SOME EFFECTS OF VARIOUS CHEMICAL
TREATMENTS ON LEGUMES AND
CERTAIN OTHER CROPS

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THE UNIVERSITY OF ALBERTA

SOME EFFECTS OF VARIOUS CHEMICAL TREATMENTS
ON LEGUMES AND CERTAIN OTHER CROPS

A DISSERTATION

SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES
IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE
OF MASTER OF SCIENCE

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DEPARTMENT OF PLANT SCIENCE

by

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REPORT NO. 1

ANALYSIS OF THE
RESULTS OF THE
SURVEY OF THE
FARMERS OF THE
STATE OF ALABAMA

REPORT OF THE
COMMISSIONER OF AGRICULTURE
AND FORESTRY

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ALABAMA, 1931

ALABAMA, 1931

1931, 1931

A B S T R A C T

This thesis reports on the effects of various growth regulating substances applied at various rates and in various ways to certain crop plants including potatoes, spring wheat, winter wheat, flax, red clover, sweet clover, alsike clover and alfalfa.

Soaking of potato eyepieces in solutions of various chemicals before planting failed to accelerate emergence or increase yield. Emergence was decreased and delayed and tuber yields reduced by as much as 72 per cent by certain chemical treatments.

Spraying of winter wheat and spring wheat with growth substances was without effect. Variation in susceptibility of flax to damage from similar concentrations of various chemicals was recognized.

Application of herbicidal sprays to sweet clover and alfalfa showed that sweet clover could not be successfully weeded from alfalfa by 2,4-D derivatives. Top growth of alfalfa and sweet clover was very susceptible to 2,4-dichlorophenoxyacetic acid and 2,4,5-trichlorophenoxyacetic acid, but their roots possessed marked resistance.

Soil applications of phenoxy compounds at time of planting showed that very small quantities of these chemicals in the soil would decrease emergence of alfalfa, sweet clover, red clover and alsike clover. Emergence

stimulation was apparent at certain concentrations but was too greatly affected by environmental conditions to be consistently predictable.

Certain low rates of phenoxy compounds sprayed on alfalfa throughout the flowering period significantly increased seed set but the margin of safety between rates causing increase or decrease was narrow.

Possible practical applications of the various results are discussed.

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SOME EFFECTS OF VARIOUS CHEMICAL TREATMENTS

ON LEGUMES AND CERTAIN OTHER CROPS

INTRODUCTION

The increase in the practical applications of plant growth regulators within the last decade has opened a vast field of research. Investigations mostly confined to selective weed control and weed eradication have resulted in the present multi-million dollar business in synthetic hormone herbicides of which 2,4-dichlorophenoxy-acetic acid is a major product. Although 2,4-D has been widely advertised and used as a herbicide there are other important uses of this and similar chemicals. Already many specialized uses have been found for these substances in horticultural work. Methods of chemical growth control have been effective in connection with rooting of cuttings, induction of dormancy in tubers and nursery stock in storage, the breaking of dormancy in tubers, production of flower clusters in place of leafy branches, stimulation of bud-growth, blossom thinning, control of flowering, influence on fruit set and control of preharvest drop of fruits. Since horticultural crops can be affected in these ways, it would seem worthwhile to investigate various possibilities in connection with growth control of field crops.

In Alberta, as in other parts of the world, agronomists strive to secure or develop high yielding, high

INTRODUCTION

The importance of the problem of the
plant growth regulator which the last decade has opened
a new field of research. Investigations in this field
no selective when control was considered have
resulted in the present model of the action of
synthetic hormone derivatives of which 2,4-dichlorophenoxy-
acetic acid is a major example. Although 2,4-D has been
already synthesized and used as a herbicide there are other
important uses of this and other chemicals. Already
many specialized uses have been found for these substances
in horticulture and in the control of plant growth and
have been effective in connection with rooting of cuttings,
regeneration of cuttings in culture and various other in vitro,
the practice of hormone in culture, production of flower
clonata in place of leafy branches, stimulation of seed-
growth, disease fighting, control of flowering, influence
on fruit set and control of transverse and of fruit
size, rootling and root set has effected in these ways,
it would seem reasonable to investigate various possibilities
in connection with control of fruit crops.
In general, as in other parts of the world,
synthetic agents to control of plant growth, high

quality crop plants well adapted to the environment. As knowledge of growth regulating substances accumulates and the mechanism of action becomes more clearly understood it seems probable that plant characteristics such as flowering time, flowering abundance, seed setting and maturity date as well as plant composition, such as protein and carbohydrate content, may be regulated to make plants more adaptable to a specific environment and for a specific use.

The writer's investigations reported in this paper were undertaken at the University of Alberta to determine the effects on legumes and certain other crops of various growth regulating chemicals applied at herbicidal and non-herbicidal rates.

LITERATURE REVIEW

It is well known that plants bend toward the light. The history of plant hormones or growth regulators commenced in 1880 when Charles Darwin became interested in this phenomenon. The advancement in knowledge pertaining to these substances is recorded by Boysen Jensen et al (5). Depending on concentration of chemical used, hormonal treatments of plants can cause a range of reactions extending from growth stimulation to inhibition or to death of certain organs or of whole plants.

quality once plants well adapted to the environment. As knowledge of growth regulating substances accumulated and the mechanism of action became more clearly understood it seems probable that plant physiologists will be able to determine the flowering stimulus, seed number and maturity date as well as plant composition, such as protein and carbohydrate content, may be regulated to make plants more adaptable to a hostile environment and for a specific use.

The writer's investigations reported in this paper were undertaken at the University of Alberta to determine the effects on legumes and certain other crops of various growth regulating chemicals applied at seedling and non-seedling stages.

LITERATURE REVIEW

It is well known that plants need light and light. The history of plant responses to growth regulating substances is 1890 when Charles Darwin became interested in this phenomenon. The advancement in knowledge pertaining to these substances is reported by Soyars (1950) and (5). Depending on concentration of chemical used, growth of some kinds of plants can cause a range of reactions extending from growth stimulation to inhibition or to death of certain organs or of whole plants.

The Treatment of Seed, Seedlings and Growing Plants With Growth Substance.

In 1933 it was shown that hormones govern, to some extent, the growth of buds (35). One practical application, which has resulted from these findings, is the use of growth substances to induce dormancy and to break dormancy in potatoes. This work is reviewed by Avery et al (4). The potassium salts of naphthaleneacetic acid (K.N.A.) and the methyl ester of naphthaleneacetic acid (MeNA) are capable of preventing formation of sprouts on potato tubers in storage while ethylene chlorohydrin and several other chemicals are capable of breaking either natural or induced dormancy. Smith et al (32) sprayed potato plants in the field with Me NA, sodium 2,4-dichlorophenoxyacetate, α -naphthaleneacetic acid, indoleacetic acid and 2,4,5 - trichlorophenoxyacetic acid and found that sprout growth was significantly reduced in the stored tubers.

Many attempts have been made to influence the subsequent growth of plants by applications of growth regulators to seeds. There have been both positive and negative results. Thimann and Lane (36) treated oat and wheat seeds with indoleacetic acid and found that, the general vegetative growth of the shoot was accelerated, the dry weight of the plant was often increased more than 50 per cent and a slight hastening of flowering occurred.

The treatment of seeds, seedlings and growing plants with

Growth Substances.

In 1933 it was shown that hormone growth, in some extent, the growth of roots (13). One practical application, which has resulted from these findings, is the use of growth substances to induce dormancy and to break dormancy in seedlings. This work is reviewed by Avery et al (4). The commercial value of auxin-like substances (5,6,7,8,9) and the method of auxin-like substances (10,11) are capable of producing formation of auxin on plants which in average with auxin-like substances and a variety of auxin-like substances of auxin-like natural or induced auxin. Avery et al (12) showed that plants in the field with 10, 20, 40, 80, 160, 320, 640, 1280, 2560, 5120, 10240, 20480, 40960, 81920, 163840, 327680, 655360, 1310720, 2621440, 5242880, 10485760, 20971520, 41943040, 83886080, 167772160, 335544320, 671088640, 1342177280, 2684354560, 5368709120, 10737418240, 21474836480, 42949672960, 85899345920, 171798691840, 343597383680, 687194767360, 1374389534720, 2748779069440, 5497558138880, 10995116277760, 21990232555520, 43980465111040, 87960930222080, 175921860444160, 351843720888320, 703687441776640, 1407374883553280, 2814749767106560, 5629499534213120, 11258999068426240, 22517998136852480, 45035996273704960, 90071992547409920, 180143985094819840, 360287970189639680, 720575940379279360, 1441151880758558720, 2882303761517117440, 5764607523034234880, 11529215046068469760, 23058430092136939520, 46116860184273879040, 92233720368547758080, 184467440737095516160, 368934881474191032320, 737869762948382064640, 1475739525896764129280, 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4742843975160471364549467545955856705669938571904637503056182640964121790051778560, 9485687950320942729098935091911713411339877143809275006112365281928243580103557120, 18971375900641885458197870183823426822679754287618550012224730563856487160207114240, 37942751801283770916395740367646853645359508575237100024449461127712974320414228480, 75885503602567541832791480735293

On the other hand Stewart and Hamner (34) soaked seeds of various vegetable and field crop plants in a number of different hormone solutions comprising a wide range of concentrations and obtained no significant increase in growth in either field or greenhouse trials. Pearse (27) records that Amlong and Naundorf obtained increased germination and increased plant size in radishes and sugar beets while Walrand using the same chemical on sugar beet seeds reported negative results.

Many controversial results have been obtained by using growth substances on growing plants. Grace (16) reported that the growth of young tomato plants was greatly increased if the plants were watered daily with nutrient solutions containing growth hormones. An optimum concentration was found and the extent of stimulation was greatest in young plants. Pearse (27) states that Amlong and Naundorf reported acceleration of vegetative growth and flowering by foliar applications of indoleacetic acid. Hamner (18) on the other hand could find no particular benefit from adding small quantities of growth regulators to the soil around the growing plants. Pearse (27) concludes by mentioning that Zimmerman in 1947 considered there was no established proof that any synthetic growth substances stimulate the growth of the whole plant.

Hastening of the period of flowering is of commercial importance with certain plants. Clark and

On the other hand, however, it is known (19) that certain plants in a number of different botanical families, including a wide range of concentrations, and obtained in different amounts in growth in relation to the amount of light. For example, (20) reports that the amount of light required for germination and increased plant size in relation to water and other plants while the amount of light is increased in water and other plants.

Many controversial results have been obtained by using growth substances in relation to plants. (21) reports that the growth of young tomato plants was greatly increased if the plants were treated with nutrient solutions containing growth hormones. An effect on concentration was found and the extent of stimulation was greatest in some plants. For example, (22) states that young and Wainwright reported acceleration of vegetative growth and flowering by foliar application of indoleacetic acid. (23) on the other hand, said that no significant benefit from such small quantities of growth substances to the soil around the growing plants. For example, (24) and (25) mention that Zimmerman in 1947 mentioned that there was no relationship between the growth of the plants and substances stimulate the growth of the plants.

During the period of flowering in certain plants, certain plants.

Kerns (10) found that naphthaleneacetic acid and other naphthalene compounds sprayed on the foliage of pineapples at low concentrations advanced the flowering time by at least two months. Conversely, flowering could be retarded by heavier applications. Van Overbeek (37) has been successful in fully controlling flowering time in pineapple with naphthaleneacetic acid and 2,4-D. Leopold and Thimann (21) shortened by 35% the time to flowering of barley treated with naphthaleneacetic acid. Zimmerman and Hitchcock (42) working with tomato plants stimulated the production of flower clusters on leafy branches by using triiodobenzoic acid.

In reviewing the uses of plant growth regulators Weintraub and Norman (41) state that experiments aimed at prolonging the blossoming period of decorative fruit trees have given promising results. Gustafson (17) has shown that the retention of the flower on tobacco is a hormone phenomenon. Application of hormones resulted in retention of the flowers, but many of these flowers did not produce fruits.

There are few indications that seed set can be increased by hormone treatments. Ennis et al (12) noticed that potato plants sprayed with 2,4-D had set a considerable number of seed balls whereas the control plants failed to set any fruit. Conceivably, seed set might be increased by use of chemicals to induce flowers to remain on the plant

Korn (10) found that auxin-like substances and other auxin-like compounds sprayed on the foliage of pineapples at low concentrations advanced the flowering time by at least two months. Conversely, flowering could be retarded by heavier applications. Van Overbeek (11) has been successful in fully controlling flowering time in pineapple with auxin-like substances and 2,4-D. Iscovich and Wilcox (12) shortened by 35% the time to flowering of barley treated with auxin-like substances. Zimmerman and Iscovich (13) showed that auxin-like substances stimulated the production of flower clusters on leafy branches by using auxin-like substances.

In reviewing the use of plant growth regulators Reinhardt and Norman (14) state that experiments aimed at producing an increasing period of dormancy of fruit trees have given promising results. Reinhardt (15) has shown that the retention of the flower on tobacco is a hormone phenomenon. Application of hormones resulted in retention of the flower, but many of these flowers did not produce fruit.

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for a longer time and hence increase the opportunity for pollination to take place. In some tests where this method has been tried on alfalfa no benefits have been obtained (8). Sokoljskaja (33), however, claims to have increased seed yield of red clover by 27.8% with one spraying of 2,4-D at the beginning of flowering.

Growth regulators have been used on various plants in attempts to alter the chemical composition of the plant parts. Erickson et al (13) showed conclusively that the protein content of wheat increased in direct relation to the amount of 2,4-D applied in heavy herbicidal rates. Other workers, however, have shown that such protein increases are accompanied by a decrease in yield of grain apparently comparable to that which occurs under drought conditions. Warden and Bullette (38) sprayed wheat with 2,4-D ester and obtained a highly significant increase in protein content of grain. There was a positive correlation between concentration of 2,4-D and protein content and a negative correlation between protein content and yield. High protein content was associated with severe stunting of the wheat plants. Friesen (14) used similar treatments in 1947 and reports that milling and baking qualities of the wheat were not affected. Pearse (27) reviewing the work of Amlong and Naundorf, noted that the sugar content of sugar beets was increased 123 per cent by soaking the seeds in a solution of indoleacetic acid before planting.

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the wheat were not affected. Brown (35) reviewing the
work of Milroy and Yarnoff, noted that the sugar content
of wheat plants was increased 100 per cent by soaking the
seeds in a solution of indoleacetic acid before planting.

On the other hand Pearse (27) claims that Walrand found the quality of the beets from the hormone treated seed was inferior.

The Response of Plants to Growth Substances Used as Herbicides.

Marth and Mitchell (22) in describing the action of 2,4-D applied in lethal concentrations to susceptible growing plants, pointed out that the growth substance does not cause rapid superficial burning like other toxic weed killers^{do} but that it brings about morphological and physiological responses at the point of application or in parts of the plant at some distance from the actual point of contact by active translocation within the tissues. Growth responses are characterized by distorted stem and leaf growth, inhibition of bud growth, especially the terminal buds, and sometimes by the production of galls on the thickened roots and main stems. Later the cells and tissues of the plant disintegrate and the plant dies. Weaver and De Rose (39) found that great stunting of bean plants occurred when 2,4-D was applied to the youngest parts of the plants. The growth substance readily passed downward through the plant and the velocity of movement was apparently greatly influenced by the photosynthetic activity and the age of tissue. Mitchell and Brown (26) concluded that when 2,4-D was applied to the leaves of bean plants the translocation

of this chemical was closely associated with that of organic food materials and therefore confined to the living cells or parenchyma. When applied to the roots the stimulus was translocated through dead portions of the stem indicating that upward translocation was probably in the transpiration stream.

Selective weeding of one species from another with plant growth regulators, as herbicides, is possible because different species show varying degrees of susceptibility to the same application. Pearse (27) compiled a list of 193 weed plants arranging them according to their sensitivity to 2,4-D. There were three divisions namely: Species readily killed; Species relatively resistant although growth retarded; and Very resistant species. The corresponding classification of weeds in western Canada include Susceptible, Intermediate and Resistant categories. (28). Akamine (1) in reviewing selectivity of growth regulators concluded that 2,4-D has relatively little effect on most of the grasses if treated at or before jointing or after heading. Legumes are generally considered to be very susceptible to herbicides but there are variations according to species and chemical as shown by Miller (24), Kratochvil et al (19), Carder (7) Buchholtz (6), Churchill and Grigsby (9) and Shaw and Willard (31). The margin of safety between dosages of 2,4-D that injure most broad leaf crop plants and the dosages which effectively control weeds is usually narrow. Weed control is often confined to a certain stage of growth.

of this species was closely associated with that of *leptus*.
Food materials and behavior patterns of the living adults
of *leptus* were similar to those of the *leptus* was
presumably through food material of the same kind.
that several specimens were reared in the same manner.
leptus.

Relative number of the species from which
with plant growth resistance, as described, is possible
because of the same species of *leptus*.
of the same species. *leptus* (11) contained a list
of 125 food plants and other items recorded in their diet.
fifty to 25-50. There were three divisions namely: *leptus*
readily killed; *leptus* relatively resistant although growth
resistant; and *leptus* resistant species. The corresponding
classification of *leptus* in various forms include *leptus*,
leptus (11), *leptus* (28), *leptus* (11).
in reviewing *leptus* of *leptus* resistance concluded that
25-50 has relatively little effect on most of the species
it treated in the *leptus* *leptus* or *leptus* *leptus*.
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leptus (28), *leptus* (11) and *leptus* (11) and *leptus*
(28). The ratio of *leptus* between *leptus* of 25-50 that
leptus most broad leaf and *leptus* and the species which
relatively resistant *leptus* is usually narrow. Used control
is often considered to a certain degree of growth.

The presence of selectivity within a species has been shown. Albrecht (2) found that the tolerance of bentgrass to 2,4-D varied considerably among strains. In 27 strains these variations extended from no injury to some strains, to almost complete destruction of others.

Derivatives of the same chemical compound show varied effects on certain species. Ennis et al (12) showed that 2,4,5-trichlorophenoxyacetic acid had an extremely injurious effect on the Irish potato but such agents as 2,4-D and 2-methyl-4-chlorophenoxyacetic acid when applied at the same rate in aqueous sprays produced little inhibition of either vegetative growth or tuber yield.

The age of plant has an important bearing on the susceptibility of the plant to herbicides. Robinson (29), summarizing trials with flax, generalized that flax is susceptible in the cotyledon stage, moderately resistant from the early rosette stage or first leaf stage to about two weeks before full bloom, very susceptible in bud and bloom stages and resistant after boll formation. These data indicate that developing floral and ovarial structures are as severely affected by the herbicide as young vegetative plant parts are. Klingman (20) working with oats and barley also expressed this view.

Most manufacturers of 2,4-D and other hormone herbicides recommend the use of these substances on clear warm days for best results. Marth and Davis (23) found that

The purpose of this study is to determine the effect of the treatment on the growth of the plants. The results of the study are presented in the following table. The data were collected from 10 plants in each treatment group. The results show that the treatment had a significant effect on the growth of the plants.

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plants are killed more readily by 2,4-D under temperature conditions favorable for growth.

Rainfall occurring shortly after a spray application of 2,4-D will result in a decreased plant response if the growth regulator is applied in aqueous spray. This was shown to be true by Weaver et al (40). If the growth substance was applied in oil solution there was no diminution in the response to the herbicide. In another investigation Weaver and De Rose (39) determined that the leaves of young soybean plants absorbed maximum amounts of growth regulator within six hours from the time of application.

Pre-emergence soil treatment is another method of plant growth control. Akamine (1) concluded from his review of the literature that since the emergence of most plants has been shown to be adversely affected or entirely prevented when selective growth regulators are applied to the soil the difference in the degree of susceptibility of the species is minimized. Mitchell and Brown (25) agreed with Allard et al (3) nevertheless that broadleaved species generally seemed to be more sensitive to 2,4-D and 2-methyl-4-chlorophenoxyacetic acid than are grass species when planted in soil treated with these compounds.

The foregoing review, though not an exhaustive account of research on plant growth regulators, has been selected to represent and provide access to the literature having a bearing on the projects discussed in the ensuing pages.

plants are killed more readily at 2,4-D under temperature conditions favorable for growth.

Michaeli observing a similar effect when a spray application of 2,4-D with result in a fourfold plant response in the growth regulator is applied in aqueous spray. While the effect is to be seen at lower rates (50). If the growth regulator was applied in oil solution there was no distinction in the response to the herbicide. In another investigation however and De Rose (53) determined that the leaves of young green plants showed greatest resistance to growth regulator within the range from low levels of application.

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The foregoing review, though not an exhaustive account of research on plant growth regulators, has been selected as pertinent and of wide interest to the literature having a bearing on the subjects discussed in the preceding pages.

PART I.

PRELIMINARY INVESTIGATIONS WITH ANNUAL CROPS

Introduction

The foregoing literature review has indicated that various effects on plants have been obtained by the use of growth regulators at various concentrations, applied in various ways and at different stages of plant growth. Apparently effects extend from growth inhibition to stimulation depending on such factors as chemical concentration and time of application.

This project was planned to investigate effects of various chemicals on perennial legume crops under field conditions. While suitable plots of alfalfa, sweet clover and red clover were being established during the first year preliminary investigations were carried out on annual crops so that techniques could be developed and resulting effects on growth and yield observed. In this way it was hoped to learn which of a large number of available chemicals might have most promise for the ensuing investigations.

Certain effects which have been reported as a result of soaking seeds and potato tubers before planting have been indecisive. In view of this fact the studies reported in Section I were undertaken to investigate further

the effects of this type of treatment on morphological and phenological responses, yield and quality of spring wheat, winter wheat, flax, corn, peas, soybeans, and potato eye-pieces at Edmonton. Similarly the works reported in Section II was undertaken to study the effects of spray treatments with various chemicals on spring wheat, fall wheat and flax.

PART I.

PRELIMINARY INVESTIGATIONS WITH ANNUAL CROPS

Section I. Preplanting Treatments With Various Chemicals.

Materials and Methods

The following chemicals and combinations of substances were used in various tests:

<u>Chemical</u>	<u>Abbreviations Used</u>
(1) 2,4-dichlorophenoxyacetic acid in 0.5% carbowax 1500.	2,4-D
(2) 2,4,5-trichlorophenoxyacetic acid (commercial isopropyl ester) Dow Chemical Co.	2,4,5-T
(3) D.D.T. (commercial 50% wettable powder) Canadian Industries Limited.	D.D.T.
(4) Naphthaleneacetic acid in 0.5% carbowax 1500. Dow Chemical Co.	N.A.A.
(5) Parachlorophenoxyacetic acid in 0.5% carbowax. Dow Chemical Co.	P.C.P.
(6) A-o-chlorophenoxypropionic acid (commercial). Dow Chemical Co.	A.O.C.P.
(7) Composite mixture containing chemicals 1-6.	Comp.
(8) Sugar solution 1% hexose and 1% sucrose.	Sugar
(9) 4-chloro-toloxycetic acid, 20 p.p.m. with 0.5% carbowax 1500.	C.T.A.
(10) Pressed juice of flowering dandelions.	Dan.

CONTINUITY IN CHEMISTRY AND PHYSICS

Section I. Specifying Elements With Various Details.

Labels and Notes

The following elements and combinations of

elements were used in various tests:

Approximate Year	Element
1900-1905	(1) 2,4-dichlorophenoxyacetic acid in 0.5% solution in water.
1905-1910	(2) 2,4,6-trichlorophenoxyacetic acid (same material isomeric with) the chemical Co.
1910-1915	(3) D.W.P. (Commercial 50% aqueous solution)
1915-1920	(4) Canadian Enthalpy Limited.
1920-1925	(5) Epithelium-like acid in 0.5% aqueous solution.
1925-1930	(6) 2,4-dichlorophenoxyacetic acid in 0.5% solution.
1930-1935	(7) 2,4-dichlorophenoxyacetic acid (commercial).
1935-1940	(8) 2,4-dichlorophenoxyacetic acid (commercial).
1940-1945	(9) 2,4-dichlorophenoxyacetic acid (commercial).
1945-1950	(10) 2,4-dichlorophenoxyacetic acid (commercial).
1950-1955	(11) 2,4-dichlorophenoxyacetic acid (commercial).
1955-1960	(12) 2,4-dichlorophenoxyacetic acid (commercial).
1960-1965	(13) 2,4-dichlorophenoxyacetic acid (commercial).
1965-1970	(14) 2,4-dichlorophenoxyacetic acid (commercial).
1970-1975	(15) 2,4-dichlorophenoxyacetic acid (commercial).
1975-1980	(16) 2,4-dichlorophenoxyacetic acid (commercial).
1980-1985	(17) 2,4-dichlorophenoxyacetic acid (commercial).
1985-1990	(18) 2,4-dichlorophenoxyacetic acid (commercial).
1990-1995	(19) 2,4-dichlorophenoxyacetic acid (commercial).
1995-2000	(20) 2,4-dichlorophenoxyacetic acid (commercial).

<u>Chemical</u>	<u>Abbreviations Used</u>
(11) Trichlorobenzene, 20 p.p.m. with Triton X emulsifier.	T.C.B.
(12) Chlordane, 20 p.p.m. with Triton X emulsifier.	Chlor.

Test 1 (Soaked Seeds), 1949.

Counted separate lots of seeds of Red Bobs spring wheat, Kharkov winter wheat, Cheyenne winter wheat, Redwing flax, Altagold corn, Homesteader peas and Kabott soybeans were soaked for 6 hours in concentrations of 5, 20 and 50 p.p.m. of chemicals 1 - 7 and in concentrations of preparations of 8 - 12 as indicated above. Seeds for check plots were soaked for the same period in distilled water. After soaking, the seeds were dried for 16 hours. Two replicates of randomized field plots were seeded in late May. Rows each 6 feet long were spaced 2 feet apart. Peas, corn and soybeans were planted 50 seeds per row and the other species at 150 seeds per row. The soil at seeding time was very dry. Emergence counts were taken when the seedlings were approximately 2 inches tall.

Test 2 (Potatoes), 1949.

Netted Gem potato eyepieces of uniform size were cut from the central portion of the tubers, and then dried for 16 hours. Counted separate lots were soaked for

6 hours in concentrations of 5,10,20,50 and 200 p.p.m. of chemicals 1 - 7 inclusive, and in concentrations of chemicals 8 - 12 inclusive as noted above. Eyepieces for check plots were soaked in water. Triplicate randomized field plots, in factorial design, were planted in mid-May. In the design each block was assigned to a particular chemical and included treatments at 5 concentrations as well as a check, with each treatment represented by a row containing 8 eyepieces. Block number 8 was assigned the name "Group". It contained chemical treatments 8 - 12 above and a check row. Rows were 12 feet long and spaced 3 feet apart. Rows were planted along the margins of the plots to eliminate border effect. At planting time the soil was very dry.

Emergence counts were recorded June 7th, 11th, 18th, 24th and July 4th and 16th. The tubers were dug by hand in mid-September. Those from each row were bagged separately and placed in storage preparatory to counting and weighing. The resulting data were analyzed statistically.

Test 3 (Potatoes), 1950.

Tubers of uniform size from each row in Test 2 were retained in storage. In the spring eyepieces from these were planted in the same design as Test 2 with the exclusion of the D.D.T. and "Group" blocks. Emergence was recorded in the first 2 weeks of June and tubers were dug in mid-September. Yields were so constant in all rows

that only the material from rows of the 200 p.p.m. treatments and from corresponding checks were bagged separately prior to storage, weighing of the tubers, and statistical analysis of the data.

Test 4 (Potatoes), 1951.

In reviewing the results of Test 2 it was noted that T.C.B. had in all replicates caused plants to emerge a few days earlier than the check. Although the difference was not quite statistically significant, further investigation was considered advisable. Twenty-five potatoes of uniform size were selected from check material of Test 3. Three eyepieces were cut from the central region of each potato to eliminate variations due to bud dominance, insofar as possible. The 3 eyepieces from each potato were identified and soaked for 6 hours in 20 p.p.m., 40 p.p.m. of T.C.B. and water respectively. They were then planted at a uniform depth in the same pot and identified by stakes. The 25 pots were placed on the greenhouse bench and watered as required. Emergence was recorded at regular intervals until one month after planting. No stimulation was evident with the concentrations used.

Experimental Results

Test 1 (Soaked Seeds).

Very dry weather after planting, in combination with the dry condition of the soil at time of planting, prevented conclusive observations regarding time and percentage of emergence of seedlings. Counts were made twice but the behavior of the checks was so erratic that further observations were considered inadvisable. In general however, the highest rate of chemical application (50 p.p.m.) retarded emergence. The winter wheat remained vegetative throughout the summer.

Test 2 (Potatoes) 1949.

The potatoes were not affected by drought to the same extent as were the seeds in Test 1. The variance analysis of the row emergence data appears in Table 1. The F. value 18.57 indicates that the differences between the treatment means were highly significant. The means of the 200 p.p.m. treatments for 2,4-D and A.O.C.P. were just significantly lower than the means of their checks while the means of the 200 p.p.m. treatments for 2,4,5-T, N.A.A., P.C.P. and Comp. were considerably lower than the means of their controls. This is shown in Column 5, Table 2. These data indicate that soaking of Netted Gem potato eye-pieces for 6 hours, in aqueous solution of 200 p.p.m. of

Experimental Results

Test 1 (Control)

Very low seedling emergence, in combination with the dry condition of the soil at time of planting, prevented conclusive observations regarding time and percentage of emergence of seedlings. Counts were made twice but the behavior of the seedlings was erratic and no definite observations were obtained. In general, however, the highest rate of emergence was obtained (70 p.p.m.) for the control. The other three remained vegetative throughout the summer.

Test 2 (Control)

The seedlings were not affected by the dry condition of the soil at time of planting. The emergence was the same as in Test 1. The analysis of the emergence data appears in Table 1. The t-value 10.57 indicates that the differences between the treatment means were highly significant. The mean of the 200 p.p.m. treatment for 2, 4, 6 and 8 p.p.m. was just significantly lower than the mean of the control. The means of the 200 p.p.m. treatment for 2, 4, 6 and 8 p.p.m. were 2.0, 2.5, 3.0 and 3.5 respectively. This is shown in Table 2. These data indicate that seedling emergence was significantly lower for 2 p.p.m. of 200 p.p.m. of

TABLE 1

Variance Analysis of the Data for Days to
Emergence of Plants from Potato Eye-
pieces Soaked in Various Chemical
Solutions

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	F. Value
Chemicals	6	442.4	73.7	1.75
Replicates	2	407.6	203.8	4.84*
Error (1)	12	504.5	42.0	
Treatments	5	4484.7	896.9	18.57**
Chemical x treatments	30	629.4	20.9	0.43
Error (2)	70	3380.7	48.3	
Total	125			

* Significant at the 5 per cent level

** Significant at the 1 per cent level

M.S.D. for treatments = 4.6 days per row.

TABLE 2

Summary of Effects of Chemical Treatments
on Row Emergence, Survival, Yield
per Plant, and Top Growth of
Netted Gem Potatoes

Col. 1	2.	3.	4.	5.	6.
Chemical	Rate in p.p.m.	Total No. of Plants (3 replicates)	Mean Yield in ozs. per Plant	Mean No. of days for complete row emergence	Mature size of tops in % of Check
N.A.A.	200	8	23	60	50% or less
P.C.P.	200	24	7	56	50% or less
2,4,5-T	200	23	18	60	50% or less
2,4-D	200	23	18	45	50% or less
A.O.C.P.	200	24	17	47	100%
Comp.	200	23	16	52	75%
Check		24	25	33	100%

TABLE I

Summary of results of the tests for the determination of the effect of the treatment on the growth of the plants in the field.

Source of Variation	Mean of Replicates	Sum of Squares	Mean Square	F
Chemicals	2	447.4	223.7	1.72
Replicates	2	407.8	203.9	1.61
Block (1)	10	501.2	50.12	0.39
Treatments	2	4484.7	2242.35	17.52
Block (2)	10	420.4	42.04	0.33
Error (2)	10	420.7	42.07	0.33
Total	160			

* Significant at the 5 per cent level.
 ** Significant at the 1 per cent level.
 S.E.D. for treatments = 4.8 days per row.

TABLE II

Summary of results of chemical treatments on the growth, survival, yield and quality of the plants in the field.

Chemical	Yield (lb./acre)	Survival (%)	Quality (lb./acre)
7.4.4.	200	31	50 on June
2.0.1.	200	31	50 on June
2.0.1.	200	31	50 on June
2.4.2.	200	31	50 on June
4.0.1.1.	200	31	50 on June
Comp.	200	31	50 on June
Check	200	31	50 on June

2,4,5-T, N.A.A., P.C.P., 2,4-D, A.O.C.P. and Comp. before planting, significantly delayed emergence.

Column 6, Table 2 summarizes the visible effects of the various chemicals and concentrations on top size of mature plants. Of the above mentioned chemicals and concentrations those tried but not listed did not visibly affect top growth. During the early part of the season 200 p.p.m. of 2,4-D and P.C.P. produced marked abnormalities in the leaves and stems. Some of the 200 p.p.m. treatments had a lethal effect on the eyepieces. This is shown in Column 3, Table 2.

The variance analysis of the data for tuber yield per row appears in Table 3. The F value 8.71 indicates a highly significant difference between tuber yields due to the effects of the different chemical treatments. Table 4 compares the chemical concentrations which significantly decreased tuber yield and delayed emergence. Column 4, Table 2, gives the mean yield per plant for treatments which, either affected top growth or which significantly reduced tuber yield.

Test 3 (Potatoes) 1950.

Potato emergence in 1950 was normal and no effects on top growth were noted throughout the season. This would indicate that the effects of the chemical treatments were not, carried over in the progeny of the treated material. As a further check on this observation it was decided to

TABLE 3

Variance Analysis of the 1949 Yield Data for
the Test with Potato Eyepieces Soaked in
Various Chemical Solutions Prior to
Planting

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square	F. Value
Chemicals	6	10150.2	1691.7	0.50
Replicates	2	8686.2	4343.1	1.29
Error (1)	12	40468.8	3372.4	
Treatments	5	109551.6	21910.3	8.71**
Chemicals x Treatments	30	75441.0	2514.7	2.30**
Error (2)	70	76682.4	1095.5	
Total	125			

** Significant at the 1 per cent level.
M.S.D. for treatments = 54 ounces per row.

TABLE 4

Summary of Treatments that Significantly
Decreased Yield and Delayed Emergence
of Netted Gem Potatoes

Chemical	Rates (p.p.m.) decreasing yield significantly	Rates (p.p.m.) delaying emergence significantly
A.O.C.P.	-	200
XXXXX	-	-
P.C.P.	200	200
2,4-D	200	200
N.A.A.	200	200
2,4,5-T	10, 20 200	200
Comp.	-	200

Table 3

Variance Analysis of the 1955 Field Data for
the 1955-56 Season
Variation between the 1955-56 and 1954-55
Seasons

Source of Variation	D.F.	Sum of Squares	Mean Square	Variance Ratio
Between	1	1150.1	1150.1	1150.1
Within	2	1150.1	575.05	575.05
Total	3	2300.2		
Between	1	1150.1	1150.1	1150.1
Within	2	1150.1	575.05	575.05
Total	3	2300.2		
Between	1	1150.1	1150.1	1150.1
Within	2	1150.1	575.05	575.05
Total	3	2300.2		

** Significant at the 1% level
F.D. for 1955-56 = 24 units per acre

Table 4

Analysis of Variance for the 1955-56
Season
Variation between the 1955-56 and 1954-55
Seasons

Source of Variation	D.F.	Sum of Squares	Mean Square	Variance Ratio
Between	1	1150.1	1150.1	1150.1
Within	2	1150.1	575.05	575.05
Total	3	2300.2		
Between	1	1150.1	1150.1	1150.1
Within	2	1150.1	575.05	575.05
Total	3	2300.2		
Between	1	1150.1	1150.1	1150.1
Within	2	1150.1	575.05	575.05
Total	3	2300.2		

compare the yields following the 200 p.p.m. treatments with those of the checks. Table 5 summarizes these results. The data were analyzed statistically but no significant differences were found.

TABLE 5

Summary of 1950 Tuber Yields from the Progeny
of Material Treated in 1949

Mean Tuber Yield in Pounds per Row						
Chemical	2,4,5-T	2,4-D	N.A.A.	A.O.C.P.	P.C.P.	Comp.
Check	22.8	23.0	21.3	20.1	22.8	20.5
200 p.p.m.	19.8	21.6	18.5	17.8	22.5	19.8

Test 4 (Potatoes), 1951.

The first plants emerged 18 days after the eye-pieces were planted. Emergence was recorded at 3 day intervals till one month after planting. Table 6 shows the percentage emergence at these various dates.

comparing the results obtained with the 200 m.p. instrument with those of the 100 m.p. instrument. The data were multiplied by 1.25 to give the values shown in Table 2.

Table 2

Comparison of the results obtained with the 200 m.p. instrument with those of the 100 m.p. instrument.

Temperature (°C.)					
200 m.p.	100 m.p.	200 m.p.	100 m.p.	200 m.p.	100 m.p.
10.0	10.0	10.0	10.0	10.0	10.0
20.0	20.0	20.0	20.0	20.0	20.0
30.0	30.0	30.0	30.0	30.0	30.0
40.0	40.0	40.0	40.0	40.0	40.0
50.0	50.0	50.0	50.0	50.0	50.0
60.0	60.0	60.0	60.0	60.0	60.0
70.0	70.0	70.0	70.0	70.0	70.0
80.0	80.0	80.0	80.0	80.0	80.0
90.0	90.0	90.0	90.0	90.0	90.0
100.0	100.0	100.0	100.0	100.0	100.0

Table 2 (Continued)

The first column shows the results obtained with the 200 m.p. instrument. The second column shows the results obtained with the 100 m.p. instrument. The third column shows the results obtained with the 200 m.p. instrument after correction for the effect of the 100 m.p. instrument. The fourth column shows the results obtained with the 100 m.p. instrument after correction for the effect of the 200 m.p. instrument. The fifth column shows the results obtained with the 200 m.p. instrument after correction for the effect of the 100 m.p. instrument. The sixth column shows the results obtained with the 100 m.p. instrument after correction for the effect of the 200 m.p. instrument.

TABLE 6

Percentage Emergence of Netted Gem Potatoes After Soaking
Eyepieces in Trichlorobenzene Solutions

Percentage Emergence			
Days after Planting	Check	T.C.B. 20 p.p.m.	T.C.B. 40 p.p.m.
18	68	44	16
21	84	68	24
24	84	68	40
27	96	72	40
30	96	72	40

Discussion

It is highly probable that, if moisture conditions had been normal in the spring of 1949, results very different from those of Tests 1 and 2 would have been obtained. More pronounced effects were expected in the potato eyepiece test but since the mean time to emergence of the checks was 33 days it is possible that the effect of the chemicals diminished with the elapsing of such a period of time in the soil.

Considering the results obtained, it is evident that the various chemicals at rates of 200 p.p.m. had varied effects on the eyepieces and also on the subsequent growth of

the plants. N.A.A. at 200 p.p.m. was drastic in its action on the eyepieces as it killed 66 per cent of them. The lethal effect of N.A.A. on bud growth of trees has been shown by other workers (4). From results obtained it is evident that the 200 p.p.m. treatments retarded the growth of sprouts from the eyepieces in the following order of decreasing effects: N.A.A. and 2,4,5-T equal, P.C.P., Comp., 2,4-D and A.O.C.P.

Although N.A.A. at 200 p.p.m. was lethal to some eyepieces it did not have an appreciable residual effect upon the growth of those which survived since their yield was almost equivalent to the checks. The tops, however, were smaller than those of the checks. P.C.P. was outstanding in its effects on both top and tuber yield. The 200 p.p.m. P.C.P. treatment reduced top size by 50 per cent or more and reduced yield 72 per cent. There evidently was an extreme residual effect attributable to only a small amount of this particular chemical in the plant. Top growth was retarded equally by 2,4,5-T and 2,4-D at 200 p.p.m. and yield was also reduced approximately 30 per cent. 2,4,5-T however delayed emergence considerably more than did 2,4-D.

Since none of the treatments increased tuber yield, they appear to have no value from a practical standpoint apart from their possible use to prevent sprouting of non dormant potatoes in storage. N.A.A., P.C.P., 2,4,5-T and 2,4-D would appear to be most promising in this regard.

N.A.A., 2,4,5-T and 2,4-D have already been used successfully by other workers (32) for this purpose. It would seem inadvisable to use tubers previously treated in this way as seed potatoes since sprout growth would likely be inhibited, as with N.A.A., or tuber yield reduced, as with P.C.P. Counter treatments with other chemicals might be used to break the imposed dormancy. Ethylene chlorohydrin has been employed successfully in this regard (4).

Apparently 2,4,5-T was the most toxic of all the chemicals used on Netted Gem potatoes as it reduced yield significantly following applications as low as 10 p.p.m. These results agree with those of Ennis et al (12) who worked with Irish potatoes.

In the second year, eyepieces which were cut from the progeny of the previous test emerged and grew normally. Although the yields of the 200 p.p.m. rows in most cases were slightly below those of the checks statistical analysis proved these differences to be insignificant. From these results it is apparent that carryover of chemical, within the tubers from soaked eyepieces, would not be sufficient to affect yields in the second year. Whether or not this would be true following vine spraying remains to be determined.

Although 20 p.p.m. of trichlorobenzene appeared to stimulate slightly the sprouting of potato eyepieces under field conditions it definitely inhibited sprouting

W.A.A., 3,4,5-7 and 5,7-9 have already been used success-

fully by other workers (5) for this purpose. It would

seem inadvisable to use potatoe tubers planted in this

way as seed potatoes since potato growth would likely be

inhibited, as with W.A.A., on other field potatoes, as with

T.B.A. Tubers obtained with other methods might be

used to make the general assembly. Studies concerning

has been employed successfully in this regard (4).

Accordingly 3,4,5-7 was the most likely of all the tubers

used to obtain the potatoe as it yielded yield significantly

following selection as far as in W.A.A. These results

agree with those of Smith et al (1961) who worked with Irish

potatoes.

In the second year, tubers which were all from

the progeny of the previous year were used and grew normally.

Although the yield of the 3,4,5-7 was in most cases

were slightly below those of the other statistical results

proved these differences to be insignificant. From these

results it is apparent that selection of tubers, which

the tubers from other sources, would not be sufficient to

affect yield in the second year. Whether or not this would

be true following virus testing remains to be determined.

Although 3,4,5-7 was the most likely of all the tubers

to stimulate tubers the selection of tubers was made

these four selections it is likely that tubers selected

under greenhouse conditions. One month from the time of planting, emergence of the treated and untreated material was at a maximum. Following the 20 and 40 p.p.m. treatments 28 and 60 per cent of the eyepieces from respective treatments failed to emerge as compared with a failure of growth of 4 per cent of the check material. From these results it is apparent that T.C.B., which is normally used as an insecticide, may have some possibilities as a plant growth inhibitor.

Summary

1. Significant delays in emergence and subsequent decrease in tuber yield of Netted Gem potatoes were caused by soaking eyepieces for 6 hours in 200 p.p.m. solutions of 2,4-dichlorophenoxyacetic acid, 2,4,5-trichlorophenoxyacetic acid, naphthaleneacetic acid and parachlorophenoxypropionic acid immediately before planting. Other concentrations namely 5, 10, 20 and 50 p.p.m. of these chemicals had no significant effect on emergence or on yield except for 2,4,5-T. Applications as low as 10 p.p.m. of 2,4,5-T significantly reduced yield of tubers.

most common... (faint text, likely bleed-through from the reverse side of the page)

CHAPTER
I

1. The first... (faint text, likely bleed-through from the reverse side of the page)

2. Sixty six per cent of the eyepieces soaked in a 200 p.p.m. solution of N.A.A. failed to emerge. The tuber yield per surviving plant was not decreased however.
3. Tuber yield of plants from eyepieces soaked in 200 p.p.m. of P.C.P. was reduced by 72 per cent.
4. Eyepieces from the progeny of the soaked eyepieces emerged normally and their tuber yields did not vary significantly from check yields. However there was a marked trend towards a yield reduction from eyepieces from treated material.
5. In these tests 2,4,5-T showed the greatest toxicity to Netted Gem potatoes.
6. A practical use for some of the chemicals has been discussed.
7. At certain rates trichlorobenzene, an insecticide, had a definite inhibiting effect upon sprouting of potato eyepieces in soil under greenhouse conditions.

2. Sixty six per cent of the specimens collected in a 200 p.p.m. solution of T.A. failed to emerge. The lower yield per surviving plant was not decreased however.
3. When field of plants were examined in 200 p.p.m. of T.A. was reduced to 78 per cent.
4. Specimens from the progeny of the second experiment emerged normally and their growth was not very significantly from those of the first. However there was a marked trend towards a slight reduction from specimens from treated material.
5. In these tests T.A. showed the greatest toxicity in the first two instars.
6. A practical use for some of the specimens has been obtained.
7. At certain levels of concentration, an insecticide had a definite inhibiting effect upon spreading of certain specimens in all under experimental conditions.

Section II. Chemical Spray Treatments of Growing Plants

Materials and Methods

Test 1 (Spring wheat).

Red Bobs spring wheat was seeded at the rate of 1 1/2 bushels per acre in the middle of May, 1949. After emergence, randomized plots were arranged in factorial design with 3 replicates. Each block contained 6 plots, each 5 rows wide and 18.5 feet long. The chemicals and concentrations used were the same as in ^{Test 2} Section I. Solutions were applied from hand sprayers at the rate of 100 cc. per 37 square feet or approximately 26 gallons per acre. Sprayer hoods and wind screens were used to eliminate drift. Spraying was commenced early in June and continued at weekly intervals until the sixth and final treatment was applied when the wheat was headed out. The plots were harvested in early September and the threshed samples were weighed and retained for protein analysis by the Kjeldahl method using mercuric oxide as the catalyst. The yield data were analyzed statistically.

Test 2 (Flax).

In this test with flax, chemicals and methods were the same as in Test 1. Flax was sown at 1/4 bushel per acre. The first spraying was on June 15th during the 4 leaf stage

and the sixth was applied during the bud stage. These plots were not harvested owing to irregular germination and uneven growth resulting from drought conditions.

Test 3 (Flax).

Plots of flax were sprayed with 2,4-D, 2,4,5-T, D.D.T., P.C.P., N.A.A., and Comp. at rates of 500, 1000, and 2000 p.p.m. during the bud stage. Solutions were applied with hand sprayers at approximately 26 gallons per acre. The results were recorded July 16th.

Test 4 (Winter wheat).

Kharkov winter wheat was seeded in the middle of May 1949. Chemicals and methods used were the same as in Test 1.

Test 5 (Winter wheat).

Duplicated plots of Kharkov winter wheat which had remained vegetative throughout the season were sprayed on August 15th, with solutions of 2,4-D amine, 2,4,5-T ester and a mixture of both. Application was at the rate of 50 gallons per acre with rates of 1, 2, 3, 4 and 5 pounds of acid equivalent per acre.

and the wheat was sown in the same way. These plots were and continued to be irrigated by hand and the results were as follows:

Test 2 (1925).

Plots of 1/2 acre were sown with 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60, 62, 64, 66, 68, 70, 72, 74, 76, 78, 80, 82, 84, 86, 88, 90, 92, 94, 96, 98, 100, and 102 bushels of seed. The results were as follows:

Test 3 (1926).

Plots of 1/2 acre were sown in the middle of May 1926. Chemicals and methods used were the same as in Test 1.

Test 4 (1927).

Plots of 1/2 acre of winter wheat which had remained unplanted throughout the season were sown on August 15th, with seedlings of 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60, 62, 64, 66, 68, 70, 72, 74, 76, 78, 80, 82, 84, 86, 88, 90, 92, 94, 96, 98, 100, 102, 104, 106, 108, 110, 112, 114, 116, 118, 120, 122, 124, 126, 128, 130, 132, 134, 136, 138, 140, 142, 144, 146, 148, 150, 152, 154, 156, 158, 160, 162, 164, 166, 168, 170, 172, 174, 176, 178, 180, 182, 184, 186, 188, 190, 192, 194, 196, 198, 200, 202, 204, 206, 208, 210, 212, 214, 216, 218, 220, 222, 224, 226, 228, 230, 232, 234, 236, 238, 240, 242, 244, 246, 248, 250, 252, 254, 256, 258, 260, 262, 264, 266, 268, 270, 272, 274, 276, 278, 280, 282, 284, 286, 288, 290, 292, 294, 296, 298, 300, 302, 304, 306, 308, 310, 312, 314, 316, 318, 320, 322, 324, 326, 328, 330, 332, 334, 336, 338, 340, 342, 344, 346, 348, 350, 352, 354, 356, 358, 360, 362, 364, 366, 368, 370, 372, 374, 376, 378, 380, 382, 384, 386, 388, 390, 392, 394, 396, 398, 400, 402, 404, 406, 408, 410, 412, 414, 416, 418, 420, 422, 424, 426, 428, 430, 432, 434, 436, 438, 440, 442, 444, 446, 448, 450, 452, 454, 456, 458, 460, 462, 464, 466, 468, 470, 472, 474, 476, 478, 480, 482, 484, 486, 488, 490, 492, 494, 496, 498, 500, 502, 504, 506, 508, 510, 512, 514, 516, 518, 520, 522, 524, 526, 528, 530, 532, 534, 536, 538, 540, 542, 544, 546, 548, 550, 552, 554, 556, 558, 560, 562, 564, 566, 568, 570, 572, 574, 576, 578, 580, 582, 584, 586, 588, 590, 592, 594, 596, 598, 600, 602, 604, 606, 608, 610, 612, 614, 616, 618, 620, 622, 624, 626, 628, 630, 632, 634, 636, 638, 640, 642, 644, 646, 648, 650, 652, 654, 656, 658, 660, 662, 664, 666, 668, 670, 672, 674, 676, 678, 680, 682, 684, 686, 688, 690, 692, 694, 696, 698, 700, 702, 704, 706, 708, 710, 712, 714, 716, 718, 720, 722, 724, 726, 728, 730, 732, 734, 736, 738, 740, 742, 744, 746, 748, 750, 752, 754, 756, 758, 760, 762, 764, 766, 768, 770, 772, 774, 776, 778, 780, 782, 784, 786, 788, 790, 792, 794, 796, 798, 800, 802, 804, 806, 808, 810, 812, 814, 816, 818, 820, 822, 824, 826, 828, 830, 832, 834, 836, 838, 840, 842, 844, 846, 848, 850, 852, 854, 856, 858, 860, 862, 864, 866, 868, 870, 872, 874, 876, 878, 880, 882, 884, 886, 888, 890, 892, 894, 896, 898, 900, 902, 904, 906, 908, 910, 912, 914, 916, 918, 920, 922, 924, 926, 928, 930, 932, 934, 936, 938, 940, 942, 944, 946, 948, 950, 952, 954, 956, 958, 960, 962, 964, 966, 968, 970, 972, 974, 976, 978, 980, 982, 984, 986, 988, 990, 992, 994, 996, 998, 1000, 1002, 1004, 1006, 1008, 1010, 1012, 1014, 1016, 1018, 1020, 1022, 1024, 1026, 1028, 1030, 1032, 1034, 1036, 1038, 1040, 1042, 1044, 1046, 1048, 1050, 1052, 1054, 1056, 1058, 1060, 1062, 1064, 1066, 1068, 1070, 1072, 1074, 1076, 1078, 1080, 1082, 1084, 1086, 1088, 1090, 1092, 1094, 1096, 1098, 1100, 1102, 1104, 1106, 1108, 1110, 1112, 1114, 1116, 1118, 1120, 1122, 1124, 1126, 1128, 1130, 1132, 1134, 1136, 1138, 1140, 1142, 1144, 1146, 1148, 1150, 1152, 1154, 1156, 1158, 1160, 1162, 1164, 1166, 1168, 1170, 1172, 1174, 1176, 1178, 1180, 1182, 1184, 1186, 1188, 1190, 1192, 1194, 1196, 1198, 1200, 1202, 1204, 1206, 1208, 1210, 1212, 1214, 1216, 1218, 1220, 1222, 1224, 1226, 1228, 1230, 1232, 1234, 1236, 1238, 1240, 1242, 1244, 1246, 1248, 1250, 1252, 1254, 1256, 1258, 1260, 1262, 1264, 1266, 1268, 1270, 1272, 1274, 1276, 1278, 1280, 1282, 1284, 1286, 1288, 1290, 1292, 1294, 1296, 1298, 1300, 1302, 1304, 1306, 1308, 1310, 1312, 1314, 1316, 1318, 1320, 1322, 1324, 1326, 1328, 1330, 1332, 1334, 1336, 1338, 1340, 1342, 1344, 1346, 1348, 1350, 1352, 1354, 1356, 1358, 1360, 1362, 1364, 1366, 1368, 1370, 1372, 1374, 1376, 1378, 1380, 1382, 1384, 1386, 1388, 1390, 1392, 1394, 1396, 1398, 1400, 1402, 1404, 1406, 1408, 1410, 1412, 1414, 1416, 1418, 1420, 1422, 1424, 1426, 1428, 1430, 1432, 1434, 1436, 1438, 1440, 1442, 1444, 1446, 1448, 1450, 1452, 1454, 1456, 1458, 1460, 1462, 1464, 1466, 1468, 1470, 1472, 1474, 1476, 1478, 1480, 1482, 1484, 1486, 1488, 1490, 1492, 1494, 1496, 1498, 1500, 1502, 1504, 1506, 1508, 1510, 1512, 1514, 1516, 1518, 1520, 1522, 1524, 1526, 1528, 1530, 1532, 1534, 1536, 1538, 1540, 1542, 1544, 1546, 1548, 1550, 1552, 1554, 1556, 1558, 1560, 1562, 1564, 1566, 1568, 1570, 1572, 1574, 1576, 1578, 1580, 1582, 1584, 1586, 1588, 1590, 1592, 1594, 1596, 1598, 1600, 1602, 1604, 1606, 1608, 1610, 1612, 1614, 1616, 1618, 1620, 1622, 1624, 1626, 1628, 1630, 1632, 1634, 1636, 1638, 1640, 1642, 1644, 1646, 1648, 1650, 1652, 1654, 1656, 1658, 1660, 1662, 1664, 1666, 1668, 1670, 1672, 1674, 1676, 1678, 1680, 1682, 1684, 1686, 1688, 1690, 1692, 1694, 1696, 1698, 1700, 1702, 1704, 1706, 1708, 1710, 1712, 1714, 1716, 1718, 1720, 1722, 1724, 1726, 1728, 1730, 1732, 1734, 1736, 1738, 1740, 1742, 1744, 1746, 1748, 1750, 1752, 1754, 1756, 1758, 1760, 1762, 1764, 1766, 1768, 1770, 1772, 1774, 1776, 1778, 1780, 1782, 1784, 1786, 1788, 1790, 1792, 1794, 1796, 1798, 1800, 1802, 1804, 1806, 1808, 1810, 1812, 1814, 1816, 1818, 1820, 1822, 1824, 1826, 1828, 1830, 1832, 1834, 1836, 1838, 1840, 1842, 1844, 1846, 1848, 1850, 1852, 1854, 1856, 1858, 1860, 1862, 1864, 1866, 1868, 1870, 1872, 1874, 1876, 1878, 1880, 1882, 1884, 1886, 1888, 1890, 1892, 1894, 1896, 1898, 1900, 1902, 1904, 1906, 1908, 1910, 1912, 1914, 1916, 1918, 1920, 1922, 1924, 1926, 1928, 1930, 1932, 1934, 1936, 1938, 1940, 1942, 1944, 1946, 1948, 1950, 1952, 1954, 1956, 1958, 1960, 1962, 1964, 1966, 1968, 1970, 1972, 1974, 1976, 1978, 1980, 1982, 1984, 1986, 1988, 1990, 1992, 1994, 1996, 1998, 2000, 2002, 2004, 2006, 2008, 2010, 2012, 2014, 2016, 2018, 2020, 2022, 2024, 2026, 2028, 2030, 2032, 2034, 2036, 2038, 2040, 2042, 2044, 2046, 2048, 2050, 2052, 2054, 2056, 2058, 2060, 2062, 2064, 2066, 2068, 2070, 2072, 2074, 2076, 2078, 2080, 2082, 2084, 2086, 2088, 2090, 2092, 2094, 2096, 2098, 2100, 2102, 2104, 2106, 2108, 2110, 2112, 2114, 2116, 2118, 2120, 2122, 2124, 2126, 2128, 2130, 2132, 2134, 2136, 2138, 2140, 2142, 2144, 2146, 2148, 2150, 2152, 2154, 2156, 2158, 2160, 2162, 2164, 2166, 2168, 2170, 2172, 2174, 2176, 2178, 2180, 2182, 2184, 2186, 2188, 2190, 2192, 2194, 2196, 2198, 2200, 2202, 2204, 2206, 2208, 2210, 2212, 2214, 2216, 2218, 2220, 2222, 2224, 2226, 2228, 2230, 2232, 2234, 2236, 2238, 2240, 2242, 2244, 2246, 2248, 2250, 2252, 2254, 2256, 2258, 2260, 2262, 2264, 2266, 2268, 2270, 2272, 2274, 2276, 2278, 2280, 2282, 2284, 2286, 2288, 2290, 2292, 2294, 2296, 2298, 2300, 2302, 2304, 2306, 2308, 2310, 2312, 2314, 2316, 2318, 2320, 2322, 2324, 2326, 2328, 2330, 2332, 2334, 2336, 2338, 2340, 2342, 2344, 2346, 2348, 2350, 2352, 2354, 2356, 2358, 2360, 2362, 2364, 2366, 2368, 2370, 2372, 2374, 2376, 2378, 2380, 2382, 2384, 2386, 2388, 2390, 2392, 2394, 2396, 2398, 2400, 2402, 2404, 2406, 2408, 2410, 2412, 2414, 2416, 2418, 2420, 2422, 2424, 2426, 2428, 2430, 2432, 2434, 2436, 2438, 2440, 2442, 2444, 2446, 2448, 2450, 2452, 2454, 2456, 2458, 2460, 2462, 2464, 2466, 2468, 2470, 2472, 2474, 2476, 2478, 2480, 2482, 2484, 2486, 2488, 2490, 2492, 2494, 2496, 2498, 2500, 2502, 2504, 2506, 2508, 2510, 2512, 2514, 2516, 2518, 2520, 2522, 2524, 2526, 2528, 2530, 2532, 2534, 2536, 2538, 2540, 2542, 2544, 2546, 2548, 2550, 2552, 2554, 2556, 2558, 2560, 2562, 2564, 2566, 2568, 2570, 2572, 2574, 2576, 2578, 2580, 2582, 2584, 2586, 2588, 2590, 2592, 2594, 2596, 2598, 2600, 2602, 2604, 2606, 2608, 2610, 2612, 2614, 2616, 2618, 2620, 2622, 2624, 2626, 2628, 2630, 2632, 2634, 2636, 2638, 2640, 2642, 2644, 2646, 2648, 2650, 2652, 2654, 2656, 2658, 2660, 2662, 2664, 2666, 2668, 2670, 2672, 2674, 2676, 2678, 2680, 2682, 2684, 2686, 2688, 2690, 2692, 2694, 2696, 2698, 2700, 2702, 2704, 2706, 2708, 2710, 2712, 2714, 2716, 2718, 2720, 2722, 2724, 2726, 2728, 2730, 2732, 2734, 2736, 2738, 2740, 2742, 2744, 2746, 2748, 2750, 2752, 2754, 2756, 2758, 2760, 2762, 2764, 2766, 2768, 2770, 2772, 2774, 2776, 2778, 2780, 2782, 2784, 2786, 2788, 2790, 2792, 2794, 2796, 2798, 2800, 2802, 2804, 2806, 2808, 2810, 2812, 2814, 2816, 2818, 2820, 2822, 2824, 2826, 2828, 2830, 2832, 2834, 2836, 2838, 2840, 2842, 2844, 2846, 2848, 2850, 2852, 2854, 2856, 2858, 2860, 2862, 2864, 2866, 2868, 2870, 2872, 2874, 2876, 2878, 2880, 2882, 2884, 2886, 2888, 2890, 2892, 2894, 2896, 2898, 2900, 2902, 2904, 2906, 2908, 2910, 2912, 2914, 2916, 2918, 2920, 2922, 2924, 2926, 2928, 2930, 2932, 2934, 2936, 2938, 2940, 2942, 2944, 2946, 2948, 2950, 2952, 2954, 2956, 2958, 2960, 2962, 2964, 2966, 2968, 2970, 2972, 2974, 2976, 2978, 2980, 2982, 2984, 2986, 2988, 2990, 2992, 2994, 2996, 2998, 3000, 3002, 3004, 3006, 3008, 3010, 3012, 3014, 3016, 3018, 3020, 3022, 3024, 3026, 3028, 3030, 3032, 3034, 3036, 3038, 3040, 3042, 3044, 3046, 3048, 3050, 3052, 3054, 3056, 3058, 3060, 3062, 3064, 3066, 3068, 3070, 3072, 3074, 3076, 3078, 3080, 3082, 3084, 3086, 3088, 3090, 3092, 3094, 3096, 3098, 3100, 3102, 3104, 3106, 3108, 3110, 3112, 3114, 3116, 3118, 3120, 3122, 3124, 3126, 3128, 3130, 3132, 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3466, 3468, 3470, 3472, 3474, 3476, 3478, 3480, 3482, 3484, 3486, 3488, 3490, 3492, 3494, 3496, 3498, 3500, 3502, 3504, 3506, 3508, 3510, 3512, 3514, 3516, 3518, 3520, 3522, 3524, 3526, 3528, 3530, 3532, 3534, 3536, 3538, 3540, 3542, 3544, 3546, 3548, 3550, 3552, 3554, 3556, 3558, 3560, 3562, 3564, 3566, 3568, 3570, 3572, 3574, 3576, 3578, 3580, 3582, 3584, 3586, 3588, 3590, 3592, 3594, 3596, 3598, 3600, 3602, 3604, 3606, 3608, 3610, 3612, 3614, 3616, 3618, 3620, 3622, 3624, 3626, 3628, 3630, 3632, 3634, 3636, 3638, 3640, 3642, 3644, 3646, 3648, 3650, 3652, 3654, 3656, 3658, 3660, 3662, 3664, 3666, 3668, 3670, 3672, 3674, 3676, 3678, 3680, 3682, 3684, 3686, 3688, 3690, 3692, 3694, 3696, 3698, 3700, 3702, 3704, 3706, 3708, 3710, 3712, 3714, 3716, 3718, 3720, 3722, 3724, 3726, 3728, 3730, 3732, 3734, 3736, 3738, 3740, 3742, 3744, 3746, 3748, 3750, 3752, 3754, 3756, 3758, 3760, 3762, 3764, 3766, 3768, 3770, 3772, 3774, 3776, 3778, 3780, 3782, 3784, 3786, 3788, 3790, 3792, 3794, 3796, 3798, 3800, 3802, 3804, 3806, 3808, 3810, 3812, 3814, 3816, 3818, 3820, 3822, 3824, 3826, 3828, 3830, 3832, 3834, 3836, 3838, 3840, 3842, 3844, 3846, 3848, 3850, 3852, 3854, 3856, 3858, 3860, 3862, 3864, 3866, 3868, 3870, 3872, 3874, 3876, 3878, 3880, 3882, 3884, 3886, 3888, 3890, 3892, 3894, 3896, 3898, 3900, 3902, 3904, 3906, 3908, 3910, 3912, 3914, 3916, 3918, 3920, 3922, 3924, 3926, 3928, 3930, 3932, 3934, 3936, 3938, 3940, 3942, 3944, 3946, 3948, 3950, 3952, 3954, 3956, 3958, 3960, 3962, 3964, 3966, 3968, 3970, 3972, 3974, 3976, 3978, 3980, 3982, 3984, 3986, 3988, 3990, 3992, 3994, 3996, 3998, 4000, 4002, 4004, 4006, 4008, 4010, 4012, 4014, 4016, 4018, 4020, 4022, 4024, 4026, 4028, 4030, 4032, 4034, 4036, 4038, 4040, 4042, 4044, 4046, 4048, 4050, 4052, 4054, 4056, 4058, 4060, 4062, 4064, 4066, 4068, 4070, 4072, 4074, 4076, 4078, 4080, 4082, 4084, 4086, 4088, 4090, 4092, 4094, 4096, 4098, 4100, 4102, 4104, 410

Experimental Results

Test 1 (Spring wheat).

Careful observation of the spring wheat revealed no visible effects of spray treatments on growth, heading or ripening. Table 7 shows the variance analysis of the yield data. Apparently Red Bobs spring wheat was not significantly increased or decreased in yield by the chemical applications. Protein data for the various treatments varied so slightly from those of the checks that statistical analysis was considered not to be worthwhile.

Test 2 (Flax).

In this test flax germination was so uneven that, at the time of the first spray application, some seedlings were in the 4 leaf stage while others had just emerged. At the time of the fourth application it was noted that the 200 p.p.m. 2,4,5-T rate had caused chlorosis and stunting. Three successive applications of 200 p.p.m. thus had a serious effect upon flax plants in the stage of active growth. A similar but less pronounced effect was observed in the plots treated with 50 p.p.m. of 2,4,5-T. By early September no plants remained alive in the 2,4,5-T 200 p.p.m. plots while those in the 50 p.p.m. plots were alive but

Experimental Results

Test 1 (Control)

Detailed description of the control group showed that no visible effects of any treatment on growth, flowering or ripening. Table 1 shows the various results of the yield data. Apparently the data given were not significantly increased or decreased in yield by the treatment applications. Protein data for the various treatments varied so slightly from those of the control that statistical analysis was considered not to be worthwhile.

Test 2 (Fertilizer)

In this test the fertilizer was applied at the time of the first early application, some seedlings were in the 4 leaf stage while others had just emerged. At the time of the fourth application it was noted that the 200 p.p.m. 2,4-D rate had caused chlorosis and stunting. Three successive applications of 200 p.p.m. had a serious effect upon plant growth in the stage of active growth. A similar but less pronounced effect was observed in the plants treated with 50 p.p.m. in 2,4-D. By early September no plants remained alive in the 2,4-D 200 p.p.m. plots while those in the 50 p.p.m. plots were alive but

TABLE 7

Variance Analysis of the Yield Data from
Chemically Sprayed Spring Wheat.

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square	F. Value
Chemicals	6	22833	3805.5	0.92
Replicates	2	31147	15573.5	3.76
Error (1)	12	49663	4138.6	
Treatments	5	5730	1146.0	0.83
Chemicals x Treatments	30	41584	1386.1	2.13**
Error (2)	70	45493	649.9	
Total	125			

** Significant at the 1 per cent level.

seriously stunted. No other effects due to treatment were observed. Growth was so irregular that plots were not harvested.

Test 3 (Flax).

As noted above, flax plots were treated at bud stage in mid-July with herbicidal rates of various chemicals in order to determine their relative toxicity to this crop. A summary of the effects of the treatments appear in Table 8. Under the conditions of the test, flax showed responses to the applied growth regulators in the following order of

Table V

Analysis of Variance of the Yield Data from
Experiment 1, 1954-55

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square	F Value
Treatments	5	10.00	2.00	1.00
Replicates (1)	10	10.00	1.00	0.50
Treatments x Replicates	50	10.00	0.20	0.10
Total	65	30.00		

** Significant at the 1 per cent level.

correlation obtained. No other effects due to treatment were observed. Growth was so irregular that data were not harvested.

Test 2 (1954)

As noted above, test data were treated as two series in this test. The results of the analysis of variance are given in Table 2. In order to determine their relative toxicity to the crop, a summary of the effects of the treatments given in Table 2. When the results of the test, they showed no significant differences in the following test of

TABLE 8

Responses of Budding Red Wing Flax to
Herbicide Rates of Chemicals

Chemical	Rates P.P.M.	Visible effects on topgrowth	
		5 Days after treatment	2 1/2 Months after treatment
2,4,5-T	2000	severe twisting, partial chlorosis	All plants dead.
	1000	severe twisting, partial chlorosis	30% of plants alive, growth retarded
	500	severe twisting, partial chlorosis	30% of plants alive, growth retarded
2,4-D	2000	severe twisting	50% of plants alive, growth retarded
	1000	severe twisting	100% of plants alive, growth retarded
	500	slight twisting	100% of plants alive, growth retarded
P.C.P.	2000	severe twisting, partial chlorosis	60% of plants alive, growth retarded
	1000	slight twisting	100% of plants alive, growth normal
	500	No visible effect	100% of plants alive, growth normal
N.A.A.	2000	No visible effect	100% of plants alive, growth normal
	1000	No visible effect	100% of plants alive, growth normal
	500	No visible effect	100% of plants alive, growth normal
Comp.	2000	severe twisting, partial chlorosis	50% of plants alive, growth retarded
	1000	severe twisting	100% of plants alive, growth normal
	500	slight twisting	100% of plants alive, growth normal

at 10.15 AM on 10.10.47
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decreasing susceptibility: 2,4,5-T, 2,4-D, Comp., P.C.P., and N.A.A. At 2000 p.p.m. 2,4,5-T was lethal while N.A.A. had no visible effects on the flax plants.

Test 4 (Winter Wheat).

The spring planted Kharkov winter wheat grew very well. After 6 weekly sprays no visible effects were observed. By the middle of August the vigorous vegetative growth was about 2 feet tall.

Test 5 (Winter wheat).

Ten days after the herbicidal rates of the chemicals were applied to Kharkov winter wheat there was evidence of burning caused by all rates except 2,4-D at 1 and 2 pounds per acre. Burning became progressively worse with increase in concentration of chemicals. Three pounds per acre of 2,4,5-T caused damage equivalent to that from 5 pounds of 2,4-D. Because all the wheat winter killed it was not possible to observe later effects of these treatments such as may have occurred the following spring.

Discussion

The results obtained from the chemical spray treatments of spring and winter wheat were of no practical value. Winter wheat remained vegetative and spring wheat was not

affected either in growth, yield or protein content. The treatments applied were considerably below the herbicidal rates known to affect yield and protein content (13).

The spray treatments gave an indication of the extent of damage produced on flax by the various chemicals, applied during the bud stage of this crop. As shown earlier, certain chemicals did not affect the flax plants while others killed the complete stand.

Summary

1. The yield and protein content of Red Bobs spring wheat was not significantly affected by any of the chemical treatments outlined in Section I.
2. Spring planted Kharkov winter wheat remained vegetative after the various chemical treatments.
3. Flax plants at the bud stage responded to aqueous chemical sprays in the following order of increasing susceptibility: Naphthaleneacetic acid, parachlorophenoxypropionic acid, composite mixture, 2,4-dichlorophenoxyacetic acid and 2,4,5-trichlorophenoxyacetic acid. At the 2000 p.p.m. rate 2,4,5-T was lethal while N.A.A. caused no visible response.

PART II.

LEGUME CROP INVESTIGATIONS

Introduction

Since it has been shown that growth regulators possess both growth inhibitory and growth stimulatory powers, investigation of the extent and importance of such responses in legume crops seemed desirable.

In the experiments dealt with in Section I an effort was made to investigate the possibility of selectively weeding sweet clover from alfalfa at three stages of growth and also to determine possibilities of using synthetic hormone herbicides for weed control purposes within these crops.

Section II was undertaken to explore possible favorable or unfavorable effects of phenoxy compounds in the soil on germination and growth of legume seedlings.

The objectives of the work reported in Section III were to determine if hormone sprays applied at relatively low rates at intervals throughout the flowering season would significantly affect seed set of alfalfa and red clover.

PART IV.

THE EFFECT OF LIGHT ON GROWTH

Introduction

Since it has been shown that growth regulators possess both growth inhibitory and growth stimulatory powers, investigation of the extent and intensity of such responses in various species seemed desirable.

In the experiments dealt with in Section I an effort was made to investigate the possibility of relating very readily sweet class from which at three stages of growth and also to determine possibilities of using synthetic hormone preparations for seed control purposes within these crops.

Section II was undertaken to explore possible favorable or unfavorable effects of phenol compounds in the soil on germination and growth of various seedlings.

The objectives of the work reported in Section III were to determine if various sources applied at relatively low rates of material brought out the flowering season would be sufficiently early and of which and red clover.

PART II.

LEGUME CROP INVESTIGATIONS

Section I. Herbicidal Applications of Synthetic Growth -
Regulators to Alfalfa and Sweet Clover

Materials and Methods

Synthetic hormone herbicides that were readily available as commercial formulations were used in these investigations. These chemicals were:

<u>Chemical</u>	<u>Abbreviations</u> <u>Used</u>
1. 2,4-dichlorophenoxyacetic acid (amine) Naugatuck.	2,4-D amine
2. 2,4-dichlorophenoxyacetic acid (ester) Green Cross.	2,4-D ester
3. 2,4,5-trichlorophenoxyacetic acid (ester) Naugatuck.	2,4,5-T ester

In the following tests the solutions were applied with a Dobbins tank-type pressure sprayer.

Test 1 (Alfalfa).

When plants were 4 inches tall, randomized plots in two replicates, in a one year old stand of Grimm alfalfa

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Total 1-3, 1, 3

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were sprayed with 2,4-D amine and 2,4,5-T ester at rates of 2, 4, 8 and 16 ounces acid equivalent in 45 gallons of water per acre. Plot area was approximately 1/2000 acre. Observations were recorded in June, July and August.

Test 2 (Alfalfa).

During the early flowering stage randomized and replicated plots, in a one year old stand of alfalfa, were sprayed with chemicals 1, 2 and 3 above at rates of 1/2, 1, 2, 4, 8 and 16 ounces per acre. Plot size and gallonage was the same as in Test 1. Observations were recorded at intervals throughout the summer.

Test 3 (Alfalfa).

The remnants of the alfalfa field, which were not under test, were mown July 31st. When the second growth was 6 to 8 inches tall on August 10th, randomized and replicated plots were sprayed with eleven rates of chemicals 1, 2 and 3 above ranging from 1 ounce to 4 pounds per acre. Plot size and gallonage was the same as in Test 1. Effects of the treatments were recorded on September 2nd and October 5th.

Test 4 (Sweet Clover).

Sweet clover 4 inches tall was treated in the same way as the plots in Test 1. Observations were recorded in June, July and August.

were sprayed with 2,4-D sprays and 2,4,5-T water at rates of 2, 4, 8 and 16 ounces per acre. The water was approximately 1/2 inch deep. Observations were recorded in June, July and August.

Test 2 (1954).

During the early flowering stage randomized and replicated plots, in the east old stand of alfalfa, were sprayed with treatments 1, 2 and 3 above at rates of 1/2, 1, 2, 4, 8 and 16 ounces per acre. The size and distance was the same as in Test 1. Observations were recorded at intervals throughout the summer.

Test 3 (1954).

The summer of the alfalfa field, which were not watered, were mowed July 21st. After the second growth was 6 to 8 inches tall on August 10th, randomized and replicated plots were sprayed with eleven rates of treatments 1, 2 and 3 above ranging from 1 ounce to 8 ounces per acre. The size and distance was the same as in Test 1. Results of the treatments were recorded on September 2nd and October 5th.

Test 4 (Sweet Clover).

Sweet clover 4 inches tall was treated in the same way as the plots in Test 1. Observations were recorded in June, July and August.

Test 5 (Sweet clover).

Sweet clover at the early flowering stage was given the same treatments as the plots in Test 2, and observations were recorded at the same times.

Test 6 (Sweet clover).

Regrowth of sweet clover in the 6 - 8 inch stage was treated with the same chemicals and concentrations in the same way as Test 3. Observations were recorded September 2nd and October 5th.

Experimental Results

Test 1 (Alfalfa).

As a result of the spray treatments on alfalfa at the early growth stage, only 2,4-D amine at 2 ounces per acre was without visible effect. All higher rates of amine and all rates of 2,4,5-T ester caused root brittleness, leaf chlorosis, stem twisting and stunting of the plant. Vigorous regrowth occurred from the crowns and from the nodes of the prostrate stems in all plots treated with 4 ounces per acre or more. The 1 pound per acre rate of 2,4-D caused death to 15 per cent of the plants while 2,4,5-T at 1 pound per acre killed 30 per cent of the plants. Flowering was delayed from 2 to 3 weeks by rates of 2,4-D higher than

2 ounces and by all rates of 2,4,5-T. One pound of 2,4,5-T per acre delayed flowering about 6 weeks. Toward the end of the season the regrowth in the plots treated with 1 pound of amine or ester per acre was as dense as the check plots and much taller despite the earlier death of some of the plants in these plots.

Test 2 (Alfalfa).

Treatments with the esters of 2,4-D and 2,4,5-T at rates of 1 ounce acid equivalent or less, and with the amine at 2 ounces or less per acre, applied to alfalfa during the early flowering stage, had no lasting effect on the appearance of the plants. The 2 ounce rate of the esters and 4 ounce rate of the amine checked the growth of stems. This retardation led to regrowth from the nodes and crowns. The terminal buds were all killed. Flowering was thus delayed about 1 month. All rates above 2 ounces of ester and above 4 ounces of amine caused leaf chlorosis and inhibition of stem growth to such an extent that regrowth was almost entirely from the crowns and not from the lateral buds on the stems. Seed pods were not present in these plots at harvesting time. All topgrowth and some roots of plants treated with 1 pound of the ester per acre died within 1 month after the spray application. By the end of the second month regrowth commenced from about 30 per cent of the plants.

Test 3 (Alfalfa).

All rates except 1 ounce of amine caused visible distortion of alfalfa regrowth, the severity increasing with the rate. Observations recorded 5 weeks after treatment showed that growth was retarded by 2 ounces or less of amine and by 1 ounce of the esters per acre. Rates greater than these caused growth inhibition, chlorosis and stem and leaf necrosis. Increase in severity was proportional to increase in rates. Although 1 pound per acre or higher rates of chemical appeared to have killed 80 to 100 per cent of the alfalfa roots a final assessment cannot be made until the next growing season arrives.

Test 4 (Sweet Clover).

As regards the spray treatments of sweet clover at the early growth stage, 2 ounces of amine per acre caused slight stem distortion while all higher rates of amine and all ester rates prostrated the stems. Within two weeks after treatment, anthocyanin pigmentation became more evident in all treated stems and depth of color paralleled treatment rates. Lesions on roots and stems appeared following all treatments of 8 ounces or more of amine and 4 ounces or more of esters. Regrowth from the crowns and also from the lateral buds on the stems was vigorous in plots treated with 1 pound or less of amine per acre and 8 ounces or less of

Test 3 (Alkali)

All rats except 1 ounce of amino acid solution
distillation of alkali solution, the activity increasing
with the rate. Investigation recorded 3 weeks after death
ment showed that growth was retarded by 2 ounces or less of
amine and by 1 ounce of the alkali per year. When greater
than these caused growth inhibition, alkaline had been
less beneficial. Increase in activity was proportional to
increase in water. Although 1 pound per year or higher
rates of chemical reported to have killed 50 to 100 per cent
of the alkali water a final assessment cannot be made until
the next growing season arrives.

Test 4 (Acid Alkali)

As regards the early treatment of wheat clover at
the early growth stage, 1 ounce of amino acid solution and
alkali solution while all higher rates of amine and
all other rates showed no effect. Alkali had weaker effect
treatment. Inhibition of germination began and evident in
all treated areas and depth of color indicated treatment
rates. Based on rate and time passed following all
treatments of 1 ounce or more of amine and 2 ounces or
more of alkali. No growth from the ground and also from the
leaves and on the stems was visible in other treated with
1 pound or less of amine or more and 2 ounces or less of

the esters per acre. Regrowth from terminal buds occurred only in plots treated with less than 4 ounces of amine per acre and with less than 2 ounces of the esters per acre. Thus of the treatments used here, it is assumed that terminal buds were killed by rates higher than 2 ounces of amine and 1 ounce of the esters per acre, and that lateral buds were killed by rates higher than 8 ounces of the esters per acre. Eighty per cent of the plants in the plots treated with 1 pound of the esters per acre were killed, the remainder produced some new growth in late August. Flowering was delayed 2 to 3 weeks by 2 and 4 ounces of the esters and by 4 ounces of amine per acre, 4 weeks by 1 pound of amine and 8 ounces of the esters per acre, and 8 weeks by 1 pound of the esters per acre. Almost without exception the results of this test show that 2,4-D or 2,4,5-T esters had a comparable effect on sweet clover. Rate for rate these esters were much more toxic to legume vegetation than was 2,4-D amine. In general twice as much 2,4-D amine as ester was required to produce a comparable effect on sweet clover. In the following discussion it can therefore be assumed that amine at double the ester rate produced a similar effect on the plants.

Test 5 (Sweet clover).

Treatments of sweet clover with 1 ounce or less of ester per acre applied during the early flowering stage

The aster was found. According to the original data collected only in place treated with less than 1 ounce of aster per acre. Some also with less than 1 ounce of aster per acre. Thus of the experimental area here, it is assumed that (a) some were killed by these insects with 2 ounces of aster and I think of the aster per acre, and that (b) some were killed by aster in less than 2 ounces of aster per acre. Eighty per cent of the plants in the plots treated with 1 pound of the aster per acre were killed, the remainder produced some new growth in late August. Lower plots were delayed 2 to 3 weeks by 2 and 4 ounces of aster per acre and by 4 ounces of aster per acre, 4 weeks by 1 pound of aster and 2 ounces of the aster per acre, and 3 weeks by 1 pound of the aster per acre. Almost without exception the results of this test show that 2, 4, 6 or 8, 10-15 ounces had a considerable effect on wheat clover. As for late wheat raising were much more toxic to legume vegetation than 2, 4-6 ounces. In several trials as much 2, 4-6 ounces as aster was required to produce a considerable effect on wheat clover. In the following discussion it can be seen that the assumed rate of aster at double the rate produced a similar effect on the plants.

Test 3 (Sweet clover).

Experiments of sweet clover with 1 ounce of aster per acre were applied during the early flowering stage

had no visible lasting effect on the plants. The rates of 2 ounces or greater checked growth^{and} caused severe twisting of stems but regrowth was vigorous from crowns and from terminal and lateral buds of plants treated with 4 ounces or less. Plants treated with 8 ounces of ester per acre sent forth regrowth from the crown and lower nodes of the stem, hence it is assumed that this concentration killed the terminal and upper lateral buds. The 1 pound rate killed 60 per cent of the plants but regrowth from the crown and lower nodes of the remainder of the plants appeared at the end of July. Anthocyanin pigmentation was more noticeable in the plants treated with 8 ounces and 1 pound per acre. Flower abundance decreased as concentration of chemical increased from 1 ounce up to 1 pound. The latter rate killed all inflorescences on the plants.

Test 6 (Sweet clover).

All treatments except 1 ounce of amine per acre applied when sweet clover regrowth was 6 to 8 inches tall caused visible distortion of the plants. Observations recorded during the first week in October, 5 weeks after the treatment, showed that growth was retarded by 2 ounces or more of ester per acre. The 4 ounce rate prostrated the stems and killed 50 per cent of the leaves while concentrations of 8 ounces or greater prostrated all stems and killed all the leaves. There was no regrowth from these plants

had no visible feeding effect on the plants. The effect of
2 ounces of greater showed greater growth leaves being
of stems but normally was slightly from crown and from
terminal and lateral buds of plants treated with 4 ounces
or less. Plants treated with 2 ounces of water per plant
kept 1 inch beyond from the crown and lower nodes of the
stem, hence it is assumed that this concentration killed
the terminal and lower lateral buds. The 2 ounce rate killed
60 per cent of the plants but regrowth from the crown and
lower nodes of the terminal of the plants appeared at the
end of July. Asparagus blight was more noticeable
in the plants treated with 2 ounces and 4 ounce per plant.
Flower abundance decreased as concentration of treatment
increased from 1 ounce to 4 ounce. The lowest rate killed
all inflorescences on the plants.

Test 5 (Leafy stems).

All treatments except 1 ounce of water per plant
applied when water stress regrowth was 4 to 6 inches tall
caused visible distortion of the leaves. Distortion
resisted during the first week in October, 3 weeks after the
treatment, showed that growth was retarded by 2 ounces or
more of water per plant. The 4 ounce rate produced the
stems and killed 50 per cent of the leaves with concentration
of 2 ounces or greater produced all stems and killed
all the leaves. There was no regrowth from base plants.

before winter but this should not be taken as final indication that all the plants were killed. Observations should be made in the spring and a further test might be advisable to study the effects of chemical on regrowth from a stand mowed earlier in the season than August 1st.

Discussion

The results from herbicidal treatments of alfalfa and sweet clover indicated that these plants were very susceptible to phenoxy compounds insofar as damage to top growth was concerned. Rates ordinarily used for weed control purposes damaged these plants at any stage of growth to such an extent that regrowth occurred only from the crown and lower nodes of the stem. Despite the fact that top growth was susceptible there was no evidence that the roots were easily killed. Applications of 1 pound per acre of 2,4,5-T ester killed about 30 per cent of the alfalfa plants and 80 per cent of the sweet clover plants in the early growth stage. Similarly 80 per cent of both alfalfa and sweet clover was killed by the same application at flowering time. Applications of 1/2 pound per acre of 2,4-D and 2,4,5-T esters and of 1 pound per acre of 2,4-D amine, applied to 6 to 8 inch regrowth after mowing, appeared to kill all the plants, but owing to the lateness of the season

confirmation remained for future observation.

In all tests 2,4-D and 2,4,5-T esters caused comparable effects while 2,4-D amine was about one half as toxic at the same rate. Sweet clover was slightly more susceptible to damage than was alfalfa at the early growth stage, but at other stages appeared equally sensitive. These findings indicate that selective weeding of sweet clover from alfalfa stands by the use of these chemicals is not feasible.

The results suggest, however, that chemical control of weeds in alfalfa and sweet clover during the early growth stage might be possible. Under the conditions of the test in 1950, applications of 1 pound of 2,4-D amine or 8 ounces of the esters retarded the growth of all plants and killed some of them, but by the end of August the potential forage yield in the plots appeared to be even greater than that of the checks. The fact that forage yield appeared to increase even after a percentage of the plants were killed suggests the possibility of using these chemicals as sprays to thin out alfalfa stands to improve later seed production.

Legume seed growers find second year stands of alfalfa are often too weedy to cut for seed, and hence mow the fields for hay. Because of the weed content the quality of the hay is often impaired. The results obtained in the above experiments suggest that weedy fields could be sprayed with 8 ounces of 2,4-D amine or 4 ounces of 2,4,5-T

confirmation received for this observation.

In all cases, 2,4-D and 2,4,5-T were found.

Commercially available 2,4-D and 2,4,5-T were found in all cases as listed in the table. These findings indicate that sufficient quantities of these chemicals were present in the area of the site. It is not possible to determine the source of these chemicals.

The results suggest, however, that chemical

contamination of the site is likely to have occurred. Early growth stages were not possible. The fact that 2,4-D was found in 1960, and 2,4,5-T was found in 1961, or a number of the other pesticides was found in all of the soil samples of this site, but not in the other 17 samples of soil. This fact alone suggests that the chemicals were present in the area. The fact that 2,4-D was found in 1960, and 2,4,5-T was found in 1961, or a number of the other pesticides was found in all of the soil samples of this site, but not in the other 17 samples of soil. This fact alone suggests that the chemicals were present in the area. The fact that 2,4-D was found in 1960, and 2,4,5-T was found in 1961, or a number of the other pesticides was found in all of the soil samples of this site, but not in the other 17 samples of soil. This fact alone suggests that the chemicals were present in the area.

Further work is being done to determine the source of

chemicals and to determine the source of the chemicals. It is not possible to determine the source of these chemicals. The fact that 2,4-D was found in 1960, and 2,4,5-T was found in 1961, or a number of the other pesticides was found in all of the soil samples of this site, but not in the other 17 samples of soil. This fact alone suggests that the chemicals were present in the area.

ester at the early growth stage. This application would seriously distort the alfalfa plants and probably delay flowering approximately 3 weeks, but if the weed growth was controlled the second growth would likely be more vigorous than the first, and therefore the quantity and quality of the hay would be improved. Moreover in view of the fact that there were seed pods on the plants in the experimental plots treated in this way there might, in a long season, be a possibility of harvesting a crop of seed. It would be necessary to investigate this method under field conditions before practical recommendations could be made.

Unpublished investigations at the University of Alberta have indicated that certain contact herbicides can be used successfully to remove annual weeds from alfalfa stands without damage to the crop. Such treatments would probably be more desirable to the seed grower but additional testing involving comparison of both types of herbicides would seem to be worthwhile.

Summary

1. The difference in the susceptibility of alfalfa and sweet clover to 2,4-dichlorophenoxyacetic acid or to 2,4,5-trichlorophenoxyacetic acid was insufficient to permit selective weeding of sweet clover from alfalfa.

2. In all tests the esters of 2,4-D and 2,4,5-T caused comparable root injury, stem and leaf distortion and damage to reproductive organs, but it was necessary to apply the amine formulation of 2,4-D at twice the rate of ester application to produce an equal toxic effect.
3. Alfalfa and sweet clover tops were very susceptible to the phenoxyacetic acid derivatives, but the roots could be considered quite resistant since concentrations greater than 1 pound of ester per acre were required to kill them.
4. Possible practical applications of the results of these tests have been discussed.

2. In all tests the average of 2, 4, 6 and 8, 10-15 minutes
concentrations were taken, and the first observation was
damage to reproductive system, but it was necessary
to apply the same treatment of 2, 4, 6 and 8, 10-15
times of 24-hour application to produce an equal toxic
effect.
3. Allergic and acute effects were very susceptible
to the pharmacological and biological, but the results
could be considered as a result of the concentration
greater than 2 points of higher per cent were required
to kill them.
4. Possible results of application of the results of
these tests have been discussed.

Section II. Effects of Chemical Soil Treatments on Emergence of Legume Seedlings.

Materials and Methods

This investigation involved the planting of 264 flats of soil with approximately 100,000 legume seeds. The tests were begun on a small scale in the greenhouse early in 1950 to determine the concentration of 2,4-D required in the soil solution to prevent emergence of seeds of alfalfa, sweet clover, alsike and red clover, and to determine possible variations in species susceptibility to the chemical.

As the test progressed indications of a stimulative effect of certain concentrations of 2,4-D became evident. The test was then moved outdoors where the number of replicates could be increased to improve accuracy and where environmental conditions would be more natural than in the greenhouse. Subsequently esters of 2,4,5-T and 2,4-D were included in the experiment to compare their effects with those of 2,4-D amine at the same concentrations.

Eight successive tests were carried out. The general procedure was the same for all experiments except that varying concentrations were used from time to time as shown below:

RESULTS AND DISCUSSION

This investigation involved the study of the
effect of soil moisture on the growth of the
plant. Tests were begun on 10-1-55 in the greenhouse and
in 1956 the tests were continued in the field. In 1956
in the field a series of tests were made of the effect of
moisture, nitrogen, and potassium, and of the effect of
various other factors on the growth of the plant.
The test was conducted in the field in a series of
plots of 100 sq. ft. each. The plots were arranged in a
randomized block design. The results of the tests are
given in the following table. The results show that the
growth of the plant is greatly affected by the amount of
moisture, nitrogen, and potassium. The results also show
that the growth of the plant is affected by the amount of
light. The results show that the growth of the plant is
affected by the amount of light. The results show that the
growth of the plant is affected by the amount of light.

Test number	Test period	Chemicals	No. of repli- cates	Concentrations used p.p.m.
1.	Feb.15--Mar.15	2,4-D	2	1000, 50
2.	Mar.15--Apr.15	2,4-D	2	10, 0.5
3.	May 15--June15	2,4-D,2,4,5-T	4	0.01, 0.001
4.	June 8--June30	2,4-D, 2,4-D ester 2,4,5-T	4	0.005, 0.0005
5.	July 1--Aug.15	2,4-D, 2,4-D ester 2,4,5-T	4	0.0001, 0.00005
6.	Aug.15--Sept.5	2,4-D, 2,4-D ester 2,4,5-T	4	0.05, 0.1
7.	Dec. 1--Dec.30	2,4,5-T.	3	10, 1, 0.1, 0.01, 0.0001
8.	Jan. 1--Jan.30	2,4,5-T	3	2, 3, 4, 5, 6, 7, 8.

Flats (22.5 x 14.5 inches) of 3 to 1 soil sand mixture were each planted with 100 seeds of each species viz: alfalfa, alsike clover, sweet clover and red clover. Each flat contained 8 randomized rows of 50 seeds per row. Immediately after planting, 3 litres of water was applied to each check flat by means of a spray type watering can and the flats for hormone treatment watered with equal amounts of chemical solution. This moistening was usually sufficient to permit germination and emergence to take place before additional watering was required. As soon as the seedlings in the check flats reached the 3 leaf stage emergence was recorded and

Test	Test	Number	Period	Therapeutic	No. of plants cases	Observations
1.	Feb. 10--Mar. 10	2	2, 4-T		2	1000, 20
2.	Mar. 10--Apr. 10	2	2, 4-T		2	10, 0.5
3.	Apr. 10--May 10	2	2, 4-T, 2, 4-T		2	1000, 0.001
4.	May 10--June 10	2	2, 4-T, 2, 4-T		2	1000, 0.001
5.	June 10--July 10	2	2, 4-T, 2, 4-T		2	1000, 0.001
6.	July 10--Aug. 10	2	2, 4-T, 2, 4-T		2	1000, 0.001
7.	Aug. 10--Sept. 10	2	2, 4-T, 2, 4-T		2	1000, 0.001
8.	Sept. 10--Oct. 10	2	2, 4-T, 2, 4-T		2	1000, 0.001
9.	Oct. 10--Nov. 10	2	2, 4-T, 2, 4-T		2	1000, 0.001
10.	Nov. 10--Dec. 10	2	2, 4-T, 2, 4-T		2	1000, 0.001
11.	Dec. 10--Jan. 11	2	2, 4-T, 2, 4-T		2	1000, 0.001

Plants (25.3 x 14.5 inches) of 1001 soil were
planted were each planted with 100 seeds of each species in:
alfalfa, alfalfa clover, sweet clover and red clover. Each plot
contained 2 randomized rows of 50 seeds per row. Immediately
after planting, 3 liters of water was applied to each plot.
Plot by means of a spray type watering can and the first for
hormone treatment was given with equal amounts of alfalfa
solution. This watering was usually applied to each
generation and emergence to take place within additional
watering was required. As soon as the seedlings in the check
plots reached the 3 leaf stage emergence was stopped and

comparisons expressed as difference between percentages of emergence of treated and untreated material.

Experimental Results

Tests 1 - 8 (alfalfa, alsike clover, red clover and sweet clover).

Test 1.

Within 9 days no seedlings emerged in the flats treated under greenhouse conditions with 50 and 1000 p.p.m. of 2,4-D amine. Emergence in the check flats was at a maximum at that time. One month from the time of treatment seedlings had not emerged in the treated flats.

Test 2.

The emergence was reduced by treatments of both 10 p.p.m. and 0.5 p.p.m. of 2,4-D amine under greenhouse conditions as shown in Figure 1. This test also supplied data on the relative susceptibility of the different species to 2,4-D under the conditions of soil treatment. Table 9 illustrates these observations. From these data it is evident that when 10 p.p.m. was used the increasing order of species susceptibility was: Red clover, alsike and alfalfa approximately equal while sweet clover was most susceptible.

FIGURE 1

Effect of Soil Applications of 2,4-D amine on the Emergence of Legume Seedlings

p.p.m. 2,4-D(Amine)

TABLE 9

Effects of 2,4-D amine on Emergence of
Legume Seedlings

	Alfalfa	Sweet Clover	Red Clover	Alsike
Check mean emergence	30	28	56	61
10 p.p.m. mean emergence	6	0	16	13
Decrease in emergence	24	28	40	48
% decrease	80	100	71	79

Test 3.

This test was performed outdoors with 4 replicates and 2 chemicals at concentrations of 0.01 and 0.001 p.p.m. The mean percentages of emergence for all species and chemicals following 0.001 p.p.m. applications were equal to or greater than the corresponding check means. These results are shown in Figures 1 and 2. Under the conditions of the trial an emergence stimulation range apparently existed in the vicinity of 0.001 p.p.m. for both 2,4-D amine and 2,4,5-T ester.

Test 4.

In order to more fully investigate the stimulation range concentrations of 0.005 and 0.0005 p.p.m. of 2,4-D amine,

TABLE 2

Effects of 2,4-D on the growth of
Larvae of *Chironomus tentans*

Concentration of 2,4-D (ppm)	Survival (%)	Growth (mm)	Remarks
0.1	100	2.5	Check mean emergence
0.2	100	2.5	10 p.p.m. mean emergence
0.4	100	2.5	Decrease in emergence
0.8	100	2.5	Decrease in emergence

Test 3.

This test was performed with a 2,4-D solution of 0.001 p.p.m. and 2 chemically pure substances of 0.01 and 0.001 p.p.m. The mean percentages of emergence for all species and emergence following 0.001 p.p.m. 2,4-D were equal to or greater than the corresponding control values. These results are shown in Figures 1 and 2. When the concentration of 2,4-D was increased to 0.01 p.p.m. the emergence of *Chironomus tentans* was reduced to 50% and the emergence of *Chironomus tentans* was reduced to 50%.

Test 4.

In order to determine the effect of 2,4-D on the growth of *Chironomus tentans* a range of concentrations of 0.001 to 0.01 p.p.m. was used.

FIGURE 2

Effects of Soil Applications of 2,4,5-T ester on the Emergence of Legume Seedlings

p.p.m. 2,4,5-T(Ester)

2,4-D ester and 2,4,5-T ester were used. Concentrations of 0.005 p.p.m. of 2,4-D increased emergence of all species more than did 0.001 p.p.m. On the other hand, 0.0005 p.p.m. of 2,4-D had no effect on alsike and sweet clover but increased the emergence of alfalfa and decreased the emergence of red clover. Application of 0.005 p.p.m. 2,4,5-T ester increased emergence of alfalfa and sweet clover but decreased emergence of red clover and alsike while an application of 0.0005 p.p.m. 2,4,5-T decreased emergence of all species. A concentration of 0.0005 p.p.m. of 2,4-D ester increased emergence of alfalfa, red clover and alsike but decreased emergence of sweet clover. A concentration of 0.005 p.p.m. of 2,4-D ester slightly increased emergence in red clover and alsike, but decreased it in alfalfa and sweet clover. These data for 2,4-D ester suggest that if a rate of 0.001 p.p.m. had been applied the species may have responded in a similar manner as they did to 2,4,5-T ester at that concentration. **Figure 3** shows the increases and decreases in mean emergences above or below the check mean resulting from applications of various concentrations of 2,4-D ester. Certain concentrations which were not included in the tests are necessarily omitted from the table, but corresponding spaces are left in the graph to avoid confusion when making inter-chemical comparisons of comparable rates of treatment.

FIGURE 3

Effects of Soil Applications of 2,4-D ester on the Emergence of Legume Seedlings

Test 5.

This test was first carried out in mid-July but heavy rains immediately after treatment necessitated covering the flats with tarpaulins. The seedlings became etiolated and died when they were exposed to the sun. The test was then repeated but rain interfered again, and the cover had to be left over the flats on the day following application of solutions. This confinement had a forcing effect on the seedlings and they began to emerge the next morning. Consequently, it is probable that the results obtained from this test are not comparable with those from previous tests. The results are included in Figures 1, 2 and 3.

Test 6.

This test was carried out in August using concentrations of 0.1 and 0.05 p.p.m. of all 3 chemicals. Sweet clover reacted normally in that emergence was not increased by either concentration of either growth regulator. The other species showed increases and decreases which did not seem to conform to the pattern indicated by the previous tests. Evidence of this erratic behavior is apparent in Figures 2 and 3. It was hoped that tests could be performed which would include all the concentrations of one chemical at one time thus eliminating the time factor. Owing to

Test 5.

This test was first carried out in mid-July but heavy rain immediately after treatment necessitated covering the flats with tarpaulins. The seedlings became etiolated and died when they were exposed to the sun. The test was then repeated but rain intervened again and the cover had to be left over the flats on the day following application of solutions. This experiment had a striking effect on the seedlings and they began to emerge the next morning. Consequently, it is probable that the results obtained from this test are not comparable with those from previous tests. The results are included in Figures 1, 2

and 3.

Test 6.

This test was carried out in August and consisted of 0.1 and 0.05 c.c.m. of a 5 cm. solution. Sweet alyssa reacted normally in that emergence was not increased by either concentration of either growth regulator. The other species showed increases and decreases which did not seem to correlate to the pattern indicated by the previous tests. Evidence of this erratic behavior is apparent in Figures 2 and 3. It was hoped that tests could be performed which would include all the concentrations of one chemical at one time thus eliminating the time factor. Being so

early frosts, however, these tests could not be performed outdoors where they should have been done in order to justify comparisons with the results of other outdoor tests.

Test 7.

Lack of bench space in the greenhouse necessitated carrying out this test with only 3 replicates and 6 concentrations (0.0001, 0.001, 0.01, 0.1, 1 and 10 p.p.m.) of 2,4,5-T ester. Substantial increases over emergence of checks were found only with alsike treated with 0.001, 0.01, 0.1 p.p.m. as shown in Figure 4.

Since the effects of 10 p.p.m. of 2,4,5-T in Test 7 and 10 p.p.m. of 2,4-D amine in Test 2 were both investigated under greenhouse conditions it seemed justifiable to compare the effects of the 10 p.p.m. treatments on the emergence of the various species. Table 10 shows the effects of 10 p.p.m. of 2,4,5-T on the emergence of these species, and Table 11 summarizes the effects of 10 p.p.m. 2,4-D amine and 2,4,5-T ester thus showing the relative susceptibility of the 4 species to the 2 chemicals under the conditions of the tests. It is apparent that sweet clover was most susceptible to both chemicals and that alfalfa and alsike clover responded similarly to either chemical. Red clover on the other hand was most resistant of all species to 2,4-D but moderately susceptible to 2,4,5-T.

Effects of Soil Applications of 2,4,5-T ester on the Emergence of Legume Seedlings

TABLE 10

Effects of 2,4,5-T ester on Emergence
of Legume Seedlings.

	Alfalfa	Sweet clover	Red clover	alsike
Check mean emergence	51	40	80	61
10 p.p.m. mean emergence	26	16	38	31
Decrease in emergence	25	24	42	30
% decrease	49	60	53	49

TABLE 11

Summary of Susceptibility of Legume Species to Soil Applica-
tions of 2,4-D amine and 2,4,5-T ester

Chemical and Concentration	% Decrease in Emergence			
	Alfalfa	Alsike	Red Clover	Sweet Clover
10 p.p.m. 2,4,5-T ester	49	49	53	60
10 p.p.m. 2,4-D amine	80	79	71	100

TABLE 10

Effects of 2,4-D ester on emergence
of larvae surviving.

	White clover	Red clover	White clover
10 p.m. 2,4-D ester	49	49	49
10 p.m. 2,4-D ester	49	49	49
10 p.m. 2,4-D ester	49	49	49
10 p.m. 2,4-D ester	49	49	49

TABLE 11

Summary of susceptibility of larvae to 2,4-D ester
of 2,4-D ester and 2,4-D ester

	White clover	Red clover	White clover	Red clover
10 p.m. 2,4-D ester	49	49	49	49
10 p.m. 2,4-D ester	49	49	49	49
10 p.m. 2,4-D ester	49	49	49	49
10 p.m. 2,4-D ester	49	49	49	49

Test 8.

This test was planned to investigate the effects of concentrations of 2,4,5-T ester between 1 and 10 p.p.m. under greenhouse conditions as in Test 7. Figure 4 combines the results of Tests 7 and 8.

Discussion

The first two tests to study the effects of various concentrations of 2,4-D amine on the emergence of legume seedlings, indicated that concentrations of 0.5 p.p.m. or greater applied to the soil at planting time reduced the emergence of seedlings under greenhouse conditions. Emergence decreased with increasing concentration of chemical and a variation in susceptibility according to species was indicated. The greenhouse tests carried out the following winter with 2,4,5-T ester showed responses generally the same as from 2,4-D amine, but when concentrations between 1 and 10 p.p.m. were tested increases of 2 to 8 per cent in emergence were apparent about midway in this range while below and above this point emergence was generally reduced. These results are not explicable on the basis of the earlier observation that susceptibility increased with increasing concentration. Variation in the environment may have been partly responsible for the differences since

Test 2.

This test was planned to investigate the effects of concentration of 2,4-D applied between 1 and 10 p.p.m. under greenhouse conditions as in Test 1. Figure 4 contains the results of Tests 1 and 2.

Discussion

The first two tests to study the response of various concentrations of 2,4-D applied on the emergence of lettuce seedlings, indicated that concentrations of 0.5 p.p.m. or greater applied to the soil at planting time caused the emergence of seedlings under greenhouse conditions. Emergence decreased with increasing concentration of chemical and a variation in susceptibility according to varieties was indicated. The greenhouse results carried out the following night with 2,4-D-1 variety showed response generally the same as from 2,4-D alone, but when concentrations between 1 and 10 p.p.m. were tested (instead of 0.5 p.p.m.) in emergence was somewhat about midway in this range. Below and above this point emergence was generally reduced. These results are not conclusive as the basis of the earlier observation that susceptibility increases with increasing concentration. Variation in the environment may have been partly responsible for the differences since

the latter tests were carried out in December and January when growing conditions were greatly different from those in the previous March and April. It was very difficult to maintain suitable temperature in the greenhouse during the very cold weather in December and January. Growth was slow under the cold conditions, and the response to growth regulators likewise is different than when weather conditions are favorable for active growth (23). This might also partially explain why the lower concentrations (0.0001 to 1 p.p.m.) failed to stimulate emergence in all species except alsike clover. Alsike is naturally adapted to a moist, cool environment.

The results of the remaining tests, performed outdoors under more natural conditions, at first seemed to conform to a definite pattern. Generally concentrations of 0.01 p.p.m. of 2,4-D amine and 2,4,5-T ester depressed emergence while concentrations of 0.005 p.p.m. and 0.001 p.p.m. caused an increase in percentage emergence. Concentrations of 0.0005 p.p.m. were responsible for still less stimulation or in some cases a slight decline in percentage emergence. The weather throughout these two tests in May and June was hot, dry and sunny. Test 5 was carried out in July and August, but cannot be compared with the others as the seedlings were forced by abnormal conditions prevailing under the tarpaulin covers. The results of this test were included with the results of the other tests to demonstrate

The latter tests were carried out in December and January when growing conditions were greatly different from those in the previous March and April. It was very difficult to maintain suitable temperatures in the greenhouse during the very cold weather in December and January. Growth was slow under the cold conditions, and the response to growth regulator likewise is different from most previous conditions are favorable for active growth (Fig. 1). This is not due partially explain by the lower concentrations of CO_2 in I.R.C. (1) failed to stimulate emergence in all species except white clover. Also in actively growing in a moist, cool environment.

The results of the remaining tests, performed outdoors under more natural conditions, at times seemed to confirm to a certain extent. Generally, concentrations of 0.01 p.p.m. of 2,4-D and 2,4,5-Cl were sufficient to emerge while concentrations of 0.005 p.p.m. and 0.01 p.p.m. caused an increase in percentage emergence. Concentrations of 0.005 p.p.m. were responsible for still less emergence or in some cases a slight decline in percentage emergence. The weather throughout these two tests in May and June was hot, dry and sunny. Test 5 was carried out in June and August, but cannot be compared with the others as the plants were found by abnormal conditions prevailing under the same conditions. The results of this test were included with the results of the other tests in the same

more effectively the extent to which results are modified by environment. During Test 6 in late August and early September the nights were cooler, and the days not so hot as those during earlier experiments. In this test the behavior of the species was very erratic involving increases and decreases in emergence for which no explanatory generalization appeared possible.

The results have shown that a variation in susceptibility of the various species to the chemicals exists and also that environmental effects probably modify chemical effects to a large extent.

The tests also indicate that soil treatments intended to stimulate growth or increase emergence of alfalfa, sweet clover, alsike clover and red clover would serve no useful purpose on a field scale because the observed increases in emergence were so small and because there is, as yet, no possible way of being sure of stimulation from a particular concentration of chemical under varying environmental conditions.

Summary

1. Applications of 7 p.p.m. or greater of the amine formulation of 2,4-dichlorophenoxyacetic acid and of the butyl ester of 2,4,5-trichlorophenoxyacetic acid

more effectively the system in which the plants are cultivated
by comparison. During the 5th year of the experiment the plants
under the highest were cooler, and the days not so hot
as those during earlier experiments. In this last the
intensity of the reaction was not greatly influenced by the
and therefore in comparison the whole was considered somewhat
reaction appears possible.

The results have shown that a reaction is
characteristic of the whole reaction to the reaction of the
and that that experimental effect is probably mainly chemical
effects to a large extent.

The results also indicate that both treatment
included in the whole growth or increase in weight of plants,
sweet clover, like other and other plants, are not
nearly as good as a field which because the plants increased
in weight were in small and because there is, as far as
possible way of being sure of elimination from a reaction
concentration of chemical under varying experimental
conditions.

Summary

1. Application of 5 g. of 5% solution of the whole to the
plants of 5-6-10-15-20-25-30-35-40-45-50-55-60-65-70-75-80-85-90-95-100
plants each of 5-6-10-15-20-25-30-35-40-45-50-55-60-65-70-75-80-85-90-95-100

definitely decreased emergence of alfalfa, alsike, red clover and sweet clover seedlings when applied as a pre-emergence soil treatment under greenhouse conditions.

2. The legume species varied in their responses to 2,4-D and 2,4,5-T. The order of increasing susceptibility to injury from 2,4-D at 10 p.p.m. was: red clover, alsike and alfalfa equal, and sweet clover most susceptible, whereas the order of susceptibility to 2,4,5-T at 10 p.p.m. was alfalfa and alsike equal, red clover next and sweet clover most susceptible.
3. The evidence of damage by applications of 0.5 p.p.m. or greater of 2,4-D and 2,4,5-T suggests inadvisability of post planting, pre-emergence treatments of small weeds which happen to emerge before the legume seedlings in newly planted fields.

definitely decreased amount of water, which
red clover and sweet clover seedlings when sown
at a pre-emergence soil temperature of 50-55°F.
consequently.

2. The legume sown in the soil temperature of
50-55°F and 55-60°F. The order of emergence was
first to last from 5-10 in 10 p.m. was: red
clover, alfalfa and white clover, and sweet clover.
Most susceptible, because the order of emergence
in 5-10 p.m. was alfalfa and white clover,
red clover next and sweet clover most susceptible.

3. The sowing of alfalfa by sowing in 10 p.m.
or greater of 5-10 and 5-10 p.m. sowing in 10 p.m.
of soil temperature, the order of emergence was:
white clover, alfalfa and white clover, and sweet
clover. The order of emergence was: white clover,
alfalfa and white clover, and sweet clover.

SECTION III. Effects of Chemical Blossom - Sprays on Seed Set of Legumes

Materials and Methods

The following hormone herbicides were used in these investigations:

<u>Chemical</u>	<u>Abbreviations Used</u>
1. 2,4-dichlorophenoxyacetic acid (amine) Naugatuck.	2,4-D amine
2. 2,4-dichlorophenoxyacetic acid (ester) Green Cross.	2,4-D ester
3. 2,4,5-trichlorophenoxyacetic acid (ester) Naugatuck.	2,4,5-T ester
4. a-o-chlorophenoxypropionic acid (formulation A 900) Dow.	A.O.C.P.

A Dobbins tank-type pressure sprayer was used in the following tests.

Test 1 (Red Clover). 1949.

In a 3 year old stand of Altaswede red clover, on the farm of H. McLaughlan at Spruce Grove, west of Edmonton, plots 2 1/2 feet by 9 1/2 feet were arranged in factorial design with 3 replicates. During the late flowering stage

SECTION III. SYSTEMS OF CHEMICAL ANALYSIS - General Analysis
Part of Laboratory

ANALYSIS AND METHODS

The following systems of analysis were used in

these investigations:

Chemical	System of Analysis
1. 2,4-dinitrophenylhydrazine acid (ester)	2,4-dinitrophenylhydrazine acid (ester)
2. 2,4-dinitrophenylhydrazine acid (ester)	2,4-dinitrophenylhydrazine acid (ester)
3. 2,4-dinitrophenylhydrazine acid (ester)	2,4-dinitrophenylhydrazine acid (ester)
4. 2,4-dinitrophenylhydrazine acid (ester)	2,4-dinitrophenylhydrazine acid (ester)

A typical analysis of a sample was made in

the following manner.

Test I (see above), 1948.

In a test run made at the University of Illinois, the results of the analysis of a sample were as follows: The sample was found to be a mixture of 2,4-dinitrophenylhydrazine acid (ester) and 2,4-dinitrophenylhydrazine acid (ester). The results of the analysis were as follows: The sample was found to be a mixture of 2,4-dinitrophenylhydrazine acid (ester) and 2,4-dinitrophenylhydrazine acid (ester).

the plots were sprayed at the rate of 50 gals. per acre with concentrations of 5, 15 and 50 p.p.m. of 2,4-D amine, 2,4,5-T ester and a mixture of both. Notes were taken 1 week after treatment and plots were harvested late in September. Yield data on threshed and cleaned seed samples were analyzed statistically.

Test 2 (Alfalfa), 1950.

Prior to the flowering stage 84 plots were arranged in factorial design, with 3 replicates, in a fairly uniform 1 year old stand of Grimm alfalfa at the University of Alberta. Plots were approximately 22.5 square feet in area. In each replicate chemicals 1, 2, 3 and 4 were applied, 2,4-D amine and A.O.C.P. at 1/16, 1/8, 1/4, 1/2, 1 and 2 ounces, and 2,4-D ester and 2,4,5-T ester at 1/32, 1/16, 1/8, 1/4, 1/2 and 1 ounce acid equivalent in 45 gallons of water per acre. A check plot was provided for each chemical in each replicate. Plots were sprayed five times at approximately weekly intervals throughout the flowering season. (July 3 - August 1st). Applications were made only on clear warm days. Visual affects of treatments were observed at intervals throughout the season.

At harvest time a rectangular iron quadrat 4 feet 4 inches by 5 feet or approximately 1/2000 of an acre was used to mark off the sampling area. After cutting, the alfalfa was dried in the field for 2 weeks, then threshed,

and weighed.

A study of the yield data showed that 5 plots on one side of the test had extremely high yields in comparison to the others. This was attributable to the fact that during the season the border on that portion of the test was accidentally removed during cultivation of the roadways. The yield values for these 5 plots were discarded and new ones calculated using the missing plot technique (15). Statistical analysis of the data was then carried out.

Test 3, 1950.

A duplicate of Test 2 was laid out in a 3 year old stand of ~~Grimm~~ alfalfa on the farm of K. McKenzie at Tiger Lily west of Barrhead. Due to a combination of circumstances these plots were sprayed only twice, during the flowering stage, with a ten day intervening period between sprays. The plots were harvested in early September, and the samples dried indoors at the University of Alberta. The samples were subsequently threshed, cleaned, and weighed, and the yield data analyzed statistically.

Experimental Results

Test 1 (Red Clover), 1949.

Three days after the spray treatments of red clover twisting of plants was general throughout the treated plots

Using extent of twisting as a criterion 2,4,5-T was most effective and 2,4-D amine least injurious. At 50 p.p.m. 2,4-D amine appeared to have an effect equal to that of 2,4,5-T at 15 p.p.m. The variance analysis of the yield data for test 1 is found in Table 12. It shows that the treatments had no significant effect on seed yield. This result however, may have been partially attributable to an early frost in the fall of 1949 which caused damage to immature red clover seeds. A duplicate experiment was planned for 1950 but much of the red clover winter killed and no fields suitable for experimental purposes were located.

TABLE 12

Variance Analysis of the Seed Yield
Data for Red Clover

Source of Variation	Degrees of freedom	Sum of Squares	Mean Squares	F. Value
Chemicals	2	112.2	56.10	0.54
Replicates	2	247.4	123.70	1.18
Error (1)	4	418.7	104.68	
Treatments (rates)	3	42.2	14.07	0.92
Chemicals x Treatments	6	128.6	21.43	1.40
Error (2)	17	263.8	14.66	
Total	34			

joint extent of twisting as a criterion 2,4,5-T was most effective and 2,4-D was least injurious. At 50 p.p.m. 2,4,5-T caused a marked increase in root growth. The variance analysis of the data for root growth is shown in Table 12. It shows that the treatments had no significant effect on root growth. This result, however, was due to the fact that the treatments were applied to the roots of the plants at the time of planting. A duplicate experiment was planned for 1952 but much of the root growth was killed and no fields suitable for experimental purposes were located.

TABLE 12

Variance Analysis of the Root Growth Data for 2,4-D and 2,4,5-T

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	F Value
Overall	3	118.2	39.4	0.46
Replicates	2	97.4	48.7	1.12
Error (1)	4	418.7	104.7	0.52
Treatments (overall)	3	118.2	39.4	0.46
Treatments	2	118.2	59.1	1.42
Error (2)	17	14.8	0.87	
Total	24			

Tests 2 and 3 (Alfalfa), 1950.

Alfalfa plots at the University of Alberta were compared at the time of the fourth treatment. Table 13 summarizes observations concerning flowering behavior and pod production of the plants. At the time the notes were recorded it was quite evident that both esters had approximately the same effect at equal concentrations, and also that twice as great a concentration of amine was required to produce an effect equal to that of the ester. Apparently sprays containing greater than 1/8 ounce 2,4-D amine or 1/16 ounce of 2,4-D ester and 2,4,5-T ester delayed abscission of flowers. Later in the season these flowers, after withering, dropped from the plants. Such behavior was especially noticeable in the plots treated with 1 and 2 ounces of acid equivalent per acre.

The effects of the chemical treatments on the yields of these plots are shown in Figures 5 and 6. The difference between the mean yields of treated and check plots was calculated as per cent increase or decrease over the control. The bar graphs compare the per cent increase or decrease for each concentration at both Edmonton and Tiger Lily.

The variance analysis of the alfalfa yield data for the Edmonton plots is shown in Table 14 and that for the Tiger Lily plots in Table 15. The F values indicated

Table 3 and 4 (Allyls), 1950.

Allyls were the principal of these were compared at the time of the final treatment. Table 3 shows the results of the analysis of variance concerning the effect of the allyls on the growth of the plants. It was found that the allyls had a significant effect on the growth of the plants, and that the effect was more pronounced in the case of the allyls than in the case of the other treatments. Table 4 shows the results of the analysis of variance concerning the effect of the allyls on the yield of the plants. It was found that the allyls had a significant effect on the yield of the plants, and that the effect was more pronounced in the case of the allyls than in the case of the other treatments.

The effect of the chemical treatment on the yield of the plants was also studied. The results are shown in Table 5 and 6. Table 5 shows the results of the analysis of variance concerning the effect of the chemical treatment on the yield of the plants. It was found that the chemical treatment had a significant effect on the yield of the plants, and that the effect was more pronounced in the case of the chemical treatment than in the case of the other treatments. Table 6 shows the results of the analysis of variance concerning the effect of the chemical treatment on the growth of the plants. It was found that the chemical treatment had a significant effect on the growth of the plants, and that the effect was more pronounced in the case of the chemical treatment than in the case of the other treatments.

The variance analysis of the allyls and the chemical treatment is shown in Table 7 and 8. Table 7 shows the results of the analysis of variance concerning the effect of the allyls on the yield of the plants. It was found that the allyls had a significant effect on the yield of the plants, and that the effect was more pronounced in the case of the allyls than in the case of the other treatments. Table 8 shows the results of the analysis of variance concerning the effect of the chemical treatment on the yield of the plants. It was found that the chemical treatment had a significant effect on the yield of the plants, and that the effect was more pronounced in the case of the chemical treatment than in the case of the other treatments.

TABLE 13

Summary of Effects of Blossom Sprays on Topgrowth of Alfalfa

Treatment	Rate ounces/acre	Leaf chlorosis	Stem distortion	Fresh flowers	Withered flowers	Pod set
Untreated		-	-	numerous	few	good
2,4,5-T ester) 2,4-D ester) 2,4-D amine)	1) (2)	partial chlor- osis	twisting & thickening	trace	numerous	poor
2,4,5-T ester) 2,4-D ester) 2,4-D amine)	1/2) (1)	nil	twisting & thickening	few	many	fair
2,4,5-T ester) 2,4-D ester) 2,4-D amine)	1/4) (1/2)	nil	nil	few	many	good
2,4,5-T ester) 2,4-D ester) 2,4-D amine)	1/8) (1/4)	nil	nil	many	many	good
2,4,5-T ester) 2,4-D ester) 2,4-D amine)	1/16 & 1/32) (1/8 & 1/16)	nil	nil	numerous	few	good
A.O.C.P.	2	nil	nil	many	many	good
A.O.C.P.	1, 1/2, 1/4, 1/8, 1/16	nil	nil	numerous	few	good

Effects of Blossom Sprays on Alfalfa
Seed Yield

* Yields significantly different from controls.

FIGURE 6

Effect of Blossom Sprays on Alfalfa
Seed Yield

* Yield significantly different from controls.

that mean yield differences due to treatments were significant to the 1 per cent level at Edmonton, and to the 5 per cent level at Tiger Lily.

TABLE 14

Variance Analysis of Alfalfa Seed Yield
Data for Edmonton Plots

Source of Variation	Degree of freedom	Sum of Squares	Mean Squares	F. Value
Chemicals	3	648.1	216.0	2.9
Replicates	2	1118.7	559.4	7.5*
Error (1)	6	448.0	74.7	
Treatments (rates)	6	1448.6	248.7	7.0**
Chemicals x Treatments	18	643.0	35.7	2.5**
Error (2)	43	624.4	14.5	
Total	78			

* Significant at the 5 per cent level.

** Significant at the 1 per cent level.

M.S.D. for treatments = 6.2 grams per plot.

that each field difference was significant
to the 1 per cent level at 1000 ft. and is also significant
level at 1000 ft.

TABLE 14

Various samples of Alkali and Soda
Data for various fields

Source of Variation	Number of Samples	Sum of Squares	Mean Square	F value
Chemicals	3	348.1	116.0	0.0
Harvesting	2	120.7	60.3	0.0
Error (1)	3	148.0	49.3	0.0
Treatments (Total)	8	148.8	18.6	0.0
Chemicals x Treatments	18	348.0	19.3	0.0
Error (2)	43	420.4	9.8	0.0
Total	78			

* Significant at the 5 per cent level.
** Significant at the 1 per cent level.
N.B.C. for treatments = 0.2 grams per unit.

TABLE 15

Variance Analysis of Alfalfa Seed Yield
Data for Tiger Lily Plots

Source of Variation	Degree of freedom	Sum of Squares	Mean Squares	F. Value
Chemicals	3	669.4	223.1	3.2
Replicates	2	1831.3	915.7	13.3**
Error (1)	6	412.6	68.8	
Treatments (rates)	6	1925.5	320.9	3.1*
Chemicals x Treatments	18	2988.9	166.1	1.6
Error (2)	48	4916.8	102.4	
Total	83			

* Significant at the 5 per cent level.

** Significant at the 1 per cent level.

M.S.D. for treatments = 16.5 grams per plot.

Table 16 shows a comparison of the significant results obtained from these analyses. Apparently 1 ounce per acre of 2,4,5-T, whether applied twice or five times to the alfalfa plants, was sufficient to cause significant decreases in yield and similarly applications of 1/4 ounce of 2,4-D ester per acre when applied either twice or five times increased yield significantly. In certain cases where significant increases or decreases were obtained only at Edmonton and not at Tiger Lily there must have been a cumulative effect from the 5 treatments.

TABLE 13

Various Analysis of Nitrate Seed Yield
Data for Nitrate Seed Yield

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	F Value
Chemicals	2	66.1	33.05	3.5
Replicates	2	121.2	60.6	12.5
Treatments (1)	2	119.8	59.9	12.5
Treatments (2)	2	121.2	60.6	12.5
Chemicals x Treatments	4	121.2	30.3	3.2
Error (2)	10	121.2	12.12	1.3
Total	20	121.2		

* Significant at the 5 per cent level.

** Significant at the 1 per cent level.

W.D.D. for treatments = 12.5 per cent.

Table 13 shows a comparison of the significant results obtained from these analyses. Apparently 1 ounce per acre of 2,4-D-7, whether applied once or five times to the nitrate crops, was sufficient to cause a significant increase in yield and nitrate concentration of 1/3 ounce or 2,4-D often was more than applied at other times on the same increased yield of nitrate. In certain cases where significant increases in treatment were obtained only at 2,4-D and not at Nitrate 111 there would have been a cumulative effect from the 2 treatments.

TABLE 16

Summary of Rates of Chemical Applications Significantly Affecting
Yield of Alfalfa at Edmonton and Tiger Lily.

	E D M O N T O N		T I G E R L I L Y	
	Rates (ounces/ acre) causing significant yield decrease	Rates (ounces/ acre) causing significant yield increase	Rates (ounces/ acre) causing significant yield decrease	Rates (ounces/ acre) causing significant yield increase
2,4-D amine	1/8, 1/4, 1/2, 1, 2	nil	nil	nil
2,4-D ester	1	1/32, 1/4	nil	1/4
2,4,5-T ester	1	nil	1	nil
A.O.C.P.	nil	1/4	nil	nil

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Discussion

Since the chemical was applied late in the flowering stage of Altaswede red clover and the first killing frost was 3 weeks later, it is probable that the seeds produced by the flowers, fresh at the time of the treatment, were immature when the frost occurred, and hence damaged by it. Shrivelled seeds were noted during cleaning of the samples so it is quite possible that any potential effect of the chemical treatments on the seed yields was masked by the frost. Sokoljskaja (33) reported increases in seed yield following sprays of 0.001 per cent of 2,4-D, but the amount of application was not stated. Further tests using various rates at various gallonages applied at various times throughout the flowering stage must be carried out before final decisions regarding effects of such chemicals on seed set of red clover can be made. Such tests would have been undertaken in 1950 at the University of Alberta had the red clover not been winter killed.

The tests carried out in 1950 using successive spray applications of 2 ounces or less of 2,4-D amine and ester, 2,4,5-T and A.O.C.P. per acre produced various results with alfalfa at University of Alberta. Where twisting and thickening of stems was noted in the 2,4-D and 2,4,5-T plots it was found later that the same applications had caused considerable reductions in seed yield. This was

Discussion

Since the chemical was applied late in the flowering stage of alfalfa, red clover and the first killing frost was 2 weeks later, it is probable that the seeds produced by the flowering plants at the time of the treatment, were dormant when the frost occurred, and hence killed by it. Surviving seeds were noted during cleaning of the samples and it is quite possible that any possible effect of the chemical treatment on the seed in this was masked by the frost. (33) reported that germination in seed yield following spray of 0.001 per cent of 2,4-D, but the amount of application was not stated. Further tests using various rates at various maturities applied at various times throughout the flowering stage may be carried out before final decisions regarding effects of such chemicals on seed set of red clover can be made. Such tests would have been undertaken in 1950 at the University of Alberta had the red clover not been winter killed.

The results obtained in 1950 using successive spray applications of 2 ounces per acre of 2,4-D alone and later, 2,4-D-E and A.D.C.P. have not produced various results with alfalfa at University of Alberta, where testing and thickening of stems was noted in the 2,4-D and 2,4-D-E plots it was found later that the same conditions had caused considerable reduction in seed yield. This was

attributable to a lethal effect of the chemical on many of the flower buds.

The graph for 2,4-D at Edmonton, Figure 6, appears to give an abnormal illustration of the effect of this chemical on yield. The mean yield for the check plots in the 2,4-D block was unusually high in comparison with the other check means. If there had been more replicates in this test the mean check yield would probably have been smaller, and hence more in line with that of comparable untreated material. In this event the graph would have resembled that for Tiger Lily plot yields.

It seems highly probable that, since retention of flowers on tobacco has been shown to be a hormone phenomenon (17), hormones applied at the right concentration might cause the retention of the flowers on alfalfa. In the observations at Edmonton it was apparent that faded flowers were retained on the treated plants for a much longer period than on the checks. These flowers might have been killed and their abscission process thus destroyed or there may have been a hormonal effect, due to the applied chemical, preventing the formation of the abscission layer. If the latter was the case it seems possible that the flowers which were retained were in a condition receptive to pollen for a longer period than normal and hence their opportunity for pollination increased as compared with that of the untreated flowers. As a result increased seed set could be expected. Since 1/4 ounce of 2,4-D ester per acre increased seed yield significantly

at both Edmonton and Tiger Lily, it does not seem possible that both these results were accidental. There is a greater probability that a significant increase at only one location might have been attributable to chance variation for example the result from treatment with 1/32 ounce of 2,4-D ester per acre at Edmonton.

A.O.C.P. seems to show promise of being able to seed increase yield of alfalfa. At Tiger Lily yield was increased by all rates of this chemical applied only twice during flowering, while at Edmonton, where plots received 5 applications, yield was increased by the lower rates and decreased following the higher rates of application. One of the increases at Edmonton, a rise of 49 per cent, was statistically significant. Possibly 3 or even 4 applications instead of the 5 actually applied might have been sufficient to give increases more significant than those observed.

More work will have to be done before definite conclusions can be drawn. Plot size and number of replications should be increased to eliminate variation which is common in perennial crops. If it is possible to consistently increase seed set by these treatments, the minimum number of treatments necessary for optimum increases should be ascertained so that as little as possible mechanical damage would occur to the crop as a result of the operation of standard field spray equipment.

at both London and River Hill, it does not seem possible that both these results were accidental. There is a greater probability that a significant increase in yield and reduction in loss have been obtained in some relation to the specific treatment with 1,2-D since at 1,2-D water

for some of the treatments.

1,2-D, 1000 ppm, was shown to be effective in increasing yield of alfalfa. At River Hill yield was increased

by all means of this chemical applied only twice during flowering, while at London, where plots received a single dose, yield was increased by one lower rate and no effect

following the higher rates of application. One of the treatments at London, a rate of 1000 ppm, was statistically significant. Treatment 3 or even 4 applications resulted in the 3 actually applied which gave a significant increase in yield.

There were still some to be done before the results could be drawn. The data was somewhat irregular and should be increased to eliminate variation in results in general terms. It is possible to consistently increase yield by these treatments, but a single amount of 1,2-D is necessary for optimum increase which is not obtained in that as little as possible mechanical damage would result in the crop as a result of the application of standard field spray equipment.

Field spray equipment should be used in further experiments because coverage by such sprayers is not as thorough as with hand sprayers. Use of a fog type spray might possibly be more effective than a high gallonage spray for this type of work. Probably large droplets from regular spray equipment contain more than enough solution to cause the flowers to remain on the plant, and may because of this possible excess damage the flower. A fog spray might provide better coverage of a greater number of flowers by volumes just sufficient to have the desired hormonal effect on the flower. It is known that pollen contains a hormone and also an enzyme system which can release a hormone from its bound form in the tissue of the pistil as the pollen tubes grow. This hormone initiates growth in the ovary, and since some of it migrates to the base of the pistil it is believed that part of it moves into the pedicel of the flower to prevent the formation of the abscission layer (17). This layer ordinarily forms when flowers are not fertilized and have outlived their natural life on the plant. The amount of hormone released by or stimulated into action by the pollen would be relatively small, and hence it is felt that a fog type application of synthetic hormone, intended to produce a comparable effect, might be most suitable for this type of work.

Future investigations should also include caged plots or portions of plots from which insects would be excluded to make possible determinations as to whether or not

field work equipment should be used in flower

experimented because coverage of work equipment is not as thorough as with hand saws. Use of a log saw may also be more effective than a high speed saw for this type of work. Probably large amounts of regular sawing would maintain some reasonable solution in some the flowers to remain on the plant, and not because of this sawing. Among the flower. A log saw may also provide better coverage of a greater number of flowers of various sizes sufficient to have the desired botanical effect on the flower. It is known that pollen contains a hormone and also an enzyme system which can release a hormone from the pollen tube in the absence of the pollen tube. This hormone initiates growth in the ovary, and since some of it migrates to the base of the style it is believed that pollen tube moves into the apical of the flower to prevent the formation of the abscission layer (12). This layer ordinarily forms when flowers are not fertilized and have outlived their useful life on the plant. The amount of hormone released by an stimulated tube which is released by the pollen would be relatively small, and hence it is felt that a log type application of synthetic hormone, intended to produce a hormone effect, might be most suitable for this type of work.

Future investigations should also include

higher or portions of plants from which tissues would be obtained to make possible observations as to whether or not

any increases in seed yield of chemically treated plots are due to selfing or to crossing. If increases in seed yield were found to be due to selfing then progeny tests would have to be carried out to determine whether or not there was a loss of vigor due to chemically induced self pollination. If there was a loss of vigor it would not be in the interests of agriculture to perfect a method of increasing seed set by these means.

If there was no loss of vigor or if increases were due to cross pollination, and if techniques could be developed satisfactorily costs would appear not to be the limiting factor. Under conditions in Alberta an increase in seed yield of only 20 pounds per acre would be sufficient to meet the cost of operation for 4 successive sprays with 2,4-D at rates that produced increases in the foregoing tests. Work of this type would have to be very accurate since, on the basis of available results, the margin between rates which increase and those which decrease yield appears to be very narrow. For example; $1/4$ of an ounce of 2,4-D ester per acre gave a significant increase in yield, but $1/2$ ounce per acre reduced yield and 1 ounce per acre significantly decreased yield of alfalfa in the tests at Edmonton.

Summary

1. Alfalfa plants treated during flowering stage with successive applications of the esters of 2,4-dichlorophenoxyacetic acid and of 2,4,5-trichlorophenoxyacetic acid at rates of 1/8 to 1 ounce of acid equivalent in 45 gallons of water per acre or with 2,4-D amine at 1/4 to 2 ounces per acre retained their flowers for longer times than did those which were untreated.
2. Successive sprays of 1/4 ounce acid equivalent of 2,4-D ester in 45 gallons of water per acre applied during flowering stage of alfalfa increased seed yield significantly both at Edmonton and at Tiger Lily. The increases were 122 per cent and 55 per cent respectively.
3. Successive sprays of 1 ounce acid equivalent of 2,4-D ester in 45 gallons of water per acre applied during flowering stage decreased seed yield of alfalfa significantly both at Edmonton and at Tiger Lily. The decreases were 75 per cent and 28 per cent respectively.
4. At Tiger Lily all rates from 1/16 to 2 ounces acid equivalent of a-o-chlorophenoxypropionic acid in 45 gallons of water per acre increased seed yield whereas

at Edmonton only rates from 1/16 to 1/4 ounce increased seed yield. Of these increases only 1/4 ounce per acre at Edmonton caused a statistically significant increase in yield.

5. Practical applications of the results have been discussed.

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REFERENCES

1. AKAMINE, E.K. Plant growth regulators as selective herbicides. Univ. Hawaii, Ag. Exp. Sta. Cir. 26:1-35. 1948.
2. ALBRECHT, H.R. Strain differences in tolerance to 2,4-D in creeping bent grasses. Am. Soc. Agron. 39:163-165. 1947.
3. ALLARD, R.W., DeROSE, H.R., and SWANSON, C.P. Some effects of plant growth regulators on seed germination and seedling development. Bot. Gaz. 107:575-583. 1947.
4. AVERY, G.S. Jr., JOHNSON, Elizabeth B., ADDOMS, Ruth M. and THOMPSON, Betty F. Hormones and Horticulture. McGraw-Hill. New York. 1947.
5. BOYSEN JENSEN, P., AVERY, G.S. and BURKHOLDER, P.R. Growth Hormones in Plants. McGraw-Hill. New York. 1936.
6. BUCHHOLTZ, K.P. Effect of 2,4-D and M.C.P. applications on stands of various legumes. Res. Rep. N.C.W.C.C. 92. 1949.
7. CARDER, A.C. Eradication of volunteer sweet clover by use of 2,4-D. Res. Rep. N.C.W.C.C. 94. 1949.
8. CARLSON, J.W., EVANS, R.J., PEDERSEN, M.W., STOKER, G.L., LIEBERMAN, F.V., SNOW, S.J., SORENSON, C.J., THORNLEY, H.F., BOHART, G.E., KNOWLTON, G.F., NYE, W.P., TODD, F.E. Growing alfalfa for seed in Utah. Utah Ag. Exp. Sta. Cir. 125:1-72. 1950.
9. CHURCHILL, B.R. and GRIGSBY, B.H. Effect of 2,4-D and dinitro sprays upon clover and alfalfa seedlings made in oats. Res. Rep. N.C.W.C.C. 94. 1949.
10. CLARK, H.E. and KERNS, K.R. Control of flowering with phytohormones. Science. 95:536-537. 1942.
11. ELLISON, J.H. and SMITH, Ora. Retarding sprout growth of potato tubers by spraying the foliage with 2,4,5-T. Proc. Am. Soc. Hort. Sci. 54:447-451. 1949.

REFERENCES

1. ALLEN, E. L. Plant growth responses as relative parameters. Univ. Hawaii, Agr. Exp. Sta. Rep. 1941-42, 1942.
2. ALLEN, E. L. & ALLEN, E. L. Growth responses as relative parameters. Univ. Hawaii, Agr. Exp. Sta. Rep. 1941-42, 1942.
3. ALLEN, E. L., BERRY, T. L., and ALLEN, E. L. Some effects of plant growth responses on seed germination and seedling development. Bot. Gaz. 107:375-383, 1947.
4. ALLEN, E. L., BERRY, T. L., ALLEN, E. L., and ALLEN, E. L. and ALLEN, E. L. Growth responses as relative parameters. Univ. Hawaii, Agr. Exp. Sta. Rep. 1941-42, 1942.
5. ALLEN, E. L., BERRY, T. L., and ALLEN, E. L. Growth responses as relative parameters. Univ. Hawaii, Agr. Exp. Sta. Rep. 1941-42, 1942.
6. ALLEN, E. L. Effects of 2,4-D and 2,4,5-T on growth responses as relative parameters. Bot. Gaz. 107:375-383, 1947.
7. ALLEN, E. L. Effects of 2,4-D and 2,4,5-T on growth responses as relative parameters. Bot. Gaz. 107:375-383, 1947.
8. ALLEN, E. L., BERRY, T. L., ALLEN, E. L., and ALLEN, E. L. Growth responses as relative parameters. Univ. Hawaii, Agr. Exp. Sta. Rep. 1941-42, 1942.
9. ALLEN, E. L., BERRY, T. L., ALLEN, E. L., and ALLEN, E. L. Growth responses as relative parameters. Univ. Hawaii, Agr. Exp. Sta. Rep. 1941-42, 1942.
10. ALLEN, E. L., BERRY, T. L., ALLEN, E. L., and ALLEN, E. L. Growth responses as relative parameters. Univ. Hawaii, Agr. Exp. Sta. Rep. 1941-42, 1942.
11. ALLEN, E. L., BERRY, T. L., ALLEN, E. L., and ALLEN, E. L. Growth responses as relative parameters. Univ. Hawaii, Agr. Exp. Sta. Rep. 1941-42, 1942.

12. ENNIS, W.B. Jr., SWANSON, C.P., ALLARD, R.W., BOYD, F.T. Effects of certain growth regulating compounds on Irish potatoes. Bot. Gaz. 107:568-574. 1946.
13. ERICKSON, L.C., SEELY, C.J. and KLAGES, K.H. Effect of 2,4-D upon protein content of wheats. J. Am. Soc. Agron. 40:659-660. 1948.
14. FREISEN, H.A. Effect of 2,4-D on the quality of spring wheat and linseed flax. Res. Rep. N.C.W.C.C. 100. 1949.
15. GOULDEN, C.H. Methods of Statistical Analysis. John Wiley and Sons, Inc. New York. 1939.
16. GRACE, N.H. Physiologic curve of response to phyto-hormones by seeds, growing plants, cuttings and lower plant forms. Can. J. Research. 15:538-546. 1937.
17. GUSTAFSON, F.G. The role of hormones in fruit development. Am. Naturalist. 84:151-159. 1950.
18. HAMNER, M.E. Effect of phenylacetic acid and naphthalene-acetamide on tomato plants grown in soil. Bot. Gaz. 103:576-80. 1942.
19. KRATOCHVIL, D.E., DERSCHIED, L.A. and STAHLER, L.M. The effect of treating sweet clover underseeded in oats at Scotland with 2,4,5-T and three formulations of 2,4-D at two rates of application and two dates. Res. Rep. N.C.W.C.C. 95. 1949.
20. KLINGMAN, D.L. Effects of spraying cereals with 2,4-D. Am. Soc. Agron. J. 39:445-447. 1947.
21. LEOPOLD, A.C. and THINANN, K.V. The effect of auxin on flower initiation. Am. J. Botany. 36: 342-347. 1949.
22. MARTH, P.C. and MITCHELL, J.W. 2,4-D as a differential herbicide. Bot. Gaz. 106:224-32. 1944.
23. _____ and DAVIS, F.F. Relation of temperature to selective herbicidal effects of 2,4-D acid. Bot. Gaz. 106:463-472. 1945.
24. MILLER, J.H. Response of legumes to 2,4-D when seeded as undercrops in Bonda Oats. Res. Rep. N.C.W.C.C. 95. 1949.

25. MITCHELL, J.W. and BROWN, J.W. Germination of seeds in soil containing 2,4-D acid. Bot. Gaz. 107:276-284. 1946.
26. _____ and _____. Movement of 2,4-D stimulus and its relation to the translocation of organic food materials in plants. Bot. Gaz. 107:393-407. 1946.
27. PEARSE, H.L. Growth substances and their practical importance in horticulture. Commonwealth Bureau of Horticulture and Plantation Crops. Tech. Bull. 20:1-233. 1948.
28. Report of the weed classification committee. Proceedings and Abstracts. W.C.W.C.C. 161-165. 1950.
29. ROBINSON, R.G. Effects of herbicides in growing crops. Res. Rep. N.C.W.C.C. 78-79. 1949.
30. SELL, H.M., LUEEKE, R.W., TAYLOR, Betty M, and HAMNER, C.L. Changes in chemical composition of the stems of Red Kidney bean plants treated with 2,4-D acid. Plant Physiol. 24:295-299. 1949.
31. SHAW, W.C. and WILLARD, C.J. The effect of 2,4-D on clovers and alfalfa sown in small grain. Res. Rep. N.C.W.C.C. 96. 1949.
32. SMITH, O., BAEZA, M.A. and ELLISON, J.H. Response of potato plants to spray applications of certain growth regulating substances. Bot. Gaz. 108:44-431. 1947.
33. SOKOLJSKAJA, B.P. The effect of 2,4-D on seed formation of clover. Herbage Abstracts. 19:28. Abst. No. 129. 1949.
34. STEWART, W.S. and HAMNER, C.L. Treatment of seeds with synthetic growth regulating substances. Bot. Gaz. 104:338-47. 1942.
35. THIMANN, K.V. and SKOOG, F. Studies on the growth hormone of plants. Proc. Nat. Acad. Sci. 19:714-716. 1933.
36. _____ and LANE, R.H. After effects of treatment of seed with auxin. Am. J. Bot. 25: 535-43. 1938.

23. BIVINS, J. L. and BROWN, J. L. Investigation of the
in vitro effects of 2,4-D on the growth of
24:24-24:24, 1948.

24. BIVINS, J. L. and BROWN, J. L. Investigation of the
in vitro effects of 2,4-D on the growth of
24:24-24:24, 1948.

25. BIVINS, J. L. and BROWN, J. L. Investigation of the
in vitro effects of 2,4-D on the growth of
24:24-24:24, 1948.

26. BIVINS, J. L. and BROWN, J. L. Investigation of the
in vitro effects of 2,4-D on the growth of
24:24-24:24, 1948.

27. BIVINS, J. L. and BROWN, J. L. Investigation of the
in vitro effects of 2,4-D on the growth of
24:24-24:24, 1948.

28. BIVINS, J. L. and BROWN, J. L. Investigation of the
in vitro effects of 2,4-D on the growth of
24:24-24:24, 1948.

29. BIVINS, J. L. and BROWN, J. L. Investigation of the
in vitro effects of 2,4-D on the growth of
24:24-24:24, 1948.

30. BIVINS, J. L. and BROWN, J. L. Investigation of the
in vitro effects of 2,4-D on the growth of
24:24-24:24, 1948.

31. BIVINS, J. L. and BROWN, J. L. Investigation of the
in vitro effects of 2,4-D on the growth of
24:24-24:24, 1948.

32. BIVINS, J. L. and BROWN, J. L. Investigation of the
in vitro effects of 2,4-D on the growth of
24:24-24:24, 1948.

33. BIVINS, J. L. and BROWN, J. L. Investigation of the
in vitro effects of 2,4-D on the growth of
24:24-24:24, 1948.

34. BIVINS, J. L. and BROWN, J. L. Investigation of the
in vitro effects of 2,4-D on the growth of
24:24-24:24, 1948.

37. VAN OVERBEEK, J. Control of flower formation and fruit size in the pineapple. Bot. Gaz. 108:64-73. 1946.
38. WARDEN, R.L. and BULLETTE, J.W. Response of six spring wheat varieties to 2,4-D. Res. Rep. N.C.W.C.C. 111 d-e. 1949.
39. WEAVER, R.J. and DeROSE, H.R. Absorption and translocation of 2,4-D acid. Bot. Gaz. 107:509-521. 1946.
40. _____, MINARIK, C.E. and BOYD, F.T. Influence of rainfall on the effectiveness of 2,4-D sprayed for herbicidal purposes. Bot. Gaz. 107:540-544. 1946.
41. WEINTRAUB, R.L. and NORMAN, A.G. Plant growth regulators. Econ. Botany. 3:289-298. 1949.
42. ZIMMERMAN, P.W. and HITCHCOCK, A.E. Flowering habit and correlation of organs modified by tri-iodobenzoic acid. Contrib. Boyce Thompson Inst. 12:491-496. 1942.

37. WATSON, J. L. Control of flower formation and fruit size in the alfalfa. 1942. 1942-43. 1942.
38. WATSON, J. L. and WILKINSON, J. W. Relationship of air drying wheat varieties to yield. 1942. 1942-43. 1942.
39. WATSON, J. L. and WILKINSON, J. W. Absorption and translocation of ^{14}C in wheat. 1942. 1942-43. 1942.
40. WATSON, J. L. and WILKINSON, J. W. Influence of rainfall on the efficiency of ^{14}C transfer for leafy material. 1942. 1942-43. 1942.
41. WATSON, J. L. and WILKINSON, J. W. Plant growth regulator. 1942. 1942-43. 1942.
42. WATSON, J. L. and WILKINSON, J. W. Flowering habit and translocation of organic acids by the alfalfa plant. 1942. 1942-43. 1942.

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