 660 pounds per acre.

NaTCA at the rates of ten and fifteen pounds per acre.

EH1 at the rate of eight pounds per acre.

EH2 at the rate of 10.2 pounds per acre.

CIPC at the rate of eight pints per acre.

S-2500, Scutl, and $CaCN_2$ were applied dry. All the other materials were applied in water.

The strawberry plants began blooming by February 28, and the blooms were removed soon after they opened in order to hasten runner production. Temperature readings of the soil were taken seventeen times during the next twenty-one days after moving the flats to the west room of the sash house. They were taken at various times during the day and readings were secured concurrently at each end of the room. The maximum reading was ninety-four degrees F. and the minimum was seventy degrees F. with the average recorded temperature being 82.8 degrees F. The east end of the room averaged 5.7 degrees F. warmer than the west end during this period. These data are recorded in table three.

When the crabgrass seed were sown, there were numerous weeds already present including several crabgrass seedlings about 1/2 to 3/4 inches high. The seed were broadcast over the surface of the soil, and flats were watered thoroughly approximately every two days in order to keep the soil surface moist to insure the maximum amount of germination.

No counts were made on runner plant production due to the small number of plants involved, but plants from at least five different treatments (Scutl at 440 pounds per acre; $CaCN_2$ at 400 and 600 pounds per acre; 2,4-D at 1½ pounds per acre; and CIPC at two pints per acre) had one or more runners before there were any runners in the check flats.

Field Trials with Chemical Weed Killers

Forty plots of Blakemore strawberries were transplanted in the field in February, 1952. These plants were in a block ten plots wide and four plots long. Each plot contained fifteen plants and was three feet wide and forty-five feet long with an alleyway three feet wide between each two replicates of ten plots. This block was in a uniform loamy soil with a gently rolling slope and was heavily infested with crabgrass.

All blossoms were removed from the strawberry plants as they appeared in order to hasten vegetative growth.

All plots were kept cultivated and hoed so that no weeds were present on May 6.

About one inch of water was applied on May 6 with an overhead sprinkler so that moisture conditions would be ideal for crabgrass seed germination. The strawberries were also irrigated as needed throughout the summer and fall.

Soil and air temperatures were recorded with a thermograph in the pecan grove which is only a short distance from the strawberry field. They were recorded for a total of twenty-six days beginning immediately before application and continuing for several days thereafter. They were recorded in the same manner for the second application. This information is recorded in charts one and two.

The thermograph failed to record the temperature for several days and temperature recordings from the campus

weather station were substituted. This information is in table four.

The following treatments were applied on May 8 in a randomized four-replicated block.

EH1 - eight pounds per acre.

CMU - ½ pound per acre.

Mulch - about ½ inch - castor bean hulls.

EH1 - ten pounds per acre.

2,4-D - 1½ pounds per acre.

2,4-D - two pounds per acre.

CIPC - ten pints per acre.

S-2500 - 100 pounds per acre.

S-2500 - seventy-five pounds per acre.

Check.

Most of the plants were growing vigorously at the time of the first treatment with several plants having from one to four runners each. A strip two feet wide was sprayed the entire length of each plot. The middles were cultivated on May 31 leaving a strip eighteen inches wide undisturbed in the row.

Crabgrass seedling counts were made on May 22 in the following manner: A small wooden frame was constructed one foot wide and three feet long. The frame was then centered over the third, eighth, and thirteenth plants of each plot, and all the crabgrass seedlings in a total of nine square feet were counted in each plot. This information appears in table five.

Pictures were taken on June 16 of an entire replicate with two plots included in each photograph. These pictures are shown in plates one to ten and each one is paired with a photograph taken of the same plots on October 20.

All plots were hoed on June 18 and were kept relatively free from weeds the remainder of the growing season.

Additional applications of chemicals were made on July 9 that corresponded to those made on May 8 except that no effort was made to maintain the mulch.

All runner plants were counted on June 19 and all rooted runner plants were counted on September 14 and 15 and again in December. This information is contained in tables six, seven, and eight.

Colored photographs were taken of single strawberry plants (mother and runners) ten days after the second applications to show the severe damage done by two of the chemicals that produced little apparent damage from the first applications. These photographs are in plates eleven and twelve.

RESULTS AND DISCUSSION OF STUDY

Greenhouse Trials with Crabgrass

In the first series of trials in the greenhouse, fifteen materials were used in an attempt to determine those that were the best crabgrass killers. The results are shown in tables one and two.

TABLE I

EFFECT OF SOME HERBICIDES

ON GERMINATION AND GROWTH OF CRABGRASS

Treatment	Rate per Acre	Germ. at 21 da.	Germ. between 21 & 30 da.	Total Germ.**	Max. Ht. (inches)	Ave. Ht. (inches)
Check (Ave.3)		23	23	46	5	2½
CIPC	1 pt	11	24	35	1	3/4
CIPC	2 pt	16	36	52	1	3/4
DNOSBP	1½ pt	26	17	43	2	1
DNOSBP	3 pt	8	26	34	1	½
PCP*	5 lb	20	13	33	½	½
PCP	10 lb	4	4	8	2½	2
kerosene	58 gal	17	22	39	1	3/4

*It has been suggested by Fosse (20) that pentachlorophenol be applied in oil; however, it was only partially soluble in kerosene and much less than the five and ten pound rates was actually applied.

**This includes only those that were alive at the end of thirty days.

The germination was very poor in this entire group, probably as a result of the low temperature where these flats were originally seeded (about sixty-five degrees F.) and also where they were ultimately moved to (about seventy to eighty degrees F.), or from the effect of the heavier textured soil.

TABLE II

EFFECT OF SOME HERBICIDES

ON GERMINATION AND GROWTH OF CRABGRASS

Treatment	Rate per Acre	Germ. at 21 da.	Germ. between 21 & 30 da.	Total Germ.	Max. Ht. (inches)	Ave. Ht. (inches)
Check (Ave.2)		125	22	147	8½	4½
Scutl	110 lb	106	18	124	5½	3
Scutl	220 lb	79	31	110	3	1½
S-2500	50 lb	20	45	65	2	½
S-2500	100 lb	0	1	1	-	-
S-2500	150 lb	0	0	0	-	-
$CaCN_2$	50 lb	42	24	66	5	3-3½
$CaCN_2$	100 lb	50	27	77	5	3-3½
$CaCN_2$	200 lb	34	25	59	3	1½
NaPCP	5 lb	16	12	28	1	½
NaPCP	10 lb	16	15	31	½	¼
TCA	50 lb	2	20	22	¼	¼
TCA	100 lb	6	31	37	3/4	¼
KOCN	8 lb	14	30	44	3/4	½
KOCN	16 lb	21	42	63	3/4	½
CMU	½ lb	11	21	32	2	3/4
CMU	1 lb	0	0	0	-	-
2,4-D	1 lb	19	18	37	3/4	½
2,4-D	2 lb	8	4	12	½	¼
PMA	3½ qt	72	26	98	5	3
PMA	7 qt	72	26	98	5	2
MH	3 lb	38	34	72	5	2½
MH	6 lb	34	39	73	5	3/4
N-1(naphthyl) phthalamide	5 lb	64	36	100	5½	2½
N-1 (naphthyl) phthalamide	10 lb	20	30	50	5	1

Effect of Various Treatments on Crabgrass

CIPC at two pints per acre caused a slight initial delay in germination and moderate stunting of seedlings but did not reduce the total stand of crabgrass when compared to the checks. The one pint rate of application produced almost the same results except it did reduce the seedling count to about seventy-five percent of that in the check.

DNOSBP at three pints per acre delayed initial germination somewhat and caused burning, stunting and a chlorotic appearance on seedlings and reduced the total stand to seventy-five percent of the check. The 1½ pint rate caused some stunting of seedlings but delayed germination very little and caused only a slight reduction in the total stand.

PCP at five gallons per acre stunted seedlings somewhat but caused little delay in germination and reduced the total to about seventy percent of the check. The ten gallon rate of application did not have much of a dwarfing effect on the seedlings but did delay germination somewhat and suppressed total germination to seventeen percent of the check.

Kerosene at fifty-eight gallons per acre had little effect except a moderate dwarfing on seedlings and a slight reduction in total stand when compared to the check.

Scutl delayed germination of crabgrass seed about seven days at 110 pounds per acre and ten to fourteen days at 220 pounds per acre. This was the only appreciable effect noted since the crabgrass made normal growth after this initial delay and there was only a small reduction in the total stand when compared to the check.

S-2500 at fifty pounds per acre delayed germination from fifteen to eighteen days and the seedlings were stunted for the entire period. The 100 and 150 pound rates of application were highly effective since one small seedling was present at the 100 pound rate and none at the 150 pound rate at the end of thirty days.

$CaCN_2$ caused a delay in germination of three to seven days at the 50 and 100 pounds per acre rates and caused a reduction of about fifty percent in the total germination of crabgrass. The 200 pound rate caused a more serious initial delay and also caused some stunting of the seedlings but it reduced the total stand very little more than the lower rate of application.

NaPCP reduced the germination to twenty percent of the check at both the five and ten gallon rates per acre. There was a delay in germination of about fifteen days and a stunting effect on the seedlings at both rates and a yellowing effect was noticeable at the ten gallon rate of application.

NaTCA reduced the total stand to twenty-five percent of the check at the 100 pound per acre rate of application and even more at the fifty pound rate. Each caused a curling and distorting effect on the crabgrass seedlings and all were severely stunted.

KOCN reduced the crabgrass counts to thirty-five percent when compared to the check. Many seedlings died shortly after emergence and the remainder were stunted and chlorotic at both the eight and sixteen pound rates of application.

CMU at one pound per acre gave complete control of crabgrass and the ½ pound rate reduced the stand to about twenty percent of the check. It also delayed initial germination several days and stunted the seedlings.

Both the one and two pound per acre rates of application of 2,4-D delayed germination a few days and severely stunted the crabgrass seedlings. The one pound rate of application reduced the total stand to twenty-five percent of the check and the two pound rate reduced the total stand to eight percent of the check.

PMA at both the 3½ and 7 quarts per acre delayed germination only a very few days and growth was almost normal after that time. Both rates of application reduced the total crabgrass counts to about sixty-seven percent of the check totals.

MH at both the three and six pound per acre rates of application caused a slight initial delay in germination and a distorting effect on the seedlings and with the six pound rate caused considerable stunting in seedlings. Each rate of application, however, reduced the stand of crabgrass to about fifty percent of the check.

N-1 (naphthyl) phthalamide caused a delay in initial germination of about ten to fourteen days at the ten pound per acre rate of application and also caused a moderate stunting of crabgrass seedlings and reduced the total stand to about thirty-four percent of the check. The five pound rate caused little delay in germination, slight stunting of seedlings, and reduced the total stand to about sixty-eight

percent of the check.

Greenhouse Trials with Strawberries

In this group of tests, all of the chemicals that had shown any promise as crabgrass killers in the first tests plus a few additional chemicals were used on growing strawberry plants to determine the effect of each on the strawberry plants. Further observations were also made on the ability of each chemical to kill crabgrass.

S-2500

Within one day after treatment the foliage of the strawberry plants was drooping and also some damage was noticeable on all broad leaved weeds. During the second day burning and wilting of crabgrass was noticeable. Six days after treatment all weeds and grass had been killed at the two heavier rates of application except for some larger crabgrass and weeds that had been present at the time of treatment. One strawberry plant in each flat had been killed by this time. Within the next ten days, one more plant died in the flat treated with seventy-five pounds per acre and two others in the flat treated with fifty pounds per acre. The two flats with the fifty and seventy-five pound application rates were near a steam pipe that leaked and the death of all these plants may have been due to the high temperature since Gray (23) has shown that the roots of strawberry plants may die if exposed to temperatures above ninety-five degrees F. for a few days. The plants in the

flat treated with 100 pounds per acre were burned and quite severely stunted, but recovered.

$CaCN_2$

Weed control was successful at the 100 and 200 pound rates of application except for a few weeds and some crabgrass that had been present at the time of treatment. Very few seedlings appeared after the treatments were made. Within three days after treatment all small weeds and crabgrass were dead. The strawberry plants were burned severely, but only one plant died and that was at the 200 pound rate of application after ten days had elapsed. Weed control was fairly successful with most of the crabgrass emerging along the edge of the flat or underneath the strawberry plants where it is doubtful if the rate of application was sufficient; however, the remaining grass grew at an excessive rate due to additional nitrogen having been made available. Injured plants made rapid recovery, especially at the 100 pound rate of application.

KOCN

Marginal burning appeared on the leaves of the strawberry plants within one day. This grew progressively worse until one plant at the sixteen pound rate of application died in seven days. Other strawberry plants made fairly rapid recovery. All grass and weeds present were killed within three days after treatment but there seemed to be no effect on the germination of crabgrass seed.

CMU

Three days were required for any damage to appear. All weeds and crabgrass were killed in about seven days and control remained very good at the one pound per acre rate of application. The strawberry plants first showed marginal burning of the leaves after seven days and this progressed until one plant in each flat died fifteen days after treatment. Two more plants at the one pound rate, and one at the ½ pound rate had died at the end of thirty days. The remaining plants recovered, but remained severely stunted for several weeks.

2,4-D

Twisting of peticles and some wilting was noticeable in the strawberry plants before the end of the first day. This became more severe in two days, but was followed by gradual recovery. The plants were slightly stunted for three or four weeks. Weed control was good at the 1½ and 2 pound rates of application with all broad-leaved weeds and most crabgrass being killed. There was also a pronounced inhibitory effect on the germination of crabgrass seed.

DNOSBP

Everything was killed in three days except a small amount of crabgrass, however, there was no delay in the germination of crabgrass seed.

NaPCP

Everything was dead at the end of three days and there was a severe inhibitory effect upon the germination of

crabgrass seed, especially at the eight gallon rate of application.

Scutl

There was some inhibitory effect on the growth of both crabgrass and strawberry plants at the 660 pound rate of application. The lower rates of application delayed the germination of crabgrass seed somewhat but had no apparent effect either on strawberry plants or crabgrass and weeds that were present at the time of application.

EH1

There was a slight marginal discoloration and possibly some stunting of strawberry plants from the eight pound rate of application. The four pound application had no noticeable effect. Weed control was good at the eight pound rate of application with some inhibition of crabgrass seed germination, the killing of a considerable portion of the crabgrass, and a severe stunting of the remainder.

EH2

The strawberry leaves had a slight marginal discoloration at the higher rate of application. There was a moderate delay in crabgrass seed germination but weed control was generally poor.

CIPC

One strawberry plant died within three days at the four pint rate of application, but this was probably due to some other cause since no other plant showed any harmful effect. There was a slight marginal burning of the leaves at the eight

pint rate of application. Some of the crabgrass was killed and the remainder was severely stunted.

TCA

Marginal burning appeared on all strawberry leaves except at the ten pound rate of application by the end of the first day. All plants were killed at the fifty pound rate of application and only one survived the twenty-five pound rate. None of the plants were killed at any lower rate of application, but burning was severe enough to delay growth somewhat. Weed control was good at the twenty-five and fifty pound rates of application, but control was poor at the ten and fifteen pound rates.

Field Trials with Crabgrass and Strawberries

Effect of Treatments on Crabgrass Stands

There was considerable variation between replicates in the crabgrass seedling counts (table five) and an even greater amount of variation between different treatments and different plots of the same treatments. Statistically, the results could be divided into two groups: (A) Check and CMU; and (B) EHl, 2,4-D, CIPC, S-2500, and mulch.

CMU gave no control when compared to the check. All of the other materials were different from CMU and the check at the one percent level with the exception of S-2500 at the 100 pound rate which was different from the check at the five percent level.

An inspection of the photographs in plates one to ten indicates that the treatments that reduced the stands of crabgrass also reduced the total growth of crabgrass by an

appreciable amount.

None of the five materials listed which were different from CMU and the check were different from each other in controlling crabgrass.

Effect of Treatments on Strawberry Plants

CMU gave a slight chlorotic appearance to the strawberry plants after about one week had elapsed, and 2,4-D caused a small amount of temporary wilting. Otherwise, there was no noticeable damage done by any of the treatments after the first application.

The first runner plant count (table six) indicates that mulch had enough more runner plants than the check to be different at the one percent level and CMU had enough fewer runner plants than the check to be different at the five percent level. All of the other treatments gave runner plant totals that were rather closely grouped around the check and none were significantly different from the check.

EH1 at eight pounds per acre had more runners than CMU at the one percent level and more than CIPC at the five percent level. Otherwise, there was no difference between any of the treatments except for mulch.

The second application of materials on July 9 caused severe burning from two different materials. S-2500 at both the 75 and 100 pound rates of application and CIPC severely damaged all the existing runner plants and killed many runner plants and a few mother plants. This damage is shown in plates eleven and twelve. Slow recovery was made by the

strawberry plants treated with CIPC and S-2500 at 100 pounds per acre whereas a more rapid recovery was made by those treated with S-2500 at seventy-five pounds per acre as is indicated by the rooted runner plant totals in tables seven and eight.

The only other noticeable damage was the same that had been observed after the first applications.

In table seven, the mulch treatment had a significant increase in rooted runner plants at the one percent level over the check. The check had a larger number of rooted runner plants than any of the remaining treatments, but EH1 at eight and ten pounds and 2,4-D at 1½ and 2 pounds were not significantly different when compared to the check. S-2500 at seventy-five pounds per acre and CMU produced differences at the one percent level when compared to the check but there was no difference when they were compared to any of the 2,4-D and EH1 treatments. CIPC and S-2500 at 100 pounds per acre affected rooted runner plant totals to the extent that CIPC was lower at the one percent level than all the other treatments except both rates of S-2500 and CMU, while S-2500 was lower at the one percent level than any other treatment except CIPC. There was no difference between CIPC and S-2500 at the 100 pound rate of application.

The total rooted runner plants per treatment, between September 15 and December, increased from a low of 163 in S-2500 at 100 pounds per acre up to 352 in the mulch (see tables seven and eight). The increases were almost in pro-

portion to the number of rooted runner plants present on September 15. The only change between September 15 and December was that S-2500 at the seventy-five pound rate of application was significantly higher than CIPC at the five percent level in December while there had been no difference in September.

CHART I

TEMPERATURE RECORDINGS IN THE PECAN GROVE DURING AND IMMEDIATELY AFTER THE FIRST APPLICATION OF HERBICIDES TO STRAWBERRIES

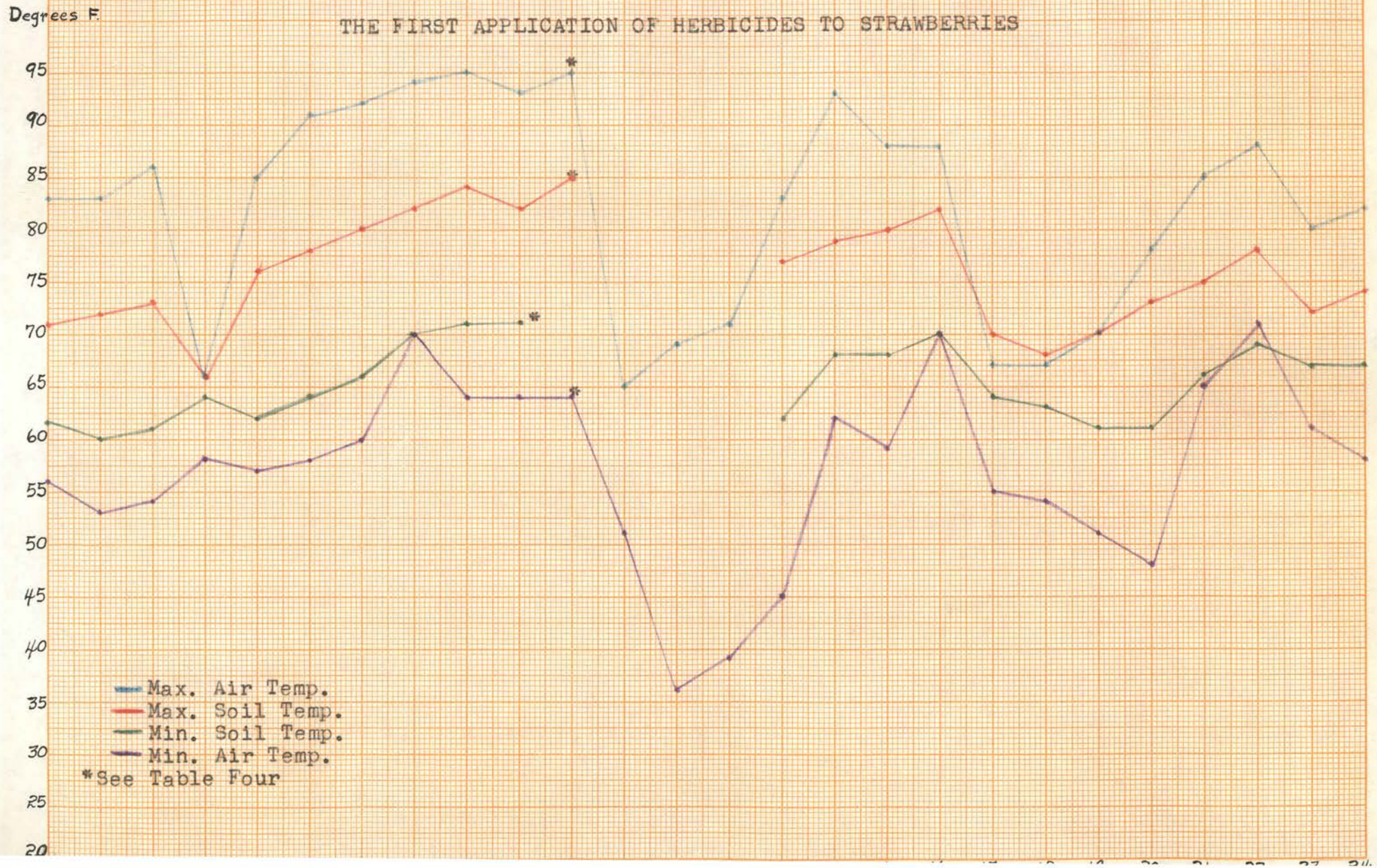

CHART II

TEMPERATURE RECORDINGS IN THE PECAN GROVE DURING AND IMMEDIATELY AFTER

THE SECOND APPLICATION OF HERBICIDES TO STRAWBERRIES

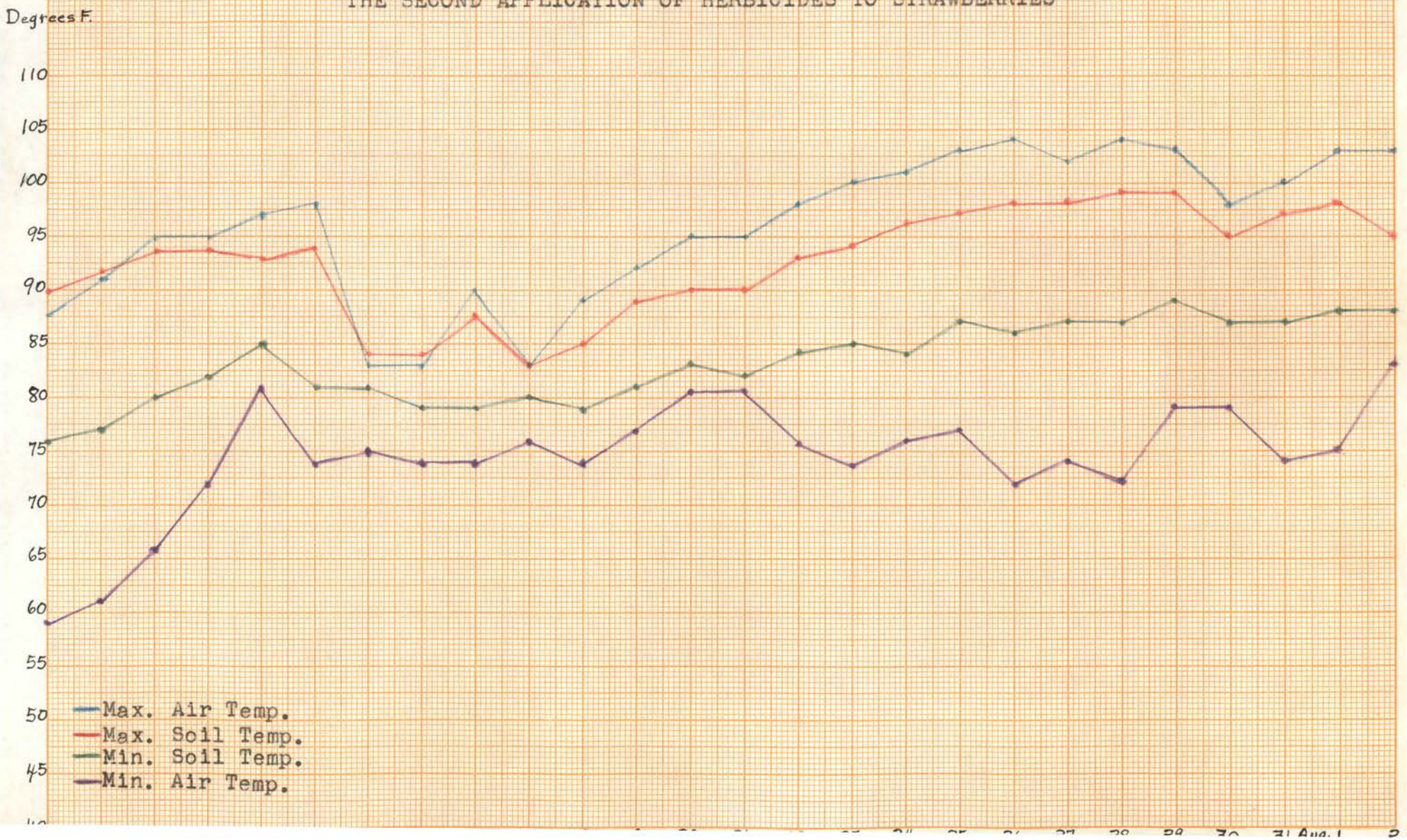

TABLE III

SOIL TEMPERATURE RECORDINGS

IN THE WEST ROOM OF THE SASH HOUSE

(Degrees F.)

Date March	Time	East End	West End
6	9:00 a.m.	83	79
7	9:30 a.m.	89	83
10	9:00 a.m.	94	89
10	6:00 p.m.	86	81
11	11:30 a.m.	80	84
13	12:00 a.m.	84	87
14	11:00 a.m.	87	80
15	8:00 a.m.	93	86
16	5:00 p.m.	82	77
17	7:30 a.m.	77	70
17	2:00 p.m.	80	72
18	9:40 a.m.	77	71
19	4:30 p.m.	93	82
20	10:45 a.m.	90	81
21	8:00 a.m.	80	74
24	7:30 a.m.	89	79
25	9:00 a.m.	92	84

TABLE IV

COMPARISON OF TEMPERATURES

RECORDED AT TWO LOCATIONS TWO MILES APART

(May, 1952)

Date	Campus Weather Station		Pecan Grove	
May	Max.	Min.	Max.	Min.
10	95	64	-	-
11	65	51	-	-
12	69	36	-	-
13	71	39	-	-
14	76	46	-	45
15	88	54	83	65
16	88	62	93	59
17	86	65	89	70
18	83	50	88	59
19	65	50	58	54
20	67	46	67	51

The thermograph failed to record the temperatures for the dates indicated by (-) in the two columns under pecan grove. The temperatures from the campus weather station at Oklahoma A. & M. College were used to complete chart one for these missing air temperatures. Several additional recorded temperatures are shown here to indicate the variation between the daily temperatures in the pecan grove and the campus weather station.

TABLE V

FIELD COUNTS OF CRABGRASS SEEDLINGS

TWO WEEKS AFTER APPLICATION OF CHEMICALS

(May 22)

Material Used	Rate Per Acre	Replicates 1	2	3	4	Totals
EH1	8 lb.	29	33	10	38	110
CMU	¼ lb.	35	228	58	64	385
Mulch		19	43	38	10	110
EH1	10 lb.	38	4	18	19	79
2,4-D	1½ lb.	31	28	71	8	138
2,4-D	2 lb.	32	19	55	49	155
CIPC	10 pts.	5	18	16	62	101
S-2500	100 lb.	9	166	9	35	219
S-2500	75 lb.	4	5	35	35	79
Check		64	68	124	142	398
Totals		266	612	434	462	1774

Difference required for significance is 156 seedlings per treatment at the five percent level and 172 seedlings per treatment at the one percent level.

TABLE VI

COUNTS OF STRAWBERRY RUNNER PLANTS JUNE 19,

SIX WEEKS AFTER APPLICATION OF HERBICIDES

Material Used	Rate Per Acre	Replicates 1	2	3	4	Totals
EH1	8 lb.	98	173	88	94	453
CMU	½ lb.	102	36	67	61	266
Mulch		87	176	124	121	508
EH1	10 lb.	89	99	128	111	427
2,4-D	1½ lb.	163	72	104	52	391
2,4-D	2 lb.	83	70	133	95	381
CIPC	10 pts.	76	116	29	107	328
S-2500	100 lb.	108	83	103	106	400
S-2500	75 lb.	103	78	78	109	368
Check		76	117	90	93	376
Totals		985	1020	944	949	3898

Difference required for significance is 112 runner plants per treatment at the five percent level and 132 runner plants per treatment at the one percent level.

TABLE VII

COUNTS OF ROOTED RUNNER PLANTS OF STRAWBERRIES SEPTEMBER 15, ELEVEN WEEKS AFTER APPLICATION OF HERBICIDES

Material Used	Rate Per Acre	Replicates 1	2	3	4	Totals
EH1	8 lb.	440	598	401	329	1768
CMU	½ lb.	564	191	235	401	1391
Mulch		561	662	565	866	2654
EH1	10 lb.	366	486	414	592	1858
2,4-D	1½ lb.	578	391	438	304	1711
2,4-D	2 lb.	426	286	597	503	1812
CIPC	10 pts.	99	460	98	313	970
S-2500	100 lb.	254	94	120	254	722
S-2500	75 lb.	327	309	210	568	1414
Check		412	602	658	400	2072
Totals		4027	4079	3736	4530	16372

Difference required for significance is 512 rooted runner plants per treatment at the five percent level and 564 rooted runner plants per treatment at the one percent level.

TABLE VIII

COUNTS OF ROOTED RUNNER PLANTS OF STRAWBERRIES IN DECEMBER, FIVE MONTHS AFTER THE SECOND APPLICATION OF HERBICIDES

Material Used	Rate Per Acre	Replicates 1	2	3	4	Totals
EH1	8 lb.	512	694	501	383	2090
CMU	½ lb.	635	236	252	492	1615
Mulch		608	774	703	921	3006
EH1	10 lb.	471	565	512	633	2181
2,4-D	1½ lb.	660	440	503	350	1953
2,4-D	2 lb.	509	324	626	586	2045
CIPC	10 pts.	136	552	123	372	1183
S-2500	100 lb.	324	146	151	264	885
S-2500	75 lb.	458	351	331	620	1760
Check		545	645	737	469	2396
Totals		4858	4727	4439	5090	19114

Difference required for significance is 532 rooted runner plants per treatment at the five percent level and 588 rooted runner plants per treatment at the one percent level.

Plate 1
Check
EH1 at ten pounds per acre
Picture taken on June 16

Plate 2
Check
EH1 at ten pounds per acre
Picture taken on October 20

Plate 3
S-2500 at seventy-five pounds per acre
CIPC at ten pints per acre
Picture taken on June 16

Plate 4
S-2500 at seventy-five pounds per acre
CIPC at ten pints per acre
Picture taken on October 20

Plate 5
S-2500 at 100 pounds per acre
CMU at ½ pound per acre
Picture taken on June 16

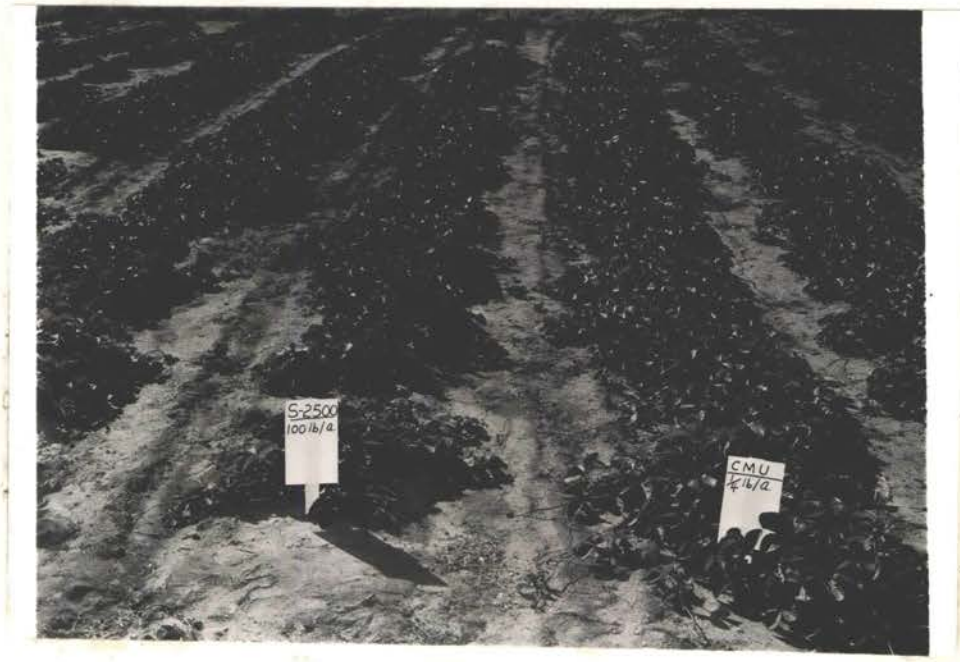

Plate 6
S-2500 at 100 pounds per acre
CMU at ½ pound per acre
Picture taken on October 20

Plate 7
2,4-D at two pounds per acre
2,4-D at 1½ pounds per acre
Picture taken on June 16

Plate 8
2,4-D at two pounds per acre
2,4-D at 1½ pounds per acre
Picture taken on October 20

Plate 9
Mulch
EH1 at eight pounds per acre
Picture taken on June 16

Plate 10
Mulch
EH1 at eight pounds per acre
Picture taken on October 20

Plate 11
S-2500 at seventy-five pounds per acre
Picture taken on July 19

Plate 12
CIPC at ten pints per acre
Picture taken on July 19

SUMMARY AND CONCLUSIONS

EH1 at eight and ten pounds per acre gave good control of crabgrass and did not result in a significant reduction of rooted runner plants in a first year planting of Blakemore strawberries.

Good crabgrass control was also obtained with 2,4-D at the 1½ and 2 pound rates of application and there was no reduction in rooted runner plants.

Mulch gave good control of crabgrass and caused rooting conditions to be more favorable to the extent that there was a significant increase in rooted runner plants.

S-2500 at 75 and 100 pounds provided good control of crabgrass and produced no injury to strawberry plants from spring applications. However, each produced burning of strawberry plants from a July application and caused significant reductions in rooted runner plants when compared to the check. The runner plant counts at the seventy-five pound rate of application were not significantly lower than either rate of 2,4-D or EH1.

CIPC gave good control of crabgrass but gave a significant reduction in rooted runner plants.

CMU did not control crabgrass and gave a significant reduction in rooted runner plants.

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