THE EFFECT OF GROWTH REGULATING COMPOUNDS ON WINTER WHEAT VARIETIES

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JONAS WILLIAM MILLER

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APPROVED:

Redacted for Privacy

Professor of Farm Crops

In Charge of Major

Redacted for Privacy

Head of Department of Farm Crops

Redacted for Privacy

Chairman of School Graduate Committee

Redacted for Privacy

Dean of Graduate School

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TABLE OF CONTENTS

TABLE OF FIGURES

THE EFFECT OF GROWTH REGULATING COMPOUNDS ON WINTER WHEAT VARIETIES

INTRODUCTION

The use of chemicals for the control of weeds in wheat fields is being used extensively in the Pacific Northwest. In recent years much experimental work has been reported on the effect of growth regulating chemicals on the control of weeds in small grain fields. There has been a limited amount of experimental work reported on varietal differences in response to growth regulating chemicals. These reports have not been consistent as some indicate varietal differences and others indicate no varietal differences to growth regulating chemicals, particularly 2,4-D. It may be of great importance to determine the extent of injury of selective chemicals to the various wheat varieties.

Several important wheat varieties of the Pacific Northwest and one wheat variety important in the Willamette Valley were selected to study differences between varieties when treated with different growth regulating chemicals.

Reduced yields of wheat treated with 2,4-D have been reported by several workers. Asana, Verma, and Mani (3, pp.334-353) indicated that the decrease in yield following treatment in the seedling stage with 2,4-D was the result of the production of fewer tillers. In one experiment of this study, three phenoxyacetic acid compounds were sprayed on six wheat varieties at five stages of growth and yield and height measurements were taken. A similar experiment, using the same chemicals and varieties, was designed to study the number of tillers produced following treatment in the seedling stage of growth.

The encroachment of weedy grasses into grain fields has become of increasing importance following effective control of broadleaved weeds. Therefore, an experiment was designed to study the tolerance of different wheat varieties to several rates of grass killing chemicals. This information would be useful in order to explore the possibility of selectively removing weedy grasses from wheat.

The objectives of this research were to study the effects of different growth regulating chemicals applied at different stages of growth on the yield and height of several wheat varieties under the environmental conditions at Corvallis, Oregon. The information from these experiments would then serve as background for similar experiments to be conducted in the wheat areas of the Columbia Basin.

REVIEW OF LITERATURE

Growth regulating chemicals have been used extensively for the control of broadleaved weeds in small grains. The small grains, in general, are relatively tolerant of certain chemicals. However, varying degrees of injury have been observed, especially when the more toxic chemicals and formulations were used. Some varieties were more susceptible than others when treated in certain stages of growth.

Factors in Selectivity

Weintraub and Norman (43, pp.289-298) pointed out that selectivity of growth regulating compounds was more apparent than real and was the result of different degrees of susceptibility to a particular concentration of active compound. Small grain plants were affected but little by top application of growth regulators of the phenoxyacetic acid type, whereas, broadleaved plants at a corresponding stage of growth were greatly affected.

The most important factors involved in selectivity of a chemical to a particular plant have been listed by Ahlgren, Klingman, and Wolf (1, pp.80-84) as physiological, absorption, wetting, translocation, and morphological differences. They summarized them as follows.

Physiological differences

Physiological differences in plants such as differences in enzyme systems, pH changes, cell membrane permeability, and chemical constituents enable some plants to tolerate certain chemicals. It is known that plant species vary in these characteristics. Plants of the same species may differ widely, by reason of age, environment, or variety. There are wide differences in the various tissues within an individual plant.

Differential absorption

The cuticle of leaves and stems is comprised of non-ionizable organic compounds and as a consequence is classified as being non-polar. Therefore, non-polar substances, such as oils and esters, tend to be absorbed more readily by the cuticle than polar compounds. Roots, having no cuticle, absorb more readily the polar compounds, such as salts.

Differential wetting

Water and liquid chemicals will readily run off plants with leaves having a large angle from horizontal. Spray materials may run off some plants as water runs off a waxed surface.

Translocation of herbicides

Some compounds are translocated in the xylem while others are associated with the movement of plant food in the phloem. Chemicals, translocated in the phloem, which kill the cells rapidly are of little value, particularly if perennial plants are to be controlled.

Morphological differences

The location of the growing point and other essential meristems and the thickness of the cuticle in various plant species are of great importance in determining the selectivity of a herbicide. The growing points of young grasses are below the ground, therefore, protected from sprays, whereas, the growing points of legumes are in the axil of the leaves and exposed to sprays.

Chemicals and Formulations

A number of different chemicals have been tested both for herbicidal action and as selective herbicides. Among these compounds are included 2,4-dichlorophenoxy-acetic acid (2,4-D), 2,4,5-trichlorophenoxyacetic acid (2,4,5-T), 2-methyl 4-chlorophenoxyacetic acid (MCPA), O-isopropyl N-phenyl carbamate (IPC), isopropyl N-(3-chlorophenyl) carbamate (Cl IPC), 3-para-chlorophenyl

1,1-dimethylurea (CMU), and 1-{2-(t-dodecyl mercapto) ethyl} pridinium chloride (P Cl). These chemicals may be formulated in a number of different ways, depending upon the chemical and physical properties of the parent compound. For example, the phenoxy acetic acids may be used as either salts or esters, each requiring a different type of formulation.

According to Weintraub and Norman (43, pp.289-298), comparative tests on compounds have been reported from only a few laboratories, and among these were many instances of contradictory results possibly caused by differences in methods.

Phillips (33, pp.71-72) summarized the work of several workers and reported little difference between the effect of 2,4-D and 2,4,5-T. Templeman and Wright (41, pp.71-72) indicated that MCPA butyl ester may be used with safety in spring cereals at somewhat heavier rates than the corresponding ester of 2,4-D. Robinson, Dunham, and Shalstad (35, p.78) reported greater reduction in yield with 2,4-D amine than the MCPA amine at the same rate.

Elder (12, p.72) reported significant differences in formulation as measured by yield when he used the ester, amine, and sodium salt of 2,4-D. Templeman and Wright (41, pp.71-72) pointed out that esters, in general agricultural practise, have proven more potent than the corresponding sodium salts in aqueous solutions. The ester of 2,4-D caused greater reduction in yield on plots treated at the seedling stage than either amine or sodium salt formulations, according to Elder (13, p.82), Derscheid (8, pp.33-34), Woestemeyer (45, p.75), and Foster (19, p.104). They also ranked the amine formulation as causing greater reduction in yield than the sodium salt.

According to Freed, Warren, and Leach (20, p.13), mixtures of 2,4-D and 2,4,5-T were recommended primarily for those plants that 2,4-D would not control satisfactorily.

Early work on IPC, reported by Templeman and Sexton (40, p.630), was interesting since its action was the exact converse of the action of phenoxyacetic acid plant growth substances. That is, concentrations of IPC which stopped the growth of many monocotyledonous plants did not affect the growth of certain dicotyledonous plants. Ennis (14, pp.95-96) concluded that IPC was active on the plants only through the soil. Recently, Wilson (44, pp.34-37) indicated that IPC could remove one grassy weed from another grass seed crop.

3-chloro IPC was less selective on some crops but more effective than IPC on Johnson grass and other weeds (44, 34-37).

Bucha and Todd (5, pp.493-494) reported that CMU was very effective in killing many plant species, particularly annual and perennial grasses. Young seedlings were killed more readily with a lower concentration of spray material than plants three months old. Preliminary observations in field experiments suggested strongly that CMU acted readily through the root system and was translocated upward to the leaves.

It was not until recently that quaternary ammonium compounds were known to control plant growth. Mitchell, Wirwille, and Weil (30, pp.252-254) reported that certain quaternary salts inhibited of the stem of bean plants when it was applied to either the stem or the leaves. They reported that the greatest reduction in growth occurred when the chemical was applied to the stem. Jones, et al (24, pp.110-114) reported that differences in reaction of oats and rape seedlings to quaternary ammonium salts indicated possible selectivity of the compounds.

Time of Application

Time of treatment with growth regulating chemicals is important in small grains since they are more tolerant at certain stages of growth, according to Andersen and Hermansen (2, pp.145-146), Elder (12, p.72), and Ahlgren, Klingman, and Wolf (1, pp.130-133). All were generally agreed that the small grains were the most susceptible, as shown by a marked reduction in yield, when treated in the seedling and boot stages of growth.

Plant Aberrations

Many workers have reported abnormalities of the leaves and the inflorescence of barley, oats, and wheat following treatment with growth regulators, particularly 2,4-D. Derscheid (7, pp.121-134) has summarized the abnormalities found in barley when treated with 2,4-D. He described them as constricted sheath, a collar constriction which does not permit the head of grain to emerge normally; incomplete heading, when the upper internode does not elongate; tweaked spike, when a rachis internode elongates more than normal; double spike, a rachilla elongated and functions the same as a rachis; multiple spikelet, more than three spikelets at one node in a spikelet group; and blasted floret, an undeveloped seed, similar to sterile floret or sterile spikelet. Anderson and Hermansen (2, pp.147-167) reported supernumary spikelets, which were similar to multiple spikelet as described by Derscheid, and onion-like leaves on cereals sprayed with two growth regulators.

Derscheid, Stahler, and Kratochvil (11, pp.11-17) and Foster (18, p.104) reported two or more panicles on one stem in oats treated with from one-half to one pound of 2,4-D ester. Other deformities reported in oats were onion-like leaves (9, pp.31-32; 11, pp.11-17) and blasted florets (11, pp.11-17; 36, p.78; 37, p.78).

Woestemeyer (45, p.75) pointed out that distorted heads in wheat were caused by difficulty of the head to emerge from the boot when the wheat was sprayed with three-fourths of a pound of 2,4-D per acre. Krall (26, pp.585-587) reported missing spikelets and supernumary spikelets in addition to crooked heads of wheat in plots treated with 2,4-D at from one-third to one and one-third pounds per acre. Large and Weston (27, p.4) indicated that onion-like leaves and tweaked heads, similar to those found in barley, were found in wheat. Deformities pointed out by Foster (17, p.104) included fused glumes, fused lemmas, missing glumes, twisted glumes, uneven spacing of the spikelets on the rachis, and two or more spikelets arising from one node on the rachis. Blanchard (4, pp.166-171) and Helgeson (23, pp.37-38) reported no head abnormalities in wheat sprayed with one pound of 2,4-D per acre but indicated a chlorotic appearance for from three to five days after the treatment.

Maturity

Phillips (34, p.83) indicated that 2,4-D ester and amine at one pound per acre applied at tillering delayed heading. Foster (19, p.104) reported heading delayed from one to three days when wheat was sprayed within thirty-one days after emergence with 2,4-D ester, amine, and sodium salt formulations.

Height

Helgeson (23, pp.37-38) reported that the height of wheat was reduced by ten per cent in two macroni wheats and six percent in five hard red spring wheat varieties sprayed with one pound per acre of 2,4-D ester and amine in the tiller stage of growth. Helgeson (22, p.109) reported later that the height of wheat was reduced from two to three inches in several wheat varieties sprayed at the time of tillering with one pound of 2,4-D ester per acre. According to Klingman (25, pp.445-447), the height of wheat was not materially lowered except in plots treated in the boot stage with 2,4-D at the rate of one, two, and three pounds per acre. Coupland and Alex (6, p.69) indicated that height was not affected except temporarily by two pounds of 2,4-D ester.

Yield and Quality

The reduction in yield of small grains was more apparent when treated with a growth regulator in the seedling and boot stages of development. The lower yield was the result of inhibition of tiller formation when the treatment was made in the seedling stage (2, pp.169-179; 3, pp.334-353; 7, pp.121-134; 10, pp.182-188; 37, p.78). However, sterile florets caused a reduced yield when small grain was treated in the boot stage (2, pp.169-179; 3, pp.334-353; 7, pp.121-134; 10, pp.182-188; 11, pp.11-17; 37, p.78).

There was no consistent effects of 2,4-D on germination of wheat as pointed out by Blanchard (4, pp.166-171) and McNeal (28, p.52), although the former worker reported germination reduced eleven percent from treatments applied in the boot stage of growth. Derscheid, Stahler, and Kratochvil (10, pp.182-188; 11, pp.11-17) reported no differences in germination from 2,4-D treatments in seven varieties of barley or in nine varieties of oats.

Erickson, Seely, and Klages (15, pp.659-660), Helgeson (23, pp.37-38), and McNeal (28, p.52) were generally agreed that protein content of the grain was increased when 2,4-D was applied to wheat. However, McNeal (28, p.52) pointed out that total protein produced per acre fluctuated very little.

Varietal Response

The reports which indicate differences in oats, wheat, and barley varieties out number those which have pointed out no varietal response. There were no apparent varietal differences in response to 2,4-D applications in oats, according to Derscheid (9, pp.31-32) and Pedersen, Andersen, and Hermansen (31, pp.145-147) or in wheat, according to Elder (13, p.82), Phillips (32, p.83), and Slife and Fuelleman (38, p.74). Ahlgren, Klingman, and Wolf (1, pp.128-136) pointed out that varieties of small grains vary considerable in their resistance to 2,4-D.

Mindo oats was rated as being more susceptible to 2,4-D over Marion and Clinton by Derscheid, Stahler, and Kratochvil (11, pp.11-17) and Staniforth and Atkins (39, pp.587-589). Robinson, Dunham, and Shulstad (35, p.78) reported significant differences among Mindo, Andrew, and Clinton oats treated with 2,4-D and MCPA. Although yield was the most common method of measuring varietal response to growth regulators, Foster (18, p.104) and Middleton, Hebert, and Klingman (29, pp.7-9) reported varietal differences observed in the vegetative abnormalities. Red Rust Proof varieties, Carolina Red, Appler, and Delta Red, showed very little injury as compared with certain Victorian strains, DeSota, Fulgrain '48 stock, Traveler St 1, Letoria Ga. Sel. 6, and Letoria (29, pp.7-9).

Grigsby and Churchill (21, pp.448-451) indicated varietal response with respect to germination in oats sprayed after heading with 2,4-D.

Varietal differences in barley have been reported by Derscheid, Stahler, and Kratochvil (10, pp.182-188) and Foster (16, p.103). Barbless barley was the most susceptible in a group of varieties reported followed by Moore, Plains, Feebar, and Kindred, while those that were more resistant were Spartan, Odessa, Manchuria, and Tregal (10, pp.182-188). Foster (16, p.103) reported that Warrior, O.A.C. #21, and Compana were the most tolerant from the yield standpoint, while Trebi, Prospect, and Vantage were the most susceptible. This author indicated that deformities were few, and, of the varieties tested, that the highest percentage of abnormalities were found in Warrior, followed by Trebi.

Wheat varieties have differences in tolerance to 2,4-D. Warden (42, p.111d) reported differences in spring wheat varieties but did not rank them according to their resistance to 2,4-D. Foster (17, p.104) pointed out that Renown and Saunders were the most tolerant from the standpoint, and that Rescue and Thatcher were the most susceptible. Krall (26, pp.585-587) reported that Yogo wheat was the least injured and had the least shattering of four varieties tested. It was interesting to note that Yogo was known for being shattering resistant in the absence of 2,4-D. Varietal differences in yield and vegetative abnormalities were reported by Woestemeyer (45, p.75). Moking, a beardless variety, had less head distortion than the other varieties tested, but had a greater reduction in yield. Of the bearded varieties, Minter had the least vegetative abnormalities and also less reduction in yield.

METHODS AND MATERIALS

The experimental plots were located on Willamette silt loam on the Hyslop Agronomy Farm approximately six miles north of Corvallis, Oregon. The plots were established on a sudan grass sod which had been plowed and disced prior to planting.

Five of the important wheat varieties grown in the Pacific Northwest and one grown in the Willamette Valley were selected for this study. They are presented and described briefly in Table 1.

TABLE 1

A Description of the Six Wheat Varieties

Variety	Description
Elmar	White club variety with excellent milling quality used for pastry flour. It ranks second in importance in the Northwest.
Brevor	Soft white, multiple-purpose variety with fair milling quality. It is a new variety released for production in 1951.
Rex	Soft white variety with very poor milling quality and the flour is rated fair for pastry uses. It ranks fifth in the Northwest.
Golden	Soft white variety with a short gluten and is used for pastry flour. It ranks sixth in production in the Northwest.
Federation	Soft white spring variety with good milling quality and is used as a pastry flour. It ranks eighth in the Northwest.
Holland	Soft white wheat grown in the Willamette Valley used for feed and milled for pastry flour.

The chemicals used in this study and their abbreviated form are presented in Table 2.

TABLE 2

The Chemicals and Their Abbreviated Form

Chemical	Abbreviation
2, 4-dichlorophenoxyacetic acid (ester)	2,4-D
2,4,5-trichlorophenoxyacetic acid (ester)	2,4,5-T
2-methyl 4-chlorophenoxyacetic acid (ester)	MCPA
O-isopropyl N-phenyl carbamate	IPC
Isopropyl N-(3-chlorophenyl) carbamate	3-chloro IPC
3-para-chlorophenyl 1,1-dimethylurea	CMU
1-{2-(t-dodecyl mercapto)ethyl} pridinium chloride	P Cl

In addition to the chemicals listed, a mixture of one part 2,4-D and one part 2,4,5-T and a mixture of one part of 2,4,5-T and one part MCPA were used as treatments.

The chemical solutions were applied at the rate of forty gallons per acre under forty pounds pressure per square inch. The small wheel sprayer used to apply the spray solutions is shown in Figure I.

FIGURE I. Small Wheel Sprayer With Boom and Air Tank

Experiment I

This experiment was planned to study the effects of different growth regulators on the six varieties of wheat at different stages of growth. The phenoxy acetic acid chemicals 2,4-D, 2,4,5-T and MCPA, plus the two mixtures of 2,4-D and 2,4,5-T and 2,4,5-T and MCPA described above, were applied at the rate of one pound of parent acid per acre at five different stages of growth.

The experimental design was a split-split plot with four replications. The treatments were super imposed at random on the stages of growth and the varieties were randomized within each treatment. The variety plots were four rows wide by ten feet long with twelve inches between rows. The seeding rate was approximately 200 kernels per row which is approximately one and one-half bushels per acre. A V-belt seeder was used to plant the wheat.

Two replications of this experiment were planted on October 9, 1951, and, because of rainy weather, the other two replications were planted on November 5, 1951. As a result of two planting dates the growth of the varieties was decidedly different and it was considered desirable to use these as two separate experiments with two replications each. The two replications planted October 9, 1951, are designated as Experiment I-a, and the two replications planted November 5, 1951, as Experiment I-b.

All varieties were treated at the seedling, tillering, jointing, heading, and flowering stages of growth. The dates of application for the two planting dates were as follows: seedling, November 3, 1951 and December 8, 1951; tillering, March 1, 1952; and jointing, April 28, 1952; while the latter two stages, heading and flowering, were treated as each variety reached that stage of development.

The plant height measurements were taken in inches two weeks before harvest when the plants had reached their full height. Eight feet of row were harvested from the center two rows of each plot. After threshing and cleaning, the grain was weighed to the nearest gram which was converted into bushels per acre.

The 2,4-D was not emulsified in the spray solution for most of the treatments. As a result, the effects of 2,4-D cannot be properly evaluated because the 2,4-D went on the plots unevenly.

Experiment II

The grass killing chemicals CMU, IPC, 3-chloro IPC, and P Cl were applied on Elmar, Brevor, Rex, and Golden to study varietal differences to these compounds. The chemicals were applied at the following rates: CMU at one, two, and four pounds; P Cl at two, four, and eight pounds; and IPC and 3-chloro IPC, each at three, six, and nine pounds of parent material per acre. The wheat was treated at the jointing stage of growth on April 2, 1952.

The wheat varieties were planted with an eight-foot grain drill set to plant at the rate of two bushels per acre.

The experimental design was a split plot with three replications. Each plot was eight feet wide, the width of the drilled strip, by eight feet long. The chemical treatments were super imposed at random upon each variety.

Height data were taken approximately two weeks before harvest. Two four-square-foot samples, taken at random, were harvested from each plot and composited into one sample for yield. The grain was threshed, cleaned, and weighed. Yields were converted into bushels per acre.

Because the treatments of IPC and 3-chloro IPC were applied on Elmar in the first replication at heavier rates than on the rest of the experiment, Elmar in the first replication was omitted in the yield and height summary tables. The summary tables include the average of two replications of Elmar and three replications of the other three varieties. The analysis of variance of yields was made on Brevor, Rex, and Golden.

Experiment III

This experiment was planned to study the number of tillers produced by the six wheat varieties after treatment with the growth regulators in the fall. The same chemicals that were used in Experiment I were applied to the wheat varieties at the one-leaf stage of growth on November 23, 1952.

A split plot experimental design was used with five replications. The varieties were super imposed at random on each chemical treatment. The variety plots were four feet by six feet, consisting of four rows spaced twelve inches apart. In each row, one kernel of wheat was planted approximately every three inches with a V-belt seeder.

Ten plants were selected at random, from each plot when they were in the six-leaf stage of growth and the number of tillers were counted on each plant.

EXPERIMENTAL RESULTS

Experiment I

The average yields of the wheat varieties treated with the growth regulators at the different stages of growth in Experiment I-a and I-b are presented in Appendix Tables I and II. These data for the two planting dates are summarized and the averages for varieties and stages of Experiment I-a are given in Table 3 and the averages for varieties and chemicals of Experiment I-b are given in Table 4.

TABLE 3

Average Yields in Bushels Per Acre of Six Wheat Varieties (Experiment I-a), Planted October 9, 1951, When Treated With Six Chemicals at Five Stages of Growth. Summary of Varieties by Stages

Stages	El.	Br.	Rex	Fed.	Gol.	Hol.	Av.
Seedling	47.0	47.6	37.4	41.4	50.7	47.0	45.2
Tillering	48.8	48.1	37.7	40.7	51.9	49.4	46.1
Jointing	43.8	43.0	33.3	31.4	44.8	44.6	40.2
Heading	44.6	41.6	34.2	37.8	47.2	47.6	42.2
Flowering	47.8	46.7	35.2	41.8	47.1	45.2	44.0
Av.	46.4	45.4	35.6	38.6	48.3	46.8	

L. S. Difference (.05) for varieties x stages is 3.1 bushels.

TABLE 4

Average Yields in Bushels Per Acre of Six Wheat Varieties (Experiment I-b), Planted November 5, 1951, When Treated With Six Chemicals at Five Stages of Growth. Summary of Varieties by Chemicals

Treatment	El.	Br.	Rex	Fed.	Gol.	Hol.	Av.
2,4-D	38.3	39.9	30.5	34.8	38.1	38.2	36.6
2,4,5-T	42.0	40.0	31.9	37.0	39.3	41.2	38.6
MCPA	42.7	41.2	34.1	37.4	39.7	41.1	39.4
2,4-D & 2,4,5-T	42.1	39.6	30.8	33.8	39.0	41.7	37.8
2,4,5-T & MCPA	42.4	40.9	30.8	37.1	39.2	38.2	38.1
Check	39.3	40.8	32.8	39.4	41.8	38.6	38.8
Av.	41.1	40.4	31.8	36.6	39.5	39.8	

L. S. Difference (.05) for varieties is 4.0 bushels.

The analysis of variance of the yields of Experiment I-a is presented in Table 5. The results of the analysis indicate highly significant differences among varieties which merely indicates the varieties were inherently different in yield. The interaction of varieties x stages was also significant.

Even though the analysis showed no significant difference between stages or chemical treatments, it is interesting to note that wheat treated at the jointing

TABLE 5

Analysis of Variance of Yields for Experiment I-a

Variation Due to:	Degrees of Freedom	Mean Square
Replications	1	9,060.10
Stages	4	40,995.74
Error (a)	4	38,711.74
Chemicals	5	7,824.70
Chem x Stages	20	5,735.43
Error (b)	25	4,653.48
Varieties	5	159,432.64**
Var x Chem	25	1,486.35
Var x Stages	20	3,231.77**
Var X Stages x Chem	100	1,156.19
Error (c)	150	1,459.80
Total	359	

**Exceeds 1% level of significance.

stage of growth was the most susceptible, as measured by yield. The mixture of 2,4-D and 2,4,5-T caused the greatest reduction in yield at this stage. The 2,4-D treatment alone cannot be considered on a comparable basis because of faulty application resulting from the failure of the chemical to emulsify with the water carrier.

(See Appendix Tables I and II.) Of the treatments applied at the jointing stage, the lowest yield of each variety was associated with 2,4,5-T, either alone or in a mixture. In general, the growth regulator treatments caused a lower yield in all varieties over the check plots. The degree of reduction, however, was relatively small.

The analysis of variance of the wheat yields of Experiment I-b is presented in Table 6. The analysis

TABLE 6

Analysis of Variance of Yield for Experiment I-b

Variation Due to:	Degrees of Freedom	Mean Square
Replications	1	72.00
Stages	4	2,288.24
Error (a)	4	9,767.41
Chemicals	5	5,292.98
Chem x Stages	20	4,119.59
Error (b)	25	3,788.44
Varieties	5	73,865.00**
Var x Chem	25	1,756.96
Var x Stages	20	2,349.42
Var x Stages x Chem	100	1,134.40
Error (c)	150	12,230.84
Total	359	

**Exceeds 1% level of significance.

again indicates that there were highly significant differences between varieties planted on November 5, 1951. The yields of Experiment I-b, however, did not follow the same pattern as the yields of Experiment I-a. In contrast to Experiment I-a in which yields were reduced slightly by the chemical treatments as compared to the check, in Experiment I-b the yields, in general, tended to be increased.

The 2,4-D treatment, although improperly applied, in the seedling stage caused a chlorotic appearance in all varieties of both Experiment I-a and Experiment I-b. In Experiment I-a, this condition was very pronounced a week after the application of 2,4-D and was only slightly noticeable one week later. The chlorotic appearance was not as pronounced in the Experiment I-b plots treated with 2,4-D in the seedling stage.

Onion-like leaves appeared on all varieties treated with 2,4-D in the seedling stage. Figure II shows the characteristic appearance of onion-like leaves in contrast with an untreated plot. The appearance of onion-like leaves in the 2,4-D plots at the seedling stage in Experiment I-a was more pronounced at the end of the plot sprayed first and decreased gradually toward the opposite end. There were more onion-like leaves in Experiment I-a than in Experiment I-b. However, when the wheat matured,

FIGURE II. Comparison of 2,4-D Applied at the Seedling Stage to Federation Wheat. (Note Onion-Like Leaves.) No Treatment on the Left there was no distortion of the heads on any of the varieties.

The plant height data of Experiments I-a and I-b are presented in Appendix Tables III and IV, respectively. No statistical analyses were made on the plant heights.

The plant height data are presented in a summarized form in Tables 7 and 8. On the average, the chemical treatments reduced height slightly over the average of the check plots. No varietal differences appear to be evident in the plant height as a result of the chemical treatments.

TABLE 7

Average Height in Inches of Six Wheat Varieties (Experiment I-a), Planted October 9, 1951, When Treated With Six Chemicals at Five Stages of Growth. Summary of Varieties by Chemicals

Treatment	El.	Br.	Rex	Fed.	Gol.	Hol.	Av.
2,4-D	38.4	35.7	40.9	39.8	41.3	47.8	40.7
2,4,5-T	38.9	35.9	41.2	40.5	41.8	47.4	41.0
MCPA	37.4	35.6	41.0	40.6	41.5	46.7	40.5
2,4-D & 2,4,5-T	38.5	35.9	40.6	39.7	42.0	47.5	40.7
2,4,5-T & MCPA	38.3	35.9	41.1	39.9	41.6	47.0	40.6
Check	38.8	36.2	41.9	41.3	42.4	47.7	41.4
Av.	38.4	35.9	41.1	40.3	41.8	47.4	

TABLE 8

Average Height in Inches of Six Wheat Varieties (Experiment I-b), Planted November 5, 1951, When Treated With Six Chemicals at Five Stages of Growth. Summary of Varieties by Chemicals

Treatment	El.	Br.	Rex	Fed.	Gol.	Hol.	Av.
2,4-D	30.6	30.9	34.7	34.1	34.5	40.4	34.2
2,4,5-T	31.6	32.0	35.4	35.1	34.7	40.5	34.8
MCPA	31.1	32.1	35.7	34.1	34.4	40.1	34.6
2,4-D & 2,4,5-T	31.4	31.7	34.6	33.8	34.8	40.8	34.5
2,4,5-T & MCPA	31.7	32.2	35.2	34.2	34.8	40.7	34.8
Check	31.7	32.0	35.9	34.5	34.8	41.7	35.1
Av.	31.4	31.8	35.3	34.3	34.7	40.7	

Experiment II

The summary of yields of four wheat varieties treated with four grass killing chemicals in Experiment II is presented in Table 9.

TABLE 9

Average Yields in Bushels Per Acre of Four Varieties of Wheat (Experiment II) Treated With Three Rates of Four Compounds at the Jointing Stage. Average of Three Replications

Treatment	El.*	Br.	Rex	Gol.	Av.**
CMU 1#	43.2	43.7	29.9	48.7	41.1
CMU 2#	44.4	45.2	30.4	48.1	41.2
CMU 4#	45.7	42.0	28.2	43.5	37.9
IPC 3#	34.3	41.7	31.7	41.3	38.2
IPC 6#	43.7	41.7	32.5	49.4	41.2
IPC 9#	45.8	39.3	30.3	40.6	36.8
3-Chloro IPC 3#	41.6	36.1	32.1	41.5	36.6
3-Chloro IPC 6#	38.0	29.7	29.0	36.6	32.0
3-Chloro IPC 9#	46.5	23.5	20.9	41.3	28.5
P Cl 2#	47.9	37.2	30.9	47.2	38.4
P Cl 4#	43.9	35.6	34.9	46.2	38.9
P Cl 8#	37.2	44.0	29.9	43.9	39.2
Check	36.7	38.3	28.5	45.1	37.3
Av.	42.2	38.4	29.9	44.2	

*Average of two replications.
**L. S. Difference (.05) for treatments is 5.3 bushels.

The analysis of variance of the yields of Brevor, Rex, and Golden of Experiment II is given in Table 10. The results again indicate a significant difference between varieties. There were also significant differences between chemical treatments. The results of the analysis indicate that 3-chloro IPC at six and nine pounds per acre reduced yields significantly.

TABLE 10

Analysis of Variance of Yields for Experiment II

Variation Due to:	Degrees of Freedom	Mean Square
Replications	2	830.87
Varieties	2	49,996.48**
Error (a)	4	3,563.05
Treatment	12	2,991.88**
Treat x Var	24	863.60
Error (b)	72	791.91
Total	116	

**Exceeds 1% level of significance.

In the CMU plots, although there were no significant differences from the check plots, it is interesting to note the striking consistency of the CMU treatments on each variety. The CMU treatments at one and two pounds per acre gave a slight increase in yield over the check plots for each variety. However, at the four pound rate, the yields of the CMU plots tended to be less than the check plots with all varieties except Elmar.

The height data of Experiment II are presented in Table 11. Variation between treatments was apparent, however, no statistical analysis was made on the plant height data.

The heavy rates of 3-chloro IPC and IPC had the most detrimental effect on the height of the wheat. There was greater reduction in height from the 3-chloro IPC than from the IPC treatments. However, Elmar did not show the same response which the other varieties did. The height of Elmar did not appear to be affected by the carbamate compounds.

The height was reduced on each of the four varieties by CMU at the rate of four pounds per acre over the check.

TABLE 11

Average Height in Inches of Four Varieties of Wheat (Experiment II) Treated With Three Rates of Four Chemicals

Treatment	El.*	Br.	Rex	Gol.	Av.**
CMU 1#	36.5	35.6	39.0	40.3	38.0
CMU 2#	36.0	35.6	38.6	40.0	37.7
CMU 4#	34.0	35.0	37.6	38.3	36.4
IPC 3#	35.5	34.3	39.6	38.6	37.1
IPC 6#	36.0	34.6	39.3	39.3	37.4
IPC 9#	35.5	31.6	37.3	38.3	35.7
3-Chloro IPC 3#	36.0	32.3	38.0	39.0	36.4
3-Chloro IPC 6#	35.5	30.0	36.6	37.0	34.7
3-Chloro IPC 9#	36.5	29.0	33.6	38.0	34.1
P Cl 2#	38.5	34.6	41.3	40.3	38.7
P Cl 4#	37.0	35.3	41.0	40.3	38.5
P Cl 5#	35.5	35.6	39.3	40.0	37.8
Check	34.5	35.6	40.6	42.0	38.5
Av.	35.9	33.7	38.6	39.4	

*Average of two replications.
**Weighted average.

Experiment III

The summary of the number of tillers developed on six wheat varieties treated with growth regulating chemicals in the fall at the seedling stage of growth is presented in Table 12. The number of tillers on ten plants were averaged together to make one observation. No analysis of variance was made of these data.

TABLE 12

Average Number of Tillers on Ten Plants of Six Varieties of Wheat Treated With Five Treatments in the Seedling Stage (Experiment III). Average of Five Replications

Treatment	El.	Br.	Rex	Fed.	Gol.	Hol.	Av.
2,4-D	6.0	6.8	4.8	5.6	5.2	6.1	5.9
2,4,5-T	6.5	6.5	6.1	6.2	5.5	6.8	6.3
MCPA	6.9	6.2	5.5	5.2	6.6	6.6	6.2
2,4-D & 2,4,5-T	6.8	6.7	4.8	5.5	6.2	6.3	6.0
2,4,5-T & MCPA	6.1	6.9	5.6	5.7	6.5	6.8	6.3
Check	6.3	6.6	5.6	6.3	6.3	6.6	6.3
Av.	6.4	6.6	5.4	5.8	6.2	6.5	

From the results of the summary there appeared to be only small differences between the treatments. The number of tillers on the plants of the wheat varieties following 2,4-D treatment was reduced only slightly more than the other treatments. The greatest reduction of the number of tillers from 2,4-D in this study appeared to be on Rex and Golden. The number of tillers developed on Golden was reduced more by the 2,4,5-T treatment than on any of the other varieties. However, the mixture of 2,4-D and 2,4,5-T on Golden appeared to have no effect over the untreated check plot.

In general, MCPA had very little decreasing effect on the number of tillers formed on the wheat varieties except on Federation where the average number of tillers were reduced by one in the plots treated with MCPA over the check plots.

DISCUSSION

One of the recent cultural methods in the production of wheat in the Columbia Basin is spraying the wheat with growth regulators for the control of weeds. Each year there is more interest in this method of weed control in the wheat fields of that area.

The wheat varieties selected for this study were the ones that are grown most extensively in the Columbia Basin, with the exception of Brevor and Holland. Brevor was included because it is a new variety recently released for general production which may replace some of the present varieties. Holland was used to represent a wheat adapted to the climate of the Willamette Valley where it is the most important variety.

Several investigators have reported reduced yields in oats, barley, and wheat as the result of inhibited tiller formation (3, pp.169-179; 10, pp.121-134; 4, pp.334-353; 45, p.78). The results reported in this study indicates there were very small differences in the number of tillers developed on the wheat varieties as a result of fall application of growth regulators. The differences were so small that it is doubtful if they would be of any significance. This lack of response in this study may be because the climatic conditions in

Western Oregon in the fall of 1952 slowed down the activity of the phenoxyacetic acid chemicals. Also, since the plants did not make much growth under such climatic conditions, the chemicals may have been broken down or leached out of the soil before they affected the wheat plants. However, future studies on the effects of growth regulators on tiller development should probably include observations from the seedling stage through to maturity of the plants which may give more opportunity to measure differences.

Various reports have been found on yield reductions in wheat following treatment with the phenoxyacetic acid compounds. For example, Elder (13, p.82) reported a significant reduction in the yield of wheat when treated in the fall with 2,4-D, while Helgeson (23, pp.37-38) indicated the yields of wheat greatly reduced when treated at the boot stage with 2,4-D. Although comparisons with 2,4-D treatments cannot be made, the other phenoxyacetic acid treatments, 2,4,5-T, MCPA, and the mixtures of 2,4-D and 2,4,5-T and 2,4,5-T and MCPA, did not reduce the yields in any important amount. It appears that these phenoxyacetic acid compounds and mixtures do not affect yield of winter wheat in the Western Oregon climate which prevailed in the fall of 1951 and the spring of 1952.

Rates of 3-chloro IPC of six pounds or more per acre were found to reduce yields significantly. Of the chemicals at the rates used in this study, 3-chloro IPC is the one that should be used with the most caution. This investigation supports the work of Wilson (44, pp.34-37) in that 3-chloro IPC is less selective than IPC. However, at low rates there appeared to be little difference between the two compounds.

Although the analysis of variance of yields indicates a significant interaction with the varieties at the five stages of growth, it may be of little consequence. There may be two reasons why this interaction may not be important in this case. First, the analysis indicates no significant differences at the stages and, second, the F value, even though it exceeded the value necessary at odds of nineteen to one, is very small. If there had been significant differences between stages and also between chemicals, there may have been more of a chance of getting important varietal response.

In the results with the grass killing chemicals, there appeared to be some varietal differences in the height and yield of the varieties as a result of the chemical treatments. Elmar appeared to be less affected by treatment with certain rates of IPC and 3-chloro IPC. The reason for this difference can be only highly speculative but it may be that these carbamates are not selective against Elmar except at certain concentrations within the range used in this study.

Several workers, although reporting no significant varietal differences, have ranked the wheat varieties they studied according to the magnitude of reduced yield in comparison with the check treatment. Ranking varieties by the amount of difference in reduced yield in this manner would seem to be a questionable procedure since there were no statistically significant differences in varietal response. There may not be any importance in ranking the varieties in this experiment since there were no significant differences between varietal responses.

One reason why varietal differences were not obtained from the phenoxyacetic acid compounds may have been the failure of these chemicals to produce greater damage at the various stages of growth. Since other workers have reported greater differences between varieties, it is suggested that this trial be repeated more than one year in different locations to determine whether the failure to obtain marked differences in yields at various stages was the result of climatic conditions. If we assume that there are no varietal differences between these varieties, then it might be accepted that there is no inherent variation in susceptibility, to these chemicals, between the varieties used in this study. Another possible explanation for the failure to obtain varietal differences might be that environmental conditions in Western Oregon were not conducive for the measurement of responses on the varieties used.

In view of the increasing number of acres of wheat being sprayed each year, it would seem desirable that all wheat varieties and new selections should be checked for susceptibility both to the broadleaved weed killers and to the grass killing chemicals. The importance of broadleaved weed control in wheat is somewhat general knowledge, but now, the number of weedy grasses appearing in the wheat fields is increasing. Resistance to grass killing chemicals as well as high tolerance to the chemicals selective for broadleaved plants should be selected for or bred into existing and new wheat varieties.

SUMMARY AND CONCLUSIONS

The growth regulating chemicals, 2,4-D, 2,4,5-T, and MCPA and two mixtures of these chemicals, 2,4-D and 2,4,5-T and 2,4,5-T and MCPA, were applied at the rate of one pound per acre on Elmar, Brevor, Rex, Federation, Golden, and Holland wheat in the seedling, tillering, jointing, heading, and flowering stages of growth. Data included the number of tillers developed, height of the wheat at maturity, and the yield of grain.

In another experiment, four chemicals selective on grasses, CMU at one, two and four pounds; IPC and 3-chloro IPC each at three, six, and nine pounds; and P Cl at two, four, and eight pounds per acre were applied to Elmar, Brevor, Rex, and Golden wheat at the jointing stage of growth. Observations recorded were plant height at maturity and yield of grain.

1. There appeared to be no important differences in effects between the phenoxyacetic acid compounds on the number of tillers produced, on the plant height at maturity, and in the yield of grain.

2. No real varietal differences were apparent following treatment with the phenoxyacetic acid compounds when applied at each of five stages of growth.

3. There was a significant reduction in yield of Brevor, Rex, and Golden from the chemical treatments of 3-chloro IPC at six and nine pounds per acre.

4. There was an indication that Elmar showed some varietal difference from Rex, Brevor, and Golden when treated with IPC and 3-chloro IPC.

5. Less selectivity of 3-chloro IPC over IPC was found at rates of six and nine pounds per acre.

6. This was a one year study and results are undoubtedly influenced by the environment. Additional studies of this nature should be designed to take environmental conditions into account.

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APPENDIX

APPENDIX TABLE I

Average Yields in Bushels Per Acre of Six Wheat Varieties (Experiment I-a), Planted October 9, 1951, When Treated With Six Chemicals at Five Stages of Growth. Average Yield of Two Replications

Chemical	El.	Br.	Rex	Fed.	Gol.	Hol.	Av.
			Seedling Stage				
2,4-D	50.2	48.3	38.4	41.6	55.0	47.5	46.8
2,4,5-T	43.8	44.8	33.4	40.8	47.6	47.2	42.9
MCPA	40.6	42.5	33.4	38.1	46.2	46.5	41.0
2,4-D & 2,4,5-T	53.3	55.2	43.9	44.7	51.5	51.1	49.9
2,4,5-T & MCPA	46.2	50.8	38.2	43.8	50.5	43.1	45.4
Check	48.1	43.8	37.1	40.2	53.5	46.4	44.8
Av.	47.0	47.6	37.4	41.4	50.7	47.0	
			Tillering Stage				
2,4-D	41.9	40.6	36.1	37.9	49.0	48.2	43.9
2,4,5-T	44.6	45.1	38.1	41.3	51.8	46.1	44.5
MCPA	50.4	45.7	39.5	36.2	51.2	48.1	45.2
2,4-D & 2,4,5-T	52.1	49.2	37.8	43.4	53.8	52.4	48.1
2,4,5-T & MCPA	47.1	53.0	38.9	43.2	49.9	53.6	47.6
Check	51.8	50.2	35.8	42.4	55.9	48.4	47.4
Av.	48.8	48.1	37.7	40.7	51.9	49.4	

L. S. Difference (.05) for varieties x stages is 3.1 bushels.

APPENDIX TABLE I (Continued)

Average Yields in Bushels Per Acre of Six Wheat Varieties (Experiment I-a), Planted October 9, 1951, When Treated With Six Chemicals at Five Stages of Growth. Average Yield of Two Replications

Chemical	El.	Br.	Rex	Fed.	Gol.	Hol.	Av.
			Jointing Stage				
2,4-D	42.8	46.1	34.2	30.8	47.6	44.3	41.6
2,4,5-T	43.0	41.1	31.1	28.6	41.8	45.1	38.4
MCPA	42.9	40.0	33.0	32.8	46.0	42.6	39.5
2,4-D & 2,4,5-T	43.0	37.6	31.5	25.8	42.3	40.8	36.8
2,4,5-T & MCPA	41.9	45.1	32.3	30.1	41.1	48.8	39.9
Check	45.2	48.5	37.8	40.6	49.7	46.4	44.7
Av.	43.8	43.0	33.3	31.4	44.8	44.6	
			Heading Stage				
2,4-D	46.0	40.2	38.0	39.6	47.8	48.5*	43.3
2,4,5-T	45.6	44.5	35.4	33.8	44.3	47.3	41.8
MCPA	42.0	38.6	33.4	40.1	48.8	49.6	42.0
2,4-D & 2,4,5-T	42.7	36.8	31.8	34.0	48.5	49.5	40.5
2,4,5-T & MCPA	42.3	44.0	34.6	38.2	44.5	43.5	41.2
Check	49.2	45.6	31.8	41.2	49.0	46.9	44.0
Av.	44.6	41.6	34.2	37.8	47.2	47.6	

*The correst 2,4-D emulsion was used.
L. S. Difference (.05) for varieties x stages is 3.1 bushels.

APPENDIX TABLE I (Continued)

Average Yields in Bushels Per Acre of Six Wheat Varieties (Experiment I-a), Planted October 9, 1951, When Treated With Six Chemicals at Five Stages of Growth. Average Yield of Two Replications

Chemical	El.	Br.	Rex	Fed.	Gol.	Hol.	Av.
			Flowering Stage				
2,4-D	45.9*	48.9	36.1	42.0	48.8	42.2*	44.8
2,4,5-T	47.9	41.0	37.2	44.4	42.6	49.8	44.6
MCPA	51.1	44.4	36.6	42.3	47.2	45.8	44.5
2,4-D & 2,4,5-T	46.8	47.7	29.1	39.3	49.1	44.2	42.7
2,4,5-T & MCPA	44.7	43.3	33.4	37.8	43.2	42.2	40.7
Check	50.2	50.1	38.7	40.2	51.6	47.0	46.3
Av.	47.8	46.7	35.2	41.8	47.1	45.2	

*The correst 2,4-D emulsion was used.
L. S. Difference (.05) for varieties x stages is 3.1 bushels.

APPENDIX TABLE II

Average Yields in Bushels Per Acre of Six Wheat Varieties (Experiment I-b), Planted November 5, 1951, When Treated With Six Chemicals at Five Stages of Growth. Average Yield of Two Replications

Treatment	El.	Br.	Rex	Fed.	Gol.	Hol.	Av.
			Seedling Stage				
2,4-D	40.0	39.6	31.2	37.0	35.6	39.7	37.2
2,4,5-T	37.8	40.0	32.3	39.0	40.6	43.7	38.9
MCPA	42.0	37.1	35.5	37.4	36.2	40.7	38.1
2,4-D & 2,4,5-T	44.8	42.2	32.3	38.7	41.7	43.0	40.4
2,4,5-T & MCPA	40.7	42.2	31.6	39.7	37.9	39.7	38.6
Check	36.0	37.1	30.1	35.2	40.2	39.0	36.3
Av.	40.2	39.7	32.2	37.8	38.7	41.0	
			Tillering Stage				
2,4-D	36.7	41.0	29.0	35.2	38.2	39.6	36.6
2,4,5-T	44.2	40.1	34.1	40.4	41.0	39.8	40.0
MCPA	47.4	43.4	36.4	38.4	39.7	38.2	40.7
2,4-D & 2,4,5-T	40.7	38.6	28.6	34.9	39.9	43.2	37.6
2,4,5-T & MCPA	47.8	45.0	32.0	38.4	40.0	35.4	39.7
Check	40.8	42.2	33.9	40.1	41.0	40.0	39.7
Av.	42.9	41.7	32.3	37.9	39.9	39.9	

APPENDIX TABLE II (Continued)

Average Yields in Bushels Per Acre of Six Wheat Varieties (Experiment I-b), Planted November 5, 1951, When Treated With Six Chemicals at Five Stages of Growth. Average Yield of Two Replications

Treatment	El.	Br.	Rex	Fed.	Gol.	Hol.	Av.
			Jointing Stage				
2,4-D	36.9	39.6	29.7	31.4	36.2	31.8	34.2
2,4,5-T	46.0	46.6	35.3	34.9	43.6	42.9	41.5
MCPA	39.6	47.6	34.6	40.9	41.4	40.4	40.8
2,4-D & 2,4,5-T	38.2	36.4	30.7	30.2	36.7	36.8	34.8
2,4,5-T & MCPA	39.1	41.7	29.6	32.5	41.0	39.6	37.2
Check	40.0	41.7	30.3	34.0	40.9	38.4	37.5
Av.	40.0	42.2	31.7	34.0	40.0	38.3	
			Heading Stage				
2,4-D	39.8	40.2	31.6	36.0	42.4	42.8*	38.8
2,4,5-T	37.8	35.8	30.0	36.3	34.6	41.8	36.0
MCPA	42.2	35.8	32.8	36.2	39.6	44.0	38.4
2,4-D & 2,4,5-T	39.7	40.3	30.2	31.9	34.6	48.8	37.6
2,4,5-T & MCPA	40.5	39.4	28.0	39.4	39.2	40.4	37.8
Check	44.0	44.2	34.1	43.2	41.6	39.3	41.6
Av.	40.7	39.3	31.6	37.2	38.6	42.8	

*The correct 2,4-D emulsion was used.

APPENDIX TABLE II (Continued)

Average Yields in Bushels Per Acre of Six Wheat Varieties (Experiment I-b), Planted November 5, 1951, When Treated With Six Chemicals at Five Stages of Growth. Average Yield of Two Replications.

Treatment	El.	Br.	Rex	Fed.	Gol.	Hol.	Av.
			Flowering Stage				
2,4-D	38.1*	39.0*	30.8	34.4	38.3*	37.2*	36.3
2,4,5-T	44.2	37.8	27.8	34.6	37.0	38.0	36.5
MCPA	42.4	42.2	31.0	34.0	41.6	42.4	38.8
2,4-D & 2,4,5-T	47.1	40.8	32.1	33.0	42.2	36.4	38.7
2,4,5-T & MCPA	43.8	36.2	33.0	35.6	38.0	35.9	37.1
Check	36.0	38.6	32.4	44.4	45.0	36.2	38.8
Av.	41.9	39.1	31.2	36.0	40.4	37.6	

*The correct 2,4-D emulsion was used.

APPENDIX TABLE III

Average Height in Inches of Six Wheat Varieties (Experiment I-a), Planted October 9, 1951, When Treated With Six Chemicals at Five Stages of Growth. Average Height of Two Replications

Treatment	El.	Br.	Rex	Fed.	Gol.	Hol.	Av.
			Seedling Stage				
2,4-D	38.0	35.0	39.5	38.0	40.5	46.5	39.6
2,4,5-T	38.0	34.5	40.5	38.5	40.5	47.5	39.9
MCPA	37.0	37.0	41.5	40.0	42.0	47.5	40.8
2,4-D & 2,4,5-T	38.5	36.5	41.0	38.5	41.5	49.5	40.9
2,4,5-T & MCPA	38.5	36.5	41.0	39.0	41.5	47.0	40.6
Check	39.0	35.5	41.5	41.5	42.5	47.5	41.2
Av.	38.2	35.8	40.8	39.2	41.4	47.6	
			Tillering Stage				
2,4-D	37.5	35.5	40.0	38.5	41.0	47.5	40.0
2,4,5-T	39.5	36.5	41.5	41.5	42.0	47.5	41.4
MCPA	38.5	36.0	41.5	40.5	41.5	46.5	40.8
2,4-D & 2,4,5-T	38.5	36.0	40.5	39.0	42.5	47.0	40.6
2,4,5-T & MCPA	39.0	36.0	42.0	41.0	42.0	48.0	41.3
Check	39.0	35.5	41.0	41.5	43.0	48.0	41.3
Av.	38.7	35.9	41.1	40.3	42.0	47.4	

APPENDIX TABLE III (Continued)

Average Height in Inches of Six Wheat Varieties (Experiment I-a), Planted October 9, 1951, When Treated With Six Chemicals at Five Stages of Growth. Average Height of Two Replications

Treatment	El.	Br.	Rex	Fed.	Gol.	Hol.	Av.
			Jointing Stage				
2,4-D	37.5	36.0	41.0	40.5	41.0	48.0	40.7
2,4,5-T	38.0	35.0	40.5	40.0	41.5	46.5	40.3
MCPA	37.5	35.0	40.5	39.5	41.0	46.0	39.9
2,4-D & 2,4,5-T	37.0	35.0	40.5	39.5	41.5	46.0	39.9
2,4,5-T & MCPA	37.5	35.5	41.0	40.0	42.0	48.0	40.6
Check	36.5	36.5	42.0	40.5	41.5	46.0	40.5
Av.	37.3	35.5	40.9	40.0	41.4	46.8	
			Heading Stage				
2,4-D	39.0	35.5	41.0	40.5	41.0	48.5*	40.8
2,4,5-T	39.5	37.0	41.0	41.0	43.0	47.0	41.4
MCPA	36.0	34.5	40.0	41.5	41.5	47.5	40.2
2,4-D & 2,4,5-T	39.5	35.0	40.5	40.5	42.0	47.0	40.8
2,4,5-T & MCPA	37.5	34.5	39.5	39.5	41.0	46.0	39.7
Check	39.5	36.5	42.5	41.0	42.5	48.5	41.8
Av.	38.5	35.5	40.8	40.7	41.8	47.4	

*The correct 2,4-D emulsion was used.

APPENDIX TABLE III (Continued)

Average Height in Inches of Six Wheat Varieties (Experiment I-a), Planted October 9, 1951, When Treated With Six Chemicals at Five Stages of Growth. Average Height of Two Replications

Treatment	El.	Br.	Rex	Fed.	Gol.	Hol.	Av.
			Flowering Stage				
2,4-D	40.0*	36.5	43.0	41.5	43.0	48.5*	42.1
2,4,5-T	39.5	36.5	42.5	41.5	42.0	48.5	41.8
MCPA	38.0	35.5	41.5	41.5	41.5	46.0	40.7
2,4-D & 2,4,5-T	39.0	37.0	40.5	41.0	42.5	48.0	41.3
2,4,5-T & MCPA	39.0	37.0	42.0	40.0	41.5	46.0	40.9
Check	40.0	37.0	42.5	42.0	42.5	48.5	42.1
Av.	39.2	36.6	42.0	41.3	42.1	47.6	

*The correct 2,4-D emulsion was used.

APPENDIX TABLE IV

Average Height in Inches of Six Wheat Varieties (Experiment I-b), Planted November 5, 1951, When Treated With Six Chemicals at Five Stages of Growth. Average Height of Two Replications

Treatment	El.	Br.	Rex	Fed.	Gol.	Hol.	Av.
			Seedling Stage				
2,4-D	29.5	30.5	34.5	33.0	34.5	40.0	33.7
2,4,5-T	30.5	31.0	35.0	33.0	33.0	40.0	33.8
MCPA	32.0	33.0	35.5	33.5	34.5	41.0	34.9
2,4-D & 2,4,5-T	30.5	32.0	33.0	32.5	34.5	41.5	34.0
2,4,5-T & MCPA	31.5	32.5	34.5	34.0	33.0	41.5	34.5
Check	31.0	32.0	35.5	34.0	34.5	42.0	34.8
Av.	30.8	31.8	34.7	33.3	34.0	41.0	
			Tillering Stage				
2,4-D	31.0	30.5	35.0	32.5	34.0	41.0	34.0
2,4,5-T	31.5	32.0	35.5	33.5	34.0	40.5	34.5
MCPA	30.5	32.0	36.5	34.0	35.0	40.0	34.7
2,4-D & 2,4,5-T	30.5	30.0	33.5	32.5	34.5	40.5	33.6
2,4,5-T & MCPA	31.5	32.0	35.5	34.5	35.5	41.0	35.0
Check	32.0	32.0	37.0	35.0	35.0	41.0	35.3
Av.	31.2	31.4	35.5	33.7	34.7	40.7	

APPENDIX TABLE IV (Continued)

Average Height in Inches of Six Wheat Varieties (Experiment I-b), Planted November 5, 1951, When Treated With Six Chemicals at Five Stages of Growth. Average Height of Two Replications

Treatment	El.	Br.	Rex	Fed.	Gol.	Hol.	Av.
			Jointing Stage				
2,4-D	29.0	31.0	34.5	33.5	33.5	39.5	33.5
2,4,5-T	32.5	32.0	36.5	37.0	36.0	42.0	36.0
MCPA	31.5	32.0	36.5	34.0	35.0	41.0	35.0
2,4-D & 2,4,5-T	31.0	31.5	35.0	33.5	34.5	41.0	34.4
2,4,5-T & MCPA	31.0	32.5	35.5	33.5	34.5	41.0	34.7
Check	31.5	31.5	35.0	34.0	34.5	41.5	34.7
Av.	31.1	31.8	35.5	34.3	34.7	41.0	
			Heading Stage				
2,4-D	31.5	31.0	35.0	35.5	35.0	40.5*	34.8
2,4,5-T	31.5	33.0	35.0	37.0	35.0	40.5	35.3
MCPA	30.0	32.0	34.5	34.0	33.0	39.0	33.8
2,4-D & 2,4,5-T	32.5	32.0	36.0	35.0	35.0	41.0	35.3
2,4,5-T & MCPA	31.5	31.5	35.5	35.0	35.5	39.5	34.8
Check	32.0	33.0	36.5	35.5	34.5	42.0	35.6
Av.	31.5	32.1	35.4	35.3	34.7	40.4	

*The correct 2,4-D emulsion was used.

APPENDIX TABLE IV (Continued)

Average Height in Inches of Six Wheat Varieties (Experiment I-b), Planted November 5, 1951, When Treated With Six Chemicals at Five Stages of Growth. Average Height of Two Replications

Treatment	El.	Br.	Rex	Fed.	Gol.	Hol.	Av.
			Flowering Stage				
2,4-D	32.0*	31.5*	34.6	36.0	35.5*	41.0*	35.1
2,4,5-T	32.0	32.0	35.0	35.0	35.5	39.5	34.8
MCPA	31.5	31.5	35.5	35.0	34.5	39.5	34.6
2,4-D & 2,4,5-T	32.5	33.0	35.5	35.5	35.5	40.0	35.3
2,4,5-T & MCPA	33.0	32.5	35.0	34.0	35.5	40.5	35.1
Check	32.0	31.5	35.5	34.0	35.5	42.0	35.1
Av.	32.2	32.0	35.2	34.9	35.3	40.4	

*The correct 2,4-D emulsion was used.