CHEMICAL CONTROL OF DOWNY BROME-GRASS (BROMUS TECTORUM L.) IN AN ESTABLISHED ALFALFA FIELD

Thesis for the Degree of M. S.

MICHIGAN STATE COLLEGE

Mark G. Wiltse

1952

THESIS

This is to certify that the

thesis entitled

Chemical Control of Downy Bromegrass (Bromus Tectorum) In An Established Alfalfa Field.

presented by

Mark G. Wiltse

has been accepted towards fulfillment of the requirements for

M.S. degree in Farm Crops

R. P. Churchill
Major professor

Date Aug. 13, 1952

O-169

CHEMICAL CONTROL OF DOWNY BROME-GRASS (Bromus tectorum L.) IN AN ESTABLISHED ALFALFA FIELD

By

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A THESIS

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

1952

ACKNOWLEDGMENT

Acknowledgment is due to Professor Boyd R. Churchill for his kind assistance, advice, and encouragement in making this thesis possible.

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TABLE OF CONTENTS

INTRODUCTION

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Downy brome-grass (Bromus tectorium L.) is a problem in pastures, hayfields and waste places on the light sandy soils of southern Michigan. It generally behaves as a winter annual but it occasionally behaves as an annual.

Downy brome-grass can be controlled easily in a cultivated field since it reproduces only by seeds. Cultivating the fields in the fall or spring after the seeds have germinated will give adequate control. Since hayfields and pastures are not clean cultivated, downy brome-grass often becomes a serious problem.

When pasturing or feeding hay infested with downy brome-grass, the awns of the seed may cause irritation of the mouths of the animals. The awns may also affect animals by lodging in their nostrils, eyes, and intestines. Downy brome-grass is very drought resistant and competes with alfalfa for the use of water when the available water supply is low.

Because of these various reasons it is desirable to eliminate downy brome-grass in hay and pasture crops. Attempts have been made by farmers to reduce downy brome-grass by cutting the hay crop early or by pasturing early. If the seeding is worked up and the field reseeded, it entails considerable expense to the farmer in labor, machine expense, and grass seed.

If an economical method of controlling downy brome-grass can be perfected, it will be a help to the grass land farming areas of southern Michigan and elsewhere. The chemical control of downy brome-grass shows promise at this time.

REVIEW OF LITERATURE

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Megee (4)* found that downy brome-grass behaved mostly like a winter annual but that some seedlings are annuals. In germinating seeds at different times of the year, he found the seeds did not germinate during mid-summer but germinated in September when the fall rains fell. He attributed the fact that there was no germination in mid-summer to the dryness at this time of the year and that there was a rest period which the seed must go through before germination would take place. Megee also found that if the seeds were allowed to mature past May 15th they would germinate and cause a serious infestation. The seeds germinated less than 50% when they were harvested in the dough stage. The seedlings that became well established in the fall produced an abundance of seed the following spring. The downy brome-grass seedlings that were not well established by the latter part of October produced very little seed the next season.

There has been little work reported on the use of chemicals for controlling downy brome-grass. Darlington, Bessey, Megee and Grigsby (1) recommended the use of stoddard solvent for the control of small patches of this weed and they further state that it should be applied before the plant heads out.

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* Number in parenthesis refers to bibliography, page 32 .

The chemicals used most in the research reports of the North Central Weed Control Conference for the control of weedy bromes have been isopropyl-N phenyl-carbamate (IPC)* and trichloro acetic acid (TCA)*. Grigsby, Churchill, Hamner, and Carlson (3) state that IPC will kill annual grasses, cultivated grains and, under some conditions, perennial grasses. They state that IPC will also kill or injure some broad-leaved plants. IPC exerts a toxic action on the roots of grasses. It has a residual action, but decomposition is rapid and no further effects are found in most soils after a period of two to four weeks. An application of 2 to 5 pounds of IPC per acre may give control of annual grasses.

Darlington, et al. (1) state that the sodium salt of TCA has given good control of quack grass and most annual grasses. It is toxic to all parts of all plants, but it is most effective when applied as a soil treatment. Treatments may be made at any season of the year but are most effective in the fall and early spring. Soil which has been treated with TCA will not be suitable for crop plant growth for 30 to 90 days following treatment. They further state that 5 to 10 pounds per acre applications may be sufficient for the control of annual grasses if applied when the grass seeds are germinating.

TCA may cause injury to the legume crops when applied to the soil in which these plants are growing according to preliminary results obtained by Grigsby, et al. (3).

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* These chemicals will be referred to as IPC and TCA.

Finnerty, Klingman, and Shafer used both TCA and IPC in an attempt to control weedy bromes in a Nebraska experiment. Applications were made in the late fall and in the early spring. IPC at 10 pounds gave 60% control in the spring treatments and 70% control in the fall, while the 20 pound rate gave 87% and 90% control, respectively. Sodium TCA at 10 pounds and 15 pounds per acre gave over 90% control. They stated that all rates of IPC or TCA which gave 80% or better control of the weedy bromes reduced the smooth brome grass stands from 16% to 93%. Neither of these materials gave satisfactory selective control in perennial grass stands; however, IPC and TCA did give satisfactory control of the weedy bromes.

Watson (9) sprayed an established field of alfalfa that was infested with downy brome-grass and quackgrass with sodium TCA. The spray was applied at the rate of 100 gallons per acre in November when the downy brome-grass was two to three inches high. All rates of ten pounds per acre and higher eliminated the downy brome-grass. Slight alfalfa injury was noticed on the alfalfa the following spring with the seventy-five pound rates and higher. This injury was not apparent by cutting time.

Shafer (7) sprayed alfalfa for the control of annual weeds in Nebraska. He found that IPC at 2 and 8 pounds per acre effectively controlled little barley, green and yellow foxtail, and barnyard grass but with injury to the alfalfa.

Miller and Dunham (5) did some additional work on the effect of IPC and TCA on legumes. Applications of 10.6 and 5.3 pounds acid equivalent TCA and 8 and 4 pounds IPC were applied in the spring when the alfalfa

was four inches high and on other plots immediately after the first hay crop. Alfalfa was not damaged by the TCA and showed only slight burning with the IPC at the first date of application. TCA reduced the stands of foxtail while IPC gave no weed control. No damage was noticed in the alfalfa at the second date of application.

Peters and Willard (6) applied TCA at rates of 0, 10, 20, 40, and 80 pounds per acre on alfalfa. The applications were made on July 18, October 12, November 15, 1950 and on April 5, 1951. In the July application, 20 pounds and above gave very little damage to the alfalfa but in the following spring the alfalfa density was reduced to 10% and 50% of the check at the 80 pound and 20 pound rate, respectively. In the October application, some temporary effects were noted in the spring of 1951 but by June 7, 1951 no evidence of treatment could be noticed in the alfalfa. The November application had no effect on the alfalfa. The April treatments reduced the density and height of the alfalfa slightly at the 10 and 20 pound rates. At the 40 and 80 pound rates, the height of growth decreased one-half and two-thirds respectively; although, there was little change in density. Leafhopper damage was greater at the higher rates of application.

Shafer and Finnerty (8) used IPC as a soil treatment at 3, 6, and 9 pounds per acre on 100 germinating seeds of four different grasses, namely: crabgrass, downy brome-grass, yellow foxtail, and hairy chess. Seedling counts were made at two weeks. IPC at 6 and 9 pounds per acre gave kills approaching 100% on all four grasses.

MATERIALS AND METHODS

MATERIALS AND METHODS

An experiment was conducted to determine the best stage to apply herbicides to downy brome-grass to get the best kill. Fifty downy brome-grass seeds were seeded on one square yard plots on April 22, 1952 at East Lansing, Michigan. The soil was a clay loam. The seeds had been harvested on November 1, 1951.

TCA* was sprayed on the plots with a hand sprayer at 5 and 10 pound rates at seeding time, emergence (May 6th), two weeks after emergence (May 20th), and four weeks after emergence (June 3rd). The applications were run in triplicate and randomized.

Seedling counts were made on June 23rd. The seedlings were cut off at the ground level on the same date and placed in a drier. From this data the number of plants, total dry weight, and weight per plant were determined. The stage at which the downy brome-grass plants were the most susceptible was determined by this time of application experiment. To determine when the plants would reach this stage under natural conditions additional experiments were made.

A germination experiment was conducted in December of 1951 at the Farm Crops Greenhouse at Michigan State College. This experiment was designed to determine if the downy brome-grass seeds would germinate in warm weather of summer as well as cool weather of fall. Both old and

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* The TCA used in all of these experiments was the sodium salt of trichloro acetic acid with 90% acid equivalent.

new seeds were used in the experiment to get an idea of how dormancy might influence the germination at the various temperatures. The old seed was one year old and had been obtained from screenings. The new seed was harvested on November 1, 1951 from plants growing on the college farm. Four different temperatures were used approximating 40, 55, 68, and 85 degrees Fahrenheit. The 40 degree test was placed in a refrigerator set at this temperature. Different rooms were used in the green house for the 55, 68 degree tests. A germinator was used for the 85 degree test. All of the tests were made in plastic boxes that were 4 1/2 by 4 1/2 inches. Fifty seeds were seeded in quartz sand to a depth of 1/4 inch in each box. Seedling counts were made at the end of two weeks.

The length of the dormancy period of seeds harvested at different stages of maturity was the basis for another germination experiment. Downy brome-grass seeds were harvested in the milk stage (June 9, 1951) in the soft dough stage (June 16th), and in the hard dough stage (June 23rd). Nine days after the last harvest date germination tests were made on the different lots of seeds. To determine what effect dormancy had on the seeds, the dormancy was broken in part of the seeds by treating them with a 0.2% KNO_3 solution and by subjecting them to a 5 degrees Centigrade temperature for five days. Both the treated and untreated seeds were tested in triplicate. One hundred seeds were planted in 4 1/2 inch by 4 1/2 inch plastic boxes at a depth of 1/4 inch in quartz sand. The seeds were then germinated under outdoor temperature and light conditions as prevailed at Ellsworth, Michigan in July, 1952. Seedlings

were counted ten days after seeding. Identical tests were made at ten day intervals to try and determine how long it would take to break the dormancy under natural conditions. The germination dates were July 2, July 12, and July 22, of 1952.

The actual spraying of an alfalfa field infested with downy brome-grass was conducted on a light, gravelly loam twelve miles west of Pontiac, Michigan. The alfalfa field was one year old and was heavily infested with downy brome-grass and scattered areas of Kentucky blue grass.

Fifty-one plots, twenty-five feet by seventeen and one-half feet (0.01 acre), were laid out in the field. By observation, each plot was rated as to the content of downy brome-grass. The classifications used were heavy, medium, light and no downy brome-grass.

The sodium salt of trichloroacetic acid (TCA) and iso-propyl-N phenyl carbamate (IPC) were the chemicals used as herbicides. The herbicides were used at 1, 5, 10 and 20 pound per acre rates. Fall applications were applied on October 31, 1951 when the downy brome-grass seedlings were approximately two inches high. The spring applications were made on April 26, 1952 after spring growth had started. The plots were randomized in triplicate.

A knapsack sprayer with two fan type nozzles mounted eighteen inches apart was used for spraying. Ninety gallons of water per acre was used for the TCA in the fall and spring and also for the 1 and 5 pound rates of IPC in the fall. The 10 and 20 pound rates of IPC in the fall was

applied with 135 gallons of water per acre. All of the spring applications of IPC were applied with 180 gallons of water per acre.

At the time of harvest, June 7, 1952, the plots were rated by observation as to the amount of control of the downy brome-grass. The ratings used were excellent, medium or poor control. Observations were also made at this time to determine the extent of damage to the alfalfa and to note the deformation of the vegetation. Three foot alley ways were cut around all plots and a 0.001 acre portion harvested through the middle of each plot to determine yields.

Samples were taken and botanical separations made to determine the percentage of downy brome-grass on a dry weight basis. Samples were also taken to determine the moisture percentage. With this experiment the actual effects of the rates, time of application, and type of herbicide upon the downy brome-grass and alfalfa was determined.

RESULTS AND DISCUSSION

RESULTS AND DISCUSSION

In all of the experiments conducted for this problem, the ultimate objectives have been to determine: (1) what herbicides to use to kill downy brome-grass in alfalfa, (2) how many pounds of the herbicide to apply per acre to obtain the best kill of the downy brome-grass with the least damage to the alfalfa, and (3) at what time of the year the application of the herbicide would control the downy brome-grass best and harm the alfalfa the least.

Time of Application Experiment

Table I shows the effect of applying TCA at 5 and 10 pound per acre rates to downy brome-grass at various stages of growth.

TABLE I

EFFECT OF THE TIME AND RATE OF APPLICATION OF TCA ON THE NUMBER OF DOWNY BROME-GRASS PLANTS AND THEIR DRY WEIGHT

Applications of TCA		Number of Plants	Total Dry Weight in Grams	Dry Weight Per Plant In Grams
Rate Pounds Per Acre	Time			
Check	Check	14.3	22.0	1.54
5	Seeding	5.6	4.4	0.77
5	Emergence	9.3	10.0	1.08
5	2 weeks after emergence	12.0	17.3	1.44
5	4 weeks after emergence	10.0	6.3	0.63
10	Seeding	1.7	0.01	0.01
10	Emergence	4.3	1.0	0.23
10	2 weeks after emergence	14.7	7.0	0.48
10	4 weeks after emergence	4.7	2.8	0.60

The ten pound per acre rate reduced the number of plants per plot more than the five pound rate except at the'two weeks after emergence' stage. The number of downy brome-grass plants were the least in both the five pound and ten pound rates when the herbicide was applied at seeding time. There were more downy brome-grass plants when the herbicide was applied at the 'two weeks after emergence' stage than when applied at the 'four weeks after emergence' stage. This may have been due to the fact that rain fell for six consecutive days after applying the herbicide at the 'two weeks after emergence' stage, and the total amount of rain in this period was 3.3 inches. This excessive amount of rainfall may have rendered the TCA less active, or the 'two weeks after emergence' stage may be a period in the plant's growth when it is more resistant to the herbicide. The comparison of the number of plants per plot when sprayed with TCA at both 5 and 10 pounds per acre rates at four different stages of growth is shown in Figure 1.

The total dry weight of all the downy brome-grass plants was the least when the TCA was applied at seeding time for both the 5 and 10 pound per acre rates. The 10 pound per acre rate of TCA reduced the total dry weight more than the 5 pound rate. The 'two weeks after emergence' stage of spraying produced the most dry weight at both rates. A graphic comparison of the total dry weight yields is shown in Figure 2.

A comparison of the dry weight per plant of downy brome-grass when sprayed with TCA at two rates and at four different stages is shown in Figure 3.

Figure 1 Comparison of the number of plants of downy brome-grass after applications of TCA at two rates and at four application dates.

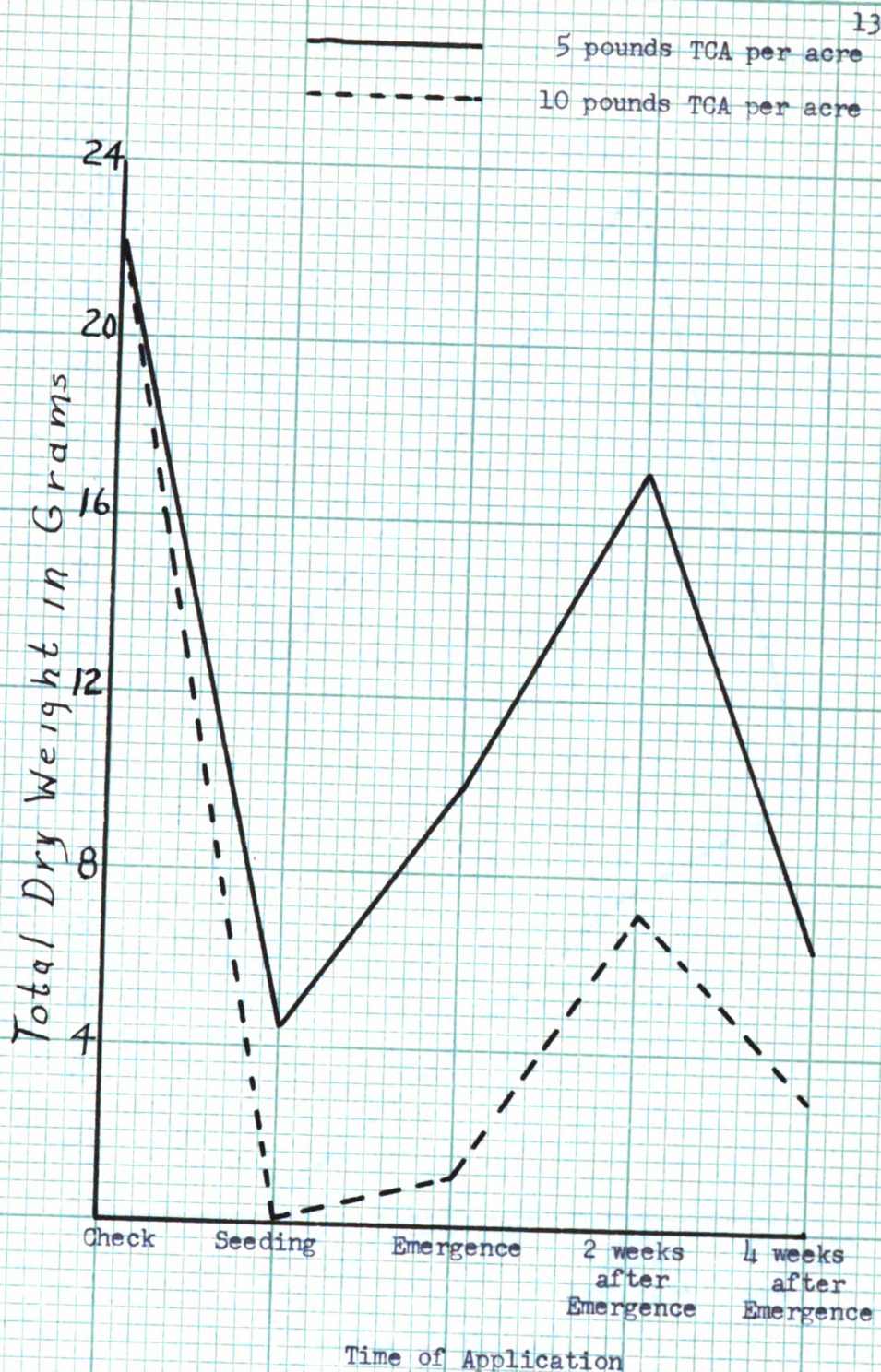


Figure 2 Comparison of the total dry weight of downy brome-grass when sprayed with TCA at two rates on four different dates.

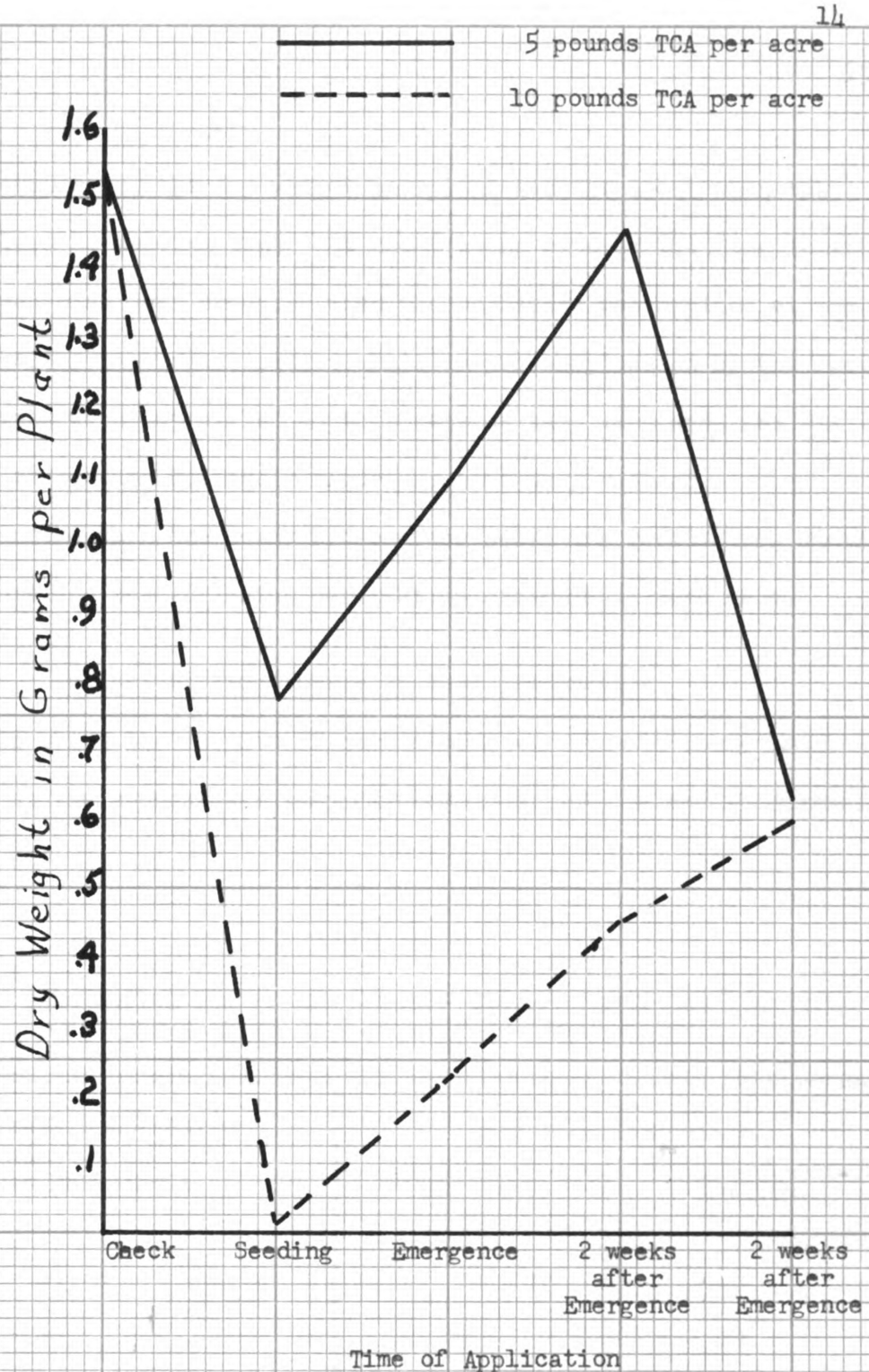


Figure 3 Comparison of dry weight per plant of downy brome-grass treated with two rates of TCA on four dates.

At the 10 pound rate, the dry weight per plant was the least when the TCA was applied at seeding time. At the 5 pound rate of TCA, the least dry weight per plant was produced when the herbicide was applied at the 'four weeks after emergence' stage. This is probably caused by the fact that the plants were not killed at this rate as they were when the TCA was applied at seeding but their vigor was seriously reduced.

To determine when the downy brome-grass seeds are germinating under natural conditions the following germination experiments were made.

Effect of Temperature on Seed Germination

Table II shows the results of germinating new and old downy brome-grass seeds at the approximate temperatures of 40, 55, 68 and 85 degrees Fahrenheit.

TABLE II

EFFECT OF GERMINATING NEW (2 MONTHS OLD) AND OLD (OVER ONE YEAR OLD) DOWNY BROME-GRASS SEED AT VARIOUS TEMPERATURES

Approximate Temperature Germinated In Degrees Fahrenheit	Percent Germination	
	Old Seed	New Seed
40	0	0
55	85	87
68	86	81
85	92	80

There was no germination of either new or old seeds at the 40 degree Fahrenheit temperature. The germination of the old seed was 85% at the 55 degree temperature and it increased to 92% at 85 degrees. The germination of the new seed reversed this increase in germination with the increase in temperature and gave 87% germination at the 55 degree temperature and only 80% germination at 85 degrees. Figure 4 shows this trend graphically.

It was also interesting to note that the seedlings from the new seed emerged first at the lower temperatures while the seedlings from the old seed emerged first at the higher temperatures.

These results indicate that the downy brome-grass seeds will germinate at the higher temperatures if there is no inhibitory factors acting upon the seeds. This would indicate that the downy brome-grass seeds will germinate in mid-summer if sufficient moisture is present and there is no dormancy in the seeds. The different germination characteristics of the new and old seed shows that there is some dormancy in downy brome-grass.

Effect of Dormancy on Germination

Table III shows the results of germinating downy brome-grass seeds that were harvested at three stages of maturity and germinated at ten day intervals. Part of the seeds were treated to break the dormancy.

When the seeds were harvested at the milk stage and soft dough stage they gave less germination, in both the treated and untreated lots, than when the seeds were harvested at the hard dough stage. The seeds that

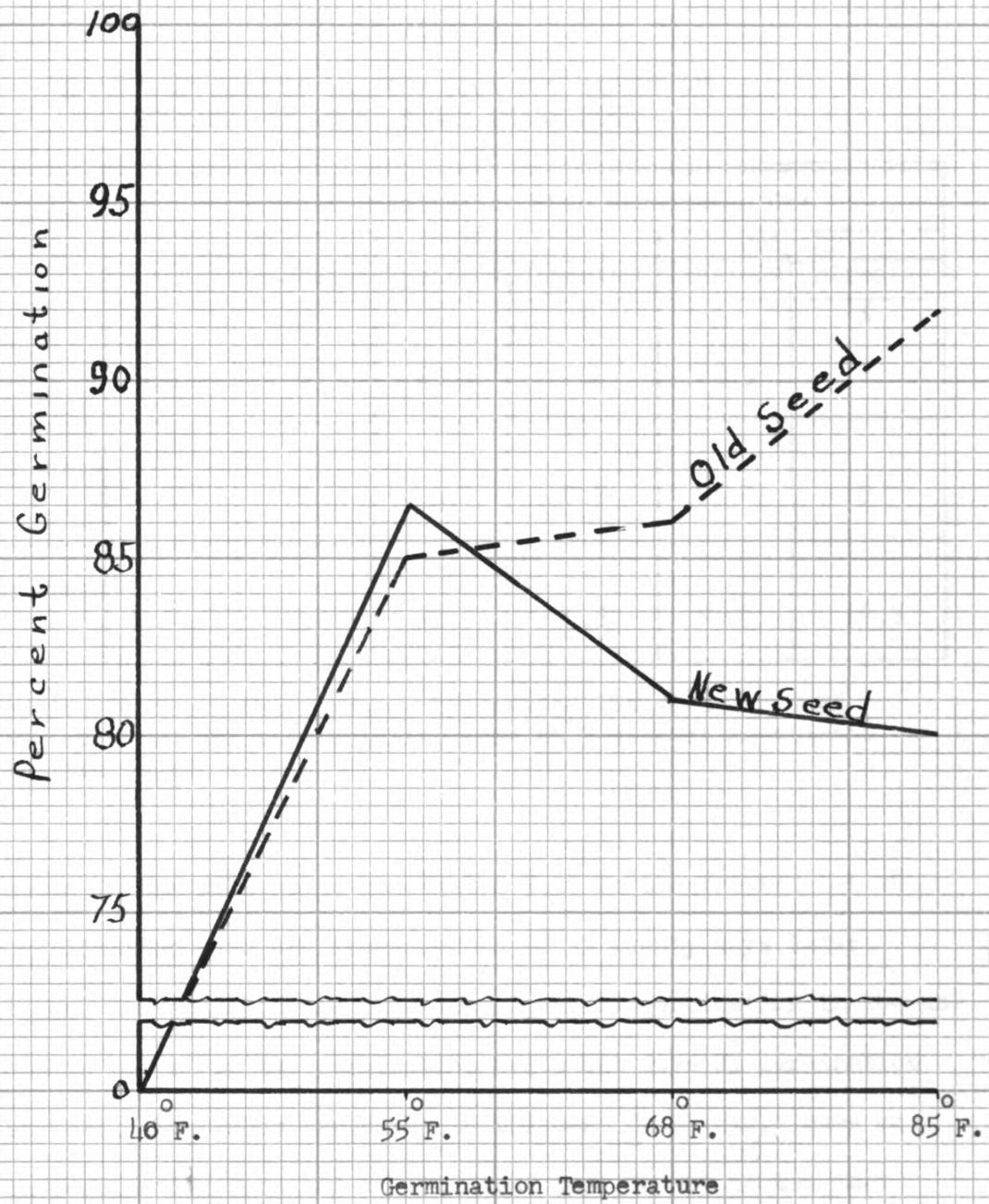


Figure 4 Comparison of new and old downy brome-grass seeds when germinated at various temperatures.

TABLE III

EFFECT OF DATE OF HARVEST UPON THE EXTENT OF DORMANCY OF DOWNY BROME-GRASS SEED

Time and Stage Seeds Were Harvested	Percent Germination When Germinated On:					
	July 2		July 12		July 22	
	Treated*	Untreated	Treated*	Untreated	Treated*	Untreated
	%	%	%	%	%	%
Milk stage (June 9)	5.3	0	23.3	0	28.3	2
Soft dough stage (June 16)	12.7	0	4.7	0.7	91.0	0
Hard dough stage (June 23)	86.0	2.7	95.3	45.3	96.0	47.3

* Treated to break the dormancy by soaking the seeds in 0.2% KNO_3 solution and then chilling them at 5 degrees Centigrade for five days.

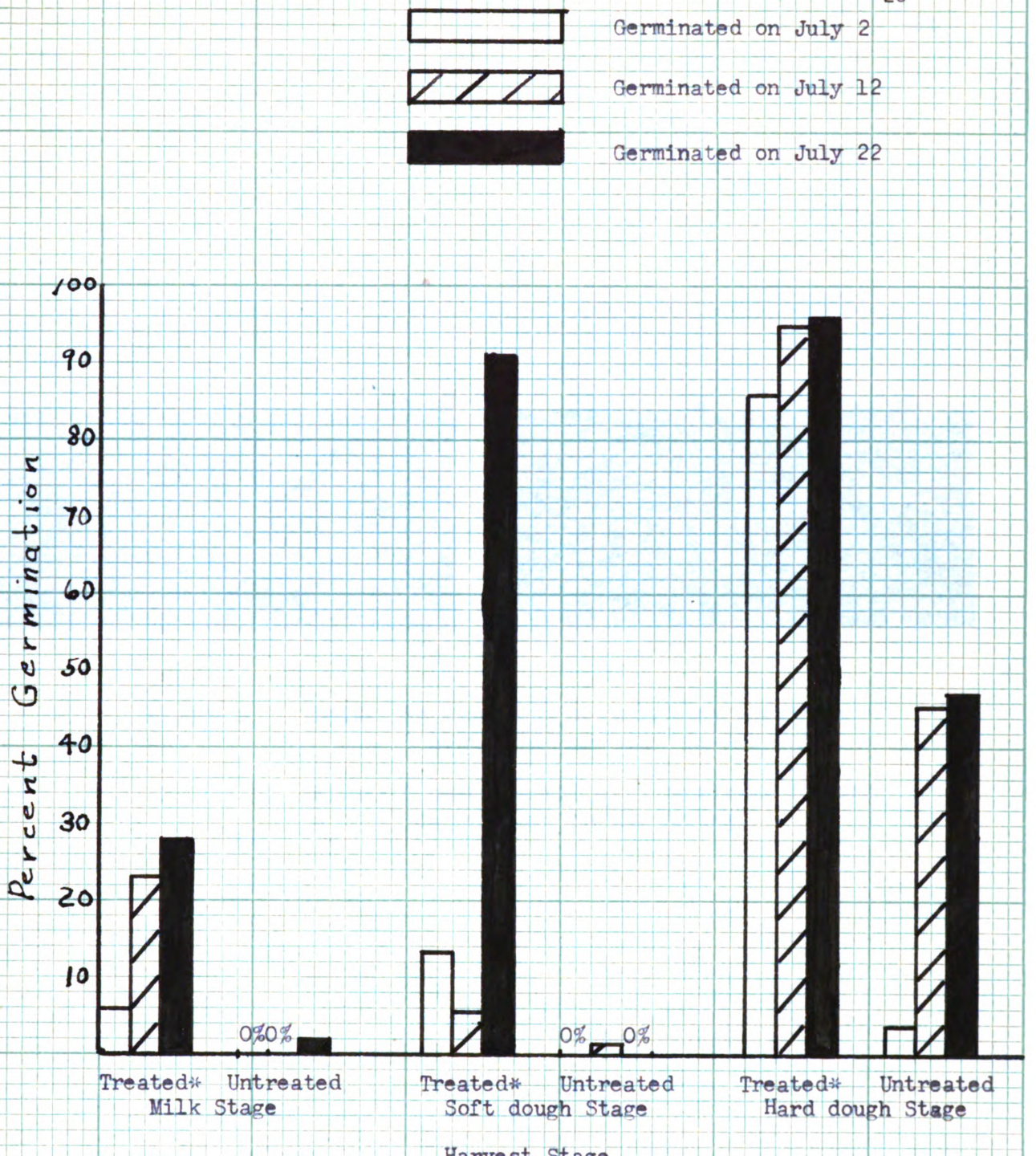
were harvested in the milk stage germinated 5.3% in the treated lot at the first germination date and increased to 28.3% twenty days later. Seeds that were harvested in the milk stage gave no germination in the untreated lots in the first two germination tests but gave 2% germination on the last test. The seeds harvested in the hard dough stage gave an increase in germination from 86% in the first test to 96% in the last test when the seeds were treated. When the seeds were not treated the increase was from 2.7% on the first test to 47.3% on the last test. The seeds harvested at the soft dough stage increased in germination from 12.7% to 91% in the treated lots in the first and last germination tests,

respectively. The seeds harvested in the soft dough stage gave 0.7% germination on the second germination test in the untreated lots of seed but no germination on the first and third germination tests. Figure 5 shows these results graphically.

Control of Downy Brome-Grass in the Field

The effect of TCA and IPC upon the alfalfa and downy brome-grass was evident in the dry weight yield and also by observation. Poor control of the downy brome-grass was observed when TCA was applied at 1 and 5 pound per acre rates in both the spring and fall. It was estimated that the control of the downy brome-grass at these rates was less than 40%. IPC gave medium control at the 1 pound rate at both the fall and spring applications. The fall application was estimated at about 50% control while the spring application was rated at about 45% control. At the 5 pound per acre rate of IPC the spring application gave medium control while the fall application gave excellent control. The excellent control rating was considered to approximate 100% control. Figure 6 shows a poor control plot with an excellent control plot.

TCA gave medium control in the fall application at the 10 pound per acre rate, while in the spring poor control was obtained with the same rate. The 20 pound per acre rate of TCA in the fall application gave control slightly less than excellent while with the spring application only slightly better than medium control was obtained. Figure 7 shows two adjoining plots; one being sprayed in the spring and the other in the fall at 20 pounds per acre of TCA.



* Treated to break the dormancy by soaking the seeds in .2% KNO_3 solution and then chilling them at 5 degrees Centigrade for five days.

Figure 5 Comparison of the extent of dormancy of downy brome-grass seeds, harvested at three stages of maturity, when germinated at ten day intervals.

Figure 6 Left: An excellent control plot receiving 5 pounds IPC per acre in the fall.

Right: A poor control plot receiving 1 pound TCA per acre in the spring.

Figure 7 Left: A plot sprayed with 20 pounds TCA per acre in the fall.

Right: A plot sprayed with 20 pounds TCA per acre in the spring.

The plots that were sprayed with IPC at the 20 pound per acre rate showed some alfalfa injury in both the fall and spring applications. The downy brome-grass that remained in the plots sprayed with IPC at 5 pounds per acre and more in the spring was stunted. These downy brome-grass plants were only about four inches high but they were heading out. The Kentucky blue grass was stunted and was not heading out in the plots sprayed with 10 and 20 pounds per acre of IPC in the fall. This effect is shown in Figure 8.

Some injury to the alfalfa was observed when the TCA was applied at the 20 pound rate in both the spring and fall applications. A slight yellowing of the leaves of the alfalfa was very evident in the spring applications.

IPC gave excellent control in the fall and spring applications with the 10 and 20 pound per acre rates. Figure 9 shows a plot sprayed with 10 pounds of IPC per acre in the fall compared with a check plot.

Table IV shows the average yields of the plots in the field trials. The total yields and the alfalfa yields are listed on the dry weight basis in pounds per acre. The downy brome-grass is listed as percent of the total yield.

The check plots compared favorably with the sprayed plots in total yield per acre. The percentage of downy brome-grass was much greater in the checks than in the sprayed plots. Figure 10 shows the effect of treatments upon the percent downy brome-grass.

The best control was obtained with IPC applied in the fall. An insignificant amount of downy brome-grass remained in the plot sprayed

Figure 8 Comparison of the effect of 10 pounds per acre of IPC sprayed in the fall (left above) and 1 pound per acre of IPC sprayed in the spring (right above) when applied to alfalfa infested with Kentucky blue grass.

Figure 9 Comparison of a check plot (on the left) with a plot sprayed with 10 pounds of IPC in the fall (on the right).

TABLE IV

EFFECT OF THE RATES AND TIME OF APPLICATION OF TCA AND IPC UPON THE YIELD OF AN ESTABLISHED ALFALFA FIELD INFESTED WITH DOWNY BROME-GRASS

Herbicide	Time of Application	Rate of Application in Pounds Per Acre	Total Yield in Pounds Per Acre	Percent Downy Brome-Grass	Alfalfa Yield Pounds per Acre
Check	Check	Check	2917	44.2	1635
TCA	Fall	1	2762	16.6	2290
		5	3153	2.1	3094
		10	3271	3.0	3179
		20	2682	1.0	2655
	Spring	1	2711	21.8	2094
		5	2468	19.9	1983
		10	2269	14.0	2008
		20	2144	12.6	1877
IPC	Fall	1	2718	7.9	2503
		5	2983	0.07	2981
		10	2313	0.03	2312
		20	3051	0.2	3046
	Spring	1	2858	13.5	2466
		5	2180	10.6	1990
		10	3153	1.2	3115
		20	1923	2.3	1880

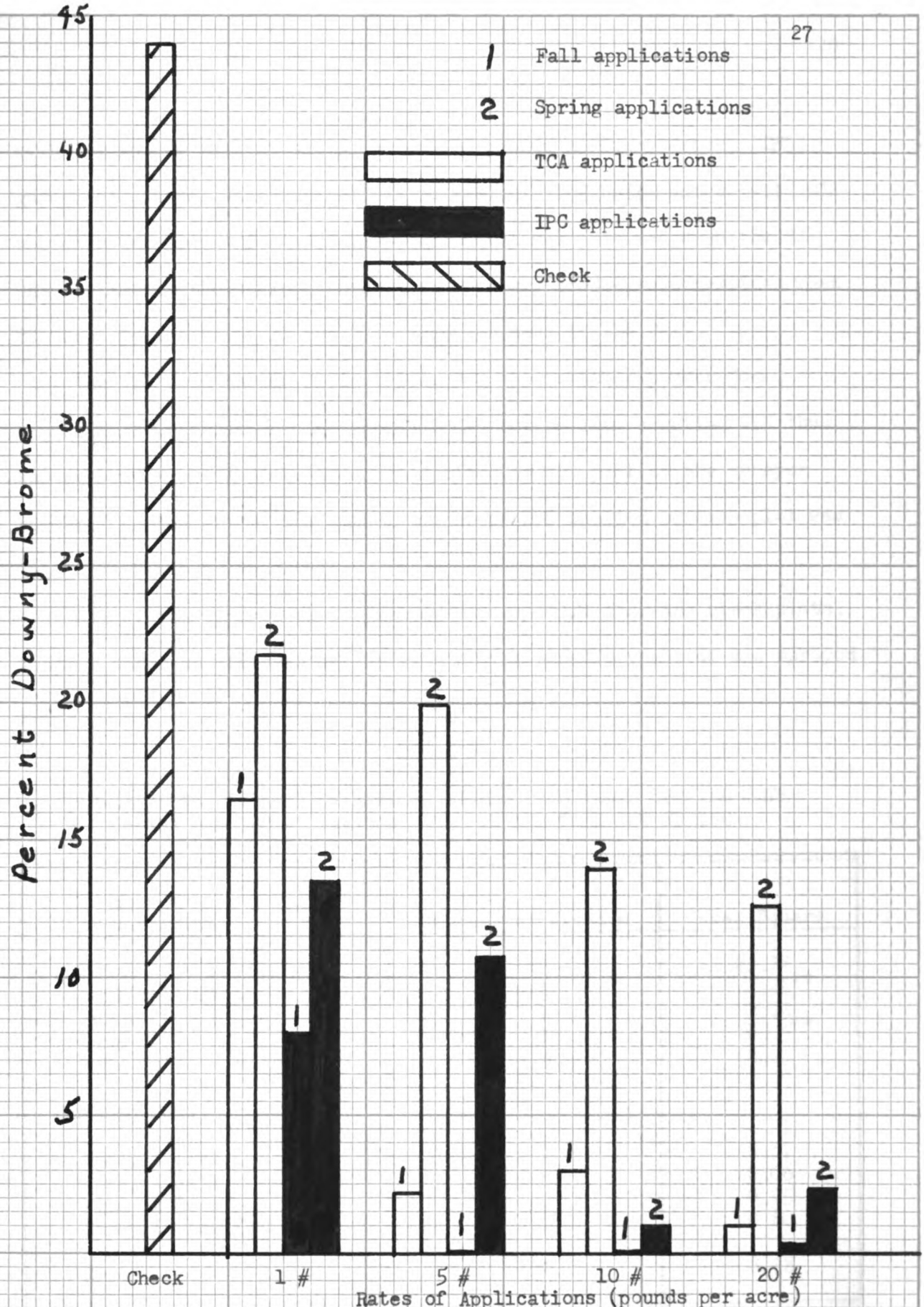


Figure 9 Comparison of the effects of TCA and IPC upon the percent downy brome-grass when applied at different times and rates to an established stand of alfalfa in fested with downy brome-grass.

with IPC in the fall at the 5, 10 and 20 pounds per acre rates. IPC gave less control when applied in the spring. The best control with TCA was obtained in the fall. Very poor control was obtained when the TCA was applied in the spring. Less than 5% downy brome-grass remained when TCA was applied at 5, 10 and 20 pounds per acre in the fall.

The IPC used in the field trials was the wettable powder form. A considerable amount of the chemical did not go into solution and thus was removed from the actual amount applied to the plot by the sprayer screen. Consequently, the actual amount of IPC applied to each plot was less than has been reported.

All of the sprayed plots yielded more alfalfa than the check plots. Table V shows an analysis of variance of the alfalfa yield of the sprayed plots.

TABLE V

ANALYSIS OF VARIANCE OF ALFALFA YIELDS FROM PLOTS SPRAYED WITH TCA AND IPC AT VARIOUS RATES IN THE FALL AND SPRING

Source of Variation	Degrees of Freedom	Mean Square
Total	47	23.37
Replications	2	2.22**
Spray	1	0.23
Time	1	4.05**
Rate	3	0.25
Interactions		
Spray X Time	1	0.67
Spray X Rate	3	0.06
Time X Rate	3	0.75
Spray X Time X Rate	3	0.80
Error	30	8.38

** Highly significant.

In regard to the effect upon the alfalfa yields by the type of spray, rate of application, time of application, and their interactions only the time of application was highly significant. The fall application yields were significantly higher than the spring application yields.

SUMMARY

SUMMARY

The chemical control of downy brome-grass in an established alfalfa field was attempted by applying IPC and TCA. Four different experiments were conducted to help determine at what rate and at what time of the year to apply the herbicides to obtain the best control.

1. TCA controlled downy brome-grass best when applied at seeding time.

2. TCA at 10 pounds per acre controlled the total dry weight and the dry weight per plant of downy brome-grass better than the 5 pound rate.

3. TCA at 10 pounds per acre controlled the number of downy brome-grass plants better than the 5 pound rate except at one stage of growth.

4. Downy brome-grass seeds germinated at high temperatures (85 degrees Fahrenheit).

5. Old downy brome-grass seeds germinated best at the higher temperatures (85 degrees Fahrenheit), while the new downy brome-grass seeds germinated best at the lower temperatures (55 degrees Fahrenheit).

6. Downy brome-grass seeds have a dormancy period.

7. The extent of dormancy of the downy brome-grass seeds is directly connected with the stage of maturity that the seeds are harvested.

8. The immature seeds have more dormancy than the mature seeds.

9. The dormancy in mature seeds is broken in 50% of them within twenty days after harvest.

10. TCA and IPC applied in the fall controlled the downy brome-grass better than the spring applications.

11. Spring applications of the herbicides significantly decreased the alfalfa yields when compared with the fall application.

12. IPC controlled the downy brome-grass better than TCA.

13. IPC at 5, 10 and 20 pounds per acre applied in the fall gave excellent control of the downy brome-grass.

14. IPC at 10 and 20 pounds per acre applied in the spring gave excellent control of the downy brome-grass.

15. TCA at 20 pounds per acre applied in the fall approximated excellent control of the downy brome-grass.

16. Slight alfalfa injury was observed when IPC and TCA were applied at 20 pounds per acre.

17. Spring applications of IPC stunted the downy brome-grass.

18. Further experiments should be conducted on the time to apply the herbicides in the fall. TCA and IPC should be applied at 1, 2, 3, 4 and 5 pounds per acre on various dates ranging from the time the first cutting of hay is made until the latter part of November. Chloro IPC should be used in some experiments to determine if it could be used rather than the wettable powder IPC.

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