THE EFFECTS OF HERBICIDES, INSECTICIDES, RATES OF PLANTING, NITROGEN FERTILIZATION AND BURNING ON YIELD AND SILVER TOP OCCURRENCE IN CHEWINGS FESCUE

Thesis for the Degree of M. S.

MICHIGAN STATE COLLEGE

Francis K. McMullen

1954

This is to certify that the

thesis entitled

THE EFFECTS OF HERBICIDES, INSECTICIDES, RATES OF PLANTING, NITROGEN FERTILIZATION AND BURNING ON YIELD AND SILVER TOP OCCURRENCE IN CHEWINGS FESCUE

presented by

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has been accepted towards fulfillment of the requirements for

M. S. degree in Farm Crops

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Date December 6, 1954

O-169

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AN ABSTRACT

Submitted to the School of Graduate Studies of Michigan State College of Agriculture and Applied Science in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

Department of Farm Crops

Year 1954

Approved 

THE

THESIS ABSTRACT

An experiment, covering a period of two years, was carried out at East Lansing, Michigan, using the insecticides Marlate, DDT, and BHC (benzenehexachloride); herbicides C-IPC and TCA; burning, with and without nitrogen fertilization; nitrogen application; and combinations of the above mentioned chemicals and practices on seed yield and silver top occurrence of Chewings fescue, Festuca rubra variety commutata. Rates of planting experiments were also included.

No significant increase in yield or justifiable decrease in silver top occurrence, between the means of all treatments and the untreated plots, was obtained the first year. The second year, significant differences of yield and noticeable differences of silver top occurrence between the means of the following treatments and untreated plots were observed, in order of effectiveness:

1) Burning of stubble in August plus application of nitrogen in August.
2) Burning of stubble in August.
3) Spring application of C-IPC, (second year yields only).
4) Spring application of DDT.
5) Spring application of nitrogen.

No significant differences in yield between the means of rate of planting were obtained the first year. A noticeable decrease in silver top was observed in those plots that were seeded at one-half pound per acre the first year. The second year, significant increases in yield and noticeable decreases of silver top were observed between the means of one-half pound rate of planting and other rates of planting.

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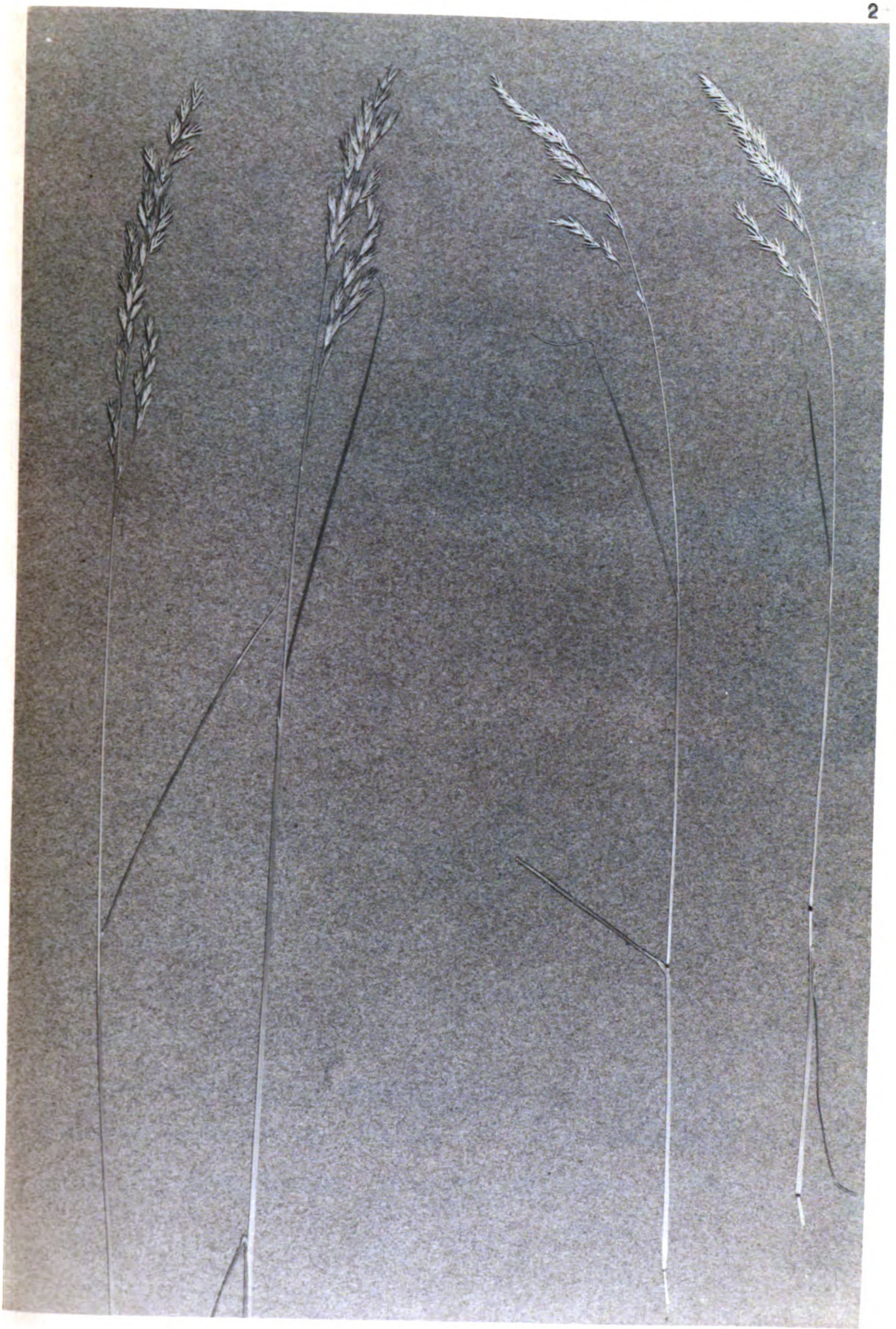
INTRODUCTION

Silver top of grasses has been a problem since the turn of the century, but to date, only limited success has been obtained in its control. Silver top is characterized by an injury involving the conductive tissue of the plant stem immediately above the topmost node. The seed bearing head of the plant dries prematurely, becomes silvery in appearance and no seeds are formed, (Figure 1). Leading authorities are still divided in their opinion as to whether silver top is caused by an insect, virus, or fungus. Fergus (10) of Kentucky reports that silver top is caused by two sucking insects whereas Hardison (14), of Oregon, and Keil (1), of Pennsylvania state that the disease is due to the combined activities of a mite and a fungus, Fusarium poae. The experiment reported here was set up to study the effects of various chemicals, rates of planting, burning, and nitrogen fertilization on seed yield and silver top occurrence in Chewings fescue, Festuca rubra variety commutata.

Figure 1. Panicles of Chewings fescue

A. Normal

B. Silver Top



A B

REVIEW OF LITERATURE

Difficulties were experienced when, in 1938, Pennsylvania farmers tried to produce seed of fescue. Low yields obtained were attributed to a disease. Later, Keil (1) suggested the presence of Fusarium poae as the possible cause of this condition.

Fernald and Hinds (5, 24) have reported the "disease" on 32 species of grasses in Massachusetts. In Pennsylvania (1) it has been reported on ten species of grasses.

Stewart and Hodgkiss (14) reported that the disease was first mentioned in 1875 by Comstock in his "Syllabus of a Course of Lectures." From this time until 1900 the disease was reported by both Fernald (7) and Lintner (3). Since then several workers have made reference to it in this as well as foreign countries.

The disease has been found in Germany, Finland, Canada and the United States. Reuter (11) reported it from Finland and named the disease "Weissahrigkeit". Kauffman (18) has shown the disease to be detrimental to grasses in Germany. Osburn (17) has stated it to be common in Canada. In the United States the disease has been reported in Maine (7), Nebraska (2, 10), Massachusetts (5), New York (15, 14), Wisconsin (8), Pennsylvania (1), and Rhode Island.

The fungus (Sporotrichum poae) associated with "white heads" was discovered by Stewart and Hodgkiss (14) who submitted it to Peck (6) in 1902 for identification. Recently, Wollenweber and Reinking (12)

published that "Sporotrichum poae" was actually a species of Fusarium. Keil presented evidence toward proving that this fungus is the cause of the disease "white heads" in fescue.

MATERIALS AND METHODS

A series of treatments were planned to develop and evaluate control measures for silver top. Several chemicals were used in addition to the burning treatments and rates of seeding. The following insecticides were used:

DDT, 50% wettable.
Rate - One and one-half pounds per acre, active ingredient, applied May 15, 1953 and May 13, 1954.

Marlate, 24% Technical.
Rate - One pound per acre, active ingredient, applied May 15, 1953.
One and one-half pounds per acre, active ingredient, applied May 13, 1953.

EM-1, Concentrate (benzenehexachloride).
Rate - Five hundred cubic centimeters per acre applied May 15, 1953.

The remaining two chemical compounds were herbicides, and consisted of the following:

TCA, Dow sodium, 90%.
Rate - Ten pounds per acre, acid equivalent, applied April 28, 1953 and November 6, 1953.

C-IPC, 40%
Rate - Five pounds per acre, active ingredient, applied April 28, 1953 and November 6, 1953.

The burning treatment consisted of burning the grass residue and dead stubble one month after seed harvest. This was accomplished by spreading a thin layer of timothy hay over the plots to be burned and setting fire to the windward end of the rows.

Nitrogen fertilization treatments were also applied in the experiment. The nitrogen fertilization program consisted of:

Ammonium nitrate: April 12, 1953 and April 12, 1954
Ammonium sulfate: August 11, 1953

The rate was 66 pounds of elemental nitrogen to the acre. Five treatments using nitrogen as a component were used in this experiment. Number one was a 1953-1954 spring application of nitrogen, at the rate of 66 pounds (elemental) per acre, plus Marlate, (24% technical), applied at the rate of one pound per acre in the spring of 1953, and one and one-half pounds per acre in the spring of 1954. Spring applications of nitrogen were used with each of the fall applications of the following herbicides:

2. C-IPC, five pounds per acre, 40% active ingredient.

3. TCA, ten pounds per acre, 90% acid equivalent.

The fourth and fifth treatments used to study fescue seed yield and silver top occurrence included the following:

4. Burning of stubble in August plus application of nitrogen in August.

5. Marlate, spring application of one and one-half pounds per acre, (24% technical).

   Nitrogen, spring application of 66 pounds (elemental) per acre.

   C-IPC, fall application of five pounds per acre, (40% active ingredient).

The above mentioned herbicides and insecticides were applied with a knapsack sprayer in liquid form using water as a carrier.

The various treatments were applied on a field previously planted at four pounds per acre to Chewings fescue, in September, 1951. Rates of seeding at one-half, one, two and four pounds were included

in the original seeding and were considered a part of the experiment. A randomized block design was used, with four replications. All plot rows were 30 inches apart and 43 feet long. Rate of seeding plots were seven rows wide, all other plots being four rows wide.

Counts for silver top were made both years during the heading stage of the grass. In 1953, silver top heads were counted June 23. This was accomplished by counting and recording the diseased heads in the center ten feet of each second row of each plot. On June 14-15, 1954, sampling of fescue panicles took place on rows one and four of the chemically treated plots and the controls. Sampling took place on rows two and six on the "rate of seeding" plots. Six random samples of panicles were taken per plot at a distance approximately ten feet apart. The plot samples were composited and the diseased and healthy panicles were counted and recorded. Percentages of diseased panicles from the plot samples were calculated and recorded. A substantial part (32%) of the tags bearing the numbers of green panicles found in the plot samples for 1954 was lost, as shown in the tables.

The fescue was harvested by hand June 29 and 30 of 1953, and June 28, 29, and 30 of 1954. In 1953, forty foot strips of the two center rows were harvested on all chemically treated and control plots. Rows three and five were harvested on the rate of seeding plots. In 1954 the same procedure was used, with the exception that the harvest rows were shortened by five feet, making their length thirty-five feet.

A rasp type thresher was used to thresh the fescue seed on August 12 and 13, 1953, and August 16-18, 1954. To insure complete separation of the seed from the panicles, the straw was run through the thresher twice. Final cleaning consisted of running the sifted seed through a Clipper cleaner (1-B) twice.

RESULTS AND DISCUSSION

Insecticides, herbicides, nitrogen application, burning, and various combinations of these practices, along with rate of seeding treatments were used on Chewings fescue plots because of the following six possible reasons:

1. Silver top of fescue may be caused or transmitted by an insect, and a control can be obtained by eliminating the disseminating agents with the use of insecticides.

2. Silver top of fescue may be caused or perpetuated by a sod-bound condition existing typically in older stands. This might be eliminated by thinning the fescue stand with herbicidal treatments or variable rates of seeding.

3. The causal agent of silver top may be lodged on the threshed straw and dead stubble after harvest time. Burning the harvest refuse would possibly eliminate the causal agent.

4. Silver top seems to be associated with succulent plants. Therefore, more damage might be noticeable in those plots that were fertilized with nitrogen.

5. Silver top of fescue may be caused by any combination of reasons' 1, 2 or 3. Therefore a combination of the above treatments might be effective in controlling silver top.

The 1954 yield of Chewings fescue seed was low. At least a part of this low yield probably was due to adverse weather conditions as shown in Table I.

TABLE I

TOTAL MONTHLY PRECIPITATION OF APRIL, MAY, AND JUNE OF 1953 AND 1954, AS COMPARED WITH A THIRTY YEAR AVERAGE, 1921-1950
(East Lansing Weather Bureau, East Lansing, Michigan)

Month	Precipitation East Lansing, Michigan		
	30 Year Average 1921-1950	1953	1954
April	2.83	2.88	2.75
May	3.75	1.75	1.52
June	3.37	2.87	4.89

The average monthly precipitation in May of 1954 was less than one-half of the thirty year average of that month. Of the 1.52 inches of rainfall accumulated during this month, only a small portion occurred during the first 28 days. This seriously reduced the yield of Chewings fescue seed which was harvested one month later. Because of the low precipitation in May of 1953, the yield that year was lowered, but not to the same extent as in 1954.

Table II shows the effect of Marlate, DDT, EM1, and combined treatments of Marlate, nitrogen and C-IPC on yield of seed, in comparison to the untreated plots.

Table II shows that there were no significant differences in yield during 1953 with any treatment. In 1954, the highest yield was obtained from the plots sprayed with DDT. Plots treated with Marlate gave yields in both years that varied only slightly from

TABLE II

EFFECT OF INSECTICIDES AND COMBINED TREATMENTS ON YIELD OF CHEWINGS FESCUE AS COMPARED WITH UNTREATED PLOTS

Treatment	Average Yield (Pounds Per Acre)	
	1953	1954
Check	247	136
Marlate (spring of 1953 and 1954)	262	156
DDT (spring of 1953 and 1954)	258	219
EM1 (spring of 1953)[1]	257	---
Marlate (spring of 1954), Nitrogen (spring of 1954) and C-IPC (fall of 1953)[2]	---	9
L. S. D. at 5% level	38	55

[1] Not included in 1954
[2] Not included in 1953

the untreated plots. The one-half pound per acre increase in spray application of Marlate in 1954 gave no appreciable results over the previous application. No significant differences in yield were obtained from plots treated with EM1. The combined treatment of Marlate, nitrogen and C-IPC resulted in stands that were very thin, poor of vigor and extremely low in yield. The herbicide injured the plants to such an extent that the stand was greatly reduced.

Table III shows the effect of spring and fall treatments of TCA and C-IPC on the yield of Chewings fescue, in comparison with untreated plots.

TABLE III

EFFECT OF HERBICIDE TREATMENTS ON YIELD OF CHEWINGS FESCUE AS COMPARED WITH UNTREATED PLOTS

Treatment	Average Yield (Pounds Per Acre)	
	1953	1954
Check	247	136
TCA (spring of 1953)	190	196
TCA (fall of 1953)[1]	---	52
C-IPC (spring of 1953)	68	222
C-IPC (fall of 1953)[1]	---	25
L. S. D. at 5% level	38	55

[1] Not included in 1953

Fall treatments of both TCA and C-IPC resulted in a very decided reduction in yield. Again, as in the combined treatment of Marlate, nitrogen and C-IPC, plants were severely burned by the herbicide, and at first the plots appeared to be a total loss. However, a significant increase in yield was obtained the second harvest year following spring application. This is in striking contrast with the extremely poor yield in 1953. In 1954, no significant differences in yield were obtained between the spring treated plots of TCA and C-IPC, and the plots treated with DDT. This is shown in Figure 2.

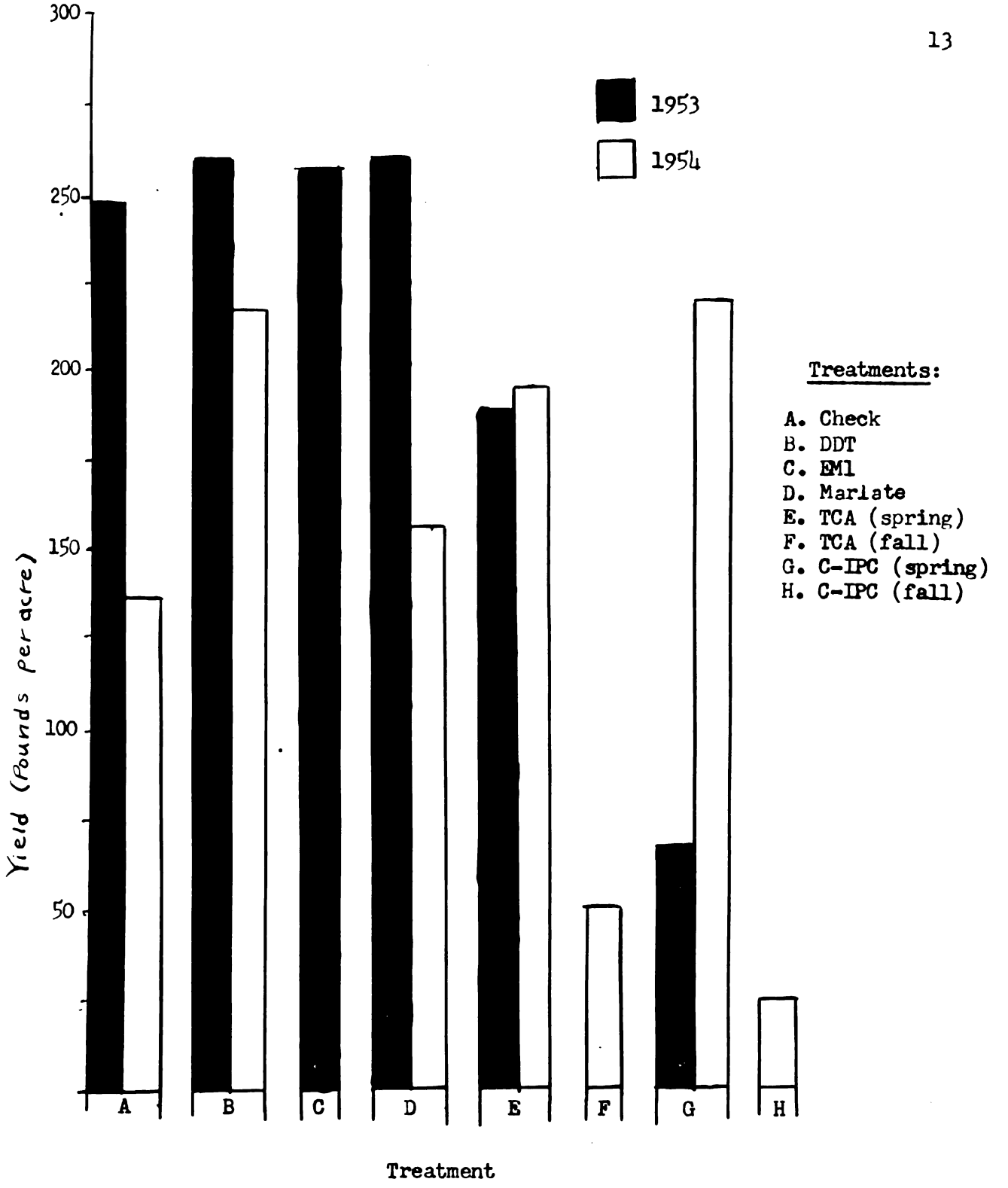


Figure 2. Average yield comparison of insecticide and herbicide treatments on Chewings fescue.

Table IV shows the effect of nitrogen, burning, and the combined treatments, nitrogen with Marlate, nitrogen with C-IPC, nitrogen with TCA, and nitrogen with burning on the yield of Chewings fescue seed, in comparison with untreated plots.

TABLE IV

EFFECT OF CULTURAL AND COMBINED PRACTICES ON YIELD OF CHEWINGS FESCUE AS COMPARED WITH UNTREATED PLOTS

Treatments	Average Yield (Pounds Per Acre)	
	1953	1954
Check	247	136
Nitrogen (spring of 1953 and 1954)	237	210
Burning (August of 1953)[1]	---	269
Burning (August) and Nitrogen (August of 1953)[1]	---	293
Marlate (spring) and Nitrogen (spring of 1953 and 1954)	242	173
TCA (fall of 1953) and Nitrogen (spring of 1954)[1]	---	74
C-IPC (fall of 1953) and Nitrogen (spring of 1954)[1]	---	12
L. S. D. at 5% level	38	55

[1] Not included in 1953

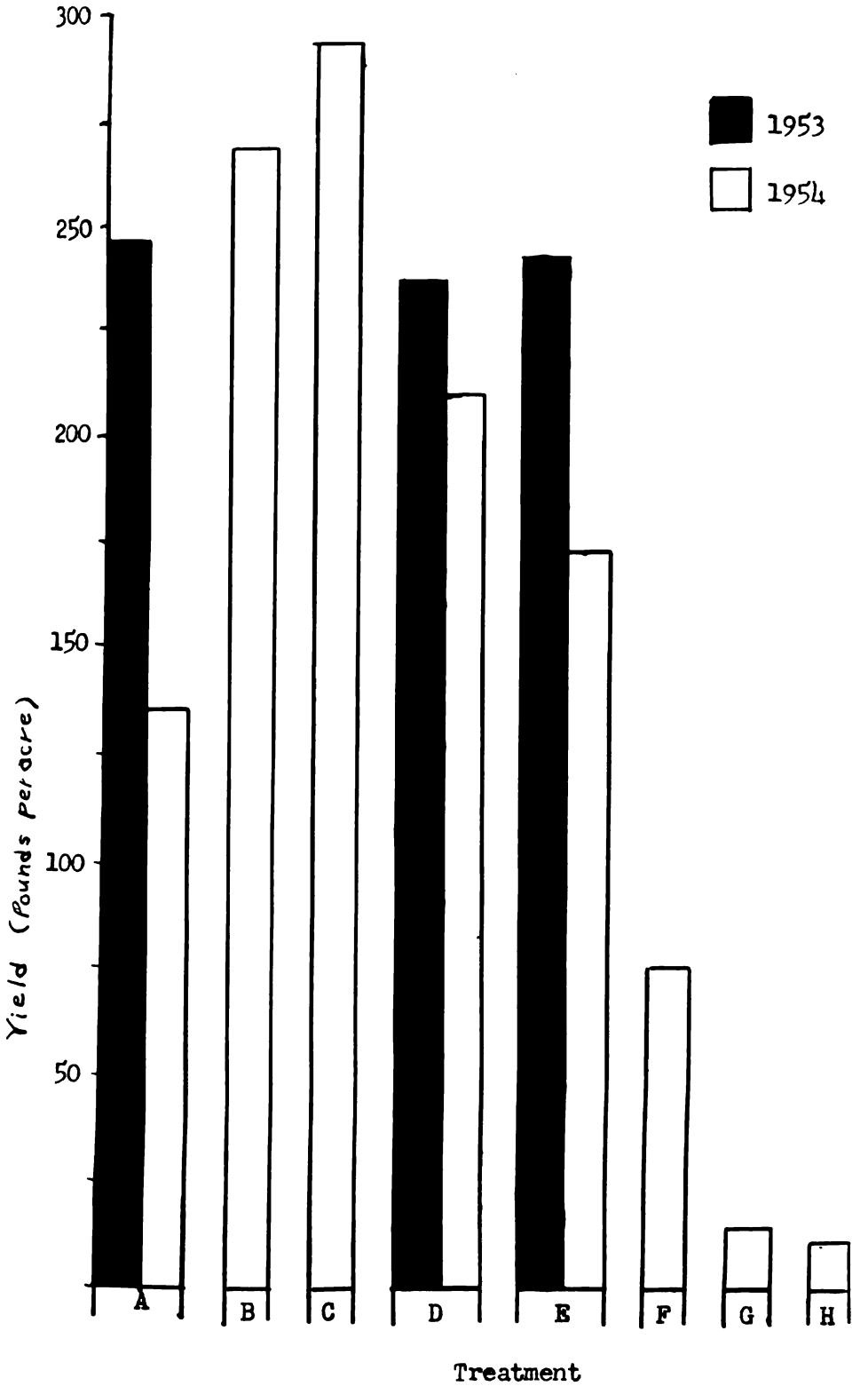
No plot yielded significantly more than the check, in 1953. In 1954, the highest yield obtained was from burning of stubble in August *after* harvest, plus nitrogen application in August. Burning in

August alone and nitrogen application alone also gave significant yield increases in comparison with the untreated plots. There was also a significant difference between burning in August plus nitrogen treatment, and nitrogen application alone. Plots burned in August and fertilized with nitrogen yielded more than those spring treated with C-IPC, TCA, and DDT. The plots treated with C-IPC plus nitrogen, and TCA plus nitrogen gave extremely low yields, (Figure 3). Again, as illustrated previously, the herbicide burned the plant to such an extent that many plants were lost and the stand was thinned considerably. The treatment, Marlate plus nitrogen gave a yield comparable to that of the untreated plots.

Figure 4 shows the effect of one-half pound, one pound, two pounds, and four pound rate of planting per acre on yield.

In 1953, yields were approximately the same regardless of rate of seeding. In 1954, seed yields decreased as rate of seeding increased. During this year, the plots burned in August plus nitrogen significantly out-yielded the one-half pound rate of seeding by 81 pounds, and the one pound rate by 89 pounds (per acre). This would indicate that higher yields might have resulted if the treatment burning plus nitrogen could have been applied to a lighter rate of seeding.

Table V shows the effects of insecticides, herbicides, burning, nitrogen, and the nitrogen-Marlate combined treatment on silver top occurrence in 1953.



Treatment:

A. Check
B. Burning
C. Burning and nitrogen
D. Nitrogen
E. Nitrogen and Marlate
F. Nitrogen and TCA
G. Nitrogen and C-IPC
H. Nitrogen, Marlate and C-IPC

Figure 3. Average yield comparison of cultural and combined practices on Chewings fescue.

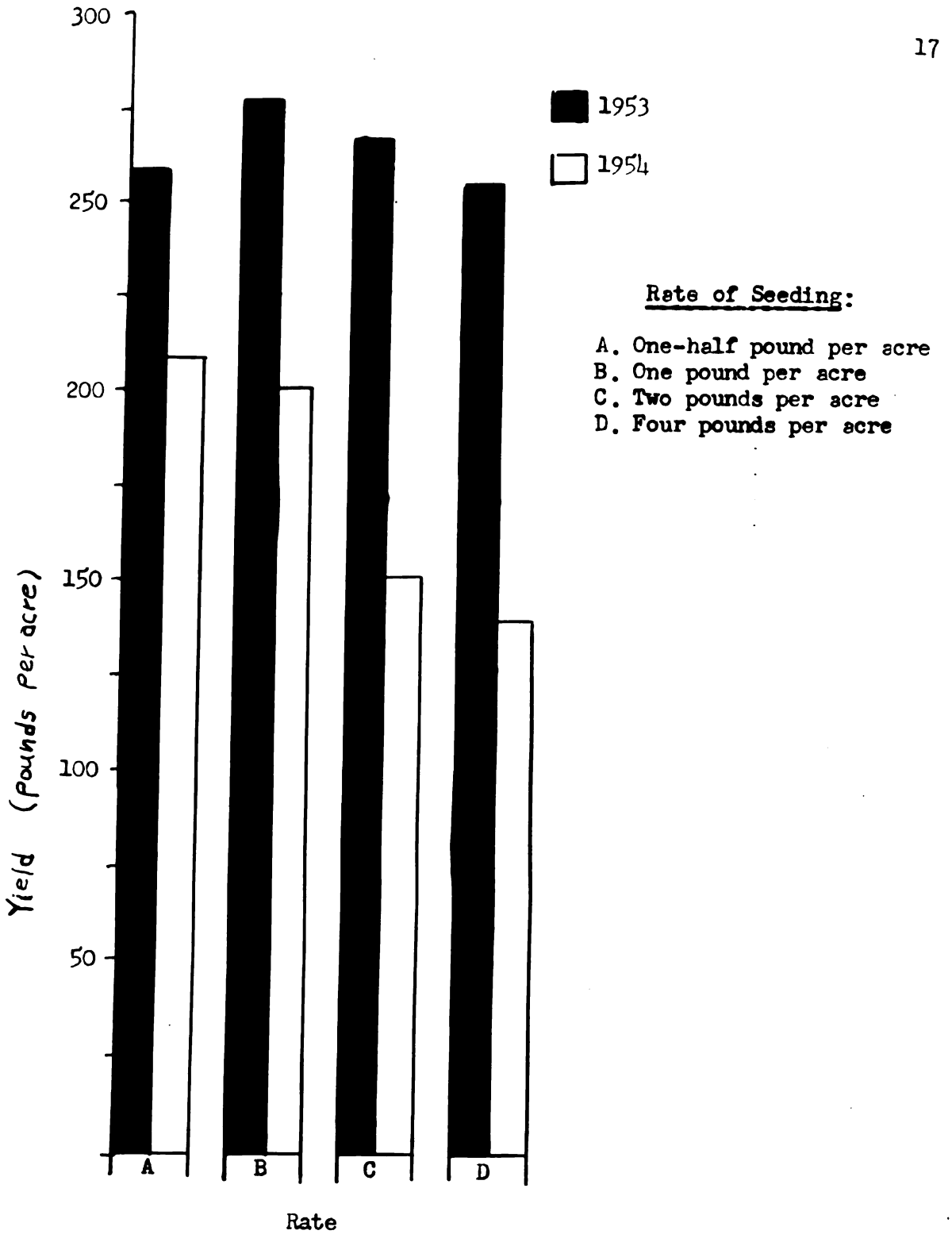


Figure 4. Average yield comparison of rate of planting experiment on Chewings fescue.

TABLE V

EFFECT OF INSECTICIDES, HERBICIDES, NITROGEN FERTILIZATION, BURNING AND NITROGEN COMBINED TREATMENTS ON SILVER TOP OCCURRENCE OF CHEWINGS FESCUE AS COMPARED WITH THE UNTREATED PLOTS IN 1953

Treatment	1953* Silver Top Occurrence
Check	36
Marlate (spring of 1953 and 1954)	24
DDT (spring of 1953 and 1954)	22
EM-1 (spring of 1953)	21
TCA (spring of 1953)	38
C-IPC (spring of 1953)	5
Nitrogen (spring of 1953 and 1954)	39
Marlate (spring) and Nitrogen (spring of 1953 and 1954)	28

* Actual count of silver top panicles, per ten foot row.

With the exception of the plots treated in the spring with C-IPC, no noticeable difference existed in the amount of silver top between the means of all treatments and the untreated plots in the first year. Although the 1953 count of the diseased heads were low in the plots treated with C-IPC in the spring, it must be noted that the yield of seed was also extremely low, as was indicated by the near loss in stand.

Table VI shows the effect of one-half pound per acre, one pound per acre, two pounds per acre, and four pounds per acre rates of seeding on silver top occurrence of Chewings fescue in 1953.

TABLE VI

EFFECT OF RATES OF PLANTING ON SILVER TOP OCCURRENCE OF CHEWINGS FESCUE IN 1953

Rate of Planting	1953* Silver Top Occurrence
One-half pound per acre	12
One pound per acre	37
Two pounds per acre	26
Four pounds per acre	25

* Actual count of silver top panicles, per ten feet of row.

The most effective rate of planting from the standpoint of silver top control was that of the lightest seeding. Other rates showed little promise of control.

Table VII shows the effects of insecticides, herbicides, burning, nitrogen and nitrogen combined treatments on silver top occurrence, in comparison with the untreated plots in 1954.

Plots burned in August plus nitrogen application in August; burning in August; spring application of DDT; and spring application of C-IPC gave a very effective control of silver top. Because of the extremely low seed yield obtained from the plots treated in the spring with C-IPC in 1953 (Table III), the treatment must be considered as economically unsound. The combined treatment of Marlate, nitrogen and C-IPC was omitted because of missing data.

TABLE VII

EFFECT OF INSECTICIDES, HERBICIDES, NITROGEN FERTILIZATION, BURNING, AND NITROGEN COMBINED TREATMENTS ON SILVER TOP OCCURRENCE OF CHEWINGS FESCUE AS COMPARED WITH THE UNTREATED PLOTS IN 1954

Treatment	1954 Silver Top Occurrence		
	Total Heads Collected	Silver Top Heads	Percent Silver Top Heads
Check	593	51	7.7[a]
Marlate (spring of 1953 & 1954)	667	49	6.6[a]
DDT (spring of 1953 & 1954)	510	4	0.6[a]
TCA (spring of 1953)	746	164	17.9[a]
TCA (fall of 1953)	900	282	26.9[a]
C-IPC (spring of 1953)	394	4	0.9[b]
C-IPC (fall of 1953)	559	75	12.8
Nitrogen (spring of 1953 & 1954)	716	78	10.6
Burning (August of 1953)	1371	7	0.6[b]
Burning (August) and Nitrogen (August of 1953)	1053	6	0.6[a]
Marlate (spring) and Nitrogen (spring of 1953 & 1954)	654	65	10.8[b]
TCA (fall of 1953) and Nitrogen (spring of 1954)	629	167	23.4[a]
C-IPC (fall of 1953) and Nitrogen (spring of 1954)	620	133	21.5[b]

[a] Only three replications used
[b] Only two replications used

Table VIII shows the effect of seeding one-half pound, one, two and four pounds per acre on silver top occurrence of Chewings fescue in 1954.

TABLE VIII

EFFECT OF RATES OF PLANTING ON SILVER TOP OCCURRENCE OF CHEWINGS FESCUE IN 1954

Rate of Planting	Silver Top Occurrence		
	Total Heads Collected	Silver Top Heads	Percent Silver Top Heads
One-half pound per acre	923	35	3.4*
One pound per acre	939	84	9.8
Two pounds per acre	676	69	10.2*
Four pounds per acre	671	58	8.2*

* Only three replications used

The most effective rate of planting from the standpoint of silver top control was that of the lightest seeding. The seed yield from this rate of seeding was also significantly higher, (Figure 4). Other rates showed little promise of control.

SUMMARY

1. The effects of DDT (50% wettable); Marlate (24% technical); EM-1 (concentrate); TCA (Dow sodium, 90%); C-IPC (40%); nitrogen (66 pounds elemental); burning, and combinations thereof on seed yield and silver top occurrence on Chewings fescue were studied.

2. The effects of sowing one-half, one, two, and four pounds of seed per acre on seed yield and silver top occurrence were also studied.

3. Yields of all plots were low, chiefly due to climatic conditions. In general, the best yields were obtained from the 1953 harvest.

4. No significant increase in yield between the means of all treatments, including rates of planting, and the untreated plots were obtained the first year.

5. The second year, significant increases in yield and noticeable decreases of silver top occurred between the means of the following treatments and untreated plots in order of effectiveness:

a) Burning of stubble in August plus application of nitrogen in August.
b) Burning of stubble in August.
c) Spring application of C-IPC, (second year yields only).
d) Spring application of DDT.
e) Spring application of nitrogen.

6. With the exception of the burning treatment, burning coupled with nitrogen gave seed yields that were significantly higher than any other treatment, treatment combination, or rate of planting.

7. Treatments which included TCA or C-IPC, in the spring of the harvest year, resulted in a very decided reduction in vigor and seed yield that year.

8. The lightest rate of planting (one-half pound per acre) was the most effective in controlling silver top and increasing yield of seed. This varied inversely as the rates were increased.

9. Higher yields and more effective silver top control might have resulted if the burning and nitrogen treatment could have been applied to a lighter rate of seeding.

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