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PREFACE

This first comprehensive Research Progress Report is to be considered a supplement to the Proceedings of the 1952 meeting of the Western Weed Control Conference. The objectives of this Report are to provide brief representative reports and as comprehensive coverage as possible of the progress that has been made in research on the different phases of weed control since the last Conference meeting in 1950.

This Report represents the combined efforts of 68 individual contributors working in 14 project committees. It has been possible to assemble the current information on weed control in the Western Region only through the close cooperation and persistent efforts of the 16 men who prepared the project summaries and summary tables and of the committee members and other individual contributors. The Chairman wishes to express his gratitude to all of those whose assistance and cooperation have made possible this 1952 Research Progress Report. Special recognition is due Mr. V. F. Bruns for his capable work in directing and supervising the paging, indexing, mimeographing, collating, and binding of the Report during the Chairman's absence.

Three indexes were prepared to facilitate the locating of information easily. The Project Index lists the pages on which the various project summaries, followed by individual reports, may be found. In all cases the project summary immediately precedes the individual reports which it summarizes. The Contributor Index lists all pages on which the contributor is listed as author or co-author of individual reports or summaries. Names of contributors and their addresses, if known, are given so that they may be contacted if desired. The Weed and Crop Index lists pages on which the response of weedy species or crops to herbicidal treatments are described. This index may be consulted in order to determine where information on a certain weed or crop plant may be found. Frequently, a species may be cited more than once on a single page.

It is the hope of the Research Section that this Report will be of value to extension workers, regulatory personnel and industrial representatives interested in weed control as well as to research workers. The degree to which this hope is realized may determine whether separate Research Progress Reports will be assembled for Conference meetings in the future.

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1. Broadleaf Perennial Weeds (except on range land)
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2. Perennial Weedy Grasses
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   B. Classification of Woody Plant Responses to Herbicides
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C. Classification of Annual Weed and Crop Responses to Herbicides

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10. Submersed Aquatic Weeds

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13. Use of Herbicides for Control of Weeds in Drying and Maturing Crops

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14. Economic Studies of Weed Problems and Control

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PROJECT 1. BROADLEAF PERENNIAL WEEDS

Bruce J. Thornton, Project Leader

SUMMARY

Six cooperators presented nineteen reports which actually covered twenty-three tests, since one report included the results of tests on four different weeds. Eight weeds were involved in the tests reported.

Field bindweed proved to be quite resistant to 2,4-D under certain conditions, showing considerable regrowth after three years of spring and fall treatments. In another test 2,4-D proved to be a valuable supplement to cultivation in controlling bindweed in a cherry orchard with no evident injury to the trees. Root studies of bindweed treated with 2,4-D indicated depth of kill resulting from different treatments and showed reduction of regrowth to be closely correlated with depth of root kill but that recovery was very rapid in the absence of competitive crops or follow up treatments.

Six reports had to do with the control of Canada thistle. The combination of cultivation, use of growth-regulating herbicides, and cropping to grain, appears to give promise and is being continued. The application in an apple and pear orchard of 2 lbs./A of 2,4-D in the sodium or amine salt form at the pre-bud stage in spring and again in the fall for four years practically eliminated Canada thistle without injury to the trees. The application for two successive seasons of 2 lbs./A, 2,4-D as the sodium or amine salt, methyl, ethyl, or butyl ester followed the third year with an ester at 2 lbs./A. and the fourth year with a 1 lb./A. spot treatment gave 99% control of Canada thistle in an irrigated grass pasture. Canada thistle also was reduced 99% with four years treatment with the amine salt at 2 lbs./A. In one test, however, six years treatments with a wide range of formulations and rates failed to reduce a Canada thistle infestation to any great degree.

Five years treatment of Russian knapweed in a favorable soil moisture location, subject to grass invasion, resulted in 99% reduction of the knapweed with the differences in effectiveness of formulations or rates decreasing as the test progressed. Another report indicated amine to be superior to ester in controlling knapweed and 2,4-D to be superior to 2,4,5-T or combinations of 2,4-D and 2,4,5-T. One years treatment with amine at 6 lbs./A. gave 90 to 99% control. The 2,4-D esters were most effective at 5 lbs./A., increasing this rate being of no benefit. A progress report indicated that after 2 years the most effective treatments with 2,4-D reduced the knapweed between 70% and 80% with no difference evident between amine and ester formulations, but with some difference apparent between rates and time of year of application.

Repeated applications of 2,4-D esters or amine at 2 lbs./A. over a four-year period reduced leafy spurge 25% to 45%. Under favorable conditions 4 lbs./A. of the amine or ester of 2,4-D was as effective as 8 lbs. but the latter rate was more effective under dry conditions. Seven treatments in three years at 1, 2, 4, and 6 lbs./A. reduced leafy spurge 70%, 85%, 90%, and 95% respectively. Combinations of amate with 2,4-D were more effective in reducing this weed than either one alone, a 100 lbs. amate + 4 lbs. 2,4-D/A. combination giving a 95-100% reduction. Prochlor gave complete eradication of leafy spurge at 600 lbs./A. injected at 6 and 8 inches, and at 500 lbs./A. injected at 6 inches, being superior to carbon disulphide at 2400 lbs./A. Emulsified 2,4-D

was found to be inferior to 2,4-D ester and the low volatility formulation was found to be somewhat superior. Another report indicated polybor at 30 lbs./sq.rd. and polybor-chlorate at 15 lbs/sq.rd. to give 99% reduction of leafy spurge with sodium chlorate at 3 and 6 lbs./sq. rd. giving 72% and 87% reduction respectively.

White top was reduced 75% with one application of the amine or ester of 2,4-D at 2 lbs./A. and 95% to 98% when repeated for four years. One application of the amine or ester at 4 lbs./A gave 90% control. Esters proved more effective than amine or sodium salt of 2,4-D in controlling white top under dry land conditions, rates of 1, 2, 4, and 6 lbs./A. all being effective where bromegrass was in competition. However, these rates did not control white top after four years treatment where brome grass was not present. Amate and 2,4-D combinations were superior to 2,4-D alone and low volatility ester appeared somewhat superior to the regular ester. 2,4,5-T was inferior and endothol was relatively ineffective. In another test the combination of cultivation and competitive cropping with the use of 2,4-D proved effective in the control of white top, three seasons giving 99% reduction when corn was used and 95% in two seasons using fall wheat. Delayed cultivation for two seasons gave 95% reduction but there was no crop return.

The treatment of silver leaf poverty weed in Lico barley at the late boot stage with the sodium salt of 2,4-D at 1 lb./A increased the yield 16% while at the other extreme the butyl ester at 1 lb./A. reduced the yield 38% and at $1\frac{1}{2}$ lbs./A reduced it 59%.

Treatment of biscuitroot infested dry land winter wheat resulted in reduction of the weed stand from 70% to 5 or 10% and increased the yield of wheat from 15 bushels to 40 bushels/A.

A single application of an ester of 2,4-D at 4 lbs./A. before the appearance of the flower stock or two years applications at 2 lbs./A. gave good control of wild onion, the ester being superior to the amine form. Some residual effect on the wheat was observed the following year which was increased by the additional spring application especially at the 4 lbs./A. rate.

REPORTS OF INDIVIDUAL CONTRIBUTORS

Results of three year's treatment of field bindweed with 2,4-D on irrigated heavy type soil. Thornton, Bruce J. This test is reported to illustrate that, although field bindweed generally is quite susceptible to 2,4-D formulations, it may be quite resistant, as experienced in this and other trials in the Arkansas Valley in Colorado. The test involved the isopropyl ester of 2,4-D at 1 and 2 lbs./A., the amine salt at 2 and 4 lbs./A., spring and spring plus fall applications, the use of oil as a spreader, and three rates of water in the spray solution. Each treatment was replicated three times and the land was un-cropped during the period of the test. Altho there was considerable variation in results from the first years treatment, observations made after three years treatment indicated that the different formulations and rates used had very little effect upon the results, the 1 and 2 lbs./A. isopropyl ester and 2 and 4 lbs./A. amine salt of 2,4-D showing no appreciable difference in effectiveness. Again spring plus fall applications appeared superior to a single spring application the first year, but after three years no difference was evident. Applying the materials in 5, 10, and 20 gal./A. of water had no appreciable effect on results and adding diesel oil to the spray solutions at the rate of 1 gal./A. was of no benefit. Reduction of the bindweed after the three years treatment approximated 80% which is less than frequently obtained with a single application in tests in other locations. Observations indicate that continuing the treatments, without benefit of competitive cropping or other supplementary measures, will result in little, if any, further reduction in the bindweed. (Contributed by the Colorado Agricultural Experiment Station.)

Control of field bindweed in cherry orchard. Thornton, Bruce J. In 1946 tests were conducted to determine the possibilities of using the 2,4-D herbicides in controlling bindweed under orchard conditions, the tests being located in a 10 acre sour cherry orchard which was quite heavily infested with field bindweed. Sodium salt, amine salt, methyl ester, and butyl ester, were used at 2 lbs./A., the treatment being replicated 3 times. Date of application tests were also made at six dates through the summer using the amine salt at 2 lbs./A. In a field test the following year the entire orchard was sprayed with a boom extending between the trees and giving full coverage, using the amine salt at 2 lbs./A. Very little bindweed was evident in 1948 and control was limited to ordinary orchard cultivation. In 1949 a limited area, apparently the original infestation, showed about fifty percent recovery with little bindweed in the rest of the orchard. Test applications were made in the infested area in July, the bindweed being in early bloom, having received an early cultivation. The amine salt at 1 lb./A. and 2 lbs./A. and a heavy ester at 1 lb./A. were applied, using water, water plus oil, and water plus a spreader, as carriers. Each treatment was replicated five times. The treated plots showed an average regrowth of less than 10 percent with no significant difference between treatments except that the addition of oil consistently reduced the effectiveness of the amine treatments although showing no effect in the ester treatments. Although there was considerable curling of the leaves of the lower branches and sprouts of the cherry trees which were directly contacted by the various sprays no instances of permanent injury to the parent tree were noted. The results indicated the judicious use of 2,4-D herbicides to be an effective supplement to cultivation in controlling field bindweed in orchards of this type. (Contributed by the Colorado Agricultural Experiment Station.)

Depth of kill of bindweed roots as result of treatment with 2,4-D and 2,4,5-T formulations. Thornton, Bruce J. One-half rod plots of field bindweed were treated on September 14 with the butyl esters of 2,4-D and 2,4,5-T at 1/4, 1/2, 1, and 2 lbs./A. and the amine salt of 2,4-D at 1/4, 1/2, 1, 2, 3, and 4 lbs./A. The bindweed was in bloom stage, with fair soil moisture, having been cultivated earlier in the season. Treatments were replicated three times. Depth of kill as determined by digging a representative number of plants from each plot, approximately six weeks later, varied from 0 to 10 inches, with treatment averages running from 0.1 inch root kill for 1/4 lb. amine salt of 2,4-D to 6.7 inches for the 1 lb. butyl ester of 2,4-D and 6.5 inches for the 3 lbs. amine treatment. The 2 lbs. butyl ester of 2,4-D and 2,4,5-T and the 4 lbs. amine salt of 2,4-D ranked next with an average depth of root kill of approximately 5 inches each. The 1/4 lb. and 1/2 lb. treatments were much less effective, the average for all formulations being 1.5 and 2.6 inches respectively, with the 1/2 lb. butyl ester of 2,4-D being high with an average depth kill of 3.4 inches. The reduction of the bindweed as indicated by new top growth at the time of making the root studies was closely correlated with the root kill, averaging 12% regrowth for all plots, but this correlation was not strongly evident in July of the following year when the ester plots averaged 64% return growth and the amine plots 72%, indicating the ability of perennial weeds to recover rapidly from treatment in the absence of competitive crops or follow up treatments. (Contributed by the Colorado Agricultural Experiment Station.)

The effects of 2,4-D on Canada thistle in orchards. Bruns, V. F. In 1948, initial applications of an amine and sodium salt of 2,4-D were made at rates of 2, 3, and 4 lbs./A. during the "rapid-growth pre-bud," "bud," "full bloom," "early fall regrowth," and "late fall regrowth" stages of Canada thistle under pear and prune trees (6 treatments randomized within 3 blocks and repeated on 5 different dates). Retreatments were made on the "pre-bud," and "full bloom" stage-of-growth plots in September, 1948. Retreatments thereafter were made on all plots in the spring and fall of 1949, 1950, and 1951. All retreatments were made with the same chemicals and at the same rates as the initial applications. Plots treated originally in the spring and in the fall received a total of 7 and 6 relevant applications, respectively. The experimental orchard is more or less sub-irrigated and the soil has a high salt content.

Original applications at the "pre-bud" stage of Canada thistle, followed by retreatments in the fall, gave the best initial results. However, the earlier differences diminished greatly with retreatments. Under the orchard conditions, the sodium and amine salts of 2,4-D appeared equally effective. The original applications of 3 and 4 lbs./A. of 2,4-D were slightly more effective on Canada thistle than 2 lbs./A. Subsequent retreatments obliterated the initial differences and apparently there was no advantage in applying more than 2 lbs./A. per treatment in this experiment. Canada thistle has been eradicated on 25 of the 90 plots under test. Based upon number of plant shoots, the original stand has been reduced 98.5% as an over-all average.

Special precautions were taken in making the 2,4-D applications and no visible injury to the fruit trees was detected. Chemicals for this experiment were furnished by the Dow Chemical Company. (Contributed by the Div. of Weed Investigations, BPISAE, USDA, and Washington Agriculture Experiment Station, cooperating.)

Treatment of Canada thistle in a thrifty, well irrigated grass pasture with 2,4-D. Thornton, Bruce J. The sodium salt, amine salt, methyl ester, ethyl ester, and butyl ester were applied at the rate of 2 lbs./A. Applications were made at the very early bloom, full bloom, and late bloom stages, the treatments being replicated three times. Soil moisture was good at all times due to frequent irrigation. Readings in July of the third year indicated the early bloom applications to have resulted in a reduction in the Canada thistle of 94%, the full bloom applications a reduction of 92%, and the late bloom applications a reduction of 86%. There were no consistent differences evident in the effectiveness of the different formulations. Digging revealed root kills up to 14 inches. On July 8 of the third year the generally sparse stand of Canada thistle with plants ranging from a few inches to eighteen inches, was given an over-all application of butyl ester at 2 lbs./A. Return growth was very slow the following (fourth) year and by the 17th of September consisted of stunted sickly plants varying in amount from 0 to 5% on the individual plots. This time a spot treatment of 1 lb./A. of isopropyl ester was applied. The following fall the over-all reduction was over 99%. No additional treatments have been made but no increase in the thistle has been apparent over the past two years. (Contributed by the Colorado Agriculture Experiment Station.)

Resistance of Canada thistle to control by use of 2,4-D as evidenced by 6 years test. Thornton, Bruce J. The replicated plots were located on a fairly fertile irrigated farm, but suffering from a shortage of water. Original treatments were made in 1945 at pre-bloom stage using 2,4-D in Carbowax, the sodium salt, the amine salt and the ethyl ester of 2,4-D at 1, 2, 3, and 4 lbs./A. In 1946 Butyl ester was substituted for the 2,4-D in Carbowax, applications again being made at pre-bloom stage with favorable soil moisture conditions. In 1947 the thistle was mowed and treated in September when in a luxurious heavy rosette stage, the isopropyl ester being used at 1, 2, 4, and 6 lbs./A. In 1948 applications were made at the late bud stage and again in September at the rosette stage with several formulations of 2,4-D and one of 2,4,5-T at rates up to 4 lbs./A. No treatment was applied in the spring of 1949 and by the middle of September the average regrowth of the Canada thistle approached 90% with no difference between rates or formulations indicated. The treatment was repeated on the north halves of the plots at this time but by the latter part of June of the following year the growth was as strong or stronger than the previous September, the north halves of the plots showing no effect from the treatments made at that time. During the period of the test the field was cropped to corn and barley with the last three years in alfalfa. However the thistles were treated as an isolated patch except that the infested area was plowed and irrigated, when water was available, with the balance of the field. All treatments were applied under favorable plant and soil moisture conditions.

Lack of competition with tolerant crops and the frequent extended dryness of the field, due to lack of irrigation water, no doubt contributed to the poor results but cannot be held entirely responsible. Since results of this kind have been evident in other tests and are not uncommon in the field treatment of perennial weeds in general, much further research is needed to determine the factors responsible for this uncertainty in the action of the growth-regulating type herbicides. (Contributed by the Colorado Agricultural Experiment Station.)

The control of Canada thistle by combination methods. Rasmussen, Lowell W. Canada thistle is the most widespread creeping perennial weed in the state of Washington. Previous tests have shown this weed to be somewhat resistant to 2,4-D, generally requiring three or more years to effect a significant reduction in stand density. Large infestations of Canada thistle occur in cropland, and since it is desirable to keep these areas in crops, tests were begun in 1950 to determine the effectiveness of cultivation, cropping and the use of selective sprays, 2,4-D and MCPA, on the control of Canada thistle and the production of crops. A field near Pullman, Washington, which was heavily and uniformly infested with Canada thistle was selected for the study. The test area was plowed on May 15, 1950, and cultivated with a duck-foot cultivator every three weeks throughout June and July. The thistle plants were then allowed to make growth during the remainder of the summer, and on September 14, 1950, one half of the area was sprayed with two pounds per acre of 2,4-D ester. Three weeks after the spraying the entire area, both sprayed and not sprayed, was cultivated with a duck-foot cultivator and then harrowed. On October 15 winter wheat was seeded. There was no apparent 2,4-D injury to the wheat as it emerged in the fall nor when growth resumed in the spring. The fall spraying did not delay the emergence of Canada thistle shoots in the spring.

Thirty-six plots each 12 by 15 feet were staked out in both the fall sprayed and fall not sprayed areas for treatment during 1951. Two materials were used, 2,4-D ester and MCPA ester, at rates of one and two pounds per acre applied at the early bud stage and late bud stage of the thistle. One check or no summer treatment was included making nine treatments. A randomized, balanced incomplete block design with (k - 1) or four replicates was used in each of the areas. At the time of the early bud spraying the wheat was 50 to 75 per cent headed and at the late bud stage the wheat was just past the pollination stage. The sprays were applied with a four-foot boom with four nozzles. A pressure of 30 psi was used and 32 G.P.A. was the volume applied.

The yield of wheat was determined for each plot, and separate analyses were made of the fall sprayed and fall not sprayed areas. Within the fall sprayed area there were no significant differences between any of the treatments nor between the summer treated and untreated plots. The mean yield on all 36 plots was 24.4 - 1.5 bushels per acre. Within the area not fall sprayed, plots treated with the one pound per acre rate of application yielded significantly more than those receiving the two pound rate. The mean of the summer treated plots did not differ significantly from the untreated checks. The mean yield of these 36 plots was 15.0 - 2.5 bushels per acre.

After the wheat was harvested the plots were maintained to permit fall regrowth of the Canada thistle plants as an indication of treatment effect on stand. On October 11, 1951, counts were made within a 1 by 10 foot quadrate in each plot. Within the fall sprayed plots the average number of thistle shoots was 7 per quadrate and the summer treated plots had an average of 20 thistle shoots per quadrate, while the check plots average 41 shoots. These plots will be continued, using spring wheat to be seeded in 1952 and applying the same summer spray treatments. (Contributed by the Washington Agricultural Experiment Station, Pullman, Washington.)

The effects of soil sterilants on Canada thistle infesting irrigation ditchbanks. Bruns, V. F. On October 25, 1949, square rod plots were laid out at various intervals along a 3/8 mile section of Canada thistle infested ditchbank. All plots extended from the top of the ditchbank to the waterline. Four plots, treated with sodium chlorate, were extended to encompass the bottom of the backslope. Twenty treatments were arranged systematically within three blocks. The chemicals applied included sodium chlorate in both the dry and spray forms at 4, 5, 6, and 8 lbs./sq. rod; a proprietary compound, containing approximately 60 percent sodium chlorate, in the spray form at 6, 8, 10 and 12 lbs./sq. rod; a soluble borate, containing 66.6 per cent B_2O_3, in the dry form at 10, 15, 20, and 25 lbs./sq. rod; and a two to one mixture of a soluble borate and sodium chlorate (49 per cent B_2O_3 equivalent and 25 per cent sodium chlorate) in the dry form at 6, 9, 12, and 15 lbs./sq. rod. Rainfall, sufficient to incorporate much of the chemicals with the surface soil, occurred shortly after the treatments were made. Additional precipitation, which was received throughout the fall and winter months, induced leaching. The composition of the large main canal bank was typically rock and light dry soil.

On November 9, 1950, one year after the application, the number of plant shoots per square rod surviving on the relatively dry shoulders and top of the ditchbank ranged from 0 to 5, with all chemicals and rates of application being highly and apparently equally effective. Follow-up applications were limited to an occasional spot retreatment. In the more "subby" area at the base of the backslope the results were not as satisfactory, although 8 lbs./sq. rod of the sodium chlorate practically eliminated Canada thistle on one of the plots. A 2- to 3-foot margin along the water-line proved to be the greater problem area. The number of plant shoots per square rod surviving at the water-line ranged from 13 to 251 and blanket retreatments were frequently necessary. Due to variability, no definite correlation in the effectiveness of different chemicals or rates of application at the water-line was possible.

Although the number of surviving plants along the water-line was further reduced by retreatments, considerable growth of Canada thistle, as well as annual weeds, remained in September, 1951. Evidently, the effectiveness of these soil sterilants was greatly reduced by the high moisture content of the soil along the water-line. On the other hand, nearly 100 per cent control of Canada thistle was maintained on the shoulder and top of the ditchbank following retreatments. Only a few scattered plants, weak and chlorotic, were detected on the otherwise denuded areas in the fall of 1951. (Contributed by the Division of Weed Investigations, BPISEA, USDA, and Washington Agricultural Experimental Station, cooperating.)

Results of five years treatment of Russian knapweed with 2,4-D. Thornton, Bruce J. These plots were located on a wide roadside adjacent to a fertile, well irrigated farm and were characterized by the invasion of native grasses as the knapweed was reduced. Sodium salt, amine salt, ethyl ester, and butyl ester of 2,4-D were applied at the rates of 2, 3, and 4 lbs./A., each treatment being replicated four times. The test period reported covers 5 years. All plots were treated at the pre-bloom stage for the first three years after which only those plots showing regrowth received treatment. Results from the first years treatment indicated the butyl ester, with a reduction of the knapweed of 53%, to be somewhat better than the other three formulations which averaged 43% reduction with no differences between them. The 4 lbs./A. treatment was consistently somewhat better than the 2 and 3 lbs. treatments although the difference was not of practical significance. With two years treatment the amine salt appeared most effective with a growth reduction of 83%, the other three formulations giving practically equal results averaging 73% reduction. The same figures applied to the rates of application, the 4 lbs./A. treatment giving average reduction of 83% and 2 and 3 lbs. being equal at 73%. The third years treatments resulted in further reduction of the knapweed with an overall average of 92%, the amine salt again looking best with 97% reduction, the butyl ester showing 95%, the ethyl 90%, and the sodium salt 89%. The 4 lbs./A. rate showed an average reduction of 99%, averaging 100% for the amine salt, 98% for the sodium salt and butyl ester, and 90% for the ethyl ester. The 3 and 2 lbs./A. rates averaged 92% and 87% respectively. The same trends continued the fourth year with all differences losing significance as the overall reduction reached 95%. After the fifth treatment the knapweed was reduced over 99%. Only 22 plots showed any knapweed to be present, and of these only 6 plots showed over 1% regrowth, most of them reading "trace." Of these 6 plots 3 showed a 10% regrowth. These were adjacent, indicating the presence of the knapweed to be due to environmental conditions, age of original plants, or some other factor or factors rather than treatment differences. The test will be continued to determine whether complete eradication can be obtained. (Contributed by the Colorado Agricultural Experiment Station.)

<u>Progress report on two years treatment of Russian knapweed with formulations of 2,4-D and 2,4,5-T applied in spring, spring and fall, and fall.</u> Thornton, Bruce J. The rather extensive knapweed area on which this test was located was isolated and non-cultivated, being cut off from the rest of the farm by a large irrigation canal. The soil was medium heavy and quite alkaline. The sodium and amine salts, and the ethyl, isopropyl, butyl and two heavy esters (butoxy ethanol ester and propylene glycol butyl ether ester) of 2,4-D were applied at rates of 2, 4, and 6 lbs./A. for the salt formulations and 1, 2, and 3 lbs./A. for the ester formulations, previous tests having indicated about half as much ester as salt to be required to produce the same effects. Treatments were replicated 3 times. Applications were made in the spring at the bud stage, the growth being very heavy and up to 30 inches tall. At the time of the fall applications plots which had received the spring treatments were characterized by plants varying from the rosette to pre-bud stage. The plots receiving only the fall applications were in the bud stage having been mowed earlier in the summer to have them in the proper stage for the late treatments. The spring applications were made in June and the fall applications in September. Since the general pattern of the results of the treatments were quite similar the first and second years, with the reduction of the knapweed averaging 43% the first year and 68% after two years, only the results of the two years treatments are reported. The greater effectiveness of the esters as compared to the salts of 2,4-D as indicated in previous work, was not evidenced in this test, the 2, 4, and 6 lbs./A. rate of the salts with 75% reduction of the knapweed being superior to the 1, 2, and 3 lbs./A. rate of the esters with 66% reduction. At the 2 lbs./A. rate, which was the only rate in the test common to both the salts and the esters, they were equal in effectiveness, each with a reduction of the knapweed of 68%. No difference was apparent in the effectiveness of the two salts at any of the poundages, each giving 68%, 79%, and 78% reduction respectively for the 2, 4, and 6 lbs./A. rates. The esters gave a reduction in knapweed of 57%, 68%, and 72% respectively for the 1, 2, and 3 lbs./A. rates, with some differences in the reductions as based on the different ester formulations, which were such as to indicate the 2,4,5-T ester to be one of the least effective and the heavy esters

to be among the more effective of the ester formulations. Average knapweed reductions for the spring, spring plus fall, and fall applications for the sodium and amine salts were 77%, 80%, and 67% respectively and 69%, 73%, and 62% respectively for the ester formulations, the consistency of these results throughout the tests indicating spring applications to be somewhat more effective than fall applications and that the increased reduction of growth resulting from both spring and fall treatments was not sufficient to justify the increased cost of the combined applications.

What effect the alkalinty of the soil has on the reaction of the salts and esters is problematical. At the beginning of the test very little kochia weed was evident in the area, but with the reduction of the knapweed the plots became strongly invaded by this weed, the growth coming in following treatment and the amount present quite generally being in direct relation to the degree of reduction of the knapweed. Cattle pastured in the area did not graze the knapweed before treatment but, as frequently is experienced, were attracted to it after the application of 2,4-D. A rather interesting angle is that they now graze it inside and outside the test area regardless of whether 2,4-D is applied or not. (Contributed by the Colorado Agricultural Experiment Station)

Effect of 2,4-D, amate, and other herbicides on leafy spurge. Krall, J. L. Replicated square rod plots of leafy spurge were treated with 2,4-D ester at 1,2,4, and 6 lbs./A. during May and July in 1948. The plots were retreated three times in 1949, which included one fall treatment. In 1950 two more treatments were made. The rate of top kill was in proportion to the amount of 2,4-D applied. After the seven treatments in three years the one pound rate reduced the stand 70 per cent, the two pound rate 85 per cent, four pounds 90 per cent, and six pounds 95 per cent.

In 1948 combinations of 33, 66, and 100 lbs./A. of amate with 1, 2 and 4 lbs./A. of 2,4-D as well as 33, 66, and 100 lbs. amate and 1, 2, and 4 lbs. of 2,4-D alone were applied on duplicate square rod plots heavily infested with leafy spurge. The combinations of amate and 2,4-D were more effective than either 2,4-D alone or amate used alone. Combinations of 33:4, 66:4, and 100:4 reduced stands 70-80, 85-90 and 95-100 per cent respectively. Combinations with lower rates of 2,4-D and amate resulted in stand reductions corresponding to the rates applied. A 4 pound retreatment of 2,4-D ester in 1949 did not decrease the per cent of stand in 1950.

During May of 1949 prochlor was tested in heavy infestations of leafy spurge. Rates of 400, 500, and 600 pounds per acre were injected at 4, 6 and 8 inch depths spaced at 12 inch intervals. One plot was treated with 2400 lbs. /A. of carbon bisulfide as a check. Complete eradication was obtained from the 600 pound rate injected at 6 and 8 inch depths and the 500 pound rate 6 inches deep. The 400 pound rate gave 90 per cent at the 6 inch depth and corresponded to the 2400 pound carbon bisulfide plot. In 1950 one plot with prochlor injected 6 inches deep at 500 lbs./A. during late June was only 75% effective, soil moisture evidently being low. The soil where tests were conducted is a clay loam.

In 1950 emulsified 2,4-D and low volatile 2,4-D were applied at 2, 4, and 8 pounds per acre. Compared to corresponding rates of 2,4-D ester, the emulsified 2,4-D was 20 per cent less effective and the low volatile ester was from 5 to 10 per cent more effective. (Contributed by the Montana Agricultural Experiment Station, Central Montana Branch Station, Moccasin, Montana.)

The effect of sodium chlorate and boron compounds on leafy spurge. Thornton, Bruce J. Sodium chlorate at 3 and 6 lbs./sq.rd. and borascu at 15 and 30 lbs./sq.rd. were applied in the dry form; polybor at 15 and 30 lbs./sq.rd. and polybor-chlorate at 7½ and 15 lbs./sq.rd. were applied in the dry form and also as a spray in water. Treatments were made in the fall and replicated three times. Readings a year later indicated the polybor dry at 30 lbs. and the polybor-chlorate wet at 15 lbs. to give 99% reduction in the leafy spurge; polybor wet at 30 lbs. gave 98% reduction and polybor-chlorate dry at 15 lbs. gave 94% reduction. Polybor at 15 lbs. gave 78% reduction for both dry and wet applications and polybor-chlorate at 7½ lbs. gave 67% and 80% reduction respectively for the dry and wet applications. 15 and 30 lbs. borascu (dry) gave 75% and 90% reduction respectively and 3 and 6 lbs. of sodium chlorate (dry) gave 72% and 87% reduction. No difference was evident between the dry and spray applications except with the polybor-chlorate where the spray applications were somewhat more effective, especially at the lower rate which, at this rate, may be a function of uniformity of application. In general it appears that little if anything is gained by applying these materials in the spray form. Plots in the same vicinity which had been treated 4 years previously with borascu showed very little recovery of leafy spurge while those treated with sodium chlorate were becoming quite heavily reinfested. Kochia and Russian thistle invaded all plots except those treated with the sodium chlorate and polybor-chlorate. (Contributed by the Colorado Agricultural Experiment Station.)

A general report on four years of research on the use of herbicides for the control of white top (Cardaria spp.). Krall, J. L. Experiments for the control of white top were started in 1948 at three different locations in Central Montana. All tests were conducted on a square rod basis with either duplicate or triplicate plots. Results were based on uncontrolled checks. At one location brome grass, seeded by the farmer one year before tests were started, aided materially in the control of white top. Corresponding rates of ester, amine, and sodium salt of 2,4-D indicated that under dry-land conditions the ester formulations were more effective. Rates of 1, 2, 4, and 6 lbs./A. of 2,4-D ester, applied twice annually, were all effective after 3 years where brome grass was in competition. However, where brome grass was not a factor the above rates did not effectively control white top even after 4 years of treatment. Relatively low rates of ½ and 1 pound of 2,4-D applied at 2 and 3 week intervals proved to be an endless process as new shoots would appear a few days after treatment. Residual pre-emergence treatments of 2½, 5, and 10 lbs./A. of sodium salt were not as effective as foliar applications. 2,4,5-T was as good but not better than the 2,4-D ester. Combinations of amate and 2,4-D at rates of 100:4, 66:4, and 33:4 gave kills of 30-40, 15-20, and 5-10 per cent better than 2,4-D at 4 pounds per acre. Grass mixtures broadcasted on plots receiving repeated applications of 1, 2, 4, and 6 lbs./A. of 2,4-D did not become established after two years, indicating that residual 2,4-D may have affected germination. Emulsified 2,4-D applied at 2, 4, and 8 lbs./A. was not as effective as the 2,4-D ester. Low volatile 2,4-D ester at rates of 2, 4, and 8 lbs./A. was from 10 to 15 per cent more effective than 2,4-D ester. Endothal at 2, 4, and 8 lbs./A. was relatively ineffective as stand reductions were only 5, 10 and 30 per cent respectively. (Contributed by Montana Agricultural Experiment Station, Central Montana Branch Station, Moccasin, Montana.)

Controlling white top (Cardaria draba) with 2,4-D. Hodgson, Jesse M. White top, often called hoary cress, has proven to be sensitive to 2,4-D treatments. However, stage of growth and plant activity definitely influence the effect of 2,4-D on this plant.

Amine, ester and sodium salt formations of 2,4-D were applied at rates of 1.5 and 3.0 pounds per acre. Plots were one square rod in size and treatments replicated four times.

2,4-D applications were found to be most effective at the bud stage of growth in the spring and on late fall rosette stage of growth in a previous test. This test compared the above rates and types of 2,4-D in control of white top on these two stages of growth. The test applications consisted of single treatments each season in spring or fall, and two treatments per season in the spring and fall.

A comparison of the averages of all treatments on the different dates showed the amine and ester formulations to be about equal in control of hoary cress. The sodium salt was less effective than either amine or ester.

Greatest reduction of white top from any single treatment was caused by the 3.0 pound rate of amine applied to late fall rosette growth. The 3 pound rate of 2,4-D was more effective in controlling white top than the 1.5 pound rate when single applications were made. However, after two or more successive treatments in one season or separate seasons the kill caused by the 1.5 pound rate was much nearer that of the 3.0 pound rate and there was little advantage in using the heavier rate when 4 successive treatments were made. Average kill for the 1.5 pound rate of all materials was 36 per cent from one treatment in the spring. The similar figure for the 3 pound rate was 63 per cent kill. However, after four successive treatments in two seasons (spring and fall each year) the 1.5 pound rate had caused 90 per cent kill and the 3 pound rate 94 per cent kill.

After one season of separate spring and fall treatments of 2,4-D on white top there was 15 per cent more kill caused by the fall treatments, however after two seasons of treatments in spring and fall there was no difference whether treatments were made in the spring or fall.

Two treatments per year spring and fall gave average kill of all rates of 85 per cent after one season as compared to 53 per cent kill for all rates applied once. Again after two seasons white top control on plots treated once each year was only slightly less than on plots receiving treatments twice each year. (Contributed by Cooperative Weed Investigations, Division of Weed Investigations, Bureau of Plant Industry Soils and Agricultural Engineering, U. S. Department of Agriculture and The Idaho Experiment Station.)

Control of white top (Cardaria draba) by combined chemical, cropping and tillage methods. Hodgson, Jesse M. The most effective control of white top (Cardaria draba) was obtained in this test by combining the proven weed control methods of cultivation and competitive cropping with chemical treatments of 2,4-D. This study of the effect of several combinations of competitive cropping, cultivation and 2,4-D spraying on white top was begun in 1948. The combined programs in the test involve 2,4-D as a selective, pre-planting and late fall spray with competitive crops of spring wheat, field corn, winter wheat and barley. Delayed cultivation was compared in two different cropping programs. Untreated plots and plots treated only with 2,4-D were also included. An established infestation of white top was leased for the test and areas 1/10 acre in size were used as test plots. Each treatment was replicated three times in the test.

Field corn and 2,4-D spraying were tested in several combinations. The best program involving corn involved treatment of white top at the bud stage in the spring followed in 8-10 days by plowing, seed bed preparation and seeding field corn. The white top infestation was reduced 99 per cent after three seasons of this program. Field corn that was selectively treated with 2,4-D caused only 60 per cent reduction of white top the first year but after 3 seasons had decreased the white top infestation as much as the one above. The stand of white top on corn plots not treated with 2,4-D increased slightly during the three cropping seasons.

Combination of 2,4-D, cultivation and fall wheat gave very good control of white top in two seasons. This program was begun by spraying white top with 2 pounds of 2,4-D per acre at the bud stage of growth in the spring. Some regrowth on these plots appeared six weeks later. The plots were then cultivated at intervals of 8-10 days after emergence of white top until time for seeding fall wheat. A total of six cultivations were made in the period. The wheat was seeded in the fall and an application of 2,4-D made in the wheat the following spring. This program caused 95 per cent reduction in white top in the two seasons. Delayed cultivation at a 14 day interval the first season and 8-10 days after emergence the second season also caused 95 per cent reduction of white top and involved twenty-one cultivation operations.

Plots treated each year only with amine or ester 2,4-D at 2 pounds per acre had decreased the stand of white top 54 to 64 per cent respectively for the two materials after 3 years. These results show that 2,4-D used alone was less effective in controlling white top than when it was combined with cropping and cultural practices. Also control by cultural practices alone was effective but did not allow any crop return as when 2,4-D and cropping was used during the control period. Observations on untreated check plots indicated that the number of white top shoots had increased 245 per cent during the three seasons. (Contributed by Division of Weed Investigations, Bureau of Plant Industry Soils and Agricultural Engineering, U. S. Department of Agriculture in Cooperation with The Idaho Experiment Station.)

Control of Russian knapweed, leafy spurge, Canada thistle, and white top with growth-regulating compounds. Bohmont, Dale W. Randomized rod-square plots replicated three times were located on uniform infestations of Russian knapweed, leafy spurge, Canada thistle, and white top in 1947 and treated with various rates of 2,4-D and 2,4,5-T, ranging from 1/4 to 2 lbs. per acre. After 3 consecutive years, the 2,4,5-T treatments were discontinued and the rates of 2,4-D were increased to range from 2 to 6 lbs per acre, each concentration being applied both once and twice a year. Thus a comparison was made of the effect of 2,4-D concentrations ranging from 2 to 12 lbs. per acre. Single treatments were made at the bud stage of growth and the double treatments consisted of application at the prebud stage and retreatments on the regrowth about 60 days later. Actual plant counts were made at the time of treatment and the following year to determine the percentage control obtained.

Russian knapweed

The percent control resulting from treatments of 2,4-D or 2,4,5-T have been quite erratic over the 5-year period; however, certain treatments were consistentl more effective than others. The 2,4-D amine formulation has consistently produced better control than a similar concentration of the ester formulation. The 2,4-D is superior to the 2,4,5-T compounds, or mixtures of 2,4-D and 2,4,5-T. The amine formulation at the rate of 6 lbs. per acre applied twice a year has resulted in 9C to 99 percent control after one year's treatment. Lesser amounts of the amine produced 50 to 70 percent control when applied two times a year. The most effective 2,4-D ester treatment was the 4 lbs. per acre treated twice a year. This treatment controlled 75 per cent of the weeds. Heavier rates of the ester did no increase the percent control.

Canada thistle

From an average of 4 years' data no growth-regulating treatment was found to eradicate Canada thistle completely although 2 lbs. of the amine 2,4-D controlled 99 per cent of the original stand. The 2 lbs. 2,4-D treatment was found to be superior to any lesser concentration. Between 50 and 70 percent control was obtained the first year of treatment with the ester or amine; however, additional treatments of the same concentration effected only 5 to 10 per cent additional control each year based upon the original plant counts. Where there was an average of 6 plants per square foot at the beginning of the experiment there remained an average of only 1 plant per 4 square feet after 4 treatments. On the basis of one year's results, the 4 and 6 lbs. per acre of 2,4-D killed 70 to 90 percent after one year's treatment.

Leafy spurge

Control of leafy spurge with growth-regulating chemicals has ranged from 0 to 65 per cent as a result of one treatment per year. Rates of 4, 6 and 8 lbs. per acre of 2,4-D have been more effective than lower concentrations. However, with good growing conditions at the time of treatment, the 8 lbs. concentration has not been significantly better than the 4 lbs. treatment. Where dry conditions prevail, the 8 lbs. treatment of either the ester or amine has produced better control than lesser amounts. Repeated applications of 2 lbs. of 2,4-D of the ester or amine over a 4 year period has resulted in a control of 25 to 45 per cent of the original stand.

White top

White top was effectively reduced by repeated applications of 2 lbs. of 2,4-D amine or ester formulation. An average of 75 per cent control was obtained after one year's applications; additional applications over a period of 4 years has controlled 95 to 98 per cent of the original stand. Those plants which survived 4 previous treatments were very small, unthrifty, and did not bloom the fourth year. One year's data indicates 90 per cent control obtained by applying 4 lbs. of the ester or amine at the pre-bud stage of growth. Treated wheat seedlings growing in the white top stand were not significantly reduced by the 4 lb. treatments and were much more vigorous than the untreated check the following year.

It is apparent from the data presented that 2,4-D is superior to 2,4,5-T for control of Russian knapweed, Canada thistle, leafy spurge, and white top. While 4 consecutive years of 2,4-D applications have controlled as much as 99 per cent of the original stand, no treatment or treatments with growth regulators has completely eradicated the weed in question. Rates of 4 and 6 lbs. of the ester or amine applied once or twice a year appear to be more effective in controlling the hard-to-kill perennial weeds than lesser amounts of 2,4-D. (Contributed by the Wyoming Agricultural Experiment Station.)

Effect on barley of treating with 2,4-D at the late boot stage for silver leaf poverty weed (Franseria discolor). Thornton, Bruce J. Treatment in a field of Lico barley infested with silver leaf poverty weed was delayed until June 19 by a series of rains at which time the barley was about 2½ feet high and beginning to head. The poverty weed was in the flowering stage. Application was made with a tractor mounted boom covering a swath of 24'. Each plot was two boom widths wide and of sufficient length to equal one acre. Treatments consisted of sodium salt, amine salt, isopropyl ester and butyl ester of 2,4-D at 1 and 1½ lbs./A. A heavy rain fell during the night following treatment. Five days later there was little evident difference between the 1 and 1½ pound rates of each formulation but considerable difference in the effects of the different formulations. The plots receiving the sodium salt were normal in appearance. The plots receiving the amine salt were erect but nozzle paths were very evident due to boom being but slightly above the level of the barley. The isopropyl ester plots showed much greater effect, all tending to lodge but especially so in the nozzle paths which were of such width as to comprise about 50% of the plot area. The effects were by far the most severe in the butyl ester plots, the barley being heavily lodged in one direction almost as though a flood of water had passed over the plots. As harvest time approached the barley had recovered and was erect in all plots, being normal in appearance in the sodium salt and amine salt plots but about 3 and 6 inches shorter respectively in the isoprop; and butyl ester plots, the nozzle paths still being evident, especially in the latter. Yield results in bushels per acre for the 1 and $1\frac{1}{2}$ pound treatments respectively were as follows: sodium salt 77.7 and 68.0, amine salt 70.6 and 62.5, isopropyl ester 58.3 and 62.5, butyl ester 41.5 and 27.7. Yield of untreated barley was 67.4. There was no reduction in germination of the barley from any of the plots. Following harvest there was no green weed growth, either annual or perennial, except in the sodium salt plots where a few greenish poverty weeds were evident. Digging revealed depth of root kill of the poverty weed to vary from practically none in the sodium salt plots up to twelve inches in the other plots with little consistent difference between them. (Contributed by the Colorado Agricultural Experiment Station.)

Percentage density of biscuitroot (Lomatium leptocarpus) as related to yield of winter wheat. Tingey, D. C. Biscuitroot, a native of western ranges has invaded a considerable acreage of dry land wheat in northern Utah and southern Idaho. This weed is largely a problem on heavy land with poor internal drainage such that the moisture is retained late into the season. This prevents early spring tillage. This weed matures relatively early and largely completes its growth by the time the land is dry enough to till.

Experiments have been under way for a number of years to determine if this species could be controlled by some of the newer chemicals, particularly 2,4-D. A further objective was to determine how serious a competitor the weed is with dry land wheat as measured by the yield of wheat. This report deals primarily with this latter phase of the study.

Various 2,4-D and 2,4,5,-T products, applied at different rates and at different stages of growth, were made on a series of plots which were treated once each year during 1949 and 1950. From these tests, stage of growth when treated and amount of chemical applied had a pronounced effect on reducing the weed population In 1951 no additional chemical treatments were made on the area. Acre yields of wheat were determined on all the plots treated during the preceding two years. Plots were equivalent to one square rod in area and the wheat yields were determined by taking four square meter samples from each plot.

From this yield data taken from this series of plots with varying density of biscuitroot on them it was possible to determine to what extent biscuitroot was affecting the yield of winter wheat under these dry land conditions. On untreated plots the weed density in 1951 averaged about 70 per cent and the wheat yield averaged about 15 bushels to the acre. On the better chemical treatments the weed density had been reduced to 5 or 10 per cent. Wheat grown under these conditions averaged 40 bushels to the acre. Plots with weed densities varying between these two extremes gave corresponding yields. There was a high negative correlation between the density and wheat yield and the regression was essentially linear. A good part of this effect on wheat is undoubtedly associated with the fact that the biscuitroot, being a perennial, has about the same effect on the land during the fallow year as if a crop of wheat had been grown. The weed apparently neutralizes the effect of the summer fallow as well as competing with the wheat during the year the land is cropped. (Contributed by the Utah Agricultural Experiment Station.)

Control of wild onion in dry land wheat with 2,4-D. Tingey, D. C. Wild onion (Allium acumunatum) is a common weed in dry land wheat throughout Utah. To what extent this early maturing weed reduces wheat yields is not known.

From earlier studies made on land infested with biscuitroot and with a light infestation of wild onion there appeared to be some difference in the effect on wild onion due to the effect of the chemical treatments. The 2,4,5-T and mixture of 2,4,5-T and 2,4-D appeared definitely less effective than the 2,4-D alone. As a result of this data it appeared possible that 2,4-D could be used to control this common weed.

An experiment was started in the early spring of 1950 on an area heavily infested with wild onion. Ethyl ester and tri-ethanolamine salt of 2,4-D were used. These were applied at various rates and at two stages of growth. A major objective was to determine, if possible, to what extent wild onion reduced the yield of winter wheat. The experiment has not advanced sufficiently to determine this latter objective.

Ethyl ester of 2,4-D was definitely more effective in the control of wild onion than was the tri-ethanolamine salt. Amount of chemical needed to get a reasonably good reduction in the stand of wild onion from one treatment was four pounds to the acre. However, one application each year for two years with two pounds to the acre appears to give about equally good control with less damage to the grain. Early applications are necessary before there is any visible appearance of the flower stock. The ester applied early at a rate of four or six pounds to the acre reduced the density of wild onion to 4 per cent as compared to 96 per cent on the untreated plots.

Following the treatments made in 1950 it was observed that these heavy dosages of 2,4-D had caused considerable damage to the wheat. However the yield of wheat on treated plots was about the same as that on untreated. Either the damage to the wheat had not reflected itself in the yield or else the competition of the onion on untreated plots was enough to offset any advantages of the chemical treatments in checking the weeds.

In the fall of 1950 the experimental area was plowed and again planted to wheat. In the late fall of 1950 and again the early spring of 1951 it was evident that there had been a residual effect of 2,4-D which reduced the stand of wheat. Furthermore, there was a definite 2,4-D effect on the plants that did emerge. This damage coupled with re-treatments made in the spring of 1951 resulted in a reduction of about 33 per cent in the yield of wheat for the four pounds treatment of ester applied early as compared to the untreated plots. However where only two pounds of ester was applied in 1951 and six pounds in 1950 the acre yield of wheat was 6 per cent higher than on untreated plots. From this it would appear that most of the reduction in yield in 1951 was associated with the treatment made in 1951 rather than the residual effect on the treatment made in 1950. If this is the case then such plants are relatively more susceptible to 2,4-D injury than normal plants. (Contributed by the Utah Agricultural Experiment Station.)

PROJECT 2. PERENNIAL WEEDY GRASSES

H. Fred Arle, Project Leader

REPORTS OF INDIVIDUAL CONTRIBUTORS

Control of quackgrass with herbicides. Timmons, F. L. Exploratory spray applications made at Logan, Utah, April 6, 1951, compared CMU (3-p-chlorophenyl-1,1 dimethylurea at rates of 20, 40, 60 and 80 lbs./A., sodium trichloroacetate (TCA) at 160 and 320 lbs./A., and sodium chlorate at 480 and 800 lbs./A. All of the treatments were duplicated on plots 15x18 feet which extended across a quackgrass-infested irrigation head ditch and into the edge of an alfalfa field. Approximately five inches of rain were received during the first six weeks after the treatments. The alfalfa field was irrigated twice during the season and water flowed through the head ditch for each of these irrigations.

CMU at 20 lbs./A. reduced the stand of quackgrass 80% on the ditch bank, 75% in the bottom of the ditch and 100% in the field. All heavier rates of CMU gave complete eradication in the field and nearly complete elimination of quackgrass both on the ditch banks and in the bottom of the ditch. There was no vegetative growth in the bottom of the ditch at the end of the season despite the heavy leaching during the use of the head ditch for two irrigations. CMU at 20 lbs./A. reduced the stand of alfalfa in the field 65% and killed all of the alfalfa at heavier rates.

TCA and sodium chlorate were much less effective on quackgrass. At the end of the season the heaviest rate of TCA had reduced the stand only about 70% in the field and on the ditch banks and 50% in the bottom of the ditch. The heaviest rate of sodium chlorate had reduced the stand of quackgrass 95% on the ditch banks but only 30% and 25%, respectively, in the field and in the bottom of the ditch, where two irrigations during the season apparently leached the chemicals from the soil before they could become effective. Both rates of sodium chlorate killed all of the alfalfa but TCA produced only a temporary reduction in vigor from which the alfalfa recovered to full stand and vigor by the end of the season. (Contributed by the Division of Weed Investigations, BPISAE, USDA, and the Utah Agricultural Experiment Station cooperating).

Recent experiments for the control of quackgrass (Agropyron repens). Renney, A. J., Freed, V. H., Laning, F. R. The ability of isopropyl N phenyl carbamate (IPC) to give selective control of many members of the grass family has led naturally to an investigation of its effect on quackgrass. Early work established the need for an oil carrier which would aid the chemical to reach the developing tissues of the grass roots and rhizomes. Five-10 pounds of IPC and 80-120 gallons of aromatic weed oil were used in these earlier trials. Little difference was noted when wettable IPC or emulsifiable IPC was used at the above rates because all the chemical could dissolve in the oil at the rates used. Plots established in 1947 indicated that the quackgrass succumbed quickest when growth was around 9 inches high rather than shorter, probably because the greater leaf area enabled more IPC to be moved to the crown and underground parts. These plots also indicated that the follow up practice (disking) had a definite effect on the control of the quackgrass. Only the replications having a combination of oil carrier for the IPC followed by cultivation gave any significant control. As moisture and temperature relations influence the length of time of residual toxicity of IPC, time of application was examined next. Plots were maintained at the same stage of growth by mowing and were sprayed in May, June, July and August. The percentage control increased from 21.2 in June to 70.1 in August. Similar trials carried out in the months of August, September, and October showed no significant differences at the 5% level for the different times of application. Soil moisture tends to be very low in Oregon soils between July and October. During the summer of 1950, mixtures of IPC and other chemicals were sprayed on quackgrass plots. The combination of maleic hydrazide at 4 pounds per acre sprayed one week ahead of the IPC at 12 pounds gave 88.4% control, the best of those tried. The most recent trials involving 44 treatments were set out in September, 1951. These plots have been given a preliminary reading two months after spraying. When examined, grass in check plots was thick and growing vigorously while the plots showing the best kill of quackgrass evidenced only 2 or 3 blades per 90 square feet. Twelve pounds of 3-chloro isopropyl phenyl carbamate per acre sprayed while rototilling and 180 pounds of trichloro acetic acid (TCA), the latter not rototilled in, gave the best control and were given equal ratings. The regrowth of broadleaf seedlings after 2 months was greater in the TCA than in the 3-chloro IPC plots. It was observed also that where the 3-chloro IPC was rototilled in water and the oil (80 gallons of A.S. 80) applied on the surface 2 days later, the percentage control was comparable to the treatment in which the oil was incorporated with the chemical.

Additional readings and treatments will be made on these plots in the spring of 1952. (Contributed by the Oregon Agricultural Experiment Station.)

The effects of TCA on quackgrass. Bruns, V.F. Two separate blocks were laid out in a quackgrass infested orchard having a relatively high water table during the growing season and subsequently requiring no surface irrigation. Initial applications of the sodium and ammonium trichloroacetates, each at 109, 163.5, and 218 lbs./A, were made consecutively on May 4, 1948, and on approximately the fifteenth of each succeeding month through November. In 1949, a second experiment of similar design was started in an open area of the orchard immediately adjacent to the 1948 experiment. Initial applications of the sodium trichloroacetate only were made in March and on approximately the fifteenth of each following month through November at rates of 130, and 150 lbs./A.

Spring and summer applications of TCA proved entirely ineffective on quackgrass. Undoubtedly, the lack of appreciable rainfall during those periods of the season was the principal factor. Applications made in September, October, and November gave excellent control of quackgrass throughout the following fall, winter, and spring months. However, regrowth of quackgrass on plots initially treated during the fall months began to emerge and develop rapidly during the early part of the following month of June.

Since previous experiments had shown that quackgrass regrowth usually appeared during the early part of June following fall applications of TCA, plots initially treated in August, September, October, and November, 1949, were retreated in April,1950, in order to take advantage of spring rains that might occur. The rates of retreatment were the same as those used for the initial applications. Residue on plots was either burned or raked off before retreatments were made. The retreatments appeared to effect further control of quackgrass throughout the spring and summer months of 1950. However, in October a sufficient number of live roots and rhizomes remained on treated plots to produce top-growth ranging from 5 to 30 per cent as dense as top-growth on untreated checks.

Retreatments were made again on these plots in October, 1950, applying the same rates as used in the previous treatments. Some regrowth of quackgrass occurred on all plots during 1951, even on plots receiving an accumulative total of 450 lbs./A. of TCA. Sheep, which were allowed to graze the otherwise undisturbed experimental area during 1951, showed preference to the quackgrass regrowth on the treated plots and consequently inhibited rapid development and spread of the surviving plants.

Recovery of quackgrass was more rapid on plots initially treated with 109 and 110 lbs./A. than on plots receiving heavier rates of TCA. However, there appeared no advantage in applying more than 130 lbs./A.

No differences in herbicidal value between the ammonium and sodium trichloroacetates were apparent in the experiments conducted on quackgrass. Chemicals for these experiments were furnished by the DuPont and the Dow Chemical Companies. (Contributed by the Division of Weed Investigations, BPISAE, USDA, and Washington Agricultural Experiment Station cooperating.)

Effect of maleic hydrazide on growth of Johnson grass and Bermuda grass. Arle, H. Fred. Applications of maleic hydrazide were made March 27, 1951 to Johnson grass growing along an irrigation canal. The grass, growing from established rhizomes, was 10 to 12 inches tall when treated. The herbicide was applied at rates of 6.66, 13.32 and 26.64 pounds and applied in 160 gallons of water per acre. To improve the wetting characteristics, .05% of a deposit building agent was added. Two weeks following the applications, it was noted that the two highest treatment rates caused a red coloration of foliage and completely inhibited growth. Effects of 6.66 pounds per acre treatment were much less evident. At this time half of each plot was sprayed with an aromatic oil, thus killing all top growth. Thereafter, it was noted that the continued suppression of growth was commensurate with the rates of application. Johnson grass treated at 6.66 pounds per acre resumed normal growth about one month following treatment. At 13.32 pounds per acre, growth was retarded for two months and at 26.64 pounds per acre, growth was suppressed for three months. After the resumption of growth, a few plants on each of the treated plots tended to grow prostrate rather than in their normal erect manner. There was no apparent advantage in following the maleic hydrazide treatment with an application of oil.

The same dosages were applied to Bermuda grass growing along a canal bank on July 31, 1951. Prior to this time, grass was kept under control with periodic applications of an aromatic oil. Approximately ten days following application of maleic hydrazide, the plots were again sprayed with oil. As was the case with Johnson grass, the low treatment rate resulted in only a temporary period of inhibited growth. Results with the two higher rates were more promising and little difference was noted between 13.32 and 26.64 pounds per acre. Both rates have kept the Bermuda grass suppressed during the remainder of the growing season. (Contributed by the Division of Weed Investigations, BPISAE, USDA, and Arizona Agricultural Experiment Station.)

Control of Johnson grass with trichloroacetate. Arle, H. Fred. Seasonal applications of 90% sodium trichloroacetate at 110 and 220 pounds per acre were applied throughout the growing season of 1948. These rates applied during the dry spring and summer months produced an effective top kill but did not result in permanent control. After making retarded growth for five to seven weeks, the grass recovered and grew normally. The same rates applied in October on 10 to 12-inch regrowth following mowing, resulted in practically complete eradication. The October applications were followed within two weeks by a .6-inch rain plus more rain during the winter months. This precipitation apparently caused conditions ideal for maximum results.

During October 1949, TCA was applied to Johnson grass regrowth following mowing. Applications were made at 55, 110, 165, and 220 pounds per acre. Following the application, no effective rainfall was received until mid-December. The low treatment rate caused delayed emergence in the spring of 1950 but did not reduce the stand. All other rates resulted in an almost complete eradication.

During October 1950, applications were made comparing TCA in acid form, applied in oil as a carrier, against 90% sodium TCA. Treatments were made at 65, 87, and 108 pounds per acre on an active ingredient basis. The ensuing months were rainless and it wasn't until the last days of January when 1.5 inches were received. This series of treatments did not compare favorably with those of previous years. Instead of bringing about a reduction in stand, the TCA merely caused delayed emergence, with the grass being somewhat less vigorous than on the untreated areas. Sodium TCA held the grass in check longer than did equivalent rates of the straight acid form. Applications, comparing the effectiveness of TCA on regrowth following mowing as against applications to mature growth were also made in October 1950. TCA applied to regrowth resulted in delayed emergence and reduced the vigor of grass while similar rates had little or no effect when applied to tall , mature grass.

Rates of TCA which had previously proven effective as a foliage application during the fall of the year were applied directly to the soil and stubble of Johnson grass during the dormant period. Applications made during mid-January of 1949 and followed by 1.0 inch of rain during the following week did not produce encouraging results. During the period of normal grass emergence in spring, regrowth was noted on all plots. The terminals showed distorted growth and for several weeks the grass grew very slowly. However, none of the treatments had any permanent effect nor did they reduce the extent of infestation. (Contributed by the Division of Weed Investigations, BPISAE, USDA, and Arizona Agricultural Experiment Station).

Control of Johnson grass with oils. Arle, H. Fred. The use of aromatic oils and other fortified petroleum products for the control of Johnson grass growth along irrigation canals have been investigated during the past several years. During 1947 and 1948, oil applications were made at a definite time interval. Initial treatments were applied in late March, when new growth had reached a height of 10-12 inches. In the experiment which was started in 1947 and continued through 1948, retreatments were made at intervals of 4 and 6 weeks. This work indicated that eradication was most economically achieved when retreatments were made at the shorter interval. Complete eradication was obtained through the use of a commercial aromatic oil in which four applications, requiring a total of 560 gallons per acre were used. At the 6 week interval, nine applications of the same oil applied during two growing seasons, required 760 gallons to produce identical results. In an experiment conducted in 1948, oil applications were made at intervals of 3, 4, and 5 weeks. Again, it was concluded that the most effective results were obtained when grass was sprayed frequently. Following the second application, it was possible to make a reduction in the volume of oil required for coverage. Total volumes required for eradication were, in most cases, less than at the longer interval. Usually, it can not be expected to completely eradicate Johnson grass with four well timed treatments. More often, 75-80 percent will be killed and 3 to 4 additional applications are necessary to complete eradication, thus bringing the total to 650-700 gallons per acre.

The addition of fortifiers, the phenol compounds, have added effectiveness to oils which in themselves show a low degree of toxicity. When added to oils, high in aromatic content, these fortifying agents have not improved their killing ability.

The work with various oils during the past several years has given strong indication that the effectiveness of a general weed oil is based upon, not only the percentage of aromatics, but also upon definite types of aromatics. Tests during the past two years have shown this to be true. Oils were obtained which contained a total of 65% aromatics. Each test sample was comprised of varying amounts of polycyclic and monocyclic aromatics. Thus far, the results have shown a decided superiority for oils containing a high percentage of the polycyclic type. When most of the aromatics in the oil are monocyclic, greater quantities were required and survival also was comparatively high.

Applications of oil-water emulsions in which oil comprised 25-50 percent of the total have usually resulted only in temporary control and eventually proved more expensive than applications of undiluted oil. Further experimental work in which emulsions, containing progressively more oil than water was carried on during the 1951 season. This work indicates a possibility of using some water with oil as an economical and effective treatment for Johnson grass eradication. (Contributed by the Division of Weed Investigations, BPISAE, USDA and the Arizona Agricultural Experiment Station).

PROJECT 3. HERBACEOUS RANGE WEEDS

Dale W. Bohmont, Project Leader

SUMMARY

Thirteen abstracts were received on the ecology or control of 12 herbaceous range weeds. The subject matter can be conveniently grouped into three categories to facilitate discussion, namely: weedy grasses, poisonous plants and other herbaceous weeds.

Weedy Grasses

The use of 7 organic chemicals and 2 hydrocarbon compounds were reported for the control of "weedy bromes" (B. tectorum) or (B. commutatus). Chloro IPC at 6 pounds per acre killed all seedlings under 3/4 inch in height; however, an increased amount of the chemical was necessary to control more mature plants. Compound P-162 at 20 pounds per acre killed all seedlings under 1-1/2 inches in height. Fall applications of oils on weedy bromes were not as effective as spring applications. Spring treatments of 60 gallons per acre of shale kerosene or gas-oil controlled over 90 percent of the bromes without permanent injury to the perennial grasses.

Poisonous Range Plants

Reports on the halogeton problem concerned grass competition, soil sterilization, control with organic chemicals and life history studies. No chemical control measure proved 100 percent effective due to the fact that seeds continued to germinate throughout the growing season, and masked the effect of the control measure. Grass competition, while effective, appears to be limited due to the wide range of adaptation of halogeton. While much of the research is preliminary it is apparent that the halogeton problem is far from being solved.

For the control of such common poisonous range plants as death camas, silvery lupine and locoweed, 2,4-D can be effectively used. In general, 2 pounds per acre of 2,4-D ester per year applied over a two-year period controlled 80 to 95 percent of the original stand. The larkspurs appear to be quite resistant to growth-regulating compounds; however, plains larkspur stands were reduced 75 percent by 2 applications of 2 pounds of 2,4-D. The 2,4-D appears to be equal to or superior to 2,4,5-T on the above plants.

Single applications of 4 pounds per acre of the 2,4-D ester have resulted in as much as 95 percent kill of sneezeweed. Infested areas may be greatly reduced by such cultural practices as tandem disking and seeding to timothy or smooth brome.

Other Herbaceous Range Weeds

One abstract pertaining to rabbit brush indicates it is resistant to 2,4-D and 2,4,5-T. Two reports received on the control of wyethia (mule ear) indicate that it can be controlled with 2 to 4 pounds of 2,4-D per acre. The most effective time of treatment appears to be at the bud to early bloom stage of growth. Increased grass production was observed on the areas where this weed was controlled.

REPORTS OF INDIVIDUAL CONTRIBUTORS

Controlling fall-germinating downy cheat with 3-Chloro IPC and P-162. Blouch, Roger, Fults, J. L., and Thornton, B. J. Applications of several chemicals were made on fall-germinating seedlings of downy cheat (*Bromus tectorum*) in a residual stand of blue gama (*Bouteloua gracilis*) on foothills range west of Fort Collins. These chemicals included 3-Chloro IPC at 3, 6, 12, and 24 pounds per acre, Julius Hyman Co. P-162 at 5, 10, and 20 pounds, CMU at 10 pounds, N. I. X. at 10 pounds, MH30 at $1\frac{1}{2}$ and 3 pounds, sodium TCA at 10 and 20 pounds, and Rosine Amine-D pentachlorophenate at 5, 10, and 20 pounds. The 3-Chloro IPC at 3 pounds and P-162 at 5 pounds were ineffective, but at 6 pounds and 10 pounds, respectively, all cheat seedings under 3/4 inch in height were killed. Twelve pounds of 3-Chloro LPG and 20 pounds of P-162 killed all seedlings under $1\frac{1}{2}$ inches, but where seedling heights ran to 3 inches only the 24 pound rate of 3-Chloro IPC was 100 percent effective. None of the other chemicals tested gave more than 20 percent control of cheat seedlings. No apparent injury to the grama was observed for the 3, 6, or 12 pound rate of 3-Chloro IPC and the 5 and 10 pound rate of P-162, but the 24 pound level of the carbamate and the 20 pound rate of P-162 produced a severe "burning" of the grama foliage. Moisture conditions throughout the initial test period were favorable for the rapid germination and growth of the cheat. Observations and measurements will be repeated in the spring of 1952, and further treatments will be made. (Colorado Agricultural Experiment Station)

Control of weedy bromes in established pasture with shale and petroleum oil fractions. Bohmont, D. W. and Klingman, D. L. Volumes of shale kerosene and gas-oil and petroleum diesel oil ranging from 20 to 60 gallons per acre as undiluted oil and water emulsions and petroleum diesel oil at undiluted rates of 100 and 200 gallons per acre were applied in the fall of 1950 and the spring of 1951 to a uniform infestation of *Bromus tectorum* and *Bromus commutatus* in a native pasture at Lincoln, Nebraska. The treatments were made when the weedy bromes were in the 2 to 4 leaf stage of growth. Transect counts were taken 250 days after the fall treatment and 68 days after the spring treatment to determine the percent control.

The spring treatments were superior to the fall treatments. As the volumes increased from the 20 gallons per acre treatment, increased control was noted. The spring application of 60 gallons per acre of shale kerosene or gas-oil controlled over 90 percent of the weedy bromes. However, a similar rate of shale oil in the fall controlled only 70 percent. The 200 gallons per acre of undiluted petroleum diesel oil was comparable to the 40 gallons per acre shale kerosene or gas-oil in effectiveness and controlled 85 percent of the weedy bromes by spring applications. Volumes of 60 gallons or less of diesel oil were ineffective treatments. The emulsified treatments were not as effective as a similar volume of undiluted oil. The phase of the diluent (whether oil-water or water-oil) was not a controlling factor in determining the toxicity of the emulsion. (Wyoming Agricultural Experiment Station and Weed Division, B.P.I.S. & A.E., Lincoln, Nebraska)

Chemical control of death camas, silvery lupine, plains larkspur and locoweed. Bohmont, Dale W. Randomized and replicated plots were established on uniform infested areas of death camas, silvery lupine, plains larkspur and locoweed in 1947. Concentrations of 2,4-D and 2,4,5-T were applied separately and in combination at 1, 2, and 3 pounds acid per acre. Plant counts were made at the time of treatment and again approximately 12 months later to determine the percent control. All treatments were made at the bud to bloom stage of plant growth.

Death Camas

Although death camas is of the lily family and as such possesses a grass-like leaf, it is susceptible to 2,4-D. The ester formulation was superior to the amine type of 2,4-D as indicated by the fact that after one year's treatment, the 2 lbs. of 2,4-D amine treatment killed only 12 percent of the plants as compared to a kill of 65 percent as a result of the 2 lb. ester treatment. Retreatments the second and third year of the amine controlled up to 67 percent of the plants while 100 percent control was recorded after the third year application of the 2 lb. ester. The 3 lb. ester treatment controlled virtually all of the old plants after one year's application. The various combinations of 2,4,5-T and 2,4-D were not as effective as the 2,4-D formulation alone.

Silvery Lupine

Approximately 75 percent of the silvery lupine plants were killed with one spraying at the bloom stage of plant growth with 2 lbs. of either 2,4-D or 2,4,5-T. The one pound treatment was definitely inferior to heavier rates and controlled 30 to 40 percent after one year's treatment. In addition to killing a large percentage of the old plants, the treatments also prevented the formation of seeds and pods, which in itself, is very important for the prevention of livestock losses due to this poisonous plant. Retreatments the second year resulted in a control of 85 to 90 percent of the plants. It appears that several years' applications are necessary for complete control of silvery lupine.

Plains Larkspur

Delphinium species appear to be rather difficult to control with growth-regulating compounds. The percent control obtained on plains larkspur has varied from 30 to 60 percent when 2,4-D at 2 lbs. per acre was applied. The poor control has resulted when the applications were made during very dry growing conditions, while control of 60 percent often results when the growing conditions are favorable. Second year treatments have resulted in an increased control of 25 to 40 percent. By the addition of a spreader, the salt formulation of 2,4-D was found to be equal to or better than a similar concentration of the ester formulation. An average of the results of 3 experimental areas indicate 75 percent of the old plants were controlled by 2 applications of 2 lbs. of 2,4-D over a two-year period. Plants that survived did not bloom the third year and appeared abnormal.

Locoweed

Locoweed has been found to be susceptible to 2,4-D and 2,4,5-T. Applications of 1 lb. per acre of either the ester or amine controlled 50 to 80 percent of the old plants after one year's treatment. Heavier rates of the ester of 2,4-D controlled over 90 percent of either white or purple locoweed. The ester formulation of 2,4,5-T was not as effective for the control of this plant as the 2,4-D formulations. Second year treatments virtually eliminated all old plants.

It is apparent that growth-regulating materials may be utilized for the control of several common poisonous range plants. It appears that 2,4-D is equal to or more effective than similar rates of 2,4,5-T on death camas, silvery lupine, plains larkspur and locoweed. While it is desirable to remove the poisonous plants in question, it should be remembered that many desirable native broad leafed plants are commonly found in close association with the poisonous plants and they, too, may be removed through the application of herbicides. It is, therefore, wise to be familiar with the problem involved before selective herbicides are used as a weed control measure. (Wyoming Agricultural Experiment Station)

Control of sneezeweed with 2,4-D. Doran, Clyde W. Orange sneezeweed (*Helenium hoopesi*) is a perennial belonging to the sunflower family. It has bright orange-yellow flowers and narrow glossy leaves. Sneezeweed grows on summer ranges in the central Rocky Mountains, where optimum growth is made at 9,000 to 10,000 feet elevation. An indigenous rather than an introduced pest, sneezeweed spreads prolifically on poor overgrazed ranges. Dense stands are now a problem on several national forests in western Colorado, but the plant can be found in all western states with the possible exception of Washington and Montana.

Sneezeweed is poisonous to sheep. It is not a spectacular fast-acting killer like death camas or halogeton. Often it takes all summer to make its kill--the sheep going through various stages of coughing, spewing, emaciation, and shedding wool before death. In other cases, death comes quickly, but the poison is accumulative and seldom do great numbers in a band die at the same time. Some owners hardly realize they have a sneezeweed problem, because the sick and weakened sheep are lost or killed by preditors on the rugged summer ranges. Sheep eat sneezeweed most readily in early spring or late fall when more platable plants are not available. Losses can be avoided by light grazing and careful herding practices as recommended in U. S. Department of Agriculture Circular 691 (Doran and Cassady, 1949). Cattle seldom eat sneezeweed, but heavey infestations of the weed are a problem on cattle ranges from the standpoint of low forage production.

Control of the weed is desirable not only to prevent poison losses, but also as a means of replacing the worthless plant with good grasses. When sneezeweed occurs in dense stands in accessible parks, control with 2,4-D sprays or by cultivation is feasible.

Single application foliage sprays with 2,4-D have resulted in as much as 95 percent kill of sneezeweed. Small scale hand spraying tests were conducted in three Colorado national forests in 1946-47 (Doran, Journal of Range Management, Jan. 1951). Single applications of butyl ester, triethanol amine, and sodium salts were tested in early spring (4-inch leaf lengths), midsummer (pre-bloom, early-bloom, and full-bloom stages), and late fall (fall growth of adventitious buds well advanced). Concentrations of 1, 2, and 4 pounds acid equivalent per acre with both water and distillate oil carriers were tested. These early trials showed that only the highest concentration of 2,4-D, or 4 pounds per acre, was satisfactory for killing sneezeweed, and then only when applied in midsummer. The most effective time of application was at the pre-bloom stage of sneezeweed development. Native grasses were not injured by the 2,4-D treatments, but most of the associated forbs were killed. By 1951 these small plots on the open range have suffered considerable reinvasion of sneezeweed and other weeds. Although native grasses have thickened in stand and have good vigor, they are sparse, and could not be expected to hold out the weeds under heavy grazing pressure.

Larger scale tests on the Uncompahgre national forest with mobile ground spraying equipment in 1948 resulted in 80 to over 90 percent reduction in the number of sneezeweed rosettes. Adjacent plots on both protected and grazed cattle ranges were treated with 4 pounds 2,4-D (ester) and 50 gallons of water per acre. These treatments were compared to check plots receiving no treatment, and with artificially reseeded plots--the reseeding following both chemical and mechanical weed control treatments. The following table shows the number of sneezeweed rosettes on these plots for three years following the 1948 treatments. The air-dry herbage yields of all grasses and weeds were determined by sample clippings in September of 1950 and 1951 on the ungrazed plots. The average annual yields are shown.

Treatment	Number of sneezeweed rosettes adjusted to base of 100: Before Treatment 1948	After Treatment 1949	1950	1951	Ave. yield (1950-51). Pounds per acre: Grasses Native	Grasses Reseeded	Weeds incl. sneezeweed
UNGRAZED RANGE							
Check (no treatment)	100	128	128	82	120	0	700
Sprayed with 2,4-D only	100	9	5	7	935	0	350
Sprayed with 2,4-D and drilled to timothy	100	18	7	2	415	500	110
Sprayed with 2,4-D and drilled to smooth brome	100	20	14	13	470	245	280
Tandem disked (mechanical treatment only and drilled to timothy)	100	10	11	6	20	1245	175
Tandem disked (mechanical treatment only and drilled to smooth brome)	100	11	9	9	15	760	200
GRAZED RANGE							
Check (no treatment)	100	85	78	76			
Sprayed with 2,4-D only	100	16	15	19			
Sprayed with 2,4-D and drilled to timothy	100	6	4	15			
Sprayed with 2,4-D and drilled to smooth brome	100	8	14	7			
Tandem disked (mechanical treatment only) and drilled to timothy	100	5	5	6			
Tandem disked (mechanical treatment only) and drilled to smooth brome	100	6	10	6			

(Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado)

Reaction of small rabbitbrush to 2,4-D and 2,4,5-T in central Wyoming. Kissinger, N. A., and Vaughn, W. T. A species of small rabbitbrush, (probably *Chrysothamnus pumilus*) has shown definite resistance to herbicide treatments which give best control of big sagebrush in central Wyoming. The tops of many rabbitbrush plants are killed back to the root crown the season of treatment. The majority, however, grow new shoots the following year and show no evidence of permanent damage. Limited data indicate that the rabbitbrush is somewhat more susceptible to 2,4-D than to 2,4,5-T. Total plant mortality of up to

50 percent has been observed with 2,4-D treatments made in the last week of June. Treatments made in early June (the optimum period for spraying big sagebrush) have resulted in an average of 30 percent mortality for 2,4-D treatments and 15 percent for 2,4,5-T treatments.

Small rabbitbrush may be a potential problem in many central Wyoming areas suited to chemical control of big sagebrush. Conservative grazing, which will allow a relatively rapid increase in palatable native forage grasses, should follow control of big sagebrush. Such a practice may well prevent a new and more difficult plant-control problem. (Rocky Mountain Forest and Range Experiment Station, Forest Service, Fort Collins, Colorado, and Branch of Soil and Moisture Conservation, Bureau of Land Management, Lander, Wyoming)

Reaction of tall larkspur to 2,4-D and a mixture of 2,4-D and 2,4,5-T. Kissinger, N. A., and Vaughn, W. T. Tall larkspur (*Delphinium barbeyi*), growing at an elevation of 7,000 feet in west central Wyoming, was sprayed when flowers were in the bud stage. Treatment was made on single, 0.01-acre plots with a hand sprayer. One year after treatment there was no visible effect from treatment with up to 6 pounds acid equivalent of Weed-No-More (butyl ester of 2,4-D) in 15 gallons of diesel oil or 15 gallons of water per acre. Treatment with 3 pounds of ACP #1054 (1.2 pounds 2,4-D and 0.6 pounds 2,4,5-T per gallon) in 15 gallons of oil per acre had killed 20 percent of the larkspur plants 1 year after treatment. Vigor of the remaining plants was impaired to the extent that a 50 percent reduction in total foliage was obtained. Follow-up treatments were not made and a larkspur stand equal to the original is expected within one or two growing seasons. (Rocky Mountain Forest and Range Experiment Station, Forest Service, Fort Collins, Colorado, and Branch of Soil and Moisture Conservation, Bureau of Land Management, Lander, Wyoming)

Studies of the herbicidal action of polybor and polyborchlorate on *Halogeton glomeratus* (Bieb.) C. A. Mey. Morton, H. L. and Erickson, Lambert C. The use of soil sterilents on relatively small infestations of halogeton when these infestations are a source of seed for possible large infestations is worthy of consideration in a halogeton control program. To determine the effectiveness of two soil sterilents, polybor and polybor-chlorate, in preventing halogeton growth, 2, 4, and 8 lb. per square rod rates of these materials were applied to halogeton infested plots on July 6, 1950. Treatments were made by applying the dry materials by hand uniformly over each 5' x 5' plot at the desired rates and by mixing the herbicidal materials with 2 qts., 1 qt., and 1/2 qt. of water per treatment plot for the 8-lb., 4-lb., and 2-lb. per sq. rod treatments respectively. Each treatment was replicated three times in a randomized block design.

The effects of thepolybor-chlorate treatments during the 1950 growing season were negligible. The only noticeable damage to halogeton plants was a slight burning of those plants treated with the wet form of polybor-chlorate at the 4 and 8 lb. per sq. rod rates. Inspection of the plots in March and April, 1951, showed that a uniform stand of halogeton seedlings covered all treated plots. By June 1, 1951, many of the halogeton seedlings on the plots treated with polybor-chlorate had died and those surviving were chlorotic and stunted. There were no appreciable differences in the appearance or number of plants surviving on the plots treated at similar rates with the dry and wet forms of polybor-chlorate.

Normal stands of halogeton were present at all times on all of the plots treated with polybor.

The average number of plants and their height in inches are recorded for each of the treatments in Table 1. This table is a composite of the results obtained on the plots treated with dry and wet materials.

Table 1 - Average number and height in inches of halogeton plants on plots treated with 2-, 4- and 8-lb. per sq. rod rates of polybor and polybor-chlorate (readings made Sept. 26, 1951).

Treatment rates (pounds per sq. rod)	Polybor 2	Polybor 4	Polybor 8	Polybor-chlorate 2	Polybor-chlorate 4	Polybor-chlorate 8
No. plants per plot	173.0	125.3	84.6	96.3	96.0	16.7
Plant height (in.)	7.0	8.0	9.0	2.1	0.9	0.3

Treatment with polybor-chlorate resulted in fewer plants per plot with a definite decrease in size and vigor. Plants growing on plots treated with 8 lbs. per square rod of polybor-chlorate showed a prostrate-rosette growth and failed to produce seed. This appearance was less pronounced in plots treated with the 2- and 4-lb. per sq. rod rates, however, no viable seed was produced by plants growing on plots treated with polybor-chlorate. The halogeton plants growing on plots treated with polybor were normal in appearance and produced viable seed. (University of Idaho Agricultural Experiment Station)

<u>The relative toxicity of three forms of 2,4-D and a Dinitro herbicide to Halogeton glomeratus (Bieb.) C. A. Mey.</u> Morton, H. L. and Erickson, Lambert C. The major halogeton infestation in Idaho is within the confines of the Raft River Valley. Numerous herbicidal tests have been run during the past two seasons. The study discussed here was conducted in the Idahome-Malta area. The plots were arranged in a 5 x 5 Latin square design and duplicated at two different sites; one a dead shadscale type and the other a denuded area seeded to crested wheatgrass.

Three kinds of 2,4-D were used: (1) water soluble amine, (2) oil soluble triethonol amine, and (3) propylene glycol butyl ether (low volatile) ester. Also included in the tests were the dinitro ortho secondary butyl phenol (DNOSBP), and the non-treated check. All the 2,4-D compounds were applied at 2 pounds acid equivalent per acre, while the 13 percent dinitro was applied at 1 gallon per acre. The amine forms of 2,4-D were fortified with fuel oil at the rate of 3 gallons per acre. All herbicides were applied in water at a total volume of 20 gallons per acre.

Treatments were applied on April 25, June 11, July 18, and September 4, 1951. These dates corresponding to the growth stages: early seedling, elongation-branching, flowering, and seed maturation.

The numerous tactics, procedures and devices employed in the halogeton-herbicide studies over the past 2 years have demonstrated that halogeton is so versatile and variable in its growth habits that no single sampling system will serve adequately throughout the growing season or at all sites. Thus the post treatment toxicity plant count readings should be made at 2,4, and 6-week intervals on April, June, and August treatments respectively. However, such 2-week readings on the spring treatments would completely disregard delayed germination, which is commonly a major factor, and would lead to misrepresentation of actual conditions. The extreme variability in density of halogeton stands (1 to 300 plants per square foot) makes the selection of the proper size of sample area a unique problem for each site.

The following table is a composite of the data gathered at the 2 sites, showing the average percentage of plants remaining 6 weeks after treatment. The average of all the plant counts taken on the check plots on June 4 was established as 100 percent and any deviations from this mean due to treatment on April 25 are indicated accordingly. The figures presented for the other treatment dates were computed from plant counts made at the time of treatment and after a six-week interval.

Table 1. Average percent of the original stand of halogeton plants remaining as a result of treatments (read 6 weeks after treatment)

	Dates of Treatment				
Herbicide	April 25	June 11	July 18	Sept. 4	Av. Herb
2,4-D H_2O Soluble dimithyl amine	8.1	12.0	29.4	92.2	35.4
2,4-D oil soluble triethanol amine	12.9	21.2	50.1	102.7	46.7
2,4-D LV ester	8.2	1.2	0.0	92.9	25.6
DNOSBP	100.8	58.5	55.2	111.6	81.5
Av. Date	32.5	23.2	34.4	99.8	
Check	100.0	87.3	103.2	103.3	

Observations showed that all the 2,4-D treatments applied on April 25 gave nearly 100 percent reductions in stand. However, when the plant counts were made 6 weeks after treating (June 4) considerable post treatment germination had occurred. These late emerging plants are recorded in Table 1 as the percentage of the original stand. These plants in the April treated 2,4-D plots, due to lessened self competition, were taller and more vigorous and exceeded the check plot yields in both plant weight and seed. The June 11 treatments generally gave excellent stand reductions except on the plots treated with DNOSBP. Only during the 6-week interval following the June 11 treatments was a decrease in halogeton stand on the check plots recorded. This decrease was due to the high soil moisture content at the time of treatment followed by high temperatures and a lock of available soil moisture later in the season. Increases in halogeton stands on the check plots at other dates of treatment are due either to post treatment germination, sampling error, or both. The July 18 treatments were generally not as effective as the June 11 treatments, except the case of the 2,4-D LV ester treatments which gave 100 percent stand reductions. The September 4 treatments gave no appreciable stand reductions. The only visible effect was a delay in maturity of those plants treated with 2,4-D herbicides. This delay in maturity was not sufficient to prevent viable seed formation.

The 2,4-D ester gave the most consistent stand reductions of all treatments used. The addition of 3 gallons of fuel oil to the 2,4-D amine treatments did not raise their toxicity to halogeton to the level of the 2,4-D LV ester. The oil soluble form of 2,4-D amine did not prove to be as effective as the water soluble form. The DNOSBP did not give satisfactory stand reductions at any dates of application. (University of Idaho Agricultural Experiment Station)

Toxicity of two 2,4-D compounds to Halogeton glomeratus as related to hour of day of application. Morton, H. L. and Erickson, Lambert C. Temperature, humidity, light intensity and time of day have been said to be important factors in the degree of toxicity of 2,4-D compounds to certain plants. The influence of these temperature and time-of-day factors upon the toxicity of 2,4-D to halogeton was measured at three dates during the 1950 growing season: June 25, July 25, and August 25.

The dimethyl amine and the isopropyl ester forms of 2,4-D were applied at rates of 1, and 1/2, pound acid equivalent per acre in water at a total volume of 20 gallons per acre. These applications were made at: 6:00 a.m., 12:00 noon, and 6:00 p.m. Treatments were replicated three times in randomized blocks, with all treatments being applied by hand with a 3-gallon knapsack sprayer.

To measure the influence of each treatment, the plants were counted on sample areas in each plot at the time of treatment and again one month after treatment. The accompanying table gives the mean percent stands of halogeton occurring on the treated plots one month after each of the three dates of application. The temperatures shown are the mean temperatures recorded at the time of herbicidal application.

Table 1 - Average percent stands of halogeton one month after treatment with two herbicides at 1 lb./acre and 1/2 lb./acre rates at three dates.

Average temperature	56°F.	90°F.	83°F.	
Time of application	6:00	12:00	6:00	
Herbicide				Herb. Av.
1# Dimethyl Amine	88.4	87.4	113.6	96.5
½# Dimethyl Amine	106.7	80.9	87.4	91.7
1# Isopropyl Ester	54.6	39.8	20.2	38.2
½# Isopropyl Ester	70.1	56.7	73.5	66.8
Time Average	80.0	66.2	73.7	73.3

The greatest reductions in halogeton stand occurred in the plots treated at 12:00 noon when the temperatures were highest. However, the differences in stand reductions were not statistically significant. The stand reductions produced by the 1, and 1/2 pound per acre treatments of the isopropyl ester were significantly greater than those produced by the dimethyl amine treatments at all dates of application.

The percent stands over 100% occurring on the plots treated with 1/2 pound per acre of the dimethyl amine were the result of seed germination in the one month interval after treatment. Damage to the plants occurring on plots treated with 1/2 pound dimethyl amine was noted, but the effectiveness of the treatment is masked by the presence of young seedling occurring on the plots.

These trials indicate that the time of day of herbicidal application to halogeton is not of sufficient importance to make it economically feasible to limit spray operation to a particular partion of the day. (University of Idaho Agricultural Experiment Station)

Chemical control of mule ear. Tingey, D. C. and Cook, C. Wayne. Mule ear (Wyethia amplexicaulis) is a common weed infesting a large acreage on western range and has little or no forage value.

Experiments have been under way since 1947 to determine if the 2,4-D or 2,4,5-T chemicals could be used in the control of this plant. The experiments have consisted of using various 2,4-D and 2,4,5-T products applied at different rates and at different stages of growth and under different environmental conditions. There are three factors which have an important bearing on the control of mule ear. These factors are: stage of growth when treated, chemical used, and rate of application. The weed is most susceptible to the 2,4-D of the 2,4,5-T chemicals when the treatments are made prior to the bloom stage. Treatments made later than the early bloom stage are definitely less effective. The ester form of 2,4-D has been more effective than the 2,4-D amine or the 2,4,5-T. However, the dust from the ester of 2,4-D has been of little or no value in the control of this species. The amount of chemical required to do the job is from two to four pounds per acre and then the weed is not completely eradicated. On treated areas, where there were some grasses present among the weeds there has been a rapid recovery of the grass after the weeds were eliminated.

While there is no doubt but what the weed can be eliminated with 2,4-D it has not been determined whether or not the 2,4-D treatments can be made economically profitable. (Utah Agricultural Experiment Station)

Ecology and control of halogeton. Tisdale, E. W. and Zappettini, George. Work on this project started in the spring of 1950 in cooperation with the Department of Agronomy. Our work to date has included studies of (a) the life history and ecological relationships of halogeton, (b) range reseeding as a means of halogeton control, and (c) the effect of range condition and management practices on the spread and abundance of halogeton. Results obtained so far include the following.

Life history--seed germination begins early in the spring, at rather low temperatures. Some germination occurs throughout the summer following showers. Vegetative growth is slow until warm weather occurs in late June or July. Flowering normally occurs early in July while the seed matures in September and is usually shed before the end of October. Preliminary tests indicate that seed dispersal by wind is quite limited. Apparently the spread of the plant over distances greater than a mile or so must be attributed to man including his livestock and vehicles. Seed production is heavy, averaging about 600 seeds per square foot from moderate stands of halogeton. After a brief fall dormancy the seeds germinate quickly two to three days and with a high percentage, 90-99 percent in the laboratory. No fall germination has been observed in the field. Tests of seed longevity both in the field and under room storage are in progress.

Studies of reseeding as a means of halogeton control are in the preliminary stage. Results to date indicate that (1) a well-established stand of crested wheatgrass will control halogeton, but competition of the weed with the grass seedlings during their first year is vigorous and the mortality of grass may be very high. (2) Much of the area occupied by halogeton offers poor conditions for reseeding, particularly if there is strong competition with weedy species. The use of early cultivation of fall seeded sites or of herbicides applied either the year before or the year after reseeding are all being investigated.

Studies of range condition in relation to halogeton infestation are in progress on a number of range types in Idaho. Large numbers of permanent transects and quadrats are being used to analyze present plant cover and to record any changes which may occur. It is evident at present that halogeton is abundant only on sites where the perennial cover is largely gone or where it is very low in vigor. At present the situation cannot be expressed in a quantitative manner.

One of the most interesting situations encountered in the Raft River Valley has been the invasion of halogeton into large areas where the dominant stand of shadscale had been killed out by a snout moth. The relationships of heavy grazing use, insect infestation, and weed invasion are not fully worked out as yet but will be studied intensively during the next field season. Similar insect attacks on other shadscale ranges would likely lead to the same mass invasion by halogeton, so the problem is one of considerable importance. (Forest, Wildlife and Range Experiment Station, University of Idaho)

Ecology and control of *Hypericum perforatum*. Tisdale, E. W. and Pringle, L. W. Work on this species was not begun until May, 1951, so few results are available yet. The project is a cooperative one with the Departments of Entomology and Agronomy of the University who have been working on the problem for several years. Our particular part of the project includes studies of (a) the rate and extent of natural plant recovery on areas where stands of *Hypericum* are being affected by Chrysolina beetles, (b) procedures and species for reseeding forage plants on areas where natural recovery is not satisfactory, (c) the relation of range condition and management to invasion by *Hypericum*, (d) aspects of the life history of the plant which are closely related to one or more of the above studies.

The work done to date includes the selection of representative study sites on areas where beetle plantings had already been made. The plant cover of 12 of these sites was analyzed intensively during 1951, while less intensive studies were made on six sites. On most of the study areas, annual brome grasses and dicotyledonous weed species, chiefly *Hypericum*, were found to compose the bulk of the plant cover. Desirable perennials are scarce and these sites are most likely to be dominated by annual bromes or other weedy species such as Verbascum and Madia if *Hypericum* is greatly reduced by the beetles.

A start was made on reseeding studies in cooperation with the Department of Agronomy, and one trial was set out in one of the drier areas where goatweed has invaded. The topography and soils of the *Hypericum* infested areas in Idaho create a problem for reseeding since a large part of the area is too steep and/or stony to allow the use of the usual tillage equipment.

Studies on phases (c) and (d) have not progressed to the point where a detailed report is justified. (Forest, Wildlife and Range Experiment Station, University of Idaho)

Response to Wyethia to 2,4-D. Woolfolk, E. J. Spraying mulesears wyethia on high mountain summer ranges in southwestern Montana in mid-July with 6,000 and 10,000 parts of 2,4-D acid (40 percent isopropyl ester), per million parts of water or diesel oil, gave very effective control. The plants were mostly past the bloom stage at the time of treatment. The two spray concentrations were equally effective in reducing the mulesears density. Diesel oil as a carrier for 2,4-D was not superior to water. At the end of two full growing seasons following spraying the study plots were still entirely free of wyethia. (Northern Rocky Mountain Forest and Range Experiment Station, United States Forest Service, Missoula, Montana)

PROJECT A. CLASSIFICATION OF PERENNIAL HERBACEOUS WEED AND CROP RESPONSES TO HERBICIDES

Prepared by Bruce J. Thornton

EXPLANATION

Classification as based on responses to herbicides:

I (Very Sensitive)	Any perennial plant that is killed at indicated stages of growth with optimum application of a herbicide.
II (Sensitive)	Any perennial plant that is controlled by an optimum application of a herbicide at indicated stages of growth and is killed by repeated treatments.
III (Semi-tolerant)	Any perennial plant that is controlled by an optimum application of a herbicide at indicated stages of growth but is usually not killed by repeated applications.
IV (Tolerant)	Any perennial plant that is not controlled by applications of a herbicide at indicated stages of growth and is not killed by repeated treatments.

Abbreviations:

Above Roman numerals are used to indicate response of weed or crop plant to herbicide.

2,4-D = 2,4-Dichlorophenoxyacetic acid
2,4,5-T = 2,4,5-Trichlorophenoxyacetic acid
MCP = 2-methyl-4-chlorophenoxyacetic acid (Methoxone)
A, E, S, indicate amine, ester, or sodium salt. LV = low volatility.
Am = ammonium sulfamate (Amate); AT = ammonium thiocyanate; Bor = boron
CMU = 3-P-chlorophenyl-1,1-dimethylurea; IPC = Isopropyl N-phenyl carbamate
MH = maleic hydrazide; NaC = sodium chlorate; Pbor = polybor;
PborC = Polybor-chlorate

The basis for classification is that adopted by the North Central Weed Conference in their 1950 Research Report.

CLASSIFICATION OF HERBACEOUS WEED RESPONSES TO HERBICIDES

Common Name	Scientific Name	Herbicide and application per acre	State or Province	Spring growth	Bud	Bloom	Fall growth
Agoseris	Agoseris sp.	AE 2,4-D 4 lb.	Colo.		II	II	
Aster, woody	Xylorrhiza parryi	E 2,4-D 1-2 lb.	Wyo.	II	I	I	
Bermuda grass	Cynodon dactylon	TCA 90 lb.	Ariz.				II
Bindweed, field (Small-flowered morning glory)	Convolvulus arvensis	A 2,4-D 1 lb.	Ariz.		II		
		A 2,4-D 1½ lb.	Calif.		II	II	
		AE 2,4-D ½ lb.	Mont.	III	III	III	
		AE 2,4-D ½-1 lb.	Utah	II	II	II	II
		AE 2,4-D 1 lb.	Mont.	II	II	III	II
		AE 2,4-D 1½ lb.	Wyo.	II	II	II	II
		AE 2,4-D 2 lb.	Mont.	II	II	III	
		AE 2,4-D 2 lb.	Colo.		II	II	II
		AE 2,4-D 2 lb.	Idaho		II	II	II
Biscuitroot	Lomatium leptocarpus	AE 2,4-D 2 lb.	Utah	II	II	III	III
		E 2,4,5-T 2 lb.	Utah	II	II	III	III
Bouncing Bet	Saponaria officinalis	AE 2,4-D 2 lb.	Colo.			III	
Burdock	Arctium minus	AE 2,4-D 1-2 lb.	Colo.	I	I	II	
Carrot, false	Pseudocymopteris montanus	AE 2,4-D 4 lb.	Colo.		II	II	
Cattail, common	Typha latifolia	AS 2,4-D 3-4 lb.	Utah	IV		III	
		A 2,4-D 4 lb. plus TCA or Am 20-40 lb.	Utah	III		III	

Common Name	Scientific Name	Herbicide and application per acre	State or Province	Spring growth	Bud	Bloom	Fall growth
Cattail, common (continued)	Typha latifolia	LVE 2,4-D 3-6 lb.	Utah	III		III	
		LVE 2,4-D 4 lb. plus D.oil 5-10 gal.	Utah	II		II	
		Aromatic oil	Utah	II,III		III	
Chickweed, mouse-ear	Cerastium vulgatum	AE 2,4-D 1 lb.	Colo.		II	II	
Chicory	Cichorium intybus	AE 2,4-D 12 oz.	Calif.	II	II	III	II
		AE 2,4-D 1 lb.	Colo.		II	II	
Cinquefoils	Potentilla fillipes and glaucaphylla	AE 2,4-D 4 lb.	Colo.		II	II	
Dandelion	Taraxacum officinale	A 2,4-D 1 lb.	Idaho	I	I	II	I
		E 2,4-D ½-1 lb.	Mont.		II	II	
		E 2,4-D 1 lb.	Idaho	I	I	I	I
		AE 2,4-D 1-2 lb.	Colo.		II	II	
		AE 2,4-D 2 lb.	Utah	II	II	II	II
Danthonia, timber	Danthonia intermedia	AE 2,4-D 4 lb.	Colo.		IV	IV	
Death camas	Zygadenus gramineus	AE 2,4-D 2 lb.	Wyo.	II	II	III	
Dock, curly	Rumex crispus	A 2,4-D 12 oz.	Calif.	II	II	III	II
		AE 2,4-D 2 lb.	Colo.			III	
Dock, veined	Rumex venosus	AE 2,4-D 2 lb.	Colo.			III	
Garlic	Allium vineale	A 2,4-D 1½ lb.	Ore.	III	IV		

Common Name	Scientific Name	Herbicide and application per acre	State or Province	Spring Growth	Bud	Bloom	Fall Growth
Garlic (continued)	Allium vineale	E 2,4-D 1½ lb.	Ore.	II	III		
		E 2,4,5-T 1½ lb.	Ore.	III	III		
Goatsrue	Galega officinalis	AE 2,4-D 2-4 lb.	Utah	II	II	II	II
Goldaster, hairy	Chrysopsis villosa	AE 2,4-D 4 lb.	Colo.		II	II	
Goldenrod, decumbent	Solidago decumbens	AE 2,4-D 4 lb.	Colo.		II	II	
Groundcherry	Physalis lobata	AE 2,4-D 2 lb.	Colo.		IV	IV	
	Physalis subglabrata	AE 2,4-D 3 lb.	Idaho		III	III	
		AE 2,4-D 2 lb.	Utah	IV	IV	IV	IV
		AE 2,4,5-T 2 lb.	Idaho		II	II	
Harebell (Bellflower)	Campanula sp.	AE 2,4-D 1-4 lb.	Colo.	IV	IV	IV	IV
Hemlock, poison	Cicuta douglasii	AE 2,4-D 1 lb.	Colo.		I-II	I-II	
	Cicuta spp.	AE 2,4-D 2 lb.	Wyo.		II	II	
Hemlock, spotted	Conium maculatum	AE 2,4-D 2 lb.	Utah	II	II	II	II
Horsetail	Equisetum arvense	AE 2,4-D 2 lb.	Idaho		II	II	
Johnson grass	Holcus halepensis	TCA 90 lb.	Ariz.				I
Knapweed, Russian	Centaurea repens (picris)	AE 2,4-D 2-4 lb.	Colo.		II-III	III-IV	III-IV
		AE 2,4-D 4 lb.	Idaho		II	III	IV
		E 2,4-D 2 lb.	Mont.	III	IV		
		E 2,4-D 4 lb.	Mont.	III	III		

Common Name	Scientific Name	Herbicide and application per acre	State or Province	Spring Growth	Bud	Bloom	Fall Growth
Knapweed, Russian (continued)		E 2,4-D 8 lb.	Mont.	II	III		
		AE 2,4-D 1-4 lb.	Utah	IV	IV	IV	IV
		A 2,4-D 1 lb. (2 treatments year)	Wyo.	III	II	III	II
Larkspur, low	Delphinium geyerii	AE 2,4-D 2-4 lb.	Colo.		III	III-IV	
		AES 2,4-D 2 lb.	Wyo.	II	II	IV	
Larkspur, Menzesis	Delphinium menzesi	AE 2,4-D 4 lb.	Colo.		II	II	
Larkspur, Tall	Delphinium barbey	E 2,4-D 2 lb.	Wyo.	II	II	II	
Larkspur, tall	Delphinium occidentale	AE 2,4-D 2 lb.	Utah	IV	IV	IV	IV
Lettuce, blue	Lactuca, pulchella	AE 2,4-D 1-2 lb.	Colo.		II	II-III	
Licorice, Wild	Glycyrrhiza lepidota	AE 2,4-D 2 lb.	Colo.		II	II	
Loco weed	Oxytropis lambertii	AE 2,4-D 1-2 lb.	Wyo.	II	I	I	
Lupine, mountain	Lupinus alpestris	AE 2,4-D 4 lb.	Colo.		II	II	
Lupine, silvery	Lupinus argenteus	AE 2,4-D 2 lb.	Wyo.	III	II	II	
Mallow, common	Malva neglecta	AE 2.4-D 2 lb.	Colo.		II	III	
Mallow, alkali	Sida hederacea	AE 2,4-D 1-2 lb.	Utah	IV	IV	IV	IV
Milkvetch, two-grooved	Astragalus bisulcatus	AE 2,4-D 1 lb.	Wyo.	I	I	I	
Milkvetch, narrow leaved	Astragalus bipinnata	AE 2,4-D 3 lb.	Wyo.	II	II	II	
Milkweed, poison	Asclepias subverticillata	E 2,4-D 2 lb.	Colo.		II	III	

Common Name	Scientific Name	Herbicide and application per acre	State or Province	Spring Growth	Bud	Bloom	Fall Growth
Milkweed, purple flowered	Asclepias purpurea	A 2,4-D 4 lb.	Idaho		III	III	
Milkweed, showy	Asclepias speciosa	EA 2,4-D 2-4 lb.	Colo.	IV	IV	IV	IV
Morning glory (large flowered)	Convolvulus sepium	EA 2,4-D ½-1 lb.	Utah	I-II	I-II	I-II	I-II
Mule ear	Wyethia amplexicaulis	E 2,4-D 2 lb.	Utah	II	II		
Mullen	Verbascum thapsus	EA 2,4-D 2 lb.	Colo.		II	II-III	
Nettle, stinging	Urtica sp.	EA 2,4-D 1 lb.	Colo.		II	II	
Nettle, white horse	Solanum elaeagnifolium	A 2,4-D 1-2 lb.	Ariz.	II	II		
Onion, wild	Allium acumunatum	AE 2,4-D 2 lb.	Utah	II	IV	IV	IV
Penstamon, Rydberg	Penstamon Rydbergii	AE 2,4-D 4 lb.	Colo.		II	II	
Pignut, Indian	Hoffmannseggia densiflora	A 2,4-D 1½-2 lb.	Ariz.	II			
Plantain, common	Plantago major	A 2,4-D 12 oz.	Calif.	II			
		AE 2,4-D 1-2 lb.	Colo.		II	II	
Plantain, buckhorn	Plantago lanceolata	A 2,4-D 12 oz.	Calif.	II	II		
Povertyweed, silver-leaf	Franseria discolor	AE 2,4-D 2 lb.	Colo.		II	II	
Povertyweed, mouse-ear	Iva axillaris	AE 2,4-D 2 lb.	Colo.		II	II	III
		AE 2,4-D 1-2 lb.	Utah	IV	IV	IV	III
		AE 2,4-D 2-3 lb.	Wyo.	II	II	II	

Common Name	Scientific Name	Herbicide and application per acre	State or Province	Spring Growth	Bud	Bloom	Fall Growth
Povertyweed, woolly-leaved (bur ragweed)	Franseria tomentosa	AE 2,4-D 2 lb.	Colo.		III	III	
Quackgrass	Agropyron repens	NaC 640 lb.	Ore.	II	III		
		NaC 320-800 lb.	Utah	II-III			I-II
		CMU 10 lb.	Ore.	I	II		
		CMU 20 lb.	Utah	II			
		CMU 40-80 lb.	Utah	I			
		TCA 120 lb.	Ore.	I	II	II	III
		NaTCA 80-160 lb.	Utah	III			III
		NaTCA 320 lb.	Utah	II-III			
		Amate 640 lb.	Ore.	II	I	II	IV
		AT 640 lb.	Ore.	II	II	II	IV
		IPC (oil) 10 lb.	Ore.	III	III	III	II-III
		MH 10 lb.	Ore.	III	III	III	IV
Ragweed, perennial (western)	Ambrosia psilostachya (coronopifolia)	AE 2,4-D 2 lb.	Wyo.	I	I	I	
Sedges	Carex sp.	AE 2,4-D 4 lb.	Colo.		IV	IV	
Skeleton Weed	Lygodesmia juncea	AE 2,4-D ½ lb.	Mont.		III		
		AE 2,4-D 2 lb.	Colo.	II	II	II	

Common Name	Scientific Name	Herbicide and application per acre	State or Province	Spring Growth	Bud	Bloom	Fall Growth
Smartweed, perennial (swamp)	Polygonum coccinium	LVE 2,4-D 3-4 lb.	Calif.		II		
		LVE 2,4,5-T 3-4 lb.	Calif.		II		
Sneezeweed, orange	Helenium hoopesii	AE 2,4-D 4 lb.	Colo.	IV	II	II	IV
Spurge, leafy	Euphorbia esula	AE 2,4-D 2-4 lb.	Colo.		III	III	
		AE 2,4-D 2 lb.	Mont.	III	III		
		AE 2,4-D 4 lb.	Mont.	II	II	III	II
		AE 2,4-D 8 lb.	Mont.	II	II		
		A 2,4-D 6 lb.	Wyo.	III	II	II	IV
		LVE 2,4-D 4 lb.	Mont.		II		
		E 2,4,5-T 4 lb.	Mont.		II		
		2,4,D acid 4 lb.	Mont.		III		
		Prochlor 400 lb.	Mont.		II		
		Prochlor 500 lb.	Mont.		I		
		Prochlor 600 lb.	Mont.		I		
		Endothal 2,4,8 lb.	Mont.		IV		
		Pbor 4800 lb.	Colo.				I
		Pbor-C 2400 lb.	Colo.				I
		NaC 960 lb.	Colo.				II

Common Name	Scientific Name	Herbicide and application per acre	State or Province	Spring Growth	Bud	Bloom	Fall Growth
Thistle, Canada	Cirsium arvense	E 2,4-D 1 lb.	Mont.		III		
		E 2,4-D 2-4 lb.	Mont.		II		
		A 2,4-D 2 lb.	Ore.	II	II	III	II
		A 2,4-D 3 lb.	Idaho	II	II	III	II
		AE 2,4-D 1-2 lb.	Utah	II-III	II-III	II-III	
		AE 2,4-D 2 lb.	Colo.	III	II	III	
		AE 2,4-D 2 lb.	Wyo.	II	II	III	II
		A 2,4,5-T 2 lb.	Ore.	II	III	III-IV	III
		E 2,4,5-T 4 lb.	Mont.		II		
		A MCP 2 lb.	Ore.	I	I	III	II
		A MCP + 2,4-D 1:1 2 lb.	Ore.	I	I	III	III
		NaC 640 lb.	Ore.	I	I	I	I
		CMU 10 lb.	Ore.	II	III	IV	III
Thistle, perennial sow	Sonchus arvensis	AE 2,4-D 1-2 lb.	Utah	II-III	II-III	II-III	
		AE 2,4-D 2 lb.	Wyo.	II	II	III	
		A 2,4-D 3 lb.	Idaho		II	II	II
		E 2,4-D 3 lb.	Idaho		II	III	II
Yarrow, western	Achillea lanulosa	AE 2,4-D 4 lb.	Colo.		II	II	

Common Name	Scientific Name	Herbicide and application per acre	State or Province	Spring Growth	Bud	Bloom	Fall Growth
White top (whiteweed)	Cardaria draba (Lepidium draba)	AES 2,4-D $\frac{1}{2}$ lb.	Mont.	III	II	III	
		AE 2,4-D $1\frac{1}{2}$-2 lb.	Utah	II-III	II-III	II-III	II-III
		AE 2,4-D 2 lb.	Colo.		II	II	II
		AE 2,4-D 2 lb.	Wyo.	III	II	II	II
		A 2,4-D 3 lb.	Idaho	II	II	III	II
		E 2,4-D 2,4,6 lb.	Mont.	II	II	III	II
		LVE 2,4-D 2,4,6 lb.	Mont.	III	III		
		2,4-D acid 2,4,6, lb.	Mont.	III	III		
		E 2,4,5-T 2,4 lb.	Mont.	II			
		Endothal 2,4,8 lb.	Mont.	IV	IV		
White top, globe podded	Cardia pubescens	AE 2,4-D $1\frac{1}{2}$-2 lb.	Utah			IV	

CLASSIFICATION OF PERENNIAL CROP RESPONSES TO HERBICIDES

Common Name	Scientific Name	Herbicides and application rate		State or Province	Pre-emerge	Seedling	Spring Growth	Established
Alfalfa	Medicago sativa	A 2,4-D	3/4 lb.	Mont.			II	
		A 2,4-D	3/4 lb.	Calif.	I	I		II
		A 2,4-D	2 lb.	Colo.		I	II	II
		A 2,4-D	4-8 lb.	Utah	III			
		DN select. 100 gal. water	3-5 qt.	Calif.		IV		
		DN gen. 50 gal. Diesel 70 gal. water	1 qt.	Calif.				IV
		DNOSBP	6-12 lb.	Utah		IV	IV	
		NaPCP	20-40 lb.	Utah		IV		
		NaTCA	4,6,8 lb.	Utah		II		
		NaTCA	80-320 lb.	Utah			III	III
		CMU	1-4 lb.	Utah			III	
		CMU	20 lb.	Utah			II	
		CMU	40-80 lb.	Utah			I	
		NaC	300-800 lb.	Utah			I	I
		IPC	3 lb.	Calif.	IV	IV		IV

Common Name	Scientific Name	Herbicides and application rate	State or Province	Pre-emerge	Seedling	Spring Growth	Established
Clover, ladino	Trifolium repens, var. lutum	A 2,4-D 3/4 lb.	Calif.	I	II		IV
		DN select. 3-5 qt. 100 gal. water	Calif.		IV		
		IPC 3 lb.	Calif.	IV	IV		IV
Clover, red	Trifolium pratense	DN select. 3-5 qt. 100 gal. water	Calif.		III		
		IPC 3 lb.	Calif.	IV	IV		IV
Trefoil, prostrate	Lutus corniculatus	A 2,4-D 3/4 lb.	Calif.	I	I		III
		IPC 3 lb.	Calif.	IV	IV		IV

PROJECT 4. UNDESIRABLE WOODY PLANTS OF FOREST AND RANGE LAND

Clyde W. Doran, Acting Project Leader

SUMMARY

Individual reports that follow present some of the 1950-51 research work being done on Ribes, velvet mesquite, big sagebrush, chamise, live oak, scrub-oak, pinyon, juniper, poison oak, blackberry, rose, snowberry, ash, and alder in the western United States. These reports describe only a fraction of the work accomplished on a few plant species, but are good examples of the type of effort being made to control undesirable woody plants. Wide variations in the nature and size of problems and possible application of research results occur among the plants discussed. For example, Ribes eradication to control blister rust in white pine forests brings to mind an entirely different set of conditions, techniques, and values than the control of mesquite, which infests millions of acres of valuable range and pasture land in the Southwest, or the control of poison oak along roadways, fence rows, and recreation areas. Practical treatment recommendations have been made for some plants, and action programs are under way. For other plants satisfactory control methods have not been perfected, or high costs delay extensive application of research results.

On relatively low-value forest and range lands practical and economical control methods are hard to contrive. The inaccessibility of these lands, the rough topography, variable soils, and growing conditions present innumerable draw-backs to attaining practical plant control. The advantages of range land brush control in increasing the grass cover and facilitating livestock movements may be obvious to the stockman. On the other hand, the watershed manager or the big-game manager might recognize some disadvantages caused by eliminating brush on certain sites. At any rate it is often impossible to prove these advantages or disadvantages on a dollar-and-cents basis.

I will not try to summarize the following reports or prophesy regarding future developments, but merely point out a few interesting high lights. Owing to the many complex factors involved, it is dangerous to generalize treatment results much more than the authors have already done in summarizing results of their work.

In Ribes suppression work, the Bureau of Entomology and Plant Quarantine recognize that (1) a certain variety of one species of Ribes requires a different formulation for spraying than the species itself; (2) effective dosages and volumes of foliage sprays differ for young and old age classes of Ribes and associated brush; (3) both dosage and volume are apparently contributing factors in getting effective kills by basal-stem treatment; (4) oil-soluble dyes, when mixed with 2,4-D and 2,4,5-T formulations act as markers to speed crew work and permit ready supervisory checks of the thoroughness of coverage; and (5) two or more low-dosage treatments have proved to be fully as effective as one or two treatments in which 10 to 20 times as much chemical had been used.

The work on velvet mesquite by the Southwestern Forest and Range Experiment Station shows that the spring season is best for spraying with selective herbicides. This optimum period in the spring is recognized by observation of the growth stage of mesquite. Of several concentrations tested, 5,000 p.p.m. of either the amine or a low-volatile ester form of 2,4,5-T produced the highest percentage of apparent plant kill. Additions of wetting agents to water solutions resulted in significantly higher plant kills. The use of radioactive isotopes to trace the translocation of herbicides in mesquite seedlings shows that movement is very limited. In no case was more than 2½ percent of the material deposited on the leaves moved downward. This

helps to explain why mesquite, with its vigorous sprouts, is so difficult to kill. In an extensive series of airplane-spraying treatments on mature mesquite south of Tucson, Arizona, it was found that soil moisture alone did not have a significant effect on the toxicity of selective herbicides.

The chamise problem is quite important in California, and the Botany Division of the University of California is the first to report on the successful use of chemicals in controlling chamise. The report stresses the important factors contributing to effective control, such as the use of oil emulsions rather than water carriers, and the role of grass competition in reducing the rate of growth and vigor of chamise seedlings. Another report of an experiment on live oak in California shows that although basal-spray treatments alone were not effective, the cut-surface method of applying chemicals was effective in killing live oak.

Results of preliminary tests by the Rocky Mountain Forest and Range Experiment Station in Colorado indicate that basal-bark spraying offers promise for controlling scrub-oak and small pinyon and juniper trees. Limited tests indicate these plants are not generally susceptible to foliage sprays.

Several reports on the control of big sagebrush show that progress has been made in the past 2 years in developing effective chemical treatments. However, variations in the success reported from different sections of the country are perplexing. Both 2,4-D and 2,4,5-T kill big sagebrush when applied in the proper amounts at the proper time. 2,4-D apparently produced very excellent kills of sagebrush on a Bureau of Reclamation project in Strawberry Valley, Utah. A formulation containing both isopropyl and amyl esters of 2,4,5-T appeared most toxic in extensive tests in Wyoming by the Rocky Mountain Forest and Range Experiment Station and the Bureau of Land Management. Colorado Agricultural Experiment Station reports that the same treatment gave different results on different sites -- 65-percent kill on swales as compared to 35- or 36-percent kills on ridge or sidehill. The development or growth stage of sagebrush at the time of chemical application is apparently a very important factor contributing to successful kills. How to recognize this period of greatest susceptibility appears to be difficult. The possibility of using the plant-development stage of associated vegetation to indicate the optimum period may aid in this respect. After it is perfected, chemical control of big sagebrush will undoubtedly find its best use where there is a fairly good understory of native grasses. Release from competition with sagebrush may permit these grasses to spread and become more vigorous. One should remember that big sagebrush may be desirable on some sites; yet undesirable on others. Wherever the range is in need of reseeding, mechanical methods of eradicating sagebrush at present are considered more efficient and economical than chemical control.

Another kind of puzzle that confronts researchers is illustrated by the work at Oregon State College in developing a program to control nuisance shrubs along roadways, fence rows, and drainage ways. One can appreciate the difficulty of formulating a specific treatment that would control poison oak, blackberry, and a half dozen other shrubs occurring in close association.

REPORTS OF INDIVIDUAL CONTRIBUTORS

USE of 2,4-D and 2,4,5-T for Ribes eradication in the western states. Offord, H.R., Moss, V.D., Quick, C.R., and Burrill, W.S. During 1950-51, 2,4-D and 2,4,5-T were used in regular blister rust control work for the suppression of *Ribes* spp. on 6,690 acres (5,190 treated by ground equipment and 1,500 by helicopter) of white pine forest land in California, Oregon, Washington, Idaho, Montana, Wyoming, and Colorado. Currently approved procedures are as follows:

(1) The application of aqueous sprays of 2,4-D or 2,4,5-T as foliage treatments during an approximate 6-week period of vigorous growth. This corresponds to the period from the first sign of swelling of the fruit until they are about two-thirds size. For selective spraying of *Ribes* in California, 2,4-D 500 p.p.m. acid equivalent (AE), or 2,4-D 500 p.p.m. + 2,4,5-T 1,000 p.p.m. is used for the eradication of *Ribes roezli* and *R. nevadense*. The mixed formulation is necessary for satisfactory kill of a varietal form of *R. roezli* occurring at the northern end of the natural range of this species. During 6 years of operations work the average volume used per acre has been about 150 gallons. In the other states named above the several important species of *Ribes* require about 3,000 p.p.m. (AE) of 2,4,5-T for satisfactory kill from a single spraying. Several esters, amines, and the sodium salt of 2,4-D and the isopropyl and butoxyethanol esters of 2,4,5-T have been found effective. For all foliage sprays, summer oil emulsion is added at the rate of 1 gallon for each 100 gallons of spray solution.

(2) The use of 2,4-D, 2,4,5-T, or 50/50 mixtures of them in ester form (5 percent total AE) diluted with Diesel oil and applied to the basal stems of intact *Ribes*. Effective basal-stem treatments can be made any time during the year, though results are consistently highest during the period of vigorous growth.

(3) The application of 1 percent (AE) 2,4-D or 2,4,5-T in oil or water to the cut-off root crown of *Ribes* spp.

Aqueous sprays are applied (1) by conventional high-pressure sprayers equipped with 1/2-inch main-line hose and 1/4- or 3/8-inch lateral, (2) by knapsack sprayer fitted with a double-acting trombone pump, or (3) by low-volume knapsack sprayer operating at 300-1,000 pounds per square inch. Basal-stem work is done largely with knapsack sprayers equipped with trombone pumps fitted with small orifice fan nozzles and oil-resistant washers and retainers.

During 1950 tests of herbicides in the western white pine type of the Northwest were concerned with studies of dosage-volume factors related to broadcast power spraying of young and old age-class *Ribes lacustre* and *R. viscosissimum* and associated brush. On twelve 2-acre plots and sixteen 1-acre plots concentrations of 500, 1,000, 1,500, 2,000, 3,000, and 4,000 p.p.m. (AE) and volumes ranging from 150 to 400 gallons per acre were used. Analysis of results in 1951 showed that the most economic and effective spray treatments are as follows: (1) For young *Ribes* 1,500 p.p.m. of aqueous 2,4,5-T with 1 percent summer-oil emulsion applied at the rate of 200 to 250 gallons per acre; (2) for large populations of mature *Ribes* 1,000 p.p.m. of aqueous 2,4,5-T with 1 percent summer-oil emulsion at 200 gallons or more per acre. The volume used should be enough to wet all *Ribes* and brush of comparable height. The object is to kill as much brush and *Ribes* as possible at lowest initial cost to facilitate the second or clean-up spray. Where mature *Ribes* bushes are less numerous and can be treated selectively, 2,000 p.p.m. of 2,4,5-T is recommended.

In California sugar-pine areas 424 field plots were established during 1950 on Ribes roezli, R. cereium, and R. nevadense. These tests were concerned chiefly with the dosage and volume of 2,4-D and 2,4,5-T ester-oil solutions needed for effective kill in basal-stem work, and with low-dosage (50 p.p.m. AE) application of aqueous sprays of 2,4-D designed to defoliate and produce lasting systemic effects on Ribes highly sensitive to this toxicant. Results of the 1950 tests showed that for basal-stem work a 50/50 mixture of the low-volatile esters of 2,4-D and 2,4,5-T (2½ percent by weight /AE/ of each) averaged about 10-percent better kill of Ribes roezli than 5 percent 2,4-D or 5 percent 2,4,5-T alone. Both dosage and volume apparently are contributing factors in getting effective kill by basal-stem treatment. For R. roezli of average size about 0.1 ounce of 2,4,5-T or 2,4-D acid in 2 fluid ounces of diluent was needed for 90-percent kill or better. On the basis of practical consideration of weight and volume of toxicant to be used, oil solutions containing 5 percent by weight of the active toxicant are recommended.

In 1951 the following markers were tested in formulations of 2,4-D and 2,4,5-T used for basal-stem work: Oil-soluble dyes (red, yellow, orange, blue, and black), oil-white house paint, aluminum paint, and lampblack in oil. The most satisfactory marker proved to be an oil-soluble red (bright scarlet) used at the rate of 1 tablespoonful of dry dye (as furnished by the manufacturer) for each gallon of 5-percent phenoxy ester-oil. Use of this marker speeded crew work and permitted ready supervisory check of the thoroughness of coverage. From results of 1950 and observations at the end of the 1951 field season it is concluded that complete kill of foliage and nearly 100-percent kill of live stem can be obtained by spraying R. roezli with aqueous 2,4-D in concentration of 50 p.p.m. AE. Two or more applications of these dilute 2,4-D sprays (two in 1950 and one in early 1951) resulted in nearly 100-percent bush kill. Two or more low-dosage treatments have therefore proved to be fully as effective as one or two treatments in which 10 to 20 times as much chemical had been used. Bureau of Entomology and Plant Quarantine, Agricultural Research Administration, U. S. Department of Agriculture, Berkeley, California.

RELATION of growth stage and season to toxicity of 2,4,5-T PGBE ester applied to velvet mesquite. Cox, Don K. Studies were initiated in the spring of 1950 to determine at what growth stage, and during which season, velvet mesquite (Prosopsis juliflora var. velutina /Woot./ Sarg.) is most sensitive to foliage sprays of 2,4,5-T PGBE ester.

Formulation used was 5,000 p.p.m. (0.5 percent) 2,4,5-T PGBE ester in a 1: 4 nontoxic oil-water emulsion using 1 percent Riverdale dispersant #6 as the emulsifying agent. Application was from a "sur-shot" spray can using 40-60 p.s.i. pressure. Two hundred ml. of solution was used on each tree and provided complete coverage.

At biweekly intervals, beginning with first appearance of leaves and ending when leaves had fully matured, a group of three trees was sprayed. With each subsequent group one tree from the previous group was resprayed. Treatments were applied in the spring of 1950 and replicated in 1951. The study was repeated during the fall of 1950 when trees appeared dormant but had full foliage and in the summer of 1951 beginning just prior to inception of summer growth and ending with cessation of growth.

Phenological manifestations of the most sensitive spring growth stage are full-size succulent leaves, catkins blooming, and pods ranging in length from 1/4 to 1-1/2 inches. Forty percent apparent plant kill was realized during the period. The growth habits of velvet mesquite are extremely variable and only an average of the aforementioned characteristics can be realized.

Treatments applied from October 3 to November 7, 1950, are characterized by extreme variability in reaction and a low percentage of plant kill. The plant kill produced all occurred during the 2-week period just prior to the time leaves yellowed and winter dormancy began.

The summer phase of this study was initiated on July 30, 1951, and continued, with treatments at biweekly intervals through September 5. It is too soon after application to interpret reaction to the herbicide. However, indications are that application during the period of most active growth will produce the most favorable results. No plants have been killed but 60-percent topkill has shown up during the active growth period (July 30 to August 3 for 1951). There was an immediate drop in topkill produced following this period with an average of 27.4 percent.

On the basis of the data it is felt that the spring season is optimum for spraying with selective herbicides. The most sensitive period may be recognized by observation of growth stage of mesquite, being on the average, from the time the leaves reach full size and are succulent with catkins blooming to the period when leaves are just beginning to harden and pods are from 1/4 to 1-1/2 inches long. The period of active growth during the summer and the time prior to leaf yellowing in the fall appear to be the best times to spray during those seasons. In neither instance has plant or topkill been sufficient to warrant recommendation of herbicidal foliage sprays for control of velvet mesquite. It is probable that respraying of treated trees may have some value outside the most sensitive period. Percentage of dead trees within the period of susceptibility which had been re-sprayed is not sufficiently high to make respraying an efficient control method. Southwestern Forest and Range Experiment Station, Tucson, Arizona.

EFFECT of wetting agents and concentration on toxicity of 2,4,5-T applied as a foliage spray to velvet mesquite. Cox, Don K. In August 1950, studies were installed on the Santa Rita Experimental Range to test relative effectiveness of the amine salt and PGBE esters of 2,4,5-T at different concentrations in a water carrier, and of the effect on toxicity of eight adjuvants added to a water solution of 2,4,5-T amine salt. Concentrations tested were 10,000, 5,000, 2,500, 1,250, and 625 p.p.m. Wetting agents were added at 1 percent by volume to a 5,000 p.p.m. solution of 2,4,5-T in water.

Observations made 15 months after spraying show that 5,000 p.p.m. of both the amine and ester forms of 2,4,5-T produced the highest percentage of apparent plant kill. All other concentrations resulted in either no plant kill or a very low percentage of plant kill. Comparison of the amine and ester forms of 2,4,5-T indicates, in this study, that the amine is a little better, producing 60-percent mortality as compared with 40 percent for the ester.

Addition of the wetting agents increased the toxicity of the herbicide in nearly all cases. Four out of the eight adjuvants tested produced a 100-percent kill as compared with 50 percent for the control treatment (table follows).

Effect of wetting agents on toxicity of the amine salt of 2,4,5-T applied as a foliage spray to velvet mesquite

Wetting agent		Percent top kill	Percent plant kill
Tween 20	1/	100	60
Riverdale Dispersant No. 6	1/	100	100
Tergitol	1/	100	100
Santomerse 88	1/	100	100
Kreelon	1/	100	100
Sterox CD		96	60
Shell Weed Killer Emulsifier		80	40
Pexsyn L206		74	20
Check		79	50

1/ Top dead, basal sprouts present

Results of these studies indicate that water used as a carrier for selective herbicides may produce plant kills as high as oil or oil:water emulsions and that 5,000 p.p.m. is the optimum dosage. Addition of wetting agents increases the action of the herbicide probably by increasing the amount and efficiency of absorption into the leaves. Addition of Riverdale Dispersant No. 6, Tergitol, Santomerse 88, and Kreelon resulted in a plant kill significantly higher than that produced by the control treatment. Southwestern Forest and Range Experiment Station, Tucson, Arizona.

TRANSLOCATION of 2,4-DI^{131} in velvet mesquite seedlings. Blair, Byron O. and Fuller, W. H. Killing of velvet mesquite (Prosopis juliflora var. velutina [Woot.] Sarg.) when treated with foliage sprays of hormone-type herbicides is dependent upon taanslocation of the herbicide to the roots and to dormant buds in the root-stem transition zone. Using a radioactive isotope incorporated in a morpholine salt of 2,4-dichloro-5-iodophenoxyacetic acid and combined at a 1: 12 ratio with nonradioactive 2,4-DI in water, and in water plus 1 percent surface-active and cosolvent agents (adjuvants), applied as foliage sprays to 8-week-old seedlings, the authors were able to show that movement of the herbicide from the isolated segment sprayed had occurred. Measurable amounts of the radioactive material were found which had accumulated in the stem above the cotyledonary node, in the hypocotyl, and in the lower roots. In no case was more than $2\frac{1}{2}$ percent of the material deposited on the leaves moved downward.

Of the adjuvants tested (Tween 20, Shell Weed Killer Emulsifier, and Riverdale Dispersant No. 6) all showed an increase in toxicity to the tissue sprayed. Less of the herbicide was translocated when adjuvants were added to the solution (Riverdale No. 6 and Shell Weed Killer Emulsifier) but a greater relative amount had accumulated in the roots. All of the aliquot samples were prepared for analysis at the end of 96 hours. 2,4-DI^{131} had been reported as being only 60 percent as toxic as 2,4-D. Adjuvants in the solution increased the local toxicity so that all plant tissue sprayed was dead in 10 days. The 2,4-DI^{131} in water alone produced no apparent contact damage during a 6-week period of observation. Limited movement of 2,4-DI^{131} as found in this study may indicate why 2,4-D and other phenoxy compounds have produced erratic reactions when applied to mature velvet mesquite trees.--D.K. Cox. (Table follows.)

Average percent movement of active material from the treated area of the stem to untreated stem, hypocotyl, and root tissue of velvet mesquite seedlings 96 hours after treatment

Treat- ment	Carrier for 2,4-DI^{131}	Total I^{131} recovered	Distribution in plant tissue			
			Treated area	Stem	Hypocotyl	Root
		Pct.	Pct.	Pct.	Pct.	Pct.
A	Water	4.42	97.74	1.21	0.60	0.45
B	Water + 1% Tween 20	4.63	99.35	0.33	0.18	0.14
C	Water + 1% Shell Weed Killer Emulsifier	3.74	98.89	0.21	0.21	0.69
D	Water + 1% Riverdale No. 6	4.50	99.52	0.16	0.10	0.22

Southwestern Forest and Range Experiment Station, Tucson, Arizona.

EFFECT of soil moisture on reaction of velvet mesquite to topical application of selective hormone type herbicides. Cox, Don K. In April, August, and November 1950, mass application of selective foliage sprays on velvet mesquite (*Prosopis juliflora* var. *velutina* [Woot.] Sarg.) from an airplane was tested on the Santa Rita Experimental Range, located 35 miles south of Tucson, Arizona. Herbicides tested included the amine salt, isopropyl and amyl ester, and PGBE ester of 2,4,5-T; and the PGBE ester of 2,4-D as well as a mixture of 2,4-D and 2,4,5-T PGBE esters.

In order to test the relation of soil moisture to toxicity of the various herbicides small plots, enclosed by dikes, were set up within each of the spray areas. Sufficient water was added to each of these plots during periods of from 3½ to 5 weeks prior to the date of spraying to maintain soil moisture at or near 10 percent to a depth of 48 inches. The additional moisture, in all cases, resulted in accelerated terminal growth on the mesquite in the watered plots as compared with those on the dry sites.

Immediately following the sprayings there was some variation in reaction between the watered and unwatered trees. Increased sap exudation, marked defoliation and, in a few instances, more topkill characterized the reaction of trees in the wet sites. With the exception of a single tree, however, all of the trees in the watered plots sprouted and produced regrowth.

Results of observations made from 12 to 18 months following treatment showed that there was no increase in topkill during any season due to additional soil moisture. General differences between watered and unwatered sites were, on the average, slightly less topkill with a tendency toward more rapid recovery in the wet sites.

The usual response of velvet mesquite to adequate soil moisture is immediate growth which continues as long as water is available and temperatures are sufficiently high. The excessive terminal growth produced has been reported as being indicative of the proper time for spraying with hormone-type herbicides. Findings from this study show that soil moisture alone is not responsible for and does not have a significant effect on the toxicity of selective herbicides applied to velvet mesquite in southern Arizona. Southwestern Forest and Range Experiment Station, Tucson, Arizona.

<u>RESULTS of a test on the chemical control of chamise sprouts (Adenostoma fasciculatum) and seedlings.</u> Leonard, O. A. Although esters superior to the isopropyl esters of 2,4-D and 2,4,5-T have been found to be effective against chamise (low-volatile glycol esters, including the propylene glycol butyl ether ester, butoxy ethanol ester, and A.C.P. 648) the following experiment is reported because the test was conducted sufficiently long ago to be relatively certain of the results; it clearly shows the effect of adding some oil to the spray mixture; and it demonstrates how native grasses have been released, because of reduced competition with the chamise following the spraying.

The area was burned as the result of a wildfire in September of 1949. The site selected for this test was at the base of a high ridge and was on a relatively gentle slope for that area. The chamise sprouts were still small and varied from just beginning to sprout, to shoots that were 6 inches long. Chamise seedlings varied from 100 to 300 per plot (110 sq. ft.). There was, also, a small amount of perennial grass present (<u>Stipa lepida</u>), as well as a little nitgrass (<u>Gastridium ventricosum</u>) and wild oats (<u>Avena fatua</u>). Plots were laid off in triplicate, each having an area of 110 square feet. The spray was applied with a Champion Knapsack sprayer having a single TeeJet No. 3 cone tip. Each plot received 379 ccs. of spray, which was equivalent to 40 gallons per acre. The soil was a light brown clay and was several feet deep, with many intermingling rocks present. The results as observed on November 12, 1951, are recorded in the following table.

The results from this study demonstrate that oil emulsions of 2,4-D and 2,4,5-T were far more effective than water against both chamise sprouts and seedlings. The optimum percentage of oil to add was not determined, although there did not appear to be any disadvantage in using Diesel oil alone in this test. On the other hand, oil is harmful to grass and it would be desirable to reduce the quantity of oil used per acre to a minimum in order to minimize this injury. At present, it appears that as little as 1 gallon of Diesel oil per acre will give results about as good as those presented in the table. There appears to be very little difference in the effectiveness of 2,4-D and 2,4,5-T on chamise.

None of the chamise plants that sprouted on the present check plots died and the percentage of natural mortality of plants that sprouted following burning outside of the experimental area appeared to be very low. On the other hand, the mortality of chamise seedlings on the check plots was very high and appeared to be directly associated with the abundance of grass.

An attempt was made to estimate the effect of the spraying on the native grass cover in the fall of 1951. The results indicate that the spraying had a marked effect on the quantity of grass on the treated and untreated plots, there being about twice as much grass on the sprayed plots as on the checks. The control of chamise on the plots surrounding the checks appears to have resulted in some increase in grass on the check plots; the untreated chamise outside of the experimental area averaged about one-fifth as much grass as on the average of the sprayed area (all plots). These results seemed to indicate that chamise competes with grass and that there was a considerable increase by either the suppression of chamise or its removal; the converse of the above is well known—that is, that grass competes with chamise, and reduces its rate of growth and vigor.

The effect of water, oil emulsion, and oil sprays containing the isopropyl esters of 2,4-D and 2,4,5-T upon seedling and sprouting chamise. Treated on May 30 to June 1, 1950; data recorded on November 12, 1951. Burned in September 1949.

Chemical used	Pounds per acre	Diluent	Percent kill of chamise Sprouts	Total live Sprouts	Chamise on three plots Seedlings
			Pct.	No.	No.
Isopropyl	1	Water	47	11	42
ester of	1	25% Diesel emul.	62	13	20
2,4-D	1	Diesel	52	16	3
	2	Water	40	19	56
	2	25% Diesel emul.	77	6	2
	2	Diesel	84	7	0
	4	Water	80	6	3
	4	25% Diesel emul.	97	1	2
	4	Diesel	88	3	0
Average of all 2,4-D treatments			70	9	14
Isopropyl	1	Water	34	27	65
ester of	1	25% Diesel emul.	61	14	5
2,4,5-T	1	Diesel	80	6	6
	2	Water	28	20	59
	2	25% Diesel emul.	72	7	5
	2	Diesel	81	5	2
	4	Water	75	9	13
	4	25% Diesel emul.	100	0	0
	4	Diesel	100	0	0
Average of all 2,4,5-T treatments			70	10	17
Check 1/	--	--	0	38	41
Average of all treatments:					
		with water	51	15	39
		with 25% emul.	78	7	6
		with Diesel	81	6	2

1/ Chamise seedlings averaged 100-300 per plot at the start of the experiment and had decreased to 41 on three plots (av. of 14 per plot) because of competition with grass, etc.

Factors that contributed to the control of the chamise in this experiment were: (1) Proper timing. It was found that chamise control became poorer as the season progressed the percentage of sprout kill in August being zero with 2 pounds of the isopropyl ester of 2,4-D per acre put out in water. It has further been found that chamise is most readily killed following burning, if the sprouts are sprayed when they are still small. It is felt that a June or July burn would have been better than the September burn, because there were probably some chamise plants that had not had sufficient time to have developed sprouts at the time of spraying. (2) Competition with grass. Fortunately, there was grass on the area where the plots were established and this grass had an opportunity to increase, especially on the treated areas. (3) Grazing by cattle and deer. Cattle prefer grass to chamise and browse chamise very little; however, when grazing grass, they do eat some chamise, and this may result in the death of some weakened chamise plants.

Grass is generally sparse where old stands of chamise are present and should be seeded following a burn. By obtaining a good stand of grass on the chamise one should be able to bring to bear the combined effects of the spray treatment, grass competition, and grazing against the chamise, the same as was accomplished in this experiment. Botany Division, University of California, Davis, California.

RESULT of a cut-surface experiment on interior live oak. Leonard, O. A. On December 4, 1950, interior live oak trees (Quercus wislizenii) were treated as follows: (1) Bark not cut. Base sprayed with 4-percent 2,4,5-T (prop. glyc. est.) in Diesel oil at the rate of 10 ccs. per inch of diameter, or equivalent to 2.4 gms. of acid for each 6 inches of diameter (volume percent used, grams per 100 ccs.). (2) Same treatment as No. 1 but moss around the base of the tree was removed. (3) Same as No. 1 except the outer dead bark was removed. (4) Hatchet cuts were spaced every 6 inches around the trunks and all of the above spray put in the cuts. (5) Same as No. 4, except the spray was applied all the way around the stem on both the cut and the uncut areas. (6) Same as No. 5 but moss removed from the uncut bark before treatment. (7) Same as No. 5 except the outer dead bark was removed on the uncut areas. (8) The amine of 2,4-D (4 pounds acid per gallon) was placed in cuts spaced 6 inches apart, near the base of the trees; this treatment received 1 cc. per cut. (9) Same as No. 8, except this treatment was 2 ccs. per cut. (10) Same as No. 8, except this treatment was 4 ccs. per cut--equal to 2 gms. of acid. (11) The amine of 2,4,5-T (triethylamine) having an acid equivalent of 4 pounds per gallon, was applied to cuts 6 inches apart, the same as with the amine of 2,4-D. One cc. was used per cut. (12) Same as No. 11, except 2 ccs. were used per cut. (13) Same as No. 11, except 14 ccs. were used per cut, which was equivalent to 2 gms. of acid for each 6 inches of diameter or about the same quantity of acid used with the ester in the basal-spray mixture, which was 2.4 gms. The trees treated in this experiment varied in diameter from 3 to 12 inches, but most stems had a diameter of about 6 inches.

The foliage of the live oak trees turned brown a little sooner with the treatments where the 2,4,5-T amine was used than where the 2,4-D amine was used. The effect of the ester treatments was considerably delayed. Results as recorded on the following table indicate that all of the cut-surface treatments, whether with the ester of 2,4,5-T in Diesel fuel or with the amines of 2,4-D and 2,4,5-T without any diluent, were effective in killing the live oak trees.

In another experiment which was conducted in January 1951 on larger live oak trees, killing of the trees has been much slower; the best treatments in this test was with 2 ccs. of 2,4,5-T amine per cut and with the basal-spray mixture of 4-percent 2,4,5-T ester in Diesel fuel. The final effect of the various treatments in this test will not be known for some time. This test is mentioned because it demonstrates that while the cut-surface treatment may be quite effective, that it still needs to be studied in order to learn more about the factors affecting the success of the method. (Table follows.)

The results of a cut-surface experiment on interior live oak. Test was conducted on Reamer Ranch near Rescue, California, in the Sierra foothills early in December 1950. Readings recorded July 20, 1951.

Material used	Ccs.per 6" of diam.	Acid equiv. per 6" of diam. gms.	Bark cut every 6"	Moss re-moved	Outer bark re-moved	Results
4% 2,4,5-T ester1/ in Diesel fuel	60	2.4	-	-	-	No effect
"	60	2.4	-	+	-	No effect
"	60	2.4	-	+	+	8 dead; 1 sprout
"(to cuts only)			+	-	-	6 dead
"	60	2.4	+	-	-	8 dead
"	60	2.4	+	+	-	4 dead
"	60	2.4	+	+	+	1 dead; 2 sprout
Amine of 2,4-D	1	0.5	+	-	-	8 dead
"	2	1.0	+	-	-	7 dead
"	4	2.0	+	-	-	6 dead
Amine of 2,4,5-T	1	0.5	+	-	-	10 dead
"	2	1.0	+	-	-	12 dead
Check	0	0	+	-	-	No effect

1/ Propylene glycol butyl ether ester of 2,4,5-T

Botany Division, University of California, Davis, California.

BASAL-BARK treatments for controlling scrub-oak, pinyon, and juniper trees. Doran, Clyde W. To determine whether basal-bark spraying is effective in controlling scrub-oak (Quercus gambeli), pinyon pine (Pinus edulis), and Utah juniper (Juniperus utahensis) limited tests were conducted near Delta, Colorado, in 1951. Preliminary results are described below:

Scrub-oak: At two sites (elevations 7,000 and 8,000 feet) 100 to 400 oak stems were basally sprayed at each of two dates, April 1 and May 1. Both dates of spraying occurred before leaf buds began to swell. Stems were sprayed in an 18-inch band beginning at ground level with a solution of 1 pint Esteron 245 in 3 gallons of fuel oil (4-percent solution). This amount of solution treated about 200 stems, which were 3 to 15 feet tall.

The treated scrub oak leafed out quite normally, but by midsummer considerable discoloration and defoliation was evident. A total stem count on September 1 (before normal fall coloring and leaf drop began) showed that 73 percent of the stems were completely defoliated. Branches were dry and brittle and the plants appeared to be dying. No acorns were produced. The remaining 37 percent of the stems were partially defoliated, many retaining leaves only near the top. These partly defoliated stems produced an abundance of acorns. The acorns were larger than usual, having a diameter about the size of a quarter-dollar as compared to a normal diameter of a dime. The April 1 date of spraying appeared slightly more effective than May 1.

Since these observations were made during the first season following treatment there is no assurance that the treated scrub-oak will not recover or produce new shoots next year.

Pinyon-pine: Plots with 10 to 50 pinyon trees were basally sprayed on March 1, April 1, and May 1 at each of two sites (elevations 6,000 and 6,500 feet). The same treatment procedure was followed as described above for scrub-oak. Small trees from 3 to 10 feet in height composed about 40 percent of the total number of trees treated. Large trees averaged 15 to 20 feet in height. Three gallons of 4% Esteron 245 solution treated 40 trees.

Needles on the smaller trees slowly became dry and brown, while most of the large trees showed little or slight discoloration. A stem count on September 1 indicated that March 1 treatments were more effective than the other dates tested: Small trees--71 percent appear dead with needles all brown, 17 percent have needles partially discolored, and 12 percent show little visible effect; Large trees--12 percent have needles all brown, 27 percent have needles partially discolored, and 61 percent show little effect of treatment.

Utah juniper: The same treatments outlined above for pinyon-pine were applied to juniper trees on the same sites. Juniper reacted in the same manner as pinyon, but appeared less susceptible to the basal spray. In general, only the foliage on the smaller trees became greatly discolored. The March 1 date of treatment appeared most effective. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado.

CONTROL of big sagebrush with 2,4-D and 2,4,5-T in western Colorado. Doran, Clyde W. Big sagebrush (Artemisia tridentata) is one of the most common plants in the West. It grows on a variety of soils, withstands drought, provides some soil cover, and furnishes forage to livestock and game. However, big sagebrush is often considered an undesirable plant; largely as a result of grazing abuse, sagebrush now excludes or suppresses palatable grasses on thousands of acres of rangeland. Numerous successful range reseeding, burning, and flooding projects illustrate how sagebrush can be replaced by grasses. Sagebrush does not normally sprout, is sensitive to fire, and is so brittle that it is easily killed by mechanical methods. An effective and economical method of controlling big sagebrush with selective herbicides appears to be desirable on many sites where mechanical methods of control are not well adapted. Chemical control will probably find its best use on ranges where there is a fairly good understory of native grasses. Release from competition with sagebrush may permit these grasses to spread and become more vigorous.

Preliminary tests with foliage sprays of 2,4-D, 2,4,5-T, and a mixture of the two were made at two sites in western Colorado by the Rocky Mountain Forest and Range Experiment Station in 1949. Mobile ground-spraying rigs were used to make the tests on one-quarter acre plots. On the basis of these tests, the more effective treatments were then demonstrated at two different sites in 1950 and in 1951.

None of the treatments were 100 percent effective in killing sagebrush. Several treatments caused an average defoliation of 75 to 95 percent, but quite often a small branch or twig apparently escaped thorough coverage with spray and continued to live. Little or no radial translocation of herbicides was apparent, and only those plants completely defoliated could be classed as dead.

Early spring treatments were more effective than those made later in the season. The exact date for obtaining best results differed with elevation of the site, and development and growing conditions of the brush. The most effective time for applying 2,4-D appeared to be slightly earlier than for 2,4,5-T.

Only a high ester formulation of 2,4-D and 2,4,5-T were tested. Both of them, or a mixture of the two, produced some kill of sagebrush when applied in dosages of 2 pounds or more acid equivalent per acre. With few exceptions, percent kill was in proportion to dosages applied, although 4 pounds AE per acre was the highest dosage used. 2,4,5-T alone appeared to give somewhat better kills than 2,4-D or the mixture at similar dates and rates of application.

Complete plant coverage was essential for good kills. Water carriers at rates of 25, 50, and 100 gallons per acre were tested with a low-pressure ground-spraying rig. Fifty gallons of water per acre resulted in less drift, better plant coverage, and higher sagebrush kills than 25 gallons. However, 100 gallons was no better than 50.

Much more extensive experimental work on sagebrush control is being done in Wyoming by the Rocky Mountain Station in cooperation with the Bureau of Land Management. A report of this work follows. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado.

CHEMICAL control of big sagebrush (*Artemisia tridentata*) in central Wyoming. Kissinger, N. A. and Vaughn, W. T. Investigation into chemical control of big sagebrush in central Wyoming was initiated in 1949. The goal of this work is a low-cost method for increasing the production of palatable native forage grasses by reducing sagebrush competition on thousands of acres of rangeland in this area. The experimental area is typical of much of the sagebrush-grassland in central Wyoming between the elevations of 5,500 and 7,000 feet. Here the mature brush plants dominate the aspect though they are seldom more than 12 inches in height. They make up about 40 percent of an all-age stand which averages 25 plants per 100 square feet. Other shrubby species include occasional plants of small rabbit-brush (*Chrysothamnus* spp.) and horsebrush (*Tetradymia* spp.). Notable in the herbaceous understory are palatable species of wheatgrass (*Agropyron* spp.), bluegrass *Poa* spp.), and needlegrass (*Stipa* sp.). Forbs are infrequent and produce little if any palatable forage. Soils are sandy loams with a deposition horizon at 13 to 16 inches depth. Annual precipitation is near 14 inches and comes largely in spring and fall.

A total of 57 different herbicide and carrier formulations were sprayed on big sagebrush in 1949. The number of formulations was increased to 59 in 1950 and reduced to 34 in 1951. All formulations were applied as foliage sprays on what was expected to be the optimum treatment date. Several of the same formulations were also applied earlier and later dates each year to isolate the period of maximum susceptibility. The large number of treatments has prevented use of replicate plots. The more promising will be further tested in several replications in future studies. The majority of chemicals tested have been various esters of 2,4-D and 2,4,5-T. Others, including amine salt of 2,4,5-T, pentachlorophenol, arsenic trioxide, maleic hydrazide, dinitro-o-sec-butylphenol, and dinitro-sec-butylphenol have been tried but only on the expected optimum dates for 2,4-D and 2,4,5-T. Water, Diesel oil, and water-oil emulsions have been used as diluents or carriers on all dates.

Tractor-spraying equipment was used to apply the chemicals on 1-acre study plots. Several treatments have been duplicated on one date each year by spraying 5-acre plots with airplane-spraying equipment.

In these studies, treatments are evaluated on the percent of plants, regardless of age or size, which are completely defoliated. Only plants which have absolutely no living foliage 1 year after treatment are considered when comparing total sagebrush kills. As may be expected, there have been some inconsistencies in the relative efficiency of different treatments. Outside factors, such as wind drift of spray and malfunctions in equipment, will usually occur and cause variation in application. Some treatments have, however, given consistently outstanding results in spite of adverse treatment conditions.

The growth stage at which big sagebrush is sprayed is a major factor in its susceptibility to 2,4-D and 2,4,5-T. The high variability in current twig growth both between and within different areas makes this value an unsatisfactory indicator of optimum spraying date. Data collected on two spraying dates in 1949, three dates in 1950, and four dates in 1951 reveal that the growth stage of associated herbaceous vegetation may be a more reliable indicator of the period of maximum susceptibility than the amount of twig growth on big sagebrush itself. Treatments made in central Wyoming just prior to the bloom stage of the native bluegrasses have resulted in highest brush kills. This growth stage has occurred between May 25 and June 5 during the past 3 years.

A commercial compound containing 43 percent isopropyl and amyl ester of 2,4,5-T has given consistently highest brush kills. One-half pound acid equivalent killed an average of 60 percent of the sagebrush plants, 1 pound killed 85 percent, and 2 pounds killed 90 percent when applied in 3 and 5 gallons of Diesel oil per acre on the optimum date. The same formulations of 46 percent isopropyl ester of 2,4-D gave average kills of 45, 60, and 65 percent, respectively. Results with 2,4-D were much more variable than with 2,4,5-T. There appears to be little difference if any between the effectiveness of isopropyl and other alkyl esters of the two compounds.

Low-volatile esters of 2,4-D and 2,4,5-T have not proven as effective as the alkyl esters in killing big sagebrush. These compounds were tested only at two rates on the expected optimum date in 1950 but were tested thoroughly in 1951. Although final counts will not be made until July 1952, a preliminary check of the 1951 work indicates results similar to those obtained in 1950. One- and two-pound rates of propylene glycol butyl ether ester of 2,4,5-T in 5 gallons of Diesel oil per acre gave kills of 45 and 75 percent in 1950. The same formulations of propylene glycol butyl ether ester of 2,4-D gave kills of 20 and 40 percent in 1950. A half-and-half commercial mixture of these two compounds gave 65- and 85-percent brush kills in 1950 when applied in 1- and 2-pound rates, respectively, but were apparently no more efficient than 2,4-D in 1951. Butoxy ethanol esters have been noticeable less effective than the propylene glycol butyl ether esters.

Highest brush kills were obtained with highest rates of 2,4-D and 2,4,5-T in all forms up to and including 2 pounds acid equivalent per acre. Three-pound rates were the highest tested and only in rare cases gave materially higher kills than the 2-pound rates.

The other chemicals tested killed less than 10 percent of the sagebrush plants with the exception of the 2,4,5-T amine salt which killed 35 percent on one plot. These materials have not, however, been adequately tested since they were applied only on the optimum dates for 2,4-D and 2,4,5-T. This date may or may not be the optimum time to treat big sagebrush with such chemicals as pentachlorophenol or dinitro-sec-butylphenol.

Diesel oil has given best results, emulsions intermediate, and water poorest results as diluents or carriers. Water has been tried in amounts varying from

3 to 50 gallons per acre. Some very high, though very inconsistent, kills have been obtained with alkyl ester of 2,4-D in water. Emulsions of 4 gallons of water and 1 gallon of Diesel oil per acre with a detergent added have been tried only on a limited scale but seem to have some promise.

There is no apparent difference between tractor- and airplane-spraying equipment as regards the efficiency of any given treatment in killing sagebrush. In 1950 there was less than 2-percent difference in average brush kills with comparable treatments.

Herbage-production data were first obtained in 1951. By the end of the third growing season herbage yields of native grasses had doubled with a 60-percent brush kill and had tripled with a 95-percent brush kill even though grazed heavily for two seasons following treatment. Even higher forage-production increases are expected under judicious grazing use or complete protection. Rocky Mountain Forest and Range Experiment Station, Forest Service, Fort Collins, Colorado, and Branch of Soil amd Moisture Conservation, Bureau of Land Management, Lander, Wyoming.

PRELIMINARY report of field demonstrations for the control of big sagebrush (Artemisia tridentata) in Strawberry Valley, Strawberry Valley Project, Utah. Hirst, W. Harold. Big sagebrush occupies considerable acreage in Strawberry Valley at an elevation varying from 7,500 to 8,000 feet. Grasses and other desirable forage plants are found as an understory to the sagebrush. Four plots of sagebrush, varying from 7.5 to 25 acres in size, were treated with an isopropyl ester of 2,4-D, applied by airplane on June 17, 1950, for the purpose of testing and demonstrating the effectiveness of 2,4-D in controlling the sagebrush. The amount of 2,4-D acid equivalent and total solution, (carrier of 2,4-D in the commercial product plus Diesel oil added to give the desired amount of solution per acre) applied per acre were varied on each plot to compare results.

Plot No. 1 was treated at the rate of 4 pounds of 2,4-D acid equivalent in 3 gallons of solution per acre. Plot No. 2 was treated with 2 pounds of 2,4-D in 3 gallons of total solution per acre. Plot No. 3 was treated with 4 pounds of 2,4-D in 1½ gallons of solution per acre. Plot No. 4 was treated with 2 pounds of 2,4-D in 10 gallons of solution per acre.

A very satisfactory topkill was observed in October 1950. On June 12, 1951, it was observed that the treatments on plots 1, 2, and 4, gave 100-percent topkill of sagebrush with no regrowth. By ocular comparison with untreated areas adjacent to the plots, it was very obvious that killing the sagebrush had released the understory of desirable plants from competition with the sagebrush, resulting in increased density and growth of those plants. Less satisfactory results, approximately a 60-percent topkill, were obtained on plot No. 3. The less satisfactory results on plot no. 3 were probably due to using less solution in combination with a strong wind at time of application which undoubtedly caused considerable drift of the chemical away from the plot. Bureau of Reclamation, Region 4.

CONTROL of big sagebrush with 2,4-D and 2,4,5-T. Hervey, D. F. In 1950, the following variables were tested as to the effect of each on the resulting kill of big sagebrush (Artemisia tridentata) when sprayed with 2,4-D, 2,4,5-T, or a mixture of the two: date of application, amount of acid equivalent per acre, and site. All applications were made in a water solution at the rate of 10 gallons per acre. In the following table each figure represents the average percent of sagebrush completely killed on three sites:

Herbicide	Acid equiv. per acre	Dates of application May 15	May 27	June 15
	Lbs.	Pct.	Pct.	Pct.
2,4-D	0.5	25	33	25
	1.0	27	25	34
	2.0	51	57	63
	Average	34	38	41
Weedone brushkiller	0.5	26	24	19
	1.0	35	43	51
	2.0	53	67	59
	Average	38	45	43
2,4,5-T	0.5	35	51	34
	1.0	53	59	56
	2.0	65	72	77
	Average	51	61	56

The table indicates that 2,4-D and 2,4,5-T are most effective on different dates. On May 15, new sagebrush leaves were formed but there was no twig elongation; on May 27, twigs were in the early stages of elongation; and on June 15, twigs were in the late stages of twig elongation. The table shows that 2,4,5-T was about one and one-half times as effective as an equal amount of 2,4-D.

The effect of site was pronounced. If an average is obtained for all applications on each of the three sites, the percent kill of big sagebrush was: Swale, 65 percent; sidehill, 36 percent; and ridge, 35 percent.

Tests made in 1949 showed esters of 2,4-D to be superior to amine or sodium salt forms of 2,4-D. Colorado Agricultural Experiment Station, Fort Collins, Colorado.

BRUSH control in western Oregon. Jordon, G. L., and Freed, V. H. Western Oregon is well adapted for the growth of a wide variety of shrubby species. However, their growth is often at the expense of desirable forage plants. In addition, these shrubs become a nuisance in the respect that they hinder activity because of their growth along roadways, fence rows, around buildings, along drainageways, etc. Poison oak is particularly objectionable regardless of where it grows.

As a consequence of this brush problem and because of the impracticality of cultural control, the work has been undertaken to develop a program of chemical brush control. The experiments thus far have been of a preliminary nature. Getting acquainted with and solving the problems of experimental procedure to obtain reliable experimental data requires a cautious approach. Uniform stands of brush, methods of application, and spray equipment for application are sought, in addition to the control of any particular species. Furthermore, when one considers that six or eight species of brush may occur within 100 feet of fence row or drainageway, he will realize the difficulty in formulating a specific recommendation.

In regard to the growth-regulating compounds, the high-molecular-weight esters tend to be more effective on brush than the low-molecular-weight esters. Also, the combination of TCA with a growth regulator appears to facilitate the entrance of the growth regulator into the leaf. This may be due to increased permeability of the leaf because of TCA acting as an anesthetic on cell membranes.

Information from the last 4 years, on the control of the various species is presented below. The data, having come from exploratory experiments, cannot constitute a basis for recommendation until further work has been done. Only the most effective chemicals are listed.

Species	Treatment	Rate and method	Percentage control
Poison oak	Ammate	2 lb./sq.rd., spray	90
	Thiocyanate	2 lb./sq.rd., spray	85
	2,4,5-T	Sprayed to wet 1000 p.p.m. solution	95
	2,4,5-T:2,4-D (1:1 ratio)	Sprayed to wet 1000 p.p.m. solution	95
Blackberry	Sodium chlorate	5 lb./sq.rd., spray	90
	DD(Prochlor)		100
	2,4,5-T	Sprayed to wet 3 lb./100 gallons	90
	2,4,5-T:2,4-D (1:1 ratio)	Sprayed to wet 3 lb./100 gallons	90
	2,4,5-T:MCP (1:1)		98 (outstanding)
Rose	Ammate	4 lb./sq.rd., spray	95
	Atlacide	6 lb./sq.rd., spray	90
Snowberry	2,4-D:2,4,5-T with TCA	Sprayed to wet 3 lb./100 gallon	
		TCA at 25 lb./100 gallon	70
		Ammate at 50 lb./100 gallon	70
Ash and alder	2,4-D 2,4,5-T MCP individually or in mixtures	Sprayed to wet 3 lb./100 gallon	Kill plants below 15 feet high

Oregon State College.

CHEMICAL control of big sagebrush (Artemisia tridentata var. typica). Tingey, D. C. and Robinson, Max E. The experiments were conducted on two areas infested with big sagebrush. One area was located on an old established stand and the other on an area that had been disked and reseeded with crested wheatgrass. Many of the sages had not been killed during the seedbed preparation. A considerable part of the population was relatively small sage interspersed among the old plants.

The experiments on the old plants consisted of using four chemicals applied at five rates in three amounts of water and applications made at three stages of growth. These variables appeared in all combinations. Each treatment was replicated three times and the plots were equivalent to 1 square rod in area. The chemicals used wer tri-iso-propanolamine salt of 2,4-D, ether ester of 2,4-D, iso-propyl ester of 2,4,5-T and a mixture of 25 percent 2,4,5-T and 75 percent ester of 2,4-D. The amount of chemical used was 0, ½, 2, and 4 pounds per acre. The stage of growth when the chemical was applied was new leaf, bud, and late seed. The corresponding dates were June 24, August 5, and November 19, respectively. The three amounts of water used in applying the chemicals were 5, 20, and 80 gallons per acre. The following season an estimate was made on the percentage of regrowth appearing on each of the plots.

Ethyl ester of 2,4-D, 2,4,5-T, and the mixture at the 4-pound rate applied at the new leaf stage all gave significantly lower percentages of regrowth than for the other treatments. For these treatments there was only about a fifth of the regrowth found on the untreated plots. Ethyl ester dust failed to show any appreciable amount of killing regardless of the stage of growth or the amount of chemical used.

The experiments on the younger stand of sage consisted of using the same chemicals at the same five rates with three amounts of water as used on the old stand of sage. Only one application was made which was at the new leaf stage. In general the percentage regrowth for the young sage was about the same as for that on the old established stand. Except for two treatments, the percentage regrowth more nearly approximated that for the untreated plots. Ethyl ester and the mixture at the 4-pound rate applied in 20 gallons of water gave the lowest percentages of regrowth of any of the treatments. As an average of the three replications the percentage regrowth was 7 percent for the ester of 2,4-D and 13 percent for the mixture as compared to 80 percent for the check or untreated plots. It would appear from the two best treatments that the 20 gallons of water gave the most effective control. However, the data for the other chemicals and rates of application where the 20 gallons of water were used were no better than for the other amounts. Furthermore, the data on the old stand of sage did not show any advantage of the 20 gallons over the other amounts. In light of these data from the two experiments and under these conditions it is evident that this variety of big sage shows a relatively high degree of resistance to 2,4-D and 2,4,5-T. Utah Agricultural Experiment Station.

CHEMICAL control of rabbitbrush (Chrysothamnus nauseosus var. consimilis). Tingey, D. C. and Robinson, Max E. The experiment on rabbitbrush consisted of using three chemicals, tri-ethanolamine salt of 2,4-D, butyl ester of 2,4-D, and iso-propyl ester of 2,4,5-T applied at three rates, 0, 1, 2, and 4 pounds per acre. Treatments were made at three stages of growth, early leaf, early bloom, and early seed. Two amounts of water were used in applying the chemicals, namely, 10 and 80 gallons per acre. These variables appeared in all combinations. There were three replications of each treatment and the plots were 1 square rod in area. Estimates were made the following year on the percentage of regrowth of rabbitbrush.

The amount of regrowth on the more effective treatments was from a third to a fourth of what it was on the check or untreated plots. Butyl ester of 2,4-D at the 2- and 4-pound rate when applied at the early leaf stage gave the most satisfactory kills. The early leaf stage of growth was the most desirable time to apply the chemical and the amount of water used showed little or no differential effect. Utah Agricultural Experiment Station.

ESTERCIDE T-4[1/] and Estercide TD2[2/] low-volatile esters. Condron, Carl H. Estercide T-4 was applied by two Stearman airplane sprayers to 114 acres of mesquite near Crystal City, Texas, on June 20, 1951. Four gallons of spray consisting of 1-1/3 pints Estercide T-4, 6-2/3 pints Diesel fuel, and 3 gallons of water, were applied per acre. This amounted to approximately two-thirds pound of 2,4,5-T acid equivalent per acre. The mesquite was in full leaf when sprayed and except for a

1/ Contains 4 pounds 2,4,5-T per gallon in the form of tetrahydrofurfuryl ester.
2/ Contains 2 pounds each of 2,4-D and 2,4,5-T per gallon in the form of tetrahydrofurfuryl ester.

moderate rainfall about 3 weeks before spraying, these trees existed under drought conditions. This spray defoliated the trees. However, on November 1, 1951, 87 percent of the trees had resprouted from the above-ground parts. No resprouting occurred from the underground bud zone. Competitive low-volatile 2,4,5-T products included in this experiment produced results similar to those obtained in the Estercide T-4 plot.

A second experiment was applied with one Stearman airplane sprayer on June 20, 1951, near Uvalde, Texas. Estercide TD2 was applied to 19 acres of mixed brush species at the rate of 0.5 pounds 2,4-D and 0.5 pounds 2,4,5-T (acid equivalents) per acre. Four gallons of spray consisting of 2 pints Estercide TD2, 6 pints Diesel oil, and 3 gallons of water were applied to each acre. Observations made 3 months after spraying showed only slight injury to tasajillo, prickly pear, and granjeno. Fair leaf kill occurred on mesquite, persimmon, and guayacan. Many branches are alive and good topkill is not apparent in this experiment.

In a third test, 10 acres of mixed brush located near Uvalde, Texas, were sprayed on June 20, 1951, with a Stearman airplane sprayer. White brush and prickly pear were the predominant species. An experimental 2,4,5-T formulation was used at the rate of 0.8 pound 2,4,5-T acid equivalent in 15 gallons of Diesel fuel per acre. On September 9, 1951, it was apparent that there was good control of white brush. Many white brush plants were found that had a good topkill and also good rootkill. This, of course, is an early observation. Prickly pear was only moderately affected by this treatment. Guayacan was about 70 percent defoliated by the spray.

Small-scale tests were conducted during October and November, 1951, on prickly pear in the vicinity of Uvalde, Texas, with Estercide T-4 in Diesel fuel. A minimum effective concentration appears to be 1 percent 2,4,5-T acid equivalent by weight. Slightly better results have occurred where Ortho Special Sticker was added to the spray. Research and Development Department, California Spray-Chemical Corporation.

PROJECT 5

UNDESIRABLE WOODY PLANTS ON IRRIGATION SYSTEMS AND IRRIGATED LANDS

C. C. Butler, Project Leader

SUMMARY

Irrigation canals, laterals and drains, areas immediately surrounding water storage facilities, certain types of natural streams and irrigated lands provide ideal environmental conditions for extensive growths of woody vegetation. At these locations the growth of such vegetation is detrimental to irrigation development because of increased costs for operation and maintenance of the irrigation facilities, because of the enormous quantities of irrigation water consumed by the woody plants which will not be available for irrigating crops of economic value and because of loss of irrigable land areas. The most common species of woody vegetation found growing at these locations are willows, salt cedar, wild rose and boxelder.

Investigations conducted at various locations in the Western states demonstrate that most of these undesirable woody plants can be kept under control by the use of chemicals presently available. The cost of chemicals is not excessive and with modern methods of application, the control program is entirely practical. The benefit-cost ratio of spraying programs to control woody vegetation on such areas is relatively high. However, it no doubt can be increased as more effective chemicals and more efficient methods of application become available.

None of the woody plants in this group are ordinarily completely killed with one application of spray regardless of the chemical used. It is doubtful if the objective of the spraying program should be to completely eradicate the plants with one application.

Willows are more easily controlled than other species in this group. Both the amine and ester formulations of 2,4-D at relatively low rates are satisfactory for this purpose. They are more effective than 2,4,5-T or combinations of 2,4-D and 2,4,5-T. This species can be controlled by both foliage and dormant spray applications. Early summer applications seem to be most effective as a foliage spray and late fall or late winter applications as a dormant spray. Aerial spraying using a large drop size has been very effective in applications as low as 3 pounds of acid equivalent in one gallon of oil per acre.

Wild rose is most effectively controlled by 2,4,5-T spray mixtures or a mixture of 2,4-D and 2,4,5-T; however, it is much more difficult to control than willows. Foliage applications made in the late bloom stage seem to be most effective. Dormant applications have not proved very successful. At least three repeated spray applications over a three-year period are probably required to eliminate wild rose.

Dormant applications of 2,4-D and 2,4,5-T on boxelder have not been very effective regardless of rates of chemical applied.

Incomplete results of aerial spraying indicate that kills of salt cedar are best with applications of 2,4-D amine salt at 2#/acid per acre with water and detergent and 2,4,5-T low volatile esters at 1½# acid per acre with water.

REPORTS OF INDIVIDUAL CONTRIBUTORS

Effect of foliage applications of 2,4-D and 2,4,5-T on willows and wild rose. Timmons, F. L. This experiment compared amine and isopropyl ester forms of 2,4-D and the isopropyl ester of 2,4,5-T at three different concentrations on willows and wild rose at three stages of growth. The amine was applied at 750, 1125, and 1500 ppm while the esters were applied at 375, 750, and 1125 ppm. all on an acid equivalent basis. Water was used as the diluent and in all treatments enough spray was applied with a high-pressure sprayer and orchard gun to give thorough and uniform wetting of the foliage. The amount of spray varied with the density and height of woody growth and the averages for the different treatments ranged from 2 to 4.4 gals./sq. rod. The average amount of 2,4-D or 2,4,5-T applied ranged from 1.21 to 7.34 lbs/A. for the different concentrations. The original spray treatments were made September 1948, June 1949, and August 1949. All of the treatments were replicated twice on plots comprising 3 square rods located along an irrigation canal. Sandbar or narrow-leaved willow (Salix exigua) was present on all plots while almond-leaved willow (S. bebbiana) was present on many plots and wild rose (Rosa woodsii) was present on almost all plots. All three species were present on at least one of the plots for each treatment.

All of the treatments gave nearly complete kills of willow foliage and most of them killed 50 per cent or more of the top-growth, with the heavier rates giving somewhat better kills. The regrowth of willows, from top-growth and roots, averaged 48 per cent for the applications made in September 1948, 58 per cent for treatments made in June 1949, and 99 per cent for those applied in August 1949. Amine and ester forms of 2,4-D gave similar results at equivalent rates and both were considerably more effective on willow than was 2,4,5-T. Unlike the top-kill, the regrowth of willows showed no advantage for heavier rates over lighter rates of any of the three chemicals. Almond-leaved willow proved definitely more difficult to kill with 2,4-D and 2,4,5-T than was sandbar willow.

The amine form of 2,4-D had little effect on wild rose at any rate of growth. The ester of 2,4-D at heavier rates resulted in 5-25 per cent kill of rose foliage and top-growth. 2,4,5-T was much more effective on wild rose giving 70-80 per cent top-kill and 30-80 per cent reduction in stand when applied in June 1949. The results were better for the heavier rates. Applications of 2,4,5-T, made in September 1948 and August 1949, gave considerably less top-kill and no reduction in stand of wild rose.

Willow and wild rose regrowth was retreated in 1949, 1950, and 1951 using the same chemicals and concentrations as in the original treatment in each case. Observations of regrowth in 1951 showed that annual applications of 2,4-D repeated over two or three years had reduced the stand of willows to 10 per cent or less of the original stand in most cases. However, 5-54 per cent of the willows still showed regrowth from the roots after two or three applications of 2,4,5-T. There was no advantage for heavier rates of application. The stand of wild rose had not been reduced by repeated applications of amine and ester forms of 2,4-D but had been reduced 80-90 per cent by the two heavier rates of 2,4,5-T applied in the spring. (Contributed by the Division of Weed Investigations, BPISAE, USDA, and the Utah Agricultural Experiment Station cooperating).

Control of wild rose with foliage applications of 2,4,5-T and mixtures of 2,4-D and 2,4,5-T. Timmons, F. L. An experiment started in June 1949 compared the isopropyl ester of 2,4,5-T, a 1-1 mixture of the isopropyl esters of 2,4,5-T and 2,4-D and a 1-2 mixture of the butoxyethanol esters of 2,4,5-T and 2,4-D on wild rose at two stages of growth. Original spray applications were made in June on wild rose in the late bloom stage and in August at the late fruit stage. All three chemicals were applied at concentrations of 1000, 1500, and 2000 ppm (acid basis) in water. The spray applications were made with a small low-pressure power and wand-type hand-boom. Enough spray was applied in each case to give thorough wetting of the foliage and woody growth. The volumes of spray varied from 227 to 750 gals./A. on different plots because of variation in the density and height of rose present. The rates of chemical applied ranged from 2.5 to 12.5 lbs./A. acid equivalent. All of the various chemical treatments were replicated twice on plots laid out in fence rows.

The spray treatments made in June at the bloom stage killed 60 to 100 per cent of the wild rose top-growth as compared to only 7.5 to 35 per cent for those applied in August at the fruiting stage. Some of the treatments applied at the bloom stage reduced the stand of wild rose 10 to 40 per cent but there was 100 per cent regrowth, mostly from top wood, on all plots treated at the fruiting stage.

Wild rose regrowth was retreated on all plots in August 1950 and again in August 1951. The regrowth did not produce blossoms in either 1950 or 1951 and remained in a succulent growing stage throughout the season in each year. The same chemicals and concentrations were used in each case for retreatments in 1950 and 1951 that had been used for the original application in 1949. The amounts of spray and of chemical used in the retreatments were about the same as those for the original applications.

The retreatments in 1950 increased the top-kill and reduced the stand of wild rose somewhat but in 1951 the regrowth, largely from roots, still ranged from 10 to 100 per cent on different plots and from 40 to 100 per cent for different treatments made originally at the bloom stage and ranged from 75 to 100 per cent for the treatments made originally at the fruiting stage in 1949. The mixtures of 2,4-D and 2,4,5-T gave as good results as straight 2,4,5-T. Heavier rates tended to give better results but the differences were small and the trend somewhat inconsistent. In this experiment wild rose proved more difficult to eradicate with 2,4,5-T or mixtures of 2,4-D and 2,4,5-T than have willows with 2,4-D in other experiments. At least three repeated spray applications over a period of three years totalling from 8.4 to 26.1 pounds of chemical per acre were required to eliminate wild rose and it remains to be seen whether additional treatments will be necessary in 1952 and subsequent years. (Contributed by the Division of Weed Investigations, BPISAE, USDA, and the Utah Agricultural Experiment Station cooperating).

Effect of dormant applications of 2,4,5-T and mixtures of 2,4-D and 2,4,5-T on wild rose. Timmons, F. L. An experiment was begun in November 1949 comparing the isopropyl ester of 2,4,5-T, a 1-1 mixture of the isopropyl esters of 2,4,5-T and 2,4-D, and a 1-2 mixture of the butoxyethanol esters of 2,4,5-T and 2,4-D as spray treatments on dormant wild rose in November 1949 and March 1950. Each chemical was tested at concentrations of .4 per cent and .8 per cent (acid basis) in diesel oil applied as a complete over-all spray and at concentrations of 1.6 per cent and 3.2 per cent in diesel oil applied as a basal spray on the rose canes in a zone from the ground up to [illegible] feet. A small power sprayer with a wand-type hand-boom was used in making the spray applications. The amount of oil spray applied varied from 39-49 gals./A. for over-all treatments and from 10-15 gals./A. for basal applications depending upon the density and height of wild rose. The amount of chemical (acid basis) ranged from 1.23 to 2.0 lbs./A. for the low concentrations and from 2.6 to 3.8 lbs./A. for the high concentrations. These rates were less than half those applied in foliage spray applications in another experiment comparing the same chemicals applied in water. All treatments were replicated three times on plots one rod long laid out in fence lines.

Observations of the results made in July 1950 showed 100 per cent regrowth of wild rose either from the woody top-growth or from the roots on nearly all plots. The over-all spray treatments made in March 1950 gave 37 to 67 per cent top kill while the applications made in November 1949 produced top kills of 13 to 57 per cent. Basal spray applications gave very little top kill on either date.

Somewhat better results than those above were obtained from dormant spray applications made in April 1951 just before the wild rose began to leaf out. In this experiment the propylene glycol butyl ester of 2,4,5-T, a 1-1 mixture of the propylene glycol butyl ether esters of 2,4-D and 2,4,5-T, and a 1-2 mixture of the butoxyethanol esters of 2,4,5-T and 2,4-D were compared at concentrations of .4 per cent and .8 per cent (acid basis) in 80 gallons of spray per acre consisting of 10 gallons of diesel emulsified in 70 gallons of water. The percentages of top kill in this experiment ranged from 47 to 93 per cent for the different treatments. The amount of wild rose regrowth which developed from roots and top-growth during the summer ranged from 55 to 93 per cent for the different treatments. All of the three chemicals gave approximately the same results at equivalent rates. The heaviest rate gave somewhat better results in each case. (Contributed by the Division of Weed Investigations, BPISAE, USDA, and Utah Agricultural Experiment Station cooperating).

Effect of dormant applications of 2,4-D and 2,4,5-T on boxelder (Acer negundo). Timmons, F. L. This experiment compared the ethyl ester of 2,4-D, the butoxyethanol ester of 2,4,5-T and a 1-2 mixture of the butoxyethanol esters of 2,4,5-T and 2,4-D in spray treatments on dormant boxelder in December 1949 and March 1950. Each chemical was applied at concentrations of 1 per cent and 2 per cent in diesel oil as basal spray treatments on trunks of the trees or sprouts to a height of 3 feet above

above the ground and at concentrations of 2 per cent and 4 per cent in diesel oil on stubs or stumps of boxelder cut 6 inches above the ground just before the treatments. The applications were made with a small power sprayer. The treatments were replicated three times on clumps of boxelder which ranged from 1 to 198 in number of shoots and from 1/8 inch to 8 inches in diameter of individual shoots and were 10 to 20 feet in height. Most of the clumps had 8 or more shoots.

The plan was to apply approximately 20 gals./A. of the spray in the basal treatments and 10 gals./A. in the stump treatments. However, it was found that much more spray than that was required for thorough and uniform coverage of the trunks or stubs. The actual amount of spray applied ranged from 123 to 2253 gals./A. for basal treatments and from 212 to 1410 gals./A. for stub treatments. The amounts of 2,4-D or 2,4,5-T (acid basis) on individual clumps ranged from 9.1 to 302 lbs./A. for basal treatments and from 58 to 211 lbs./A. for stub-treatments. These are averages for the three replicates in each case. These almost unbelievable figures are based upon actual measurements of the circumference of the boxelder clumps and take into account only the area actually treated in each case. The volume of spray used in obtaining what was considered thorough coverage tended to vary inversely with the size of clump treated. It should be pointed out that the amount of chemical and oil diluent necessary to treat an area infested with boxelder growth would be only a small fraction of the rates discussed above since only a small percentage of the land surface is occupied by the bases of boxelder clumps even in heavily infested areas.

Results from this experiment have been very disappointing despite the heavy rates of treatment. Boxelder top-growth was killed by basal treatments on only a few individual clumps and regrowth occurred on all except three of the 48 clumps. The average regrowth from the various treatments ranged from 48 to 93 per cent for basal applications and from 52 to 98 per cent for stub treatment. It was observed that on many of the boxelder trees which survived basal treatments the bark in the treated zone was severely injured and eventually died except for one or more narrow bands of living bark which extended across the treated zone and permitted the trees to recover. There was no difference in the results from the different chemicals but there was an advantage for the heaviest rate in 7 of the 8 comparisons of rates. This is of special interest in view of the fact that even the lowest rate used was 36 lbs./A. of 2,4-D or 2,4,5-T acid equivalent. (Contributed by the Division of Weed Investigations, BPISAE, USDA, and the Utah Agricultural Experiment Station cooperating).

<u>Preliminary report of field demonstrations for the control of yellow willow (Salix lutea) in Strawberry Valley, Strawberry Valley Project, Utah.</u> Hirst, W. Harold. Dense stands of yellow willow infesting lands at an elevation of approximately 7,500 feet, were treated with 2,4-D applied by airplane on six plots varying from 20 to 50 acres in size. The amounts of 2,4-D and carrier solution were varied for each plot to compare results. Applications were also made on two dates to compare results at different stages of growth. The 2,4-D applied was an isopropyl ester formulation

containing 3.34 pounds of 2,4-D acid equivalent to each gallon of the commercial preparation. The amount of carrier solution applied per acre included the carrier of 2,4-D in the commercial product plus diesel oil added to give the desired total gallons of solution per acre.

Three of the six plots were treated May 27, 1950, when leaf buds were starting to open. Plot No. 1 was treated at the rate of 7 pounds per acre of 2,4-D acid equivalent in 4 gallons of total solution (commercial preparation plus diesel oil). Plot No. 2 was treated at the rate of 5 pounds of 2,4-D in 3 gallons of carrier per acre. Plot No. 3 was treated with 6.68 pounds of 2,4-D in 2 gallons of carrier per acre (undiluted commercial preparation).

The remaining three plots were treated June 17, 1950, when the leaves were from 1/3 to 1/2 developed but not mature enough to prevent spray droplets from reaching the bottom of the willow thicket. Plot No. 4 was treated at the rate of 3 pounds of 2,4-D in 4 gallons of carrier per acre. Plot No. 5 was treated at the rate of 1½ pounds of 2,4-D in 3 gallons of carrier per acre. Plot No. 6 was treated with 3 pounds of 2,4-D in one gallon of solution per acre.

Observations made in October 1950 showed good top-kill on all plots. Some regrowth was observed on all plots but it appeared that best results were obtained on Plot No. 6, and next best results on Plot No. 4.

Observations made on June 12, 1951, showed that about equal results were obtained with treatments on Plots 1, 2, and 3, with about a 95 per cent top-kill and 20 per cent regrowth from the bottom of the willow thickets. An estimated top-kill of over 95 per cent with less than 10 per cent regrowth was obtained on Plot No. 4. A 95 per cent top-kill with approximately 30 per cent regrowth was obtained on Plot No. 5. Practically a 100 per cent top-kill and less than 5 per cent regrowth was obtained on Plot No. 6. (Contributed by Bureau of Reclamation, Region 4).

Effect of dormant applications of 2,4-D on willows. Butler, C. C. During the 1949-1950 fall, winter, and spring seasons, dormant willows (narrow leafed) were sprayed with the butyl ester formulation of 2,4-D and diesel oil, with the objectives of determining the most effective date of application, volume of oil, rate of 2,4-D, and the portion of cane where the treatment is most effective.

Five pounds of acid equivalent in 40 gallons of oil per acre were used in the date-of-application study. The resulting kill of canes was 100 per cent for those sprayed in November, 97 per cent in December, 93 per cent in January, 37 per cent in February, 97 per cent in March, and 77 per cent in April. Growth from lateral root-stocks during the following growing season followed the same trend, ranging from 7 per cent in November to 70 per cent in February.

Five pounds of acid equivalent mixed with 5, 10, 20, 40, 80, 160, and 320 gallons of oil per acre were used to study a most effective volume of oil. Below 40 gallons per acre regrowth ranged from 40 to 45 per cent. Where 40 gallons per acre or more were applied, regrowth ranged from 20 to 25 per cent.

Five pounds of acid equivalent mixed with 40 gallons of oil applied to the upper one-half, the lower one-half, a 6-inch band at the base on one side of the tree, and a 6-inch band at the base on all sides of the tree made up the study of most effective portion to be sprayed. Regrowth amounted to 3 per cent for the lower one-half, 4 per cent for the 6-inch band on all sides, 12 per cent for the 6-inch band on one side, and 48 per cent for the top one-half.

Rates of 3, 5, and 10 pounds of acid equivalent mixed with 40 gallons of oil applied in the fall and spring comprised the study of the most effective rate of 2,4-D. Three pounds of 2,4-D resulted in kills of 60 per cent, while 5 and 10 pounds were equally effective with a 90 to 95 per cent kill.

Observations made during the summer of 1951 showed a high percentage of regrowth from lateral root stocks on all treatments which indicates that more than one spraying is necessary to materially reduce willow stands by dormant applications of 2,4-D. (Contributed by Bureau of Reclamation, Region 6).

Chemical control of salt cedar. Koogler, John G. A field scale program using various formulations of 2,4-D for the control of salt cedar was commenced on June 1, 1951, on the McMillan Reservoir delta area near Carlsbad, New Mexico. The total acreage of salt cedar treated amounted to 2880 acres and chemicals were applied by airplane at a coverage rate of 5 gal. per acre. The average cost per acre was $4.078 which included brushing out mile and half mile section lines through the area, flagging and administrative charges.

The following are the acreages and formulations used in the tests:

Schedule No. 1 - 2,4-D amine salts 2# acid per acre, oil and water emulsion. A complete foliage kill was secured within two weeks after spray was applied. On August 2, 1951, active regrowth on an estimated 30 per cent of the plants was noted.

Acres 1040

Schedule No. 2 - 2,4-D amine salts 2# acid per acre water and detergent. On August 2, 1951, active regrowth on an estimated 25 per cent of the plants was noted. A large number of young plants were killed. Regrowth had started at the base of numerous old plants the tops of which were killed or which showed partial or poor recovery.

Acres 1240

Schedule No. 3 - 2,4-D and 2,4,5-T, low volatile esters, $1\frac{1}{4}$# acid per acre and water. Complete foliage kill was secured. On August 2, 1951, foliage regrowth was noted on an estimated 60 to 70 per cent of the plants. Regrowth at the base of seriously damaged plants was noted throughout the area.

Acres 550

Schedule No. 4 - 2,4,5-T low volatile esters, $1\frac{1}{2}$# acid per acre and water. Complete defoliation was secured. On August 2, 1951, only an estimated 20 per cent of the plants had started to recover.

Acres 50

The tests are being applied under the theory that woody plants, particularly salt cedar, falls in the sensitive group and will require at least two or more foliage sprays in order to secure a high percentage of dead plants. Present plans call for respraying each of the salt cedar test areas with similar formulations in October 1951.

Although an evaluation of final results cannot be made before April or May 1952 results secured from one application of the various formulations seem to favor the amine salts, water and detergent and the straight 2,4,5-T low volatile ester under conditions which existed in this area in June 1951. (Contributed by Bureau of Reclamation, Region 5).

PROJECT B. CLASSIFICATION OF WOODY PLANT RESPONSES TO HERBICIDES

Prepared by O. A. Leonard

EXPLANATION

The table forms used in this report were prepared by H. R. Offord, A. S. Crafts and myself for collecting and presenting data in the Procedings of the California Weed Conference. The present table is larger than other tables in common use, so that more of the essential information in a given test can be presented. It was felt that the data in the table should be confined to one page, since tables that require two pages for presentation of the data, become unhandy. It is considered that where significant studies have been conducted, in which the outstanding fact tors determining the outcome of a given test have been determined, that such studies should be reported in detail. There will remain a certain amount of dissatisfaction with the present forms. The terms of light or high volatile esters or heavy or low volatile esters are not satisfactory terms--either from the standpoint of volatility or from the standpoint of effectiveness.

Some of the data clearly demonstrates the importance of growth conditions of woody plants, in determing their susceptibility to the growth regulator sprays. Better methods for determining the growth status of plants are needed, since it is quite apparant that no other single factor is as important in determining susceptibility to hormone herbicides (aside from inherant susceptibility).

Since all plant leaves have surfaces composed of cuticle of varying degrees of thickness, etc. depending on age and environmental conditions, it is clear that the addition of some oil should improve the penetration of the esters. Since the cuticle barrier to entry becomes greater as it increases in thickness, and probably in composition, the importance of the addition of oil becomes greater. The question, therefore, becomes not one of whether to use oil or not in the spraying of woody plants, but how much oil to use. The physical and chemical properties of oils most desirable for use, are in need of study.

Basal spray results that were sent in, demonstrate that this method warrants further use and study. It is emphasized that the success of this method is dependent largely upon the volume of spray used per plant, providing the concentration of the growth regulator in the spray mixture does not fall below a certain minimum, as has been amply demonstrated by H. R. Offord. Complete coverage of the base of the plant is necessary for best results. Actually, the successful use of the method is not too different from the basa pour method test ed by the Southwestern Forest & Range Experiment Station on Juniper and Velvet Mesquite, but the volume necessary for a kill is much less with the basal spray method. Actually, the most successful use of the basal spray method represents a combination of wetting the lower part of the stem completely on all sides and allowing some of the spray to run off into the soil around the base of the plants.

The writer wishes to express his appreciation to all of you for your fine cooperation in sending in data, without much prior notice before the December 1 deadline--a date, however, which I did not adhere to.

Our best wishes are to George Glendening .

The data that you sent to me are presented in the following tables.

Symbols Used in Evaluating the Effect of Chemicals on Brush Control

Plant

Name -- list common and scientific names.

Age -- S= seedlings; YM= young mature (i.e. seed or fruit bearing); OM= old mature.

Stage -- C= commencing; A= active; PA= post active; D= dormant.

Character -- N= normal; SP= stem sprouts; CS= crown sprouts; RS= root or rhizome sprouts.

Soil

Type -- Deep, shallow, rocky, gravel, etc.

Aspect -- Slope and direction of slope; such as, steep NW.

Treatment

Type -- FS= foliage spray; D= dormant spray; BS= basal spray; CS= cut surface; CSF= cut surface frills; CSC= cut surface cups; Stp.= stump; S= soil.

Formulation -- Acid for acid; A= amine; LE= lower ester; HE= higher ester; WA= wetting agent.

Concentration -- ppm= parts per million; AHG= lbs. acid 100 gal.; %= per cent acid (by wt. or by vol.).

Dosage -- ppa= lbs. per acre; for basal treatments, ml/cm D; milliliters per cm. of diameter; oz./in.D= ounces per inch of diameter.

Diluent -- H_2O= water; DO= Diesel oil; K= kerosene; AO= aromatic oil.

Kill

Initial or Retreatment -- estimated top/root kill, for example
100/100= complete kill of tops and roots
100/0= complete top kill and all roots sprouting
Lvs.= leaves; St.= stem; Rt.= Root

PLANT Age	PLANT Stage	SOIL Char.	SOIL Type	Aspect	TREATMENT Type	Date	Formulation	Conc.	Dose	Diluent	% KILL	LOCATION County & State	WORKER OR REFERENCE
Arrow-weed (Pluchea sericea)													
YM	C	S	Deep	Ditch-bank	FS	March April	A 2,4-D	1250 ppm	3 ppa	H_2O	100/0	Yuma, Ariz.	Bowser
YM-OM	A	N	Deep	"	FS	April Oct.	A 2,4-D	1250 ppm	3 ppa	H_2O	100/100	"	"
Barberry (Berberis fendleri)													
OM	A	N	Rocky	Level	FS	5-8 /49-51	HE 2,4-D	2000 ppm	4 gal. sq. rd.	H_2O + deterg.	100/95-99	San Juan Basin, Colo. La Plata, Archuleta Montezuma	Melander & Lungren
OM	D	N	Rocky	Steep-level	D	9-4 /49-51	HE 2,4-D	1.75%	3/4 gal. sq. rd.	DO	100/95-99	San Juan Basin, Colo.	"
OM	A	N	Rocky	Level	FS	5-6/49	A 2,4-D	1000-2000 ppm	4 gal. sq. rd.	H_2O + deterg.	100/97-100	Archuleta, Colo.	"
OM	A	N	Ricky	Level	FS	6/51	M.C.P. A.C.P. 904	3000 ppm	5 gal. sq. rd.	H_2O	100 top	La Plata, Colo.	"
OM	A	N	Rocky	Level	FS	6/51	HE 2,4-D	2000-3000 ppm	5 gal. sq. rd.	H_2O + deterg.	100 top	La Plata, Colo.	"
OM	A	N	Rocky	Level	FS	5-6/49	HE 2,4-D	2000 ppm	4 gal. sq. rd.	H_2O	100/98-100	Archuleta, Colo.	"
Bay, California (Umbellaria californica)													
Y	A	N	Deep	S	BS	6/6/50	LE 2,4,5-T	2%		DO	100/100	Sonoma, Cal.	Leonard & Lusk
Blackberry, common (Rubus laciniatus)													
1st	year												
OM	A	N	Shallow rocky	S	FS	May	LE 2,4,5-T	3000-8000 ppm		H_2O	100/0	Nevada, Cal.	Pryor
2nd	year												
	A	CS	"	S	FS	June	LE 2,4,5-T	"		H_2O	-		
3rd	year												
	A	RS	"	S	FS	July	LE 2,4,5-T	"		H_2O	100/100		
Broom, common (Spartium junceum)													
OM	A	N	Deep	SW	BS	7/6/50	LE 2,4,5-T	4%		DO	100/100	Sonoma, Cal.	Leonard & Lusk
Broom, Scotch (Cytisus scoparius)													
OM	A	N	Deep	N	FS	6/27/50	LE 2,4,5-T	5 AHG		H_2O	100/100	Placer, Cal.	Leonard
OM	A	N	Deep	N	FS	6/27/20	LE 2,4-D	10 AHG		H_2O	100/100	"	"
OM	A	N	Deep	N	FS	7/6/50	LE 2,4-D	5 AHG		25% DO	100/100	Sonoma, Cal.	Leonard & Lusk
OM	A	N	Deep	N	BS	7/6/50	LE 2,4-D	2%		DO	100/100	"	"

PLANT Age	Stage	Char.	SOIL Type	Aspect	TREATMENT Type	Date	Formulation	Conc.	Dose	Diluent	% KILL	LOCATION County & State	WORKER & REFERENCE
Broom, Scotch (Cytisus scoparius)													
OM	A	N	Deep	N	BS	6/6/50	LE 2,4,5-T	2%		DO	100/100	Sonoma, Cal.	Leonard & Lusk
Burroweed (Haplopappus tenuisectus)													
OM	A	N	Shallow rocky alluvial	O	FS	July Aug.	LE 2,4-D	2.5-5%	20-40 gal./A	DO K	80-100/100	Pima, Ariz.	Southwestern Forest & Range Expt. Sta.
OM	A	N	"	O	FS	May	LE 2,4,5-T	0.6-4%	20-40 gal./A	DO K	85-100/100	"	"
OM	A	N	"	O	FS	July	TCA	1/2 lb./gal.	40 gal./acre	H_2O	90/90	"	"
Buckwheat (Eriogonum fasciculatum)													
OM	C-A	N			FS	4/49	A 2,4-D	20 AHG	2 ppa	H_2O	60/40	Ventura, Cal.	Dow Chem. Co.
OM	C-A	N			FS	4/49	LE 2,4-D	20 AHG	2 ppa	H_2O	70/50	"	"
Ceanothus megacarpus & C. spinosus													
OM	C-A	N			FS	6/49	LE 2,4-D	30 AHG	3 ppa	DO	100/90	So., Cal.	"
OM	C-A	N			FS	6/49	LE 2,4,5-T	30 AHG	3 ppa	DO	70/70	"	"
Ceanothus, wedgeleaf (Ceanothus cuneatus)													
OM	A	N	Shallow	E	FS	5/18/50	LE (2/3 2,4-D 1/3 2,4,5-T)	40 AHG	2 ppa	DO	100/100	Amador, Cal.	Busi
OM	A	N	Shallow	S	FS	5/17/49	LE 2,4-D	15 AHG	1.5 ppa	AO	20/20	Tuolumne, Cal.	Herbert
OM	A	N	Shallow	S	FS	5/17/49	LE (1/2 2,4-D 1/2 2,4,5-T)	15 AHG	1.5 ppa	AO	90/90	"	"
OM	A	N	Shallow	S	FS	5/17/49	LE 2,4,5-T	15 AHG	1.5 ppa	AO	99/99	"	"
OM	A	N	Deep	S	BS	3/27/50	HE 2,4-D	2%		DO	100/100	Yolo, Cal.	Leonard
OM	A	N	Deep	S	BS	3/27/50	LE 2,4,5-T	2%		DO	100/100	"	"
S	A	N	Deep	N	FS	5/30/50	LE 2,4-D	5 AHG	2 ppa	25% DO	100/100	Napa, Cal.	"
S	A	N	Deep	N	FS	5/30/50	LE 2,4,5-T	2.5 AHG	1 ppa	25% DO	100/100	"	"
OM	C-A	N			FS	1949	LE 2,4-D	60 AHG	3 ppa	H_2O	75/75	Sierra Nev. Mts., Cal.	Dow Chem. Co.
OM	C-A	N			FS	1949	LE 2,4,5-T	60 AHG	3 ppa	H_2O	100/100	"	"
Chamise (Adenostoma fasciculatum)													
OM	A	N	Rocky	S	FS	5/16/50	LE 2,4,5-T	15 AHG	3 ppa	AO	75/75	Tuolumne, Cal.	Herbert
OM	A	N	Rocky	S	FS	5/16/50	LE (1/2 2,4-D 1/2 2,4,5-T)	15 AHG	3 ppa	AO	50/50	"	"
OM	A	N	Deep	NW	FS	5/30/50	LE 2,4-D	10 AHG	4 ppa	25% DO	92/92	Napa, Cal.	Leonard
OM	A	N	Deep	NW	FS	5/30/50	LE 2,4,5-T	10 AHG	4 ppa	25% DO	100/100	"	"
S	A	N	Deep	NW	FS	5/30/50	LE 2,4-D	10 AHG	4 ppa	25% DO	100/100	"	"
S	A	N	Deep	NW	FS	5/30/50	LE 2,4,5-T	10 AHG	4 ppa	25% DO	100/100	"	"

PLANT Age	Stage	Char.	SOIL Type	Aspect	TREATMENT Type	Date	Formulation	Conc.	Dose	Diluent	KILL	LOCATION County & State	WORKER OR REFERENCE
Chamise (Adenostoma fasciculatum)													
OM	C-A	N	Loam	Steep	FS	5/50	LE 2,4-D	60 AHG	3 ppa	H_2O	60/30	Sierra Madre, Cal.	Dow Chem. Co.
OM	C-A	N	Loam	Steep	FS	5/50	HE 2,4,5-T	60 AHG	3 ppa	H_2O	70/40	"	"
OM	C-A	N	Loam	Steep	FS	5/50	HE 2,4,5-T	60 AHG	3 ppa	DO	75/40	"	"
Chaparral whitethorn (Ceanothus leucodermis)													
OM	C-A	N			FS	5/49	LE 2,4,5-T	60 AHG	3 ppa	DO	100/90	Sierra Nev. foothills, Cal.	"
Chinquapin, bush (Castanopsis sempervirens)													
OM	A	N	Deep	N,NE,NW	FS	6-8 46/51	LE & HE 2,4-D	2000 ppm	3 ppa	Emul. & Oil	75/50	Lassen to Tulare, Cal.	Offord
Cholla (Opuntia fulgida & O. spinosior)													
OM	A	N	Shallow gravelly Alluvial	O	FS	July	LE 2,4,5-T	12000 ppm	40 gal /acre	DO	77/77	Pima, Ariz.	Southwestern Forest & Range Expt. Sta.
OM	A	N	"	O	FS	July	A 2,4,5-T	10000 ppm	pint per	H_2O	100/100	Pima, Ariz.	"
OM	A	N	"	O	FS	July	LE 2,4,5-T DNOSBP	3000 ppm 3%	1/2 pint plant	K	90/90	Pima, Ariz.	"
OM	D	N	"	O	FS	March	LE 2,4-D	10000 ppm	1/2 pint plant	1:1 DO/H_2O	88/88	Pima, Ariz.	"
OM	A	N	"	O	FS	Aug.	LE 2,4-D DN OSBP	1000 ppm 1%	1/2 pint plant	DO	100/100	Pima, Ariz.	"
OM	A	N	"	O	FS	Apr.-Sept.	DNOSBP	1.5%	"	K	80/80 100/100	Pima, Ariz.	"
OM	A	N	"	O	FS	"	PCP	1.5%	"	K	85/85 100/100	Pima, Ariz.	"
Coffeeberry, California (Rhamnus californica)													
YM	A	N	Deep	NE	FS	6/16/50	H E 2,4-D	5 AHG		H_2O	100/25	Amador, Cal.	Leonard
OM	A	N	Loam	Steep	FS	5/49	LE 2,4-D	20 AHG	2 ppa	H_2O	80/30	Salinas, Cal.	Dow Chem. Co.
Cottonwood (Populus trichocarpa)													
OM	D	N	Sandy	Level	CS 4 /tree	1950	A 2,4-D	Full	1 ml./ in. diam.	none	100/90	San Diego, Cal.	Dow Chem. Co.
OM	A	N	"	"	BS	1950	LE 2,4-D	1%		DO	100/100	"	"
Coyote brush (Baccharis pilularis)													
OM	A	N	Deep	Flat	BS	7/6/50	LE 2,4-D	2%		DO	100/100	Sonoma, Cal.	Leonard & Lusk
OM	A	N	Deep	Flat	BS	7/6/50	LE 2,4,5-T	2%		DO	100/100	"	"
OM	A	N			FS	April	A 2,4-D		2 ppa	H_2O	High	San Mateo, Cal.	McNamara

PLANT			SOIL		TREATMENT						% KILL	LOCATION	WORKER OR REFERENCE
Age	Stage	Char.	Type	Aspect	Type	Date	Formulation	Conc.	Dose	Diluent		County & State	
Coyote brush (*Baccharis pilularis*)													
OM	A	N			FS	April	A 2,4-D		2 ppa	H_2O	High	Ventura, Cal.	Brendler
OM	C-A	N			FS	1949	LE 2,4-D	40 AHG	2 ppa	St. thinner	65	Monterey, Cal.	Dow. Chem. Co.
OM	C-A	N			FS	1949	LE 2,4-D	16 AHG	1.6 ppa	H_2O	90	"	"
OM	C-A	N			FS	5/49	LE (1/2 2,4-D 1/2 2,4,5-T)	32 AHG	1.6 ppa	St. thinner	100/95	Salinas, Cal	"
Currant, squaw (*Ribes cereum*)													
OM	A	N	Rocky	All	FS	47-49	2,4,5-T	3000 ppm	3 ppa	H_2O + .1% summer oil	99/90	Madera, Mariposa, Fresno, Lassen, Cal.	Offord
OM	A	N	"	"	FS	45-49	2,4-D	3000 ppm	3 ppa	H_2O	90/60	Fresno, Lassen, Cal.	"
OM	PA	N	Pumice	Flat	BS	8/49	2,4-D	5%	0.4 oz. /bush	DO	95/85	Siskiyou, Cal.	"
OM	PA	N	"	"	BS	8/49	1/2 2,4-D 1/2 2,4,5-T	5%	"	DO	99/95	"	"
Deer brush (*Ceanothus integerrimus*)													
OM	A	N	Deep	All	FS	May thru July 46-51	Na, A, HE 2,4-D	500 1000 ppm	1-2 ppa	H_2O	98/95	Lassen to Madera, Cal.	Offord
Deerweed (*Lotus scoparius*)													
OM	A-C	N			FS	4/48	LE 2,4-D	0.8 APG		H_2O	100/100	So. Cal.	Dow Chem. Co.
OM	"	N			FS	"	LE 2,4,5-T	0.8 APG		"	100/100	"	"
OM	A	N	Shallow	Var.	FS	4/9/51	HE 2,4-D	40 AHG	2 ppa	DO	100	Amador, Cal.	Leonard
Elderberry (*Sambucus glauca*)													
OM	C-A	N			FS	5/49	LE 2,4-D + 2,4,5-T	5 gal./ 100 gal.	2 qts. /acre	H_2O	98/90	Monterey, Cal.	Dow Chem. Co.
Eucalyptus sp.													
OM	D	N	Deep	Flat	CS/cuts 6"apart	1/51	A 2,4-D	4 lb./ gal.	4 ml./ cut	none	High	Sonoma, Cal.	Leonard & Lusk
OM	D	N	"	"	"	"	A 2,4,5-T	3 lb./ gal.	3 ml./ cut		High	"	"
OM	A	CS			FS		Ammate	1 lb./ gal.		H_2O + sticker	High	Oxnard, Cal.	Colbern
Gooseberry, Sierra (*Ribes roezli*)													
OM	A	N	Shallow	N	FS & S	7/42	Ammate	1 lb./gal.	3000 ppa	H_2O	100/90	Madera, Cal.	Offord
OM	PA	N	"	N	FS & S	9/42	Ammate	"	3000 ppa	"	100/93	"	"
OM	A,PA,D	N	All		Stp.	42-45	Ammate		1 oz./ in. diam.	-	97+	Lassen to Tulare, Cal.	"

PLANT			SOIL		TREATMENT						% KILL	LOCATION	WORKER OR REFERENCE
Age	Stage	Char.	Type	Aspect	Type	Date	Formulation	Conc.	Dose	Diluent		County State	
Gooseberry, Sierra (Ribes roezli)													
S	A	N	Deep	N,NE	FS & S	7/38	DO		1500 gal./acre		99/96	Madera, Cal.	Offord
OM	A,PA,D	N	All		Stp.	38-42	DO		1 fl.oz./in.diam.		98 +	Lassen to Tulare, Cal.	"
S	PA	N	Deep	N,NW	FS	8/46	NH_4 2,4-D	360 ppm	3/4 ppa	H_2O	99/85	Tuolumne, Cal.	"
S	A	N	Deep	NW,NE	FS	7/49	NA 2,4-D	250 ppm	3/4 ppa	H_2O	99/99	Tuolumne, Cal.	"
YM	C	N	Pine soils		FS	45-48	Na, A, NH_4, & LE 2,4-D	500 ppm (ave.)	1.5 ppa	H_2O	90/70	Lassen to Tulare, Cal.	"
YM	A	N	"		FS	45-48	LE 2,4-D	"	1.5 ppa	H_2O	99/55	"	"
YM	PA	N	Deep		FS	45-48	Ave. above 4 forms of 2,4-D	"	1.5 ppa	H_2O	80/55	"	"
OM	C	N	Deep		FS	45-48	"	"	1.5 ppa	H_2O	73/37	"	"
OM	A	N	Deep		FS	45-48	"	"	1.5 ppa	H_2O	99/82	"	"
OM	PA	N	Deep		FS	45-48	"	"	1.5 ppa	H_2O	80/33	"	"
YM	A	N	Deep		FS	46-48	Na 2,4-D	500-720 ppm	3 ppa	H_2O	99/94	"	"
YM	PA	N	Deep		FS	46-48	Na 2,4-D	"	3 ppa	H_2O	85/58	"	"
YM	A	N	Deep		FS	46-48	LE 2,4-D	"	3 ppa	H_2O	99/94	"	"
YM	PA	N	Deep		FS	46-48	LE 2,4-D	"	3 ppa	H_2O	80/29	"	"
OM	A	N	Deep		FS	46-48	A 2,4-D	"	3 ppa	H_2O	95/82	"	"
OM	PA	N	Deep		FS	46-48	A 2,4-D	"	3 ppa	H_2O	90/53	"	"
OM	A	CS	Deep		FS	47-48	Na,A,LE of 2,4-D	250 to 2000 ppm	1 ppa	H_2O	90	"	"
OM	A	CS	Deep		FS	47-48	LE 2,4-D	2%	1 ppa	DO	97	"	"
OM	PA	CS	Deep		FS	47-48	LE 2,4-D	2%	1 ppa	DO	74	"	"
OM	PA	N	Deep	N,NE	BS	10/49	LE 2,4-D	5%	1 fl.oz./bush	DO	80	El Dorado, Cal.	"
OM	PA	N	Deep	N,NE	BS	10/49	LE 2,4-D + 2,4,5-T	5%	"	DO	100	"	"
OM	PA	N	Deep	N,NE	BS	10/49	LE 2,4,5-T	5%	"	DO	98	"	"
YM	A	N	Deep	N,NW	FS	6/49	2/3 2,4-D 1/3 2,4,5-T	1500 ppm	3 ppa	H_2O + 1% summer oil	95/90	Sierra, Plumas, Butte, Lassen, Cal.	"
OM	A	N	Deep	N,NW	FS	6/49	"	1500 ppm	3 ppa	"	95/90	"	"
OM	PA	N	Deep	N,NW	FS	6/49	"	1500 ppm	3 ppa	"	95/40	"	"
Gooseberry, Tulare (Ribes tularense)													
OM	PA	N	Deep	Flat	FS & S	8/45	Ammate	0.83 Lb./gal.	833 ppa	H_2O	99/90	Tulare, Cal.	"

PLANT			SOIL		TREATMENT						% KILL	LOCATION	WORKER & REFERENCE
Age	Stage	Char.	Type	Aspect	Type	Date	Formulation	Conc.	Dose	Diluent		County & State	
Gooseberry, Tulare (Ribes tularense)													
OM	PA	N	Deep	Flat	FS	8/45	Na 2,4-D	1137 ppm	2 ppa	H_2O	10/0	Tulare, Cal.	Offord
OM	A	N	Deep	Flat	FS	6/49	2,4,5-T	2000 ppm	2 ppa	H_2O	98/90	"	"
OM	PA	N	Deep	Flat	FS	6/49	2,4,5-T	2000 ppm	2 ppa	H_2O	90/65	"	"
Gooseberry, (Ribes speciosum)													
OM	A	N	Rocky	Steep	BS	1949	LE & HE 2,4-D	2.5%	15 gal. /acre	DO	100/80	Orange, Cal.	Dow Chem. Co.
OM	A	N	Rocky	Steep	B S	1949	LE & HE 2,4,5-T	2.5%	"	DO	100/80	"	"
Honeysuckle (Lonicera subspicata)													
OM	A	CS	Deep	NE	FS	6/50	HE (2/3 2,4-D 1/3 2,4,5-T)	20 AHG	7 ppa	DO	100/60	Los Angeles, Cal.	Juhren
Horehound (Marubium vulgare)													
OM	C-A	N	Moisture high		FS	5/48	A 2,4-D	50 AHG	2.5 ppa	H_2O	100/95	Orange, Cal.	Dow Chem. Co.
Jim brush (Ceanothus serediatus)													
OM	A	N	Deep	E	FS	5/24/50	LE 2,4,5-T	20 AHG	2 ppa	DO	100/100	Napa, Cal.	Leonard
Juniper (Juniperus utahensis & Juniperus monosperma)													
OM	D	N	Shallow gravelly loam	O	Basal pour	Oct.	DB E	5%	pt./tree	DO	100/100	Yavapai, Ariz.	Southwestern Forest & Range Expt. Sta.
OM	D	N	"	O	"	Oct.	PCP	2.25%	pt./tree	DO	100/100	"	"
OM	D	N	"	O	FS	Oct.	LE 2,4-D	0.06 lb. /gal.	pt./tree	H_2O	100/100	"	"
OM	D	N	"	O	FS	Oct.	TCA	0.10 lb. /gal.		H_2O	100/100	"	"
OM	D	N	"	O	FS	Oct.	PCP	0.15 lb /gal.		H_2O	100/100	"	"
OM	D	N	"	O	FS	Oct.	LE 2,4,5-T	5000 ppm	qt./tree	1:3 DO:H_2O	100/100	"	"
OM	A	N	"	O	CSF	July	Na arsenite	1:2	0.1 pt. /tree		90/90	"	"
OM	A	N	"	O	FS	April	LE 2,4-D	3%	pint/tree	DO	100/100	"	"
OM	A	N	"	O	FS	April	LE 2,4-D	3%	"	H_2O + WA	80/80	"	"
OM	A	N	"	O	FS	April	LE 2,4-D	3%	"	1:1DO:H_2O	100/100	A	A
OM	A	N	"	O	FS	April	LE 2,4-D	3%	"	1:3DO:H_2O	80/80	"	"
OM	A	N	"	O	FS	April	LE 2,4-D	3%	"	1:7DO:H_2O	80/80	"	"
Lemonade berry (Rhus ovata)													
OM	A	N	Rocky	Steep S	BS	1949	LE & HE 2,4-D	2.5%	15 g/acre	DO	100/70	Orange, Cal.	Dow Chem. Co.

PLANT Age	Stage	Char.	SOIL Type	Aspect	TREATMENT Type	Date	Formulation	Conc.	Dose	Diluent	% KILL	LOCATION County & State	WORKER OR REFERENCE
Lemonade berry (Rhus ovata)													
OM	A	N	Rocky	Steep S	BS	1949	LE & HE 2,4,5-T	2.5%	15 g/acre	DO	100/70	Orange, Cal.	Dow Chem. Co.
Lupine, bush (Lupinus arboreus)													
OM	A	N	Deep	NW	BS	4/4/51	HE 2,4,5-T	4%		DO	100/100	Mariposa, Cal.	Leonard, Harvey, Lindsay
Madrona (Arbutus menziesii)													
Y	A	N	Deep	South	BS	7/6/50	LE 2,4,5-T	2%		DO	100/100	Sonoma, Cal.	Leonard & Lush
Manzanita (Arctostaphylos sp.)													
Y (1 year)	A	S			FS	7/49	A 2,4-D		3 ppa	H_2O	100/100	Lake, Cal.	Biswell
Manzanita, common (Arctostaphylos manzanita)													
OM	A	N	Deep	S	BS	7/6/50	LE 2,4,5-T	4%		DO	66/66	Sonoma, Cal.	Leonard & Lush
Manzanita, green (Arctostaphylos patula)													
OM	A	CS	Shallow rocky	NW	FS	July	LE 2,4-D	67 AHG	6.7 ppa	DO	100/10	Lassen, Cal.	Cornelius & Graham
OM	A	CS	"	NW	FS	July	LE 2,4,5-T	17 AHG	3.4 ppa	H_2O	100/0	Lassen, Cal.	"
OM	A	N	Deep	Flat & S,SW	FS	May-July	LE & HE 2,4-D	750-1500 ppm	1-2 ppa	H_2O	95/90	Lassen to Tulare, Cal.	Offord
Manzanita, whiteleaf (Arctostaphylos viscida)													
OM	A	N	Deep	Flats S,SW	FS	May-July 46-51	LE & HE 2,4-D	1000-2000 ppm	2-3 ppa	H_2O	90/75	Butte to Tulare, Cal.	Offord
OM	A	N	Deep	S	FS	8/8/50	HE 2,4-D	10 AHG		25% DO	80/80	El Dorado, Cal.	Leonard
Mesquite, Peru screwbean (Prosopis strombulifera)													
YM	A	N	Deep		BS & S	May-Oct.	LE	1%		DO	100/5	Yuma, Ariz.	Bowser
Mesquite, velvet (Prosopis juliflora var. velutina)													
OM	D	N	Shallow sandy rocky alluvial	O	Basal pour	Feb.	DBE	5%	1/2 pt./tree	K	80/80	Pima, Ariz.	Southwestern Forest & Range Expt. Sta.
OM	D	N	"	O	BS	Feb.	LE 2,4,5-T	5%	"	DO	100/100	"	"
OM	D	N	"	O	BS	March	LE 2,4,5-T	5%	"	DO	100/100	"	"
OM	A	N	"	O	Basal pour	May	LE 2,4,5-T	25%	-	Shell neut. heavy emul.	80/80	"	"
OM	A	N	"	O	Basal pour	May	LE 2,4,5-T	5%	1/2 pint /tree	K	100/100	"	"
OM	A	N	"	O	"	May	LE 2,4,5-T	5%	"	DO	90/90	"	"
OM	A	N	"	O	"	May	Kerosene		"	K	100/100	"	"

PLANT Age	Stage	Char.	SOIL Type	Aspect	TREATMENT Type	Date	Formulation	Conc.	Dose	Diluent	% KILL	LOCATION County & State	WORKER OR REFERENCE
Mesquite, velvet (Prosopis juliflora var. velutina)													
OM	A	N	Shallow: sandy-rocky alluvial	0	BS	July	Lion LHH7		pt./tree		100/100	Pima, Ariz.	Southwestern Forest & Range Expt. Sta.
OM	A	N	"	0	BS	July	DO		pt./tree		100/100	"	"
OM	A	N	"	0	BS	July	DBE	1%	pt./tree	K	90/90	"	"
OM	A-D	N	"	0	Basal pour	Aug.-March	DO		pt./tree		90-100/90-100	"	"
OM	A-D	N	"	0	FS	Aug.	A 2,4,5-T	5000 ppm	1/2 pt./tree	H_2O + 1% WA	100/100	"	"
Mexican devil-weed (Aster spinosus)													
OM	A	N	Deep	Ditch-bank	FS	March-April	A	1250 ppm	3 ppa	H_2O	100/80	Yuma, Ariz.	Bowser
OM	PA	N	Deep	"	FS	July-Aug.	A	1250 ppm	3 ppa	H_2O	50/3	Yuma, Ariz.	"
Monkey flower (Diplacus sp.)													
OM	C-A	N			FS	1949	LE 2,4-D	40 AHG	2 ppa	St. thinner	50	Monterey, Cal.	Dow Chem. Co.
OM	C-A	N			FS	5/49	LE (1/2 2,4-D 1/2 2,4,5-T)	32 AHG	3.2 ppa	H_2O	90/80	Salinas, Cal.	"
Mt. mahogany (Cercocarpus betuloides)													
OM	A	N	Rocky	S	BS	1949	LE & HE 2,4-D	5%	15 gal./acre	DO	60/40	Orange, Cal.	Dow Chem. Co.
OM	A	N	Rocky	S	BS	1949	LE & HE 2,4,5-T	5%	"	DO	50/50	"	"
OM	A	CS	Deep	NE	FS	6/50	HE (2/3 2,4-D 1/3 2,4,5-T)	20 AHG	7 ppa	DO	100/20	Los Angeles, Cal.	Juhren
Mountain misery (Chamaebatia foliolosa)													
OM	A	N	Deep	N	FS	6/27/50	LE 2,4-D	40 AHG	8 ppa	H_2O	100/100	Placer, Cal.	Leonard
OM	A	N	Deep	N	FS	6/27/50	LE 2,4,5-T	10 AHG	2 ppa	H_2O	100/100	"	"
Oak, blue (Quercus douglasii)													
OM	D	N	Med.	W	BS	2/49	LE 2,4,5-T	5%		AO	100/100	Tuolumne, Cal.	Herbert
OM	D	N	Deep	SW	CS/cuts 6"apart	1/51	A 2,4-D	4 lb./gal.	2 ml./cut		High	Napa, Cal.	Leonard
OM	D	N	Deep	W	CS/holes 6"apart		A 2,4-D	5%		H_2O	High	Napa, Cal.	Grah
Y	A	CS	Deep	E	FS	6/22/50	HE 2,4-D	5 AHG		H_2O	50/50	Amador, Cal.	Leonard
Oak, dwarf live (Quercus wislizenii)													
OM	A	N	Rocky	S	BS	1949	LE & HE 2,4-D	5%	15 gal. acre	DO	80/40	Orange, Cal.	Dow Chem. Co.
OM	A	N	"	S	BS	1949	LE & HE 2,4,5-T	5%	"	DO	60/40	"	"

PLANT Age	Stage	Char.	SOIL Type	Aspect	TREATMENT Type	Date	Formulation	Conc.	Dose	Diluent	% KILL	LOCATION County & State	WORKER & REFERENCE
Oak, interior live oak (Quercus wislizenii)													
OM	D	N	Deep	N	CS/cuts 6"apart	12/50	A 2,4,5-T	3 lb. /gal.	1 ml. /cut	None	100/100	El Dorado, Cal.	Leonard
OM	D	N	Deep	N	CS/cuts 6"apart	12/50	A 2,4-D	4 lb. /gal.	1 ml. /cut	None	100/100	"	"
OM	D	N	Deep	N	CS/cuts 6"apart	12/50	HE 2,4,5-T	4%	10 ml./ in.diam.	DO	100/100	"	"
Oak, poison (Rhus diversiloba)													
Y	A	CS	Deep	SE	FS	6/50	HE (2/3 2,4-D 1/3 2,4,5-T)	20 AHG	7 ppa	DO	100/100	Los Angeles, Cal.	Juhren
first year OM second year	A	N	-	-	FS	May	LE 2,4-D	4000 ppm		H_2O	-	Los Angeles, Cal.	Si Dudley
-	A	CS	-	-	FS	-	Ammate	2 lb. /gal.		H_2O	High		
OM	C-A	N			FS	5/49	LE 2,4-D	16 AHG	1.6 ppa	H_2O	90/60	Salinas, Cal.	Dow Chem. Co.
OM	C-A	N			FS	5/49	HE 2,4-D & 2,4,5-T	5 gal. /100 gal.	0.5 gal. /acre	H_2O	95/79	Salinas, Cal.	"
OM first year	A	N	Deep	S	BS	7/6/50	LE 2,4,5-T	2%		DO	100/100	Sonoma, Cal.	Leonard & Lusk
OM second year	A	N	Shallow rocky	S	FS	June	LE 2,4,5-T or LE 2,4-D	2000-8000 ppm		H_2O	100/0	Amador, Cal.	Pryor
	A				BS	May	"	2½-5%		DO & AO	High		
Periwinkle (Vinca major)													
OM	A	N	Deep	S	FS	7/17/50	LE 2,4,5-T	5 AHG	2 ppa	25% DO	0/0	Sonoma, Cal.	Leonard & Lusk
Prickly pear (Opuntia engelmannii)													
OM	A-PA	N	Shallow rocky alluvial	O	FS	July Aug.	LE 2,4-D	5%	pint/ plant	1:4 DO: H_2O	100/100	Pima, Ariz.	Southwestern Forest & Range Expt. Sta.
OM	A-PA	N	"	O	FS	"	LE 2,4,5-T	2-5%	pint/ plant	1:4 DO: H_2O	100/100	"	"
OM	A-PA	N	"	O	FS	"	DNOSBP	1.1%	pint/ plant	DO	100/100	"	"
OM	A-PA	N	"	O	FS	"	TCA	1/2 lb. /gal.	pint/ plant	H_2O	100/100	"	"
Rabbitbrush (Chrysothamnus nauseosus)													
OM	D-C	N			FS	4/14/51	LE 2,4-D		1 ppa	H_2O	100/0	Washoe, Nev.	Robertson
OM	D-C	N			FS	4/14/51	LE 2,4,5-T		1 ppa	H_2O	0/0	"	"

PLANT			SOIL		TREATMENT						% KILL	LOCATION	WORKER &
Age	Stage	Char.	Type	Aspect	Type	Date	Formulation	Conc.	Dose	Diluent		County & State	REFERENCE
Redberry (Rhamnus crocea)													
Y	A	CS	Deep	SE	FS	6/50	HE (2/3 2,4-D 1/3 2,4,5-T)	20 AHG	7 ppa	DO	100/56	Los Angeles, Cal.	Juhren
Redbud (Cercis occidentalis)													
OM	A	N	Deep	E	FS	5/24/50	LE 2,4,5-T	30 AHG	3 ppa	DO	100/0	Napa, Cal.	Leonard
Rose, California (Rosa californica)													
OM	PA	N	Deep	Flat	BS	10/50	HE 2,4,5-T	2%		DO	High	Sonoma, Cal.	Leonard & Lusk
Rose, wild (Rosa notkana)													
OM	A	N	Shallow	Flat	FS	6/15	LE 2,4,5-T	1000 ppm	Complete coverage	H_2O	98/75	Ada, Idaho	Hodgson
OM	A	N	Shallow	Flat	FS	6/15	LE 2,4,5-T	1500 ppm	"	H_2O	100/95	"	"
OM	A	N	Shallow	Flat	FS	6/15	LE 2,4-D	1510 ppm	"	H_2O	25/20	"	"
OM	A	N	Shallow	Flat	FS	6/15	LE(2/3 2,4-D 1/3 2,4,5-T)	1000 ppm	"	H_2O	90/75	"	"
OM	A	N	Shallow	Flat	FS	6/15	"	1500 ppm	"	H_2O	100/92	"	"
OM	A	N	Shallow	Flat	FS	6/15	Ammate	3%	"	H_2O	70/50	"	"
Rose, wild (Rosa woodsii)										read	7/27/51		
OM	Full L.	N	Shallow	Flat	FS	5/10/51	HE 2,4,5-T	1000 ppm	2 ppa	H_2O	100/10	Cache, Utah	Timmons & Lee
OM	"	N	"	"	FS	"	"	1500 ppm	3.7 ppa	"	100/15	"	"
										read	9/17/51		
OM	Bud	N	"	"	FS	6/4/51	HE 2,4,5-T	1000 ppm	1.5 ppa	"	90/50	"	"
OM	"	N	"	"	FS	"	"	2000 ppm	2.8 ppa	"	100/88	"	"
OM	Bloom	N	"	"	FS	6/22/51	"	1000 ppm	2.3 ppa	"	100/88	"	"
OM	"	N	"	"	FS	"	"	2000 ppm	4.8 ppa	"	100/87	"	"
1st. treatment													
OM	L.Bloom	N	"	"	FS	6/23/49	LE 2,4,5-T	1500 ppm	5 ppa	"	99/30	"	"
2nd. treatment													
	Full leaf				FS	8/12/50	LE 2,4,5-T	1500 ppm	5.8 ppa	"	100/44	"	"
1st. treatment													
OM	L.Bloom	N	"	"	FS	6/23/49	LE (1/2 2,4-D 1/2 2,4,5-T)	1500 ppm	6.6 ppa	"	92/12	"	"
2nd. treatment													
	F. Leaf				FS	8/12/50	"	1500 ppm	7.6 ppa	"	90/46	"	"
1st. treatment													
OM	L.Fruit	N	"	"	FS	8/9/49	LE 2,4,5-T	1500 ppm	6.5 ppa	"	21/0	"	"
2nd. treatment													
	F. Leaf	N	"	"	FS	8/12/50	LE 2,4,5-T	1500 ppm	5.9 ppa	"	75/35	"	"
1st. treatment													
OM	L.Fruit	N	"	"	FS	8/9/49	LE (1/2 2,4-D 1/2 2/4/5-T)	1500 ppm	6.6 ppa	"	27/0	"	"

PLANT Age	Stage	Char.	SOIL Type	Aspect	TREATMENT Type	Date	Formulation	Conc.	Dose	Diluent	% KILL	LOCATION County & State	WORKER OR REFERENCE
Rose, wild (Rosa woodsii)													
2nd. treatment													
OM	F.leaf	N	Shallow	Flat	FS	8/12/50	LE (1/2 2,4-D 1/2 2,4,5-T)	1500 ppm	6 ppa	H_2O	63/51	Cache, Utah	Timmons & Lee
Sage, black (Salvia mellifera)													
OM	C-A	N			FS	5/49	HE 2,4-D + 2,4,5-T	5 gal./ 100 gal.	0.5 gal. /acre	H_2O	98/85	Monterey, Cal.	Dow Chem. Co.
Sage, purple (Salvia leucophylla)													
OM	C-A	N		Moisture high	FS	4/49	LE 2,4-D	60 AHG	3 ppa	H_2O	90/80	Ventura, Cal.	Dow Chem. Co.
OM	A	N			FS	April 1	A 2,4-D		2 ppa	H_2O at 6 gal/A	Close to 100/100	Ventura, Cal.	Brendler
Sage, white (Salvia apiana)													
OM	C-A	N			FS	5/49	LE 2,4-D	60 AHG	3 ppa	DO	10/10	Orange, Cal.	Dow Chem. Co.
OM	C-A	N		Moisture high	FS	5/48	A 2,4-D	50 AHG	2.5 ppa	H_2O	100/85	"	"
Sagebrush, big (Artemisia tridentata)													
OM	A	N	Medium deep sl. rocky	Level	FS	June	Butyl ester 2,4-D	1.25-2.5%	1-2 ppa	9¼ g. H_2O ½ g. DO acre	95/95	Lassen, Cal.	Cornelius & Graham
OM	A	N	"	"	FS	July	"	"	"	"	40/20	"	"
OM	A	N	Deep	Level	FS	5-15	HE 2,4-D	6000 ppm	0.5 ppa	H_2O	45/45	Moffat, Colo.	Hervey
OM	A	N	Deep	Level	FS	5-15	HE 2,4-D	12000 ppm	1 ppa	H_2O	55/55	"	"
OM	A	N	Deep	Level	FS	5-15	HE 2,4-D	24000 ppm	2 ppa	H_2O	85/55	"	"
YM, OM S	A	N	Deep	Level	FS	5-15	HE 2,4-D	6000 ppm	0.5 ppa	H_2O	20/20	"	"
"	A	N	Deep	Level	FS	6-15	HE 2,4-D	12000 ppm	1 ppa	H_2O	35/35	"	"
"	A	N	Deep	Level	FS	6-15	HE 2,4-D	24000 ppm	2 ppa	H_2O	55/55	"	"
YM 5% S	A	N	Deep-gravel	Level	FS	5/2/49	HE 2,4-D	4 AHG	2 ppa	H_2O	52/10	Delta, Colo.	Doran
"	A	N		Level	FS	5/2/49	HE 2,4-D	4 AHG	2 ppa	H_2O	54/16	Montrose, Colo.	"
"	A	N	Deep grav.	"	FS	5/25/49	HE 2,4-D	4 AHG	2 ppa	H_2O	59/12	Delta, Colo.	"
"	A	N		"	FS	5/25/49	HE 2,4-D	4 AHG	2 ppa	H_2O	70/28	Montrose, Colo.	"
"	A	N	Deep grav.	"	FS	6/20/49	HE 2,4-D	4 AHG	2 ppa	H_2O	23/0	Delta, Colo.	"
"	A	N		"	FS	6/20/49	HE 2,4-D	4 AHG	2 ppa	H_2O	59/16	Montrose, Colo.	"
"	A	N	Deep grav.	"	FS	5/2/49	LE 2,4,5-T	4 AHG	2 ppa	H_2O	85/40	Delta, Colo.	"
"	A	N		"	FS	5/2/49	LE 2,4,5-T	4 AHG	2 ppa	H_2O	51/16	Montrose, Colo.	"
"	A	N	Deep grav.	"	FS	5/25/49	LE 2,4,5-T	4 AHG	2 ppa	H_2O	75/28	Delta, Colo.	"
"	A	N		"	FS	5/25/49	LE 2,4,5-T	4 AHG	2 ppa	H_2O	60/28	Montrose, Colo.	"

PLANT		SOIL				TREATMENT					% KILL	LOCATION	WORKER OR REFERENCE
Age	Stage	Char.	Type	Aspect	Type	Date	Formulation	Conc.	Dose	Diluent		County & State	
Sagebrush, big (Artemisia tridentata)													
YM 5% S	A	N	Deep gravel	Level	FS	6/20/49	LE 2,4,5-T	4 AHG	2 ppa	H_2O	24/4	Delta, Colo.	Doran
"	A	N		"	FS	6/20/49	LE 2,4,5-T	"	"	"	54/16	Montrose, Colo.	"
"	A	N	"	"	FS	5/25/49	HE 2,4-D	2 AHG	1 ppa	"	29/0	Delta, Colo.	"
"	A	N		"	FS	5/25/49	HE 2,4-D	2 AHG	1 ppa	"	43/12	Montrose, Colo.	"
"	A	N	"	"	FS	5/25/49	HE 2,4-D	4 AHG	2 ppa	"	59/12	Delta, Colo.	"
"	A	N		"	FS	5/25/49	HE 2,4-D	4 AHG	2 ppa	"	70/28	Montrose, Colo.	"
"	A	N	"	"	FS	5/25/49	HE 2,4-D	8 AHG	4 ppa	"	76/32	Delta, Colo.	"
"	A	N		"	FS	5/25/49	HE 2,4-D	8 AHG	4 ppa	"	83/76	Montrose, Colo.	"
"	A	N	"	"	FS	5/25/49	LE 2,4,5-T	2 AHG	1 ppa	"	33/0	Delta, Colo.	"
"	A	N		"	FS	5/25/49	LE 2,4,5-T	2 AHG	1 ppa	"	60/24	Montrose, Colo.	"
"	A	N	"	"	FS	5/25/49	LE 2,4,5-T	4 AHG	2 ppa	"	75/28	Delta, Colo.	"
"	A	N		"	FS	5/25/49	LE 2,4,5-T	4 AHG	2 ppa	"	60/28	Montrose, Colo.	"
"	A	N	"	"	FS	5/25/49	LE 2,4,5-T	8 AHG	4 ppa	"	80/52	Delta, Colo.	"
"	A	N		"	FS	5/25/49	LE 2,4,5-T	8 AHG	4 ppa	"	89/64	Montrose, Colo.	"
"	A	N	"	"	FS	5/25/49	BK 32 (2/3 2,4-D 1/3 2,4,5-T)	2 AHG	1 ppa	"	19/0	Delta, Colo.	"
"	A	N		"	FS	5/25/49	"	2 AHG	1 ppa	"	42/8	Montrose, Colo.	"
"	A	N	"	"	FS	5/25/49	"	4 AHG	2 ppa	"	77/12	Delta, Colo.	"
"	A	N		"	FS	5/25/49	"	4 AHG	2 ppa	"	50/12	Montrose, Colo.	"
"	A	N	"	"	FS	5/25/49	"	8 AHG	4 ppa	"	76/12	Delta, Colo.	"
"	A	N			FS	5/25/49	"	8 AHG	4 ppa	"	86/44	Montrose, Colo.	"
							Delta county (elev. 6000 ft.); Montrose county (elev. 7500 ft.)						
YM	A	N	Deep gravel	3% S	FS	5/17/50	LE 2,4,5-T	3.75 AHG	3 ppa	H_2O	84/52	Gunnison, Colo.	"
YM	A	N	"	"	FS	4/25/51	LE 2,4,5-T	3.75 AHG	3 ppa	"	94/59	Gunnison, Colo.	"
All	A	N	SL	S 3-5%	FS	5/30	LE 2,4,5-T		1 ppa	DO @ 3.5 gal./A	85/85*	Fremont, Wyoming	Kissinger, Hull & Vaughn
All	A	N	SL	S 3-5%	FS	5/30	LE 2,4,5-T		2 ppa	"	90/90	"	"
All	A	N	SL	S 3-5%	FS	5/30	LE 2,4-D		1 ppa	"	60/60	"	"
All	A	N	SL	S 3-5%	FS	5/30	LE 2,4-D		2 ppa	"	65/65	"	"
All	A	N	SL	S 3-5%	FS	5/30	HE 2,4,5-T		1 ppa	"	45/45	"	"
All	A	N	SL	S 3-5%	FS	5/30	HE 2,4,5-T		2 ppa	"	75/75	"	"
All	A	N	SL	S 3-5%	FS	5/30	HE 2,4-D		1 ppa	"	20/20	"	"
All	A	N	SL	S 3-5%	FS	5/30	HE 2,4-D		2 ppa		40/40	"	"

*Percent kill (Wyoming tests) is percent of plants which had no living foliage one year after treatment.

PLANT			SOIL		TREATMENT						% KILL	LOCATION County & State	WORKER & REFERENCE
Age	Stage	Char.	Type	Aspect	Type	Date	Formulation	Conc.	Dose	Diluent			
Sagebrush, big (Artemisia tridentata)													
OM	C	N	Shallow	Gentle	FS	6/17/50	LE 2,4-D	17.62%	4 ppa	DO	100/100	Duchesne, Utah	Bur. Reclamation Region 4
OM	C	N	"	"	FS	"	LE 2,4-D	9.13%	2 ppa	DO	100/100	"	"
OM	C	N	"	"	FS	"	LE 2,4-D	31.01%	4 ppa	DO	60/60*	"	"
*Poor results probably due to wind drift, due to small volume of diluent and heavy winds.													
OM	C	N	"	"	FS	"	LE 2,4-D	4.9%	2 ppa	DO	100/100	Duchesne, Utah	Bur. Reclamation Region 4
OM	A	N	Mt. soil		FS	May	A 2,4-D	5 AHG	2 ppa	H_2O	40-75	Albany & Campbell, Wyoming	Bohmont
OM	A	N	"		FS	May	HE 2,4-D	5 AHG	2 ppa	H_2O	50-90	"	Bohmont
OM	A	N	"		FS	May	HE 2,4,5-T	5 AHG	2 ppa	H_2O	30-60	"	"
Sagebrush, black (Artemisia arbuscula)													
OM	A	N	Medium deep	Level-rolling	FS	July	LE 2,4,5-T	1.25%	1 ppa	9¼ gal. H_2O + ½ gal. DO per acre	40/20	Lassen, Cal.	Cornelius & Graham
Sagebrush, coast or California (Artemisia californica)													
OM	A	N	Gravelly loam	All	FS	4/12/50	A 2,4-D	34 AHG	2 ppa	6 gal. H_2O/acre	95/95	Santa Barbara, Cal.	Coryell
OM	A	N		Best on north slopes	FS	Apr. 1	A 2,4-D	35 AHG	2 ppa	6 gal. H_2O/acre	about 100/100	Ventura, Cal.	Brendler
OM	C-A	N			FS	5/49	LE 2,4-D	60 AHG	3 ppa	DO	70/70	Orange, Cal.	Dow Chem. Co.
OM	C-A	N		Moisture high	FS	5/48	LE 2,4-D	50 AHG	2.5 ppa	H_2O	100/95	"	"
OM	C-A	N		"	FS	5/48	LE 2,4,5-T	50 AHG	2.5 ppa	H_2O	100/95	"	"
OM	C-A	N		"	FS	5/48	A 2,4-D	50 AHG	2.5 ppa	H_2O	100/95	"	"
OM	C-A	N		"	FS	5/49	LE (1/2 2,4-D 1/2 2,4,5-T)	60 AHG	3 ppa	DO	95/80	"	"
OM	C-A	N		"	FS	5/49	LE 2,4-D	60 AHG	3 ppa	H_2O	95/90	Ventura, Cal.	"
OM	C-A	N		"	FS	5/49	LE 2,4-D	16 AHG	1.6 ppa	H_2O	100/95	Salinas, Cal.	"
OM	C-A	N		"	FS	5/49	LE 2,4-D	40 AHG	2 ppa	St. thinner	100/95	"	"
Sagebrush, silver (Artemisia cana)													
OM	A	N	Deep	Level-rolling	FS	June	LE 2,4-D	2.5%	2 ppa	9¼ gal. H_2O + ½ gal. DO acre	95/90	Lassen, Cal.	Cornelius & Graham
OM	A	N	"	"	FS	July	LE 2,4,5-T	1.25%	1 ppa	"	40/20	"	"

PLANT		SOIL			TREATMENT						% KILL	LOCATION	WORKER OR REFERENCE
Age	Stage	Char.	Type	Aspect	Type	Date	Formulation	Conc.	Dose	Diluent		County & State	
Salt cedar (Tamarix gallica)													
YM	A	N	Sandy	River bottom	FS	May-July	A 2,4-D	3.3%	4 ppa	H_2O	90/10	Yuma, Ariz.	Bowser
YM	A	N	"	"	FS	"	HE 2,4-D	3.3%	4 ppa	H_2O	95/40	"	"
YM	A	N	"	"	Stp.	Dec.-Feb.	LE 2,4-D	1%		DO	100/100	Clark, Nev.	"
YM	A	N	Deep	Flat	FS		A 2,4-D		2 ppa	H_2O	50/25	Eddy, Texas	Koogler
OM	PA	N	"	"	FS		A 2,4-D		2 ppa	DO	50/30	"	"
OM	PA	N	"	"	FS		HE 2,4-D		2 ppa	H_2O	50/30	"	"
Silktassel, Fremont (Garrya fremontii)													
OM	A	N	Rocky	Steep S	BS	1949	LE & HE 2,4,5-T	2.5%	15 gal./acre	DO	100/85	Orange, Cal.	Dow Chem. Co.
OM	A	N	"	"	BS	"	LE &HE 2,4-D	2.5%	"	DO	100/85	"	"
Snowbrush (Ceanothus cordulatus)													
OM	A	N	Deep	All	FS	May through July	Na, A, & HE 2,4-D	500-1000 ppm	1-2 ppa	H_2O	95/90	Lassen to Tulare, Cal.	Offord
Sumac, laurel (Rhus lauriana)													
Y	A	CS	Deep	SE	FS	6/50	HE (2/3 2,4-D, 1/3 2,4,5-T)	20 AHG	7 ppa	DO	100/15	Los Angeles, Cal.	Juhren
Sycamore (Platanus recemiosa)													
OM	D	N	Sandy	Level	CS	1/50	A 2,4-D	4 lb. acid /gal.	2 ml./ in. diam.	none	60/60	San Diego, Cal.	Dow Chem. Co.
Toyon (Photinia arbutifolia)													
OM	A	N	Shallow	E	FS	9/4/51	HE 2,4-D	40 AHG	4 ppa	25% DO	100 top	Amador, Cal.	Leonard & Carlson
Willow (Salix sp.)													
OM	D	N	Deep	Levee	CS/6" apart	2/51	A 2,4-D	4 lb. acid /gal.	2 ml./ cut	none	90/90	Sutter, Cal.	Leonard
Willow (Salix laeirgata)													
OM	D	N	Sandy	Level	CS/4 per tree	1/50	A 2,4-D	4 lb. acid /gal.	1 ml./ in. diam.	none	97/80	San Diego, Cal.	Dow Chem. Co.
OM	A	N	Sandy	Level	BS	1950	HE 2,4,5-T	2%	run off	DO	100/100	"	"
OM	A	N	Sandy	Level	BS	1950	HE 2,4,5-T	1%	"	DO	91/90	"	"
OM	D	N	Sandy	Level	BS	1/49	LE 2,4-D	2%	"	DO	70	"	"
OM	D	N	Sandy	Level	BS	1950	HE (1/2 2,4-D 1/2 2,4,5-T)	2%	"	DO	93/90	"	"
Willow, sandbar (Salix sp.)													
OM	A	N	River sand		FS	May	HE 2,4-D	5 AHG	2 ppa	H_2O	95	Albany, Wyoming	Bohmont

PLANT			SOIL		TREATMENT						% KILL	LOCATION	WORKER OR REFERENCE
Age	Stage	Char.	Type	Aspect	Type	Date	Formulation	Conc.	Dose	Diluent		County & State	
Willow, sandbar (Salix exigua) and almond leaved willow (Salix bebbiana)													
1st. treatment													
OM	A	N	Shallow	Level	FS	9/20/48	A 2,4-D	Ave. 750-1125 ppm	2.68 ppa	H_2O	?/60	Utah	Timmons & Lee
2nd. treatment													
young regrowth					FS	9/14/49	"	"	2.92 ppa	"	99/96	"	"
1st. treatment													
OM	A	N	"	"	FS	9/20/48	LE 2,4-D	"	2.7 ppa	"	?/70	"	"
2nd. treatment													
young regrowth					FS	9/14/49	"	"	2.65 ppa	"	99/84	"	"
1st. treatment													
OM	A	N	"	"	FS	9/20/48	LE 2,4,5-T	"	2.96 ppa	"	?/31	"	"
2nd. treatment													
young regowth					FS	9/14/49	"	"	3.01 ppa	"	92/56	"	"
1st. treatment													
OM	A	N	"	"	FS	6/28/49	A 2,4-D	"	2.86 ppa	"	85/42	"	"
2nd. treatment													
young regrowth					FS	9/6/50	"	"	2.84 ppa	"	99/98	"	"
1st. treatment													
OM	A	N	"	"	FS	6/28/49	LE 2,4-D	"	3.17 ppa	"	95/62	"	"
2nd. treatment													
young regrowth					FS	9/6/50	"	"	2.91 ppa	"	99/96	"	"
1st. treatment													
OM	A	N	"	"	FS	6/28/49	LE 2,4,5-T	"	3.02 ppa	"	88/26	"	"
2nd. treatment													
young regrowth					FS	9/6/50	"	"	3.13 ppa	"	98/58	"	"
1st. treatment													
OM	A	N	"	"	FS	8/14/49	A 2,4-D	"	5.35 ppa	"	58/1	"	"
2nd. treatment													
young regrowth					FS	8/16/50	"	"	3.13 ppa	"	86/73	"	"
1st. treatment													
OM	A	N	"	"	FS	8/14/49	LE 2,4-D	"	4.08 ppa	"	85/5	"	"
2nd. treatment													
young regrowth					FS	8/16/50	"	"	2.8 ppa	"	87/79	"	"
1st. treatment													
OM	A	N	"	"	FS	8/14/49	LE 2,4,5-T	"	3.92 ppa	"	68/0	"	"
2nd. treatment													
young regrowth					FS	8/16/50	"	"	3.13 ppa	"	100/90	"	"

PLANT		SOIL			TREATMENT					% KILL	LOCATION County & State	WORKER OR REFERENCE
Age	Stage	Char.	Type	Aspect	Type	Date	Formulation	Conc.	Dose	Diluent		
Willow, yellow (Salix lutea)												
OM	C*	N	Deep	SE slight	FS	5/27/50	LE 2,4-D	22.65%	7 ppa	DO	95/80	Duchesne, Utah	Bur. Reclamation Region 4
OM	C	N	"	"	FS	"	LE 2,4-D	21.55%	5 ppa	DO	95/80	"	"
OM	C	N	"	"	FS	"	LE 2,4-D	39.53%	6.7 ppa	DO	95/80	"	"
~~OM~~	~~A**~~	~~N~~	~~"~~	~~"~~	~~FS~~	~~6/17/50~~	~~LE 2,4-D~~	~~10.24%~~	~~3 ppa~~	~~DO~~	~~95/90~~	~~"~~	~~"~~
OM	A	N	"	"	FS	6/17/50	LE 2,4-D	6.91%	1.5 ppa	DO	95/70	"	"
OM	A	N	"	"	FS	6/17/50	LE 2,4-D	36.14%	3 ppa	DO	100/95	"	"
	*leaf buds starting to open. All aeroplane application												
	**leaves 1/3 to 1/2 developed												
Yerba santa (Eriodictyon californicum)												
~~OM~~	~~A~~	~~N~~	~~Shallow~~	~~All~~	~~FS~~	~~4/9/51~~	~~HE 2,4-D~~	~~40 AHG~~	~~2 ppa~~	~~DO~~	100 top	Amador, Cal.	Leonard & Carlson
Y	A (1 year)	S			FS	7/49	A 2,4-D		3 ppa	H_2O	100/100	Lake, Cal.	Biswell & Hedrick

PROJECT 6 ANNUAL WEEDS IN SMALL GRAINS, GRASS CROPS AND FLAX

Robert L. Warden, Project Leader

SUMMARY

Fourteen abstracts were submitted on the various phases of this project from 7 states within the Western Weed Conference Region. The subject matter is divided into small grains, grasses and flax in the following summary and in the line-up of abstracts.

A. Small Grains

Krall (1)* has summarized four years data on the response of three varieties of winter wheat to two rates of 2,4-D under weed free conditions. He appears to have shown a difference between varieties in that the yield reductions on the variety Yogo were considerably less than those of the other varieties.

In another report (2), Krall reduced weed free spring wheat yields significantly with 2,4-D applications in the early growth, boot and heading stages.

Rasmussen (3,4) reported on the control of Tarweed (Amsinkia intermedia) and Gromwell (Lithospermum arvense) in the winter cereals. Pre-emergence fall applications of 2,4-D to tarweed reduced weed stands more than 90% but did not increase winter wheat yields. In another test spring applications to tarweed in the rosette stage gave control at lighter rates than did later applications. Wheat yields were increased significantly by all treatments. Gromwell was controlled most satisfactorily in winter wheat and winter barley fields by 1-1/2 pounds of 2,4-D ester. A 1:1 mixture of 2,4-D and 2,4,5-T was not as good and considerable tolerance to a MCP ester was exhibited by Gromwell at the same rate. None of the materials used gave good control at 3/4 pound.

Thornton (5) compared rates and formulations of 2,4-D on dryland winter wheat and irrigated spring barley infested mostly with Kochia. No significant yield differences due to formulation, rate or hand weeding were noted at the early date. However, the untreated check was higher than the treatment mean with barley. Treatments at the late date reduced yields more than the early date and yield reductions increased progressively with increasing rates of 2,4-D. Barle was affected to a greater extent by rates and formulations than was wheat.

Tingey (6) reports that pheasant eye (Adonis annua) can be controlled in dryland wheat with 1 to 2 pounds 2,4-D. Control has not increased wheat yields however, and Tingey concludes either that pheasant eye does not offer the winter wheat crop serious competition or 2,4-D injury to the wheat offsets any beneficial effect obtained by the control of the weed.

Tingey (7) also noted an interesting differential development of Alternaria on wheat stubble in the late fall due to 2,4-D applications made to the growing crop. The noted differences were affected by stage of growth at treatment, fertilization and formulation of 2,4-D.

* Refers to abstract number.

B. Flax

Arle and Cords (8)* have summarized their conclusions concerning the use of herbicides in Punjab flax from 1948 to 1950.

Freed (9) tested the toxicity of various solvents on fiber flax and found that tributyl phosphate was toxic to young flax at 7 gallons per acre. Other materials were less toxic.

C. Grasses

Bayer and Freed (10) in field plots controlled an annualy weedy fescue in three varieties of perennial fescue seed crops with a combination of IPC and calcium cyanamide and increased seed yields significantly. The fertilization affect was in part responsible for the increased seed yield. October treatments appeared to be better than those applied in November or December. IPC and 3 Chloro IPC were also used.

Bayer and Freed (11,12) also reported on greenhouse trials involving IPC and 3 Chloro IPC on Alta Fescue, _Bromus erectus_ and _Echinochloa crusgalli_. _Bromus erectus_ appeared to be more tolerant to both herbicides (pre and post-emergence) than alta fescue. A second planting indicated that 3 chloro IPC has a longer residual than IPC. Pre-emergence combinations of IPC and 3 chloro IPC were studied as to their effects on _Bromus erectus_ and _Echinochloa crusgalli_.

Hodgson (13) reported on the tolerance of four grass varieties to three rates of 2,4-D applied at four growth stages. The increasing order of tolerance was apparently orchard grass, alta fescue, manchar brome and crested wheatgrass. Tolerance increased with the age of the plants.

Krall (14) in preliminary work has classified 18 grasses into three groups based on their tolerance to 2,4-D applications before and after emergence.

* Refers to abstract number.

REPORTS OF INDIVIDUAL CONTRIBUTORS

A. SMALL GRAINS

(individual reports)

(1) Effects of 2,4-D on three winter wheat varieties. Krall, J. L. During the past 4 years, the ester of 2,4-D was applied at 1/3 and 1 pound equivalent per acres on three replicates of Yogo, Karmont, and Newturk winter wheat. In 1948, the winter wheat was treated at two stages of growth, in 1949 five stages, in 1950 seven stages and in 1951 two stages. All experiments were conducted on a weed free basis. Significantly lower yields were obtained at 1/3 and 1 pound rates in 1948 and 1950 when 2,4-D was applied at early tillering and late boot stages. The four year summary as given below indicates an advantage for Yogo over the other two varieties:

Four year summary:

Variety	Year	Rate of 2,4-D Check	1/3#	1#	Loss in Bu. 1/3#	1#	Percent of Check 1/3#	1#
Yogo	1948	54.0	51.4	47.7	-2.6	-6.3	95	88
	1949	29.0	28.8	27.4	-0.4	-1.6	99	94
	1950	33.6	34.4	33.9	-2.2	-2.7	94	93
	1951	18.5	19.4	17.7	.9	-0.8	105	96
	4 yr. ave.	34.5	33.5	31.7	-1.0	-2.8	97	92
Karmont	1948	55.9	50.0	45.1	-5.9	-10.8	89	80
	1949	28.9	29.2	26.3	.3	-2.6	101	91
	1950	36.4	34.2	32.5	-2.2	-3.9	94	89
	1951	18.5	17.9	17.8	-0.6	-0.7	97	96
	4 yr. ave.	34.9	32.8	30.4	-2.1	-4.5	94	87
Newturk	1948	57.6	50.3	47.0	-7.3	-10.6	87	92
	1949	27.7	26.9	27.6	-0.8	-0.1	97	100
	1950	36.8	32.9	30.5	-3.9	-6.3	90	83
	1951	19.2	20.0	16.0	.8	-3.2	104	83
	4 yr. ave.	35.3	32.5	30.3	-2.8	-5.0	92	86

(Contributed by Montana Agricultural Experiment Station, Central Montana Branch Station, Moccasin, Montana).

(2) Effects of 2,4-D on spring wheat when sprayed at various stages of plant growth. Krall, J. L. The ester of 2,4-D was applied at 1/3 and 1 pound equivalent per acre on three belts of Ceres spring wheat during 11 stages of plant growth in 1950. Complete randomization was maintained throughout the experiment. All plots were kept on a weed free basis. Water at a rate of 20 gallons per acre was used as a carrier. Significant reductions in yield were obtained at seedling, tillering and late boot stages for both levels of 2,4-D. Observed damage occurred in the seedling and tillering stages in the form of onion leaf and head deformities. Damage in the late boot stage occurred as sterility. The yield in bu./a. and percent of check for each stage of plant growth are given below:

Seeding date May 10, 1951

Date Sprayed	Days After Seeding	Stage of Growth	Yield in bu./a.* 1/3#	1#	Percent of Check 1/3#	1#
June 1	20	Seedling	17.5 (s)	20.4 (s)	52	60
June 4	23	Tillering	23.8 (s)	20.5 (s)	70	61
June 5	24	Late Tillering	23.0 (s)	24.4 (s)	68	72
June 9	28	Culms Elongating	29.9	23.4 (s)	88	69
June 13	32	" "	31.1	26.2	92	78
June 15	34	" "	34.1	28.5	101	84
June 19	38	" "	31.7	31.5	94	93
June 24	43	Early Boot	32.3	35.9	96	106
June 26	45	" "	36.0	34.9	107	103
July 3	52	Boot Stage	25.5 (s)	21.6 (s)	75	63
July 10	59	Heading	27.0 (s)	24.7 (s)	80	73
Check			33.8	33.8		
L.S.D. 5%			4.9	8.7	14	26

F test highly significant at 1%
(s) significantly higher or lower than check
* Average of three replications

(Contributed by Montana Agricultural Experiment Station, Central Montana Branch Station, Moccasin, Montana).

(3) Control of tarweed (*Amsinkia intermedia*) in winter wheat. Rasmussen, Lowell W. Tarweed, principally a winter annual plant, is becoming increasingly prevalent in the winter wheat areas of Eastern Washington, Oregon and Northern Idaho. This weed is relatively resistant to 2,4-D at the rates of application commonly used for most annual weeds in winter wheat.

During 1950 and 1951, tests were run to determine effective quantities and formulations of 2,4-D and the timing of applications for tarweed control.

The amine and ester formulations of 2,4-D were applied as pre-emergence sprays in a winter wheat field near Walla Walla on October 14, 1950. One and two pounds acid equivalent per acre of each material were applied in a volume of 28 gallons of spray per acre. The treatments were randomized and replicated six times in complete blocks. Two untreated check plots were included in each block. The plots were 14 by 30 feet in size. Weed counts were made on May 3, 1951, counting all tarweeds occurring between four 6-inch drill rows through the length of the plot. The check plots had an average of 226 tarweed plants in the four rows counted, while the amine 2,4-D treated plots at 1 pound per acre had 18 plants and at 2 pounds per acre 12 plants. The ester 2,4-D treated plots at 1 pound per acre had 20 plants and at 2 pounds per acre had 9 plants. The weed plants were mostly large and vigorous in the check plots, while those in the treated plots were mostly small and weak appearing.

Sample wheat plants were removed from each plot in two replicates and the roots were washed clean and separated from the tops for top-root ratio determinations. It was evident from these studies that the treatments did not cause any decrease in root or top growth.

The yield of wheat was not affected by the treatments, which was somewhat unusual in view of the differences in weed populations. Apparently there were no limiting factors as a result of the weeds.

A spring application test was run in a winter wheat field 12 miles east of LaCrosse, Washington. The amine and ester formulations of 2,4-D were applied at 1/2 and 1 pound in 20 gallons of water per acre and at two times, April 3 and 26, 1951. A check or untreated plot was also included making nine treatments. The treatments were arranged in a balanced incomplete block design with three treatments per block, three blocks per replicate and $2(k + 1) = 8$ replicates.

Weed control was determined by independent ratings of three men without knowledge of specific treatments. This method was necessary because spring applications often fail to kill tarweed completely but merely stop further growth and development. Both formulations at 1/2 and 1 pound per acre gave satisfactory weed control when applied April 3 at which time the tarweed was still in the rosette stage of growth. Applications on April 26 when the weeds were developing stalks, only 1 pound per acre of ester gave satisfactory results and these were not equal to the results of 1/2 pound at the earlier time. The yield of wheat was increased significantly by all 2,4-D treatments compared to the untreated check plots. Differences in yield approached significance in favor of the 1/2 pound rate and the early application.

The use of the incomplete block design gave a 39 percent increase in efficiency compared with a randomized complete block design. (Contribution-Washington Agricultural Experiment Station, Pullman, Washington).

(4) Control of Gromwell (Lithospermum arvense) in small grain. Rasmussen, Lowell W. Gromwell is a winter annual plant which occurs very abundantly in winter wheat and barley fields in Spokane County. Recently this plant has been noted with increasing frequency throughout the Palouse Region. Gromwell begins growth very early in the spring and is highly resistant to the usual small quantity rates of 2,4-D applications.

In the spring of 1951, tests were run in fields of winter wheat and winter barley in western Spokane County. Both grains had been badly winter killed which made yield determination useless but provided ideal conditions for Gromwell growth. The materials used in the tests were 2,4-D ester, MCPA ester, and 1:1 mixture of 2,4-D, 2,4,5-T esters. The quantities applied were 3/4 and 1-1/2 pounds acid equivalent per acre. The treatments were randomized in complete blocks and replicated 4 times in the wheat field and 4 times in the barley field. The plots were 14 by 20 feet and the spray was applied with a 7-foot boom plot sprayer at a volume of 20 gallons per acre. The treatments were made on April 19, 1951 at which time the Gromwell was 3 to 4 inches tall and some of the plants had produced flower buds. This plant begins blooming in the early spring and continues until late summer.

Since none of the spray treatments caused complete killing of the weed plants, it was impossible to evaluate the results by weed counts. Many of the Gromwell plants were severely damaged and failed to develop further. This was considered good control. Some plants were temporarily damaged but later partially recovered. To evaluate the results, five separate and independent ratings were made on the plots without the raters knowing the treatment.

The plots receiving 1-1/2 pounds per acre of 2,4-D ester showed consistently good weed control, the plots having only a trace of Gromwell persisting. The 1-1/2 pound application of the 1:1 mixture of 2,4-D and 2,4,5-T gave fair weed control but not as good as 2,4-D alone. The MCPA ester at both rates and the 3/4 pound rate of all materials were definitely unsatisfactory for the control of Gromwell at the stage of growth present when these treatments were made.

Pre-emergence applications of several herbicides have been applied during the fall of 1951 in winter wheat fields known to be heavily infested with Gromwell. (Contribution - Washington Agricultural Experiment Station, Pullman, Washington).

(5) Effects of several methods of weed control on the yield of dryland fall wheat and irrigated spring barley. Thornton, Bruce J. Sodium salt, amine salt, and butyl ester of 2,4-D were applied in replicated plots at 1/2, 1 and 2 pounds per acre to dryland fall wheat and irrigated spring barley on May 29 when both grains were 8 to 12 inches tall and to another set of plots on June 19 when 15 to 20 inches tall. Plot locations were selected because of a heavy undergrowth of annual weeds mostly Kochia. At the first date, Sinox and hand-weeding were included in the treatments. At harvest time, yields were taken from all plots. No significant difference was evident either in the barley or in the wheat as a result of any of the treatments made on May 29 either as to formulation, rate or hand weeding. However, the barley yields from treated plots, averaging 55.4 bu./A. were significantly lower than the untreated check yield of 61.8 bu./A. There was no significant difference between the yield of the treated wheat plots, averaging 33.5 bu./A., and the check yield of 34.0 bu./A. The June 19th treatments reduced the average barley yield to 47.1 bu./A. as compared to 55.6 for the May 29th treatments and 61.8 for the check, while the wheat treatments for that date reduced the average treated yield to 28.8 bu./A. as compared to 33.5 and 34.0 for the treatments at the earlier date and the check respectively. Treatments at the later date also showed a reduction in yield to be associated with the increase in the rate of application of the 2,4-D formulations which was quite marked in the barley but much less so in the wheat; also the greater yield reduction by the butyl ester as compared to the sodium and amine salts was strongly significant in the case of the barley but not significant in the case of the wheat. (Contributed by the Colorado Agricultural Experiment Station).

(6) Control of pheasant eye (Adonis annua) with 2,4-D. Tingey, D. C. A considerable acreage of dryland used for the production of winter wheat in northern Utah is infested with pheasant eye. This early maturing annual is most troublesome on heavy soil with poor internal drainage, since the soil remains wet late in the season. In the fallow year, it is difficult, if not impossible, to destroy the weed before it produces seed. Experiments extended over a period of three years have shown that this specie can be controlled by the use of 2,4-D at the rate of one to two pounds per acre applied early in the season while the weed is small. However, when the weed is controlled in the wheat crop with 2,4-D, there has been no increase in the yield of wheat. Untreated or weed infested plots have yielded just as high and often higher than where the weed has been controlled with 2,4-D.

Apparently the 2,4-D injury to the wheat offsets any advantage of eliminating the weeds or else this early maturing annual gives little competition to wheat. Since pheasant eye does not emerge to any extent in the stubble, it has little or no effect on the soil during the fallow year.

(7) Growth of a specie of Alternaria on wheat stubble as related to 2,4-D treatments. Tingey, D. C. Differential growth of a species of Alternaria developed in the late fall on stubble that remained from an experiment on the control of pheasant eye in wheat. The area was staked off into plots of one square rod. The plots received various 2,4-D treatments. These treatments were applied during the early spring and summer of 1950. Growth of the Alternaria was first observed December 23 when the writer made a visit to the area to observe some experimental work started in the fall of 1950. At that time, some plots were distinctly dark in appearance as if they had been sprayed with a suspension of soot. On closer examination, it was evident that the discoloration was caused by masses of mycelium growth of some organism on the nodes, sheathes and culms of the wheat stubble. This was identified as a specie of Alternaria by Dr. B. L. Richards, Plant Pathologi U.S.A.C. Plants on some plots were less severely infected and on others there was little or no infection. Observations were made on all plots in the experiment and each was listed in one of four categories based on degree of Alternaria infection, namely zero, light, moderate and heavy. When the data was assembled by treatments, it was evident that previous treatment was associated with the development of the Alternaria.

The treatments consisted in using the tri-ethanolamine salt and ethyl ester of 2,4-D. Each was applied at one, two, three and four pound per acre rates. The fertilizer was broadcast April 22, 1950.

These variables appeared in all combinations and each treatment was replicated four times. The 2,4-D treatments were applied when the pheasant eye was one to two inches tall or four to eight true leaves for the first date which was May 6, second date when the weed was in the bud stage May 26 and third date at early seed stage June 3. The corresponding growth stages of the wheat were 4 to 8 inches tall with from 1 to 5 tillers, pre-boot and boot stage. Only one application of 2,4-D was made on each plot.

Except for two plots, all the growth of Alternaria was on the plants treated with the ester form of 2,4-D. Furthermore, Alternaria developed only on the plants treated at the two latter stages of growth and for the second stage only on the plots receiving the 3 and 4 pound rates and fertilized. The heaviest growth of Alternaria appeared on the plants treated at the latest stage of growth and on the fertilized plots at all rates and only on the 3 and 4 pound rates on the unfertilized plots. No Alternaria developed on plots not receiving 2,4-D nor on any 2,4-D plots when the plants were treated at the earliest stage of growth nor on any tri-ethanolamine of 2,4-D treated plants when treated at the second stage.

From these data, it appears that kind of 2,4-D stage of growth when applied, and fertilizer, to a lesser extent, all influenced the development of the Alternaria.

Apparently the ester form of 2,4-D effects the plants in a different way from that of the amine form of 2,4-D. Furthermore, this effect, so far as Alternaria is concerned, was associated only with application made in the later life of the plant.

B. FLAX

(8) Chemical Control of Weeds in Punjab Flax. Arle, H. Fred and Cords, Howard P. The use of various herbicides in Punjab flax has been investigated during the past several years. In the fall of 1948, a large number of treatments were applied in duplicate for the purpose of screening out the obviously poor ones. 2,4-D was applied pre-emergence and at the three to four inch stage of the flax at rates

varying from 1/4 to 1 pound per acre. Sodium salt, amine and ester formulations were used. IPC was applied at the same stages at rates varying from 1 to 6 pounds per acre. Pre-emergence treatments were applied 1 to 7 days after planting for all materials.

Data from these tests resulted in the elimination in 1949 of (a) all 2,4-D formulations except the amines, (b) all pre-emergence applications, (c) the 1/4 pound rate for 2,4-D, (d) all IPC rates below 2 pounds and above 3-1/2 pounds per acre. These experiments were continued in 1950, along with preliminary trials of maleic hydrazide, Methoxone (ester) and 3 chloro IPC. The use of foliage applications of nitrogenous fertilizer (nugreen) to overcome ill effects of 2,4-D was also investigated. Rates ranged from 5 to 20 pounds nugreen (43%N) per acre. Results may be summarized as follows: 1. Minimum injury to the flax has resulted from applications of 2,4-D at the 3 to 4 inch stage and IPC at the 3 to 4 true leaf stage. 2. Ester formulations of 2,4-D are most effective on both flax and common weeds. The sodium salt formulations are least effective with the amine formulations intermediate in effectiveness. 3. The ester formulations cannot be recommended for use on Punjab flax because of the serious yield reductions obtained at all rates used. 4. The amine formulations have not seriously reduced flax yields when used at rates of 1/2 pound per acre or less. 5. Rates less than 1/2 pound per acre of any formulation of 2,4-D tested have not been effective in weed control. 6. 1/2 pound rates of the amine formulations of 2,4-D have successfully controlled but not eliminated such weeds as wild mustard, (Sisymbrium irio), nettle leaf goosefoot (Chenopodium murale), sour clover (Melilotus indica) and mallow (Malva parviflora). 7. Control of knotweed (Polygonum argyrocoleon) may be obtained with rates of 3/4 pound per acre. Some injury to flax must be expected at this rate. 8. Rates of IPC from 2 to 3 pounds per acre have successfully controlled wild oats without significant reductions in flax yields. The higher rate has been more consistent. 9. IPC works through the roots and must be carried into the root zone to be effective. A light irrigation, immediately following application, has accomplished this. 10. Maleic hydrazide and 3 chloro IPC have severely damaged flax at all rates effective in weed control. 11. Methoxone (ester) caused greater flax yield reductions than 2,4-D (amine) at the same rates and was no more effective in weed control. 12. The use of foliage sprays of nitrogenous fertilizers to counteract the ill effects of 2,4-D applications has shown some promise. (Submitted by Arizona Agricultural Experiment Station and the Division of Weed Investigations, BPISAE, USDA).

(9) <u>The effect of a number of solvents on Linum usitatissimum (fiber flax, variety Cascade).</u> Freed, Virgil H. Flax sown in gallon cans and grown under greenhouse conditions was sprayed with various solvents when 2 to 3 inches in heigth using 3 replications and 3 controls. The solvents were mixed with water and a few drops of emulsifier were added. Solvents used were acetone, methyl isobutyl ketone, ethylene dichloride, tributy phosphate, methyl alcohol, benzene, toluene, zylene and dioxane. The applications were made at the rate of 7 gallons per acre.

Tributyl phosphate was extremely toxic and killed 74% of the plants. Several of the solvents caused slight spotting of the foliage a few days following the application. However, this was of no consequence and disappeared as the plants became older. Tributyl phosphate was the only solvent having any lasting effect on this variety of fiber flax when applied at the rate of 7 pounds per acre. (Contributed by Oregon State College).

(10) The effect of IPC and 3 Chloro IPC on the seed yield of perennial fescues and the control of Festuca myuros. Bayer, D. E. and Freed, V. H. Trials were laid out in the field using IPC (O Isopropyl N phenyl carbamate) as an emulsifiable liquid alone and in combination with $CaCN_2$ (calcium cyanamide as a 50% wettable powder, and 3 Chloro IPC (Isopropyl N 3 Chlorophenyl carbamate). The chemicals were applied at 3 different times, October, November and December. The October rates of application for IPC were 3 and 4.5 pounds per acre, 3 Chloro IPC 3 and 4.5 pounds per acre, and IPC, $CaCN_2$ combination 3 and 320, and 3 and 480 pounds per acre respectively. The November and December rates of application were IPC 4.5 pounds per acre and 3 Chloro IPC 4.5 pounds per acre.

Applications were made on solid stands of Alta fescue, Red fescue and Chewings fescue that was uniformly infested with rattail fescue (Festuca myuros). Treatments were made on plots 10 feet by 16 feet replicated three times.

The IPC, $CaCN_2$ plots showed a decided stimulation of growth of the seed crop plant in combination with a good control of the rattail fescue. The yield from these plots in general were significantly larger than the check or other treatments. Stimulation of the seed crop was due in part to the effect of the nitrogen that was liberated as the $CaCN_2$ was broken down.

The yields from the November treatments were significantly lower than yields from the October treatments. The December treatment yields were greater than on the November treatment but not equal to the October treatments. This may be explained by the grass having a critical period when the chemicals affect the seed bud primordia more severely than at a stage before or after this crucial period. (Contributed by Oregon State College).

(11) The effect of IPC and 3 Chloro IPC on Bromus erectus and Alta fescue (pre-emergence and post-emergence). Bayer, D. E. and Freed, V. H. Trials were set-up in the greenhouse to determine the effect of IPC (Isopropyl N phenyl carbamate) and 3 Chloro IPC (Isopropyl N 3 chlorophenyl carbamate) on Bromus erectus and Alta fescue (Festuca elatior var. arundinacea) at pre-emergence and post-emergence.

Alta fescue and Bromus erectus seeds were sown separately in 1 gallon cans with 2 replications for each treatment with 4 controls. In the pre-emergent trials, 25 seeds per can were sown with the exception of the controls. In these 100 seeds per can were sown with Alta Fescue, and 50 seeds per can with Bromus erectus. For the post-emergent trials, a random number of seeds were sown.

IPC and 3 Chloro IPC were applied to both pre-emergent and post-emergent trials at 1, 2 and 4 pounds per acre in the form of a spray.

After the pre-emergent treatments were harvested, they were resown.

In the pre-emergent trials, IPC and 3 Chloro IPC at 1, 2 and 4 pound rates completely inhibited germination of Alta fescue and Bromus erectus except for IPC at the 1 pound rate on Bromus erectus. In this case, the germination was reduced to practically one-half that of the control.

The resown pre-emergence cans showed no residual effect of IPC 2 months after the application of this chemical. The 3 Chloro IPC over the same period of time showed a strong residual effect on both grasses.

In the post-emergent trials, IPC at 1, 2 and 4 pound rates showed no effect on the Alta fescue and Bromus erectus. The 3 Chloro IPC at these same rates caused severe damage to the grasses with the exception of Bromus erectus at 1 pound rate. In this case, the damage was slight. (Contributed by Oregon State College).

(12) The effect of mixtures of IPC and 3 Chloro IPC on Echinochloa crusgalli and Bromus erectus. Bayer, D. E. and Freed, V. H. Trials were set-up in the greenhou to determine the effect of mixtures of IPC (Isopropyl N phenyl carbamate) and 3 Chloro IPC (Isopropyl N 3 Chlorophenyl carbamate) on Echinochloa crusgalli and Bromus erectus at pre-emergence.

Echinochloa crusgalli and Bromus erectus were sown separately in 1 gallon cans with two replications. 25 seeds were planted per can.

The ratios of IPC to 3 Cl IPC used were 1:0, 1:3, 1:2, 1:1, 2:1, 3:1 and 0:1. They were applied at the rates of 1, 2 and 4 pounds per acre. The materials were applied at a 1% dust. When the control cans were approximately 6 inches tall, all the cans were harvested.

All combinations of IPC and 3 Cl IPC used gave complete control of Bromus erectus with the exception of the 1:0 ratio at 1 pound per acre. In this case, germination was reduced to 16%. For the Echinochloa crusgalli, the 1:3 ratio applied at 2 and 4 pounds per acre; 1:2 ratio applied at 2 and 4 pounds per acre; 1:1 ratio applied at 2 and 4 pounds per acre; 2:1 ratio applied at 4 pounds per acre; 3:1 ratio applied at 4 pounds per acre; and 0:1 ratio applied at 1, 2 and 4 pounds per acre gave complete inhibition of seedling germination. The ratios of 1:3 applied at 1 pound per acre; 1:2 applied at 1 pound per acre; 1:1 applied at 1 pound per acre; 2:1 applied at 2 pounds per acre; and 3:1 applied at 2 pounds per acre reduced germination to less than 50%. (Contributed by Oregon State College).

(13) The effect of 2,4-D on four forage grasses. Hodgson, Jesse M. Perennial forage grasses have proven themselves as good competitive crops for weed control and 2,4-D as a supplement to weed control with these crops has been favorably reported many times. However, 2,4-D has caused serious damage to grass type crops under some conditions. This study of the effect of 2,4-D on grasses was designed to determine the tolerance of four varieties to different rates of 2,4-D application on four stages of growth. The data obtained has shown them to be quite variable in tolerance to different rates of 2,4-D applied at different growth stages.

Grass varieties included in the study were, Alta fescue, Standard crested wheatgrass, Orchard grass and Manchar smooth brome. Plantings of the four varieties were made in rows. Five replicates of each variety were randomized in the planting. Date of planting was varied according to the known length of germination period for each variety so that emergence of all varieties would be on the same day as nearly as possible. 2,4-D treatments were made at the following 2 week intervals, 2 weeks, 4 weeks, 6 weeks and 8 weeks after emergence of the seedling grasses. Amine 2,4-D was applied at 1/2, 1 and 2 pounds of acid per acre in 25 gallons of water on each date. Individual plots consisted of one row of each variety 3 feet wide and 16.5 feet long. Plant stand and yield samples were taken from one half of each plot near the center.

Treatments of 2,4-D two weeks after emergence greatly reduced the yield of all varieties in the test. All grasses exhibited very serious root damage from treatments 2 weeks after emergence. The heaviest rate, 2 pounds per acre inhibited root growth on all the grasses and they had not entirely overcome effects of the treatment 3 months later.

Root damage was not readily apparent on treatments at any other interval. However, yield reductions occurred from treatments of 2 pounds per acre on the 4 and 8 week growth stage.

Orchard grass was the most sensitive of the grasses to 2,4-D. Yield of orchard grass was decreased 66% when treated with 2 pounds of 2,4-D 2 weeks after emergence. This same treatment 6 weeks after emergence yielded about the same as the untreated checks.

Alta fescue was quite sensitive to 2,4-D treatments 2 weeks after emergence and was reduced about 25% in forage yield by 1/2 pound of 2,4-D per acre. None of the later treatments of 1 or 2 pounds of 2,4-D per acre caused any reduction of yield of alta fescue. This species was the most resistant of the grasses at the 4, 6 and 8 week growth stages.

Crested wheatgrass withstood treatments at two weeks somewhat better than the other species but was decreased in yield as much as 31% by the 2 pound rate of application. However, there was very little reduction in forage from any treatment on this species 4 or 6 weeks after emergence.

The 1 and 2 pound rates of 2,4-D caused many sterile florets or complete absence of florets in some locations on the rachis. Leaf distortion and twisting of culms were also noted, mostly where 2 pounds of 2,4-D were applied at earlier stages of growth. (Contributed by Division of Weed Investigations, BPISAE, U. S. Dept. of Agriculture in cooperation with Idaho Agricultural Experiment Station).

(14) Effects of 2,4-D on germinating and seedling grass. Krall, J. L. The isopropyl ester of 2,4-D was applied at 1 pound equivalent per acre as a pre-emergence, emergence and post-emergence treatment on 18 species of grass in 1950 and 42 species in 1951. In 1950, the greatest reduction in grass stands resulted from application of 2,4-D at pre-emergence. Big bluegrass and green needle grass were entirely eliminated by pre-emergence sprays while Hopkins timothy, intermediate wheatgrass, alta fescue, Lincoln brome and mountain brome were 100% resistant to the effects of 2,4-D. Tall wheatgrass, Russian wild-rye, standard crested wheatgrass, fairway crested wheatgrass, pubescent wheatgrass, tall oatgrass and blue bunch wheatgrass were from 70 to 90% resistant. Western wheatgrass, Canadian wild-rye, slender wheatgrass and red fescue were from 30 to 40% resistant. Emergence sprays were not as harmful as pre-emergence treatments. Only those species that were susceptible when treated at pre-emergence had reduced stands with emergence sprays. The post-emergence treatments did not reduce the stands of any of the species.

The 1951 results were inconclusive due to drought conditions which caused poor germination of the grasses and poor penetration of the 2,4-D down to the grass seeds. (Contributed by Montana Agricultural Experiment Station, Central Montana Branch Station, Moccasin, Montana).

PROJECT 7. ANNUAL WEEDS AND LEGUMES - ALFALFA, CLOVERS, PEAS, ETC. ALSO EFFECTS OF HERBICIDES ON THESE CROPS.

Luther G. Jones, Project Leader

SUMMARY

The 6 reports received represented 5 states: California, Colorado, Idaho, Utah and Washington.

California - This report is a summary and is concerned with the herbicides and formulations that are in general use over the state in the control of weeds associated with small seeded legume crops.

Colorado - Chemical control of annual grasses in alfalfa - pre-emergence applications of 1.5 lbs./A. of 3-chloro-IPC gave a 30 to 50 per cent control of stinkgrass, barnyard grass and witchgrass on sandy soil and was ineffective on heavy clay soil. Under similar conditions STCA at 10 lbs./A. was rated 20 on the sandy soil and 90 to 100 per cent on the clay.

Again on sandy soil under low moisture conditions applications of 6 lbs./A. of 3-chloro-IPC and STCA at 10 lbs./A. were ineffective. However, in the same area a fall application of 3-chloro-IPC at 6 lbs./A., flooded in gave 95 per cent control and STCA at applications of 10 and 20 lbs./A. were ineffective.

Both chemicals must be retained in the primary root zone to be effective.

Idaho - The effects of 2,4-D on four forage legumes. Seedling Ranger alfalfa, Birdsfoot trefoil, Kenland red clover and Ladino white clover were rated on their resistance to 2,4-D used at rates of .5, 1 and 2 lbs./A. Ranger alfalfa was most sensitive. Birdsfoot trefoil was second, Kenland red clover third and Ladino white clover most resistant. In general, the damage to seedlings of the four varieties was progressive with each increase of 2,4-D. The seedling gained in tolerance with age. The .5 lb./A. rate of 2,4-D gave little yield reduction when used on Ladino white clover, Kenland red clover or Birdsfoot trefoil.

Utah - Exploratory experiments on the control of dodder in alfalfa. In the seven tests conducted in 1950, 3 materials were outstandingly good in the control of dodder. The materials were aromatic oil, furnace oil and a 1-2 furnace oil-water emulsion fortified with DNOSBP. 2,4-D applied pre-emergence at rates of 4 and 8 lbs./A. was rated at 65 per cent effective. Both rates, however, caused serious damage to the alfalfa.

In the 1951 tests the aromatic oil at 120 gals./A. gave a 98 per cent control, furnace oil 80 and the 1-2 furnace oil-water emulsion fortified with DNOSBP only 55 per cent.

Washington - Control of wild oats in peas. In the control of wild oats in peas, the effectiveness of IPC wettable, IPC emulsifiable and a 1-2 mixture of 3-chloro-IPC and emulsifiable IPC were not significantly different. The minimum effective rate for each material was 4 lbs./A.

The 60 per cent increase in seed yield of the treated over the untreated was significant.

Washington - Evaluating chemical sprays for controlling cheatgrass in established alfalfa. In series 1 the pre-emergence treatment September 20 proved ineffective. Likewise, in series 3, the aromatic weed-killing oils, reinforced oils containing PCP and dinitro applied on November 7 were unsatisfactory. In series 2, seedling treatment October 23, 3-chloro-IPC, STCA each at 4 and 8 lbs./A., maleic hydrazide at 3 lbs./A., and IPC at 4 lbs./A. gave marked control for a short time but failed to give protection over the desired period. The disodium salt of 3,6-endoxohexahydraphthalic acid at the 8 lbs./A. rate gave complete control. The 4 lbs./A. rate was considered 85 to 95 per cent effective. The 8 lbs./A. rate of IPC was in third position with a rating of 70 to 85 per cent. In the 4th series, the advanced seedling stage, treated March 1, only the 8 lbs./A. rate of the disodium salt of 3,6-endoxohexahydraphthalic acid plus 10 and 20 lbs./A. ammonium sulphate proved effective. The control was rated at 70 to 85 per cent.

The highlights of the reports presented emphasize the importance of the amount of chemical used, the stage of plant growth, the sensitivity of crop plants, the susceptibility of weedy plants, the soil type, the soil moisture and the climatic conditions in the successful use of herbicides.

REPORTS OF INDIVIDUAL CONTRIBUTORS

Herbicides and formulations that are in general use in the control of weeds associated with legume seed production in California. Jones, Luther G., and W. A. Harvey. Seedlings - For seedling stands of alfalfa, Ladino clover and red clover the dinitro selective sprays, such as Dow or Sinox selectives, used at rates of 4 to 6 qts. in 15 to 20 (airplane application) or 60 to 80 (ground rig) gallons of water have proven effective against broadleaved annual weeds like mustard, chickweed, shepherd purse, star thistle, wild lettuce, wild radish and others.

Pre-emergence - IPC and 3-chloro IPC at rates of 3 to 4 lbs. in 60 to 100 gals. of water per acre, as pre-emergence sprays have been used to control weedy grasses in alfalfa, Ladino clover, red clover, and trefoil. But because of the high cost their use has been rather restricted. This year for the first time these materials are being used to place-spray large acreages of row-planted alfalfa. The sprays are applied to 8 to 10" bands covering the planted rows and the 28 to 30" unsprayed strips between rows are cultivated. Place-spraying and cultivation effects a reduction in cost of 1/2 to 2/3 over complete coverage.

Pre-planting - Preplanting sprays have been used to a limited extent. The general contact sprays such as are used on established stands of alfalfa have been effective in eliminating seedlings of both grasses and broadleaved plants. The preplanting sprays are particularly suited to treating fall or winter prepared seed bed preparatory to spring planting.

Established stands - In established stands of alfalfa, red clover and trefoil the control measure used is a general contact spray made up of 2 to 3 pints of a dinitro product, such as Dow or Sinox general, 35 to 65 gals. of diesel oil and 65 to 90 gals. of water per acre. Other reinforced oils of a comparable strength are also used. Avon, analos 7 and 11, Shell 20, standard 2 and others are sometimes used in an emulsion with water without added dinitro.

The dinitro, oil, water emulsion may also be used between cuttings during the summer to control annual weeds. If only broadleaved weeds like star thistle are present, much or all of the oil may be omitted. If applications are made for water grass, sandbur, cupgrass, tickle grass or love grass, they must contain oil, and the spray should be applied immediately after mowing for best results. Yellow star thistle has been successfully controlled by application of 2 qts. of Dow or Sinox general as the only herbicide in 100 gals. of water per acre, applied between the first and second or the second and third cutting of hay.

On established stands of Ladino clover and trefoil 2,4-D at rates of 8 to 12 ozs. in 10 to 60 gals. of water per acre properly used has proven effective in eliminating dock, buckhorn, plantain, chicory, sedges, dodder, star thistle, wild lettuce, bur clover, mustard, etc.

The following points are important when spraying seed fields with 2,4-D.

1. Timing is important. Spraying may delay the seed harvest as much as 30 days if done after early May. The best time to spray appears to be in April after the clover has really started growing. Dormant clover (Nov., Dec., Jan.) should not be sprayed.

2. Use from 1/2 to 3/4 pound of actual 2,4-D acid per acre. If buckhorn is the principal weed to be controlled, use 3/4 pound of actual 2,4-D acid per acre.

3. The amine form of 2,4-D appears to be safer to use on clover than does the ester form.

4. Ground rig equipment appears to give very good results providing not less than 20 to 50 gals. of water are used per acre.

5. All 2,4-D sprayed fields should be kept well irrigated following spraying.

6. 2,4-D sprayed stands should not be grazed during the recovery period.

7. Delayed spraying permits water grass to become established and become a serious pest in the subsequent seed crop.

For best control of buckhorn, the field should be grazed or mowed back before spraying to expose the prostrate growing buckhorn plants. Dock and chicory appears to be readily killed by 2,4-D in normal unmowed or ungrazed stands. The sedges may require treatment for several years before they are checked.

Ryegrass, foxtail, poa annua, wild oats, chickweed, etc., usually volunteer freely in seed fields, even though only pure ladino may be seeded into the field. IPC applied in late February at the rate of 3 to 5 lbs. in 60 to 100 gals. of water per acre, has given excellent control of these weeds.

If applied too early (Dec. and Jan.) the IPC may be leached to below the grass root zone by winter rains. If applied too late, it may not be carried down deep enough into the soil. Timing to get it on when most of the grasses are just germinating or in the seedling stage is also an important consideration.

Dodder - Infestations of dodder in Ladino clover, red clover, alfalfa and trefoil have been satisfactorily controlled with application of oil-dinitro-water emulsion sprays. On alfalfa, trefoil and red clover best results were obtained when the sprays were applied immediately following cutting for hay at rates of 2 to 3 pints of dinitro, 15 to 35 gals. diesel oil and 60 gals. of water per acre. On Ladino clover the sprays gave good results when applied during the bloom to ripe seed stage of the dodder.

For spotted infestations of dodder, place-spraying with oil and subsequent burning is effective.

Chemical control of annual grasses in alfalfa, sugar beets, onions, and certain truck crops. Blouch, Roger, J. L. Fults, and B. J. Thornton. 3-chloro IPC, sodium TCA, and maleic hydrazide (MH30) were field-tested in three areas of Colorado for selective action against annual grasses. Results with pre-emergence sprays of 3-chloro IPC on onion seed beds near Greeley showed that 1½ pounds per acre gave 30-50 percent control of stinkgrass (Eragrostis cilianensis), barnyard grass (Echinochloa crusgalli), and witchgrass (Panicum capillare). The onions showed no injury. Sodium TCA at 10 pounds per acre gave only 20 percent control of the grasses, and produced severe chlorosis in the onions. The soil was sandy in testure, and moisture abundant. On a heavy clay soil near Ft. Collins, 3-chloro IPC at 1½ pounds was ineffective, whereas sodium TCA at 10 pounds gave 90-100 percent control. In this treatment, sodium TCA did not injure sugar beets, but did severely injure lettuce, red beets, and cucumbers. In a later trial on loamy soil, 3-chloro IPC at 6 pounds gave 100 percent control of green foxtail (Setaria viridis) and 40 percent control of wild oats (Avena fatua). Onions, alfalfa, and sweet clover showed no injury, but sugar beets were stunted for a period of four to six weeks. Again moisture conditions were adequate. In the subnormally dry San Luis Valley, near Center, spring treatments with 3-chloro IPC, sodium TCA, and MH30 (the latter post-emergence) were ineffective in the control of wild barley (Hordeum jubatum) and volunteer grain in second-year alfalfa pastures. Evidently conditions must be favorable for plant growth before these herbicides can function effectively. Fall treatments in the same area with 3-chloro IPC at 6 pounds, followed by flood irrigation, gave 95 percent control of volunteer oats in five-month-old alfalfa. The alfalfa showed no injury at this rate. Sodium TCA at 10 and 20 pounds gave no control of the volunteer oats. Soil texture varied on the plots from sandy to gravelly. From the results obtained in all three areas it would appear that 3-chloro IPC is better adapted to lighter-textured soils, and sodium TCA to heavier soils, with both chemicals requiring adequate moisture for efficient results. MH30 in greenhouse trials effectively prevented awn formation without leaf-kill in wild barley at 1½ and 3 pounds per acre. (Contribution of the Colorado Agricultural Experiment Station).

The effect of 2,4-D on four forage legumes. Hodgson, Jesse M. The forage legumes are usually classed as sensitive to 2,4-D treatments. However, because of the urgent need of better means of controlling weeds in these crops and indications of resistance of some of these plants to 2,4-D this study of the effect of various rates of 2,4-D applied to legumes at different stages of growth was undertaken.

Legumes included in the study were Ranger alfalfa, Ladino white clover, Kenland red clover and Birdsfoot trefoil. Plantings of the four varieties were made in rows. Five replicates of each variety were randomized in the planting. 2,4-D treatments were made at the following 2-week intervals: 2 weeks, 4 weeks, 6 weeks and 8 weeks after emergence of the seedlings. Amine 2,4-D was applied at ½, 1 and 2 pounds of acid per acre in 25 gallons of water on each date of treatment.

Changes in plant stand and reduction of yield indicated a high degree of damage to most of the legumes from 2,4-D treatments. However, Ladino white clover and Kenland red clover exhibited considerable tolerance to some of the treatments. Ranger alfalfa was the most sensitive legume in the test. Least reduction in stand and yield of alfalfa occurred from treatments of ½ pound per acre at four and six weeks after emergence. Stand was reduced about 90 per cent and yields decreased about 75 per cent as an average for all 2 pound treatments with 2,4-D on this plant.

Birdsfoot trefoil was next in sensitivity to 2,4-D treatments. Stand reduction was usually much less than alfalfa and forage yields indicated that these plants made good recovery. The average yields of treatments at ½ pound of 2,4-D two weeks after emergence almost equaled the check plots although there had been some reduction in stand. Again the 2-pound rate caused major loss of stand and yield on all dates of treatment with the 1-pound rate being intermediate in effect. At four and six weeks after emergence average yields of birdsfoot trefoil treated with ½ pound of 2,4-D were equal to the yield of untreated checks.

Kenland red clover withstood ½ pound of 2,4-D per acre at 6 weeks after emergence with no decrease in yield and there was only slight yield decrease from this rate at the eight-week interval. Red clover plants did not exhibit the ability to overcome 2,4-D effects as well as other legumes in the test. Rates of 1 or 2 pounds of 2,4-D usually caused severe decrease in yields on all dates of treatment.

Ladino white clover was most resistant of the legumes to 2,4-D treatments. This variety was decreased only slightly in stand from treatments with one pound of 2,4-D per acre and yield decrease from this treatment was 20 per cent. However, ½ pound of 2,4-D on this date caused no reduction in stand or yield of Ladino white clover. (Division of Weed Investigations, BPISAE, USDA, in cooperation with the Idaho Agricultural Experiment Station).

<u>Results of exploratory experiments on the control of dodder in alfalfa.</u> Timmons, F. L., and W. O. Lee. An exploratory experiment comparing seven spraying, burning, and hand-cutting treatments for control of small-seeded dodder (Cuscuta arvensis Beyrich) was conducted in 1950 in an alfalfa seed field near Mendon, Utah. Each treatment was made on a single plot 1x2 rods in a part of the field where numerous dodder-infested patches were present. The dodder-infested spots, numbering 30-90 per plot, were spot-treated July 19 to eliminate the dodder from the first cutting alfalfa seed crop. At the end of the season the yield of alfalfa seed and the amount of dodder seed contained was determined for each plot.

Three spray treatments: an aromatic oil, a furnace oil, and a 1-2 furnace oil-water emulsion fortified with DNOSBP, each applied as a foliage wetting spray, gave complete or nearly complete elimination of dodder seed without reducing the yield of alfalfa seed as compared with the untreated check and with the plot on which the dodder patches were cut by hand, bagged, and removed. Spray treatments with ammonium DNOSBP and KOCN reduced the amount of dodder seed 86% and 92%, respectively. Burning with a knapsack kerosene weed-burner eliminated the dodder 100% but also killed most of the alfalfa top-growth and reduced the alfalfa seed production to almost nil. Burning required more than twice as much time as the oil spray treatment. Hand-cutting, bagging, and removing the infested material required 500% more time than the oil spraying treatment and resulted in a lower yield of alfalfa seed. All spraying and burning treatments killed the alfalfa top-growth in the treated areas but regrowth from the crowns showed no permanent injury.

Another exploratory experiment conducted in the same field in 1951 tested CMU (3-para-chlorophenyl-1,1-dimethylurea) at 1, 2, 3, and 4 lbs./A., micronized 2,4-D acid at 4 and 8 lbs./A., sodium PCP at 20 and 40 lbs./A., and ammonium DNOSBP at 6 and 9 lbs./A. as pre-emergence treatments for the control of dodder. The applications of CMU and 2,4-D were made March 29 when alfalfa was just beginning new growth from the crowns. Sodium PCP and ammonium DNOSBP applications were made May 3 when the alfalfa growth was 4-6 inches tall. The first emergence of dodder on untreated areas was observed May 14. Ample precipitation was received after the spray treatments and before the emergence of dodder to leach the chemicals into the soil. All of the treatments were made on single plots 1x2 rods leaving a strip ½x2 rods untreated in each plot as a check.

On August 2, 1951, the number of dodder patches in the plots ranged from 12-71 in the treated half and from 29-90 in the untreated half. Both rates of 2,4-D acid reduced the number of dodder infestations about 65%. None of the other chemical treatments gave a consistent reduction in the amount of dodder. 2,4-D reduced the stand of alfalfa 20% for the 4 lbs./A.-rate and 30% for the 8 lbs./A.-rate. CMU and sodium PCP at heavy rates caused considerable injury to the alfalfa from which it eventually recovered.

A third exploratory experiment in the same alfalfa field compared spray treatments of aromatic weed oil, furnace oil, and 1-2 furnace oil-water emulsion fortified with DNOSBP. All of the spray treatments were made at 120 gals./A. on alfalfa stubble June 29, 1951, after the first cutting. The treatments were duplicated on plots 1x2 rods. Observations on August 6 showed that the number of dodder patches per plot ranged from 0-38. The dodder control was 98% for aromatic weed oil, 80% for furnace oil, and only 55% for the DN fortified oil-water emulsion as compared with untreated check plots. None of the chemical treatments affected the stand or vigor of alfalfa. The effect on alfalfa seed yield was not determined. (Contributed by the Division of Weed Investigations, BPISAE, USDA, and the Utah Agricultural Experiment Station, cooperating).

<u>Control of wild oats in peas.</u> Rasmussen, Lowell W. The growing of dry edible and seed peas in the Palouse region had favored the increase of wild oats to the extent of affording serious competition to the peas and the subsequent wheat crops. Previous tests applying herbicides pre-emergence or as selectives after the peas and wild oats had emerged, failed to give control of the wild oats.

Three wild oat infested pea fields were selected in 1951 for tests of the effectiveness of IPC applied during seedbed preparation and harrowed into the soil before seeding the peas.

In the tests on two of the fields the object was to determine the relative effectiveness of three IPC formulations, IPC wettable, IPC emulsifiable, and 1:2 mixture of 3-chloro-IPC and IPC emulsifiable, each at the rate of 4 pounds actual IPC per acre. The treatments were randomized and replicated six times on one field and four times on the other field. The plots were 20 to 50 feet in size. Stand counts of wild oat plants were taken in three five square foot quadrates randomly placed in each plot. The variability in plant numbers was high within plots and between plots which resulted in very poor precision even with 10 replicates comparing treatment differences. The differences between the formulations used were small and consequently not significant.

In a separate test on another field two formulations were used, IPC wettable and the 1:2 mixture 3-chloro IPC and regular IPC emulsifiable at rates of 2, 4, and 6 pounds of IPC per acre. A check plot was included making seven treatments which were arranged in a balanced incomplete block design having four plots per block, seven blocks being required to complete the balance.

Wild oat plant counts were taken in three quadrates in each plot and when the peas matured quadrates were harvested for pea yield determinations.

The treated plots had significantly fewer wild oat plants than the check plots. The two-pound rates of application did not give satisfactory control. The 4- and 6-pound treatments did not differ significantly in numbers of wild oat plants. This test indicates 4 pounds to be the minimum effective rate of application.

The yield of peas was increased significantly in the treated plots, the check plots mean yield being 1167 pounds per acre, the 6-pound IPC treated plots mean yield being 1869 pounds. (Contribution Washington Agricultural Experiment Station, Pullman, Washington).

Evaluation of chemical sprays for the control of cheatgrass in established alfalfa. Bruns, V. F., and C. O. Stanberry. On September 28, 1950, immediately after the last cutting of alfalfa was removed, isopropyl N phenyl carbamate (IPC), isopropyl N 3-chlorophenyl carbamate (Chloro-IPC), sodium trichloroacetate (STCA), and the disodium salt of 3,6-endoxohexahydraphthalic acid, each at the rate of 4, 6, and 8 lbs./A., and maleic hydrazide and EC-5722, each at 3 and 6 lbs./A. (all active ingredient basis) were applied as pre-emergence treatments. Although the disodium salt of 3,6-endoxohexahydraphthalic acid exhibited considerable control of cheatgrass (Bromus tectorum) for eight weeks following the applications, all treatments were considered ineffective at the time of the first cutting of alfalfa on May 23, 1951.

A second series of applications was made on October 23, 1950, at which time cheatgrass averaged 1½ inches in height. These treatments included IPC, Chloro-IPC, STCA, and the disodium salt of 3,6-endoxohexahydraphthalic acid, each at 4 and 8 lbs./A., maleic hydrazide at 3 lbs./A., potassium cyanate at 20 lbs./A., EC-5722 at 3 and 6 lbs./A., and Formulated #2-73 (dichloral urea) at 5 and 10 lbs./A. Ammonium sulphate at 20 lbs./A. and a small amount of spreader-sticker were added to the disodium salt of 3,6-endoxohexahydraphthalic acid in this series of applications. Chloro-IPC, STCA, maleic hydrazide, and the light rate of IPC gave marked control until

February or March, after which cheatgrass emergence and growth developed rapidly. Best results were obtained with 8 lbs./A. of the disodium salt of 3,6-endoxohexahydraphthalic acid preparation. Almost 100 per cent control of cheatgrass was maintained by this treatment without apparent injury to the alfalfa. The same preparation at 4 lbs./A. maintained nearly 100 per cent control of cheatgrass until 3 or 4 weeks before the first cutting of alfalfa (May 23), after which some growth of cheatgrass occurred. This treatment was considered 85 to 95 per cent effective. The only other encouraging treatment in this series was IPC at 8 lbs./A. with a comparative herbicidal rating of 70 to 85 per cent.

A third series of applications, which was made on November 7, 1950, included an aromatic weed-killing oil, an aromatic weed-killing oil plus 15 per cent pentachlorophenol, and diesel oil, each at 20 and 40 gals./A., and a dinitro-diesel oil-water emulsion in the ratio of ½-5-35 gals./A. None of these treatments proved satisfactory.

The last series of treatments was made on March 1, 1951, just before alflafa broke dormancy. Chloro-IPC, IPC, and STCA were applied at 4 and 8 lbs./A. each. Ammonium sulphate was applied at rates of 10 and 20 lbs./A. alone and in all combinations with 4 and 8 lbs./A. of 3,6-endoxohexahydraphthalic acid. A commercial product containing 38 per cent disodium salt of 3,6-endoxohexahydraphthalic acid as the principal active ingredient was included also at the rate of 4 lbs./A. (a.i.b.). Although less effective than when applied October 23, the disodium salt of 3,6-endoxohexahydraphthalic acid at 8 lbs./A., plus the ammonium sulphate, gave from 70 to 85 per cent control of the cheatgrass. This material was more effective with the addition of 20 lbs./A. of ammonium suophate than with the addition of 10 lbs./A. The commercial product appeared fully as effective as the other disodium salt of 3,6-endoxohexahydraphthalic acid preparations. All other treatments were considered ineffective.

The size of the plots used in this experiment was 60 square feet. The treatments were completely randomized within three blocks and included three untreated checks per block. (Contributed by the Div. of Weed Investigations, BPISAE, USDA, and Wash. Agric. Expt. Sta., cooperating).

Project 9. The Control of Annual Weeds in Row Crops and Vegetables

Lambert C. Erickson, Project Leader

Summary

It is significant that although nine individual reports arrived in time to be considered in this summary no two reports can be considered as duplicate studies. This illustrates the great variation in crops and cropping conditions common to the eleven western states.

The reports show that 30 different chemical compounds were employed in studies involving 18 different crops. Many of the chemical compounds were used in several phases indicating that about 62 different chemical test trials were made. This figure multiplied by, in some instances, several crops, times the number of replications per chemical compound employed indicates the great amount of effort that is at the present time devoted to chemical control in row crops in the western states.

Considering further, that considerable additional work is being done that was not submitted for this report, we can look hopefully forward to assistance in many problems which are at present beyond control.

The Effect of Various Herbicides on Stands and Yields of Fullgreen Beans. Barnard, E. E. and R. L. Warden. Fullgreen beans were planted in randomized four replicated plots on June 5, 1951. On June 8, the following preemergence treatments were applied: DNOSBP-amine salts, 2, 4, and 6 pounds per acre; sodium isopropyl xanthate, 15, 20, and 25 pounds per acre; 2,4-D, sodium salt, 1 and 2 pounds per acre; endothal, sodium salt, 2 and 4 pounds per acre; and PCP, sodium salt, 10, 20 and 30 pounds per acre. Weed stand counts were not made due to a non-uniformity of weed seed germination. The patch was sprinkler irrigated, and after July 5 weeds were suppressed mechanically. The crop was harvested as snap beans on August 20 and 29, after which plant stand counts were made and the field abandoned. Germination started on June 17 and was considered completed on June 21. Delayed and reduced germination occurred in the plots treated with endothal. In addition, the plants were stunted throughout the season. Lowest germination and greatest stunting occurred with the heaviest application. 2,4-D effects were observed on both of the 2,4-D treatments initially, after which the plants apparently outgrew them. Sodium isopropyl xanthate at 15 and 20 pounds per acre showed a stimulation in growth which was maintained throughout the season. However, the stimulation was not reflected in increased production. Stand counts of all treatments approximated those of the checks except for the endothal treatments which caused highly significant reductions at both rates. Two checks were included in the experiment, check A receiving cultivation throughout the season, check B being cultivated only at the times the other treatments were cultivated; viz: after July 5. Using check A as the base, the yields were highly significantly reduced by both treatments of endothal and the high rate of 2,4-D. In addition, yield of check B were significantly lower than check A. Yields of the plots treated with DNOSBP at the 2-pound rate, sodium isopropyl xanthate at all rates, 2,4-D at the 1-pound rate, and PCP at all rates were lower than check A but not significantly so. Using check B as the base, DNOSBP at all rates, sodium isopropyl xanthate at all rates, 2,4-D at the 1-pound rate and PCP at all rates gave greater yields, the 4 and 6-pound rates of DNOSBP significantly so. DNOSBP at the 4 and 6-pound rates yielded slightly higher than did either of the checks or any of the other treatments. (Contribution of the Montana Agricultural Experiment Station.)

The Effect of Various Herbicides on Stands and Yields of Freezonian Peas. Barnard, E. E. and R. L. Warden. Freezonian peas were planted in randomized four replicated plots on May 14, 1951. Precipitation of 0.59 inches was received that evening which established good germination conditions. On May 17, the following pre-emergence sprays were applied: DNOSBP, amine salts, 2, 4, and 6 pounds per acre; sodium isopropyl xanthate, 15, 20 and 25 pounds per acre; 2,4-D sodium salt, 1 and 2 pounds per acre; endothal, sodium salt, 2 and 4 pounds per acre; and PCP, sodium salt, 10, 20, and 30 pounds per acre. Stand counts of weeds were not read due to non-uniformity of weed seed germination. After June 15, all weeds were suppreseed and thereafter the patch was maintained with sprinkler irrigation and other regular cultural practices. The peas were harvested at the green pod stage on July 28 and 30, and August 2, 6, and 13, after which peas stands were made and the field abandoned. Germination started on May 28 and was considered finished on June 4. Those plots treated with 2,4-D at both rates and those treated with endothal at 4 pounds per acre germinated slowly and poorly, producing weak plants which never recovered. 2,4-D and endothal at all rates resulted in highly significant reduction in stands and yields. Stands and yields of all treatments using DNOSBP, sodium isopropyl xanthate, and PCP closely approcimated those of the check. The 4 pounds-per-acre treatment of DNOSBP demonstrated a slight advantage in stands and production over the check and other treatments. (Contribution of the Montana Agricultural Experiment Station.)

<u>The Effect of Pre-emergence Treatments with C. M. U. upon Cotton.</u> Dotzenko, A. D. This experiment was primarily designed to determine the sensitivity of cotton to C. M. U. in heavy clay adobe soils in the Mesilla Valley. Rates of 1/4, 1/2, 3/4, 1 and 2 pounds of C. M. U. per acre were applied following the planting of cotton. The plots were irrigated immediately after the chemical was applied. All treatments were replicated three times.

All of the treatments, including the 1/4-pound application of C. M. U.; caused serious damage to the young cotton seedlings. When compared to the check treatments, the 1/4-pound application had 8.3 per cent surviving cotton plants, the 1/2-pound rate 3.3 per cent and all other treatments had no surviving cotton plants. The same experiment was repeated at a later date with similar results. New Mexico Agricultural Experiment Station, State College, New Mexico.

<u>Chemical Weed Control in Lillies and Daffodils.</u> Laning, E. R. Jr. and Freed, V. H. In areas where lillies and daffodils receive optimum moisture either through natural rainfall or irrigation, handweeding is usually a serious economic problem.

Results from several investigations show that a pre-emergence chemical application can be made to these crops. A mixture of 6 pounds of IPC (actual material), 1 1/2 quarts of dinitro general, and 20 gallons of diesel oil mixed with enough water to make 75 gallons of solution per acre gives good weed control with little or no damage to the lillies or daffodils if applied in the fall just after the weeds emerge but before the lillies or daffodils emerge.

Post emergence treatments have not yet been developed to the extent that definite recommendations can be made. However, in the case of lillies some investigational work has indicated the possibilities of a chemical weed control treatment which may in the future be used. Early work indicated that the sodium salt of 2,4-D or the sodium salt of MCP showed promise in the control of weeds in lillies but were somewhat injurious to the lillies. Calcium cyanamid dust gave very excellent weed control in most cases but at the same time severely injured the lillies. Potassium cyanate gave insufficient control of weeds and also injured the lillies to considerable extent.

Trials conducted during the summer of 1951 have brought out some promising treatments. It was shown that the mixture of 2,4,5-T at the rate of 1 pound per acre and 3 chloro IPC at 5 pounds per acre as well as Dow Premerge at 1 pound per acre gave very promising results when two applications were made--one in July and the second in August--both on the same plot. Other mixtures of chemical weed control compounds:

1. 2,4-D-S at 3 pounds per acre with 3 chloro IPC at 5 pounds per acre.
2. 2,4-D amine at 1 pound per acre with 3 chloro IPC at 5 pounds per acre.
3. MCP amine at 1 pound per acre with 3 chloro IPC at 5 pounds per acre.

All gave results that indicate that other investigations should be carried on. CMU applied at the low rates, 1 pound per acre, showed much promise for weed control with very little injury to the lillies. Possibly the degree of weed control exhibited by CMU at this low rate was enhanced by the large amount of moisture in the soil and the regular irrigation of the field. Oregon State College.

Weed Control in Garden Flowers. Laning, E. R. Jr., and Freed, V. H. Preliminary experiments conducted in the summer of 1951 indicated the possibility of a chemical control for weeds in garden flowers. The application of certain chemicals with observance of certain precautions did not bring about any discernable harm to these flowers.

Snapdragons, large marigolds, small marigolds, and asters were chosen as representative plants found in home gardens and commerical cut flower and flower seed producer's fields. The first group of tests were applied when the flowers were not yet blooming. There were very few weeds present in the field at the time of spray application since the area had just been cultivated. The entire plot area, however, was undersown with mustard before application of the chemicals. The spray treatments included:

1. A mixture of 2,4-D-S at 1 1/2 pounds per acre with 3 chloro IPC at 2 pounds per acre.
2. 2,4-D-S at 1 1/2 pounds per acre and 3 chloro IPC at 4 pounds per acre.
3. 2,4-D-S at 3 pounds per acre.
4. 2,4-D-S at 1 1/2 pounds per acre.

A strip 1 foot wide was sprayed down, each row of flowers with the nozzles arranged so that the spray pattern would hit only on the lower portion of the flower stems.

Two weeks after application all plots were virtually free of weeds. After five weeks, some grasses primarily sudan grass from a nearby field, and some lambsquarter were growing back into the plots.

At this time there were about half as many weeds in ecah of the treated plots as there were in the check area. In all cases the mustard was controlled. No treatment caused any damage to the flowers.

The second group of tests was designed to take weeds out from between the rows of the flowers. The plants were protected by metal shields which prevented the spray from hitting the plants except the very lowest portion of the stem. The treatments consisted of:

1. A mixture of 2,4-D amine at 1 pound per acre, and 3 chloro IPC at 3 pounds per acre, with Multifilm L added to the solution.
2. An aromatic oil fraction, sprayed at 80 gallons per acre.

The sudan grass growing between the rows was not affected by the 2,4-D and 3 chloro IPC mixture. Practically all dicots were controlled and killed. The aromatic oil knocked down all weeds, grass and dicotyledonous. In only one case was a flower hurt by the aromatic oil. And in this case the oil accidentally hit the upper portion of the plant when the sprayer slipped. The flower plants were not hurt at all by the 2,4-D and IPC mixture. Oregon State College

<u>CMU for Weed Control</u>. Laning, E. R. Jr., and Freed, V. H. CMU, the new soil sterilant chemical brought out by the Du Pont Company, seems to be quite effective in western Oregon. Experimental trials with this material have shown toxicity to most plants when applied as a soil sterilant. Treatments laid out on road shoulders and on fine crushed stone which supports considerable and varied vegetation, at rates of 30 pounds per acre and higher have remained toxic to practically all plants for the period from March through November, 1951. There is no indication that the effect is lessening at this point.

Trials on a railroad right-of-way and around a lumber mill at rates of 20 pounds per acre and up show greater toxicity than other soil sterilant materials now in use. Wild carrot and a few brush plants are the only evidences of resistance to this chemical so far.

There have been reports that at low rates (1/2 to 4 pounds per acre) CMU is promising as a pre-emergence spray material. Trials in the summer of 1951 indicate that this is unlikely in certain instances at least. Treatments of 3/4 and 1 1/2 pounds per acre were made on replicated and randomized blocks containing plantings of corn, wheat, oats, barley, beets, peas, and beans. The plot layout was duplicated so that differential irrigation could be supplied.

In plots receiving optimum irrigation, 3/4-pound treatments gave tip burning to all the crops except beans. One and one-half-pound treatments resulted in quite noticeable injury to all crop plants investigated. In plots allowed to get very dry before irrigating, 3/4 pound-per acre treatments gave no injury but the 1 1/2-pound application again injured the crop plants.

Both 3/4 and 1 1/2-pound-per-acre spray applications controlled mustard but no discernible effects were shown on Canada thistle nor on most grasses in either of these irrigation procedures.

Results from spraying CMU at a rate of 1 pound per acre on lilly bulbs, however, indicated that the 1-pound rate was sufficient to give considerable control of weeds without undue injury to the lilly plants. Possibly the lilly plants are resistant to the CMU while the irrigation applied to the lilly field enhanced the effectiveness of the CMU sufficiently that it gave good control of weeds which were primarily annuals. Oregon State College.

Weed Control in Vegetable Crops. Kosesan, W. H., Freed, V. H., and Laning, E. R. Jr. Selective herbicides have been developed for many crops, but chemical control of weeds in the vegetable crops has not been developed to any great extent. Consequently pre-emergence weed control has begun to play an important role in the development of suitable weed control programs for vegetable crops. Satisfactory weed control prior to crop emergence could possibly solve or greatly reduce the cost of weed control during at least the early portion of the growing season of vegetable crops.

In the development of this program it was felt that factors and conditions having a bearing on the crop, on weed control measures and on the chemicals employed must first be investigated.

From the work covering two years in greenhouse and field trials certain conclusions were reached:

1. The chemical and the rate of application are the most important factors affecting pre-emergent weed control in vegetables.
2. The solubility and residual effect influence the results obtained. Water soluble substances are more easily leached in the soil to the region of seed germination. Residual effect is desirable, but in excess without selectivity may cause injury to crop plants.
3. Moisture tends to increase the activity of chemicals used for pre-emergent weed control.

Following is a summary of crops studied and materials showing some promise for pre-emergence spraying of crops:

Crop	Suitable Materials	Type of Application	Type of Application
Beets	$NaHCN_2$	Pre-emergence	40 lbs/acre
	Standard No. 1	" "	40 gals/acre
	IPC	" "	4 lbs/acre
Beans	NaPCP	" "	6 lbs/acre
	Na 2,4,5-TCP	" "	6 lbs/acre
Peas	IPC plus DNG @ 3/4 qt/acre	" "	2 lbs/acre
Corn	$NaHCN_2$	" "	40 lbs/acre
	Na 2,4-D	" "	1 lb/acre
Lettuce	IPC	" "	4 lbs/acre
Squash	$CaCN_2$	" "	120 lbs/acre
Cucumbers	$CaCN_2$	" "	80 lbs/acre
Cabbage	$CaCN_2$	" "	160 lbs/acre
Spinach	IPC	" "	2 lbs/acre
	Xanthogen disulfide	" "	15 lbs/acre

Oregon State College.

Effect of Pre-emergence Chemical Treatments on Annual Weeds and Onions. Timmons, F. L. Experiments in 1949, 1950, and 1951 at Farmington, Utah, tested a considerable number of chemicals in comparison with untreated hand-weeded check in pre-emergence treatments replicated five times in randomized blocks on plots 8x15 feet containing six rows of yellow sweet Spanish onions. All plots were cultivated and irrigated uniformly by the usual method of growing market onions. All treated plots and untreated check plots were hand-weeded as necessary during each season and the hand-weeding time required was recorded separately for each plot.

The chemicals compared in 1949 were: sulphuric acid, two aromatic weed oils, diesel oil fortified with DN, aromatic oil fortified with PCP, potassium cyanamid, and micronized 2,4-D acid. The applications were made three days before onion emergence and before many annual weeds had emerged. 2,4-D at 1 and 2 lbs/acre reduced the population of broad-leaved weeds and weedy grasses 80-90% but also reduced the yields of marketable onions 65-90%. All of the other chemicals had little effect on the stand of weeds or onions and most of them reduced the yield of onions slightly.

The experiment in 1950 compared 12 different chemical treatments applied March 29, just before the onions started to emerge, and compared seven of these applied April 1 when 10% of the onions had emerged. The contact herbicides such as sulphuric acid, aromatic and fuel oils alone and fortified with DN or PCP had little effect on weeds or onions on the first date. Some of these treatments reduced the stand of weeds somewhat on the second date but also reduced the stand and yield of onions significantly. IPC and TCA had little effect on weeds or onions. The only chemical that appeared to justify further testing was Endothal (disodium salt of 3,6-endoxyhexahydrophthalic acid). Endothal at 4 lbs/acre plus ammonium sulphate at 20 lbs/acre gave much better control of weeds, especially grasses, and reduced the hand-weeding time 51-62%, or 44-53 man-hours per acre. The same chemical at 2 lbs/acre plus ammonium sulphate at 10 lbs/acre reduced the hand-weeding time 24-32 man-hours per acre. However, Endothal reduced the yield of marketable onions 3-5 tons per acre (11-19%) for the 4-lb-acre rate and 1.4-2.3 tons per acre for the 2-lb-acre rate.

The experiment in 1951 compared sodium PCP at 20 and 30 lbs/acre, IPC and TCA at 4 lbs/acre, endothal at 2 and 4 lbs/acre, 3-chloro IPC at 2 and 4 lbs/acre, potassium cyanamid at 125 and 250 lbs/acre, and CMU (3-parachlorophenyl-1,1-dimethylurea) at 1 and 2 lbs/acre. CMU at both rates gave almost perfect control of annual weeds until August but also eliminated nearly all of the onions. Sodium PCP gave good weed control and reduced hand-weeding time 65-80% but also reduced the yield of onions 50% or more. Potassium cyanamid reduced hand-weeding time only 25% and reduced onion yields 10%. TCA reduced the weed growth 70% and hand-weeding time 35% without reducing the stand or yield of onions. IPC was somewhat less effective on weeds and reduced the yield of onions slightly. Endothal gave good weed control, especially on grasses, and reduced hand-weeding time 70-80% (70-80 man-hours per acre). However, the yield of onions was reduced 25% by the 4-lb rate and 8% by the 2-lb rate. 3-chloro IPC gave the best results of all chemicals tested. It reduced hand-weeding time 50% for the 2-lb-acre rate and 75% for the 4-lb-acre rate without reducing the onion yield as compared with untreated hand-weeded checks which averaged 24 tons per acre. (Contributed by the Division of Weed Investigations, BPISAE, USDA, and the Utah Agricultural Experiment Station, cooperating.)

Control of Annual Weeds in Market onions with Post-emergence Chemical Treatments. Timmons, F. L. Three experiments conducted at Farmington, Utah, in 1949, 1950, and 1951 tested a considerable number of chemicals in post-emergence treatments for the control of annual weeds in market onions as compared with untreated hand-weeded check. The treatments were replicated five times in randomized blocks on plots 8x15 feet, each containing six rows of onions. All of the plots were cultivated and irrigated uniformly by the usual method of producing market onions. All treated plots and the untreated check plots were hand-weeded as necessary and the time required was recorded separately for each plot.

The experiment in 1949 tested sulphuric acid, ammonium and sodium salts of dinitrophenol, ammonium sulfamate, and potassium cyanate (KOCN), each at 1-3 rates. The applications were made April 30 when the onions and weeds were in the seedling stage and May 28 when the onions had three true leaves, and when the surviving weeds were 1-6 inches tall. KOCN at the seedling stage reduced broad-leaved weeds 46-70% but reduced weedy grasses only 11-17% and hand-weeding time only 16-24%. The second application of KOCN produced no additional weed kill even at the heaviest rate. All of the other chemicals were less effective. The average yield of onions for chemical treatments ranged from 25-95% of that for the untreated hand-weeded check. Much of the yield reduction probably was due to the fact that hand-weeding was delayed on treated plots until after the second post-emergence spray application.

The 1950 experiment compared KOCN at 5, 7 1/2, and 10 lbs/acre in 60 gallons of water, sodium PCP at 5 and 10 lbs/acre in 60 gallons of water, sodium DNOC at 6 lbs/acre in 80 gallons of water, and sulphuric acid at 2% by volume in 100 gallons of water. All of the treatments were repeated three times during the season (April 25, May 23, and June 30) when weeds were 1/2 to 2 inches tall. The rates of all chemicals were increased 50% on the two later dates of application when the onions were larger. All plots were hand-weeded three times (May 13, June 20, and July 13) and the hand-weeding time was recorded separately for each plot.

All of the chemicals except the dinitro compound gave fair to good weed control, reduced the hand-weeding time for the season 36-60 man-hours per acre, and resulted in onion yields as high or higher than that on the untreated hand-weeded check plots. Light rates of sodium PCP and KOCN increased the yields of onions 2 1/2 tons per acre. Most of the weed control and the reduction in hand-weeding time resulted from chemical applications made May 23 and June 30. The applications made April 25 were much less effective probably due to unfavorable cool weather conditions. Sodium PCP gave weed control results slightly superior to those form KOCN or sulphuric acid.

The experiment in 1951 tested KOCN at 5, 7 1/2, and 10 lbs/acre both with and without a liquid soap spreader, sodium PCP at 5, 10, and 15 lbs/acre, and sulphuric acid at 2% by volume, all in 80 gallons of water per acre. The spray treatments were made May 18 and July 6. For the later treatments the rates were increased to 10, 15, and 20 lbs/acre of KOCN, to 10, 15, and 20 lbs/acre of sodium PCP, and to 3% by volume of sulphuric acid.

All of the chemical treatments gave less satisfactory weed control in 1951 than in 1950, probably because weedy grasses constituted about 80% of the weed population early in 1951 while in 1950 few grasses were present. Both KOCN and sodium PCP reduced hand-weeding time 20-40 man-hours per acre in 1951 and resulted in onion yields as high or higher than that on untreated hand-weeded plots. The weed control increased with rate. Sodium PCP gave slightly better weed control than KOCN or Sulphuric acid.

The conclusions from the three experiments in 1949, 1950, and 1951 are that sodium PCP, KOCN, and sulphuric acid are safe to use in onions at the rates tested and that under favorable conditions they will give good control of most broad-leaved weeds in the seedling stage but little control of seedling grasses or larger broad-leaved weeds or grasses. These chemicals have reduced considerably but have not eliminated the necessity for hand-weeding. Where weedy grasses are known to be a serious problem post-emergence chemical treatment probably could be supplemented advantageously by pre-emergence application of TCA or 3-chloro IPC or possibly, Endothal. (Contributed by the Division of Weed Investigations, BPISAE, USDA, and the Utah Agricultural Experiment Station cooperating.)

Factors Influencing the Effectiveness of Oils in Weeding Carrots. Pew, W. D. and Arle, H. Fred. In commercial carrot production, the use of an oil spray as a selective herbicide has become a widely accepted practice. In spite of the wide use, certain growers have experienced discouraging results. Some growers have obtained excellent results while others have found the spray ineffective in controlling the weeds as well as being injurious to the crop seedlings. Because of the inconsistent results obtained under Arizona conditions, a carefully designed, controlled experiment was employed to determine why deviations from a consistent, effective control are experienced.

Three factors which are unquestionably of utmost importance in determining the toxic value of an oil spray as a weedicide were included in the test. These factors are: rates of application, types or fractions of oil, and times of application determined by air temperatures.

The yield data indicates that each of the variables studied had a direct bearing on the effectiveness of the herbicide. Highest yields of marketable carrots were obtained from plots receiving a standard commercial carrot oil applied at the rate of 75 gallons per acre when the temperature was below 80 degrees F. and remained under this point several hours following application. When the carrot oil was applied when temperature exceeded 90 degrees F. its effectiveness was rapidly reduced. When weed infestations are severe, 50 gallons per acre is insufficient for adequate weed kill. However, in severely infested areas, an application of 75 gallons per acre when temperature is below 80 degrees F. is adequate. Stove oil was found to give a more complete kill than carrot oils if applied when the temperature was above 90 degrees F. Stove oil did not, however, give as complete a control as did carrot oils when the latter were applied properly.

Weed population counts made approximately five weeks following the oil applications ranged from an average of one per square yard for the 75-gallon-per-acre, low-temperature, application of carrot oil to 206 per square yard for the check plots. Chenopodium album was more resistant to oils than was Chenopodium murale. (Contribution of the Arizona Agricultural Experiment Station and the Division of Weed Investigations, BPISAE, USDA.)

PROJECT C. CLASSIFICATION OF THE RESPONSES OF ANNUAL, WINTER ANNUAL AND BIENNIAL WEEDS AND CROP PLANTS TO HERBICIDES

Prepared by C. E. Otis and R. N. Raynor

The following ranking system was used to summarize and classify weed and crop plant responses to herbicides:

I (Very Sensitive) - Plants are killed at indicated stages of growth with lower dosages (where a dosage range is given) of the specified chemical.

II (Sensitive) - Plants are killed at indicated stages of growth with higher dosages (where a dosage range is given) of the specified chemical.

III (Semi-tolerant) - Plants are severely affected but not killed at indicated stages of growth with indicated dosages of the specified chemical.

IV (Tolerant) - Plants are not affected to any extent at indicated stages of growth with indicated dosages of the specified chemical.

Pre-emergence treatments were made by applying the chemical to the soil before the indicated plants had emerged. In measuring plant tolerance to these treatments the I, II, III, IV ranking system, explained above, was used.

For the sake of brevity, these abbreviations are used: A -- amine; E -- ester; MCP -- 2-methyl-4-chlorophenoxyacetic acid or 4-chloro-2-toloxyacetic acid; DN -- dinitro; NH_4 -- ammonium; CMU -- 3-(p-chlorophenyl)-1,1-dimethylurea; 2,4-D-S -- sodium 2,4-dichlorophenoxyethyl sulfate; NaPCP -- sodium pentachlorophenate; TCA or STCA -- sodium trichloroacetate; Chloro IPC -- isopropyl-N-(3-chlorophenyl)carbamate; IPC -- isopropyl-N-phenylcarbamate; KOCN -- potassium cyanate; Endothal -- 3,6-endoxohexahydrophthallic acid.

RESPONSES OF ANNUAL, WINTER ANNUAL AND BIENNIAL WEEDS TO 2,4-D

Common Name	Scientific Name	Chemical Formulation and Rate (in lbs./acre)	Pre-emergence	Seedling Growth	Shooting	Bud	Bloom	State or Province
Bassia, five-hook	Bassia hyssopifolia	A,E, 1		II	III	III		Calif.
"	"	E, 1/4 to 1/2		I	I	II	III	Colo.
Beeplant, rocky mountain	Cleome serrulata	E, 1/4 to 1/2		I	I	II	III	"
Beet, wild	Beta maritima	A, 1/2 to 3/4		I	III			Calif.
"	"	A, 1		II	III	III	III	"
"	"	E, 1		II	III	III	III	"
Beggar ticks	Bidens frondosa	A, 1		II	III	III		"
Black medick	Medicago lupulina	A,E, 1 to 2			II	II	II	Utah
"	"	A,E, 1		II	III	III	III	Calif.
"	"	E, 1/4 to 1		I	I	II	III	Colo.
Brass buttons, Australian	Cotula Australis	A,E, 1		II	II	II	III	Calif.
Bristly ox-tongue	Picris Echiodes	A,E, 1		II	II	III	III	"
Buckwheat, wild	Polygonum convolvulus	E, 1/3		I	II	III		Mont.
"	"	E, 1/2 to 1		II	III	III	IV	Colo.
Buffalo bur	Solanum rostratum	E, 1/2 to 2		II	IV	IV	IV	"
Burdock	Arctium minus	A,E, 1 to 2		II				Utah
"	"	E, 1/4 to 1/2		I	I	II	III	Colo.
Buttercup, field	Ranunculus arvensis	A,E, 1 to 2		II	II	II	II	Utah
Butterfly weed	Gaura parviflora	E, 1/4 to 1/2		I	I	II		Colo.
Careless weed	Amaranthus palmerii	A, 1/2 to 3/4		I	II		III	Ariz.
Cheeseweed	Malva parviflora	A, 1		II	II	III	III	Calif.
"	"	E, 1/2		I	III	III	III	"
"	"	E, 1		I	II	III	III	"
Chickweed	Stellaria media	E, 1/2 to 1		I	II	III	III	Colo.
		A,E, 2 to 4			II	II	II	Utah
"	"	(2 applications)			II	II	II	"
"	Cerastium vulgatum (this acts like a biennial or perennial in Utah)	A,E, 2 to 4 (2 applications)						

RESPONSES OF ANNUAL, WINTER ANNUAL AND BIENNIAL WEEDS TO 2,4-D

Common Name	Scientific Name	Chemical Formulation and Rate (in lbs./acre)	Pre-emergence	Seedling Growth	Shooting	Bud	Bloom	State or Province
Clover, bur	Medicago hispida	A, 3/4 to 1		I	I			Ariz.
Clover, sour	Melilotus indica	A,E, 1		II	III	IV	IV	Calif.
"	"	A, 3/4 to 1		I	I			Ariz.
Cocklebur	Xanthium italicum	E, 1/4 to 1/2		I	I	I	II	Colo.
Cocklebur	Xanthium spinosum	E, 1/4 to 1/2		I	I	II	III	"
"	"	A, 1/2		I	III	III	III	Calif.
"	"	A, 1		II	II	III	III	"
"	"	E, 1/2		I	III	III	III	"
"	"	E, 1		II	II	III	III	"
Cocklebur	Xanthium canadense	A, 1/2		I	III	III	III	Calif.
"	"	A, 1		II	II	III	III	"
"	"	E, 1/2		I	III	III	III	"
"	"	E, 1		II	II	III	III	"
Crabgrass	Digitaris sanguinalis	E, 1/2 to 1		II	IV	IV	IV	Colo.
Dodder, small seeded	Cuscuta arvensis	A, 4 and 8	III					Utah
Fanweed	Thlaspi arvense	E, 1/4 to 1/2		I	I	II	II	Colo.
Fanweed (Penny Cress	"	E, 1/3		I	I	I	II	Mont.
Fennel, dog	Anthemis cotula	A, 3/4		I	III	III	III	Calif.
Fiddleneck	Amsinckia sp.	E, 3/4, 1-1/2		II	III	IV		Oregon
"	Amsinckia douglasiana	A,E, 1		II	III	IV	IV	Calif.
Filaree, red stem and Filaree, white stem	Erodium cicutarium Erodium moschatum	A,E, 1	III	III	III	IV	IV	Calif.
Flax, false	Camelina sativa	E, 1/3		I	I	II	II	Mont.
Foxtail, green	Setaria viridis	A,E,S & acid, 1-3	II					Utah
Goatsbeard	Tragopogon	E, 1/3		I	I			Mont.
Goosefoot, narrow-leaved	Chenopodium leptophyllum	A, 1/2 to 3/4			I			Ariz.
Gromwell, corn	Lithospermum arvense	E, 1/3		II	III	IV	IV	Mont.

RESPONSES OF ANNUAL, WINTER ANNUAL AND BIENNIAL WEEDS TO 2,4-D

Common Name	Scientific Name	Chemical Formulation and Rate (in lbs./acre)	Pre-emergence	Seedling Growth	Shooting	Bud	Bloom	State or Province
Ground cherry	Physalis sp.	A, 1/2 to 3/4		I	II	II	II	Ariz.
Ketmia, bladder	Hibiscus trionum	E, 1/4 to 1/2		I	I	II	II	Colo.
Knotweed	Polygonum aviculare	E, 1/2 to 1				IV	IV	"
"	"	E, 3/4, 1-1/2	II-III	III	IV			Oregon
"	"	A, 3/4 to 1		II	II-III	III	IV	Ariz.
"	"	E, 1/2 to 1		II	III	III	III	Calif.
"	"	A, 3/4 to 1		II	III	III	III	"
Knotweed, silver-sheathed	Polygonum argyrocoleon	A, 3/4 to 1		II	III	III	III	Calif.
"	"	E, 1/2 to 1		II	III	III	III	"
"	"	A, 3/4 to 1		II	II-III	III	IV	Ariz.
Kochia	Kochia scoparia	E, 1/4 to 1/2		I	I	II	III	Colo.
Lambs'-quarters	Chenopodium album	A, 1/2, 1	II	I	II	III		Oregon
		A 2,4-D & 2,4,5-T (1:1) 1/2, 1	II	I	I			"
"	"	A,E, 1-2				III	III	Utah
"	"	A, 3/4		I	I	II	IV	Calif.
"	"	E, 1/4 to 1		I	I	III	IV	Colo.
"	"	E, 1/3		I	II	II	III	Mont.
London rocket	Sisymbrium Irio	A, 1/2		I	I	I	II	Ariz.
"	"	A, 1/2		I	I	III	III	Calif.
"	"	A, 1			II	II	III	"
"	"	E, 1/2		I	I	III	III	"
"	"	E, 1			II	II	II	"
Mallow	Malva neglecta	E, 1/2 to 1				III	IV	Colo.
Mallow, bull	Malva borealis	A, 1		II	II	III	III	Calif.
"	"	E, 1/2		I	III	III	III	"
"	"	E, 1		I	II	III	III	"
Mallow, common	Malva rotundifolia	A,E, 2			II	II	II	Utah
"	"	E, 1/3		I	III	IV	IV	Mont.
Malva	Malva sp.	A, 1		II	II	III	III	Ariz.

RESPONSES OF ANNUAL, WINTER ANNUAL AND BIENNIAL WEEDS TO 2,4-D

Common Name	Scientific Name	Chemical Formulation and Rate (in lbs./acre)	Pre-emergence	Seedling Growth	Shooting	Bud	Bloom	State or Province
Marsh elder	Iva xanthifolia	E, 1/4 to 1		I	I	II	III	Colo.
Mustard	Brassica spp.	A, 1/2 to 3/4		I	I	II	II	Calif.
Mustard, ball	Neslia paniculata	E, 1/3		I	I	I	II	Mont.
Mustard, black	Brassica nigra	A,E, 1/2 to 1		I				Utah.
Mustard, blue	Chorispora tenella	E, 1/4 to 1/2		I	I	II	II	Colo.
Mustard, common	Brassica arvensis	E, 1/4 to 1/2		I	/I	II	II	Colo.
"	"	A, 1/2, 1	I	I	I	II	II	Oregon
Mustard, hare's-ear	Conringia orientalis	E, 1/4 to 1/2		I	II	III	IV	Colo.
Mustard, tansy	Descurainia pinnata	A,E, 1 to 2				III	III	Utah
"	"	E, 1/4 to 1/2		I	II	III	III	Colo.
Mustard, tansy	Sisymbrium incisum	E, 1/3		I	II	III	III	Mont.
Mustard, tumbling	Sisymbrium altissimum	A,E, 1 to 2				III	III	Utah
"	"	E, 1/3		I	I	I	II	Mont.
Nettleleaf goose-foot	Chenopodium murale	A, 1/2 to 3		I	I			Ariz.
"	"	A, 1/2		I	III	III	IV	Calif.
"	"	A, 1		II	II	III	III	"
Nightshade, hairy	Solanum villosum	A,E, 1 to 2				III	III	Utah
Nightshade, black	Solanum nigrun	E, 1/3		I	I	I		Mont.
Nightshade, cut-leaved	Solanum triflorum	E, 1/4 to 1/2		II	III	III	IV	Colo.
Peppergrass	Lepidium sp.	E, 1/4 to 1/2		I	I	II	III	Colo.
Pheasant eye	Adonis annua	A,E, 1 to 2		II	II	II	II	Utah
Pigweed	Amaranthus spp.	A,E,S, and acid 1 to 3	I					Utah Utah
Pigweed, prostrate	Amaranthus blitoides	A,E, 1 to 2				III	III	Utah
"	"	A,E, 1		II	III	III	III	Calif.
"	"	E, 1/3		I	II	II	III	Mont.
Pigweed, rough	Amaranthus retroflexus	E, 1/4 to 1/2		I	I	II	III	Colo.
"	"	A,E, 1 to 2				III	III	Utah
"	"	A, 3/4		I	II	IV	IV	Calif.
"	"	E, 1/3		I	II	II	III	Mont.

RESPONSES OF ANNUAL, WINTER ANNUAL AND BIENNIAL WEEDS TO 2,4-D

Common Name	Scientific Name	Chemical Formulation and Rate (in lbs./acre)	Pre-emergence	Seedling Growth	Shooting	Bud	Bloom	State or Province
Pigweed, tumbling	Amaranthus graecizans	A, 1		II	IV	III		Calif.
"	"	E, 1		II	III	III		"
Pimpernel, red	Anagallis arvensis	A, 1		II	III	III		"
Pineapple, weed	Matricaria suaveolens	A,E, 1		II	II	II	III	"
Plantain, common and	Plantago major	A,E, 1		II	III	III	III	"
Plantain, buckhorn	Plantago lanceolata							
Poison hemlock	Conium maculatum	A, 1/2		III	III	III	IV	Calif.
"	"	A, 1		II	II	III	III	"
"	"	E, 1/2		III	III	III	IV	"
"	"	E, 1		II	III	III	III	"
Puncture vine	Tribulus terrestris	A, 1/2		I	III	III	IV	"
"	"	A, 1		II	II	III	III	"
"	"	E, 1/4 to 1/2		I	I	II	II	Colo.
"	"	A, 1/2 to 3/4		I	I	I	II	Ariz.
Purslane	Portulaca oleracea	A, 1		II	II	III	III	Ariz.
"	"	E, 1/4 to 1/2				IV	IV	Colo.
"	"	A, 1		II	III	III	III	Calif.
"	"	A,E, 2			II	II	II	Utah
Ragweed, common	Ambrosia elatior	E, 1/4 to 1/2		I	I	III	III	Colo.
Ragweed, great	Ambrosia trifida	E, 1/4 to 1/2		I	I	III	III	"
Roemeria poppy	Roemeria refracta	A,E, 1 to 2		II	II	II	II	Utah
Russian thistle	Salsola kali	E, 1/3		I	II	IV	IV	Mont.
"	"	E, 1/4 to 1/2		I	II	IV	IV	Colo.
Sandbur	Cenchrus pauciflorus	E, 1/4 to 1/2			IV	IV	IV	Colo.
Shepherd's purse	Capsella Bursa-pastoris	A, 3/4		I	I	I	I	Calif.
Sow thistle, common	Sonchus oleraceus	A, 3/4 to 1		II	II-III	IV	IV	Ariz.
Sow thistle, common See Wild lettuce								
Sow thistle, prickly	Sonchus asper	A, 1/2		I	III	III	IV	Calif.
Spikeweed, common	Centromadia pungens	A,E, 1		II	III	IV	IV	"
Spurge, spotted	Euphorbia, maculata	A,E, 1		II	IV	IV	IV	"

RESPONSES OF ANNUAL, WINTER ANNUAL AND BIENNIAL WEEDS TO 2,4-D

Common Name	Scientific Name	Chemical Formulation and Rate (in lbs./acre)	Pre-emergence	Seedling Growth	Shooting	Bud	Bloom	State or Province
Sunflower	Helianthus annuus	E, 1/4 to 1/2		I	II	III	IV	Colo.
"	"	E, 1/3		II	III	IV	IV	Mont.
"	"	A, 1/2 to 3/4		I	I	II	III	Ariz.
"	"	A, 1		I	II	III		Idaho
Sweetclover	Melilotus spp.	E, 1/3		I	I	I		Mont.
Telegraph plant	Heterotheca grandiflora	A,E, 1		II	III	III	IV	Calif.
Thistle, blessed	Cnicus benedictus	A, 1		II	III	IV		"
"	"	E, 1		II	III	III		"
Thistle, distaff	Carthamus lanatus	A, 1		II	III	III	IV	"
Thistle, milk	Silybum marianum	A, 3/4		I	I	I	I	Calif.
"	"	A,E, 1		II	III	III	IV	"
Thistle, yellow star	Centaurea solstitialis	A, 3/4		I	I	I	II	"
Tocalote	Centaurea melitensis	A,E, 1		II	III	IV	IV	"
Turkey mullein	Eremocarpus setigerus	A, 1		II	II	III	III	"
Wild carrot	Daucus carrota	A, 1		I	II	III	IV	Idaho
Wild lettuce	Lactuca scariola	A, 3/4			I			Calif.
Wild lettuce and Sow thistle, common	Lactuca scariola, Sonchus oleraceus	A, 1/2		I	III	III	IV	"
		A, 1		II	II	II	III	"
		E, 1/2		I	III	III	IV	"
		E, 1		II	II	II	II	"

RESPONSES OF ANNUAL, WINTER ANNUAL AND BIENNIAL WEEDS TO CHEMICALS OTHER THAN 2,4-D

Common Name	Scientific Name	Chemical Formulation and Rate (in lbs./acre)	Pre-emergence	Seedling Growth	Shooting	Bud	Bloom	State or Province
Beet, wild	Beta mantima	NH_4, DN 1-1½		I	III			Calif.
Bluegrass, annual	Poa annua	IPC, 3		I				"
"	"	STCA 4-8	II	II-III	III	IV	IV	"
Brome, downy	Bromus tectorum	IPC, 2	I	III	IV	IV		Mont.
"	"	4	I	I	IV	IV		"
"	"	8	I	I	III	III		"
Chickweed	Stellaria media	IPC, 3	I	I				Calif.
"	"	NH_4, DN 1-1½	III	I	III	IV	IV	"
Clover, sour	Melilotus indica	DN, 1		I	I			Ariz.
Crabgrass	Digitaria sanguinalis	STCA 4-8	I	III	IV	IV	IV	Calif.
Crabgrass	Digitaria spp.	CMU, 2	II	II	IV	IV	IV	Neb.
"	"	Chloro IPC, 3	II	II	IV	IV	IV	"
"	"	TCA, 5	I	II	IV	IV	IV	"
"	"	2,4-D-S, 4	II	IV	IV	IV	IV	"
"	"	Shale Kerosene (40 gal./acre)		I	I	IV	IV	"
Dodder, small seeded	Cuscuta arvensis	NaPCP, 20 & 40	IV					Utah
"	"	NH_4 DN 6 & 9	IV					"
Fescue, rattail	Festuca myuros	IPC, 4	I	I	II			Oregon
"	"	ClIPC, 4	II	II	II			"
Fiddleneck	Amsinckia sp.	E 2,4,5-T 3/4, 1½		I	I	II		Oregon
"	"	E NCP, 3/4 to 1½		II	III			"
Foxtail, common	Hordeum murimen	IPC, 3		I				Calif.
"	"	STCA, 4-8	I	II-III	III	III	III	"
Foxtail, green	Setaria viridis	TCA, 7	I					Idaho
"	"	IPC, 4	III					"
"	"	Na PCP, 20-30	III					Utah
"	"	5-15		III	IV			"
"	"	KOCN, 5-15		III	IV			"
"	"	TCA, 4	II					"
"	"	IPC, 4	III					"

Common Name	Scientific Name	Chemical Formulation and Rate (in lbs./acre)	Pre-emergence	Seedling Growth	Shooting	Bud	Bloom	State or Province
Foxtail, green	Setaria viridis	Cl IPC, 2 & 4	II					Utah
"	"	CMU, 1 & 2	I					"
Goosefoot, narrow-leaved	Chenopodium leptophyllum	DN, 1		I	I			Ariz.
Knotweed	Polygonum aviculare	E 2,4,5-T, 3/4, 1½		II	III			Oregon
"	"	IPC 2 to 4	II	III	IV			"
"	"	Cl IPC 2 to 4	I	II	IV			"
"	"	CMU 5 to 10	I	I	II			"
"	"	Endothal 2-4		II				"
"	"	2,4-D-S 2,8	III					"
"	"	NH_4DN 1 to 1½	IV	II	II	IV	IV	Calif.
"	"	NH_4DN 1 to 1½		I				"
Lambs'-quarters	Chenopodium album	A MCP 1/2, 1		I				Oregon
"	"	A 2,4,5-T 1/2, 1	II	I	II			"
"	"	2,4-D-S 2,4	II	III				"
"	"	Endothal 2,4		III				"
"	"	KOCN 6 to 12		II	IV			"
"	"	CMU, 2	II	II	IV	IV	IV	Neb.
"	"	Cl IPC, 3	II	II	IV	IV	IV	"
"	"	TCA, 5	I	II	IV	IV	IV	"
"	"	2,4-D-S, 4	II	III	IV	IV	IV	"
"	"	Shale Kerosene (60 gal./acre)		I	II	IV	IV	"
"	"	NH_4DN, 1-1½	IV	II	III	IV	IV	Calif.
"	"	NH_4DN, 1-1½		I	III			"
Lovegrass	Eragrostis spp.	STCA, 4-8	I	III	III	IV	IV	Calif.
Mustard	Brassica spp.	NH_4DN, 1-1½		I				"
Mustard, common	Brassica arvensis	A MCP 1/2, 1	I	I	I	I	II	Oregon
"	"	A 2,4,5-T 1/2, 1	II	I	II			"
"	"	2,4-D-S 1,4	I	II	IV	IV		"
"	"	KOCN		II	III	IV		"
"	"	IPC 2,4	III	IV				"
"	"	Cl IPC 2,4	II	III				"

Common Name	Scientific Name	Chemical Formulation and Rate (in lbs./acre)	Pre-emergence	Seedling Growth	Shooting	Bud	Bloom	State or Province
Mustard, common	Brassica arvensis	CMU 1,5	II	III				Oregon
"	"	Endothal 1,4		I	II			"
"	"	Amine DN 2,4	I					"
"	"	NH_4 DN 1-1½	III	I	II	III	IV	Calif.
Mustard	Brassica & Sisymbrium spp.	Na PCP 5-15		II	IV			Utah
"	"	Na PCP 20-30	II					"
"	"	KOCH 5-15		II	IV			"
"	"	IPC 4	IV					"
"	"	TCA 4	IV					"
"	"	Cl IPC 2 & 4	II					"
"	"	CMU 1-2	I					"
Nettle-leaved goosefoot	Chenopodium murale	DN 1-1½		I	I			Ariz.
Pheasant eye	Adonis annua	2,4,5-T 1-2		II	II	II	II	Utah
Pigweeds	Amaranthus spp.	Na PCP, 20-30	II					"
"	"	5-15		II	IV			"
"	"	KOCH, 5-15		II	IV			"
"	"	IPC, 4	IV					"
"	"	TCA, 4	IV					"
"	"	Cl IPC, 2 & 4	II					"
"	"	CMU, 1 to 2	I					"
Pigweed, rough	Amaranthus retroflexus	NH_4 DN 1-1½	IV	II	III	IV	IV	Calif.
"	"	CMU, 2	II	II	IV	IV	IV	Neb.
"	"	Cl IPC, 3	II	II	IV	IV	IV	"
"	"	TCA, 5	I	II	IV	IV	IV	"
"	"	2,4-D-S, 4	II	III	IV	IV	IV	"
		Shale Kerosene (60 gal./acre)		I	II	III	IV	"
Purslane	Portulaca oleracea	KOCH		IV	IV			Utah
"	"	IPC, 3	I	I				Calif.
Rescue grass	Bromus catharticus	IPC, 3		I				"

Common Name	Scientific Name	Chemical Formulation and Rate (in lbs./acre)	Pre-emergence	Seedling Growth	Shooting	Bud	Bloom	State or Province
Romeria poppy	Roemeria refracta	2,4,5-T 1-2		II	II	II	II	Utah
Ryegrass	Lolium multiflorum	IPC, 4	I	I	II	IV		Oregon
"	"	STCA 4-8	II	III	IV	IV	IV	Calif.
"	"	Cl IPC, 4	I	II	II			Oregon
Shepherd's purse	Capsella bursapastoris	NH_4DN 1-1½		I	I			Calif.
"	"	NH_4DN 1-1½	III	I	III	IV	IV	"
Stinkgrass	Eragrostis cilianensis	Na PCP 5-10		III	IV			Utah
"	"	Na PCP 20-30	III					"
"	"	KOCN, 5-15		III	IV			"
"	"	TCA, 4	II					"
"	"	IPC, 4	III					"
"	"	Cl IPC 2 & 4	II					"
"	"	CMU 1 & 2	I					"
Thistle, milk	Silybum marianum	NH_4DN 1-1½		I				Calif.
Thistle, yellow star	Centaurea solstitialis	NH_4DN 1-1½		I				"
Watergrass	Echinochloa crusgalli	STCA, 4-8	I	II-III	III	IV	IV	"
Wild lettuce	Lactuca scariola	NH_4DN 1-1½		I				"
Wild oats	Avena fatua	IPC 1½-3	I	II				Calif. & Ariz.
"	"	TCA, 7	II					Idaho
"	"	IPC, 4	II					"
"	"	STCA, 4-8	II	II-III	III	III	III	Calif.
Wild radish	Raphanus sativus	NH_4DN 1-1½	III	I	II	III	IV	"

RESPONSES OF CROP PLANTS TO 2,4-D

Common Name	Scientific Name	Chemical Formulation and Rate (in lbs./acre)	Pre-emergence	Seedling Growth	Shooting	Bud	Bloom	State or Province
Alfalfa, Buffalo		A, 1/2		III	III			Calif.
Barley		A, 3/4-1½			IV			Ariz. & Calif.
"		E, 1/4-1/2		III	IV		III	Colo.
Beans, pinto		E, 1/2-1		I	II	II	III	"
Beets, sugar		E, 1/4-1		I	II			"
Burnet	Sanguisorba annua	E, 3/4, 1½		III	III			Oregon
"	"	E 2,4-D/2,4,5-T (1:1) 3/4-1½		I	II			"
Castor bean		A,E, 1		II	II	III	III	Calif.
Corn, sweet		A,E,S & acid 1-3	IV					Utah
"		4	III					"
Flax, Punjab		A, 1/2		IV	IV			Calif.
		A, 1		III	III			"
		E, 1/2		III	IV			"
		E, 1		III	III			"
		A, 3/4		IV	III			"
		E, 3/4		III	III			"
		A, 3/4		IV	IV			Ariz. & Calif.
Maize		A, 3/4-1			IV			Ariz.& Calif.
Oats		E, 1/4-1/2		III	IV		III	Colo.
Onions (from bulbs)		A,E, 1-3	III					Utah
Onions (from seed)		Acid, 1 & 2	I					"
Vetch, purple		A & E, 1/2		I	II	III		Calif.
Wheat		E, 1/4-1/2		III	IV		II	Colo.

RESPONSES OF CROP PLANTS TO CHEMICALS OTHER THAN 2,4-D

Common Name	Scientific Name	Chemical Formulation and Rate (in lbs./acre)	Pre-emergence	Seedling Growth	Shooting	Bud	Bloom	State or Province
Alfalfa		DN(NH_4 salt), 1-1½		IV				Ariz. & Calif.
Alfalfa, Buffalo		A MCP 1/2		III	III			Calif.
Barley		STCA 4-8	I	I	II	II	III	"
"		DN(NH_4 salt), 1-1½	IV	IV	IV			"
Beans, common		STCA 4-8	I	I	II	II	III	Calif.
"		DN(NH_4 salt), 1-1½	IV	IV-III	III	IV		"
Beans, lima		STCA 4-8	I	I	II	II	III	"
"		DN(NH_4 salt), 1-1½	IV	IV-III	III	IV		"
Beets, sugar		STCA 4-8	IV	IV	IV	IV	IV	"
"		DN(NH_4 salt), 1-1½	III	I	II			"
Burnet	Sanguisorba annua	E 2,4,5-T 3/4-1½		I	II			Oregon
Canary grass	Phalaris canariensis	IPC 1½-3	I	I				Calif. & Ariz.
Carrots		Petroleum naphtha fractions 75 gal./acre		IV				Calif. & Ariz.
"		CMU, 2		III	IV	IV	IV	Neb.
"		Cl IPC, 3		III	IV	IV	IV	"
"		TCA, 5		II	IV	IV	IV	"
"		2,4-D-S, 4		IV	IV	IV	IV	"
"		Shale Kerosene 60 gal./acre		II	III	IV	IV	"
Clover, Kenland red		DN(NH_4 salt), 1-1½	IV	III	IV	IV		Calif.
Corn, sweet		TCA 2-6	IV					Utah
Flax, Punjab		IPC, 2½-4		IV	IV			Ariz. & Calif.
"		DN(NH_4 salt), 1		IV	IV			"
Lettuce		STCA, 4-8	IV	IV	IV	IV	IV	Calif.
Melon, honey dew		STCA, 4-8	IV	IV	IV	IV	IV	"

Common Name	Scientific Name	Chemical Formulation and Rate (in lbs./acre)	Pre-emergence	Seedling Growth	Shooting	Bud	Bloom	State or Province
Onions		Potassium cyanate 20		IV				Ariz. & Calif.
"		DN(NH_4 salt)1-1½	III	III	IV	IV		Calif.
"		STCA, 4-8	II	III	III	IV	IV	"
Onions, Hybrid Yellow Globe (Seedling)		CMU, 2		II	IV	IV	IV	Neb.
"		Cl IPC, 3		III	IV	IV	IV	"
"		TCA, 5		I	III	IV	IV	"
"		2,4-D-S, 4		II	IV	IV	IV	"
"		Shale Kerosene 60 gal./acre		II	IV	IV	IV	"
Onions (from bulbs)		CMU, 2	IV					Utah
"		Na PCP, 30	IV					"
Onions (from seed)		Potassium cyanate 5-15		IV	IV			Utah
"		Na PCP, 5-15		IV	IV			"
"		Na PCP, 20-30	II-III					"
"		TCA, 4	IV					"
"		IPC, 4	III-IV					"
"		Cl IPC 2 & 4	IV					"
"		Endothal 2 & 4	III					"
"		CMU 1 & 2	I					"
Tomato		STCA, 4-8	IV	IV	IV	IV	IV	Calif.
"		DN(NH_4 salt)1-1½	III	I	II	III	III	"
Vetch, purple		A MCP 1/2			I	II	III	Calif.
Wheat		STCA, 4-8	I	I	II	II	III	"
		DN(NH_4 salt)1-1½	IV	IV	IV			"

PROJECT 10. SUBMERSED AQUATIC WEEDS

V. F. Bruns, Project Leader

SUMMARY

Seven individual reports were received for inclusion in the Research Progress Report under Project No. 10.

Numerous experimental tests and wide-scale usage by public and private irrigation districts indicate that aromatic solvents, when meeting Type A specifications, have been very effective in giving seasonal control of submersed aquatic weeds in irrigation channels. In some instances, aromatic solvents of coal tar origin have given slightly better results, gallon for gallon, than solvents of petroleum origin and the advantage was attributed to a greater percentage aromatic content. Nonionic emulsifiers, when used at the rate of 2% by volume of aromatic solvent, have provided effective emulsions for distances ranging up to 5 and 7 miles of channel.

Leafy pondweed (Potamogeton foliosus), sago pondweed (P. pectinatus), anacharis (Anacharis canadensis), and white water-crowfoot (Ranunculus aquatilis) have been controlled effectively with 444 to 600 parts per million (6 to 8 gals./cfs) of aromatic solvents when introduced over 30-minute periods of time. The more resistant species, such as gigantic sago (Potamogeton interruptus), Richardson's (P. richardsonii), and American (P. nodosus) pondweeds, have been controlled with 30-minute introductions of 740 ppm (10 gals./cfs) of aromatic solvents. The "slug method" (higher concentrations over shorter periods of time) generally has not been as satisfactory in irrigation channels.

Aromatic solvent treatments usually have been most effective when pondweeds were in the rapid-growth pre-fruiting stage and beginning to interfere noticiably with the water flow. One potent treatment per season usually has been sufficient, except in regions with long or year-around periods of irrigation.

Investigations in the field and greenhouse have shown that field crops are not injured by aromatic solvents at concentrations now being recommended for aquatic weed control. A concentration of 1600 ppm of aromatic solvents was required to reduce appreciably the yields of flood-irrigated seedling grain sorghum and row-irrigated sugar beets. Although slight, temporary contact injury was noted on flood-irrigated alfalfa and cotton, many other crops, which were irrigated with solvent-treated water under varying field and greenhouse conditions, were not injured by concentrations ranging up to 1600 ppm. However, higher concentrations appear to become relatively more hazardous.

Aromatic solvents have been very effective in the control of filamentous green algae. Concentrations as low as 150 ppm for 15 minutes have killed this organism throughout irrigation laterals ranging up to 2½ miles in length. Rosin amine D acetate also has been reported to be effective on green and red filamentous algae at concentrations ranging from 10 to 20 ppm and introduced over periods ranging from 15 to 20 minutes. Two treatments per season are recommended on the Yuma Project in Arizona. Previous reports

indicated that some difficulty had been experienced with this material in waters with a high salt content.

Studies have indicated that a number of species of submersed aquatic weeds were effectively controlled by aerial applications of 2,4-D, at rates ranging from 5 to 20 lbs./A, under laboratory and greenhouse conditions. These studies were carried into the field during 1951 and the results from these investigations should become available during 1952.

Further studies also have been initiated to determine the mulch and fodder values of waterweeds growing in lakes and ponds as well as to classify a broad range of chemicals according to relative toxicity on aquatic plant and animal life.

REPORTS OF INDIVIDUAL CONTRIBUTORS

Aromatic solvent applications for the control of submersed aquatic weeds. Bruns, V. F. In accordance with a uniform plan of experiment developed in 1950, a petroleum aromatic solvent (meeting Type A specifications and containing 2% nonionic emulsifier) was introduced into six similar irrigation laterals on the Roza Division of the Yakima Irrigation Project. Each lateral was treated with a different concentration of the aromatic solvent. Treatments were made early in July at which time the aquatic weed growth was nearing the surface of the water and was tending to impede the water flow. Gigantic sago pondweed (Potamogeton interruptus) and Richardson's pondweed (P. richardsonii Rydb.) were present in all laterals. In previous tests, these species of pondweed, particularly gigantic sago pondweed, proved more resistant to aromatic solvents than leafy pondweed (Potamogeton foliosus Raf.), horned pondweed (Zannichellia palustris L.), and white water-crowfoot (Ranunculus aquatilis L.).

A concentration of 300 ppm of the aromatic solvent (4.05 gals./cfs), introduced over a 30-minute period, gave unsatisfactory results. Only 60 to 70 per cent control of the aquatic weeds, within a distance of 3/4 mile, was apparent two weeks after the treatment. Rapid recovery and growth of pondweeds followed.

A concentration of 400 ppm (5.4 gals./cfs), introduced over a 30-minute period, was more effective than the application of 300 ppm. Two weeks after treatment the control of aquatic weeds for a distance of 1½ miles ranged from 80 to 100 per cent. However, eight weeks after the application aquatic weeds, especially gigantic sago pondweed, were making rapid recovery in this lateral also.

The generally recommended rate of 600 ppm (8.1 gals/cfs) for 30 minutes gave disappointing results during the 1950 season. In this particular test, 600 ppm appeared no more effective than 400 ppm two weeks after the application. However, 75 per cent control of aquatic weed growth still was apparent eight weeks following the treatment.

A rate of 800 ppm (5.4 gals./cfs) for 15 minutes was very effective for a distance of 3/4 mile. From 90 to 100 per cent control of weed growth was maintained in this section of the lateral for eight weeks. Beyond a distance of 3/4 mile the control of aquatic weeds was much less effective.

A 7.5-minute introduction of aromatic solvent at a concentration of 1600 ppm (5.4 gals/cfs) effected from 90 to 100 per cent control of pondweeds from points 3/4 to 1 mile below the initial station, as recorded eight weeks after the treatment. At the same time, weed control in the first 1/4 to 1/2 mile of treated lateral ranged from 30 to 60 per cent only.

A similar pattern of results became even more pronounced when introducing 2400 ppm (5.4 gals/cfs) of aromatic solvent over a period of 5 minutes. Eight weeks after the treatment 5-10, 50, and 90-95 per cent control of aquatic weeds was recorded 1/4, 1/2, and 3/4 mile below the point of introduction, respectively. Thus, weed control was very limited in the first 1/4 mile or more of treated channel by the so-called "slug method", while excellent control of weeds was obtained from 3/4 to 1 mile or more downstream.

During 1951, experimental tests and wide usage by public and private irrigation districts showed that aromatic solvents, if meeting Type A specifications, gave excellent control of gigantic and Richardson's pondweeds when applied at a concentration of 740 ppm (10 gals/cfs) for 30 minutes.

Introductions of aromatic solvents at concentrations as low as 150 ppm (1.01 gals/cfs) for 15 minutes killed green filamentous algae throughout irrigation laterals ranging up to 2-1/2 miles in length. (Contributed by the Division of Weed Investigations, EPISAE, USDA, and Washington Agricultural Experiment Station, cooperating).

Controlling submersed waterweeds with aromatic solvents. Hodgson, Jesse M. Test applications of aromatic solvents to control submersed waterweeds in 1949 and 1950 proved this material to give effective control of several species which infest irrigation systems. The species involved in these tests were horned pondweed (Zannichellia palustris), leafy pondweed (Potamogeton foliosis) and sago pondweed (Pontamogeton pectinatus). These waterweeds were found to be sensitive to aromatic solvents in the order listed. All of the above species were effectively controlled in one mile of ditch when 6 gallons of aromatic solvent per one cubic foot per second flow of water (cfs) was applied over a period of 30 minutes (444 ppm for 30 min.).

The aromatic solvent type waterweed chemicals were applied by spraying them beneath the surface of the water with conventional weed spraying equipment at 60 to 100 psi pressure. They cause a contact type of kill.

Plant growth stage, density of waterweed growth, water velocity and temperature are factors found to influence the effectiveness of aromatic solvent tests. Treatments were most effective when applied at an early growth stage when the pondweeds were growing rapidly causing the water to rise in the channel and before seed heads were formed.

Tests comparing a set amount of aromatic solvent applied over periods of 15 or 30 minutes gave about equal control of pondweeds when all conditions were good. However, when some conditions were adverse treatments applied over the longer periods were more effective. This was especially true when the application period was decreased to 5 minutes.

Four different aromatic solvent products, each sold commercially as a waterweed killer, were compared during 1951. Two paint thinner solvents, to which were added 2 per cent nonionic emulsifier, also were included in this comparison. All of the materials except one gave satisfactory control of horned, leafy and sago pondweeds when applied at 6 gallons per cfs for periods of 15 to 30 minutes. Effective control usually extended 1 to $1\frac{1}{2}$ miles from the point of introduction. The one commercial product, which gave no control of the waterweeds in the tests, was found to be faulty on several counts when checked against specifications.

The one solvent of coal tar origin included in the test seemed to be slightly more effective than the other materials. However, this material was specified as 100 per cent aromatic content active ingredient whereas the petroleum solvents ranged from 87 to 89 per cent aromatic. (Division of Weed Investigations, BPISAE, USDA, in cooperation with the Idaho Agricultural Experiment Station).

Effect of aromatic solvents on several crops. Arle, H. Fred. Studies to determine the possibility of crop damage by aromatic solvents in irrigation water have been conducted during the past several years. Plots were laid out along a small canal and bordered sufficiently to allow flood irrigation and to prevent any water from leaving the plot area. Solvent was introduced into the irrigation water at concentrations of 400, 800, and 1600 ppm. For each irrigation, water was allowed to flow onto the plots for a period of 40 minutes. During this time the equivalent of .25 acre foot of water was introduced. Water remained standing on the surface for two to three hours before completely filtering into the ground. Crops included in these tolerance studies were alfalfa (Chilean) cotton (Acala 33) and grain sorghum (Plainsman).

There was no evidence of permanent injury as a result of any of the treatments on alfalfa. Each of the concentrations burned the leaves which were submerged in treated water and also caused a slight delay in growth. This was most pronounced at the higher concentrations. The detrimental effect, however, was only temporary as there was no difference in the yield of alfalfa hay regardless of treatment.

Applications made to cotton during the 1950 season resulted in very slight yield decreases. Lowest cotton yields were obtained at the highest concentrations. The test was repeated during 1950 on a more comprehensive scale. On one series of plots, treated irrigation water was used for the second irrigation. The cotton plants were 10 to 12 inches tall at this time. On another series, treated water was used for the fourth irrigation at which time cotton ranged from 24 to 30 inches tall. Slight contact injury was observed on the portion of stem which was submerged in the solvent-treated water. Also some leaves became yellow and withered. The latter effect was apparently due to the evaporation of solvent with the fumes causing a contact burn. More leaf damage was noted at the 1600 ppm concentration than at lower rates. This minor injury was not evident in the yield of cotton lint as plots treated with 1600 ppm solvent yielded equally as well as check plots. Neither were there any differences when yield comparisons were made between the two stage-of-growth applications.

During 1950, treated water was used for irrigating grain sorghum at four stages of growth: (1) seedling stage-3 inches. (2) 14 inches tall. (3) boot stage. (4) heading stage. Contact action of the solvent killed some plants when applications were made during the seedling stage. Lowest yields were obtained at the 1600 ppm concentration. There was no apparent injury or reduction in yield when treated water was used in irrigating sorghum that had passed the seedling stage. In 1951, treated water was used in three of the six irrigations necessary in bringing the crop to maturity. Yields have not yet been obtained. However, it appears that only the 1600 ppm concentration, applied during the seedling stage, will reduce yields. This treatment resulted in a stand reduction of 35%. Lower concentrations applied during the seedling stage and all treatments at more advanced growth stages have had no visible effect upon the stand or growth characteristics of the grain sorghum. (Contributed by the Division of Weed Investigations, BPISAE, USDA, and the Arizona Agricultural Experiment Station.)

Controlling algae with rosine amine D acetate. Hodgson, Jesse M. Algae presents a problem of control in many irrigation systems and is usually most serious in very slow flowing water and on flumes of various types. Recently rosin amine D acetate (RADA) was reported to be toxic to algae in very light concentrations in irrigation waters.

A test application of RADA this season gave very effective control of green filamentous algae in a small irrigation ditch. The ditch was very heavily infested with strands of algae up to 4 feet in length. Water flow was almost stopped at the lower end of the ditch and water was being crowded over the bank. Since RADA is soluble in water it was applied as a water spray. A five per cent solution was sprayed beneath the water surface at 40 psi pressure. Some difficulty was encountered in getting the last part of the solution through the spray nozzle because of the stickiness of the material. A concentration of 21 ppm was maintained for 20 minutes in the ditch.

The effect of the treatment was evident the day following. The algae had lost some of its green color, small strands were breaking off and the longer strands were being forced to the sides and bottom of the ditch. Three days after the treatment all the algae had lost its green color and 90 per cent of the algae had disappeared. Water movement had increased and the water level was about 3 inches lower on the bank.

There was no green algae remaining in the ditch five days after the treatment and the ditch continued to be free of algae for 6 weeks following the treatment.

Horned pondweed (Zannichellia palustris) was markedly inhibited in growth in the vicinity of the application of RADA. The pondweed plants were discolored following the treatment and did not make any growth for several days following the treatment. (Division of Weed Investigations, BPISAE, USDA, in cooperation with the Idaho Agricultural Experiment Station).

Progress report on field-scale demonstrations with rosin amine D acetate to control algae (Compsopogon sp.) in irrigation drainage water. Bowser, Curtis W. Filamentous-red algae floating with the current in unlined irrigation drainage systems Yuma Project, Arizona, created problems from 1946 through 1949 by raising the water level thereby reducing effectiveness of the open ditch, and also the filaments would collect upon trash racks to such extent that intakes to lift pumps would clog unless continuous cleaning operations were practiced. The many-branched, unicellular thallus plants grew as summer annuals attaining their maximum growth, filaments often 10 to 20 inches in length, during midsummer and early fall in direct response to the mean temperature and its attendant effect upon the water. To clear the pumping plant trash racks of collecting algae during summer seasons 1946 through 1949 required in excess of 8,000 man hours of labor and during this period 400 or more dump-truck loads of debris were removed. Investigations conducted by Bureau of Reclamation weed control-research technicians and Hercules Powder Company chemists revealed rosin amine D acetate, a product derived from a modified rosin, to be a powerful but inexpensive algaecide. Trial demonstrations of this chemical at 10 parts per million to algae-infested drainage water in 1950 effectively destroyed most algae filaments throughout the entire length of the treated drain and as a result the labor crews engaged in forking material from pumping plant-trash racks immediately were transferred to another activity. Field applications of rosin amine D acetate during each 1950 and 1951 seasons have demonstrated the desirability of introducing chemical during early spring and again in late summer before either algae filaments or reproducible neutral spores build-up in great numbers throughout the system. Applications of chemical at points 2 miles apart throughout the drainage network, using 10- to 12-parts per million concentration of algaecide for 15-minutes contact time at each introduction point now is recommended. At this concentration fish mortality is low and the probability is remote that warm-blooded animals could ingest a lethal quantity of chemical-charged water. (United States Department of Interior, Bureau of Reclamation, Regional Office, Boulder City, Nevada).

Effect of translocated herbicides on submerged tissues of aquatic plants. Oborn, Eugene T. In order to grow diversified crops on much of the land in the western United States it is necessary to supplant the moisture provided by nature in the form of rain, snow, etc., with additional water which reaches farm lands through established irrigation canal distribution systems. These systems frequently support heavy growths of vascular aquatic plants which prevent or slow down the passage of water. Since reducing the carrying capacity of a canal makes it necessary to deprive some potentially crop-producing land of the required water to bring the crop to a satisfactory harvest, it is imperative to keep the waterways open.

This report describes certain pertinent investigations which suggest improved and more effective field techniques to accomplish a solution of the problem at hand.

Broad- and narrow-leaved cattail, water sedge, true watercress, true waterweed, American pondweed, horned pondweed, leafy pondweed, Richardson's pondweed, gigantic sago pondweed, and slender sago pondweed plants were transplanted from the field directly to containers with as little root disturbance as possible. Spraying of the submerged aquatic plant materials in the water drained tanks was performed with a one quart capacity model A, Sure Shot pneumatic sprayer. Lethal effects of 2,4-D ester appeared to be transmitted through the immersed cattail leaf, past the waterline, and into the crown of the plant. No shoot regrowth developed in ester treated plants.

When broad-leaved cattail roots were immersed for 24 hours in 10 ppm of the salt and ester formulations of 2,4-D, and the ester formulation of 2,4,5-T, effect of the passage of the systemic herbicides into the plants was evidenced by the fact that no shoot regrowth was in evidence eight weeks following leaf harvest.

When aerial herbicidal treatments were made the following single or repeated 2,4-D applications were effective in obtaining complete, or nearly complete, eradication of the waterweeds growing in the soil bottom of the treated tanks.

Plant species treated	Pounds per acre	Number of treatments	Percentage eradication
American pondweed	10	1	95
Broad-leaved cattail	35	1	100
Gigantic sago pondweed	20	2	95
Horned pondweed	11	2	100
Leafy pondweed	5	1	100
Narrow-leaved cattail	15	1	100
Richardson's pondweed	12	2	98
True watercress	10	1	100
True waterweed	5	1	100
Water sedge	27	1	85

A study was made of the changes in cattail root reserves in underground plant parts which are due to seasonal growth phenomena. Weekly measurements were made throughout the entire growing season in an attempt to correlate below-ground carbohydrate root reserves with easily observed above-ground phenomena.

Broad- and narrow-leaved cattail roots showed considerable variation in the amount of carbohydrates present during the growing season. Highest carbohydrate was present during the winter dormancy period and lowest carbohydrate was associated with production and maturation of male and female fruiting bodies. Root reserves are low from the time of the first appearance of the fruiting stalks until pollination has been completed.

In the narrow-leaved and broad-leaved cattail growth sites, not inundated by water, root reserves were at a minimum when the plants had attained a height of approximately 100-130 cm and 50-120 cm above the ground line respecively.

Crop tolerance studies indicate that it is safe to use water passing over water plant areas sprayed with systemic herbicides after wasting the first five minutes of wash water. (Division of Weed Investigations, BPISAE, USDA, in coöperation with the U. S. Dept. of the Interior, Bureau of Reclamation).

Aquatic weeds in western Oregon. Jordan, G. L. and Freed, V. H. There has been some work done on aquatic weeds. This type of weed does not assume the importance in Oregon as it does in other regions of the western states. This problem is not too widespread but is confined to certain localities such as a few irrigation and drainage ditches. However, *Anacharis densa* is rapidly becoming a menace to certain lakes. This weed has become established in several lakes of southwestern Oregon and the resultant growth is so dense that it prohibits boating, swimming, angling, and logging operations.

The main weed in irrigation and drainage ditches is *Typhis latifolia* (cattail). The most effective treatment on cattail has been this formulation: 3/4 pound (a.e.) butoxyethanol ester 2,4,D, 4 pounds 70% sodium TCA, and 1/2 pint multifilm. This is applied in 25 gallons of solution to an area of about 1800 square feet.

For the Anacharis problem at this time there is no effective treatment. A unique problem in selectivity is confronted here. How can this weed be treated with a herbicide at an effective concentration and not leave the lake destitute of all aquatic life or kill all of the fish. This aquatic is very resistant to chemicals and furthermore it spreads very easily by vegetative propagation. Having these characteristics, it is only a matter of time before the weed spreads to all usable waters in the state.

As Oregon obtains about 1/3 of its income from the tourist trade, the occlusion of its lakes by this weed will constitute a serious loss of income. Likewise, if this weed becomes established in the irrigation systems of the state a serious economic loss may ensue.

Experiments are being conducted to determine the value of Anacharis when used as a mulch. This weed contains 3% nitrogen on an air dry basis which is a desirable factor in that it does have some fertilizing value. In comparison with peat moss when used in mulching new lawn seedings, Anacharis appears favorable. It does not have the water holding capacity that peat moss has, but on the other hand, seedings have a more vigorous green growth with Anacharis due to the added nitrogen. Experiments conducted to determine the rate of bacterial decomposition of Anacharis have disclosed yet another factor. In about two weeks in the process of decomposition, there appears to be a toxic substance liberated which inhibits the germination of bentgrass. This substance may be extracted with ether. An experiment was conducted in which Anacharis was extracted with ether. The extract was mixed in the soil in greenhouse pots. The Anacharis from which the extract was taken was also mixed in the soil in the greenhouse. These pots were planted to bentgrass. The Anacharis treated pots allowed the grass to grow whereas the extract treated pots were barren. Also, there still remains the possibility of using Anacharis as fodder. Chemical analysis shows that this plant is nutritious, comparing favorably with alfalfa.

Secondly is the problem of chemical control. Chemicals are expensive but it is hoped that utilization will help to defray expenses. It is thought to be impractical to control this weed by utilization, therefore, chemicals will have to come into use in the final analysis.

None of the common herbicides are effective on Anacharis at concentrations low enough to be practical. An intensive screening program has been set up to find possible chemical killers. To date there have been approximately 500 chemicals tested. They are being tested qualitatively at 25 parts per million. Remember that the chemical has to kill the Anacharis without killing all other aquatic life in the lakes and that the cost of treating a lake at 25 parts per million with even the cheapest chemicals is very expensive.

Classifying the chemicals that have proven toxic thus far into groups, it has been found that the aromatic amino compounds are toxic the highest percentage of the time. The quarternary ammonium compounds have also proven very toxic to the plant. The next step will be to conduct quantitative tests on the chemicals that are toxic. In this manner it is hoped to narrow the number of compounds to a few which should give us an idea of the type of compounds most toxic to Anacharis. Further work may be necessary in order to obtain the desired degree of selectivity between the fish and the aquatic weed. Groups of compounds toxic to Anacharis listed in order of toxocity: (1) high toxicity - heavy metals; (2) intermediate toxicity - aromatic amines, quaternary ammonium compounds, phenols, poly chlorinated compounds and phenoxy compounds; (3) low toxicity - diphenyl derivatives, benzene derivatives, and napthalene compounds.

PROJECT 11 EMERGENT AQUATIC WEEDS

Jesse M. Hodgson, Project Leader

SUMMARY

The individual reports received concerning control of Emergent Aquatic Weeds emphasize the fact that cattails are the most troublesome species in this category as all of the reports except one concern either (Typha latifolia) common broadleaved cattail or (Typha angustifolia), narrowleaved cattail. The other report concerns field tests to control Nebraska sedge (Carex nebraskensis).

A combination of the butoxy ethanol ester of 2,4-D at 4 pounds and 5 or 10 gallons of diesel oil with enough water to make 160 gallons per acre was found to be the most effective chemical treatment to control common cattail in a test conducted by Timmons in Utah. Other chemical treatments found to be less effective in order of decreasing effectiveness were: 4 pounds 2,4-D plus ammonium sulfammate at 30 or 40 pounds per acre, 4 pounds 2,4-D as amine plus co-solvent, 4 pounds 2,4-D acid plus co-solvent, and 4 pounds 2,4-D as amine plus TCA at 10 or 20 pounds per acre. Two of the above treatments per season were generally much more effective than one.

Broadleaved cattail roots immersed for 24 hours in 10 ppm of the salt and ester formulations of 2,4-D did not make any shoot regrowth for eight weeks following in a test reported by Oborn. This report appears under project No. 10 on page 137. Oborn also found that carbohydrate reserves in the roots of cattail were lowest from the time of first appearance of fruiting stalks until pollination was completed.

Bowser reports field applications of a mixture of 1.5 pounds of 2,4-D as amine or sodium salt, 8 pounds trichloroacetic acid, and 3/4 pint of sticker spreader in 100 gallons of water applied as a drenching spray at 500 to 600 gallons per acre to be highly effective against the most troublesome emergent weed species.

A comparative test of chemical and mechanical methods of controlling common cattail by Timmons revealed that 3 cuttings per season below the waterline were more effective than 3 aromatic oil sprayings at 160 gallons per acre, 3 tramplings (simulated chainings), 3 pounds of 2,4-D plus 10 pounds of ammate per acre, and some other chemical treatments in controlling broadleaved cattail. This evidence indicates that more consideration should be given to the cutting method in controlling cattails.

Nebraska sedge control reported by Wirth indicated this plant is a serious problem in certain areas. Three applications of Herbicidal oils, of the Lion Oil Company at 100 gallons per acre each time during the season gave 90 per cent eradication of the Nebraska sedge in one season.

REPORTS OF INDIVIDUAL CONTRIBUTORS

Effect of growth regulator chemicals and additives on common cattail (Typha latifolia). Timmons, F. L. An experiment started in 1950 tested 27 different chemical treatments for effectiveness on cattail in a continuously flowing irrigation drain canal. 2,4-D, 2,4,5-T or a mixture of the two were used in all treatments, in most cases at 4 lbs/A. Acid, amine, ethyl ester, and butoxyethanol formulations of 2,4-D were compared at 4 lbs/A, the latter being tested also at rates of 3, 5, and 6 lbs/A. Additives tested in combination with the amine form of 2,4-D included ammonium sulfamate at 10, 20, 30, and 40 lbs/A, sodium TCA at 10, 20, and 40 lbs/A, sulphuric acid, a co-solvent, and a soap spreader. The co-solvent was also tested in combination with the acid form of 2,4-D. Diesel oil at 5 and 10 gals/A was tested in combination with the butoxyethanol ester of 2,4-D at 4 lbs/A. The total spray volume in all treatments was 160 gals/A. All treatments were replicated twice on plots two rods long. The original spray applications were made June 15-16 when the cattail was 3-5 feet tall and in a rapid growth pre-heading stage. One-half of each plot received a second treatment July 30-31, 1950, thus providing a comparison of one and two applications of each treatment.

Cattail regrowth in 1951 showed the combination of diesel oil and butoxyethanol ester of 2,4-D to be definitely more effective than all other chemicals or combinations, followed in order by 2,4-D amine plus ammonium sulfamate at 30 or 40 lbs/A, 2,4-D amine plus the co-solvent, 2,4-D acid plus the co-solvent, and 2,4-D amine plus TCA at 10 or 20 lbs/A. In most cases two applications were considerably more effective than a single application. Cattail regrowth from the treatments which included diesel oil at 10 gallons and 5 gals/A in combination with the butoxyethanol ester of 2,4-D was 6% and 15%, respectively, from two applications and 40% and 60% from single applications.

The esters of 2,4-D and 2,4,5 -T used alone without additives were slightly more effective than the amine and acid forms used alone. However, the results from the esters of 2,4-D alone were not satisfactory even at 5 or 6 lbs/A. The addition of the co-solvent greatly increased the effect of both the acid and amine forms of 2,4-D. The addition of ammonium sulfamate or sodium TCA to amine 2,4-D also increased the effectiveness on cattail but ammonium sulphate, sulphuric acid, and the soap spreader apparently had no additional effect.

Retreatments of surviving cattail growth were made in July 1951 for the 16 treatments which showed some promise from the applications made in 1950. Observations of top-kill and regrowth made in August 1951 again showed the combinations of diesel oil and butoxyethanol ester of 2,4-D to be most effective, followed by combinations of amine of 2,4-D with ammonium sulfamate. It will not be possible to make final evaluations of the treatments on the basis of cattail regrowth in 1952 because the drain canal was cleaned by a drag-line at the end of the 1951 treatments. (Contributed by the Division of Weed Investigations, BPISAE, USDA, and the Utah Agricultural Experiment Station cooperating).

Results with chemical and mechanical methods of controlling common cattail (Typha latifolia). Timmons, F. L. Two experiments, one started in 1949 and the other in 1950, each tested eight mechanical and chemical treatments for effectiveness in control of cattail in irrigation drain canals. In each experiment all treatments were replicated twice in two series of plots arranged systemmatically. In the 1949 experiment the mechanical treatments tested were: cutting below the water line and trampling below the water line (simulated chaining) three times, twice, and once during the season, respectively, in treatments begun at pre-heading (June 7), early heading (July 12), and fully headed (Aug. 5) stages of growth. The chemical treatments included spraying with an ethyl ester of 2,4-D at 3 lbs/A acid equivalent in 240, 120, and 20 gals/A of water; amine salt of 2,4-D at 3 lbs/A acid equivalent plus ammonium sulfamate at 10 lbs/A in 120 gallons of water; an aromatic weed oil at 160 gals/A, and a 1-2 mixture of aromatic oil and water at 160 gals/A. The oil and oil-water spray treatments were made three times, twice, and once, respectively, in the different date series but only two repeated 2,4-D applications were made in the series beginning June 7 and only one 2,4-D treatment was made in each of the series that were begun July 12 and August 5.

Cattail regrowth in the spring of 1950 averaged only 8% on plots where the cattail had been cut three times in 1949 as compared to 70, 20, and 57% regrowth, respectively, for three trampling, aromatic oil spraying, and oil-water spraying treatments. Two treatments in 1949 started at the early heading stage were definitely less effective in each case. None of the single treatments made August 5 reduced the stand of cattail significantly. Spraying with the ethyl ester of 2,4-D reduced the stand of cattail very little regardless of the date or volume of application. The amine salt of 2,4-D plus ammonium sulfamate reduced the cattail 40% from two applications and 25% from one application.

All 2,4-D treatments were discontinued after 1949 but the cutting, trampling, oil spraying, and oil-water spraying treatments that had been started at the pre-heading and early heading stages in 1949 were continued through 1950. The cattail regrowth in the spring of 1951, after two years of these treatments, ranged from .5% to 37.5%. The treatments in order of their effectiveness were; cutting, oil spraying, trampling, and oil-water spraying. Treating three times each year starting at the pre-heading stage was more effective in every case than two treatments started at the heading stage.

In the experiment started in 1950 the same cutting, trampling, oil spraying, and oil-water spraying treatments were compared in series beginning at pre-heading and early heading stages. An amine salt of 2,4-D at 4 lbs/A plus ammonium sulfamate at 20 lbs/A in 20, 80, 160, and 240 gallons of water were tested at both stages of growth.

Regrowth in the spring of 1951 showed all of the 2,4-D treatments to be ineffective. On the other hand, cattail regrowth was reduced to 1% of the original by cutting three times or only twice in 1951, to 3% by trampling three times, and to 6.5% by trampling twice. Spraying with aromatic oil three times in 1951 reduced the stand to 12.5% while spraying twice reduced the cattail to 22.5% of the original stand. The oil-water emulsion was much less effective than the oil alone.

All 2,4-D treatments were discontinued but the cutting, trampling, oil spraying, and oil-water treatments were continued through 1951. The stand of cattail was further reduced by October 1951 to 1-3% by cutting or trampling to 4-30% by oil spraying, and to 20-30% by spraying with the 1-2 oil-water emulsion. A total of 460-630 gallons of aromatic oil was used during the two years for the treatments using oil alone as compared with 167-276 gallons of oil per acre for the oil-water emulsion. (Contributed by the Division of Weed Investigations, BPISAE, USDA, and the Utah Agricultural Experiment Station cooperating).

Progress Report on Field-Scale Developments to Control Cattail (*Typha* spp.) and other Emergent Plants which Frequent Irrigation Systems in Pacific Southwest: Bowser, Curtis W., Emergent weeds, primarily cattail (*Typha* spp.) and frequently rushes (*Juncus* spp.) and sedges (*Scirpus* spp.), create vexing weed problems in deep open irrigation drains, and to some extent these plants congest and cause operating problems in water delivery canals. Spraying contact and fortified oils, periodic burning, application of 2,4-D formulations in each water and in oil-water carriers have been demonstrated to be ineffective and under existing conditions these operations can be regarded only as suppressive measures.

Mechanical removal of emergent plants by dredging is an expedient method of thinning the plant infestations but immediate regrowth from undisturbed rootstocks quickly will reinvade the ditch. Crushing down emergent plants by pulling a heavy chain over the cattail beds has been proved effective if emergent plants are not severed at bases but merely are broken down into water of sufficient depth that to again grow erect the vegetation must expend a considerable quantity of stored-root reserves. Four or more chainings, each spaced three to five weeks apart, or at such time when regrowth attains height of 16 to 24 inches above the water surface, normally are required.

Recent investigations by Imperial Irrigation District and Bureau of Reclamation field workers have revealed a mixture of 1.5-pounds acid 2,4-D as the amine or sodium salt, 8-pounds trichloroacetic acid, and 3/4-pint sticker-spreader in 100 gallons water applied as a coarse drenching spray at rate of 500 to 600-gallons fluid per acre to be highly effective against the most troublesome emergent weed species. Investigations with both ionic and nonionic sticker-spreaders incorporated in the aforementioned mixture of herbicides have not revealed superiority of either type product. The field-scale applications of TCA - 2,4-D mix to control emergent weeds have been so effective that during 1951 in excess of 650 miles infested ditchbanks were sprayed in the Southwest. From observations of the field demonstrations it has been noted that complete foliage coverage is necessary to insure success of spraying operations. Spraying should be performed prior to seed-head development, or at a time immediately following flush of spring growth but before plants have attained such height and density to make foliage coverage impractical. United States Department of Interior, Bureau of Reclamation, Regional Office, Boulder City, Nevada.

Progress Report on Field Tests to Control Nebraska Sedge (*Carex nebraskensis*). Wirth, Laurel D. In late May of 1948 chemical tests were made to control Nebraska sedge growing in, and at times, completely over small farm laterals. Application of ammonium and sodium trichloroacetate at 326.7 pounds per acre and Sinox General, 3 quarts in 30 gallons of #2 diesel fuel plus 50 gallons of water, all gave top kills to within a few inches of the ground. The dead tops were later burned to further delay regrowth. Sodium pentachlorphenate used at some unrecorded rate gave poor results on this sedge. No tests were conducted in 1949.

In early June of 1950 large plot tests of three experimental herbicidal oils labeled LHH6, LHH7, and 19-37 by the Lion Oil Company of El Dorado, Arkansas, were made by the Goshen Irrigation District at Torrington, Wyoming, and by the Scottsbluff County Weed District at Gering, Nebraska. The emulsifiable 19-37 oil gave very poor results when applied with water at 25-30 gallons of oil per acre. The rates for the straight oils varied from 44 to 218 gallons per acre at each of three applications spaced one month apart. Results indicated that three applications of 100 gallons per acre each for three times during the season should give 90% to 100% eradication for any of the three oils. A small plot was treated with a single application of 320 gallons of LHH6 plus 20# of sodium salt of 2,4-D per acre on July 7, 1950, and gave 95% eradication.

The 1950 tests led to large scale field tests of the three oils in 1951 on three different irrigation districts of the North Platte Project. The oils were applied at 100 gallons per acre for three times during the season at variable dates. Three of the applications were made during conditions of high humidity and cloudiness with some water droplets on the leaves. A very poor top kill resulted from those applications even though the oil appeared to cover the leaves thoroughly. One plot was inadvertently burned off between a first and second spraying and had a short 4" to 6" growth at the time of the second spraying. The results were very poor on this spot indicating that the second spraying should have been delayed to obtain a taller growth or that the burning in some way nullified the effects of the first spraying. Twenty pounds of 2,4-D in 100 gallons of diesel oil per acre was applied three times, one of which was during a period of high humidity, to give only a 50% reduction in stand at the end of the growing season. The straight oils gave approximately 90% eradication for the three applications. However, early treatment in 1952 should be done to complete the kill. Complete eradication of the sedge must necessarily require complete coverage of all plants in a given infestation as the underground rhizomes from surviving plants spread rapidly. Ditchbank excavation frequently uncovers 20' to 30' long rhizomes.

Investigations considered for 1952 include alternate burning and spraying with various contact herbicides, soil sterilant plots, 2,4-D in aromatic oils and with TCA, and pasturing studies. United States Department of Interior, Bureau of Reclamation, North Platte River District, Casper, Wyoming.

PROJECT 12. PHYSIOLOGICAL AND CHEMICAL STUDIES

Jess L. Fults, Project Leader

SUMMARY

Physiological studies

A contribution from the California Agricultural Experiment Station has shown that the absorption and translocation of 2,4-D acid and 2,4,5-T acid are enhanced by emulsions with a low pH, at least down to pH2. Although 2,4-D acid presents difficulties in field application an emulsifiable acid formulation has proved very effective on Russian knapweed where absorption and translocation are critical factors.

Studies at Oregon State College have shown that bean seedlings treated with CMU in dust form had significantly higher total nitrogen, "organic nitrogen" (by difference) and water content. Ammonium nitrogen, nitrate and nitrite nitrogen were significantly lower in treated plants. These results suggest that CMU may inhibit nitrogen absorption, may shift the nitrogen equilibrium toward "organic" nitrogen and may block nitrogen utilization within the plants.

At Colorado A & M College, potatoes have been used to study the mechanisms of action of 2,4-D. A recently completed study of the free amino acids in tubers from treated and control plants has shown that 2,4-D treatment significantly increases glutamic acid and decreases isoleucine, phenylalanine, valine, gamma amino butyric acid, lysine, glutamine, alanine, threonine, asparagine, serine and aspartic acid. These results suggest that 2,4-D may act to free transaminases and oxidative deaminases from their bound substrates. A high level of these enzymes might act to speed up the transamination or oxidative deamination of amino acids other than glutamic acid. The increase in glutamic acid suggests that 2,4-D may also act to prevent incorporation of glutamic acid into protein, at least by the usual route.

Studies at Colorado A & M College have been continued in the past year to further evaluate the relationship of scopoletin (6-methoxy-7-hydroxy-1:2 benzo pyrone) to the herbicidal action of 2,4-D. We had previously suggested that the increased concentration of scopoletin in 2,4-D treated bindweed, castor bean and tobacco plants was the direct cause of 2,4-D phytotoxic action. In order to obtain data on the possible universal role of scopoletin in 2,4-D treated plants a survey of 58 species of common weeds, grasses and shrubs was made. Of the total only 8 species of untreated plants contained scopoletin. Treatment with 2,4-D did not cause its accumulation if it was not already present. Plants containing scopoletin before treatment accumulated it after treatment, and in those tissues shown to be dead by sprouting tests. These studies show that although scopoletin is probably not universally present, it is closely correlated with the disturbed metabolism of certain species treated with herbicidal dosages of 2,4-D. Scopoletin may be a model system illustrating a broader implication, i.e., that auxins change the course of normal metabolism so that abnormal accumulations of normal metabolites occur which finally result in death. This idea supports those recently published by Van Overbeek, Blandeau and Horne.

Recent work by the Division of Weed Investigations, U.S. D. A., and the Washington and Utah Agricultural Experiment Stations has shown that soil applications of TCA around apricot and prune trees for the control of quackgrass, caused leaf chlorosis in the two kinds of trees. Spectrographic and chemical analyses showed leaves from treated plants contained greater amounts of copper, manganese, silicon, phosphorus, magnesium, calcium, sodium, potassium and chloride.

According to the literature, results with TCA and 3-Chloro IPC for selective pre-emergence annual grass control in sugar beets, onions, and legumes have been variable. Results at Colorado A & M College suggest that a major reason for such variability is soil type. Best selective action over a range of rates with both chemicals has been secured on a loam soil with high organic matter content, whereas poor to no selective action has been secured on clay or sand of low organic matter content.

Chemical and herbicidal screening studies

An annotated list of herbicide evaluation studies has been prepared by A. W. Swezey of Dow Chemical Company. This list includes 35 different techniques which have been used. They include tests for foliar contact activity, soil persistence and leaching, translocating, germination seed tests, tests with excised plant parts and miscellaneous tests. Details of other published or unpublished tests are solicited by your committee for inclusion in future W. W. C. C. research reports.

The Oregon State College workers have continued screening tests for both pre-and post-emergence herbicides. Applications of ten IPC derivatives were made pre-emergence to soil in which oats were planted. The most phytotoxic chemical as indicated by weight of tops was 3 amine IPC. Tests indicated 3-chloro 2 tolyl IPC and 2,4 dimethyl IPC to have most residual toxicity.

The Union Carbide and Carbon Company chemicals No. 1700 and 5722 were evaluated as pre-emergence herbicides on oats and mustard. Both showed phytotoxicity. Results were not compared to a standard material.

Five derivatives of 2,4-D were screened for pre-emergence effects on mustard, peas and oats. Two showed non-selective herbicidal effect, one showed slight selective effect against mustard in oats, and two slight to no herbicidal effect.

Oxanilide and oxanilic acid were compared to IPC and 2,4-D ethyl sulfate as pre-emergence herbicides on oats and mustard. Post-emergence comparisons were made between oxanilide, oxanilic acid, 2,4-D and endothal. Oxanilide and oxanilic acid as pre-emergence herbicides showed but little activity. Used as post-emergence spray the oxanilic acid slightly stunted mustard but not oats at high rates; oxanilide acted similar to 2,4-D against mustard but with lower degree of phytoxicity. Endothal and oxanilide were similar.

Comparisons of IPC, 3-chloro IPC and Maleic hydrazide as growth inhibitors on bent grass lawn indicate that IPC may slow growth without loss of green color which is characteristic of both maleic hydrazide and 3-chloro IPC. The effect of IPC did not last as long as the other two chemicals.

REPORTS OF INDIVIDUAL CONTRIBUTORS

Relation of pH to the penetration and translocation of 2,4-D in plants. Crafts, A. W. Since the demonstration of the activation of Sinox with acid salts such as ammonium sulfate, it has been recognized that penetration of organic herbicides depends upon the reaction of the applied solution. Experiments proved that any one of a number of acids and acid salts will activate dinitro salts. Further, the same rule applies to salts of pentachlorophenol and other substituted phenols. The ammonium salts of such compounds are more active than the sodium salts because they are inherently more acid.

In seeking an explanation for such activation it was proposed that undissociated molecules of the phenols could penetrate the cuticle and enter the plant more readily than the anions of the salts. Consequently any repression of ionization would enhance penetration. Complete association of the phenol molecules would not be required so long as the herbicide solution were buffered on the acid side because, as soon as undissociated phenol molecules enter the plant from the applied solution, association of others will take place by mass action.

After introduction of 2,4-D, field observations and controlled experiments proved that the same generalization applied to this herbicide. The ammonium salt proved more effective than the sodium; the nonpolar esters were two to three times as effective as the salts; the acid as a suspension or emulsified in a cosolvent was highly effective.

In five controlled experiments with 2,4-D acid and one with 2,4,5-T using the acids in buffered solutions, it has been proved that absorption and translocation are enhanced by low pH down to pH2. At pH values below 2 contact injury from the hydrogen ion in the solution results in inhibited translocation. These experiments involved curvature tests with beans and black-eyed peas. They were replicated in some cases five times, in others ten times.

Solutions containing 500 ppm. of 2,4-D acid were used; an unbuffered solution of 2,4-D acid at this strength has a pH of 3.3; its absorption and translocation as indicated by the bean test lies between values of solutions buffered to pH 4 and pH 3. Because a solution buffered to pH 2 gives higher values by the bean test, association values beyond the pK point apparently enhance absorption. This strengthens the conclusion that association is the critical factor involved.

Suspended 2,4-D acid presents difficulties in field application; an emulsifiable acid formulation has proved very effective on Russian knapweed where absorption and translocation are critical factors. Certain non-volatile ester formulations seem to offer much promise along the same line. Apparently they are effectively absorbed by brushy species having thick cuticle. (A contribution from the California Agricultural Experiment Station.)

Free amino acids in potato tubers altered by 2,4-D treatment of plants. Payne, Merle, Jess Fults, and Ruth Hay. A number of workers have studied the effects of natural and synthetic plant hormones on nitrogen metabolism. A survey of the literature has failed to show a critical study of the free amino acids in plants treated with natural or synthetic plant hormones. The free amino acids, especially glutamic acid, have been shown to occupy a key position in the interpretations of the mechanisms of respiration and protein synthesis. Investigations of the free amino acids in 2,4-D treated Red McClure potatoes were begun at this station in the summer of 1950. Samples of control and treated tubers were frozen, allowed to thaw and the proteins precipitated with ethyl alcohol. Filtrates were concentrated to 1/5 original juice volume by evaporation. The technique of one dimensional and two dimensional paper partition chromatography was used. The amino acid spots were developed by spraying with ninhydrin in ethyl alcohol. Relative densities of the spots were measured by a Welch Co. densicron No. 2150 with a green filter. A summary of the effect of 2,4-D treatment is shown in the following table.

Effect of 2,4-D treatment on free amino acids in tubers of Red McClure potatoes* **

Spot No.	Amino acids	Mean densichron units Treated	Control	Diff.	Standard deviation	Min. difference req. for significance .05	.01
1	Isoleucine, phenylalanine	1.63	1.95	-0.32	0.13	0.03	0.04
2	Valine, gamma amino butyric acid	2.06	2.35	- .29	.18	.14	.19
3	Lysine	1.46	1.58	- .12	.14	.11	.15
4	Glutamine, alanine	2.47	2.82	- .35	.14	.11	.15
5	Threonine	1.40	1.58	- .18	.10	.08	.11
6	Asparagine	1.78	1.93	- .15	.10	.08	.11
7	Serine	1.46	1.56	- .10	.03	.08	.11
8	Glutamic acid	2.68	2.57	- .21	.15	.12	.16
9	Aspartic acid	2.07	2.17	-0.10	0.12	0.09	0.12

*Arginine, proline, histidine, tyrosine, methionine sulfoxide, and cysteic acid, although identified by two-dimensional chromatograms, appeared in concentrations too small to measure.

**Concentrated filtrates were used on one-dimensional chromatograms for this table.

These results show that there were significantly more glutamic acid and significantly less of all other amino acids in the treated tubers. If one considers the interlocking mechanisms of photosynthesis, respiration and protein synthesis, 2,4-D may act to free transaminases and oxidative deaminases from their bound substrates. This is in accordance with Eyster's theory. Acceptance of this idea would account for the accumulation of glutamic acid. (A contribution from the Colorado A & M College.)

<u>Correlation between soil type and rates of Sodium TCA and 3-Chloro IPC application for pre-emergence grass control.</u> Blouch, Roger and Jess Fults. When field results with 3-Chloro IPC and Sodium TCA were being tabulated at the close of the 1951 growing season, certain inconsistencies appeared. Identical rates of application under identical temperature and moisture conditions produced totally different results in several localities. In the Greeley area, for instance, 3-Chloro IPC at $1\frac{1}{2}$ pounds per acre gave 30-50 percent control of grass weeds, while the same rate at Fort Collins gave no results whatever. TCA injured onions severely at 10 pounds per acre at Greeley, but removed grasses effectively from onions at Fort Collins without apparent injury to the crop. An analysis of the conditions present in the various testing areas revealed one variable, the soil type. In order to test the validity of this finding, three widely divergent agricultural soil types common to northern Colorado were selected and placed in deep flats. These soils, Valentine fine loamy sand, Fort Collins loam, and Terry silty clay loam were planted to field depths with sugar beets, onions, sweet clover and alfalfa, wild oats, millet, barley, and crested wheatgrass. 3-Chloro IPC at 3, 6, 9, and 12 pounds per acre, and Sodium TCA at 5, 10, and 15 pounds were compared against

untreated checks in each soil type. Results conclusively show that the selective effect against grasses of either chemical per unit weight is far less on the sand and clay than on the productive, highly organic loam. The lowest rates of TCA and C-IPC injured all crops on the sandy soil, and all but the lowest rate injured crops on the clay, whereas sugar beets were uninjured on the loam at 15 pounds per acre of TCA. Barley did not appear in any of the flats containing the sandy soil, but germinated and grew normally at 6 and 9 pounds per acre of C-IPC on loam. The other crops and grasses responded similarly. This comparison under controlled conditions closely paralleled the field results obtained earlier, and indicate a high degree of necessity in properly gauging field rates of application with the varying soil types encountered. To date it appears that organic matter and structure are probably more of a factor than is texture. This is brought out by the similar lack of resistance to the action of the chemicals by both sand and clay. The medium-textured loam, with high organic content and friable structure, probably adsorbs the chemicals to a high degree and prevents effective usage of a large percent of the total amount applied. Differences in residual effects on these various soil types will also be studied, in an attempt to arrive at a usable index for determining rates of application of pre-emergence grass herbicides. (Contribution from the Department of Botany and Plant Pathology, Colorado A & M College.)

The relation of scopoletin (6-methoxy-7-hydroxy-1:2 benzo pyrone) to the herbicidal action of 2,4-D. Johnson, Milton and Jess L. Fults. During the summer of 1946, it was discovered that the leaves, stems and roots of tobacco plants sprayed with herbicidal dosages of various 2,4-D formulations accumulated a blue-fluorescing compound visible in ultraviolet light. This was isolated and identified as the coumarin derivative 6-methoxy-7-hydroxy-1:2 benzo pyrone or scopoletin. This same chemical has been shown to accumulate in tobacco plants infected with tomato spotted wilt virus and in potatoes infected with leaf roll virus. The growth inhibiting action of scopoletin on elongating *Avena* roots has been established by the agar blanket technique. Its occurrence as a normal metabolite has been established in *Avena* roots, tobacco and bindweed stems and roots. The mechanism of growth inhibiting action appears to be interference with sulfhydryl (-SH) containing dehydrogenase enzymes. These facts suggest that 2,4-D interrupts normal metabolism in such a way that abnormal accumulations of normal metabolites occur which in turn prevent the natural auxins from functioning. In order to test this hypothesis it is essential (1) to know what normal metabolites accumulate in plants treated with phytotoxic levels of 2,4-D; (2) the relationship between the accumulation of normal metabolites and tissues killed by 2,4-D; (3) what common plants normally contain scopoletin and (4) what fluorescent compounds other than scopoletin occur which might be used to test the hypothesis in the same manner as scopoletin. A survey of 58 species using paper chromatographic methods and ultraviolet light absorption data has shown that scopoletin occurs in 8 species. These were bindweed (*Convolvulus arvensis*), stiff mentzelia (*Mentzelia nuda*), fringed sage (*Artemisia frigida*), nightshade (*Solanum triflorum*), common mallow (*Malva neglecta*) and cocklebur (*Xanthium italicum*), castor bean (*Ricinus communis*) and tobacco (*Nicotiana tobacum*). Twenty of the 58 species contained flourescent compounds other than scopoletin and 27 species contained no detectable fluorescent compounds (butanol extractions). There were 14 fluorescent compounds other than scopoletin in the 58 species. The relative amounts of scopoletin in five species of perennial weeds have been determined. Determinations were made before and after phytotoxic dosages of the butyl ester of 2,4-D. Only one of the five contained scopoletin, i.e., bindweed. The absolute amount increased after treatment. No scopoletin was found before or after treatment in Canada thistle (*Cirsium arvense*), hoary cress (*Lepidium draba*), Russian knapweed

(Centaurea picris), or leafy spurge (Euphorbia esula). Detailed study of the bindweed samples showed that scopoletin accumulated in stem and root tissues which greenhouse sprouting tests showed to be dead. In other words "depth of kill" was well correlated with the accumulation of scopoletin. These studies show that although scopoletin probably is not universally present it is closely correlated with the disturbed metabolism of certain species treated with herbicidal dosages of 2,4-D. Further studies of the accumulation of other fluorescent, normally occurring metabolites are needed. (A contribution from the Botany and Plant Pathology Section, Colorado A & M College.)

The effect of CMU on the nitrogen metabolism of bean plants. Baldwin, Roger, and Freed, V.H. The purpose of this work is to give a preliminary report on the effects of 3 (p-chlorophenyl) 1, 1 dimethylurea (CMU) upon the nitrogen metabolism of bean plants.

Number 10 cans, cut to 2/3 their original height were filled with sand and planted with black wax beans. As the plants were emerging, CMU was applied as a dust (0.005 gm. CMU per can). When stunting and mild chlorosis had occurred, the plants were harvested, weighed, dried, and reweighed. They were then ground up and analyzed for total nitrogen, nitrate and nitrite nitrogen, amide nitrogen, and ammonium. Symptoms of CMU poisoning were also noted.

The treated plants were significantly higher in total nitrogen, "organic" nitrogen (determined by difference), and water content; significantly lower in ammonium nitrogen and nitrate and nitrite nitrogen. No amide N was observed in either treated or untreated plants.

Symptoms of CMU poisoning are as follows: The leaves and stems curl. General chlorosis occurs in the leaves, starting first on the edges of leaves and on older leaves. Roots are branched more and are shorter than untreated roots. Seedlings emerge chlorotic.

Three hypotheses for the effects of CMU upon N metabolism were suggested by the results of this experiment.

1. CMU may inhibit nitrogen absorption.
2. CMU may shift the equilibrium toward organic nitrogen.
3. CMU may tie up or block the nitrogen and render it useless to the plant.

None of these hypotheses is in opposition with the others, so it may be that the effects of CMU is a combination of two or all three of the factors. (A contribution from Oregon State College.)

Screening and evaluation techniques for herbicides. Swezey, A. W.

Tests for Foliar Contact Activity

1. Spray test on foliage-can use crops and weeds grown in pots and sprayed with atomizer. Determines rapidity of injury, estimated percent injury, value of additives. Crafts & Reiber, Hilgardia 16:487. (1945).
2. Test with submersed waterweeds -- use stems of Potomogeton spp. immersed for varied times in toxicants as aqueous solutions or emulsions. Orthoxylene is the standard. Shaw, J. M. U. S. Dept. Int. Bur. Rec. Denver, Colorado and Oborn, E. T. U. S. D.A., B.P. I. SAE, Denver, Colo.
3. Drop test on plant parts -- water plants used by placing drop of toxicant formulation on leaf and observing action under microscope. Has not been reported as used with land plants. Shaw, J. M. U. S. Dept. Int., Bur. Rec., Denver, Colo.
4. Test with floating waterweed, Lemna minor -- similar to test "2" but uses a surface floating plant with leaves and roots. Fromm, Science 103:474 (1946.)

Soils Tests

5. Soil persistence test -- soils treated with chemical and several crops

and weeds grown. Persistence determined by repeated harvesting and replanting. Robbins, Crafts & Raynor. Weed Control. McGraw-Hill Book Co., New York. (1942.)

6. Soil leaching test — chemicals applied in solution to top of 2 - 3 ft. cylinders of soil and then cut soil cylinder into sections and plant with seeds. Crafts, A.W. Hilgardia 9:470 (1935.)

Translocation tests

7. Spray test with mesquite seedlings--top half only of plants sprayed with herbicides. Epinasty, chlorosis, defoliation, bark fissuring, callus formation noted on sprayed and unsprayed portions. U. S. D. A. Forest Service, Southwest Forest & Range Exp. Sta., Tucson, Arizona.
8. Leaf dip test--terminal portions of leaves of intact plants are dipped in solutions of toxicants for varied periods and observations made on necrosis or other activity on dipped and untreated portions of plants. King, Contr. Boyce Thompson Inst. 15:165.
9. Drop test on tomato leaf--growth-regulators placed on leaf in 0.01 ml. drop and typical responses graded by arbitrary ratings and analyzed by rank technique. Hitchcock & Zimmerman, Contr. Boyce Thompson Inst. 76:225 (1951) and Mullison, Bot. Gaz. 112, June, 1951.
10. Drop test on bean-similar to "9" but data interpreted from measurements of leaf expansion. Brown & Weintraub, Bot. Gaz. 111:448.
11. Drop test on bean--similar to "9" and "10" but translocation of growth regulator determined by bending of stem and rapidity of penetration and translocation by cutting out treated portions and measuring response on rest of plant. Day & Crafts, Botany Div., Univ. of California.
12. Drop test on bean--similar to "9", "10" and "11" but effect of chemical measured by weight of stem growth after treatment. 2,4-D used as standard. Thompson, et al. Bot. Gaz. 107.
13. Paste application of growth-regulators--similar to "9", "10" and "11" but growth-regulators applied in a Carbowax or lanolin paste. Beal, Bot. Gaz. 106:165.
14. Injection test--systemic chemicals are injected into growing plants. Roach, Ann. Bot. N.S. 3:155 (1939).
15. Field test with mesquite-tips of branches of plants in the field are immersed in herbicidal solutions for varied exposures. Observations are made as to activity of chemical on rest of plant. Mostly growth-regulators used. Fischer & Young, Research Rept. NCWCC, 1949.
16. Oil spray test on bean--entire plant sprayed in enclosed chamber with toxicant dissolved in non-toxic oil. Weight of plant parts is criterion; used for growth-regulators but can be used for contact herbicides. Swanson, Bot. Gaz. 107.

Tests with Germinating Seed

17. Root elongation test with corn seed--germinating seeds treated with growth-regulators and root elongation measured. Thompson, et al. Bot. Gaz. 107.
18. Germinated radish seed test--both radicle and hypocotyl measured as index of activity of low (0.1 ppm) concentrations of growth-regulators. VanOverbeek, Science 103:472 (1946)
19. Cucumber seed test--similar to "18". Ready & Grant, Bot. Gaz. 109:39. (1947).
20. Lentils seedlings test--effects of growth-regulators measured by phototropic activity. Mentzer. Chem. Abs. 43:1833 (1949)
21. Cress seed test--measures inhibition of root growth of garden cress under carefully controlled conditions. Audus. Univ. College, Cardiff, Wales.

22. Avena rootlet test—root tips only are immersed in solutions of toxicants for varying periods. Goodwin & Taves, Am. J. Bot. 37:224 (1950)

Physiological Tests with Excised Plant Parts

23. Avena coleoptile test--sections placed in nutrient media will elongate if treated with auxin-like materials. Bonner, J. Gen. Phys. 17:63 (1933).
24. Pea curvature test--etiolated pea epicotyls are divided longitudinally for a portion of their length and then when placed in solutions of auxin-like chemicals the ends curve inward instead of outward as when in water. Went, Proc. Kon. Akad. Wet. Amster. 31:59 (1927).
25. Bean stem test--etiolated stem pieces placed in solution of toxicant, indoleacetic acid, sucrose, and buffer. 2,4-D and As_2O_3 used as standards. Used for phytocidal measurements of insecticides. Cassida & King, J. Econ. Ent. 44:737 (1951.)
26. Avena curvature test--auxin in agar block placed on one side of decapitated coleoptile; index of activity is amount of curvature. Went et al. Phytohormones. MacMillan Company, New York. 1937.
27. Tradescantia test— protoplast coagulation, nuclei browning after chemical treatment determined by microscopic examination. Lepesckin, Ber. Deut. Bot. Ges. 1908).
28. Drop test on bean stems--etiolated stems treated with micro-syringe and activity measured by stem bending. Am. J. Bot. 38:435.

Miscellaneous Tests

29. Nutrient culture test--plants grown in nutrient culture and treated by adding toxicants to nutrient solution. Robbins, Crafts & Raynor, Weed Control. McGraw-Hill Book Co., New York (1942.)
30. Tomato dip test--foliage of intact tomatoes grown in pots are dipped in test solutions. Reported for growth-regulator comparisons but could be used as foliage tests with most herbicides and plants. Mullison, Bot.Gaz.112, June 1951.
31. Test with 2,4-D, 5I*--growing aquatics treated with I* labeled growth-regulator. Translocation measured by geiger counter and autoradiograph. Oborn, E. T. U. S. D. A., BPISAE, Denver, Colorado.
32. Tomato split-stem test--stem of tomato split longitudinally 3 in. above soil level and cut portion immersed in nutrient solution which allows growth of adventitious roots. Not reported as an herbicidal treatment. Miller, Contr. Boyce Thompson Inst. 14:443.
33. Fumigant test--root of morning glory suspended in large flask and exposed to gas (CS_2) vapors. Root pieces then planted to determine sprouting. Hannesson, et al. Univ. of Calif. Agr. Exp. Sta. Bull. 693.
34. Fumigant test with soil--a complicated apparatus accurately measures rate of gas flow through soil. CS_2 used. Hagan, Hilgardia 14:83 (1941.)
35. Pollen tube test-chemicals applied to pollen tubes to determine effect on cell division. Eigisti et al. Am.Jour.Bot. Dec. 1947 Supp.

(A contribution from the Dow Chemical Company.)

<u>Determination of the effect of ten carbamates on Lolium perenne L. (Perennial or English ryegrass).</u> Freed, Virgil H., and Kosesan, Willy H. Ten carbamate compounds were screened in the greenhouse during 1950 and 1951 to determine their effect on perennial ryegrass sown in gallon cans and dusted with a 1% dust at the rate of 4 pounds per acre. The top growth was harvested when 5 inches high in the control cans and ryegrass resown to determine the residual effect of the chemicals. Three replications were used for each treatment.

Ryegrass started emerging 5 days after sowing in the control cans followed by a smaller number of seedlings in the treated cans at about 10 days following the sowing.

The harvested weights of top growth were as follows:

Treatment	Grams Total weight
3 hydroxy IPC	0.80
3,4 dichloro IPC	0.43
6 ethoxy 2 methyl 3 chloro IPC	0.42
B napthol IPC	1.77
2 benzathiozole IPC	1.94
2,4 dimethyl IPC	0.18
3 chloro 2 tolyl IPC	0.47
2 pyridine IPC	0.52
O acetophenone IPC	0.15
3 amine IPC	0.12
Control	4.15

In the resown cans germination was even throughout and superficially there was little to distinguish one treatment from another. A lapse of 38 days from the time of application of the 10 carbamates had greatly lessened the toxicity. The residual toxicity seemed to be evident with 3 chloro 2 tolyl IPC and 2,4 dimethyl IPC. (A contribution from Oregon State College.)

The effect of Union Carbide and Carbon chemicals 1700 and 5722 on the test plants mustard and oats. Freed, Virgil H. Chemicals 1700 and 5722 were screened on oats and mustard grown in gallon cans in the greenhouse during March, 1951. Application rates in this trial were 12.5, 25, and 50 pounds per acre for chemical 1700 and 1, 2, and 3 gallons per acre for chemical 5722.

Herbicide 1700 was dissolved in a small amount of acetone with an emulsifying agent added in water. Herbicide 5722 was applied as an emulsion. Twenty-five oat grains and an indefinite number of mustard seeds were planted in 10 gallon cans and were given a pre-emergence spray using 3 replications for each treatment. The top growth was harvested and weighed when several inches high and the cans resown to determine the residual effect.

Both herbicides gave stunting and distortion of the oat seedlings. The severity of the stunting and distortion increased directly in proportion to the rate applied. The total weight of the harvested top growth decreased directly with the increase in rate of application. The average top growth weights for herbicide 1700 were 2.92, 1.92, and 0.72 grams ranging from the 25 pound to the 100 pound rate of application. For herbicide 5722 the weights were 2.62, 6.92, and 0.70 grams ranging from the 1 gallon to the 3 gallon rate of application. The control plot weights averaged 14 grams.

The percentage germination for mustard was decreased by the application of either herbicide even at the lowest rate. In both cases the plants showed more vigor and darker green foliage than the check plants. Comparing germination on the basis of 100% germination for the control cans, herbicide 1700 showed a percentage germination of the mustard of 50, 5, and 1 per cent ranging from the low to the high rate of application. On the same basis herbicide 5722 gave 24, 34, and 18 per cent germination. After removal of the first crop the cans were resown to determine the residual effect of these herbicides. Results taken 117 days after spraying showed a slight residual effect on the oats at the 100 pound rate of application in the case of herbicide 1700. No residual effect was apparent in the case of the mustard. Herbicide 5722 showed no residual effect for either oats or mustard. (A contribution from Oregon State College.)

The effect of a number of 2,4-D derivatives on mustard, peas, and oats. Freed, Virgil H. Five 2,4-D derivatives were screened in the greenhouse on mustard, peas, and oats during 1951. The 3 test plants were sown in gallon cans using 25 oat seeds, 10 peas, and an indefinite number of mustard seeds. The materials were applied as a pre-emergence spray using 2 replications per treatment. Harvesting occurred when the control plants were showing strong growth. This was followed by resowing and harvesting to determine the residual effect. Rates of application used were 5 and 25 pounds per acre.

Results of first sowing:

Plant	Material	Germination	Growth
Mustard	1. 2,4-D ethyl alcohol	none	none
	2. 2,4-D ethyl sulfate	none	none
	3. 2,4 dichlorophenyl ethyl alcohol	greatly reduced	stunted
	4. 2,4-D methyl ester	normal	normal
	5. 2,4-D ethyl formate	normal	normal
Oats	1. 2,4-D ethyl alcohol	slightly reduced	stunted
	2. 2,4-D ethyl sulfate	greatly reduced	stunted
	3. 2,4 dichloro phenyl ethyl alcohol	normal	normal
	4. 2,4-D methyl ester	normal	normal
	5. 2,4-D ethyl formate	reduced at high rate	reduced at high rate
Peas	1. 2,4-D ethyl alcohol	none	none
	2. 2,4-D ethyl sulfate	none	none
	3. 2,4 dichloro phenyl ethyl alcohol	none	none
	4. 2,4-D methyl ester	normal	normal
	5. 2,4-D ethyl formate	normal	normal

The results of the second planting were taken 40 days after spraying. The only residual effect on mustard in the second planting was a 95% reduction in germination at the 25 pound rate of ethyl sulfate and stunted growth at the 25 pound rate of 2,4-D ethyl formate. Both 2,4-D ethyl alcohol and 2,4-D ethyl sulfate reduced the germination and stunted the growth of the second planting of oats. No second planting results were obtained on peas due to root rot. (A contribution from Oregon State College.)

Determination of the toxicity of oxanilide and oxanilic acid in comparison to other materials. Freed, Virgil H. These tests were carried out in the greenhouse using oats and mustard sown in gallon cans for test plants. The materials were applied as pre-emergence and post-emergence treatments. The materials for pre-emergence included oxanilic acid at the rates of 1, 5, and 25 pounds, oxanilide at 1, 5, and 25 pound rates, IPC 1, 3, and 5 pound rates and 2, 4-D ethyl sulfate at 2, 4, and 8 pound rates. The materials for post-emergence treatment were oxanilic acid and oxanilide at the same rates as for pre-emergence, 2,4-D at 1/2, 1, and 2 pounds and endothal at 1, 2, and 4 pounds per acre. Three replications were used for each treatment.

As a pre-emergence treatment, neither the oxanilic acid nor oxanilide showed much activity. IPC was very effective on the oats but not on mustard. The 2,4-D ethyl sulfate also showed some activity when used as a pre-emergence treatment. Used as a post-emergence spray oxanilic acid showed no effect on the oats at any rate but gave a slight stunting of mustard at the 25 pound rate. Oxanilide had no effect on oats but stunted mustard at the 1 pound rate and killed the mustard at both the 5 and 25 pound rates, the kill at the 5 pound rate being 50% and 80% at the 25 pound rate with the remaining plants being yellowed and stunted in both cases. 2,4-D had no apparent effect on the oats at any rate but the mustard was killed at all three rates. Endothal had no apparent effect on the oats. At the 1 pound rate mustard appeared injured and 50 to 60 per cent was killed at the 2 pound rate with the remaining plants showing yellowing and leaf burn. At the 4 pound rate 80% of the mustard plants were killed with burn. At the 4 pound rate 80% of the mustard plants were killed with the remaining plants showing severe injury. (A contribution from Oregon State College.)

Growth inhibition of grasses. Laning, E.R. Jr., and Freed, V.H. In an attempt to inhibit and retard the growth of lawn grasses, chemical spray applications were made on bent grass lawn. Plots were laid out in a randomized block design using three replications. Treatments were made in June with the weight of the grass clippings taken 1 week and 3 weeks after application. The color of the grass was rated 7 weeks after treatment. The chemical treatments included IPC, 3 chloro IPC, and maleic hydrazide, each at 2 and 4 pounds per acre.

Results obtained at each clipping date indicated that maleic hydrazide at both 2 and 4 pounds per acre caused severe reduction in the weight of the clippings and growth of the grass. This material also brought about a serious loss of the green coloring of the grass. The effect of the maleic hydrazide lasted over a longer period of time than the other treatments. The 3 chloro IPC treatment retarded the grass growth to a certain extent but only at the 4 pound per acre rate, which also caused a moderate amount of injury to the green coloring of the grass. IPC gave satisfactory inhibition of the grasses for 2 weeks, after which recovery was complete. IPC did not cause a reduction of the green coloring in the grass as much as did the other two treatments. The IPC treatment also did not last over as long a period of time as the maleic hydrazide or the 3 chloro IPC. (A contribution from Oregon State College.)

The effects of TCA on some fruit trees and seedlings. Bruns, V. F. Initial injury to apricot and prune trees from soil applications of the ammonium and sodium trichloroacetates (ranging from 54.5 to 218 lbs./A.) for the control of quackgrass was in the form of leaf chlorosis. Yellow spots appeared first between the veins of the leaves. This yellowing gradually spread until entire leaves were affected and ultimately fell from the trees. Moreover, the tips and margins of the leaves appeared brown and brittle. Spring and summer applications of TCA caused leaves on old branches near the bases of the trees to be affected first, with the chlorosis gradually spreading upward and outward until considerable portions of the trees appeared damaged. Leaves on new growth of the same branches did not show injury until about two weeks later.

Damage to prune trees from the fall applications of TCA appeared the following spring. This damage was far more injurious since chlorosis affected the entire leaf growth of the trees simultaneously. Furthermore, many leaf and fruit buds failed to develop. No fruit was produced on affected trees during the following two seasons and only an occasional fruit during the third season.

Leaves were collected from injured and uninjured apricot and prune trees in the orchard and sent to Logan, Utah, where spectrographic and chemical analyses were made by Dr. M. C. Cannon, Chemistry Section, Utah State College.

	Determinations in per cent of ash			
	Apricot leaves		Prune leaves	
	Soil treated	Soil untreated	Soil treated	Soil untreated
Copper	0.0014	0.001	0.0014	0.0008
Iron	0.14	0.08	0.06	0.08
Manganese	0.006	0.002	0.004	0.003
Silicon	0.2	0.1	0.2	0.1
Phosphorus	0.6	0.2	0.4	0.2
Magnesium	1.5	0.7	0.9	0.9
Calcium	1.8	1.3	1.5	0.9
Sodium	0.7	0.3	0.5	0.3
Potassium	4.4	3.6	3.5	2.7
Boron	(not determined)			
Aluminum	(not determined)			
Titanium	(not determined)			
Chloride	0.06	0.035	0.03	0.025

Copper, iron, and manganese are accurate to 10-15% of the reported values. The rest of the spectrographic determinations were done by a semi-quantitative method and indicate the general range of concentration. Chloride was determined by a turbidimetric method.

Interpretation of these data is difficult since the minimum and maximum tolerance ranges of the various elements for leaves of apricot and prune trees in this area are not available. Although conclusions are thus limited, some valuable leads for further study may be afforded.

In nearly all cases the analyses indicated greater quantities of anions and cations in the affected leaves. A 25% decrease in the iron content of affected prune leaves was an exception. This suggested possible injury to the permeable membrane of the feeder roots as a result of direct toxicity. In addition, identical TCA symptoms were reproduced on peach seedlings in the greenhouse and most of the feeder roots of such seedlings were found to be brown, brittle, and dead.

The data further showed that several of the elements may have been sufficiently excessive to cause chlorosis. The 71 and 20 per cent increases in chloride in the affected leaves of apricot and prune trees, respectively, also indicated the possibility of translocation of the TCA.

Undoubtedly the metabolic processes were seriously disturbed, since the analyses indicate a departure from the normal Mg:K, Mg: (K/Na), and Fe:Mn ratios and also an increase of 100 and 200% phosphorus in the affected leaves. (A contribution from the Division of Weed Investigations, BPISAE, USDA, and Washington Agricultural Experiment Station cooperating.)

PROJECT 13. USE OF HERBICIDES FOR CONTROL OF WEEDS IN DRYING AND MATURING CROPS

Chester E. Otis, Project Leader

SUMMARY

This project signifies recognition by the Western Weed Control Conference of the important problem of preparing crops for harvest. Weed control experimenters are rightfully interested and involved in this work because the materials used and problems to solve are usually very similar to those found in the field of weed control.

Three workers submitted eight reports discussing preharvest treatment of flax, castor beans and legume and grass seed crops. They point out the needs for crop maturation and the advantages which accrue from successful programs.

Chemicals in commercial usage are Diesel or aromatic oil fortified with DN general weed killers or pentachlorophenol and aromatic oils alone. Other chemicals offering promise are sodium acid cyanamide, borate-chlorate mixtures, sodium monochloroacetate, Endothal, Ammate, ethyl xanthogen disulfide and sodium pentachlorophenate.

Effective dosage and spray volume depend in part on crop and weed density and maturity and on temperature and humidity.

Most treatments are applied by spray plane but ground sprayers also have a place.

REPORTS OF INDIVIDUAL CONTRIBUTORS

Preharvest spraying as a means of shatter-proofing and drying hairy vetch cut for seed. Furtick, W. R. and Freed, V. H. Extensive acreages of hairy vetch are harvested for seed annually in Western Oregon. Most years the vetch does not ripen uniformly throughout the field, numerous patches remaining green after the rest of the field has ripened sufficiently to harvest. As a result, vetch is usually dried in windrows before threshing the seed. Many farmers favor combining the crop standing without first windrowing to dry the green plants because the pods shatter easily when handled.

The uses of various compounds to dry up the green areas in vetch fields were tested in trials near Corvallis by Oregon State College during 1951. The effect of various compounds on shattering was also studied. Eight contact herbicides were used on one quarter square rod plots in a screening test to determine their relative effectiveness for drying up the unripened vines. The herbicides used were sodium pentachlorophenate, Endothal, pentachlorophenol in oil, dinitro general in oil, trichloroacetic acid, ethyl xanthogen disulfide, sodium isopropyl xanthate, Ammate, and an aromatic oil. Additional plots were sprayed with latex and methyl cellulose in an attempt to prevent shattering.

The aromatic oil, Endothal, dinitro general in oil, and ethyl xanthogen disulfide were the most effective herbicides in this screening test. The mean ranking of these compounds as to per cent necrosis ranged from 65 per cent for ethyl xanthogen disulfide to

90 per cent necrosis for the aromatic oil. The plots were harvested for seed samples to be used in germination tests of both the vetch and the oat companion crop.

The aromatic oil showed a decided shatter-proofing effect on the vetch pods. Less shattering on the check plots was also observed with the latex and methyl cellulose. All three of these compounds resulted in the pods being difficult to thresh. In order to thresh the seed from the pods, a high cylinder speed had to be used which cracked many of the seeds.

The results of this trial indicate that several compounds are promising both for drying and for shatter-proofing vetch. The biggest difficulty encountered in this trial is getting penetration of the heavy vetch growth. Oregon State College.

<u>The use of contact herbicides for preharvest drying of tall fescue.</u> Furtick, W. R. and Freed, V. H. Producers of tall fescue seed have shown considerable interest in harvesting the crop standing. Combining fescues for seed presents the problem of having the crop dry enough to avoid heating of the seed during storage. Since this crop shatters readily as the seeds ripen, it is difficult to have dry seeds without excessive shattering.

Contact herbicides were screened during the 1951 crop year to determine their relative effectiveness in causing necrosis of tall fescue just prior to ripening and their effect on the amount of seed shattering. In the screening trial individual plants of heterogenous genetic origin were sprayed with fourteen different contact herbicides, using two volumes of application. Herbicides screened in this test were sodium pentachlorophenate, pentachlorophenol in oil, chlorate-borate mixture, dinitro general in oil, sodium thiocyanate, trichloroacetic acid (TCA), sodium isopropyl xanthate, isopropyl-N-phenylcarbamate (IPC), isopropyl-N-(3-chlorophenyl)carbamate (Chloro IPC), aromatic solvent, Endothal, ethyl xanthogen disulfide, monochloroacetic acid, and Ammate. Five replications were used for each volume of application. The two volumes of application used in this trial were 20 and 40 cubic centimeters per plant. Each plant was rated as to forage density, head type, and maturity before being sprayed. The plants were rated as to total percentage necrosis five days following the spray applications. The seeds were harvested and bulked according to treatment for germination.

Aromatic solvent, pentachlorophenol, Ammate, and monochloroacetic acid gave the highest percentage of necrosis, ranging from an estimated 50 to 75 per cent. The estimated necrosis caused by natural ripening of the check plants ranged from 20 to 25 per cent. There was no apparent difference between volumes of application.

In order to determine whether or not the use of contact herbicides increased the amount of shattering, a second trial was established in an attempt to measure differences in shattering between treatments on tall fescue plants of the same genotypes. Four herbicides--Endothal, sodium pentachlorophenate, dinitro general, and ethyl xanthogen disulfide--were used at two rates on three clonal genotypes with two replications for each treatment. The volume used on each plant was twenty cubic centimeters. The day following application of the herbicides three samples with four panicles per sample were selected on each plant and twisted together and placed in bags. The plants were rated five days following spraying for the percentage necrosis. The bagged panicle samples were harvested and the seed shattered out into the bag weighed. The average weight in shattered seeds as measured in milligrams ranged from 78 to 130 milligrams. The highest average weight in shattered seeds was obtained from the check plants, indicating that the use of contact herbicides does not increase the amount of seed shattering.

The results of these trials indicated that several contact herbicides show promise as drying agents for preharvest treatment of tall fescue grown for seed and that drying of tall fescue in the hard-dough stage prior to normal ripening will not increase the rate of shattering. Oregon State College.

Preharvest drying of Lotus corniculatus with herbicides as a means of harvesting the crop standing. Furtick, W. R. and Freed, V. H. Loss of seed due to shattering is a major problem in the production of lotus seed. The standard harvesting procedure involves cutting and drying lotus in windrows before threshing. Combining the crop standing is impossible due to the continued growth of the plant at the time of seed ripening. Direct combining should decrease the amount of seed shattering due to the lessened amount of handling involved. Twelve herbicides were screened on 1/4 square rod plots of the Granger strain of Lotus corniculatus during the 1951 crop year at Corvallis, Oregon, to determine their relative necrotic effect on this crop. Herbicides used were ethyl xanthogen disulfide, Endothal, an aromatic oil, Shell 11 weed oil, pentachlorophenol, dinitro general, trichloroacetic acid, potassium cyanate, sodium acid cyanamide and potassium methyl xanthate. The materials giving the highest percentage of necrosis were the aromatic oil, sodium pentachlorophenate, ethyl xanthogen disulfide, dinitro general, and sodium acid cyanamide, ranging from an estimated 70 per cent necrosis for the aromatic oil to 50 per cent necrosis for sodium acid cyanamide.

Plot samples were harvested to obtain seed for germination tests. No attempt was made in this trial to combine the sprayed plot. The trial did give indications that several contact herbicides show promise for preharvest drying of this crop to permit direct combining. Oregon State College.

Experiments in the prevention of shattering in Lotus corniculatus. Buckovic, Richard, Furtick, W. R., and Freed, V. H. One of the main problems in the production of birdsfoot trefoil and other legume seed is loss of seed through pod dehiscence. Losses average about 50 per cent of the potential yield. An adequate method of control for this problem would not only greatly increase the net yield of this crop but could be applied to other similar crops as well. Increases in seed yields would increase the amount of seed on the market, thus reducing the price and increasing the demand.

Among the factors associated with the dehiscence process are air temperature, relative humidity, moisture content of the pods, and movement of the plants. The shattering rate of pods has been found to increase sharply as the moisture content of the mature pods is reduced. The greatest increase in this shattering rate is noted when the pods lose 59 per cent of their original weight through moisture loss. In view of this, it appears that if a film-forming chemical could be found which would reduce or prevent the loss of some of this moisture, shattering could be reduced.

Therefore, field trials were established at the Astor Branch Experiment Station, Astoria, Oregon, and at the Oregon State College Experiment Station, Corvallis, Oregon. In the Astoria experiment, thirty-one treatments (15 chemicals at two rates and one check) and six replications were used on the plots which consisted of six individual plants. The six plants of each plot were treated by spraying the chemical (diluted with water) on them just prior to the brown pod stage. The plants were cut, bagged, and tagged at maturity. They were then dried in the bags under outside weather conditions. Representative random samples were taken from each bag; two counts were made--the number of pods shattered, the number of pods not shattered, in the chosen sample. The shattering rate was expressed as a percentage of the total number of pods counted:

$$\frac{\text{Number of pods shattered}}{\text{Total number of pods counted}} \times 100.$$

Summary of Results:

Chemical	Rate	Ave. rate of shattering for the six replications
Check		28.6%
Barkwax	4 lbs./acre	12.5%
Barkwax	12 lbs./acre	7.1%
3-M	4 lbs./acre	7.8%
3-M	12 lbs./acre	9.0%

Field trials were established on a solid stand of birdsfoot trefoil at Corvallis. Three replications of nine treatments were made one week before harvesting. Approximately 100 brown pods were gathered from each plot and placed in paper bags. The pods were then dried in these bags at room temperatures ranging from 50 to 110 degrees Fahrenheit. The shattering rate was again expressed as a percentage of the total count.

Summary of Results:

Chemical	Rate	Ave. rate of shattering of the three replications
Dow Latex 513-K	1:10 dilution	53.9%
Dow Latex 513-K	1:20 dilution	55.1%
Dow Latex 762-K	1:10 dilution	47.8%
Dow Latex 762-K	1:20 dilution	55.5%
Sodium Acid Cyanamide	40 lbs./acre	20.4%
Sodium Acid Cyanamide	20 lbs./acre	34.5%
Barkwax	16 lbs./acre	52.5%
Barkwax	8 lbs./acre	55.0%
Check		61.5%

Conclusions

1. The rate of shattering by the check plants is less in the Astoria area than the over-all average. This is undoubtedly due to the environmental factors, higher relative humidities for longer periods of time, and lower average day temperatures than are found in inland areas.

2. The shattering rate was reduced by many of the treatments used at Astoria. The two chemicals which produced the best results were Barkwax and 3-M, a film-forming product of the Minnesota Mining Company. Sodium Acid Cyanamide was unavailable at that time.

3. Sodium Acid Cyanamide produced excellent results in the experiment at Corvallis, Oregon, and, of all the chemicals used, appeared to be the most promising. Oregon State College.

Use of herbicides for control of weeds in drying and maturing crops. Jones, L. G. The preharvest spraying of a seed crop may have many advantages for a grower. Some of the more important advantages are: (1) it conditions the crop so that direct combining is possible, thereby avoiding windrowing and possible losses that occur as a result of wind damage to windrowed crops, (2) it may kill or retard green weed growth present at the time of harvest, (3) it permits the grower to make better use of optimum threshing conditions, and (4) it may permit the crop to be harvested earlier, thus preventing excessive seed shattering of certain crops. The treatment consists of flying on 10 to 15 gallons of Diesel oil containing 1 to 3 pints of Dow or Sinox general weed killer per acre 1 to 5 days prior to harvest.

The development and use of the treatment has been in progress on alfalfa and flax for several years. On Ladino clover and trefoil it has been in progress only during the present and last season.

In the case of trefoil, the treatment is used purely as a conditioner to cause the foliage to wilt, to dry out, and to toughen up rapidly enough to permit harvesting to be started before the pods have dried sufficiently to shatter appreciably.

In some cases, only slight wilting of the stems begins before the seed pods start to pop or dehisce. Under such conditions, harvesting normally is done on the same day the defoliant is applied, which means that when the temperature is 90° or above and good threshing weather prevails, operations may be started within 3 to 24 hours after application. On the other hand, if the temperature drops appreciably below 90°, the interval between defoliant application and the beginning of harvest may range from 1 to 2 days. It is important that not more than a day's harvest be sprayed with the defoliant at any one time, since timing of the subsequent harvesting operation is of the utmost importance. The general dinitro defoliant material was used at the rate of from 1 pint to 1 quart per acre in 10 to 12 gallons of Diesel oil as the carrier. The material is usually applied by airplane. It may be applied by ground rigs effectively but usually required 1½ to twice the amount of oil used in airplane application.

(1) Type stand or growth that may be successfully treated. The defoliants do best on mature, uniformly open stands where the spray covers and kills all green foliage. It does not give satisfactory results on thick, matted, lodged stands. Such stands should be cut and windrowed to be threshed by a pickup combine for best results.

(2) How long after spraying before harvesting may be started? It depends on the crop.

Trefoil - 3 to 24 hours after spraying
Ladino clover - 1 to 3 days after spraying
Alfalfa - 1 to 3 days after spraying
Red clover - 1 to 3 days after spraying.

(3) How much should be sprayed in advance of the threshing operation?

Trefoil - 1 day's run
Ladino clover - 3 to 4 days' run
Alfalfa - 4 to 6 days' run
Red clover - 6 to 8 days' run.

(4) Why not spray more at a given time? Because each crop has some critical factor or factors that will affect the success of the operation if delayed much beyond the time interval. For example, the critical factor for trefoil is natural shattering. The seed pods dehisce naturally upon maturing or when the humidity is reduced below a certain minimum.

Ladino clover. Recurrent growth and head shattering are the critical factors. Ladino is quick to start growth after cutting, grazing or spraying, and as soon as the young leaves appear the effectiveness of the defoliant is diminished. In alfalfa the critical factors are pod drop, seed shattering and recurrent growth. When the environment surrounding the seed pod is changed, such as would result from defoliation, pod drop and popping open of the pods is a natural sequence.

Red clover. Here the critical factor is head shattering and usually starts about 10 days after spraying.

(5) Materials and rates. Diesel oil--10 to 15 gallons plus 1 to 3 pints of DN (Sinox or Dow general type) per acre.

Fortified oils. Pentachlorophenol--3 to 5 pounds in 4 to 5 gallons of Shell 30 with 5 to 6 gallons of Shell 30 per acre.

Annolos 7 and 11--10 to 15 gallons per acre.

Other products that may be used but have not been tested here: sodium acid cyanamide, sodium chlorate and sodium pentaborates, Endothal, Ammate and ammonium thiocyanate, Shell XP 3 and others.

(6) Precautions. All green pods that are hit by spray are killed, rendering the seed non-viable. Too much spray may affect germination.

Tender crops growing adjacent to the defoliated crop may be injured by drift if care is not exercised in the application. Agricultural Experiment Station, University of California.

<u>Preharvest use of contact herbicides for control of weeds and maturation of seed flax.</u> Irvine, Milton B. Development: The new concept of the use of contact herbicides for the preharvest treatment of seed flax was first tested in the Imperial Valley of California in 1947 and 1948. The need for such a treatment arose from the presence of bothersome green summer weed growth at harvest time which interfered with direct combining. It was determined by field testing that the application of a fortified oil by airplane a few days prior to harvest sufficiently dried the weed growth to allow direct combining and that the treatment resulted in a higher recovery of seed from weed-infested fields.

Treatment: The treatment consists of applying a dinitro fortified Diesel oil or aromatic weed oil 3 to 6 days prior to harvest. Dinitro-o-secondary-butylphenol or dinitro-o-secondary-amylphenol is used, as a formulation, at the rate of 1.2 to 1.8 pounds of active chemical ingredient in from 10 to 15 gallons of oil per acre, applied by spray airplane. Other methods of application have not been generally used. The amount of fortifier and oil used is dependent upon the density and amount of green weed growth present.

Dense growth requires the higher amount indicated which, as a formulation, is 3 pints of a general oil soluble dinitro fortifier in 15 gallons of oil per acre. Likewise, humid and cool weather indicate the use of the higher dosage. The use of straight unfortified aromatic or other oils has not proved to result in sufficient drying to warrant their use.

Results: The treatment results in the drying of green weed growth so that direct combining can be accomplished at harvest time without windrowing or waiting for the weeds to dry naturally. Direct combining is generally preferred over windrowing because of a saving in time, cost, and results in a higher recovery of seed. One test in the Imperial Valley showed an increase of 8.4 bushels per acre in favor of preharvest spraying and direct combining as against windrowing.

The weeds that are generally a problem at harvest in the desert growing flax areas are nettle-leaved goosefoot (Chenopodium murali), sour clover (Melilotus indica), silver-sheathed knotweed (Polygonum argyrocoleon), common sunflower (Helianthus annuus).

An additional result from application of fortified oils is the complete drying of green flax pods and plants. It has been determined that flax pods which are mature to the point where the seeds are plump and white when seen in cross section will mature following preharvest spraying.

Depending upon the weather conditions, flax will be ready to harvest 3 to 6 days following application. The warmer and dryer the weather the more rapid the drying. The earliest date of complete drying following treatment is the time flax should be harvested. A delay in harvesting may result in excess drying and subsequent seed shattering.

Less dockage and less heating of harvested seed results from preharvest treatment. Tests have shown that only about one-half the dockage results from treated as compared with untreated fields. The Dow Chemical Company.

Preharvest use of contact herbicides for drying and maturation of seed alfalfa. Irvine, Milton B. Development: The use of fortified oils for the preharvest drying of alfalfa grown for seed is the outgrowth of results that developed from the preharvest spraying of flax. The problem in many alfalfa seed fields is the presence of green alfalfa foliage and seed pods at the time of harvest. Green weeds in seed alfalfa are not generally a problem at harvest time. In cases where natural drying does not take place , alfalfa must be cut and windrowed to induce drying and maturity. Rain, wind, and insects can damage seed in windrows and in most instances direct combining is preferred. The use of fortified oils sprayed prior to harvest dries the foliage and green seed pods and permits direct combining.

Treatment: Treatment consists of applying a dinitro or pentachlorophenol fortified Diesel oil or aromatic weed oil 3 to 6 days prior to harvest. Dinitro-o-secondary-butylphenol or dinitro-o-secondary-amylphenol is used, as a formulation, at the rate of .6 to 1.2 pounds of active chemical per acre in from 7 to 12 gallons of oil. Pentachlorophenol, as a formulation, is also used as a fortifier at the rate of 2.3 to 4.9 pounds or an average of 4 pounds in 7 to 12 gallons of a high aromatic weed oil per acre. Both types of chemicals are applied by spray airplane.

Some limited use has been made of applying a dinitro fortified oil-water emulsion with ground equipment. In this case, a mix consisting of 1 pint of a dinitro formulation, which contains about .6 pound of dinitro-o-secondary-butylphenol or dinitro-o-secondary-amylphenol, is used with 5 gallons of Diesel oil or an aromatic weed oil plus 45 gallons of water per acre. Results obtained from both airplane and ground sprayer are comparable. The dosage is dependent upon the density and amount of green growth present. Likewise, humid and cool weather conditions indicate the use of the higher dosages. As in the case of other preharvest treatments, the use of straight unfortified Diesel oil or aromatic weed oil has not proved to result in sufficient drying to warrant their use.

Results: The treatment results in the drying of green alfalfa foliage and seed pods so that direct combining can be accomplished. The warmer and drier the weather the more rapid the drying.

Alfalfa seed that is plump and near maturity will completely mature and the pods will dry following treatment. Very little or no plant activity takes place between treatment and harvest; consequently, any immature seeds will not mature.

Preharvest treatment results in the earlier direct combining of alfalfa seed than may be accomplished when natural drying practices are used. This has proved to be an advantage when two seed crops are grown in the same season which is practiced in some of the desert alfalfa seed growing areas.

This practice has become established in alfalfa seed growing areas and has been used on a f ield scale for three years. The Dow Chemical Company.

<u>Preharvest use of contact herbicides for drying and maturation of castor beans.</u> Irvine, Milton B . Development: The use of contact herbicides for the preharvest drying of castor beans for seed has resulted from the type of harvesting procedure employed and the need for drying if harvested before frost. In the harvesting of this crop, the entire plant is cut and passes through the thresher, and successful seed separation is accomplished only after the plant is sufficiently dry from a killing frost or from preharvest treatment. Maximum plant dehydration or maturation and not defoliation is the desired result. Test work during the season of 1951 has indicated that the use of fortified oils is most suitable to accomplish maximum drying. Weed control is generally incidental to the drying of the crop, although green weed growth present will be sufficiently dried so the crop can be readily combined.

Treatment: The treatment consists of applying a dinitro or pentachlorophenol fortified Diesel oil or aromatic weed oil to the crop 5 to 7 days prior to the estimated date of harvest. Dinitro-o-secondary-butylphenol or dinitro-o-secondary-amylphenol is used, as a formulation, at the rate of 1.2 pounds of active chemical per acre in from 10 to 12 gallons of oil. Pentachlorophenol, as a formulation, is also used as a fortifier at the rate of 4 pounds in 10 to 12 gallons of a high aromatic weed oil per acre. Both types of chemicals are applied by airplane.

Results: The treatment results in the dehydration of the entire castor bean plant and renders it suitable for combining. Some defoliation of the leaves takes place but is incidental to the drying of the stock and green pods that are present. Treatment enables the harvest of this crop prior to a killing frost. Treatment likewise prevents natural seed shattering of early set seed, which may occur if the crop is allowed to go to natural maturity at time of frost.

Inasmuch as castor beans are often grown as a secondary crop in a double cropping program, many farmers desire to harvest prior to frost so that a second or winter crop can be planted. In such cases, the preharvest spraying affords the farmer the choice of picking his time of harvest without depending upon frost to mature and dry the crop.

This treatment was first used on a large commercial scale in the season of 1951 and was widely employed in the desert castor bean growing areas. The Dow Chemical Company.

PROJECT 14. ECONOMIC STUDIES OF WEED PROBLEMS AND CONTROL

D. C. Myrick, Project Leader

In lieu of results of research in the field of this committee, its report can cover only progress and a brief statement of the program on economic studies of weed problems and control.

The work of this committee has developed into the process of organizing a regional program of research, Economic Studies of Weed Problems and Control, which we hope will be approved and sponsored by the Western Agricultural Economic Research Council. This program is being prepared by agricultural economists in several western states and the Bureau of Agricultural Economics, U.S.D.A., for presentation to the council when it meets late in February, 1952.

Need for the program is, (1) to appraise annual losses and costs attributable to weeds in order to evaluate the over-all problem of weeds as a background for expenditures and efforts devoted to the control and eradication of weeds, including research and experimentation; (2) to make economic evaluations of new weed control methods before they are offered for general use; (3) to provide economic appraisals that will assist farmers and others engaged in weed control in determining when control is needed or feasible, and in choosing among various methods; (4) to make economic and social studies that will help to determine the proper incidence of costs and returns between participants, such as farm operators, land owners, and local, state, and Federal levels of government.

Its objectives are, to stimulate and coordinate economic studies of weed problems and control in the Western Region, to meet the needs outlined above. It will provide a means of exchange of ideas on approachesto the problems, methods of research and analysis, and ways of presenting and using results.

The procedure includes, (1) cooperation, among agricultural economists in the Western States and BAE who will have primary responsibility for the work; with technicians for technical information and interpretation, and with other agencies and individuals, public and private, engaged in weed control activities; (2) the organization of a regional project committee of economists from the experiment stations and BAE to promote attainment of the objectives; (3) classification and arrangement by the technical committee of likely lines of research under the title of the program; (4) advisory and consulting work by the technical committee in setting up individual projects; (5) coordination with other regional programs of economics research; (6) relationships with the Research Section of the Western Weed Control Conference; and (7) consultation with the BAE representative on the technical committee of RMA Project W-11, weed control.

With specific reference to point (5) above, in the regional research project on The Economics of Range Land Development, control of weedy plants is one of the two development measures to be stressed, the other being range reseeding. These appear to be considered almost companion measures -- reseeding requiring prior removal of undesirable plants, or removal of undesirable plants must be followed with the seeding of desirable species. The project will consist of economic analysis of various practices, including comparisons of costs and returns and evaluation of alternatives. This will require the assembling and use of physical information, analysis of costs and returns and effects on ranch organization and operation, and study of institutional relationships such as effects on land values and rents, public land management, and incidence of costs and returns.

THIRTEENTH WESTERN WEED CONTROL CONFERENCE

RENO, NEVADA · FEBRUARY 5, 6, 7

HEADQUARTERS · MAPES HOTEL

Is There a Better Way?

EXECUTIVE COMMITTEE

President of Conference	W. W. Robbins	Member	Chester Otis
Vice President	C. J. Seeley	Member	F. L. Timmons
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THIRTEENTH MEETING OF THE WESTERN WEED CONTROL CONFERENCE

MAPES HOTEL, RENO, NEVADA • FEBRUARY 5-6-7, 1952

February 5—Forenoon

9:00-12:00—Registration, Committee meetings.
Herbicide and Equipment Exhibit, Main Floor, State Building.

February 5—Afternoon

REPORTS OF RESEARCH

Chairman, F. L. Timmons, USDA, Division of Weed Investigations, Logan, Utah

1:00- 1:10—Message of Welcome by Governor Charles Russell.

1:10- 1:40—Relation of pH to the penetration and translocation of 2,4-D in plants.
A. S. Crafts, California Agricultural Experiment Station, Davis, California.

1:40- 2:10—Factors which determine the effectiveness of growth regulator herbicides on Canada thistle.
L. W. Rasmussen, Washington Agricultural Experiment Station, Pullman, Washington.

2:10- 2:30—Control of whitetop by combined chemical, cropping and tillage methods.
J. M. Hodgson, USDA, Division of Weed Investigations, Meridian, Idaho.

2:30- 2:40—Recess.

2:40- 3:05—The response of Thatcher spring wheat to 2,4-D rates applied in low volumes of oil and water carriers.
R. L. Warden, Montana Agricultural Experiment Station, Bozeman, Montana.

3:05- 3:30—Weed control in peas with herbicides.
C. I. Seely, Idaho Agricultural Experiment Station, Moscow, Idaho.

3:30- 4:00—IPC and 3-chloro IPC, their use as herbicides
Virgil H. Freed, Oregon Agricultural Experiment Station, Corvallis, Oregon.

4:00- 4:30—The Columbia Basin Weed Committee.
W. Dean Boyle, Agriculturist, U. S. Bur. of Reclamation, Prosser, Washington.

February 6—Forenoon

Chairman, B. J. Thornton, Colorado Agricultural Experiment Station, Fort Collins, Colorado.

8:30- 9:00—Progress of research on control of halogeton.
L. C. Erickson, H. L. Morton, Idaho Agricultural Experiment Station, Moscow, Idaho.

9:00- 9:25—Biological control of St. Johnswort.
James K. Holloway, USDA, Bureau of Entomology and Plant Quarantine, Albany, California.

9:25– 9:45—Chemico-ecologic suppression of ribes in forested areas.
H. R. Offord, USDA, Bureau of Entomology and Plant Quarantine, Berkeley, California.

9:45–10:05—Studies of herbicidal action on aquatic weeds using radioactive 2,4-D-51.
H. E. Hosticka and W. T. Moran, Bureau of Reclamation, Denver Colorado, and E. T. Oborn, USDA Division of Weed Investigations, Denver Colorado.

10:05–10:15—Recess.

10:15–12:00—Question box, discussion of research papers and Research Progress Report.

February 6—Afternoon

1:30—Important range weeds of the Great Basin from the Ecological Point of View.
Joseph H. Robertson, Associate Professor, Range Management and Agronomy, University of Nevada, Reno.

Bureau of Land Management's Plan for Halogeton Control, 1952.
R. K. Pierson, Chief, Division of Soil Moisture Conservation, Washington, D. C.

Weed Control Program on Irrigation Systems.
Paul Baranek, Regional Weed Specialist, U. S. Bureau of Reclamation, Sacramento, California.

Chemical Formulations.
W. J. Hanson, Agricultural Research, Western Division, Dow Chemical Company, Seal Beach, California.

6:00– 7:00—Cocktail Party, Nevada Room. With compliments of the Herbicide Industry.
(See List of Firms on Back Page)

7:30—Banquet.
Floor Show, Sky Room, featuring The Deep River Boys and Eddie Fitzpatrick and His Orchestra.

February 7—Forenoon

9:30—Weed Problems of Europe.
L. M. Stahler, Senior Agronomist, U. S. Department of Agriculture, Columbia, Missouri.

Business Session.

Regulation of Pest Control Operators.
Allen B. Lemmon, Chief, Bureau of Chemistry, State Department of Agriculture, Sacramento, California.

Soil Sterilants.
W. L. Klatt, Assistant Manager, Pacific Coast Borax Company, Los Angeles, California.

Physiological Principles of Brush Control.
C. E. Fisher, Superintendent and Agronomist, Texas Experiment Station, Spur, Texas.

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