



EFFECTS OF MCP, 2, 4-D, AND
ENDOTHAL ON OATS AND WEED SPECIES

Thesis for the Degree of M. S.

MICHIGAN STATE COLLEGE

Charles Cottingham

1953

This is to certify that the

thesis entitled

Effects of MCP, 2-4-D, and Endothel

on Oats and Weed Species.

presented by

Charles Cottingham

has been accepted towards fulfillment
of the requirements for

M. S. degree in Farm Crops


Major professor

Date Nov. 24, 1953

EFFECTS OF MCP, 2,4-D, AND ENDOTHAL
ON OATS AND WEED SPECIES

By

Charles Cottingham

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 1953

Approved

R. P. Churchill

THESIS ABSTRACT

The effects of the amine form of MCP and 2,4-D, and Endothal on Clinton Oats and weed species at various stages and rates were studied in a field experiment at Michigan State College in 1953.

The treatments studied were the effects of: (1) Pre-emergence spraying, (2) Spraying when the oats were eight inches high and (3) Spraying when the oats were fully headed.

The rates of spraying were (1) one quarter, one-half, and three quarters of a pound per acre of MCP, and 2,4-D, and (2) one, two, and four pounds per acre of Endothal.

The results of this experiment indicated that (1) the best yield of oats came from plots having the best control of Lady's thumb Smartweed, (the predominating species). However, all plots produced low yields due to climatic conditions. (2) Test weights were inconsistent among treated plots, and differences were not great enough to be considered important due to an adverse growing season. (3) None of the chemicals adversely affected the number of heads per unit of row. (4) Plots were very weedy, with an average of 1495 weeds per square yard. (5) Endothal gave excellent control of lady's thumb for all rates and stages of spraying. The post emergence stages and rates burned the leaves of the oats. (6) Endothal was efficient in killing wild buckwheat where it was present. (7) Best control of tickle grass was obtained from 2,4-D applied as a pre-emergence spray. However, all chemicals at all rates and stages of application gave some control. (8) Lambsquarter was controlled best

by applications of MCP at the fully headed stage. (9) In general, 2,4-D gave best control of ragweed. All chemicals gave some control for all rates and stages of application. (10) Because of low yield, test weight, and a thin stand of oats, along with a lack of uniformity of weed species, and adverse weather conditions, this experiment should be duplicated.

EFFECTS OF MCP, 2,4-D, AND ENDOTHAL
ON OATS AND WEED SPECIES

By

Charles Cottingham

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

1953

ACKNOWLEDGMENTS

The writer wishes to express his sincere thanks to Professor Boyd K. Churchill for his valuable advice and encouragement in making this thesis possible. Appreciation is also expressed to my wife Laura for her continued assistance and encouragement through the entire program.

*

TABLE OF CONTENTS

	PAGE
INTRODUCTION.....	1
REVIEW OF LITERATURE.....	2
MATERIALS AND METHODS.....	4
RESULTS AND DISCUSSION.....	5
Effect on Yield of Oats.....	5
Effect on Test Weight of Oats.....	7
Effect on Number of Heads per Unit of Row.....	9
Total number of Weeds by Species.....	11
Effect on Lady's Thumb Smartweed.....	11
Effect on Tickle Grass.....	17
Effect on Lambsquarter.....	17
Effect on Ragweed.....	22
Effect on Foxtails.....	26
Effect on Wild Buckwheat.....	29
Effect on Barnyard Grass.....	29
SUMMARY.....	30
BIBLIOGRAPHY.....	32

INTRODUCTION

Chemicals were used for weed control as early as 1900, but little emphasis was placed upon their use until around 1936. Sulfuric acid was one of the earlier chemicals used, but with the discovery of 2,4-D in 1944, it has all but disappeared for this purpose. Wartime investigations showed the usefulness of 2,4-D as a possibility of destroying enemy crops as a selective spray on small grains. Damage to crops may be caused by 2,4-D if applied at too high a rate, or at the wrong time. Dinitro compounds have also been used for selective sprays on small grains, but they too have some objectionable features.

The experiment reported here was set up to study the effects of various chemicals on yield, test weight, and number of heads of oats, and on the weed species present.

REVIEW OF LITERATURE

Burrows and Olsen (1) reported that injury to oats occurred when sprayed with 2,4-D ester at six ounces acid equivalent per acre when the oats were 5-6 and 20 inches high.

Coupland (3) reported that weed control in oats was better when treated with 2,4-D than when MCP was used. MCP caused less damage to oats than 2,4-D. Yields were higher from MCP treated plots than from plots sprayed with 2,4-D.

Shafer and Finnerty (7) found that one-quarter and one-half pounds of 2,4-D ester applied at the jointing stage resulted in serious yield reductions in two of four years. Amine salt at one-half and one pound resulted in similar reductions in one year.

Finnerty (5) found that MCP amine, while slightly less effective in weed suppression, was definitely less injurious to oats than were either 2,4-D amine or ester.

Taylor (8) reported that treatments with 2,4-D ester, and MCP amine applied at eight ounces per acre, two weeks after emergence to wheat and barley were relatively ineffective against such weeds as wild buckwheat, Lady's thumb, and barnyard millet. A reduction in yield was experienced from the 2,4-D ester on barley, and the MCP amine on wheat.

Zalik (9) found that applying six and twelve ounces of 2,4-D ester to oats when they were six inches high reduced the yield significantly.

Davidson (4) reported that there is a period when oats are vulnerable to 2,4-D treatments, commencing about two weeks after emergence and lasting for a period of about two weeks.

Janzen (6) reported that 2,4-D ester reduced the yield of oats by about ten percent with the three ounce rate, and by fifty percent with six ounces in cold weather, but no reduction in yield occurred from eight ounces applied in warmer weather.

Burrows and Olson (2) reported that oats treated with 2,4-D ester and amine, showed no significant difference in the mean yields for chemicals, rates of seeding, and dates of treatment, and damage to the main culms by early treatment was compensated for in all cases by tillering.

MATERIALS AND METHODS

Clinton oats were planted at the rate of one and one-half bushels per acre in rows one foot apart on May 5, 1953. Plots were 6 x 24.2 feet, randomized, and in quadruplicate.

The chemicals used were the amine form of MCP and 2,4-D, and endothal. The rates used were one-quarter, one-half and three-quarters pound acid equivalent per acre for MCP and 2,4-D. The rates for endothal were one, two, and four pounds per acre. Chemicals were applied,

- a) as a pre-emergence spray,
- b) when the oats were eight inches high,
- c) when the oats were fully headed.

When the chemicals were applied when the oats were fully headed, the spray nozzle was held below the oat heads, and above the weeds. All treatments were compared with the check plots which were not sprayed.

Weed counts by species were made in plots representing the pre-emergence and eight inch stages on June 29, 30 and July 1. Similar counts were made for treatments made after the oats were fully headed, on July 15, 16 and 17. The number of heads per twelve feet of row was determined for each plot. The four center rows of each plot were harvested on July 25 to determine yields per acre. Test weight per bushel of oats from each plot was also determined.

RESULTS AND DISCUSSION

Effect on Yield of Oats

All yields of oats were very low due to adverse weather conditions.

Table I shows the effect of MCP, 2,4-D and endothal applied at three different rates and dates upon the yield of oats in bushels per acre.

When MCP was applied as a pre-emergence spray, yields varied less than one bushel per acre for all spraying rates. The same is true for the eight inch stage of application. With one exception, this was also true for the fully headed stage of application. Changing the rate of application or applying MCP at the eight inch or fully headed stages had little detrimental or beneficial effect on yield. However, applying MCP as a pre-emergence treatment increased yields 3.6 bushels or more per acre, regardless of the rate used.

When 2,4-D was applied as a pre-emergence spray, yields varied only nine-tenths of a bushel per acre between the one-quarter and one-half pound rates, in contrast to 3.1 bushels for the three-quarter pound rate. With one exception, the yield of oats varied less than one bushel per acre where 2,4-D was applied when the oats were eight inches high. Applications made when the oats were fully headed resulted in only seven-tenths of a bushel difference between the three rates of spraying. All yields were only slightly greater than the check plot.

TABLE I

YIELD OF OATS IN BUSHELS PER ACRE WHEN SPRAYED WITH
M.C.P., 2,4-D, AND ENDOTHAL AT DIFFERENT RATES

Chemical	Rate	Time of Application		
		Pre-emergence	Eight Inches	Fully Headed
M.C.P.	.25	27.2	23.4	23.7
2,4-D	.25	24.8	25.6	25.1
Endothal	1.0	29.2	27.9	26.1
M.C.P.	.5	27.6	23.8	27.3
2,4-D	.5	25.7	21.3	25.7
Endothal	2.0	30.8	29.6	23.2
M.C.P.	.75	27.9	24.3	23.2
2,4-D	.75	27.9	25.7	25.3
Endothal	4.0	23.7	25.7	21.8
Check		24.1	24.1	24.1

Post emergence treatments with endothal showed some burning of the oats leaves especially when spraying was made after the oats were fully headed, and at the higher rates.

When endothal was applied as a pre-emergence spray the yields were highest when the rate was two pounds per acre. The one pound rate, however, was only 1.6 bushels per acre lower. The four pound rate was 7.1 bushels less than the two pound rate. The highest yield may be explained by the excellent control of Lady's thumb smartweed, the most frequent appearing species, as shown in Table II. Yields varied 3.9 bushels per acre at the eight inch stage of application for all spraying rates, with the lowest occurring from the four pound rate of application. As the rate increased, the yield decreased for all rates of applications when the oats were fully headed. Yields varied 4.3 bushels per acre between treatments, with the lowest again at the four pound rate of application. All yields from endothal applied at one pound per acre were greater than the check plots, however, the two pound rate applied when the oats were fully headed, and the four pound rate applied as a pre-emergence spray and when the oats were fully headed gave slightly less yields than the checks.

Effect on Test Weight of Oats

Table II shows the effect of MCP, 2,4-D and endothal applied at three different rates and dates upon the test weight of oats per bushel.

Test weights were very low for all plots including the checks due to adverse growing conditions. Check plots averaged only 27.0 pounds

TABLE II

TEST WEIGHT OF OATS PER BUSHEL SPRAYED WITH M.C.P., 2,4-D,
AND ENDOTHAL AT DIFFERENT RATES AND DATES

Chemical	Rate	Time of Application		
		Pre-emergence	Eight Inches	Fully needed
M.C.P.	.25	29.0	25.0	27.6
2,4-D	.25	28.3	27.0	25.9
Endothal	1.0	27.8	27.5	27.3
M.C.P.	.50	27.4	26.3	23.8
2,4-D	.50	24.9	27.3	27.0
Endothal	2.0	27.1	27.1	24.9
M.C.P.	.75	28.0	27.1	25.8
2,4-D	.75	26.4	27.9	25.0
Endothal	4.0	24.4	27.7	25.3
Check		27.0	27.0	27.0

per bushel. Test weights of treated plots were inconsistent and differences were not great enough to be considered important.

Effect on Number of Heads per Unit of Row

Table III shows the effect of MCP, 2,4-D and endothal applied at three different rates, and two different dates upon the head count of oats per twelve feet of one row in each plot.

When MCP was applied as a pre-emergence spray, head counts varied less than six heads per twelve feet of row for all spraying rates. All rates of spraying were greater than the check plot which received no treatment. As the rate increased, the number of heads increased slightly for all spraying rates when the oats were eight inches high. As in the pre-emergence date of application, all spraying rates were greater than the check plot.

When 2,4-D was applied as a pre-emergence spray, head counts varied less than eight heads per twelve feet of row for all spraying rates. All spraying rates were greater than the check plot. Head counts varied 9.3 heads between the one-quarter and three-quarter pound rates, in contrast to 20.3 heads for the one-half pound rate when the oats were eight inches high. Again, all spraying rates were greater than the check plot.

As the rate of endothal was increased as a pre-emergence spray, head counts also increased, with the largest number for all rates and dates of spraying occurring at the four pound rate. When endothal was

TABLE III

NUMBER OF HEADS OF OATS PER TWELVE FEET OF ROW WHEN SPRAYED WITH
MCP, 2,4-D AND ENDOTHAL AT THREE DIFFERENT RATES AND TWO DATES

Chemical	Rate	Time of Application	
		Pre-emergence	Eight inches
M.C.P.	.25	177.5	166.0
2,4-D	.25	183.3	193.8
Endothal	1.0	173.5	196.3
M.C.P.	.50	172.3	171.5
2,4-D	.50	184.3	173.5
Endothal	2.0	189.0	181.3
M.C.P.	.75	172.5	189.6
2,4-D	.75	177.0	184.5
Endothal	4.0	209.0	197.3
Check		164.0	164.0

applied when the oats were eight inches high, head counts were approximately the same for the one and four pound rates, however, the two pound rate was lower. Endothal showed higher head count than the check, as was true for MCP and 2,4-D.

The fully headed stage of application was not recorded because it was the same as the check plot.

Total Number of Weeds by Species

Table IV shows the total number of weeds by species per square yard. The field was very weedy, with lady's thumb smartweed being the predominating species. Since the check plots contained a small number of wild buckwheat, barnyard grass, foxtails, and other weeds, and they were not evenly distributed over the field, they are not shown in tabular form. The four predominating species were more uniformly distributed and are shown in tabular form. The term foxtails, includes both the green and yellow species. Other weeds includes Canada thistle, black nightshade, perennial sowthistle, quackgrass, perennial smartweed, rough pigweed, field sorrel, knotweed, major plantain, bull thistle, and yellow trefoil.

Effect on Lady's Thumb Smartweed

Table V shows the effect of MCP, 2,4-D and endothal applied at three different rates and dates upon the average number of Lady's thumb smartweed plants per square yard.

TABLE IV
TOTAL NUMBER OF WEEDS BY SPECIES PER SQUARE YARD

Species	Weeds Per Square Yard
Lady's Thumb	1041
Tickle Grass	100
Lambsquarter	136
Ragweed	96
Foxtails	27
Wild Buckwheat	6
Barnyard Grass	3
Other Weeds	6
Total	1495

TABLE V

AVERAGE NUMBER OF LADY'S THUMB PLANTS PER SQUARE YARD
WHEN SPRAYED WITH A.C.P., 2,4-D AND ENDOTHAL

Chemical	rate	Time of Application		
		Pre-emergence	Eight inches	Fully headed
A.C.P.	.25	427.5	259.7	663.5
2,4-D	.25	419.0	207.6	292.5
Endothal	1.0	56.6	0.0	40.6
A.C.P.	.50	483.3	349.6	756.5
2,4-D	.50	455.3	237.5	325.0
Endothal	2.0	4.5	0.0	11.3
A.C.P.	.75	556.5	117.3	1131.0
2,4-D	.75	473.3	177.8	174.3
Endothal	4.0	6.5	0.0	1.5
Check		1041.0	1041.0	1041.0

MCP was the least effective of the three chemicals for controlling Lady's thumb. It was most effective if applied when the oats were about eight inches high giving approximately seventy-five percent control. When applied as a pre-emergence spray, the control was only slightly above fifty percent. Spraying with MCP when the oats were fully headed gave very little control as far as actual kill was concerned but the weeds did show some effects of the treatment. The effectiveness of the chemicals was not influenced to any great extent by rates that were used.

The amine form of 2,4-D was somewhat more effective in controlling Lady's thumb than MCP. The pattern of control was very similar for the two chemicals as far as rates and times of applications were concerned. Pre-emergence was least effective of all dates used, and applications made when the oats were eight inches high were most effective. Results from the three rates used were very similar as shown in figure 1. The effect of 2,4-D on lady's thumb that was short of killing was very similar to that of MCP. Plants twisted, showed malformations and were stunted to varying degrees.

Endothal gave excellent control of lady's thumb as shown in Table V. Best control was effected at the heaviest rate, however, excellent control resulted when only one pound of endothal was used per acre. The most effective time of application was when oats were eight inches high, but applications at other times were also very efficient.

A comparison of the three chemicals at the three rates can be noted readily by referring to figure 1. A similar comparison of these chemicals can be made for the three times of application by referring to figure 2.

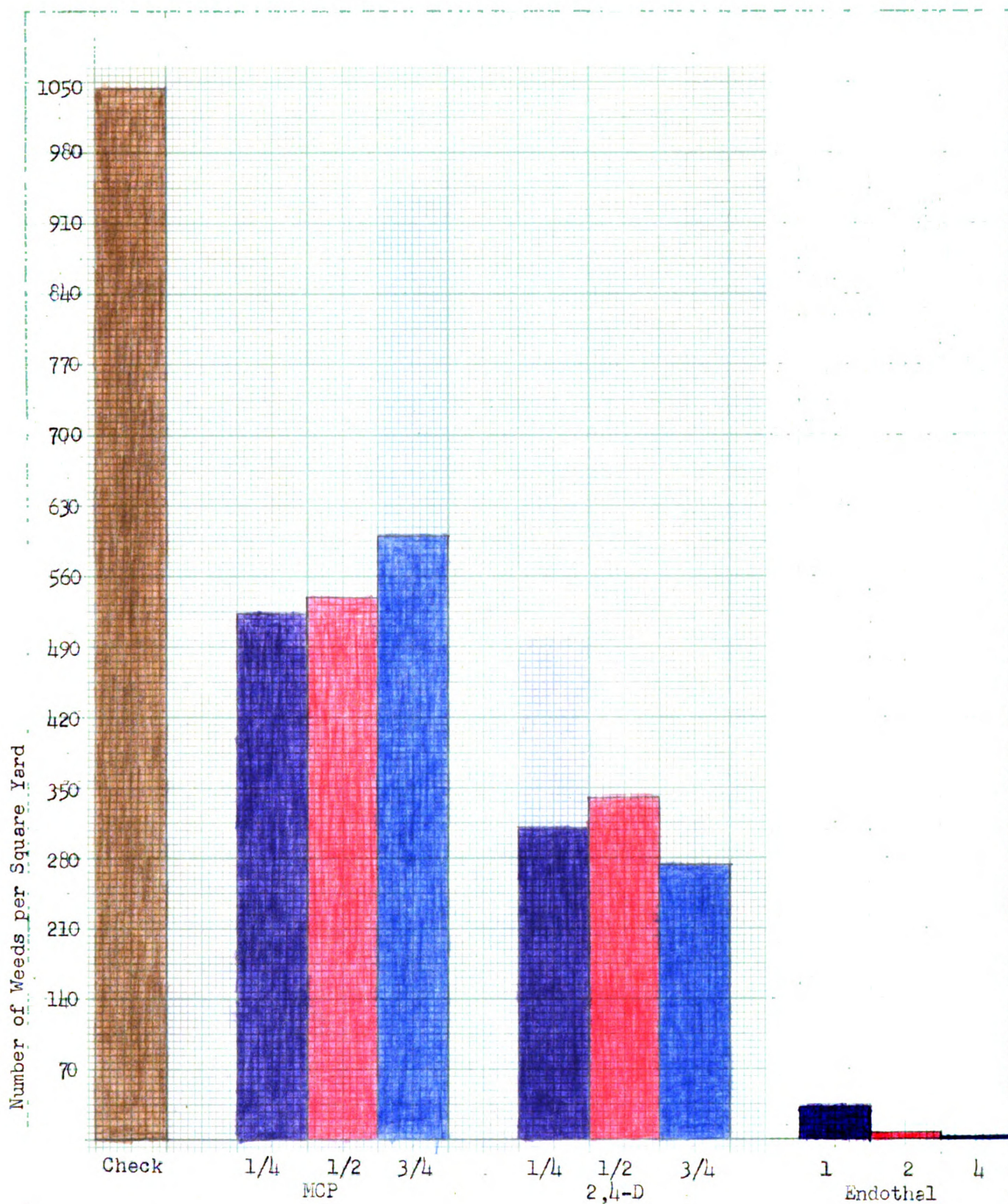


Figure 1. Comparison of MCP, 2,4-D and Endothal applied at three different rates on Lady's thumb.

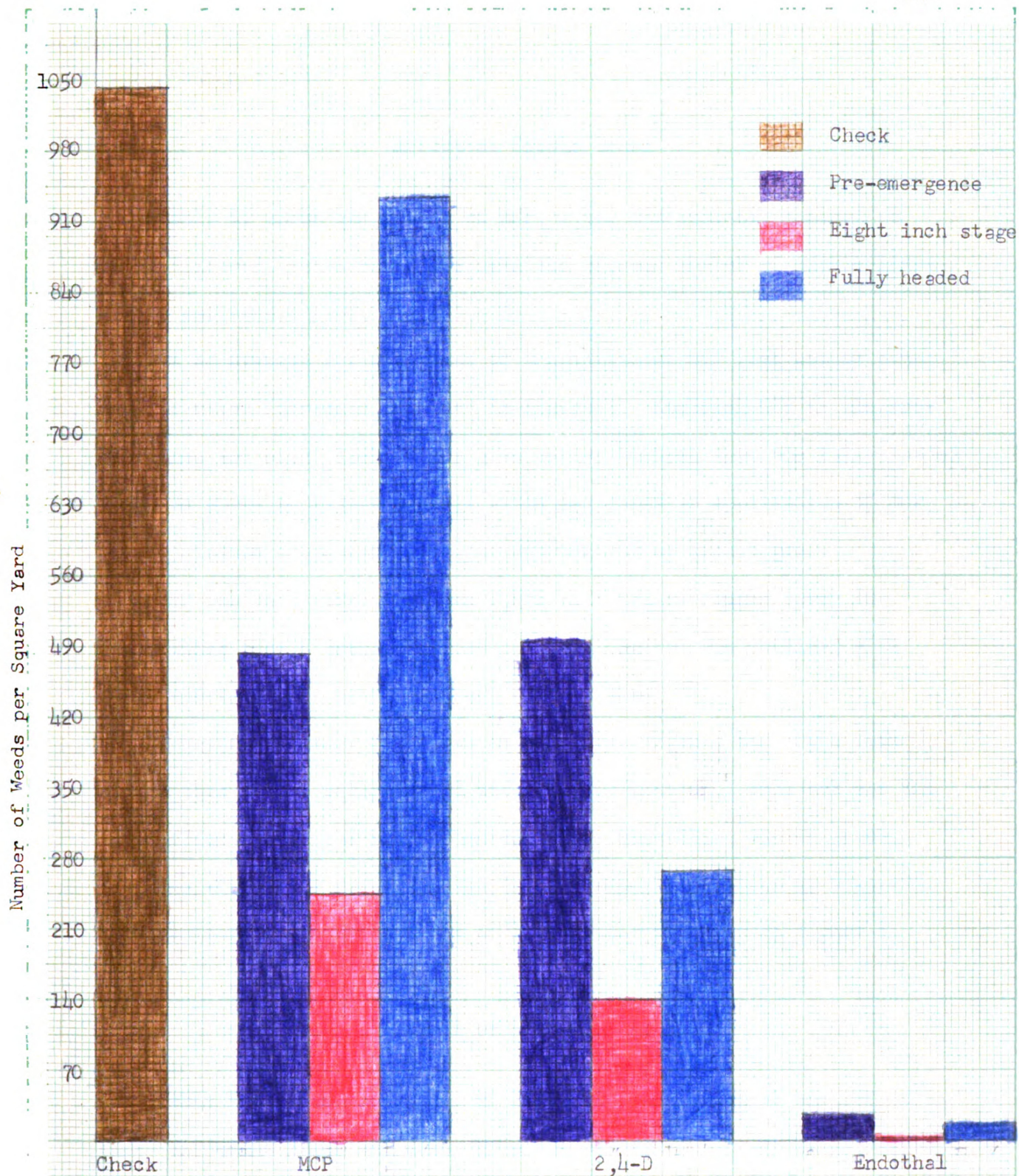


Figure 2. Comparison of MCP, 2,4-D and Endothal applied at three different dates on Lady's thumb.

Effect on Tickle Grass

Table VI shows the effect of MCP, 2,4-D and endothal applied at three different rates and dates upon the average number of tickle grass plants per square yard.

As an average for all times of applications, MCP gave better control as rates increased as shown in figure 3. Applying MCP at the pre-emergence and eight inch stages gave better control than the fully headed stage as shown in figure 4. All rates and dates of application of MCP gave a minimum of seventy-five percent control of tickle grass.

MCP was less effective than 2,4-D as a pre-emergence spray for controlling tickle grass. Almost complete control was obtained with three quarters of a pound of 2,4-D on this weed.

Endothal was more effective at the pre-emergence and eight inch stages than at the fully headed stage of application. Endothal was the least effective of the three chemicals for controlling tickle grass.

The effects of rates for the three chemicals is shown in figure 3. A comparison of the three times of application is shown in figure 4.

Effect on Lambsquarter

Table VII shows the effect of MCP, 2,4-D and endothal applied at three different rates and dates upon the average number of Lambsquarter plants per square yard.

MCP was the most effective of the three chemicals for controlling lambsquarter. It was most effective if applied when the oats were fully

TABLE VI
AVERAGE NUMBER OF TICKLE GRASS PLANTS PER SQUARE YARD
WHEN SPRAYED WITH MCP, 2,4-D, AND ENDOTHALE

Chemical	Rate	Time of Application		
		Pre-emergence	Eight Inches	Fully headed
MCP	.25	53.3	50.3	71.3
2,4-D	.25	37.3	32.3	59.3
Endothal	1.0	25.0	14.3	58.0
MCP	.50	21.0	27.8	76.5
2,4-D	.50	8.3	48.0	48.0
Endothal	2.0	3.0	35.5	137.3
MCP	.75	31.3	17.8	50.6
2,4-D	.75	.8	54.0	49.5
Endothal	4.0	38.3	14.3	32.3
Check		180.0	180.0	180.0

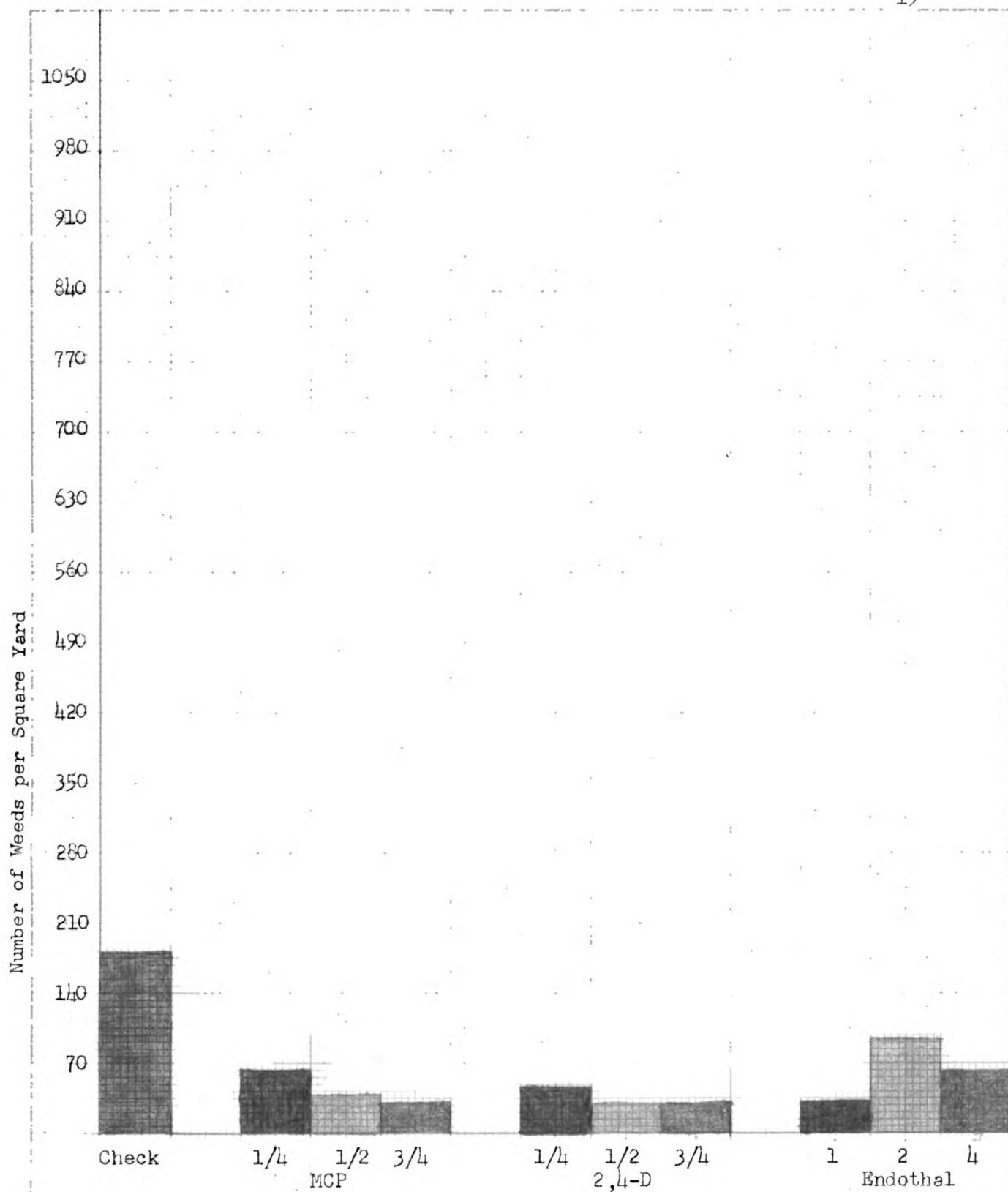


Figure 3. Comparison of MCP, 2,4-D and Endothal applied at three different rates on tickle grass.

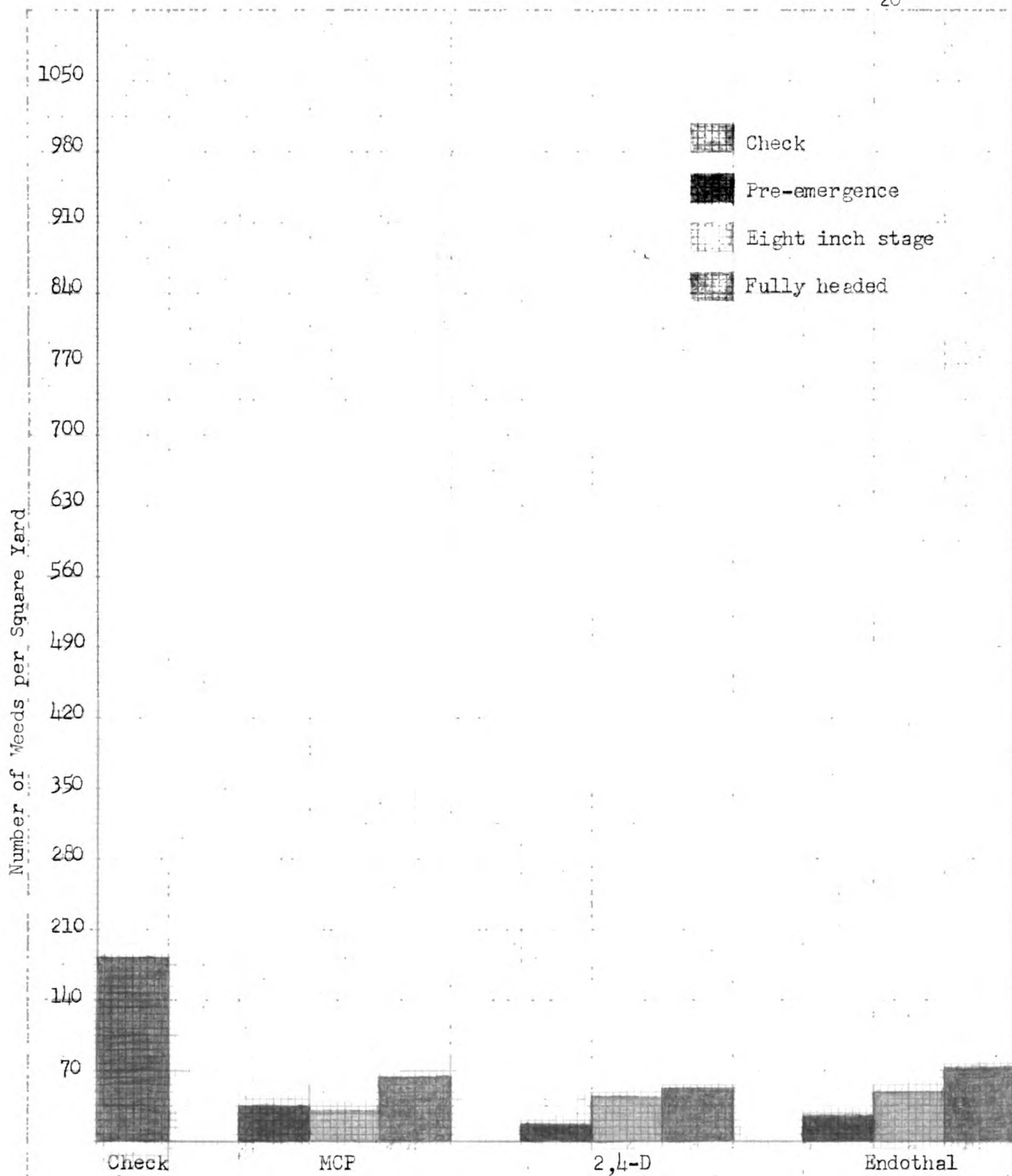


Figure 4. Comparison of MCP, 2,4-D and Endothal applied at three different dates on tickle grass.

TABLE VII

AVERAGE NUMBER OF LAMBSQUARTER PLANTS PER SQUARE YARD
WHEN SPRAYED WITH MCP, 2,4-D AND ENDOTHAL

Chemical	Rate	Time of Application		
		Pre-emergence	Eight Inches	Fully headed
MCP	.25	63.3	39.0	51.8
2,4-D	.25	72.3	53.3	22.5
Endothal	1.0	113.5	63.0	85.3
MCP	.50	28.5	74.3	23.3
2,4-D	.50	41.0	33.0	52.5
Endothal	2.0	68.3	75.5	125.8
MCP	.75	17.5	17.0	15.0
2,4-D	.75	31.5	63.0	42.8
Endothal	4.0	57.8	53.3	97.5
Check		136.5	136.5	136.5

headed giving approximately eighty percent control, however, the pre-emergence and the eight inch stage of application gave more than sixty percent control as shown in figure 6. The effectiveness of the chemical was influenced as the rates increased as shown in figure 5.

The amine form of 2,4-D gave somewhat less control of lambsquarter than MCP. The pattern of control was similar for the two chemicals as far as dates were concerned, but different for the rates. Applications made when the oats were fully headed gave slightly better control than applications made at the other two dates. Results from the three rates were very similar, with the one-half and three-quarters of a pound rates giving slightly better control than the one-quarter of a pound rate as shown in figure 5.

Endothal was the least effective of the three chemicals for controlling lambsquarter. It was most effective if applied when the oats were eight inches high giving approximately fifty percent control. When applied as a pre-emergence spray, the control was about forty percent. Spraying with Endothal when the oats were fully headed gave very little kill, but the weeds were stunted and showed some effects of the chemical. The effectiveness of the chemical was influenced slightly by the four pound rate of application, as shown in figure 5.

Effect on Ragweed

Table VIII shows the effect of MCP, 2,4-D and endothal applied at three different rates and dates upon the average number of ragweed plants per square yard.

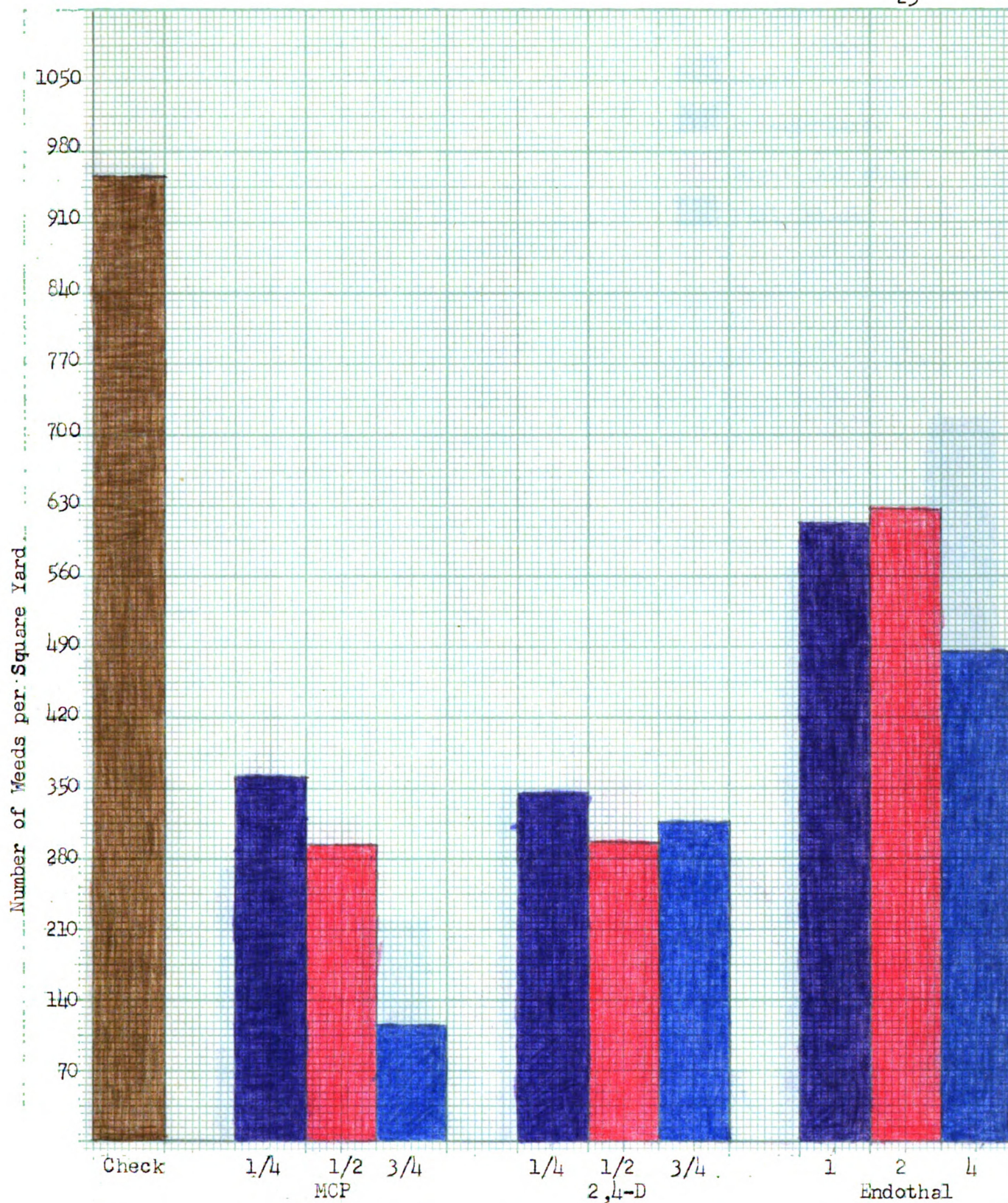


Figure 5. Comparison of MCP, 2,4-D and Endothal applied at three different rates on Lambsquarter.

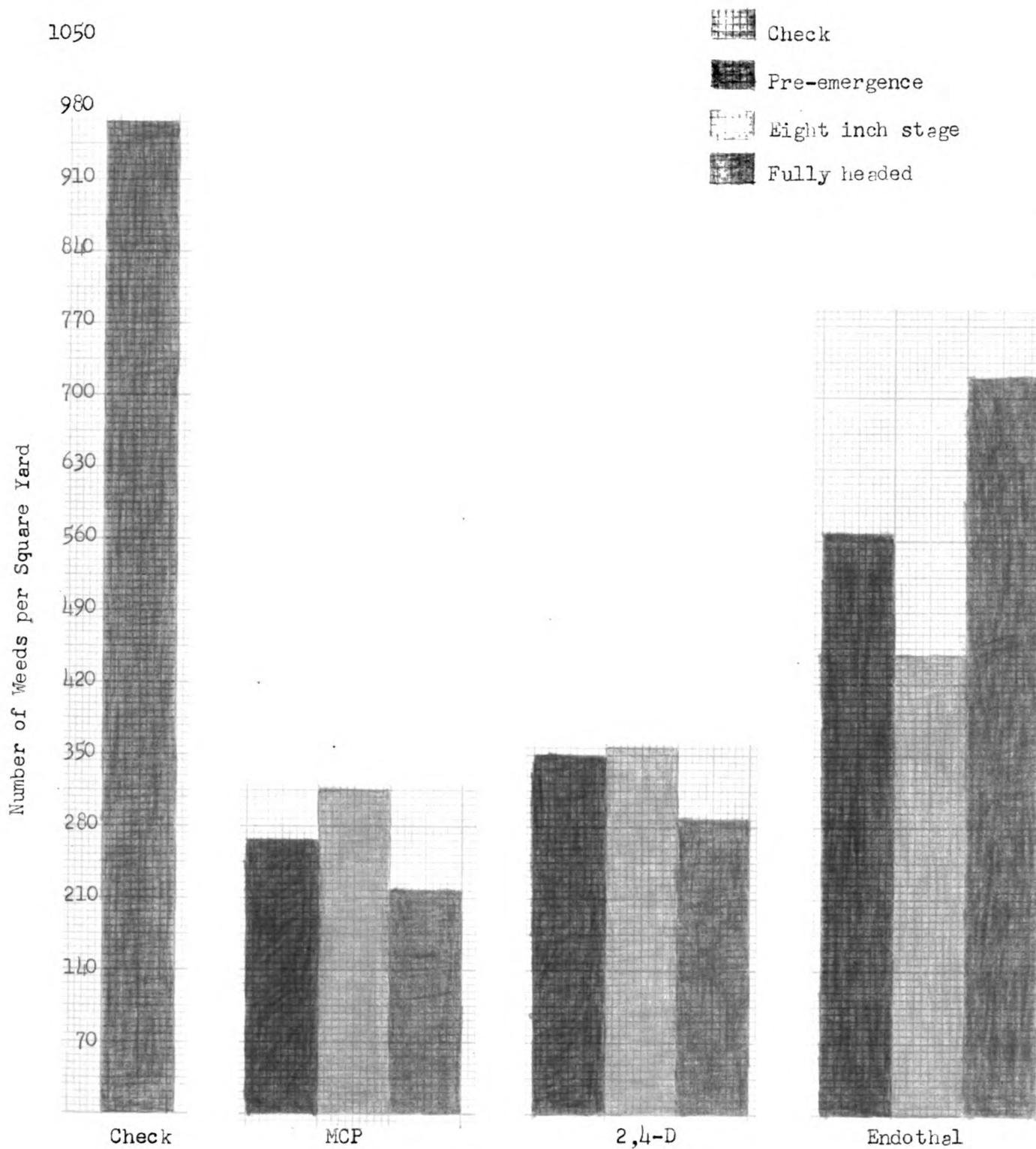


Figure 6. Comparison of MCP, 2,4-D and Endothal applied at three different dates on Lambsquarter.

TABLE VIII
AVERAGE NUMBER OF RAGWEED PLANTS PER SQUARE YARD
WHEN SPRAYED WITH MCP, 2,4-D AND ENDOTHAAL

Chemical	Rate	Time of Application		
		Pre-emergence	Eight inches	Fully headed
MCP	.25	73.8	26.3	21.3
2,4-D	.25	34.3	24.8	9.8
Endothal	1.0	38.0	10.5	22.5
MCP	.50	9.5	28.3	31.0
2,4-D	.50	5.3	38.5	8.5
Endothal	2.0	15.8	2.5	22.5
MCP	.75	11.3	36.0	5.3
2,4-D	.75	6.8	50.3	6.8
Endothal	4.0	5.5	9.8	8.3
Check		96.0	96.0	96.0

Data on ragweed control is less reliable than for lady's thumb because of less uniform distribution of the weed.

As an average for all times of applications, MCP gave better control of ragweed as rates increased. (Shown in figure 7.) Applying MCP when the oats were fully headed gave approximately eighty percent control. The pre-emergence, and eight inch stages gave slightly less than seventy percent control as shown in figure 8.

With the exception of the eight inch stage of application, 2,4-D was more effective than MCP. The effectiveness of the chemical was not influenced to any great extent by the different rates that were used.

Endothal was most effective at the eight inch stage of application. At the pre-emergence and fully headed stages of application, Endothal was less effective than 2,4-D. The effectiveness of the chemical was greatly influenced by the rate of application. The heaviest rate gave the best control.

A comparison of the three chemicals as to rates is shown in figure 7. The effectiveness of the different dates of application is shown in figure 8.

Effect on Foxtails

The effect of MCP and 2,4-D on foxtails was erratic, and in over fifty percent of cases, no control was indicated at any rate or time of application. Endothal was ineffective as a pre-emergence spray regardless of rate, but gave complete control on two occasions at the

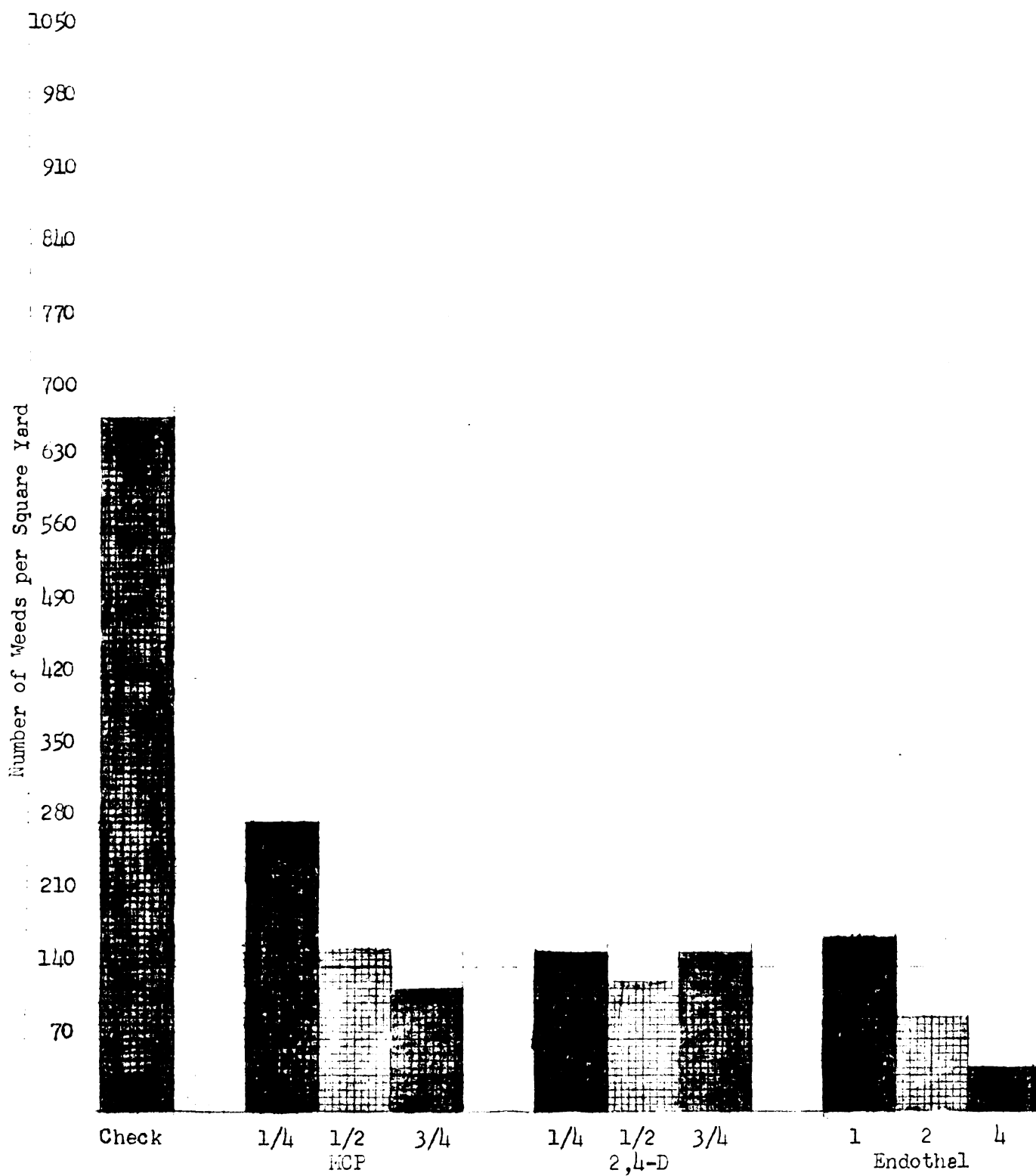


Figure 7. Comparison of MCP, 2,4-D and Endothal applied at three different rates on Ragweed.

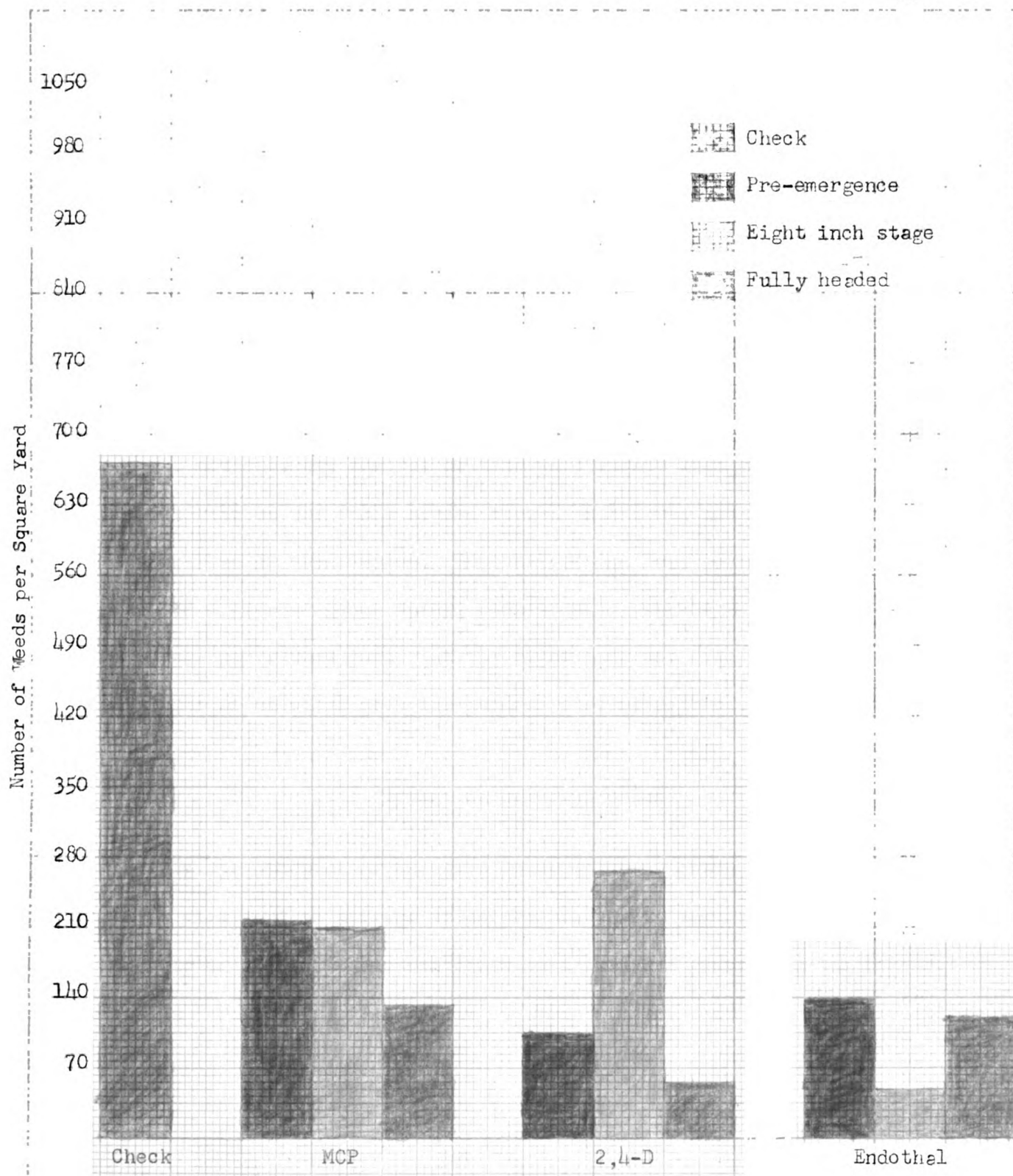


Figure 8. Comparison of MCP, 2,4-D and Endothal applied at three different dates on Ragweed.

eight inch and fully headed stages of application. Rates of endothal did not make much difference.

Effect on Wild Buckwheat

Stands of wild buckwheat were not uniform, and treated plots often contained more of this species than was found in the check plots. MCP did not show any control of this weed except when applied at the highest rate at the fully headed stage. 2,4-D was not effective at any rate or time of application. Endothal at the four pound rate when applied as a pre-emergence spray, reduced wild buckwheat to five-tenths of a weed per square yard. At the eight inch and fully headed stages, all rates of endothal gave one-hundred percent control.

Effect on Barnyard Grass

The distribution of barnyard grass was very irregular, and the checks contained an average of only three plants per square yard. The majority of treated plots contained more barnyard grass than the checks.

SUMMARY

1. The effects of the amine form of MCP and 2,4-D and Endothal on Clinton oats and weed species at various times and rates were studied.

2. Yields of all plots were low due to climatic conditions. Best yields came from plots with the best lady's thumb control.

3. Test weights were inconsistent among treated plots, and differences were not great enough to be considered important due to an adverse growing season.

4. None of the chemicals adversely affected the number of heads per unit of row.

5. Plots were very weedy, with an average of 1495 weeds per square yard.

6. Endothal gave excellent control of lady's thumb for all rates and dates. The post emergence rates and dates of spray burned the leaves of the oats. Endothal was efficient in killing wild buckwheat where it was present.

7. Best control of tickle grass was obtained from 2,4-D applied as a pre-emergence spray. However, all chemicals at all rates and dates of application gave some control.

8. Lambsquarter was controlled best by applications of MCP at the fully headed date. The effectiveness of 2,4-D was almost as pronounced as MCP.

9. In general, 2,4-D gave best control of ragweed. All chemicals gave some control for all rates and dates of application.

10. Because of low yield, test weight, and thin stand of oats, along with a lack of uniformity of weed species, and adverse weather conditions, this experiment should be duplicated.

BIBLIOGRAPHY

1. Burrows, V. D., and Olson, P. J. Reaction of Oats to 2,4-D butyl ester when applied at twenty different stages of growth. No. Cent. Weed Cont. Conf. 9:74, 1952.
2. Burrows, V. D., and Olson, P. J. The effect on yield of Ester oats (sown at two rates) by treating with two rates of 2,4-D ester (butyl) and amine (mixed) at four dates. No. Cent. Weed Cont. Conf. 9:74-75, 1952.
3. Coupland, R. T., Relative effect of MCP and 2,4-D on yield of oats. No. Cent. Weed Cont. Conf. 9:75-76, 1952.
4. Davidson, J. G., Reaction of Exeter oats to 2,4-D applied at different growth stages. No. Cent. Weed Cont. Conf. 9:84, 1952.
5. Finnerty, D. W., Yield of Nemaha oats and seed production of wild buckwheat as affected by 2,4-D and MCP applied at tillering and jointing stages of oats. No. Cent. Weed Cont. Conf. 9:82-83, 1952.
6. Janzen, P. J., Control of Weeds in Small Grains. No. Cent. Weed Cont. Conf. 9:84, 1952.
7. Shafer, N. E. and Finnerty, D. W., Response of Nemaha oats to 2,4-D. No. Cent. Weed Cont. Conf. 9:82, 1952.
8. Taylor, D. K., Effect of CMO in comparison to 2,4-D and MCP on wheat and barley. No. Cent. Weed Cont. Conf. 9:83, 1952.
9. Zalik, Saul, Effect of two 2,4-D esters on the yield of Victory oats and Argentine rape. No. Cent. Weed Cont. Conf. 9:84, 1952.

ROOM USE ONLY

ROOM USE ONLY

MICHIGAN STATE UNIVERSITY LIBRARIES



3 1293 03046 8460