M I N U T E S

NINTH ANNUAL WESTERN WEED CONTROL CONFERENCE

MULTNOMAH HOTEL

PORTLAND, OREGON

FEBRUARY 6 AND 7, 1947

INDEX

NINTH ANNUAL

WESTERN WEED CONTROL CONFERENCE

Multnomah Hotel February 6-7, 1947
Portland, Oregon

H. E. Morris, President

Thursday, February 6

Morning Session

The meeting was called to order at 9:30 a.m. by President Morris. Dr. A. L. Strand, President of Oregon State College, Corvallis, was introduced and made the following introductory talk:

It is a pleasure for me to welcome this important gathering to Oregon and extend to you the greetings of Oregon State College, where the investigational work on weed control is centered in this state.

My only contact relative to appearing on your program was with Mr. Freed and I have to confess that I was unaware of the other officers of the organization until I came into the room this morning and received a program. But I am beginning to understand things better now. I held my first job in Montana as an experiment station worker under your President, Mr. Elwood Morris, about thirty-three years ago. He was studying the burning effects of arsenicals on apple foliage at the time and my job was to mix up the various concoctions and operate the bucket pump with which he applied them. He was very particular about the nozzle end of that primitive apparatus and always handled that himself. I never got away from the pump handle. Like a lot of young fellows I suppose I figured that advancement was going to be pretty slow and I switched my course from botany to entomology.

I remember how hard it was to make that decision. I realize now how little information I had on which to base it, but it wore me down. In that regard, I like the story of the hired man who was engaged by a Hood River apple grower. He had had little experience and was put to work building fences and doing various odd jobs around the place. His work was so good that the grower decided to keep him and began to give him more responsible assignments. One day he put him in the apple house to sort over some fruit that was left over from the regular grading operation. He was told to put C grade (or whatever they call them now) in one lot, the fancies in another, and so on. This was in the morning and later in the day the grower went back to see how his new apple grader was progressing. He found his man sweating and fuming. "Why, what's the matter?" he asked. "Oh", said the man, as he looked closely at an apple and hesitated as to where it should go, "I just can't stand this. Put me back on the fence repairs. These decisions are just killing me!"

Well, I made my decision and in a few years was engaged in some state work in insect control which was supported by a special legislative appropriation. But it wasn't long until the legislature made a decision too and I found myself cut off at the pockets. That was the most fortunate action I ever received from a legislature for it sent me packing and I soon found myself working as a research assistant at the University of Minnesota and developing a course in insecticides.

Although the objectives were different, I was treating and struggling with about the same factors as you men in weed control. In fact, while reading over some papers on the chemical control of weeds, which I requested of Mr. Freed so that I would not be entirely ignorant of what was going on here, it was like reviewing some old subjects I had studied before. For instance some of them dealt with the availability of a poison in contrast with its actual toxicity. I even harked back to some old work by Volck, Moore, and others. I came across the name of Professor Bolley who was working on the selective control of weeds by means of chemicals before 1900. There was a man who was often about twenty years ahead of his time when it came to ideas. I used to tell my students in entomology that, before they think they have a new idea, they should study closely the works of C. V. Riley and his Commission, George D. Shafer, and even back to Reaumur. Bolley was somewhat like them and must have been one of the earliest to try selective herbicides. What he accomplished in this regard I do not know, but I strongly suspect that what he was dreaming about were some of the miraculous results in selective toxicity that have come about only in the last few years.

It would be very presumptious on my part to attempt to discuss any of the technical aspects of weed control. However, as a bystander, I have observed the acceleration of interest and accomplishments in the subject and I wanted to get some more accurate picture of this development. And so last night I did a little of what some people call research work. I took the rather comprehensive review by Dr. H. K. Wilson in the May, 1944, number of The Botanical Review and noted the years when the 409 papers listed in the bibliography were published. Not all of these deal with control measures; some twenty or so have to do with related subjects. But relatively few papers dealing with the control of noxious weeds are listed for the years previous to 1910. The great impetus seemed to come about 1925 for which year there are 40 citations. From then on to the present time there has been a steady flow with some marked increase in the late 30's with the new findings on plant growth substances. Forty-six are listed for 1940, 27 for 1941, and 20 for 1942, which is about the end of the period covered by the review.

To me, as an outsider looking on, the results of the last few years can be called nothing less than spectacular. When one considers that weeds have been rated in many parts of the country as the No. 1 problem from the standpoint of crop production, the niceties of the control measures developed constitute one of the outstanding accomplishments of agricultural science. If an attempt were made to estimate the annual saving, arising directly and indirectly from the improvements obtaining now in the destruction of noxious weeds, the figure would be so large that no one would believe it, not even yourselves.

When some of my friends and acquaintances saw by the papers that I was to attend a weed conference in Portland, I seemed to catch some rather belittling expressions. Ignorance on the part of the general public of the nature of many agricultural problems, particularly in regard to the quality of the scientific investigations going into them, is often appalling. Explanations are of little avail because they of necessity require some background information and understanding. Now if some of my educator friends had any comprehension of the mechanisms at work in their own metabolism, one might do something with them in the way of improving their appreciation of the newer findings in scientific weed control. Actually, when it comes down to the final spot where the materials you use take effect on plant metabolism, you get to the physiology of the cell. When you follow out the action of insecticides you reach the same place. That is where cancer research leads and so it goes with practically all biological work. Accordingly, for weed specialist, entomologist, medical researcher or other investigator of biological matters, the cell, with its complicated processes of oxidation and reduction, is the frame of reference that unites them all. For a little insight into the role of physiology in all the fundamental agricultural sciences, I refer anyone interested to page 70 of Shepardson's little book on Agricultural Education in the United States. Some day, maybe, biologists and other agricultural scientists may begin to work in the other direction. They'll start with the cell and wind up with some kind of a 2-4-D, or whatever may be the ultimate objective being sought. Well, that may be very visionary but it's one of the trains of thought that flashes through my mind when some one, safe in the security of his own ignorance, seems to lift an eyebrow over the scientific nature of agricultural problems.

However that may be, one thing I am sure of: the spectacular results of your efforts in scientific weed control during the last ten years is something for which you can all feel very proud. Their importance to agriculture, and the business enterprises related to agriculture, is attested by the size and scope of this conference itself. I am glad to have the honor of extending to all the representatives of the Western States a hearty welcome to Oregon. I am sure your discussions will be very profitable to yourselves as well as to the great industry of which you are a part.

MORRIS: We will now have the report of the Secretary-Treasurer.

BALL: Gentlemen--and lady: We will dispense with reading of the minutes. I will give you the report of the treasurer as of January 31, 1947:

1945 Balance		$379.00
1946 Collections		315.00
Expenses in connection with Reno meeting (dinner, name plates, stenographic services etc.	$133.00	
Postage	32.91	
Expenses of Walter S. Ball to attend the North Central Weed		

Control Conference at Des
Moines, including rail travel 169.64

	$335.55	$694.00
	358.45	
	$694.00	$694.00

1947 dues collected to date	$240.00
1946 Balance	358.45
Cash on hand	$598.45

MORRIS: We have heard the report of the treasurer and it is very gratifying to know we have a balance and are not in the red. May we have the official roll call by states, Mr. Ball?

The official roll call follows: California-Walter S. Ball, State Department of Agriculture, Sacramento; Colorado-Bruce J. Thornton, Experiment Station, Colorado A & M, Fort Collins; Idaho-V.A. Cox, Superintendent. Ada County Weed Control, Meridian; Montana-H.E. Morris, Botany Department, State College; Nevada-(a telegram explaining the absence of Lee Burge); Oregon-Virgil H. Freed, Experiment Station, Corvallis; Utah-George L. Hobson, State Department of Agriculture, Salt Lake City, Washington-Harold S. Schaad, State Department of Agriculture, Olympia; Wyoming-Charles Allen, State Seed Laboratory, Laramie.

MORRIS: We will now proceed with the state reports:

Charles E. Allen, State Seed Laboratory, Laramie, Wyoming, was introduced and gave the Wyoming report:

I am very sorry Dr. Snipes is not here to give you a report of what has been going on in Wyoming in the way of weed control. The state, counties and landowners are working together on the problem which, during the past year, dealt almost entirely with 2,4-D. Some of the counties have picked up quite a little weed spray equipment--we particularly like sprays in Wyoming. Most of our cattlemen already have spray equipment so this program fits in rather nicely. Aside from 2,4-D work there is little to report.

Mr. Morris then called on H.S. Schaad of Washington who introduced W. C. McMinimee. Mr. McMinimee's report follows:

Before setting up our program I made a trip through various states to see what they were doing in the way of weed control. We have set up the Grand Coulee Dam project as a weed control district, hoping to keep it under control before it becomes a problem.

In order to secure as complete a report as possible of weed infestation and weed control operations in the state, a survey was conducted through the cooperation of county weed supervisors, county agents, and farm groups. The following statements are based on results of this survey. Reports received from 37 counties covered 77,747 farms containing 6,045,763 acres.

Fourteen counties had infestations of noxious weeds; 6 counties had from 75% to 85% infestation; 5 counties had from 50% to 75% infestation; 10 had from 25% to 50% infestation and one had less than 25% infestation. Weed control work was done on 28,593 farms where the survey was conducted and patches were treated on many other farms, the survey reported. It was found that 26,311 farms were using weed control practices. The total amount of money budgeted for weed control work by the counties was $58,770. Twenty-six counties reported a total of 78,106 acres non-productive because of infestations of noxious weeds while one county reported the loss of $600,000 due to heavy infestations of noxious weeds. The most prevalent weeds are: Canada thistle, Morning-glory, Quackgrass, Hoary cress, Russian knapweed, St. Johnswort and many others.

Cultural control programs were reported by 27 counties which covered an area of 76,122 acres. A chemical control program was employed on 2,874 farms including some 13,555 acres. Sodium chlorate, 2,4-D and carbon bisulphide were used.

Twelve counties reported having organized weed control districts operating under the 1937 State Weed Law. These counties reported a gradual improvement in eradication and control of noxious weeds. At the present time seven other counties are considering the formation of weed districts. These counties expect to hire full time weed supervisors to carry on an educational program and assist the farmers and farm groups in weed problems.

The most encouraging findings in the survey are: The increased interest being taken by federal, state and county governments, railroads, and farm groups in weed problems, the increased number of counties forming weed control districts; the intensive research programs now being carried on by federal agencies, the State College and Experiment Station in the field of organic chemistry with special emphasis on the new herbicides and other complex materials for killing weeds, and that increased efforts must be made to eliminate noxious weeds from our soil and to eradicate and control weeds now in existence.

UTAH WEED REPORT -- George L. Hobson

At the close of the season a questionnaire was forwarded to the various counties in the State requesting information with reference to the program operated and the results of the season's work.

In this report I am submitting the questions together with the answers. Besides this questionnaire we also received monthly reports which, to date, have not been compiled so my report will deal with the report on the questionnaire. The item first discussed will be with reference to 2,4-D.

Question No. 1. What is the total amount of 2,4-D used? The amount of 2,4-D was 1,096,298 gallons in mixed form. I have not given here the rate that each county used, but an average of them all. At least 12 different manufacturers' 2,4-D were used. Again I have not segregated the various manufacturers' material.

Question No. 2. How many acres have you treated on land producing crops? (A) What is the effect on the crops? (B) Give the result of eradication of obnoxious weeds in the crop.

There were 3,125 acres of crop land treated. The result of the eradication in the crop reported varied from 20% to 95% kill.

Question No. 3. Give the time of year you began the use of 2,4-D. The earliest use of 2,4-D was by Salt Lake County on April 11. The last county to start was Kane County on the first of June. Most counties, however, started in the month of April.

Question No.4. State the weeds which responded to 2,4-D best. White top and wild morning glory were named by every county in the State and on other plants there was quite a divided opinion. However, listed as responding were: white top, wild morning glory, puncture vine, burdock, Canada thistle, Russian knapweed, and cocklebur.

(A) Give the name of noxious weeds difficult to kill. Again this report varied. Knapweed and Canada thistle quite universally appeared in answer to this question. However, several of the counties mentioned white top, burdock and Russian knapweed.

Question No.5 State the brand of chemical making the best kill. Twelve of the counties reported Weedone; 9 reported no difference; 6 reported various chemicals worked better on some weeds than others.

Question No.6. Give the reasons for failing to get results.

(A) Was the solution too weak? From the replies to this question I could detect that if they had used a strong solution and got poor results that they then said the strong solution was the cause of the poor results. If the solution was weak then the report was that the solution was too weak.

(B) Did weather conditions interfere? Poor results were also blamed to the weather being too cold, too wet or too windy. However, there was not much complaint on interference.

Question No. 7. Did you note any difference on dry or moist soil? To this question seventeen counties replied that moist or wet soil produced the best results. Five reported that dry land gave the best results. The balance of the counties reported that moisture or dryness made no difference.

Question No. 8. How late in the season did you make your last application? The first county to discontinue the use of 2,4-D stopped work on September 9 and the last was Weber County where operations were discontinued October 16.

Question No. 9. What is the outlook for 1947 for 2,4-D? Every county reported that they expected the use of 2,4-D would be greater than in 1946.

(A) Give the kind of chemical you prefer to use. Twelve counties reported they preferred to use Weedone; 6 counties reported that they could see no difference and several of the counties, rather than answer, commented that the price would determine the kind they would prefer to use.

Question No.10. Did you note that certain brands worked best on certain weeds? To this question a multitude of answers were given. It does not have too much bearing on giving us the information.

Question No.11. To what extent are farmers prepared to apply 2,4-D? All but two counties stated that farmers were in a very poor condition to dispense 2,4-D. The two counties made comment, however, that they had done much to get the farmers to buy dispensing equipment.

Question No.12. Do you think there will be an increased demand on crop producing lands? Almost universally, the answer was yes.

Question No. 13. How many acres have you retreated with 2,4-D? (A) The second time, 975 acres. (B) The third time, 522 acres.

Question No.14. What has been the result of follow-up treatment every time sufficient regrowth appeared? Seventeen counties reported good results; four, fair; and one, poor. Five counties did not do any follow-up work.

Question No.15. Have you been successful in treating land that has been plowed or cultivated prior to application? I could note that this question was a little bit confusing but it was my observation in inspecting the State that if land had been plowed or cultivated it would create a very uneven growth which, in nearly all cases, would require a second treatment. To this question 12 counties answered yes and 6 no.

Question No.16. What do you think is the proper stage of growth to apply 2,4-D? Twenty-three counties reported mature growth varying between the approach of blossom time and the beginning of seed development. Three counties singled out Russian knapweed and Canada thistle and preferred to treat them when the growth was quite young.

Question No.17. Do you have adequate equipment to apply 2,4-D? Twenty counties reported yes, and seven counties no.

CULTIVATION

Question No.1. How many acres did you have under cultivation in 1946? There were 2507 acres.

Question No. 2. How many acres will be released? There will be 1262 acres.

Question No.3. What have been the results of cultivation this season? Nearly all counties reported good results.

Question No.4. Have you treated any land with 2,4-D after discontinuing cultivation in midsummer? Only 4 counties treated land after discontinuing cultivation in midsummer and reported good results.

Question No.5. What is the outlook for cultivation for 1947? Five of the counties which are conducting the largest programs reported the outlook good but no increase. Six of the smaller counties reported discontinuing the cultivation program.

CHEMICALS

Question No.1. Give the amount of chlorates used. The total amount used in all the counties was 109,816 pounds most of which was Atlacide.

Question No.2. Give results obtained. Most counties reported fair results; good if follow-up work was practiced

Question No.3. What will be the demands for chlorates in 1947? Answers ranged from poor to good. I noted those counties which were conducting an eradication in quackgrass or Bermuda grass reported good. But for other uses the demand was not promising.

MONTANA STATE REPORT -

County Weed Control Activities by D. J. Leubbe Extension Weed Specialist.

On June 1, 1946 the Montana Extension Service appointed a weed specialist to assist county agents and weed districts with weed control problems.

A summary of the weed control activities is as follows:

a. There were 47 weed districts in 22 different counties.

b. Counties appropriated a total of $230,200 for weed control as compared to $141,000 in 1945.

1. Seventeen counties appropriated $5000 or more, the highest being $34,000 in one county.

c. Almost 700,000 pounds of chlorates were used in 1946.

d. 330 gallons of carbon bisulphide were used.

e. 35,000 pounds of borax were used.

f. There were 22,000 acres under a supervised cultivation program.

g. Almost 1500 acres were sprayed with 2,4-D by weed districts.

h. Very little searing or oil spraying was done in 1946. Two counties used about 5500 gallons of oil.

To determine the reaction of 2,4-D under various conditions in the State there were 117 demonstrations on the use of 2,4-D put out in 22 counties in Montana by county agents in cooperation with local weed supervisors.

Some of the problems that were encountered by county weed districts this past year might be summarized as follows:

a. Difficulty in obtaining equipment, particularly spraying equipment. Some districts also had a hard time obtaining trucks to transport spraying equipment.

b. Lack of experienced personnel in weed districts. Many districts tried to revive their program after the war and others starting in for the first time had difficulty in obtaining men to supervise the program who had any experience with this type of work.

c. Lack of sufficient information on use of chemicals which resulted in many weed districts operating on more of a demonstration basis rather than an active control program.

d. Lack of initiative and experience on the part of weed district personnel to encourage a more active program.

e. Need for more educational work on all phases of weed control. The large turn-over of county agents and many new agents with little Extension experience made it difficult for them to take a very active part in educational work on weed control until they have had an opportunity to become more familiar with their respective counties.

Eight counties used a considerable amount of 2,4-D this past year for spraying most types of perennial weeds along highways, county roads, railroads and ditchbanks as a seed control measure to replace burning. The results were generally quite successful. Next year most of the weed districts will probably follow this practice.

Weed Control Investigations by Dale G. Smeltzer

Introduction

Weed control investigations at the Montana Agricultural Experiment Station in 1946 were largely confined to testing selective herbicides. There were three principal phases of work, i.e. (1) tests of the effectiveness of 2,4-D on perennial weeds, (2) 2,4-D for control of lawn weeds, and (3) selective herbicides for control of annual and perennial weeds in small grain fields.

2,4-D on Perennial Weeds

Extensive treatments were made on areas which contained one or more of the following troublesome perennial noxious weeds: field bindweed (Convolvulus arvensis), Canada thistle (Cirsium arvense), Russian knapweed (Centaurea picris), leafy spurge (Euphorbia esula), perennial sow thistle (Sonchus arvensis) and white top (Cardaria draba). In most cases treatments were made on randomized duplicate square rod plots. Principal emphasis was placed on determining relative effectiveness of various commercial preparations of 2,4-D when sprayed at the rate of 1½ gallons per square rod in concentrations of 1000, 1500, and 2000 parts per million calculated on the basis of the pure acid equivalent of the products. This is about equal to 2, 3, and 4 pounds of acid per acre.

Seed control was obtained in nearly all cases. Excellent top kill resulted in bindweed and leafy spurge; fair results were obtained on perennial sowthistle while on Canada thistle the top kill was variable, even between plots treated alike.

The ester formulations seemed superior to the sodium salts for top kill throughout the tests. Additional readings will be made this spring to determine root kills.

Retreatments of plots treated in 1945 were made this year on Canada thistle, perennial sow thistle and white top. Final readings of root kills on those plots also will be made this spring.

Lawn Treatments

An extensive experiment involving rate, concentration and date of treatment with 2,4-D on lawn weeds was also performed. This was carried on as a thesis problem by Mr. Jesse Hodgson. Treatments were made on June 4, July 6, and August 3 using concentrations of .1, .15 and .2 percent and with rates varying from one to two gallons. He found that early treatments were the most effective. This he attributed to the growing condition of the plants. The highest rates and concentrations gave statistically significantly higher percentage kills of dandelion and buckhorn plantain than the lowest rates and concentrations. Common and mouse-ear chickweed were not satisfactorily controlled by any of the treatments.

Some late fall treatments were made on the campus lawn, using a large number of 2,4-D preparations in an attempt to evaluate them for this purpose.

Some demonstration sprayings for control of dandelion on some golf fairways were begun for the purpose of promoting the use of 2,4-D.

Selective Herbicides on Fields of Small Grains

Approximately 30,000 acres of wheat were treated by farmers with Sinox 10 dust in Montana in 1946 in an attempt to control fanweed, mustards, and other annual weeds. Results were variable. Most of the dusting was done in the north central part of the State. Early spring conditions were not conducive to the best action of the chemical. The temperature and humidity were low, and the weeds (especially fanweed) were in a rather advanced stage, when dusting operations started in April. The relatively mild winter contributed to the latter condition. Wind velocities were high, making it difficult to get uniform applications. Both airplanes and ground dusters were used. Airplane applications were generally unsatisfactory. With the ground dusters some excellent results were obtained. In one field where the weed infestation was heavy, the wheat yield was increased by 76 per cent.

It is felt that there is a critical need for better equipment for application of the dust. In spite of the variable results for 1946, many farmers are planning to use the new Sinox B dust this year.

OREGON STATE REPORT - W. G. Nibler, Assistant Extension Specialist in Farm Crops

Oregon with 36 counties had a total county appropriation for weed work of $36,000 during the 1945-1946 year. There were 15 counties with no appropriation and 7 with less than $1000. Only 1 county appropriated more than $5000. During the 1946-1947 year, interest in weed control picked up considerably but with little change in the amount appropriated. During this period, however, some progress was made in getting increased contributions for the 1947-1948 year.

In Union County a one mill tax levy for a weed fund was passed by the voters and will provide $19,000 a year on a continuing basis. In Malheur County a one mill tax levy will provide $14,000 for one year to get started, as a smaller amount has a continuing appropriation.

Sixteen counties in Oregon now have county-owned weed spraying equipment and 4 counties have cultivation equipment but are just getting back into a program of operating it following the war. Klamath County, which has provided a $7000 county weed fund for many years, is continuing to be the leading county in weed work.

The following figures are estimates, only, of the field acreages of grass and grain selectively treated with 2,4-D. The estimates are conservative:

Klamath	1500	This acreage was grass for seed and some barley created for annual weeds
Willamette Valley	5000	Big majority was grain and common ryegrass sprayed for hairy vetch, wild peas, Canada thistle, and annual weeds. Some perennial grass was treated.
Blue Mountain	1500	The majority of this acreage was the perennial grass weedings of the Blue Mountain area.
Columbia Basin and Miscellaneous	2000	The majority of these were preliminary trials of 2,4-D on grains in the Columbia Basin.

This makes a total of 10,000 acres, which is a very small part of the acreage that could profitably be treated.

It is anticipated that 1947 will see a large expansion in acreage treated. The practice is well established on the grass fields in the Blue Mountain area and on common rye grass in Linn and Marion Counties.

The coming year will be one of large-scale trials on grain in the Klamath and Columbia Basin sections. There will be many trials in selective spraying of Canada thistle wherever they are found in the state. It is anticipated that at least 100,000 acres will be treated in 1947.

COLORADO STATE REPORT - Bruce J. Thornton
State Weed Control

Colorado's weed control program is conducted on the county or weed district level. The State Weed Law provides that a weed district or weed districts may be created by the Commissioners of any county to include the entire county or any portion or portions of a county. They are further authorized to purchase equipment and materials, employ a weed supervisor, and other help, enter into contracts with landowners for control or eradication of designated weeds within the weed district, pay the costs incurred out of the General Fund or designate a weed fund, and enter into cooperative agreements with State and Federal agencies or departments for the furtherance of weed control efforts. The county commissioners are further authorized to levy a tax for the purpose of defraying the costs of the weed control work not to exceed .5 mill in any one year. Weed control districts set up under these provisions are operated on a voluntary basis.

Under this law numerous weed control districts have been in operation in the state on the basis of clean cultivation and chlorate programs. More recently 2,4-D has been added to the control programs and is tending to decrease the cultivation activities. The advent of the 2,4-D herbicides has given a great impetus to the weed work in the state, numerous additional weed districts having been formed and new ones constantly being formed.

Under another Colorado law, known as the Pest Law, compulsory weed control districts may be formed by petition of a majority of the resident land owners of the designated district. No compulsory weed control districts are now in effect and their formation is not encouraged at the present time.

Results of Field Applications

Although results from field applications, whether by county equipment or custom work, varied from very poor to good and in general averaged far below the early claims made for 2,4-D, the general attitude toward the use of 2,4-D appeared favorable at the end of the season and it is evident that the use of the material will be expanded greatly next year.

Field Research in Weed Control

Most of the research in weed control in Colorado has centered around the use of the 2,4-D herbicides. Efforts largely have been limited to testing the comparative effectiveness of the four principal types of 2,4-D herbicides available on the market, namely: (1) 2,4-D acid in a carrier, (2) sodium and ammonium salts of 2,4-D, (3) amine salts of 2,4-D, (4) esters of 2,4-D. The greatest effort was concentrated on the last three groups since the use of 2,4-D in a carrier has definite limitations from the commercial and practical application angles. Some effort was also made to compare compounds within the respective groups. Tests involved many different plants but most of the effort was expended on field bindweed.

The following observations are based on the results of the field research under Colorado conditions as apparent to date:

1. The 2,4-D herbicides, although falling far short of the original claims made for them, continue to offer great promise in weed control.

2. The use of 2,4-D should be viewed as a control rather than an eradication measure in dealing with most weeds.

3. In general, best results were obtained in treating weeds growing in competition with cultivated crops including permanent pasture, the cereals, and corn. This offers a distinct advantage in that it permits conducting a weed control program on the farm without laying the land out of production.

4. The applications of 2,4-D at the proper stage and under the proper conditions constitute the most important factor influencing its effective use. Therefore, successful weed control on the farm may be dependent upon each farm having its own weed spraying equipment.

5. There is a need for efficient equipment that will apply the required amount of 2,4-D uniformly in concentrated form, thus requiring much less solution per acre than has been recommended and materially reducing the costs of application.

6. A wide variation in results may be obtained even when treating the same weed species under similar conditions. Factors responsible for these variations need to be determined.

7. Best results on white top (Lepidium draba) were obtained from early spring treatments and from treatments made in the summer on regrowth which followed cutting off earlier in the summer.

8. Fall observations and digging indicate considerable reduction of Russian knapweed by early applications of 2,4-D.

9. Whorled milkweed was effectively reduced by treating in the early bloom stage.

10. The ester forms of 2,4-D appeared most effective in treating whiteweed, knapweed, and the whorled milkweed.

11. In one test on Canada thistle application of the 2,4-D herbicide in the morning showed highly significant superiority over mid-day application, and mid-day application showed highly significant superiority over evening applications.

Physiological and Chemical Research with 2,4-D

This work is being conducted under the direction of Dr. Jess L. Fults of the Botany Section in cooperation with Merle Payne of the Chemistry Section.

The physiological tests involved greenhouse and laboratory methods. Of a large number of plants tested in the greenhouse, castor bean proved to be the most sensitive. Its reactions were quick and positive. Russian knapweed and Canada thistle were the most satisfactory perennials. Wendt's etiolated pea test was used in the laboratory trials.

Something over a hundred organic chemicals were tested to determine their possibilities as herbicides. Of these, ten have been selected for further investigation.

The effect of ultra-violet light on the action of 2,4-D formulations has been under investigation and publication of the results in the near future is contemplated.

NEVADA WEED REPORT - Lee M. Burge

Control measures have continued more on a local basis than on large scale or state-wide levels. However, more interest has developed during the past year than has been evident in recent seasons, due primarily to the let up of pressure of the War and to progress being made in the field of research with herbicides.

The State Production and Marketing Administration has placed morning-glory and Canada thistle on the eligible list for payment under its program when treated with 2,4-D.

Individuals and small communities have organized local control programs on some specific weed, the largest of these programs being a three-year project in the Truckee Meadows for the control of water hemlock.

Two counties have begun an aquatic weed program with the use of Benachlor. Results from preliminary work have been quite satisfactory but at a higher cost per mile than had been anticipated and which resulted from the naturally slow flow of the water in the ditches treated.

In Clark County some 175 to 200 acres of field-grown plants are being kept under constant observation to guard against any possible danger of weeds being sent into plant importing states. Any plants found to be infested with objectionable weeds are immediately destroyed or the acreage cleaned up by selective sprays in the case of onion sets, cabbage and celery plants. An estimated one hundred million tomato plants will be shipped from this area beginning in late April, such shipments being made in iced baggage cars and by air transport.

Plots measuring 50' x 50' have been continued during the past season to determine the value of 2,4-D. Approximately 130 test plots were used during the season involving 45 different weeds.

Field trials carried on by the State Department of Agriculture in cooperation with farmers, water districts and County Agents have proven that 2,4-D has a definite place in the weed control program. At the same time, several factors, such as plant resistance, stage of growth, type of soil and possible humidity must be taken into consideration. Also, nozzle pressure has an important bearing on results obtained.

All trials under the supervision of the department were made with dry material, carrying 60 per cent acid, and with liquid material, carrying 40 per cent acid. In some plots oil was added and when thus used generally appeared to give better results. Observations indicate that when the plants have been injured or mutilated by mechanical means, the chemical seems to be more effective.

The following table divides the many species of weeds sprayed into two groups, namely, those susceptible and those which were resistant. Final observations on all field test plots will be made before June 1, 1947.

WEEDS SUSCEPTIBLE TO 2,4-D	WEED RESISTANT TO 2,4-D
Canada Thistle**	Halogeton
Camel thorn	Knapweed
Willow	White top**
Stinging Nettle	Licorice
Narrow leaf milkweed	Syrian rue**
Broad leaf milkweed	Wild Rose
Indian hemp	Mallow
Worm wood	Iris**
Morning-glory	Goldenrod***
Buckwheat	Bassia**
Poison hemlock	Cottonwood
Sweet clover	
Dock	
Poverty weed	
Yerba Mansa***	
Smartweed	
Chicory***	
Five finger***	
Tansy	
Wild currant	
Lambsquarters	
Dandelion	
Plantain	
Leafy spurge****	
Burdock	
Bull thistle	
Sunflower	
Mustard	
Cockle	
Elm	

** Moderately
*** In Meadow
**** Tentative

2,4-D as a selective spray proved effective in wheat and barley in all stages of grain maturity. These trials were principally against sow thistle, bassia, sunflower and morning-glory at concentrations ranging from one-fourth to one pound of 60 per cent 2,4-D to 50 gallons of water. Complete control of the weeds listed above was obtained with no injury to the grain.

2,4-D has a place as a selective spray in control of many meadow weeds, principally yerba mansa, five finger, smartweed, poverty weed, dandelion and chicory and probably iris. These plants were all controlled, with the possible exception of iris, at concentrations ranging from one-half to one and one-half pounds of 60 per cent 2,4-D.

In relation to white top and knapweed, results with 2,4-D were not as satisfactory as had been expected. Two year plots on white top are showing fairly good control. Knapweed plots are discouraging except on sandy soil where some fine kills have resulted.

All plots treated in 1946 will be studied again this coming season.

Surveys made throughout the range areas show a continued spread of Halogeton in a southerly direction.

CALIFORNIA STATE REPORT - Walter S. Ball.

Mr. Chairman, my report is going to be rather brief as I wish only to mention a few of the problems we have in California that I feel are of interest to the group.

First of all, I want to clear in the minds of many the situation that has brought numerous inquiries to our office as well as to Dr. Robbins's office at the Botany Division at Davis, relative to the work carried on with the Electrovator for the control of weeds in California. I have personally seen this piece of equipment operate and have made root studies in the areas after several treatments and have noted dead roots of Russian knapweed three to four feet deep. We have requested that one of these machines be placed at the disposal of the Experiment Station at the University Farm at Davis, in order that we might learn more about the action of the electricity on different species of plants under various known conditions such as plant growth, soil moisture conditions and other factors that might aid us in discussing the merits of this equipment with those people who are interested in this type of weed control. So far this equipment has not been given to the Experiment Station and therefore we are unable to answer many of the questions relative to the various conditions under which the machine best operates and what can be expected of one, two, four or more applications per season. We have learned in some cases that four applications on Russian Knapweed give very encouraging results, in other cases it is noted that six to seven applications are needed. We readily recognize that at $10 per treatment this method of weed control can soon become more expensive than some of our more recent chemical practices, and it would seem to me that this is an important factor to be considered. If, however, this equipment proves satisfactory for shallow-rooted perennials such as Johnson grass, quackgrass and Bermuda grass, there are hundreds of acres of orchards and vineyards infested with these plants that might be controlled quite satisfactorily. We have requested that tests of this nature be demonstrated but as yet we have been unable to make such observations.

The Selective Weed Control program has expanded very rapidly. The dinitros have continued to be very satisfactory in the control of weeds in grain and onions. The use of oil for selective spraying of carrots has continued to expand although there are still reported troubles with the taste of the oil carrying over into the marketed product. We realize there is work yet to be done in perfecting an oil that will not deposit a residue in the crown of the carrot, and I understand that the Shell Oil Company at the present time are working on and have possibly developed such a product. The contact sprays have proven satisfactory and very encouraging for the control of annual grasses and weeds in alfalfa.

One of the most recent and outstanding selective weed control programs has been in the control of water weeds in rice throughout the rice-growing areas. This has been accomplished through the use of 2,4-D formulations and has brought relief to the rice growers who have in the past been unable to handle their weed problem. The 2,4-D's are being used for selective sprays rather extensively and we are making careful checks, determining results and any possible injuries resulting from its use. The airplane application of the selective sprays is advancing rapidly and the development of this equipment, although in a very elementary stage, is giving a great deal of promise. Some of the dusts are being applied and for some of this year's work it will be necessary to work a little later to get final results.

The use of oil for the control of weed growth in citrus, on which I have reported in past years, has continued and is now being carried on to some extent in vineyards. The results of this work over a good many years in the citrus area have proven to be very satisfactory and economical and have shown no apparent injury to trees or quality of fruit. It bears out one point that was quite noticeable in one inspection I had the opportunity to make and that is that the feeder roots of the trees were very close to the surface and could be exposed by merely scratching the soil, showing in this case that cultivation apparently kept these roots pretty well pruned out.

Although I have mentioned Borax annually I feel it should be mentioned again due to the fact that it is being used rather extensively by the Southern California Edison Company for soil sterilization around power towers and for fire breaks. The results of the application of 240 tons of Borascu revealed effective kills a year later. Its use in our Klamath weed program has continued.

I would like to mention just one more point that we feel is going to be of much importance in California and that is the new practice that has been approved under the Agricultural Conservation program where each county is permitted to use ten per cent of its total allocation for a project they wish to select. Of course, this project must meet the approval of the State Committee. In California there are several counties that have selected the problem of weed control for this practice and have selected puncture vine and yellow star thistle, two of our annual plants that are very widespread in the areas in which these counties are located. It is one of those conditions where the weed has actually gotten away from the grower as well as public agents, and now with the Federal funds appropriated under this program and additional funds which they are attempting to get from their own county, and state funds if possible, they are launching upon a very expanded program. We are somewhat fearful that such a program may not be successful in many of these counties and it will definitely be a discouraging factor in so far as future weed control programs are concerned. We are hopeful that if money is appropriated it can be allocated for the control of perennial weeds of noxious characteristics that we know are much more detrimental to agriculture than annuals that can normally be handled through good cultural practices and good farming methods.

This, Mr. Chairman, does not cover all of our weed programs in California but I wanted this report to be rather brief and touch only upon those points that I thought outstanding.

IDAHO WEED REPORT - V. A. Cox

The report for Idaho will be extemporaneous inasmuch as we have lost our weed man. However, I thought you might be interested in what Idaho is doing. Our research men, Mr. Seely and Mr. Erickson, have certainly done a magnificent job. Their work has been of great benefit to the State of Idaho. Our weed problem is the number one problem of the state. Of the 44 counties in the state, 16 have full time county weed supervisors. The others participate in the work of weed control largely through the county agents who have more or less active programs. These programs consist chiefly of chemical control through the use of chemicals purchased by the individual farmers although some cultural control is done. We have in our state an organized weed control association. This association is formed by the various county commissioners and county weed supervisors and others who are interested primarily in the control of noxious weeds. This association is divided into five districts, each district represented by a director.

During the three years this association has been in operation we have found it to be quite profitable. Meetings have been held semi-annually over the state and at each meeting Seely and Erickson gave detailed reports of the results of their experimental work. This has been extremely helpful.

We are using a great deal of 2,4-D in Idaho and we are largely agreed that it definitely has a place in weed control. We know of no place where complete kill has been recorded.

Cultivation has played a large part in the weed control program in Idaho. It varies from 250 acres in the smaller counties to 1000 acres in the larger counties. Most of the work is being done in irrigated sections.

I do not think we are in any sense controlling the spread of weeds. We have been hoping to have laws enacted which would be helpful in reducing the spread of weeds through feed and fertilizers. Many noxious weeds are spread through the sales of unclean hay and grain. Livestock sales have also contributed to the spread of noxious weeds.

CHAIRMAN MORRIS: Mr. Ball, would you like to report on the North Central Weed Control conference?

MR. BALL: I should like to state briefly that I did attend the North Central Weed Control Conference and they certainly had a fine meeting. They had a better meeting than ours so far as the number of states represented is concerned, with representatives of 13 states in attendance whereas we have only 8. It was a good meeting, very instructive, with a good program. I am not going to say too much about it because Mr. Hanson is here to give us a report on the meeting and I don't want to use any of his material.

Chairman Morris then introduced Noel S. Hanson of the Agronomy Department, University of Nebraska, Lincoln, Nebraska.

NORTH CENTRAL WEED CONTROL CONFERENCE -- Noel S. Hanson

Friends of the Western Weed Control Conference: I might say that it is a pleasure for me to accept your kind invitation to report to you on the activities of the North Central Weed Control Conference, but that would be stating it much too mildly. It is a rare privilege to have the opportunity to meet, to visit with, and to talk to a group of investigators and weed officials who have been so active and have done so much fine work in the field of weed control. I wish to thank Mr. Ball and to thank you for this invitation, and also, of course, for the chance to visit your fair City of Portland and the interesting country through which we have traveled to come to your conference. Being heretofore definitely landlocked midwesterners, Mr. Klatt of the Nebraska State Department of Agriculture and I are enjoying your Western scenery and hospitality.

I bring you greetings and best wishes from the North Central Weed Control Conference. I know that many of our members would like to be here today for we all feel that we can learn many things from you. We are deeply appreciative of the assistance which Mr. Walter Ball has rendered us during our first two years in existence. He has attended our three annual meetings, has given us some excellent advice, and I hope that it will be possible for him to continue attending our meetings in the future. We extend this same invitation to any or all of you here in the Western Conference.

Mr. Ball has asked me to report briefly on the activities of the North Central Conference. In doing so I will cover the last annual meeting which was held at Des Moines, Iowa, on December 11, 12, and 13, 1946, and some of the work handled by our committees. Our first half day was devoted to committee action during which time policies and reports were shipped into form for presentation to the conference. At a noon luncheon on Wednesday, we got under way with an address by Mr. Kirk Fox, Editor of Successful Farming, a fine Midwestern farm magazine to which some of you are no doubt exposed at times. Mr. Fox is greatly concerned with the various weed problems and their effect on good agriculture in the midwest and the United States. He very strongly appreciates and encourages further research and education in weed control with strong legislation applied where needed. He places great hope in the provision of the Hope-Flanagan Bill to further research in weeds as well as other phases of agriculture. As an editor, he very strongly urged cooperation of research workers with the press and radio in order that the best information might be presented in understandable language to farm folks who are greatly in need of information on new and improved methods.

Mr. Fox pointed out a few interesting items in regard to typical reading sources of an average farm family, that family which all of us are interested in reaching with the best information we compile on how to destroy weeds. These reading sources include (1) three farm publications, one of a general type, another a state paper, and third, a special kind of fruit publication in which the farmer is most interested; (2) a local weekly newspaper; (3) a news daily; (4) an average of one new book and two borrowed books per year; and (5) college bulletins and manufacturers' literature. Some 92 per cent of midwest homes have radios from which the farmer obtains 85 per cent of the general news. These means of education must not be overlooked by those of us who are interested in seeing a good job of weed control done on the farm. I don't believe there is one of us here who is not intensely interested in seeing the fruits of his labors find some application in good agriculture. As Mr. Fox says, "Know the Press and Radio Folks." This is all important in the education of farm people.

The need for research and education as well as regulation received further emphasis in our first afternoon's program. Mr. Ball gave an excellent report from the Western Conference in which he pointed out that education, research and regulation were three of the most important factors to be considered in weed control by all agencies. His paper will be published in the proceedings of our Third Annual Conference Meeting. I hope it will be possible for all of you to read it. Another paper entitled "Weed Control Week" was presented by the present speaker. This paper which was presented as a committee report, outlined a plan for a "Weed Control Week" campaign, on much the same basis as the "Fire Prevention Week" campaign. It was proposed through such a campaign by press, radio, special publications and the endeavor of various organizations to reach as many farmers and land owners as possible with the best information on losses from weeds, weed control methods, and to encourage weed destruction by any or all approved methods over as wide an area as possible. Such a campaign, while its success could not be measured in dollars and cents, would be in direct proportion to the support given to it. It was proposed that such a campaign be started on a state or regional basis in the coming year, and perhaps might become national in scope at some later date if found successful in some areas.

Another matter receiving attention at our first session was a Constitution and By-Laws for our conference under which we now have an executive committee and Board of Directors with one director from each state and province. Under our constitution it has been possible for us to take in the provinces of Alberta, Manitoba, Saskatchewan, and the Dominion Experimental Farms at Ottawa, as active members. Some time was spent in viewing some of the present items of spraying equipment and chemicals for weed control.

The second day's program consisted of panel and forum discussions covering the research of 2,4-D conducted by and reported to our Research Committee of which Mr. F.L. Timmons is Chairman. Mr. Timmons is here today. Inasmuch as he will be working closely with some of you in this area, I will say that he has done an excellent job as Chairman of our Research Committee and I hope that we will not lose him completely to the western conference. We are having Dr. C. J. Willard of Ohio State University, assist him as Vice-Chairman of the Research Committee this year so that someone is ready to assume the duties if Mr. Timmons can no longer do so.

Dr. Willard is Chairman of our Policy Committee on the Use of Herbicides. He and his committee prepared a report which was adopted by our conference and includes recommendations covering the use of the several herbicides, including 2,4-D, the dinitros, chlorates, and borax. Classified lists of species of weeds, crop and ornamental plants showing their relative reaction to 2,4-D are attached to the report. Both Mr. Timmons and I have extra copies with us and they are available if you wish to have one.

Our banquet program included very informative addresses by Dr. C. E. Minarick of the U. S. Chemical Corps at Camp Detrick, Frederick, Maryland, and by Dr. A. D. Hess, Biologist for the Health and Safety Department of the Tennessee Valley Authority at Wilson Dam, Alabama. Since Dr. Norman will be here and will speak to you about their work at Camp Detrick, I will not report further on Dr. Minarick's address. Dr. Hess pointed out that their studies on weed control in the Tennessee Valley area are primarily for the elimination of breeding areas of the malaria bearing (Anopheles) mosquito in impounded waters of the T. V. A. System. Through the effective cooperation of Biologists, entomologists, and Engineers, considerable success has been gained in developing airplane spraying equipment for the application of low-rate, highly-concentrated 2,4-D spray. No doubt much of this information can be used in the control of weeds in irrigation reservoirs and main canals.

Some studies in the application of 2,4-D as a spray by airplane, were initiated in several states last year. I understand that some experiments were conducted in California. We in Nebraska had an opportunity to cooperate with the Sherwin-Williams Company in some studies using 2,4-D in diesel fuel on pennycress in growing wheat last fall. To date these applications appear to have eliminated from 90 to 100 per cent of the pennycress without apparent severe injury to the wheat. We will not know until spring and summer, however, what the actual effect on the weed or the crop has been. I think from what we have seen thus far, that airplane application will be practical for the destruction of annual weeds under some conditions.

The last forenoon program at Des Moines was given over to special talks by Mr. Kephart, Mr. Balcom, Mr. Lewis Evans, and by one of our Canadian members, Mr. George Knowles of the Dominion Experimental Farms at Ottawa, Ontario. These talks covered the proposed cooperative studies being initiated by the Bureau of Reclamation and the Bureau of Plant Industry here in the West, investigations in the eradication of water hyacinth in Florida, as well as research of 2,4-D and the dinitros in Canada and Great Britain. We believe in learning what is being done in other areas besides our own, for much can be gained by a free exchange of ideas and information.

We, in Nebraska, are intensely interested in the work that will be conducted here in the West on irrigated lands, for we already have several thousands of acres in our state under irrigation, both by gravity and by pumping systems. Already new weed problems are facing us with which we are not prepared to cope at present. North Dakota, South Dakota, and Kansas will, no doubt, be looking to these problems in the near future as irrigation becomes more developed in those states.

We have several standing committees besides the Research Committee. These include one for the study and preparation of the main provisions of a uniform state weed law. Another for the study of educational methods in weed control employed by the various state extension services. Now that we are coming into an era in the use of herbicides when there will be many commercial products on the market with the possibility of claims and counter-claims regarding their active ingredients and their uses, there will no doubt be many states looking to the enactment of legislation for the control of these products. One of our committees made a study of the ramifications of such a law and have set up a proposed herbicide law as a model for the various states to consider. During the study of such legislation, the committee found that there were two bills pending which included not only herbicides, but insecticides, fungicides and rodenticides, as well. One of these bills (H.R. 5645), a bill to regulate the marketing of economic poisons and devices and for other purposes, was introduced in the last session of Congress, but failed by reason of its being on the calendar at the close of the session. The other was a draft of a model insecticide, fungicide, and rodenticide act, including herbicides, that was proposed by the Council of State Governments. Without doubt a revision of H.R. 5645 will come before the 80th Congress. With this proposed legislation for the federal statutes there may be little need at present for each state to enact laws covering economic poisons. These are just a few of the matters being given consideration by our committees.

As an organized group, we wish to stress the importance of continued and expanded research weed control to gain information, increased educational activity for the purpose of disseminating the compiled information to the weed plagued public, particularly in agriculture, and to back the research and education with strong, but discreet and just, legislation for systematic regulation of the destruction of weeds on farms and the movement of weed-infested crop seed in intra and interstate commerce. To further our aims, we intend to continue our efforts in the direction of encouraging the procurement of funds for expanded research in our member states as well as in the U. S. Department of Agriculture. We will cooperate with the Western Weed Control Conference in any joint undertaking that would further the aims of both conferences. The suggestion has been made that perhaps we could hold our meetings together occasionally--maybe once every five years. I am sure that our group would be greatly in favor of such joint meetings, and if you wish, we can plan for this in 1948. In the meantime, we extend cordial invitation to all of you to attend our 1947 meeting at Topeka, Kansas. I am sure that Ted Yost and the rest of the Kansans will have a good meeting place for us. Thank you.

CHAIRMAN MORRIS: Thank you, Mr. Hanson, for your report on the conference of the North Central States. We hope that your group will continue to send a representative to meet with us. You made a suggestion about joint conferences--that it might be a good thing once in awhile for the two groups to meet together. The housing situation would make it rather difficult to find a location to handle 500 people. The way these conferences are growing housing has to be considered when we hold the meetings. If such arrangements could be made it certainly seems to me that it would be a desirable thing.

As you know, a good part of the work of the conference is done in committee meetings. They really formulate the policies and do the active work in the conferences. I will, therefore, appoint the following committees:

Nominating Committee:

E. J. Kreizinger, Chairman
C. E. Otis
W. A. Harvey

Resolutions Committee:

Bruce Thornton, Chairman
V. A. Cox
H. S. Schaad

Legislation Committee:

George Hobson, Chairman
L. E. Harris
Lambert Erickson
Frank McKennon
H. E. Morris

We are now operating under a set of rules and regulations adopted at Denver. We have been able to get by with these up to now, but believe the time has come to draw up a formal constitution and by laws for the Conference. Will the following people please meet with me for luncheon: Walter Ball, Virgil Freed, Charles Allen, C. E. Otis, Bruce Thornton, Harold Schaad, George Hobson and V. A. Cox.

The morning session adjourned until 1:30.

The afternoon session was called to order at 1:30 by President Morris who introduced Dr. E. O. Essig, Head, Division of Entomology and Parasitology of the University of California at Berkeley, California.

INSECTS IN RELATION TO WEED CONTROL - E. O. Essig

I greatly appreciate being invited to attend this convention.

The recent discoveries and developments of herbicides, fungicides, insecticides, and rodenticides have been unprecedented in the history of the world.

The judicious uses of these new chemicals require the hearty and complete cooperation and combined efforts of all parties engaged in and interested in the control of weeds, fungus diseases, insects, and rodents.

The most important problems in economic entomology arise from the devastating attacks of insects upon plant life. To agricultural crops these infestations are often the cause of great losses or utter ruin unless adequate control measures are taken to destroy the pests. The control measures inaugurated against these injurious insects constitute a never ending campaign that continues year after year without apparent prospects for permanent dimunition or cessation.

Insects have always been associated with plants. Probably half of the species are plant feeders and are sustained entirely by vegetation while the other half are predacious and parasitic upon the plant feeders. However, all are dependent upon the vegetable kingdom.

In this discussion only the insects feeding upon plants will be considered.

Geologically speaking insects are very old--perhaps 50 million or more years. This long association with plants has resulted in many interesting and complicated developments and specializations of both plants and insects. In a great many cases these relationships are beneficial to both groups. So much so that neither could continue to exist alone. In gathering nectar and pollen, insects have become specialized in structure and habits so as to cross-pollinate plants whose reproductive powers are wholly dependent upon the food-foraging bees, wasps, flies, beetles, butterflies, moths, and other insects. The extraordinary adaptions of certain moths, to pollinate orchids and yuccas are well known examples of the exactness of these relationships. Certain ants collect seeds of plants for food, but in so doing many seeds are scattered along their trails and about their nests and are thus distributed.

Insects respond to plants in innumerably different ways. Many are monophagous and can subsist on only a single species; others may expand their diet to embrace a genus of plants, still others have enlarged their quota to a single or several related families, and a great many have become omnivorous or polyphagous and are able to subsist and propagate on a great variety of plants in many widely separated families.

No terrestrial plant is known to be wholly free from insect attacks. Many plants like the pines, oaks, willows, poplars, roses, and composites may be the hosts of hundreds and even thousands of species of insects throughout their geographical range. The feeding of insects upon certain plants may be a very complicated and specialized process.

There are very many examples of important insect pests that require weeds as hosts and as shelter.

The chinch bug, one of the most serious pests of wheat and corn in the Mississippi, Ohio, and Missouri River Valleys, could not well exist without the protection of weeds, grasses, and litter for protection during the severe winters of its habitat.

The green soldier bug, so destructive to ripening peaches in parts of the San Joaquin Valley, California, does not over-winter in clean-cultivated orchards.

Lygus bugs, the most important pests of seeding alfalfa, breed up in great numbers in uncultivated wastelands and continuously migrate into the alfalfa fields where they destroy the blossoms. They also infest beans, cotton, and other crops.

White grubs, the larvae of June beetles, reproduce extensively on and owe their existence chiefly to wild grasses. They have always been serious pests of wheat, corn, and other grains in grassland areas.

The alfalfa and clover leaf weevils reproduce abundantly on wild clovers, melilotus, vetches, and other legumes from whence they transfer to alfalfa and clover.

Cutworms and armyworms breed up in tremendous numbers in uncultivated weed and grassland areas and move over onto cultivated crops of all kinds. Their infestations have been greatly lessened by reclaiming these wild areas for cultivation and by weed control.

Grasshoppers and locusts, the arch-enemies of ancient and modern agriculture, cannot continue to exist in grassless and weed-free areas. The destruction of the wild hosts in breeding areas could solve the great international problem of locust control.

Aphids and leafhoppers propagate in unbelievable numbers on the numerous wild weed hosts that occur in uncultivated waste lands and in pastures, roadsides, ditch banks, fence rows, and on poorly farmed lands. From the wild hosts they often transmit serious virus diseases to farm crops.

The Colorado potato beetle owes its existence in parts of North America to wild solanaceous plants like the buffalo bur from which it transferred to the much preferred potato when the latter became available in the habitat of the beetle.

The various cabbage aphids, bugs, maggots, and worms find natural food supplies in the great fields of wild mustards, radish, and other cruciferous plants. These wild hosts furnish abundant food for their propagation during the winter months in temperate and sub-tropical areas like the Pacific Coast and the Southern Gulf States.

Weeds As Reservoirs Of Virus Diseases: Many weeds and grasses are reservoirs of virus diseases that are transmitted to agricultural crops by insects. The study of plant virus diseases is a relatively new subject, but it has already shown that there are many very important and destructive ones that are extremely injurious to living plants and most difficult to control. One method in dealing with these diseases is to destroy the intermediate plant hosts.

It seems very likely that these virus diseases originated in wild hosts and that they have been transmitted to cultivated plants by insects for ages. Fortunately, not all insects are able to accomplish this transfer. In fact, only a relatively few groups now appear to be endowed with the capacity to act as intermediaries in taking a virus from one plant and transferring it to another. Certain aphids, leafhoppers, and a few thrips, and beetles, are capable of making the transfer. These carriers are generally omniverous feeders and capable of carrying the virus to many host plants. The beet leafhopper is the only known insect capable of transmitting North American curly top virus; whereas, the green peach aphid is able to transmit more virus diseases than all of the other known aphid carriers.

In the case of the beet curly top virus, the winter and spring host is chiefly the red-stemmed filaree (Erodium cicutarium) which grows abundantly on grassy hillsides and plains everywhere in the middle and southern parts of California. The beet leafhopper, Eutettix tenellus, overwinters on this plant which is a favored reservoir of the virus. In the spring, the infected leafhoppers migrate to the valleys on both sides of the Coast Range Mountains in Middle California and continue to feed and breed on the filaree and also on salt bushes (Atriplex spp.) and other plants. Along the eastern slopes of the hills and the east side of the San Joaquin Valley the leafhoppers gradually work down into the cultivated areas. On the margins of these are great stretches of Russian thistle (Salsoli kali), which furnish food for the insects during the late spring and early summer. These plants also become reservoirs of the virus. Thus laden with the disease the leafhoppers migrate to cultivated fields of melons, sugar beets, tomatoes, and other crops and, in feeding, transmit the virus to these plants. In most cases, during years of abundance of leafhoppers, the crops in these infected fields are total losses. Through extensive studies covering a long period of years, it has been discovered that the leafhopper migrations can be greatly retarded and reduced by spraying the weed hosts to destroy the insects as they progress from the hill areas to the cultivated fields. This work has cost the sugar beet growers and refineries thousands of dollars annually and has been remarkably successful. In recent years these repressive measures have been taken over by the state which has extended the control program to the actual destruction of Russian thistle and other weed hosts on several thousand acres of grazing land. At the present time the complete extermination of the Russian thistle is being contemplated as a measure likely to prove most practical in reducing future outbreaks of the curly top virus in the San Joaquin

Valley.

Investigations in the control of the bean thrips (Hercothrips fasciatus) have shown that the destruction of the wild prickly lettuce (Lactuca scariola), which is the most important winter host of this insect, adds very greatly to the reduction and the elimination of the thrips as a pest of field agricultural crops in many sections of California during the succeeding year.

It has also been shown that the elimination of grasses in and around vineyards greatly reduces the numbers of leafhoppers which transmit Pierce's disease of grapevines. Although these leafhoppers do not multiply on the grapevines, yet they do feed sufficiently upon them to transmit the deadly disease which occurs in grasses, alfalfa, and other plants growing in and around the vineyards. Here clean culture again appears to be the most effective means of reducing and controlling a virus disease.

It is hardly necessary to pursue this line of argument further to show the great importance of weed control to prevent the great financial losses caused by weeds which act as reservoirs and intermediate host of plant virus diseases.

Insect Control Of Weeds: One phase of biological control is concerned with the directed destruction of weeds by insects. This method might prove hazardous if not regulated by state or national authority and if competent men are not in charge. For weed control it is necessary to select only insects that have definite restricted food habits and preferences. Even with these precautions it is always possible that certain insects may change their food habits when introduced into new environments and brought into contact with entirely new and different kinds of plants. The fact that there are so many omnivorous species indicate that untold numbers of insects have gradually widened their dietary routine. The cottony cushion scale in its native Australia appears to have been restricted to the members of the large general Acacia, Pittosporum, Casuarina, Grevillea, Hakea, and possibly other native Australian plants. When introduced into other parts of the world it almost immediately extended its host range to include Citrus, Rosa, Prunus, Pyrus, Robinia, Vitis, Laurus, Magnolia, Quercus, Buxus, and many other surprisingly different food plants.

It was introduced into California on Acacia and in the very short space of a few years became one of the most serious pests of Citrus. Later it appeared in great numbers on other crops including French hybrid pears and many widely different fruit trees and ornamentals.

Many other examples of the sudden expanding of the host range of introduced insects could be cited.

Because of the dietary changes in insects the greatest care is exercised to employ only the most rigidly restricted species for the control of weeds in new areas. Naturally, if a weed is abundant and over-aggressive in a locality it is assumed that efficient insect enemies do not exist there or that they would be held in subjection by insect predators and parasites or by other natural checks.

The actual use of insects to destroy weeds or other over-aggressive and destructive plants is relatively recent. Scientists of the Territory of Hawaii, in 1902, began utilizing and distributing the introduced coccid, Orthezia insignis Douglas, in an attempt to check the obnoxious Lantana camara which had purposely been introduced into the islands as an ornamental and which became a very abundant and severe pest in open grazing lands and in forested areas. In 1902 also twenty-three different species of insects were introduced into Hawaii to prey upon the lantana plant. The most beneficial insects were those that prevented seed production.

Similar programs of weed control were later adopted against the blackberry (Rubus fruticosus), gorse (Ulex europaens), ragwort (Senecio jacobaea), foxglove (Digitalis purpurea), and bracken (Pteris aquilinia) in New Zealand, and the prickly pear or opuntia cacti (Opuntia inermis and O. stricta) in Northern Australia. These investigations required the cooperation of botanists, ecologists, agriculturists, and entomologists.

The most recent attempt along these lines are aimed at the control of the St. Johnswort (Hypericum perforatum L.). This work began in Australia several years ago. A number of insects were introduced from southern Europe. They show such promise in reducing stands of the weed that steps are now being taken to establish colonies of the most efficient beetles into California to fight St. Johnswort in the Sierra foothills and in the northern coast counties. The success of this project in this area, although encouraging, is yet to be ascertained.

Literature cited:

ESSIG, E. O. - Insects of Western North America. Macmillan, N.Y. ixt 1035, 766 figs. 1926
PERKINS, R. C. L. and SWEZEY, O. H. - The Introduction into Hawaii of Insects that Attack Lantana. Hawaiian Sugar Planter's Association, Expt. Sta. Bul. 16:1-83, 1924
ROBBINS, W. W., BELLUE, M. K., and BALL, W. S. - Weeds of California. Calif. State Dept. Agr., Sacramento, 1-491, 16 maps, 344 figs, (24 col. pls.), 1941
THOMPSON, W. R. - The Biological Control of Insect and Plant Pests. London, Eng. 1-124, 1930

CHAIRMAN MORRIS then introduced H. R. Offord of the U. S. Department of Agriculture, Agricultural Research Administration, Bureau of Entomology and Plant Quarantine, who presented the following paper:

The Control of Weed Hosts in Plant Diseases

Weeds help to spread plant diseases and insect pests that damage crop plants by serving directly as hosts of fungi, insects, virus and bacteria or by harboring insects which in turn spread the disease-causing organisms. Dr. Essig has just reviewed the problem of insects and insect vectors in respect to weed hosts and has pointed out the value of weed eradication in the control of virus diseases. The need for close coordination of practical insect and disease control work has been widely emphasized by the program committee in scheduling companion reports on weeds as alternate hosts of insect pests and plant diseases. The purpose of my talk is to outline some of the factors to be considered in control work when plants are designated as weeds because of their role in the spread and development of plant diseases.

Usually a plant is designated as a weed when it competes for space, moisture, and light with crop plants or when its physical presence is troublesome in the use of water and agricultural machinery, or because it is a poison hazard to man or animals. However, the eradication of a weed plant may be necessary solely on the grounds that the plant is host to a destructive disease. Weed workers may have "builded better than they knew" in controlling plant diseases by their eradicative efforts even though disease control has not necessarily been the principal objective of such work. The development and the spread of virus diseases of tomatoes, cucumbers, celery, and sugar beets has been significantly reduced by the eradication of weed hosts. Destructive soil-borne fungi, such as those causing Verticillium wilt are perpetuated by the root systems of dead and dying plants and by many weeds common to agricultural land. Damage to crops from bacterial wilts (Phytomonas spp.) and downy mildews (Phytophthora spp.) is often chargeable to nearby weeds closely related botanically to the crop plant.

May I generalize for a moment and say that the effective management of crop land will minimize many plant disease problems. Skillful use of water, fertilizers, and fungicides, timely and effective clean-up practices, intelligent rotation of crops, and careful selection of species and varieties that are well adapted to soil and climate are the usual safeguards against plant diseases.

The heteroecious rusts, such as white pine blister rust (Cronartium ribicola), black stem rust of cereals (Puccinia graminis tritici), and cotton rust (Puccinia stakmanii), are among the economically important plant diseases that cannot be effectively controlled by the use of fungicides or by culture of the crop plant. These fungi require two different plants, or alternate hosts, to successfully maintain themselves as virulent and epidemic organisms. One of these hosts must be destroyed to control the disease. For example, cotton rust has occasionally done significant damage to irrigated cotton in Arizona; it can be effectively controlled by clean cultivation of the principal alternate host Bouteloua grasses. Blister rust is directly controlled by destroying currants and gooseberries. Local spreads of stem rust are controlled by eliminating susceptible barberries and Mahonia in the northern grain-producing states. Cedar (apple) rust Gymnosporangium juniperi-virginianae), controlled largely by killing red cedar, may also be controlled by some of the newer fungicides. Chestnut blight (Endothia parasitica) and Coryneum canker of Monterey cypress (Coryneum cardinale), are autoecious fungi that develop and spread without another plant as host. With these fungi the plant to be protected becomes the weed that must be destroyed--a most unhappy paradox. These two classes of fungi may be taken to illustrate some of the problems peculiar to weed control in relation to plant diseases.

Direct eradication of host plants or of diseased plants must be supported and preceded by adequate surveys, by eradication and quarantine laws, by an understanding of the ecology and physiology of the host plants and of the life history and characteristics of the pathogen, by methods, materials, and equipment for successful control work, by an objective appraisal of the effectiveness of control, and by allocation of responsibility and funds for the completion of the scheduled job.

Surveys

The importance of timely and adequate surveys in relation to pest-control work cannot be overemphasized. An informative report on this subject was given at the meeting of the Pacific Slope Branch of the American Association of Economic Entomologists, June 25-27, 1946, by W. L. Popham, Assistant Chief of the Bureau of Entomology and Plant Quarantine. He said, "Roughly, one-half of all funds expended for large-scale Federal-State cooperative insect, pest, or plant disease control work is used simply to locate and delimit areas of infection." Mr. Popham emphasized the needs for further development of the science of surveys by commenting on (1) basic research, (2) adequate inspection at ports of entry, (3) rapidity and extent of movement of new or foreign pests under modern methods of transportation, (4) time element in completing surveys and making initial control efforts, (5) study of important foreign pests in their native environment. The importance of these matters in preventing the spread of chestnut blight and Dutch elm disease (*Ceratostomella ulmi*) remains vividly in the minds of those who have worked on these problems.

The science of making surveys is related to and is measured by the effectiveness of any control work undertaken. The need for continuing with the control work or for revising control methods must be upheld and justified by an objective periodic survey of the status of the pest.

Quarantine and Eradication Laws

Plant diseases that are spread long distances by wind-blown spores present some special legal problems. A landowner may be helpless to protect the crop on his own land unless control work is extended to adjacent lands. Thus in the case of heteroecious rusts, such as blister rust, black stem rust, and cedar rust, it is necessary to define by law the weed plant or the host plant to be eradicated. No difficulty is encountered if there is a clear cut economic superiority of one host over the other. For instance, in forested areas, the white pine is definitely of greater value than native currants and gooseberries, and in grain-growing regions the cereals are obviously of more economic importance than barberry plants. On the other hand, eradication laws dealing with the protection of apple orchards from cedar rust have been more controversial. There has been more litigation on this subject than over cases of blister rust and stem rust because of the conflicting interests of owners of red cedar and their neighbor orchardists. E. H. Fulling (Bot. Rev. 9:483-592. 1943), gives a detailed account of the history of legislation and litigation in the United States respecting federal and state eradication and quarantine laws for black stem rust, white pine blister rust, and cedar (apple) rust. Both federal and state quarantine and eradication laws may be needed to permit the control of a new plant disease and to prevent its spread.

The Pathogen

The practical methods for the control of a destructive plant disease must be based on a thorough understanding of the life cycle and the characteristics of the pathogen so that these control methods may take advantage of any special weakness of the organism. With the heteroecious rusts the basis of control is to separate the weed plant from the crop plant widely enough to prevent significant damage; i.e., about 1,000 feet in the case of white pine blister rust and about 2 miles cedar (apple) rust.

The eradication of a host plant sometimes serves a special purpose in control work. Destruction of barberry not only prevents local epidemics of stem rust but eliminates the substrata on which new and virulent races of the fungus can develop. Thus, the work of barberry eradication points to the importance of breeding and planting disease-resistant cereals. With an autoecious pathogen, control must depend on fungicides or on the rapid and complete elimination of diseased material. Here, the importance of adequate surveys and the speed of applying initial control measures are at once apparent.

Those especially interested in the subject of potentially destructive plant diseases not yet established in North America should refer to an excellent summary of this topic by N. Rex Hunt (Bot. Rev. 12:593-627. 1946).

Many fungi, especially those spread by wind-blown spores, do not become epidemic unless environmental conditions are favorable. Thus, data on temperature, humidity, and wind movement may be used successfully to predict the extent of spread and the amount of infection to be expected. For diseases controlled by the application of fungicides it is possible to make one well-timed spray do the work of several routine protective sprays. In 1943 the War Committee of the American Phytopathological Society undertook a spray-warning service for potato blight (Phytophthora infestans) based primarily on rainfall and temperature records. White pine blister rust, black stem rust of cereals, apple scab (Venturia inaequalis), downy mildew of grapes (Plasmopora viticola), and potato blight are diseases for which control methods have been aided by analysis and use of weather data. A comprehensive review of The Relation of Weather to Fungus Diseases of Plants was given by C. E. Foister (Bot. Rev. 12:546-591. 1946).

The Weed Plant

Many diseases are difficult to detect in the early stages by ordinary observation of the plant. In addition to knowing the pathogen the field worker must be thoroughly familiar with the characteristics of the normal healthy plant or he may miss the first symptoms of the disease, particularly those caused by bacteria or a virus. Data on factors relating to growth, fruiting, seed production, seed viability, requirements of light, water, and nutrients, and general competitive ability with associated plants can be integrated into effective control methods of the weed plant and into successful management or cultural practices of the crop plant. Results of ecology studies on Ribes have been used effectively to coordinate blister rust control methods with long range plans for the management of western white pine lands. When timber marking and cutting practices are specified in the timber sale contract or the management plan, pine management, blister rust control, and insect control are given joint attention.

The need for coordinating insect and plant disease control work is well illustrated by an article by T. Johnson (Canad. Jour. Research 24 (2, sec. C):23-25. 1946. He states that seedling leaves of Khapli wheat, a variety highly resistant to physiologic races of Puccinia graminis tritici prevalent in North America, became susceptible a few days after spraying with DDT.

Control Methods

Control methods used for the suppression of the weed plant are essentially the same as those used in general weed control work, though there may be more exacting requirements on the timing of control work or on the residual weed population. Otherwise control methods are developed in the usual manner by laboratory, greenhouse, and field tests and may involve physical eradication by use of hand tools, power machinery, or dynamite; chemical eradication by hand methods or by use of power sprayers, blowers, or dusters; or biologic control by means of flooding, burning, or the use of grazing animals. Cultural practices, and breeding, selection, and planting of resistant varieties should be noted as the indirect methods of control. In the case of chestnut blight, indirect control has been widely practiced in the East by planting the resistant Asiatic chestnut. In California orchards the blight is being controlled directly by eradicating diseased trees and by pruning cankered limbs. However, the planting of chestnuts resistant to blight seems to be the best solution to the control of this fungus. The same situation prevails in the case of Coryneum canker of Monterey Cypress.

Responsibility for Control Work

Federal and State agencies have assumed primary responsibility in furnishing materials and personnel for plant disease control work in those instances where the pathogen cannot be suppressed by the efforts of individual landowners. In blister rust control work the Federal Government has appropriated funds to do all necessary control work on Federal lands; and the Lea Act of 1940 authorizes the expenditure of Federal funds on State and private lands whenever these agencies provide matching funds for cooperative work or whenever control work on these State and private lands must be done to protect nearby Federal lands. Diseases that can be controlled locally by the use of fungicides or by cultural practices are the responsibility of the individual farmer, aided directly by State and county farm advisors and by information furnished by Federal and State research stations. Technicians from private industry provide data on new developments in pest control work and maintain direct and helpful contacts with the grower.

As previously pointed out, adequate surveys are essential to timely and economic control of plant diseases. During the war years special funds were made available to the U. S. Department of Agriculture for plant disease surveys. Federal funds for disease survey work are no longer available, except as they are furnished for specific control jobs, such as barberry eradication and blister rust control. At present many states are without adequate facilities for keeping watch on plant disease problems.

The control of insect and plant disease pests is an important part of the overall job of maintaining high productivity of farm and forest.

In the actual job of eradicating weeds, improvements are continually being made in the use of old-established herbicides, such as arsenicals, borax, carbon bisulphide, chlorates, oils, and salt. New herbicides, such as 2,4-D, dinitro cresol, and ammonium sulfamate, and new techniques for applying dusts, sprays, and aerosols by airplane, turbine blower, speed sprayer, and aerosol generator hold great promise that the future job will be done more quickly, more effectively, and more cheaply than ever before.

MR. MORRIS then introduced Robert B. Balcom, Agronomist, Bureau of Reclamation, Washington, D.C., Cecil Graham of the Bureau of Reclamation Region 88, Sacramento, California, and L. E. Kephart, Senior Agronomist in Charge of Weed Investigations, USDA, Beltsville, Maryland, who presented the Federal weed research program in three parts:

WEED PROBLEMS AND CONTROL PROGRAM OF THE BUREAU OF RECLAMATION - Robert B. Balcom

Mr. Chairman, members and friends of the Western Weed Control Conference: It has been the good fortune of the Bureau of Reclamation to be represented at many of your worth-while meetings and it is a pleasure to be present at this ninth annual conference.

While the program committee has suggested that this discussion be on the "Federal Weed Research Program" it is perhaps more fitting that the bureau briefly present its problems, the main features of its control program and the research it believes is needed. You will note from your conference program that Mr. L. W. Kephart, Senior Agronomist of the Bureau of Plant Industry and representative of the research agency will conclude this topic.

Through your own experience and discussions at your past conferences, many of you are acquainted with the work of the bureau and the weed problems confronting irrigation farmers and irrigation project officials.

The primary purpose of the Bureau of Reclamation is to develop semi-arid lands into family-sized irrigated farms which are not only self-supporting and self-liquidating but will produce sufficient income so that irrigation farmers can maintain the standard of living generally acceptable throughout the United States. This general interest in the economic welfare of the project farmer specifically extends to his ability to repay the construction costs so the Government's investment will be returned, and further, meet the costs of operating and maintaining the reservoirs, thousands of miles of supply canals, laterals and drains as economically as possible.

A menace, such as weeds, affects the economic welfare and repayment ability of project farmers by increasing his production costs, decreasing the quality and quantity of his crops, and wasting the irrigation water which is so vital to western agriculture.

The reduction in gross agricultural incomes due to extra costs and the various losses which can be attributed to weed infestations have been estimated by many different organizations at from 10 to 30 per cent. From special studies made by the bureau in 1946 it has been conservatively estimated that this reduction in income on irrigation projects averages at least 10%. The total crop valuation on Reclamation projects in 1945 was in excess of 435 million dollars.

This 10 per cent estimated loss or 43½ million dollars would pay more than 12 times the total project payments due on construction costs allocated to irrigation for the fiscal year 1946 on all Federally constructed projects. From these figures it is believed that when you combine reclamation and private irrigation, the farmers in the west are losing at least 200 million dollars annually and perhaps much more, because of the weed scourge.

Other studies made by the bureau showed that if sufficient help had been available to accomplish all the desirable weed work on the canal banks and in the channels, it would have cost considerably over a million dollars. Land weeds on canal banks and waterweeds in channels affect the efficient and economical operation of the irrigation system by reducing channel capacity, preventing efficient delivery of water and proper inspection of the system and creating numerous other operation problems and maintenance costs.

Ditchbank weeds consist of many of the same weeds found in cropped areas and also include many others, such as willows and tamarisk, not usually associated with farm weed problems. Submersed waterweeds--for example, pondweed, horned pondweed, water buttercup, and waterweed and the emergent waterweeds--cattails, tules and watercress--present particular problems in efficient water delivery.

Because of these facts the Bureau of Reclamation believes that it should give as much aid as possible in controlling all types of weeds affecting irrigation projects and it has therefore formulated programs for accomplishing this purpose.

A weed control specialist has been employed in each of the seven reclamation regions to plan and supervise the program in his region. He studies specific problems on each project and recommends control measures for solving them. In the one year of an organized regional weed control program, several effective methods of weed control have been introduced which are resulting in considerable savings to the projects. These specialists are present at your meeting to obtain the latest findings from weed research in the states covered by the conference.

No actual weed control is done on private lands by bureau forces. Our weed work among farmers is limited to an educational program which is directed toward showing the need for and advising in effective methods of weed control. This program is not conducted independently but in cooperation with Federal, State, county, and other existing agencies interested in weed control. Conferences are held with the weed leaders to determine how the bureau can best cooperate with them and prevent duplication.

The bureau is deeply indebted to your organization and to the individual weed leaders in agricultural departments and colleges of the states in which Federal reclamation projects are located for the fine cooperation it has received in supplying information on weed control methods. I have been instructed to take this opportunity to thank publicly all those who have aided us in our weed control program and to ask for your continued cooperation in the future.

In addition to continuing the special economic weed control studies in 1947 for determining the costs and losses which can be attributed to weeds, other weed surveys will be made to be used as a basis for formulating more effective weed control programs.

A manual on "Control of Weeds in Irrigation Systems" has been prepared and a mimeographed edition has been distributed to irrigation districts, state colleges and others interested in this phase of weed control. A more permanent and complete form of the publication will be printed as soon as revisions are made which will include suggestions received from the field on making it a more valuable handbook for irrigation projects. A few copies of the preliminary edition are still available and may be obtained upon request to the Commissioner, Bureau of Reclamation, Interior Building, Washington 25, D. C. There is still time to suggest changes for the revised edition and any such suggestions will be appreciated.

The bureau has continued its tests and demonstrations in the use of Benoclor for the control of waterweeds and 2,4-D formulations for the control of annual and perennial weeds on ditchbanks.

The bureau feels that its obligation to the public extends farther than merely controlling existing infestations with the most efficient methods now known. The realization of the costs and losses which weeds can create on farm land and irrigation systems definitely indicate that no comprehensive weed control program is complete which does not include every possible means of preventing as much future weed infestation as possible particularly on new projects such as the Missouri Valley and Columbia Basin, and a program for determining more permanent and economic control methods.

The bureau is studying irrigation system designs and where feasible will construct canals, laterals and drains in a manner which will help prevent weed infestations and facilitate future weed control activities. Plans have been made, and in some areas put in effect, for seeding new canal banks with weed competing grasses. In the educational program designed to assist new settlers, interest is created in the planting of clean crop seed and in becoming acquainted with the various means of weed prevention and control on farms.

As it was desired that a research program be designed to benefit all irrigation projects in the 17 western states, it was only natural that the bureau turned to the Bureau of Plant Industry Soils and Agricultural Engineering which has charge of weed investigations for the Department of Agriculture. The Congress appropriated funds to the Department of Agriculture and a Memorandum of Understanding was signed by the Bureau of Reclamation and the Bureau of Plant Industry for the purpose of conducting a co operative program of research on weed problems under irrigation conditions

It should be emphasized that while the Bureau of Reclamation is a cooperating agency and many of its available facilities are being used in conducting the research, the work is not being done for the bureau alone, but for all irrigation in the West--both Federal and private. Both of the cooperating bureaus will cooperate with state colleges and experiment stations and anyone interested is invited to participate directly in the program or present weed problems needing further study and suggest methods to be tested.

In connection with the research program the Bureau of Reclamation Chemical Laboratory in Denver is conducting investigations on chemical weed control with the assistance of a plant physiologist stationed there in October by the Bureau of Plant Industry.

Research workers in federal and state agencies and commercial firms have made much progress in determining more efficient methods of weed control during the past few years. While the results of their work have been very encouraging it is certain that they would be the first to deride any suggestion that all of the best and most economical control methods have been discovered.

There is still a need for a more comprehensive study of the farm land weed problems under irrigation, and for research to determine more economical solutions. More importance should be given to cultural methods of weed control and the use of the proper combinations of cropping, clean cultivation or "shoot cutting" and selective herbicides. Studies should be made to learn if the application of irrigation water at the proper time can be used as a factor in effecting more economical control. The new selective sprays now being tested are showing promise on broad-leaved species but there is a special need for more research in controlling Johnson grass and other grass weeds on both farm land and irrigation systems.

While much of the ground work has been laid by federal, state, and commercial agencies in landweed control for farms, a particular need has been felt for more basic scientific research in weed problems peculiar to irrigation systems.

Much more work is necessary in life history studies of waterweeds and other research directed toward finding more effective control methods of these pests. Chemical control is in its infancy and there is every reason to believe that more effective chemicals will be found through comprehensive research programs. More efficient equipment should be developed for applying chemicals particularly in special locations such as ditchbanks and irrigation channels.

This brief summary points out the principal weed problems confronting reclamation projects, some of the methods now being used, and plans for increasing the effectiveness of weed control under irrigation conditions. The research program in cooperation with the Bureau of Plant Industry and state experiment stations and independent research programs now being conducted or planned by state colleges, chemical companies and others have given much hope of eventually developing more practical, permanent and economical solutions to weed problems in the West.

As mentioned before, Mr. Kephart will tell you about the proposed program of research for this year, where, when, and by whom it will be conducted and other details of interest to you. To give you a specific example of one of the regional programs, I'm going to ask Mr. Graham to describe his program in Region II, Sacramento, California

In closing, the Bureau of Reclamation wishes to assure you of its desire to cooperate with all state and county weed programs and wishes you every success in this Ninth Annual Western Weed Control Conference.

WEED CONTROL PROGRAM - Cecil Graham, U. S. Bureau of Reclamation, Region II

The bureau's regional weed control program in Region II was begun in 1946 with long-range functions aimed toward the conservation of water, more economical operation and maintenance of bureau canals, and protecting the general welfare of present and future project water users. Weed prevention will be the theme of the program, for, as you know, in the case of weeds, an ounce of prevention is worth a thousand pounds of cure. The program is one which emphasizes the fullest cooperation between all interested agencies on the levels of investigation, planning, and actual physical control.

Region II extends from the Mojave Desert in Southern California to Klamath County in Oregon; and it includes the Central Valley, the Orland and the Klamath Projects. By 1960, approximately 3,000,000 acres of land in the Central Valley Project will receive irrigation water through approximately 650 miles of bureau main canals. Approximately 1,000,000 acres of this land will receive water for the first time.

An analysis of the present and possible future weed problems, largely based on 20 years of far-sighted work by the University, the State Department of Agriculture, and County Agricultural Commissioners, showed the immediate need for the following four point program:

First, reconnaissance weed surveys.

Second, studies of comparative costs and results of different methods of control and other studies of this nature.

Third, development of an educational program.

Fourth, organization of weed control activities on operating bureau distribution systems.

As a first step, reconnaissance weed surveys have been started on canal rights of way, on lands withdrawn for reclamation purposes, and on public lands in the watersheds of bureau reservoirs. The two reservoirs with which we are mainly concerned at present are those created by Shasta and Friant Dams.

Weed mapping, aimed toward an over-all weed prevention program, was begun in 1946 on areas that will be served with Central Valley Project water in the future.

In the past year, reconnaissance weed surveys were begun and partially completed in all districts of Region II. The Madera Canal, approximately 36 miles long, was surveyed for weed growth in 1946. Plans are being made to survey the rights of way of both the Friant-Kern Canal, 160 miles long, and the Delta-Mendota Canal, 120 miles long, during 1947. Recreational areas on public lands around Shasta Reservoir will be surveyed to determine the extent of work and equipment that will be necessary to control poison oak in cooperation with the National Park Service.

A general Klamath weed survey will be conducted around Shasta Reservoir to determine the bureau's obligation in the Klamath weed control program in Shasta County, California.

A detailed survey of the weed situation on the Klamath and Orland Projects will be conducted in 1947.

From the results of these and other surveys that will be conducted in the future, we can study and analyze the weed problems that confront us in Region II; and we will be able to formulate a more comprehensive weed control program.

The second function of the weed program was the beginning of some special studies aimed toward the discovery of more economical and effective methods of controlling ditchbank and water weeds, particularly water weeds.

These studies will include, among others, the following:

a. A Comparison of Results and Costs of Various Methods of Weed Control.

This information will be of value in helping to recommend the most economic methods of weed control to our project water users and will eventually help reduce operation and maintenance costs created by weed problems.

b. Losses Due to Weeds.

It will be advantageous for several reasons to have accurate records on the losses caused by weeds. Weed losses in crops will be broken down for each farming operation from seed bed preparation through harvesting. Weed losses on and in ditches will include costs of water lost in transit due to increased seepage, evaporation, and transpiration, and costs in rectifying damages caused directly or indirectly by weeds; such as cleaning channels of deposited silt, ditch breaks, etc.

c. Study of Weed Infestations Developing on New Land After Being Irrigated.

It is known that most virgin land is comparatively free from noxious weeds, excepting perhaps a few of the most drouth-resistant species. Soon after this land is irrigated and cultivated, many kinds of noxious weeds appear. There is no doubt that weed seeds maturing on ditchbanks contribute to this spread.

A number of irrigation districts who will use Central Valley Project water have requested the construction of closed distribution systems. One of their chief reasons has been to prevent the growth and spread of weeds. Although the initial cost of installing a closed distribution system is comparatively high, it is felt that the cheaper operation and maintenance expenses over a period of years will more than compensate for the initial cost.

In order to prevent weed infestations on new projects in the future, it is desirable to obtain more comprehensive data on how these infestations originate. It is especially important to learn how irrigation water influences the spread of land weeds. This information will be obtained in respect to noxious weed seeds carried by distribution systems from rivers, streams, and reservoirs above projects to crop lands as well as those seeds which have matured along canals and laterals and carried by water to farm fields.

d. Effect of Water Velocities on Water Weed Growth.

It has been observed that waterweed infestations are more prevalent and more serious in channels having flat grades and low velocities. It has also been observed that where waterweeds have invaded higher velocity channels, the infestations have usually originated behind structures, in wider reaches of the channel, or in any other section where the velocity has been reduced.

The weeds, once established, are able to continue to spread, though usually more slowly in fast than in slow velocities.

Consideration will be given to improved types of construction such as narrowing and deepening channels or increasing the grade or both, which may help prevent waterweed growths on new projects.

Studies will be made to determine the effects of types of construction to facilitate weed control, such as designing the slope of channels to increase the velocity of water where feasible, and designing the size of channels to allow for some inefficiency due to weed growth between cleanings.

The third function of the weed program has been the development of the educational activities that will ultimately aid project farmers in landweed control on farms. The bureau cannot control farm landweeds; that is for the farmer to do. But the bureau has a definite obligation to protect the general welfare of its project water users, and thereby safeguarding the government's investment. getting water to farmers is one of the most important functions of the that we assist the farmer in using his water properly after he gets it by giving him advice in better methods of controlling weeds, better irrigation practices, etc. The bureau, through its contacts with irrigation districts, and agricultural agencies, can help disseminate to farmers the findings of research on the most effective and economical weed control methods.

There are several educational media that will implement the dissemination of weed control information, and we are building our educational program to include most of the more popular educational methods.

An educational program will precede the first irrigations on new projects and will continue to be conducted during the operation of the project, stressing the importance of early control measures.

Every effort has been made and will be made in the future to avoid unnecessary duplication of work done by other agencies interested in weed control and to cooperate with these agencies to the fullest extent. Where weed control is already being done, we go in seeking information, and offer such helpful material as we may have. At present we have available a weed control film, an extensive weed control manual with helpful pictures and diagrams, and are now working on slide lectures and weed-control informational kits.

The fourth function of the program has been to organize effective weed control activities on operating bureau distribution systems with the purpose of facilitating the operation and maintenance of canals and of conserving water. In the past, many weed control programs have lacked definite aims and have often consisted of following the same methods year after year. During the war, a shortage of labor and materials seriously handicapped weed control activities.

During 1946, we put into operation several new chemical and mechanical controls to replace older, less effective, and more costly methods of controlling ditchbank and waterweeds, on our distribution systems. We will make preliminary observations of these newer controls this coming year in order to determine their effectiveness and the need for additional control measures. As more economical and permanent methods of control are carried out, savings in operation and maintenance costs should definitely be shown.

We are formulating plans for trial plantings of grasses and other vegetation for weed and erosion control on canal banks. Since weeds can be replaced by some types of vegetation, we are hopeful of some success with this method of control.

An effort will be made to devise an inexpensive method of irrigating canal banks for the growth of weed-competing vegetation in the more arid sections of the region.

Ditchbank pasturing is practiced on portions of operating projects in Region II, and it is an effective method of controlling practically all weeds. We feel, that properly managed, ditchbank pasturing can be extended to other areas with equally as good results. Studies are being made to determine the financial benefits of pasturing to both the bureau and farmer.

We think that the formation of weed abatement districts by project water users will be one of the most effective measures that can be taken to control weeds. Farmers, on a cooperative basis, can undertake the spraying and clearing of weeds, which as individuals, they would find much more expensive.

The Klamath Project has two such weed abatement districts. Operation and Maintenance Funds buy chemicals for these districts, and other cooperation is given to the weed control supervisor of each district.

Region II of the bureau is putting a great deal of emphasis on the weed prevention portion of the program. We do not want to be responsible for increasing weed losses by disseminating weed seeds and by bringing weed infestations onto lands under their first irrigation.

While we hope to be able to assist those administering existing weed programs, we also realize the need for their cooperation and advice and our entire program is planned on this basis.

MR. KEPHART stated that E. S. Rosenfels will be stationed in Denver with a laboratory to work on the technical and chemical phase of weed control in close cooperation with W. T. Moran of the Bureau of Reclamation who also is stationed in Denver. The work will be separated into three phases.

1. Project on aquatic weeds, which constitute a tremendous problem. Much work is now underway. Lewis Evans at Phoenix and J. M. Hodgson at Boise will work out on a field scale the experiments in the laboratory. There will be a "Mars canal system" set up, a carefully controlled water system similar to irrigation canals, to grow aquatic plants and try out ideas from the Denver laboratory in replication.

2. Project on ditchbank weeds.

3. Project on farm weeds under irrigation conditions and non-irrigation conditions, some special emphasis on bind weed.

This is to be a highly integrated program with little duplication.

MR. KEPHART then indicated his delight with Dr. Strand's talk, saying that most top-ranking officials have no experience, no comprehension of weed control. The science has grown so fast the people have been unable to keep up with it. Until about 12 years ago there were only 3 full time weed men in the United States. There were close to 1,000 entomologists with a budget of 4 or 5 million dollars; 600 or 700 pathologists with a budget of 2 or 3 million. Today there are perhaps 50 full time research men in weed control with a budget of perhaps a quarter million dollars which would seem to be out of proportion. The Hope-Flannagan bill was cited as an illustration. When workers in agricultural colleges indicated which research they thought should be supported, weed control lead. As it progressively went up to higher levels it was shunted down the list, and by the time the bill had reached the top planners, weeds had disappeared. Mr. Kephart ended by saying that "Weed control is out of the horse-and-buggy stage, it is now big-league stuff".

MR. BALCOM then introduced W. T. Moran of the Bureau of Reclamation at Denver.

MR. MORAN: Our work has been essentially devoted at this stage of the game to soil sterilization, in view of the fact that we have a good sized program of asphaltic construction. In the organization on weed control we have two chemists working along with Dr. Rosenfels. Their work since about November of this year has been pretty intensively along the lines of aquatic plants. Two weeks ago at San Francisco we were in conference with the chemists of the Asphalt Institute. We are using soil sterilants on the Pasco laterals. This is the extent of the work we have done so far.

MR. MORRIS: Mr. Kephart made a good point in saying that we were not paying enough attention to weeds. I think it is a known fact that weeds are perhaps the number one problem in agricultural production, but we get a very small proportion of the appropriations for the control of weeds. Mr. Kephart's remarks about the place of weed control in the Hope-Flannagan bill are absolutely correct. I will not say more about the Hope-Flannagan bill now; we will have a brief discussion on that later, but it is a very important bill and the appropriations will amount to a great deal in the development of agricultural research.

Now, I should like to introduce Cecil Tapp, Supervising Seed Analyst, Plant Products Division, Canada Department of Agriculture, Vancouver, British Columbia.

CECIL TAPP: I feel that I am just a little bit out of place today. I was invited very kindly to come down here to speak to the seed people regarding our system of seed movement in Canada and then I could enjoy myself. Until now I can say I have enjoyed myself thoroughly. I am not a speaker but should like just to say that our set up in Canada is rather different. So far as our own Division, is concerned, we have nothing to do with weeds except as they are found in seed. The weed control work in Canada is carried on through the provinces rather than the Department of Agriculutre. The Experiment Station carries on experimental work. All of these people cooperate very closely. I think it would be very nice if we could have some weed representatives from Canada here in the weed conference.

So much has been said about weeds and how injurious they are. At a meeting of the Association of British Columbia we discussed weeds, and one of our own men mentioned how much weeds cost in the production of a seed crop, how many times a lot of seed had to be cleaned, the cost of machinery for cleaning, the cost per hour of cleaning, etc. We thought he had done a good job, but the next subject on the program was Soils. One of our University professors got up and said "Thank God for weeds. I wonder if you have thought of the fundamental part they play in the control of soil erosion."

I, too, thought that Dr. Strand made an excellent remark this morning. I feel that we need to drive home the fact that our science stands just as high as that of doctors, mining engineers, etc.

Dr. W. W. Robbins, Botany Division, University of California at Davis, was scheduled to present a paper entitled "Weed Control in the Farm Program". Dr. Robbins was unable to attend the conference and his paper was read by Walter S. Ball.

WEED CONTROL ON A 1700-ACRE FARM - W.W. Robbins

It is the purpose of this discussion to outline the program now in effect to control in a practical manner the weeds on a 1700-acre farm--the University Farm of the California College of Agriculture at Davis. For many years this farming area, parcelled out to various Divisions on the Farm, has been under no organized plan of weed control. Rather, each Division was responsible for its own alloted acreage Lack of knowledge, lack of interest, and division of responsibility were all factors which contributed to unsatisfactory results. In addition, a farm such as this has a great variety of crops, some experimental, some commercial; many small parcels or plots of land; miles of fences, ditches, roadsides, and acres of other crop-free areas about farm buildings. Thus there is almost every type of situation where weeds grow, and an opportunity is offered to practice many of the known weed control methods.

The program now in effect, and receiving the cooperation of all divisions concerned, places responsibility in the Botany Division, with a special weed-control budget of $7000 annually. We are well into the first season under the plan. There is available the following equipment: a Bean power sprayer, an Essick air-pressure sprayer, a custom-made power sprayer, each equipped with booms, hose connections, and ample lengths of hose; weed burners of several types, applicators for dry chemicals, Mack weed-guns, knapsack sprayers and dusters; and such cultivating equipment as may be required. There are large tanks for the storage of oils, and a building for the storage of chemicals and equipment.

We operate at present with a full time working foreman and such seasonal labor as may be required. In so far as possible we employ student labor, selecting such labor from the two classes in weed control. Thus we attempt to give these students as much practical experience as possible, enabling them to become familiar with equipment and methods of applying herbicides and to evaluate various methods of weed control for special situations.

Thus far, the following work has been done on this farm:

(1) Certain areas have been sterilized, using borax chlorate, arsenic, and some mixtures of these chemicals. These were applied dry with a Gandy spreader, during late December and early January.

(2) Grain crops have been sprayed with se-

lective herbicides, using Sinox Selective, Dow Selective, and 2,4-D.

(3) Nearly all the old stands of alfalfa have been sprayed within the last few weeks with diesel oil plus a dinitro (either Dow General or Sinox General). For the most part we have used 30-40 gallons of diesel oil and one quart of the above dinitros per acre. Most of the alfalfa acreage has been sprayed with a ground rig, but a small acreage was sprayed by airplane. It should be mentioned in this connection that first cuttings of alfalfa on the University Farm are infested with foxtail (Hordeum murinum) and certain other annuals which germinate in the fall and early winter and are quite worthless as feed. Sprayers were equipped with .039 Monarch nozzles, the pressure was approximately 80 pounds, the ground speed about 4 miles per hour.

(4) Roadsides and other crop-free areas have been and are now being sprayed with fortified diesel oil. All fence lines and areas that can not be reached with the disk are treated.

(5) Vineyards have been sprayed with oil, substituting this method for cultivation.

(6) Milo was sprayed last season with 2,4-D to control wild morning-glory. Applications were at the rate of 1 to 1.4 pounds of 2,4-D acid per acre, and at a time when the morning-glory was 8 to 14 inches tall. At this time, the weed was actively growing and offering some competition to the milo. The control was such that all competition to the milo was eliminated for the remainder of the season.

The program contemplates, in addition to the continuation of the above practices, the following:

(1) Improvement of lawns, combining the use of 2,4-D, reseeding and fertilization.

(2) The grazing of sheep to the larger, fenced ditches.

(3) Pre-emergence spraying of row crops.

(4) A non-cultivation program in orchards.

It is usually agreed that a University Farm should be a model (or at least a fairly satisfactory example) from the standpoint of productiveness, cleanliness, and freedom from agricultural pests, including weeds. It should be a demonstration of what is practical, new, and forward looking. Cost records are being kept on every type of weed control. These are broken down into costs of materials, labor, equipment, and overhead. We hope to have, after a few years, an actual demonstration of practical weed control on a large acreage, that will serve as a guide and a stimulus to operators of large farming areas.

Merits of Chemical & Cultural Weed Control

A round table discussion on the respective merits of chemical and cultural control involved D. D. Hill, Department of Farm Crops, Oregon State College; L. E. Harris, Chipman Chemical Company, Portland; C.I. Seely, Associate Agronomist, Weed Investigations, University of Idaho, Moscow, Idaho and Dick Raynor, Dow Chemical Company, Pittsburgh, California.

MR. HILL: This panel discussion will represent another attempt on the part of the program committee to provide the variety that your Chairman mentioned a while ago. This program developed because some of our people don't know enough to keep our mouths shut. Once upon a time I made a comment, as I often do, and Virgil Freed took me up on it and that set up the general discussion. Let me assure you that this is entirely unrehearsed. The four of us met for lunch today in an attempt to provide discussion which might be of some merit. We thought perhaps we might allocate certain phases of the discussion and got into such a debate immediately that we decided there was no point in going ahead with it. so here we are. In connection with the way this weed work has developed, it calls to mind some other situation. Whenever we have a major problem in agriculture, or any other field, but I think particularly in agriculture, and a major contribution is made, there is a tendency on the part of many to think that we have developed a panacea. Actually there are few panaceas. I recall quite a few years ago, back in the Great Plains when the dust mulch theory of dry farming was developed in the laboratory. It was a very plausible theory and was widely accepted. Eventually a couple of enterprising young agronomists arrived at the point where they had the courage to question the theory and eventually developed an understanding of the dust mulch theory.

We are about the same in the chemical development of weed control. I think your program committee thought we would get into an argument. I don't think we will - we are pretty much agreed on our subject. I have made this statement before and have almost made it a slogan for any development in weed control. THERE IS NO SUBSTITUTE FOR GOOD FARMING! My friends at the lunch table came back with "What is a good farmer?" I shall attempt to define that term.

In my book, a good farmer is one who can operate an acreage profitably and leave his land better than he found it. Fundamentally that is sound. In the last 20 years I have had the opportunity to be on a good many farms in Oregon inspecting seed crops. A good farmer shows up in many ways. One is his lack of weeds. He plants clean seed. He adjusts his tillage operations. He destroys weeds before the crop is planted. Of course, some conditions are beyond the control of the operator. Sometimes a week's difference in time of planting means the difference between failure and a successful crop. The function of successfully adjusting the tillage of the seed bed preparation so that one can kill those weeds before the crop is even planted.

MR. HARRIS: I think there will be no arguments for no matter how good a farmer, chemicals still have a place in weed control on the farm. I should like to point out that I have seen good farmers who employ chemicals early when the creeping patch starts on the edge of his field. He doesn't wait until it gets so widespread over his entire field that he has to employ clean cultivation as well as a combination of farming practices.

I should like to mention some of the chemicals. It has been so long since we have heard anything but 2,4-D that I wonder if you realize there are some other chemicals still being used. Harry Jucksch will collaborate in the statement that carbon bisulphide is still being used; sodium chlorate is still being used--maybe not very diligently--but there is a place for chlorates; there is a place for Ammate and there is a place for dinitro oil compounds for quick knockdowns and there is a place for 2,4-D. But certainly I have not yet seen where 2,4-D is going to replace all methods, both chemical and farming.

Yesterday when the research committee met, one research worker said there is already beginning to be a kick-back. There has been a lot of good missionary work done on 2,4-D and a lot of confidence built up, but there have been a lot of faulty recommendations. I think I can say we have all been at fault. I know it was reported to me that one individual reported that the Western Weed Control Conference said 2,4-D was wonderful and would solve all problems. As far as 2,4-D is concerned I am likely to say that its selectivity is its biggest asset as well as a disadvantage.

MR. SEELY: I think there is one big thing Don forgot. I am in complete agreement that probably if you had a good farmer, as he defines it, on this place as a homestead and his son was as good a farmer as he, the place could be left in good condition. However, we have many good farmers who take over farms which are in a bad way. That is a different picture and usually calls for drastic action. I personally consider it in this light: any control method which one is going to use must be determined largely by two things. How quickly must the weeds be eradicated? and How much does it cost? So far as most of our methods are concerned the ones which are the cheapest take longest. In any particular situation both things must be considered.

There is a very definite place in a control program for tillage--specialized tillage if you will. Short cuts have a very definite place in getting the stand under control so that ordinary good farming then will take care of the situation from there on out. One more thing Don mentioned as a possibility--we do not always get good annual weed control by good farming for some reason or other. The weather may be wet, and you have to do certain things so you may end up with a very bad weed situation on your hands over which you have no control. An emergency measure is called for, probably a good selective spray.

MR. RAYNOR: I should like to present some points where chemicals have been used successfully to supplement good farming. In one instance in California, near Montpelier, wild radish was a problem in grain. The old method was to wait until after the rains had germinated the radish and then seed the grain. The heavy rains which usually came a couple of months later then caused severe erosion. It is now possible to plant dry; have the grain and weeds come up together, and by the use of a selective spray get control of both weeds and erosion.

Another instance of supplementing good farming practices is spraying alfalfa for control of foxtail. Under some conditions annual weeds become a problem in alfalfa. They reduce the value of the first cutting--quality as well as yield. One method of cultivation would be with the use of a spring-tooth harrow to drag the weeds out. However, in some cases where diseased alfalfa (wilt) was present, the use of the spring-tooth harrow would scatter the disease. An alternative that would kill the weeds without injury to the alfalfa, and without scattering the disease, would be to spray with a contact spray. That is becoming a common practice in some sections of California now.

A third instance is that of certain weed problems in the rice area in the Sacramento Valley. Arrowhead lily was the most troublesome it had been in 15 years. None of the rice culture methods would control the weeds. The only satisfactory answer so far is the answer that was arrived at this past season when spraying with 2,4-D. It controlled the arrowhead lily as well as the other weeds. In specialized crops, such as rice, chemicals can supplement.

MR. HILL: Let me cite you illustrations of the thinking I have in mind by "good farming". I question whether we are making enough use of good competitive crops. There are many places where crested wheatgrass can be used very effectively in the control of morning glory. I have seen that done successfully and profitably. There are other cases where grasses such as Alta fescue have crowded out weeds. I never go out on Harry Schoth's original planting of alta fescue without marveling. The seeding is 30 years old and actually has practically no weeds in it. Although fescue is doing a good job of keeping out everything, also there is a lot of fescue which maintains itself. When we have something like that, let's use it in our farming program.

Mention was made of the gorse program. I know that we have yet failed to kill mature gorse with chemicals. We have tried them all. We have, however, been able to burn the stuff and put a flock of goats in; they do a magnificent job. We have killed gorse with a light application of chemical after two years of pasturing. I don't think we have begun to explore the possibilities of livestock such as sheep and goats. Good grass management in weed control is applicable on such a wider scale than chemical treatment that it staggers the imagination.

MR. HARRIS: I should like to make one point and that is the increased interest right along the line Dick pointed out, the increased interest the orchard people are taking in weed control. I am thinking primarily of chemicals around the out of way portions to decrease the host plants in places where cultivation is not always possible. This would be supplemental to good cultural practices in orchards. The Northwest is a good grass producing area. 2,4-D has come to the rescue of growers by killing weed species that would lower the quality. Then there is water hemlock. 2,4-D has given 100% kill, one of the few that we can say that about.

The conference was adjourned until 9:00 Friday morning.

The meeting of the second day of the Western Weed Control Conference was called to order at 9:35 a.m. on Friday, February 6 by President H. E. Morris.

Mr. Morris introduced Virgil Freed, Assistant Agronomist and Chemist in Charge of Weed Investigations, Oregon State College, who gave the following talk:

Soil Fumigants

Soil fumigants have long been the last resort of weed control men in combatting some of the more pernicious deep-rooted perennial weeds. While cost and labor requirements of these materials prohibit their use on large acreages, they are, nonetheless very important supplements to the family of herbicides. It is with these materials that with proper application some assurance may be felt that the job is effective. While a number of soil fumigants have long been known and used by entomologists, the most important one so far as weed control is concerned has been carbon bisulphide. The entomologists have been using such materials as chloropicrin, hexochloroethane, and tetrachlorethylene for a number of years, but certain features of these materials has rendered them generally unsuitable for weed control work. To list some of the objectionable features of the older soil fumigants we might enumerate for carbon bisulphide too great a volatility and the ever present danger of fire. Chloropicrin again has too great a volatility, coupled with an obnoxious property of inducing the user thereof to a copious flow of tears and a definite queasiness in that region of the alimentary tract known as the stomach. It is our purpose today to discuss one of the more recent additions to the family of soil fumigants, which material appears to have certain superior qualities over some of the above named products.

Many of you have already heard of the mixture of chlorinated hydrocarbons, or more specifically, a mixture of chlorinated propane and propene which has been causing something of a stir in the field of entomology for the control of wire worms, nematodes and symphilid. This material has been known to entomologists as D-D but because the symbol D-D is not representative of all the materials that have been under investigation, we prefer to refer to the material as prochlor, which is an abbreviation of chlorinated propane and propene.

Before discussing this soil fumigant with any degree of specification, perhaps we should direct our thoughts for a moment toward the requirements of a soil fumigant. In using a soil fumigant it is the aim of the user to kill something-either insects or weeds. That premise therefore establishes the first requirements of a soil fumigant. It must have sufficient toxicity in reasonable dosage to kill the organism for which it is used. Secondly, because it is a soil fumigant, it must function as a gas and hence must have a reasonable amount of volatility. Now because the user does not care to become a victim of the material he is handling, it should have some ease and safety of handling. If one applies it on a large scale the cost must be reasonable. If the material under investigation meets these requirements, then we have a product which will prove more or less satisfactory for our purpose.

The prochlor which we are discussing today was first studied intensively by the research department of the Shell Oil Company. The discovery of the fumigating property of this material is credited to one Mr. Carter, working in Hawaii where it was established that this material had a very definite value in the control of certain insect pests on pineapple plantings. In 1944 the Oregon Experiment Station received a small sample of prochlor for test work. In plots established in comparison with carbon bisulphide on morning-glory, the herbicidal value of this material was readily recognized. Further plots were then established on the two major perennial weed pests in Western Oregon, morning glory and Canada thistle, with equally encouraging results. This led to a more intensive study of the material as a herbicidal agent.

Before going into a discussion of the results on a number of different plants, perhaps we should take a look at the physical and chemical make-up of the prochlor liquid. Originally this material was to have been a mixture of 1-2 dichloro propane and 2-3 dichloro propene. However, in the manufacture of this material certain reactions are difficult to stop, and consequently more chlorine attaches itself to the material than was originally intended. Consequently we get a mixture of different chlorinated products of propane boiling anywhere from 90 to 155 degrees Centigrade. For purposes of discussion, let us call the more highly chlorinated products the "heavy ends". As one might suspect, the volatility or the rate at which they evaporate, of these heavy ends, goes down as the boiling point goes up. Now, since we pointed out that a soil fumigant has to have volatility in order to function efficiently it might be suspected that these materials boiling at a higher temperature are less effective as herbicidal agents. That is not exactly true, however, if the temperature is high at the time of application. The materials with which we have worked to date consist of a fraction starting to boil at 90^0 and with 80% of it coming off at 115^0. The other fractions boiled from 100^0 with 75% coming off at 144^0, one boiled at 113^0 and 80% coming off at 151^0, and one boiling at 130^0 with 70% coming off at 146^0. The weight of these, or specific gravity, ranged from 1.28 to 1.3325. In most cases the degree or amount of chlorinated propene present was from 40 to 60%. Because of this range of physical properties it was found that there was some difference in toxicity. The higher boiling fractions being the most toxic where there was sufficient temperature to stimulate their action, but requiring closer attention to injection, which point we will take up later. While we are considering the more technical points of soil fumigation, it might be well to point out that the soil absorbs the soil fumigant when it is in the gaseous state. In general, it might be stated that clay soils tend to absorb more of the material than do sandy soils, and thus render more of the material unavailable for the plant. Also, it might be pointed out that the heavier the material or the more slowly it evaporates the more any given soil is apt to adsorb it. In practical field application that means then that for heavier materials or for clay type soils a slightly larger dosage may be required. Generally speaking, however, the dosage of any of these materials in comparison to the amount of adsorption is so large that we need not worry ourselves unduly about it. Now one other point before going on with the discussion of results, and one that is extremely important - the spacing of these materials.

Now as all of you know, in the use of carbon bisulphide, the standard spacing is 18 inches, but in using the prochlors in this manner we soon discovered that this was too far apart.

Plots treated at 18 inch intervals showed an excellent kill down the row of injections to a width of about 10 inches. But since the gas from the two rows of injections did not come together, it left a row of plants growing in between. By reducing the interval between the row of injections very good results were obtained. The reason for this, we found later, was that the gas formed by the liquid was so heavy that it settled down quite rapidly before it had a chance to come in contact with the gas diffusing from the other row of injections. A simple rule of thumb which can be followed in the field for determining how close any material should be spaced is this: take a small quantity of liquid, say a couple of tablespoonfuls and put in a saucer or cup. At the same time take an equal quantity of carbon bisulphide and treat in the same manner. If the material evaporates half as rapidly as carbon bisulphide then the injections of the heavy material should be placed at intervals not to exceed 12 inches apart. The standard practice of alternating the injections as is done with carbon bisulphide is the best procedure in applying the prochlors.

Now as to the depth of spacing, this is another equally important point as the spacing of the injection and will vary with the plant to be controlled. We found with quackgrass that if the material were injected too deep, 4 to 6 inches, it would kill out the lower roots and rhizomes of the quackgrass but leave the crown still growing, even though injected at intervals of 9 to 12 inches. This, of course, is very undesirable. By making the injections 2 inches deep, however, we would quite successfully eliminate any of the quackgrass on the plot. The reason for this again is because the gas is quite heavy and settles rapidly. As you have surmised by this time, this soil fumigant has proved to be effective against quackgrass, morning glory, Canada thistle, white top and Russian knapweed.

To summarize the work briefly on quackgrass, I will say that we used dosages ranging from 300 to 600 pounds an acre at 15 inch intervals two inches deep and secured anywhere from 80 to 100% control of the quackgrass. Wherever the control of quackgrass dropped below 95% it could usually be attributed to the soil being too dry or to the injections too far apart or too deep. Most of the work done on quackgrass was done on a sandy loam type of soil. When properly applied 100% control was secured on Canada thistle, morning glory, white top and Russian knapweed. For these four plants the injections should be anywhere from four to six inches deep, preferably four inches and at foot intervals. The reason why we are quite favorably impressed by this material is the fact that it can be used under a wider variety of conditions than any soil fumigant heretofore tested. Now where carbon bisulphide and chloropicrin require a rather high soil moisture to get a seal, the prochlor can be used in a reasonably dry soil. If the hole is tightly packed or has not been cultivated during that season, the heavier fractions of the prochlor can be used under rather dry conditions, and the higher the temperatures the more rapid the action and the more effective. In general, we have followed the rule that whenever there was sufficient moisture for plant growth, there was sufficient moisture for application of the prochlors.

MR. MORRIS: What about residual effects?

MR. FREED: Residual effects seldom last more than one or two months. We have had some of the "heavy ends" leave an effect up to three months--varies from six weeks to three months. However, by aeration through cultivation it is altogether feasible to make the seeding before that time. Quite possibly the seeds are less susceptible to injury than are the plants.

VOICE: What about depths of injection?

MR. FREED: Two to three inches for quackgrass, four to six inches for the others. It will vary somewhat if your plant colony has been disturbed.

VOICE: With shallow applications, do you still maintain 18 inch intervals?

MR. FREED: No, we maintain 12 inch intervals throughout. It is considerably more work, gentlemen, but the results are worth it. The material is so expensive, $75 an acre, that an incomplete coverage cannot be chanced.

MR. TINGEY: What is the effect of wind passing over the treated area?

MR. FREED: I will attempt to follow along the physical laws. If you had a pressure gradient across the area into which the material had been injected and above the soil as the wind swept the vapors away, a deficiency would be created and consequently more of the vapors would pass upward through the soil to maintain this gradient level and there would be more loss. Under average conditions the loss probably would be negligible if proper application had been made.

MR. HOBSON: How much liquid material is used?

MR. FREED: One and one-half to five cc's per injection, or about a teaspoonful per hole.

VOICE: Any way for field application?

MR. HOBSON: Have there been any experiments tried to inject carbon bisulphide by a continuous flow from the chisel type cultivator by pressure if the question of fire hazard can be eliminated.

MR. FREED: I believe Harry Jucksch has some answers to that question.

MR. JUCKSCH: It has proved better than the intermittent application method, but intermittent application was established by reason of the fact that there was no other way to put the material into the soil by hand. You can't do much else than drop it into the furrow by continuous application. It was established that the only way to apply it was by holes and they finally settled upon an 18 inch measurement between injections. We now have machines under construction to put this into the soil with a 2 ounce dosage spread over 18" which has heretofore been put in intermittently. The effect is the same, if not better. The land under certain conditions may allow the diffusion under these intermittent applications to cover the entire area, but with the continuous flow applicator we hope to accomplish the same thing with better results.

MR. MORRIS: I was quite sure that soil fumigation would be an interesting subject. The next thing on our program is a panel discussion.

WEED CONTROL EQUIPMENT -- Chet Otis, Moderator

MR. OTIS: Gentlemen, this panel was set up by the program committee primarily to discuss, both generally and in detail, various types of equipment that are being used in weed control work, including airplane dusting and spraying, fog machines, ground spraying and dusting, soil fumigant applicators, and any other types of equipment that are either in the experimental stage or in commercial use. It is our hope today, through brief talks to be given by the panel members and through discussions to follow, to answer questions in the minds of some of you. We realize that some of the information given here will be somewhat repetitious to people who have had experience with equipment. On the other hand, much of it should be new to many of you. Panel members are: **F. E.** Price, formerly head of the agricultural engineering department at Oregon State College and now Assistant Dean of the School of Agriculture there; William Harvey who is in the Department of Botany, University of California, College of Agriculture at Davis; and **R.** N. Raynor who now is with Dow Chemical Company. We hope that following the talks given by each of these we can have a good discussion with questions from the floor. Otherwise, I am afraid your questions will be unanswered. We now introduce Earl Price.

MR. PRICE: Gentlemen, Don Hill told you his idea of their sticking his neck out yesterday in the discussion his group presented, and I am sure we are going a little further. The one thing that is going to help a lot in this discussion is that our panel leader, Chet Otis, agreed in our breakfast meeting this morning that if there are any questions that any of us cannot answer he will take them. Chet gets around quite a bit and keeps up with the new developments, so, with that understanding we will get along with our discussion.

We of O. S. C. are quite interested in working on this problem of weed control. We are particularly pleased with the work of our agronomist, Virgil Freed, and feel that the equipment end of the deal which is relatively simple as compared with the other phases of the work, has not kept abreast of the other research. I think there is an opportunity for all people interested in weed control work to do a little more to assist the program. This could include the agricultural engineering departments, commercial people in charge of equipment, and many others. This has gone beyond the time when it can be solved by the chemist or the agronomist. We need to team up on this problem and bring in other specialists to help. At OSC the equipment end, I fear, has not had the study it should have had.

Less than a year ago a group met here at the Multnomah Hotel to attempt to bring together some weed spray equipment recommendations. Unfortunately the recommendations were not based upon a great deal of research, but it was felt that with the recommendations and general knowledge we could integrate the problem into fundamentals and it would be a substantial contribution to the state of confusion existing in some places. I will proceed to hit the high spots of the points we discussed at that time, with such other things that may have come up since then, not all of which I know about myself, I am sure.

I think one of the problems in the equipment field is the lack of a common understanding of basic specifications and requirements between agronomists, chemists or botanists on one side and agricultural engineers and equipment specialists on the other side. Progress has been made along this line, but unless we continue to work closely together we cannot keep our equipment specifications up to date.

In some instances considerable research will be required to adequately answer questions regarding specifications for equipment. The rates of application per acre--of what rates are you thinking in 1946 and 1947, and what are you going to be thinking about as we go into this picture? We mentioned a year ago that the low rates of application pivoted around 50 to 125 gallons per acre. I think we are agreed that that situation has changed, so if we are thinking of low rates this year it will be 10 gallons per acre or less. So I feel that the equipment situation must be kept right up to date. The low rate of application phase of it will be discussed by other members of the panel as it has developed just recently--the past year or so. For the higher rate of application a year ago we were thinking of 150 gallons an acre or more.

What about pressure? When this situation started it took from the industry that equipment which was used to spray orchards for pest control. Well, you know what happened to the orchard spray equipment in the way of pressure. Orchardists want 600 pounds of pressure for their work. Well, that equipment is available; it does the job; you can throttle it back to what you want it do do BUT it costs money and I think we ought to use the least expensive equipment that will do the job. It was generally conceded, and I think we hear it from the discussion here that about 100 pounds per square inch is adequate to do the job in the field we are talking about. I am not at all sure that enough work has been done to determine whether lesser pressure might not do it, although the equipment problem does not change greatly from there on down, but it does change a lot between 100 pounds and 600 pounds. So we will say that our pressure set up is about 100 pounds per square inch. Now from that picture we go to pumps.

What type of pump? This pressure situation lets you down into your less expensive pumps. Rotary pumps, centrifugal or turbine pumps as compared to the displacement pumps which are more expensive. In determining the capacity of a pump we must know (1) the rate per acre, (2) the swath we are going to take, and (3) the rate of travel. This requires planning of the boom, how long is it going to be? I think size of field and topography is quite a factor. If we are in Oregon we plan differently when we go on the relatively small field and farms of Western Oregon, or the large fields of Eastern Oregon. That becomes a practical interpretation, to get the job done. Forty to fifty feet is on the long side and when it gets that long we have a problem of support.

A problem has come up about the size of the boom. Prof. French of California says 1 inch pipe is the minimum size. We prefer 1¼ inch pipe as minimum size. If we get into longer sizes they have to be guyed in both ways to take out whip. As we go to the Sacramento Valley of California I can see why they don't have to worry too much about the length of the boom. But when you get into the rolling land and hill land of the Northwest you are likely to stick the end of the boom into the ground, if you don't have a wheel out there to support it. Plans now have a tiller wheel to travel out at the end of the boom to guide it. Booms must be adjustable in height so that they can be a proper distance above the crop, and the crop may be a different height for different spraying jobs. That is an important specification.

I'm going to ask one of the other men to mention the marker chemical to be put into the sprays for a marker when you do not have a tiller wheel at the end. The tiller wheel does serve as a marker, which is often an advantage. If you put in a chemical so that the colored sprays will give you a marker strip, then the wheel isn't necessary for that reason alone. In making up the boom it is generally considered desirable not to put the outlets on the bottom of the boom. Install the outlets along the side of the boom and you will get away from the sediment which sometimes causes clogging in spite of everything you can do. By having a cap or valve on the end of the boom we can flush it out from time to time. So outlets on the side are better than on the bottom.

In order to keep the sprays from interfering with each other it is considered desirable to have one nozzle on the front side and the next one on the back side of the boom, particularly where you are using 100% overlap plan. For this method a fan type nozzle is used, and it then becomes a problem of rate of speed, spacing of nozzle, discharge per nozzle, and pounds of pressure. We have to put those together to figure out the pounds per acre applied.

In the OSC pamphlet that we have mimeographed on weed spraying equipment recommendations we mentioned nozzles briefly, the usual spacing of nozzles if 15 to 18 inches for double coverage and the height of the nozzles above the crop to get complete or double coverage for 90^{o} nozzles is the same as the spacing on the boom. A pump discharge shut-off valve should be very definitely included. One that could be shut off quickly in case you should want to stop it in the field, or at the end of the rope. A relief valve naturally will be a part of the system and also a pressure gauge so that operating conditions can be determined. The pressure gauge should be placed so that it represents pressure on the boom. We have worked out a problem in the OSC circular in which the various factors are analyzed and size of equipment, nozzle spacing, etc. have been worked out. Among other things that will be needed are a table of discharge of nozzles, in gallons per minute in order to get the necessary field speed worked out in tabular form. I was able to get from Mr. Harvey of California, the discharge data on the various size nozzles and if he has later information than we had a year ago I am sure he will tell you. That is the type of procedure that I think we will have to follow to keep up with the changes that are going on in various rates per acre. Here is another one that comes along -- Virgil Freed came over the other day and wanted a dusting outfit, right away, to do some dusting on weed control. Frankly, we feel that we should check on some of the dusting equipment that we already have in order that we can get the simplest type of outfit that will do the work the way you folks want it done. So we are setting up in the department at the college to do the work this spring and we hope that we will be able to recommend the type of equipment that will be satisfactory to go into the field. I feel that the equipment situation for soil fumigation needs further study. I appreciate the work that has been done by the commercial people and feel that if they hadn't done it, it wouldn't amount to very much right now. They are doing a good job and I think we need to study that situation further to see just what is the best type of equipment to do the job the way it should be done and keep the cost down. Now, Chet, I'll turn the microphone over to the next speaker.

MR. OTIS: Thank you, Earl. I think we might withhold our questions now; not that I don't want Earl to talk anymore, but we will later discuss some of these things in greater detail. Perhaps after Harvey talks we can get some questions on airplane equipment and after Raynor talks we can get some questions on dusting and spraying again, and at that time the questions you have in mind to ask, Earl, can be asked. Now, the next thing that we have is Bill Harvey to discuss airplane application of herbicides, and Bill, I think you have some slides.

MR. HARVEY: I'd better do the talking first before I show you the slides. There was considerable request this morning for a brief period of darkness along in the middle of the morning for some of you to catch up on the last few minutes of sleep that you didn't get after the girl called up this morning and said in a cheery voice "Good morning, it's 7 o'clock and the temperature is 42^{o}". She told me that too. It was colder in my room.

Airplane application of herbicides has developed as a field practice with essentially no research behind it. What I have to say here is based primarily on a series of field operations with some photographs of the planes and their methods of distributing the chemicals.

In general in California there are as many different types of airplane herbicide applicators as there are airplanes. Some of them use a wire brush, run the solution down a hollow shaft and spin it off the brush to get a droplet size. Some use a series of nozzles with a breaker bar behind. Some use a number of little nozzles and some of the newer rigs have banks of nozzles every foot on a boom beneath the wing of the machine. I think in general we are coming to a boom type sprayer on the airplane. The better booms, at least they look better and the flyers seem to prefer them, are made of an airfoil tubing. The actual boom is made of the same material of which they make struts for Piper Cubs and some others. Frequently they graduate it and run the size down as they get out to the end of the boom, although some do not, and it doesn't seem to make much difference.

As to pressures used, they range all the way from a gravity flow which is a variable pressure to a definite pump arrangement. Almost all of the early ones used a wind-driven pump, a little pump and propellor stuck down between the wheels or some other place to develop pressure on the pump. Some of the newer rigs are driving off V-belts on the propellor shaft.

As to size of plane, I think some of the early ones were Cubs or that sort, which wouldn't carry much of a load, but I believe the general type plane now is a Stearman, or that type, and most of the outfits are trying to mount heavy motors, 300 horse, maybe 400 horse power. If you fly, as some of those boys do, and go as near to the end of the field as you can and pull up and over telephone poles, turn around and come back over, then flatten out over the field, you need quite a little power to pull you and the plane and a couple of hundred gallons of solution on up out of there in a hurry. In airplane application in general you are allowed just one error. The pilots are usually pretty careful. I mean the ones we have left are the careful pilots--it's the survival of the fittest. Some of the companies insist that some of the best war pilots are not the best dusting and spraying pilots.

Now, what are they using airplanes for in California? In general, for selective sprays, and the interest has been primarily in 2,4-D because large areas of grain lend themselves admirably to plane application. I think the larger the field the more applicable is the plane application. In the smaller field the difficulty is in getting in and out of the field because it takes a few feet to drop down, even when coming down from over the pole line with the airplane. There has been a good deal of 2,4-D applied by plane both on grain and on rice. Rice is one of the obvious places for using an airplane, primarily because you can't use anything else.

There were considerable acreages of rice sprayed with the plane in the Sacramento Valley last year and there will be considerably more sprayed this year. I have some photographs of that to show you. Now there is no reason why planes can't be used with other sprays--dinitros, both in grain and for other crops if you have a large enough field to justify it.

We have done some contact spraying with airplanes in some of our alfalfa contact work, but in general it hasn't been too good. The use of the airplane defeats our purpose to some extent, or perhaps it's vice versa because with a straight, non-selective contact in our alfalfa program where we have quite a little grass, there is a minimum volume of oil we have to get on per acre to get a kill of grass, and that minimum runs above 30 gallons per acre. If your plane application has to run much above 30 gallons the economics pretty well rules it out, because the plane can't carry a heavy enough load. One of the operators told me the other day that he had been making some studies on the cost of application and he had to gross between $50 and $75 an hour to make it pay. If you have to put on 30 gallons or more per acre it's pretty hard to gross that much. Acre rates run $1.50 to $2.00 or if you want to go up to the higher applications of 30 gallons an acre the figure may run up to $2.25 or $2.50, depending on the particular outfit with which you are dealing.

The advantages of the plane are several, at least. One of the obvious ones is speed. In regions of tricky rainfall, you have a situation where you have to get the applications on in a hurry; you can't wait several weeks for the operation. With some fields as large as 500 acres or more, some of these pilots are flying steadily for eight hours.

Some planes carry up to about 160 gallons of solution. If the pilot can get by with 10 gallons to the acre he can treat 16 acres at a load. If he can get by with 5 gallons to the acre, and some of them are trying that this year, he can treat twice as much and that is an important factor with plane application. Another thing, the boys don't like to fly far to the field. If at all possible they will have you grade up a landing strip right beside the field. We found in one instance where the airport was five miles away they still preferred a landing field right beside the field to be treated.

On some of the alfalfa contact work that was done last year, we timed a plane and found that he was treating about five acres per load at something like 30 gallons to an acre, with a 150 to 160 gallon tank. He was making a round trip every 7 minutes, treating five acres every seven minutes, which means he had to land quickly when he ran out of solution. He had to reload in a hurry and get in the air because that is where they make their money. Another thing about plane application is that it isn't as dependent on ground conditions as an ordinary ground applicator. You can treat fields that are soft, and the ground moisture causes no trouble. There is a definite advantage there.

Now as to disadvantages: One of the obvious ones--there is in general a poorer control of spray materials than in ground spraying. That has been remedied in part by being very careful of their nozzle shut-off. Some of the early planes had a shut-off at the tank and then with a 20 foot boom on either side of that, using a pretty concentrated spray, the booms were full when they cut off the valve shut-off and when banking for a turn to come back, both booms are emptied. When spraying rice and both booms empty on a bean field--it isn't good. Most of them are now coming to individual shut-offs using wire-cable arrangements. Each nozzle has a separate shutoff and are getting very little leakage.

Now some of the things we would like to know about plane application--just how low can we go on volume? The plane operators say they can put out 3 gallons to the acre and get pretty good distribution; now, whether that's enough we don't know for sure--it isn't enough for a non-selective contact. Whether or not it is enough for 2,4-D is a question. Ten to twelve gallons has been the usual volume up until now, although they are dropping it this year, partly because of price competition. If they can put on 5 gallons to the acre they can put it on a little cheaper. Some of the work with 5 gallons looked pretty good in early results this year. We would also like to know the relation of droplet size to total volume used. We think that we want fair-sized droplets (I won't attempt to define fair-sized, because I'm not sure what that is, but we do know we don't want little tiny droplets because they drift too badly). With plane application, you frequently find drift a couple of hundred feet away. In large grain areas that isn't bad but in a checkerboard region that drift could cause difficulty. With respect to dust we have very little information. They are making dust applications with planes, but again with dust we would like to know more about particle size of the dust, the weight of the carrier, and also electrical charge of the dust. There is considerable interest in that and there has been some work done, but there is a possibility of increasing effectiveness of airplane dusting by some attention to the charge on the particles. Now I would like to show you some slides.

--- ---

Mr. Harvey explained some interesting photographs showing types of planes, types of sprayers, nozzles, etc. and exhibited color slides showing spraying operations and effects on the crop.

VOICE: How about helicopters?

MR. HARVEY: We have had very little experience with helicopters in California. I believe in the Yakima Valley you have had more experience than we have. They have certain advantages over airplane application, but the cost of the helicopter in the first place is one of the disadvantages. If you want a helicopter you are going to have to wait a while and then put out about $25,000 for it. I think the ordinary biplane type which we use for this work is going to function pretty well for most of our weed work; perhaps not for all of them. For orchard spraying certainly the helicopter would have advantages.

MR. OTIS: Further questions?

VOICE: What pressures are used?

MR. HARVEY: Pressures are quite variable. As I mentioned, some of them use a gravity flow, so that they have very little pressure, although most of them are coming to a positive direct driven pump from the prop shaft with a pressure of perhaps 100 to 150 pounds, well maybe not that high. Mr. Raynor thinks not more than 100 pounds. The pressures aren't high at all.

MR. [illegible]: Coming from the East--I hate to tell Californians we can do it better, maybe I should tell this to Bill Harvey in private, but it might interest you to know that the TVA has done a beautifully engineered job spraying from airplanes. They use a quart and a half to the acre. You might write the TVA at Chattanooga, Tennessee. They could send you a great deal of information on it.

MR. OTIS: There is the answer to your spray problem, Bill.

MR. THORNTON: Bill, that is in an oil carrier, isn't it? The sprays you mentioned were with a water carrier, were they not?

MR. HARVEY: That's right. I was speaking of water carriers and in dropping even to 3 gallons, some of them are using oil because it gives a better droplet size. If you drop down very low with water you get into difficulty.

MR. KEPHART: I might mention that Noel Hanson has some information on this, in regard to grasses.

MR. HANSON: An experiment was conducted with airplane spraying at Lincoln, Nebraska, in the fall of 1946, in cooperation with representatives of the Sherwin Williams Company of Cleveland, Ohio. These experiments were set up for the purpose of determining the effectiveness of low volume highly concentrated 2,4-D esters in diesel fuel on pennycress, Thlaspi arvense, in growing wheat. Concentrations of from .15 pounds to 1.2 pounds of butyl ester of 2,4-D were applied in from 1¼ gallons to 5 gallons of No. 2 diesel fuel per acre. These dosages were applied by an airplane belonging to the Aerial Insecticiding Company of Orlando, Florida.

The plane was a Stearman PT 17 with a streamlined fuel cell mounted between the wheels under the fuselage. The spray was delivered by a rotary pump run by a small, four bladed propellor to a boom of ¼ inch pipe under the low wing of the biplane, the boom being located near the trailing edge of the wing and the spray being broken up by the air flowing under the lower air foil.

By the use of cover glass laid out across the flight path in the field, it was determined that the coverage varied from 64 droplets per square inch from 1¼ gallons of the diesel fuel per acre to 169 droplets per square inch at 2½ gallons per acre, and 400 droplets per square inch, which constituted almost complete coverage from 5 gallons per acre. From the use of .3 pound of butyl ester in 1¼ gallons of diesel fuel per acre 90 to 100% of the pennycress plants were killed. The original stand of pennycress plants varied from approximately 250 to over 500 plants per square yard.

In an attempt to devise over the ground equipment for utilizing this low volume, highly concentrated spray an experimental sprayer was built at Lincoln which consisted of a 3/4-inch boom set between two wheels at a height of approximately 10 inches. Fuel oil furnace nozzles with a delivery of 1.6 gallons per hour and at a spray angle of 80^{0} were mounted at 12-inch intervals along the boom. The boom was covered with a canopy of sheet iron leading down to approximately 5 inches from the ground. A trailing canvas was mounted below this to drag on the ground. To this boom was attached another pipe 3/4-inch in diameter leading forward and serving as a tongue for pulling the sprayer. To this was attached a pump and engine for delivering the spray solution from the supply tank to the boom.

In a preliminary test of this outfit it was shown that at a forward speed of 5 miles per hour and at a pressure of 30 pounds per square inch and with the above described nozzles, it was possible to apply approximately the same volume of the diesel fuel as was applied by airplane, or in other words 5 quarts per acre. The make of nozzle used in this case was the Ballofeet nozzle sold by the Delevan Company of Des Moines, Iowa. Similar nozzles have also been used that are manufactured by the Monarch Manufacturing Works, Inc., of Philadelphia, Pennsylvania and the Benjamin Company, St. Louis, Missouri.

MR. OTIS: There is quite a little information on the sprays, as both Kephart and Hanson have mentioned. Anyone else have any information on this? Any further questions directed to Harvey, or any point you wish to bring out? We will switch immediately then to Dick Raynor who will discuss ground spraying, ground dusting and fog machines.

MR. RAYNOR: I think the ground spraying was pretty well taken care of by Price's discussion. Fogging seems to be pretty well taken care of because certainly when you are putting on 3 pints to the acre it must be going out in a fog. I don't know anything about dusting, so I don't know what I'm doing up here. However, I should like to point out that there is no fundamental distinction between these different methods of applying herbicides, whether it is from the ground or airplane or the Besler fog machine or what not, the fundamentals in which we are interested are what volume per acre and what droplet size are going to be most efficient with the particular material being used. After we have that fundamental information, then the machine can be adapted to do the sort of job we want. It has been indicated this morning we are getting considerable information on the low volume application.

One of the things I had in mind this morning when I got up here was the Besler fog machine numbers of which are being sold in the west. Some thought has been given to using those for low volume application of weed control material. I have had a little experience with the use of materials in the Besler fog machine and in general what I have seen hasn't been too satisfactory to me. I think mainly it is because we haven't had the proper background of droplet size to use. In other words, we should have had this fundamental background of droplet size to use and at what volume to get the results we want. Had we known that, we certainly could have adjusted the machine to give the droplet size desired, and the volume could have been adjusted to a matter of a gallon or two per acre. There has been some talk among those interested in using the fog machine of adapting this by the addition of a boom so that the direction of the spray or fog can be controlled. In other words, instead of just permitting the fog to roll back over the ground, attempt to pass the fog through a boom and through nozzles so that it can be directed downward to the ground. The same principle would be involved in the use of an air atomizing nozzle for the similar low volume small particle size application. The Agricultural Engineering Department at Davis has used this air atomizing type of nozzle in attempting to get at these fundamental problems of relation of droplet size to low volume per acre, and we hope that they will have those that can be used effectively in other types of machines or used as a background for designing new types of low volume machines.

From an equipment angle, there is not much to be said about dusting, for aside from airplanes, of which Bill has spoken, are the boom type of duster and so far as I know there has not been much thought about design for dusters until very recently. Price mentioned Virgil Freed coming to him for a duster. Again, that brings up many questions. How much carrier do you want to put with that per acre--5 pounds, 10 pounds, 15, 20, or what? After we have those questions answered, then I believe we will be in a better position to go out and design a duster for a specific job of herbicidal dust. Now, I may be a little out of the line of the panel when I say my thoughts of the relative value of dust versus spray. While we may come to no conclusions, here are some things that may be of interest to consider. Some of these applications, using 2 pounds to the acre of liquid, for example. The weight of material which you find there certainly compares well with the amount of dust you would be applying when using 20 pounds to the acres. We will have to give some thought to what would be the best type of application or at least the most efficient. What is the best type of application from a practical standpoint?

Certainly I feel the virtue of a low volume application of liquids is that the diluent may be oil, water, or some other material locally available and the material being manufactured and shipped would then be a concentrate, bringing the cost to a minimum. On the other hand the 2,4-D dust would have to be mixed with a diluent, involving the cost of mixing and shipping, so it rather looks to me as if low volume spraying and dusting will be about the same thing so far as the low cost of application resulting in low volume of material handled is concerned. I believe we should be thinking of the relative value. So far, the thinking about low volume applications of dust and spray has been on 2,4-D. I should like to point out that there are still other materials being used as sprays and dusts, and these considerations do not apply to them. Harvey pointed out one of these considerations, such as fortified oils for alfalfa--one cannot go below a certain minimum volume per acre because of the toxicity of the materials and the type of material one has to kill, and there is no point in attempting to go any lower. On certain types of dinitro selective sprays on certain crops, for example, the application by airplane at 5 gallons per acre on peas did a nice job of covering, but as Chet Otis tells the story, it did a nice job of taking the peas out of the smartweed. So there are certain limits to which one can go in attempting to lower the total volume being used, particularly with certain chemicals and crops. One has to know the results when using a certain volume, certain particle size, and certain materials on crops. When we have that straightened out we have come to the problem of the type of equipment that will do the job.

MR. OTIS: Any questions on spraying, dusting, and fogging?

MR. HUBER: Has anything been done on airplane dusting?

MR. HARVEY: Very poorly will I answer that, because I don't know much about it. There has been some application of 2,4-D dust by plane in California this spring and the last I saw of them they were looking very good. There hasn't been as much application of dust as spray. Does anyone else have any information?

MR. THORNTON: We did some dusting last year using Weedone, put on about 3 pounds an acre, and from our observation we didn't get a very uniform coverage. The consideration of drift is rather serious.

MR. PRICE: I think those of you working with dust by any method should be directed to the thinking that is going on relative to size of particle and its settling. You can get your particles so small that they will perform as a gas. I would direct you to a paper given on that subject by Dr. Brooks of the Agricultural Engineering Department at Davis last summer at the St. Louis meeting of the ASAE. I do not know what issue that was published in, but it could be checked in your library some time between that date and now. It is good fundamental thinking that everyone of you should have in your research program. There has been a discussion of the display on the tables around the room. One of these is the method of producing pressure, with an air compressor into a hydropneumatic tank. Again, if we analyze that back into fundamentals, it can be appraised as fitting into your program just as your appraisal would be made of any of the pumps. You want to get a certain amount of liquid, a certain amount of pressure, a certain rate per acre and you want to carry a certain volume. When you appraise that you base it on the size of tank required and the convenience in the field. Fundamentally it is as sound as any other method. Practicability, filling, size of tank, volume, etc.

VOICE: What material is available for coloring matter to add to spray as a marker?

MR. HARVEY: The best information I have comes from Mr. Offord who was here yesterday. He gave me the formula he is using with 2,4-D as a marker. With his work, a crew of men running through the forest can't follow a straight line because of the trees and it is hard to tell where you have been. If you have done any sizeable work with lawns or golf courses, you realize that it is hard to tell where you have been when you come around with a swath. The material which Offord suggests as being quite efficient is Titanox B 30. It is a white substance, rather reasonable, about 6, 7 or 8 cents a pound, and he uses about a pound and a half per hundred gallons of spray. He was interested in whether or not anyone had found anything better. That was the best thing he had run into, but certainly we should like to know if any of you have found anything better.

MR. FREED: Oregon has a little different problem in spraying certain grains and grasses instead of woody shrubs. We have tried a number of dye materials, and other products to give coloring, but as yet have found no satisfactory method of tracing the weed sprayer, other than careful application.

MR. OTIS: I have tried this Titanox as a color marker; I tried two compositions of it at varying rates from ½ to 2 pounds per 100 gallons. I tried it on turf because the weeds found there were approximately the same weeds found in our grain fields where we also want markers. I can't say that I like Titanox very well, because I wasn't getting enough mark to see where I had been. In one case where I had some fairly large leaved white clover I was getting a little droplet rolling up there, the water was cohering, and I was able to see a little of this marking. I also had difficulty with this material settling in my spray tank, leaving quite a deposit. If one has good mechanical agitation it might help, but it is quite heavy. I don't think from the limited experience I have had, that Titanox is the answer to our problem. I'm sorry I don't have a good answer.

MR. HANSON: In Nebraska we have found that a low concentration of Sinox in the 2,4-D solution made a good track over grass. In practical operation a careful operator will track well enough so that no additional color marker is necessary.

MR. BELL: In using an oil emulsion, the oil is either very bright white or yellow, and will stay on the plant for ½ to 1 hour, long enough for the operator to see where he has been.

MR. OTIS: All right, gentlemen. I wish we could continue this for quite awhile longer because I was going to call on one or two others to discuss certain features of spraying, but I don't think we can do it; we have extended our welcome now. So I'm afraid those of you who have questions may have to take care of them out in the lobby or up in the room tonight. Let's pass on and briefly discuss equipment for soil injected herbicides. Harry Jucksch discussed a few moments ago, after Freed talked, the type of equipment that is being used and has been used for the application of carbon bisulphide. I would like now to ask Bob Rieder of Shell Oil Company to outline the principles of operation of the machine used to inject their prochlor material.

MR. RIEDER: Chet, we have used different machines in Oregon to inject D-D into the soil. The first machine we had was one developed by Shell Chemical and which is pulled by the tractor on which is mounted a barrel of D-D. The D-D is metered from this barrel by the drive from the wheels of the trailer, through a series of trunks, the pulleys on which regulate the amount of D-D injected by the shanks beneath the soil surface. This is a very simple machine which can be hooked to a piece of power equipment and which will deliver a given dosage of the chemical into the soil at a given speed. The other machine is a tractor-mounted injection tool which by a series of orifices delivers under a constant pressure a given or desired dosage or rate of application of the liquid chemical. The principle of this machine is primarily involved in a gear pump which is run from the power takeoff of the tractor and this pumps the chemical from the drum which is mounted somewhere on the tractor and injects it through the orifices behind the shanks as they are drawn through the soil.

I think those few points will give you a somewhat general picture of this type of equipment. The tractor-mounted injection tool has been very effective in treating a sizeable acreage in a short time. We can treat up to 20 acres a day with the tractor-mounted injection tool. There again, it will depend on pre-soil treatment--factors with respect to how far the tractor operator has to go to load on another barrel of D-D, etc.--would cut down a lot of acreage which could be treated in a given amount of time. But under ideal conditions, and in one field where you have 20 acres all prepared for soil injection, it could be treated in one day.

VOICE: What provision do you have for sealing?

MR. RIEDER: The machines which we have used have incorporated the dragging of a railroad iron or drag, depending on the type of soils which are being worked. This has in all cases effectively sealed the trails left by the shanks as they are drawn through the soil.

MR. OTIS: Any other questions?

MR. HERBERT: I might add there that they are using plastic tubing so that they can watch and see whether the material is flowing through the shank. This is quite successful.

MR. RIEDER: There is another reason for the plastic tubing and that is that our product D-D is extremely corrosive to most metals and they have developed a Resisto-Flex plastic lining for the rubber tubing which is resistant to the D-D and also "Saran" visible tubing which Mr. Herbert mentioned as being used so that you know the D-D is being delivered to the orifices and into the ground behind the shanks as they are drawn through the soil.

MR. OTIS: Thank you, Bob, very much. Another word on soil injection equipment. Dow, too, has been working along the same line with fumigants and equipment for the application of them, and our equipment that is being used doesn't vary too much in principle from what Bob has given us. It is a matter of a tank, either tractor-mounted or trailer-drawn, to contain the liquid or material; a gear pump to pump it out of there, a shank placed every 12 inches, either on the tractor cultivator bar, or if it is a trailer rig, behind the tank; and behind each shank a tube and in the tube an orifice. Then by controlling tractor speed with a speedometer, and by controlling pressure or by changing orifice size you can meter your dosage up or down as you wish. That type of equipment has been used commercially for almost two years now for the application of insecticidal fumigants, and has been used experimentally for the application of soil injected herbicides of which Mr. Freed spoke.

One other phase of this that is receiving attention now is this matter of plow-sole application of soil injected material. It merits mentioning but it is still, as you might say, in the experimental stage. Some of them are being produced for trial work and for field work, and they generally are of two types. I think the early ones were usually a gravity feed where the material was put down in front of or behind the plow shear and was turned under as the plow went through the earth. Other types employ a power take-off driven gear pump which pumps it in and it is turned under as the plow goes through the ground. I don't believe the plow-sole type of equipment has been used with soil injected herbicides but it has been used with soil injected herbicides experimentally.

Do any of you gentlemen have any more to add to this? All right, we thank you for your attention and we are sorry we ran over our time.

MR. FREED then introduced Mr. R. S. Bessee, Assistant Director of the Oregon Experiment Station, Oregon State College, Corvallis, who presented and elaborated upon the following chart of the Hope-Flannagan Act (Public Law 733).

Title	Section	To Agency Appropriated	Purpose	First Year's Appropriation	Fifth Year's Appropriation
I	9 A	3% O.E.S.	Federal Admin.		
	9 B 1&2	72% State Exp.Sta.	Special Projects		
	9B 3	25% Group Cooperating States	Regional Cooperative Projects	$2,500,000	$20,000,000
	10 A	U.S.D.A.	Utilization	$3,000,000	$15,000,000
	10 B	U.S.D.A. (Coop. with States)	Other than Utilization	$1,500,000	$ 6,000,000 (4th year)
II	204 A	U.S.D.A. for Contract States & Others	Marketing	$2,500,000	$20,000,000

The meeting was adjourned for lunch to reconvene at 1:30.

The afternoon session was called to order at 1:45 by President Morris who introduced Dr. A. G. Norman, Chief, C Division, Chemical Corps, Camp Detrick, Frederick, Maryland.

Dr. Norman then read the following paper:

SYNTHETIC GROWTH REGULATORS AS HERBICIDES - A. G. NORMAN

The use of synthetic growth-regulators as herbicides is a comparatively recent development and one which has moved fast from the laboratory to large scale use. To a certain extent, developments have been somewhat unbalanced, as will be indicated later, and there are reasons for wondering whether in fact some of the recommendations that have been made are as soundly established as would be desirable. There may be some reasons for thinking that practice has run ahead of theory. It seems to me that there are a number of questions that arise in any discussion of herbicidal use of this class of compound for which the answers are not available, and yet which it would be most desirable to have if these interesting compounds are to be used most effectively. It might be worthwhile to consider some of these questions together and in particular those that directly link practices with theory.

For the purposes of killing weeds, 2,4-D has occupied the spotlight and in many respects it is admirably suited for that purpose. We ought to recognize, however, that this compound is but one of a family of related compounds that seem to possess somewhat similar activities, and it is reasonable to inquire whether preoccupation with 2,4-D is wholly wise. In this connection it is interesting to note that in England, Imperial Chemical Industries selected another compound, 2-methyl-4-chlorophenoxyacetic acid, for development. The reasons for this, however, do not apparently relate so much to the relative effectiveness of this compound as compared with 2,4-D but to the availability of the chlorocresol used as an intermediate in production. The British compound, which is marketed in the form of a dust under the name of "Methoxone", does not have properties that are quite identical with those of 2,4-D

Other representatives of the substituted phenoxyacetic acid are similar to and yet different from 2,4-D or methoxone. It may be said of 2,4-D that it is rather broadly toxic or lethal on a wide range of plants at appropriate concentrations and in lesser concentrations is strongly inhibitory.

In the course of studies carried on by the Chemical Corps, a very large number of compounds was prepared and tested for herbicidal activity. Many of these were inactive, but some exhibited activity apparently similar in type to that possessed by 2,4-D. The compounds having some activity, possessed diverse structures. Some of them were variously substituted phenoxyacetic acids; others did not contain this grouping. It was obvious that no simple generalization could be made as to the active grouping concerned, although in some cases it was possible to indicate important substituent groups.

Some of the compounds tested were not as lethal or toxic as 2,4-D but produced growth modifications and growth abnormalities that oftentimes resulted in a failure to produce seed or to be fruitful. For some purposes compounds of this type might be quite as effective in a weed control program as those more lethal substances that result in early death of the weed. They might be somewhat safer with respect to damage caused by misuse. It would be desirable, therefore, to have more information about the "growth-modifying" substances and to know more of their potentialities. "Growth inhibitors" are often also "growth-modifiers" in lower concentration, but the converse does not seem necessarily to be the case. It is perhaps more dramatic to have a weed die rapidly and more in line with the conventional idea of what a herbicide should accomplish, but not always essential if seed production can be prevented.

In reviewing the properties of the many active compounds that were found, one thing that emerged was the general lack of specificity, either in terms of compound or plant. It is only possible to conclude that this class of substance has a sort of unspecific trigger effect on some mechanisms of the plant, as a result of which the sequence of events in the meristematic, or actively growing tissues, is changed. Little of substance is in fact known of the real physiology and biochemistry of the responses produced in plants by these compounds.

I believe it is desirable to emphasize before this group that there is in general a lack of plant specificity. 2,4-D is often referred to as a selective herbicide. This does not seem to me to be at all an accurate statement. Instead, I believe that we should recognize the fact that the apparent selectivity is merely the result of different degrees of susceptibility to a particular dosage. It is commonly said, for example, that the grasses and other monocotyledons are unaffected by 2,4-D, whereas the broadleaf plants are quite susceptible. Indeed, the most widespread use for 2,4-D exploits this apparent situation. The fact of the matter is that the differences observed are merely due to relative differences in susceptibility to a particular dosage rate at a particular state of growth. The germinating seed of grasses or cereals is severely inhibited by extremely low concentrations of 2,4-D and similar compounds. It is a paradoxical fact that good predictions of herbicidal activity on established broadleaf plants can be made from a study of the effect of any compound in reducing root elongation of germinating corn. This has been employed by us as a primary test of inhibitory activity. It is perfectly possible to kill established grasses and grassy weeds with 2,4-D and other synthetic growth-regulators of the phenoxyacetic type, but the amounts required are much greater than those necessary for killing broadleaf plants. Inasmuch as the germination of the seeds of broadleaf plants is inhibited by concentrations of these growth-regulators of about the same order as inhibit the development of cereal or grass seeds, one has to recognize that the susceptibility of cereals or grasses decreases with age much more rapidly than does that of most broadleaf plants.

Another of the questions to which we need an answer is why this should be the case. A compound which would be effective on the grassy weeds at levels which did not injure broadleaf plants would find many agricultural uses. We have some reason for thinking that the explanation of the lesser apparent sensitivity of established grasses is connected with the anatomy of the conducting tissues of this group. It appears that compounds reaching the leaf of grasses or cereals are not so readily transported to the growing point as is the case with broadleaf plants.

There is a somewhat greater chance of controlling grassy weeds by soil applications that result in uptake through the roots but even this does not prove too effective. Injury when it occurs is usually limited to enlargement of the crown and reduction in adventitious root development.

This raises the most interesting question of the transport or "translocatability" of the synthetic growth-regulators within the plant. It is this property which distinguishes them from the older class of contact herbicide. It must be recognized that it is wholly unnecessary to wet all exposed surfaces of a plant in order to kill it or inhibit its further growth. Not merely is it unnecessary, but it may actually be most wasteful in practice, both in expenditure of material and labor. It is now well established that an adequate dosage reaching the plant in a few droplets only will be as effective as higher volume rate treatments. One of the standard tests which we have used for evaluating this class of substance calls for the application of a single droplet on a single leaf of a suitable plant. This serves to separate those compounds which have the property of "translocatability" from any that merely produce local contact action, or are poorly absorbed.

I wonder if we should not ask ourselves whether full advanatge is being taken of this characteristic of the synthetic growth-regulators as herbicides. In effect, it means that in spraying, volume rates need be only sufficient to insure that a few drops are intercepted by each plant, provided that the concentration of the liquid is high enough so that an effective amount will be intercepted. Many of the recommendations which are currently made for the use of 2,4-D call for wholly unnecessarily high volume rates of application and employ solutions which are too dilute. There are, of course, some reasons why such recommendations have been made. Much of the equipment used in weed control was developed for the older type of contact herbicide which was only effective if applied in the form of saturation sprays. Another contributory factor in the recommendation of the use of high volumes of solution of low concentration may have been the desire to avoid that injury which might arise from misuse of more concentrated solutions. It is possible to saturation spray a lawn with a low concentration of 2,4-D without causing obvious injury to the grass. This would not be possible with higher concentration solution, and in consequence those people who believe that because a certain amount produces good results, then twice the amount must be twice as good, would have seriously damaged lawns.

There would seem to be ample opportunity for great improvement in spray equipment in the direction of obtaining good distribution at low volume rates. I am inclined to believe that the day of all-purpose spray equipment is over; moreover, for herbicidal purposes, we should not allow ourselves to be influenced too strongly by developments in the insecticidal field. Desirable spray characteristics for 2,4-D are not identical with those for DDT. This then is a plea to the equipment men to reconsider their spray equipment so that the volume rate is controllable and much reduced, without at the same time putting out such extremely fine droplets that they do not easily settle.

While on this subject, it might be well to point out that effective rates of these compounds might better be expressed on the dry basis of the active component instead of in terms of a concentration of solution to be used without specifying volume rates. It is apparently the case that if 1/10th of a gram per acre, is an effective rate, it does not matter greatly for practical purposes whether this be applied in two gallons or 200 gallons of liquid, provided it be done in such a manner that reasonable interception occurs at the lower volume rates. There is some good evidence, in fact, that indicates that per unit of active material used volume rates of the order of 12-25 gallons per acre are more effective than lower or greater volume rates.

It has been somewhat surprising to me that water should have so uniformly been recommended as the spray medium for 2,4-D. There are, of course, circumstances where water is preferable, but there are strong indications that per unit weight of active substance employed, oil sprays are more effective than water sprays, and particularly is this the case with the more resistant woody type of vegetation. There is no problem in formulating the necessary solutions because esters of 2,4-D that are directly miscible with oil are currently in production, or alternatively the free acid put into oil by solution in tributylphosphate or other suitable co-solvent could be used. It would seem to me that wherever there are major problems of eradication to be considered, oil sprays would be preferable to water sprays.

There are unanswered questions as to the most effective droplet size to be employed in spraying these growth-inhibitors. Where the volume rates are high and the foliage in consequence is completely wetted, the droplet size is obviously unimportant. If low volume sprays are employed, it is probably desirable that a number of droplets should reach each plant because it must be recognized that droplets of equal size and containing equal amounts of active material are not equally effective at all points on the plant. As indicated earlier, it is not necessary for a droplet to reach the growing point to cause inhibition or death. It is not known, however, whether an adequate amount of material is more effective if it reaches the plant in the form of x drops or 2x drops of half the size. In general, the magnitude of the response following treatment is greater, however, if the droplets fall on the younger tissues of a plant than on the older. The reasons for this are not obvious. They may relate to absorption into the leaf tissue and transfer to the conducting system. A leaf is an organ in which the vascular system is extremely well-developed, and as a result it might be expected that an absorbed material, if transportable at all, would be rather readily transferred to other parts of the plant. It has been determined that the velocity of downward movement from a leaf is markedly influenced by photosynthetic activity, or perhaps more clearly by conditions that permit high photosynthetic activity. It is difficult to understand, therefore, why older, fully expanded leaves that are photosynthetically highly active are less sensitive locations for a droplet of 2,4-D than younger leaf tissues. This is clearly a question for which an answer would be desirable.

Wherever the droplets fall on a plant it must also be recognized that there is in general a decreasing sensitivity of the plant as a whole with increasing age, that is to say, the effective dosage rate in weight of material per unit area increases as the plants get older. The implications of this in a weed control program are, I think, important. It means that much smaller amounts can be used to kill young weeds or weed seedlings than would be required to kill the established plant. A weed control program using synthetic growth-regulators should then by all means be, where possible, a weed prevention program, and this can undoubtedly be done by the use of amounts that are extremely moderate. If one extrapolates backwards, the logical conclusion would be reached that it would be better to prevent the germination of the weed seeds in the first place than to kill the plants later after they have developed. This can be done with amounts and concentrations that are astonishingly low. Most seeds fail to germinate successfully if exposed to a concentration of 2,4-D as low as 10 parts per million. You are aware that the British program with "Methoxone" has centered round its use as a dust on the surface of the soil in established grain fields. They have not, to my knowledge, made any recommendations with respect to spraying, and the effectiveness of the material is due primarily to the prevention of germination of those annual weeds, such as poppy and mustard that reduce the yield of cereals by competition. It would seem to me that there are numerous circumstances where some similar usage might be developed here. From what is known of the persistence of 2,4-D in soil, there need be no concern as to the possibility of cumulative deleterious effects. Indeed, it is possible that 2,4-D is not sufficiently persistent for all purposes, but there are others of this group that might alternatively be employed. Vigorous experimentation along these lines might be productive of some new methods and accomplishments.

In closing, I would like to repeat the statement with which I opened, namely, that the present practices with respect to the herbicidal use of plant growth-regulators are a little unbalanced, no doubt excusably in view of the rapid development of the subject. These substances have unique properties. We should ask ourselves whether we are properly or fully exploiting these unique properties. We should ask ourselves whether the use of solutions for eradicating weeds in lawns, valuable as this may be for aesthetic reasons, really contributes as much to the problems of weed control as might be the case. Weeds are the enemy of every farmer; weeds compete with every crop. The truly agricultural uses for these compounds have not yet appeared. We ought to be able to look forward to the day when the ordinary farmer, with ordinary equipment, growing the ordinary crops of his locality, does make use of these compounds in fighting weeds. Weed control on the ordinary farm is, in general, at present largely accomplished by cultural means. Chemical eradication is practiced only if some weed has got out of bounds. We should look forward and work for the time when cultural methods and chemical control are meshed together in such a way that the weed menace is greatly reduced. I am convinced that the synthetic growth-regulators can be widely adopted as an adjunct to cultural control if the cooperation of the necessary groups in the fields of equipment design, agronomy and plant physiology can be directed towards this end. Research laboratories may well provide us with more active compounds, or compounds with a greater degree of selectivity than those we have at present. Research men must provide us with the answers to some of the basic physiological questions that have been referred to if we are to perfect these new uses, and employ to the full extent the potentialities of new materials. It is not beyond the bounds of possibility that as a result this might bring about almost revolutionary changes in agricultural practices.

President Morris then introduced Dr. R. W. Allard who read the following paper:

EFFECT OF CERTAIN GROWTH REGULATING COMPOUNDS UPON GRASSES Dr. R. W. Allard, Agronomy Division, University of California, Davis, Calif.

This report will be concerned with the effect of a single growth regulating compound upon grasses. This compound is O isopropyl N phenyl carbamate. For want of a better nickname this compound is referred to merely as the carbamate. The reason that this compound is called to the attention of this group is that it has received considerable publicity as the "2 4 D for grasses". The purpose of this discussion is to present the small amount of information which is available on what it will do and will not do.

Like many new compounds O-isopropyl N phenylcarbamate is not really new at all. Chemists have investigated members of the carbamate or urethane series since the last century. In fact, the activity as growth regulators of various carbamates upon animal tissues has been known for at least 30 years. The activity of phenylurethane upon plants dates to Friezen's work of 1929 He found that phenyl urethane retarded germination and caused abnormal development of cereals which were germinated in dilute solutions of the compound. The idea that O isopropyl N phenylcarbamate might have use as a weed killer is recent however. It dates to the work of Templeman and Sexton in England and to work done at Camp Dietrich, Frederick, Maryland, in 1944 and 1945. In screening large numbers of organic compounds for growth regulating activity, the activity of O isopropyl N phenylcarbamate as a growth regulator was nearly overlooked in the work at Camp Dietrich. The reason was that it has little effect upon corn seeds germinating in dilute solutions in petri dishes. The corn germination test provided the basic screening method at Camp Dietrich. This experience indicates the need for several tests in screening new compounds if some of possible value are not to be overlooked.

Despite its mediocre performance in petri dishes, O-isopropyl N-phenylcarbamate has a remarkable effect upon cereals when grown in soil. When the carbamate was applied in aqueous solutions at the rate of 3 lbs per acre it killed seedling oats, wheat, and barley. Both greenhouse and field results established beyond reasonable doubt that the carbamate is several times as effective as 2 4 D in reducing the growth of certain cereals. It was found that resistance increases very rapidly with age. The plants are susceptible from time of seeding until six to eight inches tall. Older plants proved extremely resistant.

The symptoms produced by the carbamate were quite different from 2 4 D. With the carbamate no curvatures were noted or gall like growths such as are stimulated by 2 4 D. Rather, growth stopped and plants became a very dark blue-green color. They remained alive for a month to two months after treatment, but eventually the tips of the leaves turned brown. This progressed down the leaf until the entire plant was dead.

Because it seemed to work differently from 2,4-D, the effect of mixtures of the two compounds was investigated. The results indicated that there was no interaction between 2,4-D and the carbamate. For example, 2 pounds of a 50-50 mixture produced about the same effect upon cereals as 1 pound of the carbamate. Similarly 2 pounds of the mixture produced about the same effect upon dicotyledonous plants as 1 pound of 2,4-D. Thus, mixtures of the carbamate phenylacetic acids are not general herbicides which will control both grasses and dicotyledonous weeds.

Further experiments established that carbamate is not equally effective upon all grasses. Rates of approximately 1½ pounds per acre applied to several cereals in the greenhouse showed oats to be the most susceptible of the cereals. That rate reduced the vegetative growth of oats 78 percent in contrast with the growth of wheat which was reduced 71 percent, barley 58 percent, corn 57 percent, rice 23 percent, and millet 2 percent. The reduction in the growth of millet was not statistically significant.

At Davis rates of 1 to 10 pounds per acre were applied to 9 species of weedy grasses grown in pots in the greenhouse. These species were killed by rates of 5 pounds per acre: soft chess, Bromus mollis, foxtail, Hordeum murinum, annual bluegrass, Poa annua, and Mediterranean canary grass, Phalaris minor. Paspalum dilatum was severely stunted by a rate of 10 pounds per acre. These species were unaffected or only slighted stunted by a rate of 10 pounds per acre: Watergrass, Echinochloa crusgalli; Johnson grass, Sorghum halepense; Kentucky bluegrass, Poa pratensis and Panicum capillare. It is apparent that the unimportant weeds were susceptible to the carbamate. Unfortunately the very bad weeds, watergrass and Johnson grass were very resistant.

The carbamate does not affect most dicotyledonous plants, though much work is needed to establish tolerances. The tomato is a notable exception. It is sensitive at rates which will kill or stunt susceptible grasses, that is, rates of 3 to 5 pounds per acre. Buckwheat is also sensitive to the carbamate. Beans and sugar beets will stand up to 50 pounds per acre so there is a large safety factor with these two crops.

Perhaps you have wondered about applying the carbamate as a spray. This is difficult because the compound is quite water insoluble. Not more than 100 parts per million will dissolve in cold water. It is also rather difficult and cumbersome to prepare oil sprays and emulsions. Most important, however, is that sprays are not effective except for the soil contamination which occurs during the spraying operation. The compound is apparently not absorbed by the leaves or else is not translocated in the plant. It apparently must be absorbed through the root system to be effective.

A method of application which has been successful where there is rainfall during the growing season has been top dressings of the compound applied in inert diluents, such as Fullers Earth or sawdust. Rainfall then served to wash the compound into the soil. In irrigated districts in certain western areas this is obviously impractical. Results obtained in the summer of 1946 indicated that top dressings cannot be irrigated into the soil where a system of irrigation is used. Only in the furrow were the weedy grasses killed. No weed control was accomplished in the row where chemical methods of control would be most valuable. The low solubility of the compound precludes application in the irrigation water as practiced with gaseous ammonium fertilizer. In the West a method of application of this compound may prove a most serious problem.

These points should be made in summary:

1. The carbamate has proved much more toxic to some grasses than 2,4-D. This has been particularly true of the less important grassy weeds. Other grasses have proved very resistant, including Johnson grass and water grass, two of the worst weeds in California.
2. Most of the dicotyledonous plants so far tested have been unaffected by rates of application which stunt or kill susceptible grasses. The tomato has proved an exception. Further work is necessary to determine the plants which the carbamate does and does not affect.
3. The carbamate has not been effective when applied in sprays. It apparently must be absorbed through the root system if it is to be effective as an herbicide.
4. Top dressings in inert diluents may prove a satisfactory method of application in humid areas. In irrigated districts a satisfactory method of application seems likely to be a different problem.
5. Although the compound has received considerable publicity for grasses, the present evidence indicates that its place as a weed killer will be eliminated.

MR. MORRIS: Thank you, Dr. Allard. I think ofttimes some of our negative evidence is just as valuable as our positive evidence. Dr. Allard has brought that out today.

VOICE: Will it kill out the roots as well as the tops when it is used on young growth?

DR. NORMAN: That refers to the whole plant.

MR. LONG: Where the plant is a noxious perennial with a very extensive root system, will you kill the root system while the plant is very young?

DR. NORMAN: I don't believe I am the right person to answer that question. I don't have experience. My guess is that it would be rather difficult.

MR. LONG: The plant that has heavy reserves built up in the root system--the early growth is built in the root. Would it be better to apply chemicals after some of the reserve has been used up, at a season when manufacture is not surplus to the use of the plant.

DR. NORMAN: It has been found that the application is often followed by the depletion of the reserves, but I am not sure it applies to the extreme case that you refer to. The extent of translocation is very complicated.

VOICE: What about the use of carbamate in control of wild oats in flax or nightshade in lima beans.

DR. ALLARD: Virgil Freed has some information on wild oats in flax.

MR. FREED: It didn't affect the flax very much but if you let the oats get too old it doesn't affect them either, I don't believe the carbamate is entirely worthless we just need more information.

MR. McCAMBRIDGE: There has been discussion of oil sprays taking the place of water sprays. What type of oil and how does it affect the selectivity? Where does it fit in the program?

DR. NORMAN: No difference, generally we use lighter ones as sprays I would add also that there are some types of plants where the differential between oil and water is not very great. There are others where oil is much better. It has something to do with spreading direct oil sprays or emulsions. They spread better than water on some kinds of plants By and large, our experience has been that the differential between the two has become wider as we go into the field It is greater in field than in the greenhouse

MR. HANSON: Has it been possible to determine yet whether this first change of color away from green is a direct effect of 2,4-D on the chlorophyll or secondary effect of other changes taking place in the plant?

DR. NORMAN: A common experience where only part of a plant is treated those treated tissues will be much darker. Dr. E. J. Krause, of the University of Chicago, has a rather large project based on that study on tissues The actual mechanism has not been studied at all.

President Morris then adjourned the meeting for 15 minutes.

Mr. W. A. Harvey then presented the report of the Research Committee

REPORT OF THE RESEARCH COMMITTEE OF THE WESTERN STATES WEED CONTROL CONFERENCE W. A. Harvey, Chairman.

Although the recommendations of the research committee of the Western Weed Control Conference have been primarily concerned with chemical methods of control, the committee would like to emphasize strongly the desirability and the need for continued and even increased attention to other practical methods of controlling weeds, such as cultivation, cropping methods, flooding, etc.

The committee would like to emphasize the need for further coordination of the research programs of the various State, Federal, and commercial agencies. It is felt that a greater interchange of information between agencies as well as some specialization by certain agencies would be highly desirable. Thus an organization with a field force working over a considerable territory would be adapted to obtaining information on a wide range of species and environmental studies and could concentrate on the more fundamental problems including translocation, relation of chemical structure to toxicity, soil factors, etc These recommendations are not intended to limit the research activities of any group but rather to increase these activities in the fields where a particular group is best qualified to obtain information.

As a step toward attaining these objectives, the research committee has appointed a number of sub-committees dealing with fundamental problems, screening tests, plot technique and chemistry of herbicides.

The committee would like to emphasize that the present information on 2,4-D is incomplete and that much of the work is preliminary. Thus the recommendations given herein are tentative and should be considered subject to revision as our information and knowledge increases. It would be well to consult local agencies, such as Farm Advisors, County Agents, Agricultural Commissioners, Experiment Station workers or Extension Services, who may have definite and more specific information for local conditions.

The following is recommended as a general guide for testing 2,4-D but should not be considered as supplanting available local information.

I. Established grass lawns, turfs, grass pastures, and grass seed fields - 1½ to 2 pounds 2,4-D acid or equivalent per acre in 100 to 200 gallons of water. At the seedling stage use no more than 3/4 pound 2,4-D acid or equivalent per acre.

II. For the control of young broad-leaved annual weeds in corn, barley, and wheat when the grain is at least tillering, but the weeds are as small as possible, ½ to 1 pound 2,4-D acid or equivalent per acre in 100 gallons of water.

III. For the control of the listed susceptible weeds with the expectation of some regrowth occurring in the case of creeping perennials, ½ to 1 pound, selective; or 1½ to 3½ pounds, non-selective, of 2,4-D acid or equivalent per acre in sufficient water to give coverage.

IV. For the prevention of seed formation by weeds with properly-timed applications of ½ to 2 pounds of 2,4-D acid or equivalent per acre in sufficient water to give coverage.

V. We recommend that labels of 2,4-D weed killer give the following information and in the following order

A. 1. For powders (and tablets) the net weight (avoir.) in the package.

2. For liquid the content of the package in liquid measure and the net weight (avoir.) in the package.

B. The equivalent percentage by weight of 2,4-D in the formulation as sold.

C. State the chemical compound(s) of 2,4-D which constitute(s) the active ingredient(percentage of derivative optional).

Treatment should be made as soon as maximum emergence takes place, but before any seed is formed.

Susceptible	
Annual sow thistle	Sonchus oleraceus L. & S. asper (L.) Hill
Austrian field cress	Roripa austriaca Spach.
Black medick	Medicago lupulina L.
Bull thistle	Cirsium lanceolatum (L.) Scop
Burdock	Arctium minus Benth.
Bur-reed	Sparganium spp
Chicory	Cichorium intybus L.
Cockle bur	Xanthium canadense Mill.
Common mallows	Malva parviflora L. & M. rotundifolia L.
Dandelion	Taraxacum vulgare (Lam.) Schrank
False dandelion	Hypochaeris radicata L.
Fanweed	Thlaspi arvense L.
Fennel	Foeniculum vulgare (L.) Gaertn
Heal-all	Prunella vulgaris L.
Lambs'-quarters	Chenopodium album L.
Lawn pennywort	Hydrocotyle umbellata L.
Milk thistle	Silybum marianum Gaertn.
Mustards	Brassica spp.
Nettles	Urtica spp
Perennial ragweed	Ambrosia psilostachya DC.
Plantains	Plantago spp.
Poison hemlock	Conium maculatum L.
Prickly lettuce	Lactuca scariola L.
Prostrate pigweed	Amaranthus blitoides Wats.
Purslane	Portulaca oleracea L.
Rough pigweed	Amaranthus retroflexus L.
Shepherd's purse	Capsella bursa pastoris (L.) Medic.
Spiny clotbur	Xanthium spinosum L.
Sweetclover	Melilotus spp
Tule	Scirpus acutus Muhl.
Tumbling pigweed	Amaranthus graecizans L.
Water hemlock	Cicuta spp.
Wild carrot	Daucus carota L
Wild radish	Raphanus sativus L.
Intermediate	
Blue lettuce	Lactuca pulchella DC.
Common cattail	Typha latifolia L
Curly dock	Rumex crispus L.
Golden rod	Solidago spp
Hoary cress	Cardaria spp.
Knotweed	Polygonum aviculare L.
Mouse ear chickweed	Cerastium viscosum L
Oxalis (green)	Oxalis corniculata
Perennial dogbane	Apocynum cannabinum L.
Spotted spurge	Euphorbia maculata L
St. Johnswort	Hypericum perforatum L.
Wild morning glory	Convolvulus arvensis L.
Willow	Salix spp
Yarrow	Achillea millefolium L. var. lanulosa Piper
Yellow star thistle	Centaurea solstitialis L.
Resistant	
Alkali mallow	Sida hederacea (Dougl.) Torr
Blackberry	Rubus spp
Bracken fern	Pteris aquilina L. var. lanuginosa (Bory) Hook.
Button willow	Cephalanthus occidentalis L.
Canada thistle	Cirsium arvense Scop
Dog fennel	Anthemis cotula L
Horsetail	Equisetum spp.
Leafy spurge	Euphorbia esula L.
Milkweed	Asclepias speciosa Torr
Oxalis (red)	Oxalis corniculata var. atropurpurea Planch
Perennial ground cherry	Physalis spp
Poison oak	Rhus diversiloba T. & G.
Russian knapweed	Centaurea repens L.
Sheep sorrel	Rumex acetosella L
Tansy ragwort	Senecio jacoboea L
Toad flax	Linaria vulgaris Mill.

MR. MORRIS: We will take up the topic of 2,4-D now. At previous conferences we have spent as much as two days in discussion of 2,4-D but we haven't that much time. I shall ask Lin Harris, who is going to lead the discussion, to limit it to 15 minutes.

MR. HARRIS: This is a place where we really miss Dr. Robbins. These so-called "discussions" are usually carried on by Doc, who got a lot out of them and didn't let them drag. I don't know why this group put me up here, but what I am going to do is recognize hands from the floor. We are going to have to keep it short and snappy. You have heard the report as presented by Mr. Hanson. I should like to hear some discussion as to time of applying 2,4-D to particular weed problems. Bindweed or morning glory seems to bring up the most discussion. Among other things, the problem of emergence What is the experience of California as far as time of application for morning-glory?

DR. HARVEY: You are thinking of non-selective spraying?

MR. HARRIS: think we ought to cover that, too.

MR. HARVEY: The bindweed in our state is primarily a problem of dry areas, although it occurs pretty much all over the state. We have to treat pretty early--try to get uniform emergence, then spray. date of application wouldn't mean anything because of variety of climate. Morning glory never has a complete emergence, there are rhizomes around the edge of the plant that are always emerging. We go for a pretty early application with no pretreatment or cultivation.

MR. SEELY: We do have an entirely different picture in Idaho. Our spring emergence is extremely erratic--over a period of a month or six weeks from time plants emerge. We are working almost exclusively on water which is in the soil, which we conserve with spring cultivation and hold it until we want to spray.

VOICE: How deep do you cultivate?

MR. SEELY: No particular depth, just normal cultivation.

VOICE: If you chop up roots you have a variation in time of emergence.

MR. SEELY: If you make a tillage operation you kill to a uniform depth.

MR. OTIS: Seely, what is your rainfall and the distribution of it?

MR. SEELY: Rainfall rate is about 21 or 22 inches, generally less than 25% between first of May and middle of October.

MR. OTIS: The inference is that you are in a low rainfall area. That is really quite a bit of moisture. You have stored soil moisture and can carry-on later operations.

MR. THORNTON: Can you overcome these difficulties by irrigation?

MR. HARRIS: What is the opinion of the group regarding soil moisture in respect to growth stage? Mr. Timmons, would you say something about soil moisture?

MR. TIMMONS: Moist soil is considerably better in our case for bindweed and hoary cress in preliminary test. We put our tests where we can find hoary cress. The plots ran up a slope and down a ravine. Our kill was very good. Soil moisture was a much greater factor than was consideration of type of material. Even with dandelion moisture is very important. We can get full emergence of bindweed in the fall of the year, it continues through the rest of the season on what moisture it has. We get better results on hoary cress through late fall application.

MR. THORNTON: In Colorado moisture is all-important. You can kill bindweed any time of the year if the moisture is in the soil. We also have had our best results when growing with competitive crops.

MR. HARRIS: Is there any difference in effects in Kansas and Nebraska?

MR. HANSON: We have had somewhat better results on bindweed in Nebraska. The soil moisture very definitely is important. In the spring and fall of 1945 our best results from treatment of bindweed showed up in the fall treatment under adverse conditions. In 1946 our best results were in treatment of the full emergence stage. One reason perhaps why we got poorer results from full emergence treatment in 1945 was that we had extremely wet weather in spring of 1945. We got poorer results on dandelion in the spring when we had cool weather and rainfall. In Nebraska we have treated Canada thistle on dry land three times and the reduction has been only 50% of the original stand. On irrigated territory (two ends of the State) we have treated the Canada thistle along an irrigation ditch and had what appeared to be a complete kill, with one treatment. Twelve to fourteen inches down we couldn't find any live roots.

MR. HARRIS: We get a wide variation in reports of results on Russian knapweed, all the way from "no good" to "kills it every time". What is the opinion of the group?

MR. THORNTON: "Tough" is my opinion.

MR. HARRIS: "Tough" is my opinion, too. To the extent I can't make recommendations for control.

MR. BALL: Very poor results down in the Valley area. The only place that we have actually killed Russian knapweed and did it comparatively easily was in Lassen County, where it appears that moisture is a factor.

MR. ERICKSON: I can substantiate that. In the south central area of Idaho, near Burley, there is some sandy irrigated land and the water level is very high, only a couple of feet down. There one treatment came very close to taking it out -- it was a satisfactory cleaning out.

MR. HARRIS: Anyone else?

MR. BAIN: We had some knapweed plots on the banks of a drainage ditch, and got so much re-growth that we couldn't get a count.

MR. HARRIS: I have no disagreement with that. I know of one or two cases where a high water table plus a bluegrass stand gave a good result, but if water factors are poor it is bad. Now a little about temperature in treatment. Do we have to have 70° or above? If you have read the policy committee report from the North Central States, I think they said you did.

MR. HANSON: Temperatures of 40 - 60° there would show the effects slowly, and the effects would be reduced. However, from 60° on up the activity would be increased. There is some indication that high temperature would increase 2,4-D activity.

MR. STARK: In our experience there is a definite relation between temperature and concentration. Those factors haven't been properly considered, hence the wide variation. We have tried one-tenth of 1% concentration on morning glory, and the best control we got was 1 to 500 under hot conditions. The best control we got at .1% was in the higher, cooler elevations. Our company is going to recommend a mixture of 1 gallon to 200 of water for morning glory. We are going to vary it with the altitude of various sections. I don't believe we can divorce temperature and concentration.

MR. TIMMONS: With dandelion in the summer when the temperature was 95° the day it was applied and 105° the next day, our best kill was at the lightest concentration with the ester, and got poorer as we went on to the higher concentrations. The esters were better at the lightest rate and the salts better at .1%, poorer as we went up. At high temperatures we don't want a high dosage.

VOICE: We like dust better in Washington. Where we used too strong a concentration it tends to burn the top off and prevents translocation. We find a heavier re-growth with heavier concentration.

MR. ERICKSON: Much of my work has been on running concentrations against regrowth. As an overall picture, taking all our plots throughout the state, we found definite relationship between concentration and the amount of regrowth.

MR. SCHAAD: About the concentration and rate of application. We are hearing that there is some advantage to airplane application. Has anyone had any experience that will be helpful?

MR. HARRIS: Has there been any work done with these high concentrations and low volumes on perennials?

MR. RAYNOR: The only thing I know about is airplane application on morning glory, and that was two years ago, using about 14 gallons an acre total liquid. The regrowth was less on the airplane job than on the ground job.

MR. TIMMONS: I believe it was purely a matter of dosage.

MR. TINGEY: How rapidly does this material enter the plant? How soon are the effects complete? In a short time or a long time?

MR. NORMAN: By taking photographs of treated material it is possible to see it move, in about an hour if there is bright sunshine and the application is made as a single drop. Another thing that we have done is to make single drop applications and cut off the leaf. The answer is usually that if it is bright and sunny and the leaf is left on six hours the effect was at a maximum. If one cuts off the leaf the plant dies anyway. That was an aqueous solution of 2,4-D salt on beans of one sort or another.

MR. TINGEY: On morning glory about the same thing happened. I sprayed the whole thing and removed the top. There was not much difference after 10 hours. It hadn't starved itself.

MR. MORRIS: This concludes the formal part of our program. We have a great deal of business to attend to. We should like to have those of you who are interested stay. We have a hold-over from last year of the constitution and by-laws, so first we will have the report from the chairman of that committee, Mr. Thornton.

MR. THORNTON then presented the following constitution and by-laws, which were adopted by the Conference:

WESTERN WEED CONTROL CONFERENCE
Constitution and By-Laws

CONSTITUTION

ARTICLE I - Name

The name of this organization shall be "Western Weed Control Conference", hereafter referred to as the "Conference". It shall include the States of Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, Wyoming, and such other States and Provinces of Canada that may become members.

ARTICLE II - Objects

The objects of the Conference shall be:

1. To function as a clearing house on weed matters.
2. To foster regional organizations and a national organization of weed control agencies to act as regional and national clearing houses in connection with weed problems.
3. To cooperate with other regions and with governmental, private, and commercial agencies in the solution of weed problems.
4. To foster educational work in weeds and weed control through all appropriate agencies.
5. To foster plans for organized weed research and control programs.
6. To encourage national and state research in weed control and foster legislation to that end.
7. To assist in the development of uniform state weed and seed regulations and quarantine legislation.
8. To foster adequate national weed and seed regulations and quarantine legislation.

ARTICLE III - Membership

Any person, organization, cooperative association, governmental agency or corporation operating within the region covered by the Conference and actively interested in weeds and weed control shall be eligible to membership.

ARTICLE IV - Officers and Executive Board

The officers of the Conference shall be: President, Vice-President, Secretary-Treasurer.

The Executive Board shall be:

President, Vice-President, Secretary-Treasurer, Immediate Past President, Chairman of the Research Committee and one associate member to be appointed by the other members of the Executive Board.

The officers shall be elected at the annual meeting of the Conference and, unless otherwise provided, shall serve for one year beginning at the close of the annual meeting and ending with the close of the next annual meeting or until successors have been elected. All official state members of the Conference shall be eligible to hold an elective office.

ARTICLE V - Committees

The President shall appoint all committee chairmen and committee members. All members of the Conference shall be eligible to appointment on committees.

Standing Committees:

1. Program	4. Legislation
2. Membership	5. Nominations
3. Research	6. Resolutions

ARTICLE VI - Election of Officers

Officers shall be elected by ballot. The ballots shall be prepared by the nominating committee and submitted to the members by the Secretary-Treasurer.

ARTICLE VII - Voting

Voting by ballot shall be by the official representatives of the States in good standing, each state being entitled to one official representative. A representative of a state present may vote for another representative by proxy

ARTICLE VIII - Vacancies

Should a vacancy occur in the Presidency, the Vice-President shall become President. In case of a vacancy in any other elective office the same may be filled for the unexpired term by a person appointed by the President.

ARTICLE IX - Dues

Classes of membership and annual dues shall be as follows:

Official State Memberships	$15 00
Associate Memberships	25 00
Registration	2 00
Sustaining Memberships	50 00

Dues are for the current calendar year

ARTICLE X - Meetings

The annual meeting shall be held at such time and place as shall be determined by the Executive Board.

Special meetings of the Conference or the Executive Board may be held at the call of the President, subject to the approval of the Executive Board.

ARTICLE XI - By-Laws

The Conference shall adopt By-Laws.

ARTICLE XII - Amendments

The Constitution and By-Laws may be amended by a three-fourths vote of the members present at any regular meeting.

BY LAWS

BY-LAW I - Duties of Officers

1. It shall be the duty of the President to preside at all meetings of the Conference, to perform the usual duties of such office and in addition:
   a. Serve as Chairman of the Executive Board.
   b. Appoint all Committee Chairmen.
   c. Appoint all Committee Members, with the advice of the respective Chairmen of the Executive Board if he so desires.
2. The Secretary-Treasurer shall perform the duties common to that office.
3. The Executive Board shall:
   a. Transact the business of the Conference when the Association is not in session.
   b. Be responsible for the program at the annual meeting.

BY-LAW II - Membership

1. All members in good standing in the year of adoption of this Constitution shall automatically become members of the Conference.
2. Application for membership shall be submitted to the Membership Committee. If approved applicant shall become a member of the Conference upon payment of dues

BY-LAW III - Publications

The annual proceedings shall embrace reports, papers and the minutes of the annual meeting. Copies of the "Proceedings of the Conference" shall be furnished to members in good standing. Other copies may be distributed or sold as the Executive Board shall direct.

BY-LAW IV - Order of Business

Business at all regular meetings of the Conference will be conducted according to Robert's Rules of Order.

BY-LAW V - Quorum

A quorum at any regular meeting shall consist of representation of five states, including two members of the Executive Board.

BY-LAW VI

All previous rules and regulations of the Conference shall become null and void with the adoption of this Constitution and By-Laws.

MR. BALL: One rather notable fact is that we raised the associate membership fee to $25. The reason for that was that we have made only the manufacturers members and they will have the privilege of requesting additional copies of the minutes.

It was moved and seconded that the constitution and by-laws be accepted as read.

The report of the Nominations Committee was given by E. J. Kreizinger. The nominations were: President - Virgil Freed, Vice President - Bruce Thornton, Secretary-Walter Ball

It was moved and seconded that the nominations be approved. Motion carried.

The report of the Resolutions Committee was given by Bruce Thornton:

Resolution No. 1:

WHEREAS, the weed problem is a serious menace in all sections of the United States and especially on irrigated and range land in the Western United States, and

WHEREAS, this problem affects practically all classes of people and there is an ever-growing demand for public assistance in combatting weeds, and

WHEREAS, widespread interest is being shown in research methods designed to solve or minimize the weed problem, and

WHEREAS, this widespread interest and participation in weed research by State Experiment stations, manufacturers of chemicals used in controlling weeds and by many other agencies needing coordination of research effort and direction of eradication programs.

NOW, THEREFORE, BE IT RESOLVED that the Western Weed Control Conference, assembled at Portland, Oregon, February 6 and 7, 1947, recommend to the Honorable Secretary of Agriculture and to the Chief of the Bureau of Plant Industry, Chemistry, Soils and Agricultural Engineering that a separate Division of Weed Research and Control be established to carry out adequately the needs of this program; and that additional regional experimental work be carried on by the government in the irrigated sections of the West on control of important noxious weeds, and that the work of the proposed new Division be closely coordinated with the work of the State Experiment stations.

Resolution No. 2:

WHEREAS, the leading agriculturists and others familiar with the facts recognize weeds to present one of the most serious problems facing American agriculture today, being responsible for enormous losses each year through reduced production and decreased land values, and

WHEREAS, the control of weeds is essential to the production of high quality and marketable farm crops, and

WHEREAS, these facts apparently have been lost sight of in the final drafting of the Hope-Flannagan Act.

NOW, THEREFORE, BE IT RESOLVED that the Western Weed Control Conference, assembled at Portland, Oregon, February 5, 6 and 7, 1947, and representing eleven western states, hereby recommend to the Honorable Secretary of Agriculture and the Members of the Congress that the importance of the weed problem be fully recognized in the administration of the Hope-Flannagan Act (Public Law 733) and that funds be provided under the Act for conducting research on weed control by the State Experiment Stations and Federal Agencies to the extent demanded by the importance and urgency of the weed problem.

The motion was made that copies of the above resolutions be provided for the members of the conference to be sent to their respective Congressmen by themselves and by interested and influential citizens of their respective states, with a personal letter of transmittal urging full consideration and support of the Resolutions.

Resolution No. 3:

WHEREAS, the weed problem of Western Canada is similar to those of the United States, and

WHEREAS, the coordination of the research efforts on weed control of these Western provinces and the Western states will be beneficial and profitable to both groups.

THEREFORE, BE IT RESOLVED, that the Western Weed Control Conference, assembled at Portland, Oregon, February 6 and 7, 1947, extend an invitation to the Western provinces of Canada to become members of the Conference on the same membership basis as that of the states.

Resolution No. 4:

WHEREAS, there is great need for trained and practical field men and supervisors for weed control work, and

WHEREAS, there is a great shortage of available men for this type of work

BE IT HEREBY RESOLVED that the Western Weed Control Conference, assembled at Portland, Oregon, February 6 and 7, 1947, urge that the State Agricultural Colleges of the member states organize and present courses in weed control and eradication, leading to a degree in such courses, and that this be undertaken at the earliest possible date.

Resolution No. 5:

WHEREAS, the Division of Cereal Crops and Diseases of the United States Department of Agriculture has on their staff a weed specialist who when possible attends the meetings of the North Central Weed Control Conference, the Eastern Weed Control Conference, and Western Weed Control Conference and has kept abreast of weed control throughout the United States; and

WHEREAS, it is highly desirable that information obtained relative to weed control by this representative be discussed with other groups so that these organizations may have an opportunity to learn of the research and other investigational programs which have been carried on in other areas, thus eliminating much duplication.

THEREFORE, BE IT RESOLVED, that the Western Weed Control Conference, assembled at Portland, Oregon, February 6 and 7, 1947, urge that the chief of this Division make it possible for Mr. L. W. Kephart or a representative interested in weed control from that office to plan their annual itinerary in order that they may be present at each annual meeting of the Western Weed Control Conference.

President Morris issued an invitation to the Conference to hold the 10th annual meeting in Bozeman, Montana.

Mr. Ball read a telegram from Sacramento inviting the members of the Conference to consider Sacramento as their 1948 meeting place.

Mr. Hobson extended an invitation also to meet in Utah.

The meeting then adjourned.

The 1948 meeting will be held in Sacramento on February 2,3 and 4.

Walter S. Ball
Secretary-Treasurer

REGISTRATION

ARIZONA

Lewis Evans	USDA, Room 24, New Post Office, Phoenix

CALIFORNIA

Harry Voorhies	NACO Mgf. Co., Huntington Park
A. J. King	NACO Mgf. Co., Huntington Park
J. F. Kagy	Dow Chemical Company, Seal Beach
Harry H. Jucksch	Wheeler, Reynolds and Stauffer, 636 California Street, San Francisco
F. G. Parsons	University of California, Davis
R. N. Raynor	Dow Chemical Company, San Francisco
C. A. Ferris	Standard Agricultural Chemicals, P. O. Box 45, San Jose
C. J. Medberry	Pacific Coast Borax Company, 510 West Sixth Street, Los Angeles
R. K. Blanchard	California Forest Experiment Station, Berkeley
Walter S. Ball	State Department of Agriculture, Sacramento
H. H. Merritt	Essick Manufacturing Company, 1950 Santa Fe Avenue, Los Angeles, 21
James W. Meyers	Sherwin Williams Company, 1450 Sherwin Avenue, Oakland, 8
L. F. Harris	Sherwin Williams Company, 1450 Sherwin Avenue, Oakland, 8
J. L. Sanders	California Spray Chemical, Richmond
C. C. James	E. I. DuPont de Nemours Company, 1549 - 49th Street, Sacramento
R. K. Vickery	California Spray Chemical Company, Richmond
J. L. Todd	Los Angeles Chemical Company, Los Angeles
B. B. Boyer	Cloroben Corporation, Los Angeles
W. A. Harvey	University of California, Davis
Frank B. Herbert	Shell Oil Company, Modesto
E. O. Essig	Head, Division of Entomology and Parasitology, University of California, Berkeley
John M. Bell	California Research Laboratory, Richmond
R. W. Allard	Agronomy Division, University of California, Davis
Warren A. Westgate	Standard Agricultural Chemicals, Sacramento
R. W. Finch	Swift and Company, Los Angeles
W. Glenn Wunderly	J. T. Baker Company, 953 S. Hope Street, Los Angeles
Cecil J. Graham	Bureau of Reclamation, 224 California Fruit Building, Sacramento
C. C. Cassill	Niagra Spray Chemical Company, P. O. Box 1589, Richmond
H. R. Offord	Division of Plant Disease Control, USDA, Berkeley
W. D. Hay	Federal-State Seed Laboratory, Sacramento
M. M. Harris	Braun-Knecht-Heimann Company, 1400 - 16th Street, San Francisco
James Mills	James Mills Orchards Company, Hamilton City

COLORADO

Bruce J. Thornton	State Seed Laboratory, Fort Collins
J. M. Shaw	Bureau of Reclamation, Denver Laboratory, Denver
W. T. Moran	Bureau of Reclamation, Denver
R. S. Rosenfels	USDA, Denver

IDAHO

Sidney Harris	Production and Marketing Administration, USDA, Boise

W. L. Jensen	Rexburg
A. C. Jensen	St. Anthony
Ben Tomlin	Chaney Wholesale Company, Payette
A. V. Kinney	Chaney Wholesale Company, Fruitland
R. E. Ames	Dow Chemical Company, 2700 Ponderosa Road, Boise
George D. Vanderhoff	Director, Weed Association, Homedale
D. L. Huey	Supervisor, County Weed Control, Gooding
Clagg Raymond	Bannock County Commissioner, Box 591, Pocatello
M. B. Smith	Bannock County Weed Agent, Route 2, North Pocatello
J. M. Dodds	Boise
Oscar Green	Green's Seed & Floral Company, Idaho Falls
George Whornham	Route 3, Rexburg
C. O. McDannel	Caldwell
George Forbes	Bonneville County, Idaho Falls
F. W. Heuer	Jerome
J. R. Seeley	Hazelton
H. J. Goemmer	Jerome
D. K. Hendry	Supervisor, Department of Noxious Weed Control, Jerome
V. A. Cox	Superintendent, Ada County Weed Control, Meridian
C. I. Seely	University of Idaho, Moscow
Lambert Erickson	University of Idaho, Moscow
Jesse M. Hodgson	Agronomist, Bureau of Plant Industry, Boise
Arlon Frazier	Payette
J. N. Grimes	Weed Director, Twin Falls
E. J. Mess	Payette
M. A. Lyman	State Department of Agriculture, Boise
Jerome Evans	Supervisor of Weed Control, Boise
D. R. Young	Twin Falls, Idaho
L. W. Hawkins	Filer Seed Company, Blackfoot
Clayton L. Long	Bureau of Reclamation, Boise

MONTANA

Dale G. Smeltzer	Montana State College, Bozeman
H. Clay Scott	Bureau of Reclamation, Billings
J. D. Corkins	Occident Elevator, Billings
D. J. Luebbe	Extension Weed Specialist, Montana State College, Bozeman
H. E. Morris	University of Montana, Bozeman
H. E. Hagen	H. C. L. Equipment Co., Billings
William Love	Weed Control, Fort Shaw

NEVADA

E. R. Greenslet	U. S. Department of Interior, P. O. Box 751, Reno
C. W. Bawser	Bureau of Reclamation, Region 3, Boulder City

OREGON

J. D. Vertrees	Stauffer Chemical Company, North Portland
W. G. Nibler	County Agent, St. Helens
Dan Young	Niagara Spray Company, 1715 North 22nd, Salem
Harry Riches	County Agent, Salem
Joseph F. Pechanec	423 U. S. Courthouse, Portland, 5
J. R. Roaf	408 Governor Building, Portland
S. W. Cellers	Buchanan-Cellers Grain Company, McMinnville
J. R. McCambridge	E. F. Burlingham & Sons, Forest Grove
Leo Herb	744 North 12th, Corvallis
Arthur Donavan	415 South 11th Street, Corvallis

Kirt Skinner	Van Waters & Rogers, Portland
Larry Blue	Van Waters & Rogers, Portland
Ira Stauss	Western Chemicals, Portland
H. C. Danforth	American Cyanamid Company, 3508 West Interstate, Portland
C. F. Howell	Vale Irrigation, Vale
J. L. Claflin	1924 S. E. 67th Avenue, Portland
F. H. Schiller	1924 S. E. 67th Avenue, Portland
A. P. Sprague	California Packing Company, Salem
Linn Harris	Chipman Chemical Company, North Portland
Gene Bates	Chipman Chemical Company, North Portland
F. D. Carroll	Zehrung Chemical Company, 2201 N. W. 20th Avenue, Portland
Ben Reed	Zehrung Chemical Company, 2201 N. W. 20th Avenue, Portland
Joseph E. Mills	Birdseye-Snyder Division, Hillsboro
L. E. Wright	Junction City
Keith Sime	Chipman Chemical Company, North Portland
E. H. Bingenheimer	210 State Street, Salem
C. E. Ctis	Dow Chemical Company, 2745 Arnold Way, Corvallis
Earl J. Chartrey	Route 1, Box 137, Clatskanie
J. B. Rodgers	Head, Agricultural Engineering Department, Oregon State College, Corvallis
D. D. Hill	Head, Department of Farm Crops, Oregon State College, Corvallis
Joe Schuh	Box 101, Gresham
E. M. Nelson	County Agent, The Dalles
F. E. Price	Assistant Dean, Oregon State College, Corvallis
Dean Anderson	Northwest Canners Association, 514 Board of Trade Building, Portland
Phillip Beilke	3410 Sunnyview Avenue, Salem
Roy E. Miller	Miller Products, 1932 S. W. Water Avenue, Portland
Claude J. Snow	Invasion Service Company, 1017 S. W. Washington, Portland
M. G. Huber	Extension Agricultural Engineer, Oregon State College, Corvallis
Harry Schoth	Senior Agronomist, USDA, Corvallis
Webb B. Hayes	Monsanto Chemical Company, 5660 S. W. Menefee Drive, Portland
C. E. Hesp	G. M. Whitney Company, Athena
R. D. Boatman	Route 1, La Grande
James Hill, Jr.	Box 798, Pendleton
J. A. Keeler	Route 1, Pilot Rock
Robert Rieder	Shell Oil Company, Portland
John Craig	Willamette Weed Chemical, 1972 Emerald Street, Eugene
William Craig	Willamette Weed Chemical, 1972 Emerald Street, Eugene
J. N. Frowein	Pacific Supply Co-op., Box 3819, Portland
Chas. Starker	Pacific Supply Co-op., Box 3819, Portland
Tom Fraser	American Cyanamid Company, Pendleton
J. V. Walters	1204 N. W. 20th, Portland
Bill Sutton	California Spray Chemical Company, Portland
Virgil Freed	Farm Crops Department, Oregon State College, Corvallis
Jean Scheel	Extension Service, Oregon State College, Corvallis
R. V. Sluman	Swift and Company, North Portland
K. B. Peterson	Wasco County, A. C. A., The Dalles
George Bain	Assistant County Agent, Malheur County, Ontario
Herold Loughead	California Spray Chemical Company, Portland
Frank McKennon	State Department of Agriculture, Salem

UTAH

Harold Hirst	Bureau of Reclamation, Salt Lake City
George L. Hobson	412 State Capitol, Salt Lake City
Wynn Davis	State Department of Agriculture, Brigham City
T. L. Blanchard	Smithfield
H. W. Gore	Richfield
Emil Savage	Porter Walton Company, 522 South Third West, Salt Lake City, 4
H. S. Snyder	F. C. Olsen Company, Provo
F. C. Olsen	F. C. Olsen Company, Ogden
L. W. Thatcher	Wasatch Chemical Company, Salt Lake City
A. Stark	Wasatch Chemical Company, Salt Lake City
Ray Whiting	State Department of Agriculture, Ogden

WASHINGTON

H. W. Leonard	Winlock
G. D. Radebaugh	Blue Mountain Canneries, Dayton
E. J. Kreizinger	Extension Service, Washington State College, Pullman
W. C. McMinimee	301 Courthouse, Yakima
Willard Crawford	Pacific N. W. Crop Improvement Association, Walla Walla
E. W. Brockman	Chipman Chemical Company, 121 Madison, Spokane
R. S. Braucher	Dow Chemical Company, 1702 Textile Tower, Seattle
C. Spencer Clark	Chemi-Serve, 7315 East Marginal Way, Seattle
Louis P. Smith	Van Waters & Rogers, 4000 First Avenue South, Seattle
M. J. Benjamin	Van Waters & Rogers, North 809 Washington Street, Spokane
A. E. Bonn	Van Waters & Rogers, 4000 First Avenue South, Seattle
William H. Tyler	Waterville
P. J. Blanchett	Dow Chemical Company, Seattle
C. E. Graves	DuPont Company, P. O. Box 1563, Tacoma
W. A. Shearing	Route 2, Selah
H. S. Schaad	State Department of Agriculture, Olympia
Henry Williamson	State Department of Agriculture, Olympia
C. L. Moon	Soil Conservation Service, Sunnyside
S. P. Swenson	Assistant Director, Experiment Station, Washington State College, Pullman
Chris Diede	American Chemical Paint Company, 204 Meadow Street, Renton
Fred A. Kirsch	California Spray Chemical Company, Yakima
J. L. Toevs	Bureau of Reclamation, Ephrata
L. G. Koch	General Electric Company, Richland
Moyle Binns	General Electric Company, Richland
H. C. Danforth	2203 First Avenue South, Seattle 4

WYOMING

Chas. E. Allen	Seed Laboratory, Laramie
F. A. Chisholm	Extension Agronomist, Laramie

KANSAS

F. L. Timmons	Hays Experiment Station, Hays
G. L. McCall	E. I. DuPont de Nemours, Manhattan

MARYLAND

A. G. Norman	Chief C Division, Chemical Corps, Camp Detrick

MICHIGAN

Keith Barrons	Dow Chemical Company, Midland

NEBRASKA

Noel Hanson	Department of Agronomy, University of Nebraska, Lincoln
W. L. Klatt	State Department of Agriculture, Lincoln

PENNSYLVANIA

Franklin D. Jones	American Chemical Paint Company, Ambler

TEXAS

W. H. Mercer	Bureau of Reclamation, Amarillo

VIRGINIA

R. H. Bogle	USDA, Alexandria

WASHINGTON, D. C.

L. W. Kephart	Weed Specialist, Division of Cereal Crops and Diseases, USDA, Washington, D. C.
R. B. Balcom	Bureau of Reclamation, Washington, D. C.

CANADA

Cecil Tapp	Department of Agriculture, Postal Station "C", Vancouver, B. C.