RESEARCH PROGRESS REPORT

RESEARCH COMMITTEE

WESTERN WEED CONTROL CONFERENCE

BOISE, IDAHO

MARCH 20 AND 21

1957

PREFACE

The Research Progress Report has been prepared in advance of the 1957 meeting of the Western Weed Control Conference as a supplement to the conference proceedings. It consists of abstracts and summaries of current findings of research workers throughout the conference area. This report is particularly to be recommended for its timeliness. Results are fresh from the laboratory and field plots and were assembled in time to be available at the conference meeting only by a last-minute effort of the personnel of the research committee. Hasty preparation must necessarily forego some of the safeguards obtainable by more leisurely coordination between authors and editors. Time has permitted only the correction of obvious typographical errors, and I fear not all of these. Questions of clarity and content requiring correspondence with the authors remain unresolved.

The content of the report must, therefore, be considered as tentative and not for publication, being primarily a "notebook" for correlating the latest findings of research workers.

The research committee is organized into ten projects each having a project leader. The real burden of assembling and summarizing the information contained in this report has been on the shoulders of these project leaders.

To them and to the many research workers of the West who have contributed reports of their findings, I want to express my warm appreciation for their cooperative efforts.

Boysie E. Day
Chairman, Research Committee

University of California
Citrus Experiment Station
Riverside, California

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NOMENCLATURE and ABBREVIATIONS

Tables 1 and 2 below are nomenclature and abbreviation lists proposed by the Terminology Committee of the Weed Society of America (Shaw, et al. WEEDS. 4:278-284. 1956). We have urged authors to use this terminology wherever applicable.

TABLE 1. Chemical Designations

CHEMICAL NAME	DESIGNATION
2,4-dichlorophenoxyacetic acid	2,4-D
2-methyl-4-chlorophenoxyacetic acid	MCPA
2,4,5-trichlorophenoxyacetic acid	2,4,5-T
3,4-dichlorophenoxyacetic acid	3,4-DA
4-chlorophenoxyacetic acid	4-CPA
2-(2,4-dichlorophenoxy)propionic acid	2-(2,4-DP)
2-(2-methyl-4-chlorophenoxy)propionic acid	2-(MCPP)
2-(2,4,5-trichlorophenoxy)propionic acid	2-(2,4,5-TP)
2-(3,4-dichlorophenoxy)propionic acid	2-(3,4-DP)
2-(4-chlorophenoxy)propionic acid	2-(4-CPP)
4-(2,4-dichlorophenoxy)butyric acid	4-(2,4-DB)
4-(2-methyl-4-chlorophenoxy)butyric acid	4-(MCPB)
4-(2,4,5-trichlorophenoxy)butyric acid	4-(2,4,5-TB)
4-(3,4-dichlorophenoxy)butyric acid	4-(3,4-DB)
4-(4-chlorophenoxy)butyric acid	4-(4-CPB)
sodium 2,4-dichlorophenoxyethyl sulfate	2,4-DES
sodium 2,4,5-trichlorophenoxyethyl sulfate	2,4,5-TES
sodium 2-methyl-4-chlorophenoxyethyl sulfate	MCPES
sodium 2,4-dichlorophenoxyethyl benzoate	2,4-DEB
trichloroacetic acid	TCA
2,2-dichloropropionic acid	dalapon
2,2,3-trichloropropionic acid	2,2,3-TPA
dichloral urea	DCU
2-chloro-N,N-diallylacetamide	CDAA
2-chloro-N,N-diethylacetamide	CDEA
isopropyl N-phenylcarbamate	IPC
isopropyl N-(3-chlorophenyl)carbamate	CIPC
sec-butyl N-(3-chlorophenyl)carbamate	BCPC
2-chloroallyl diethyldithiocarbamate	CDEC
3-(phenyl)-1,1-dimethylurea	fenuron
3-(p-chlorophenyl)-1,1-dimethylurea	monuron
3-(3,4-dichlorophenyl)-1,1-dimethylurea	diuron
3-(3,4-dichlorophenyl)-1-methyl-1-_n_-butylurea	neburon
pentachlorophenol	PCP
4,6-dinitro ortho secondary butylphenol	DNBP
4,6-dinitro ortho secondary amylphenol	DNAP
3,5-dinitro ortho cresol	DNC
2,3,6-trichlorobenzoic acid	2,3,6-TBA
2,3,5,6-tetrachlorobenzoic acid	2,3,5,6-TBA
N-1-naphthyl phthalamic acid	NPA
3,6-endoxohexahydrophthallic acid	endothal

Table 1 continued

CHEMICAL NAME	DESIGNATION
phenyl mercuric acetate	PMA
potassium cyanate	KOCN
hexachloroacetone	HCA
isopropyl xanthic acid	IPX
maleic hydrazide	MH
trichlorobenzenes	XTB
2-chloro-4,6-bis(diethylamino)-S-triazine	CDT
3-amino-1,2,4-triazole	ATA
octochloro cyclohexenone	OCH
ethyl xanthogen disulfide	EXD
monomethyl arsonic acid	MAA
2-(2,4,5-trichlorophenoxy)ethyl 2,2-dichloropropionate	erbon

TABLE 2. Standard Abbreviations (lower case letters without punctuation)

ABBREVIATIONS	DEFINITIONS
ahg	acid equivalent per 100 gallons
A	acre
bu	bushel or bushels
diam	diameter
ft	foot or feet
fpm	feet per minute
gal	gallon or gallons
in	inch or inches
mph	miles per hour
ppmw	parts per million by weight
ppmv	parts per million by volume
pt	pint or pints
lb	pound or pounds
psi	pounds per square inch
qt	quart or quarts
gal/A, oz/A	rate per acre
rpm	revolutions per minute
sq	square
wt	weight
gpa	gallons per acre
gph	gallons per hour
oz	ounce or ounces
ht	height
mi	mile or miles
ml	milliliter
L	liter
gpm	gallons per minute
cfs	cubic feet per second
mm	millimeter or millimeters
mp	melting point
ppt	precipitate
sp. gr.	specific gravity
tech	technical
temp	temperature

PROJECT 1. PERENNIAL HERBACEOUS WEEDS

W. R. Furtick -- Project Leader

SUMMARY

Sixteen reports were received from 13 investigators in seven different states. The findings are summarized by species.

Canada thistle (Cirsium arvense). Chemical control methods tested in Wyoming showed high rates of 2,4-D and DB granular at equivalent 2,4-D rates to be equally effective. Treatments containing 80 pounds per acre of 2,4-D controlled at least 75% of the thistles. ATA at rates of five - fifteen pounds per acre was much less effective.

Work in Idaho indicated that under a four-year treatment program, initial cultivation plus 2,4-D followed by spring wheat grown under high nitrogen fertility and sprayed with 2,4-D was the most effective control method for Canada thistle. This method gave 99% control. Four years of alfalfa or 2,4-D sprayed pasture were nearly equal in effectiveness. Slightly less effective control was obtained with fertilized spring wheat sprayed with 2,4-D Non-fertilized spring wheat sprayed with 2,4-D was only half as effective compared with fertilized wheat. Wheat grown under high fertility without 2,4-D treatments resulted in an increased thistle density. The untreated check was spring wheat grown without 2,4-D or fertility. This increased thistle density 39% over the four-year period.

Perennial morning glory (Convulvulus arvensis). A report from Oregon indicated 2,3,6-TBA applied in July at rates of 40 and 50 pounds per acre gave essentially complete kill of morning glory plants when measured a year later.

Leafy Spurge (Euphorbia esula). A report from Montana indicated amino triazole was much more effective than three pounds of 2,4-D. ATA at rates of five to ten pounds killed over 50% of the spurge. Combinations of amino triazole with 2,4-D were equally effective when applied separately the same day or when 2,4-D was applied fourteen days after ATA. Applying ATA 14 days after 2,4-D was not effective.

Russian knapweed (Centaurea picris). A report from Wyoming indicated rates of 2,4-D amine or ester above 20 pounds per acre gave nearly complete kill when measured a year later. Rates of DB granular with equivalent amounts of 2,4-D gave equal control.

Quackgrass (Agropyron repens). Tests in Idaho on quackgrass fertilized with various forms of nitrogen followed by treatment with dalapon MH and ATA at four and eight pounds per acre rates

indicated nitrogen fertilizer stimulated regrowth of the quackgrass. Dalapon gave the best control up to the time the plots were cultivated about two months after treatment. Regrowth after cultivation occurred on all plots but was least dense on the high rate of dalapon treatment. None of the materials gave practical control.

In Wyoming, dalapon and TCA both alone and combined with ATA were compared. Under the arid conditions of this trial, dalapon at rates of 20 and 40 pounds either alone or combined with amino triazole gave a high percent of quackgrass kill. TCA at 100 pounds per acre alone or at 25 pounds per acre combined with amino triazole gave nearly complete quackgrass kill.

Foxtail (Hordeum jubatum). Several reports from Nevada compared foxtail growth under various levels of water table, soil salinity and fertility. These trials indicated foxtail was as tolerant of high water tables as other species which might be used for competition. Foxtail appeared to be as tolerant of salinity conditions as species which might be seeded in its place and had greater salinity tolerance than tall fescue. Foxtail responded vigorously to nitrogen fertilizer whether on saline or non-saline soils. This indicated fertility could not be used as a means of giving competing species an advantage. Studies on seed germination and dormancy in foxtail indicated that foxtail has a very short dormancy and that viability decreases rapidly. It is seriously affected by low temperatures. This appears to explain the characteristic fall establishment of this weed species.

Johnson grass (Sorghum helepense). Several reports from Arizona and California indicated single applications of dalapon regardless of date were not effective for Johnson grass control. Much more effective results were obtained by repeated applications. Burning Johnson grass with L.P. gas was effective when burned at two-week intervals throughout the season. Increasing the length of intervals decreased the amount of kill.

Bermuda grass (Cynodon dactylon). Work in California with Bermuda grass indicated this species is very similar to Johnson grass in its response when sprayed with dalapon. Repeat applications appeared to be superior to single applications.

Dallas grass (Paspalum dilatatum). Work in California indicated this grass is sensitive to dalapon. Even ten pounds per acre was enough to give control.

Knot grass (Paspalum distichum). This grass appeared to be similar to Johnson grass in its tolerance of dalapon. Repeated applications were necessary but even after repeated applications there was regrowth.

Chemical control of canada thistle. Alley, H. P. An old established stand of Canada thistle (Circium arvense) was located in the spring of 1955. Application of chemicals was made at the time the Canada thistle plants were in early bloom.

Materials used, the rate of application, and the resulting control, as determined 12 months later, are presented in the following table:

Chemical Treatment	Rate/A	1955 Rep I 1/	1955 Rep II	1955 Total	1956 Rep I	1956 Rep II	1956 Total	% Cont.
		Counts 3/						
2,4-D amine	20	31	10	41	12	5	17	59
" "	40	8	14	22	7	2	9	59
" "	60	18	7	25	7	0	7	72
" "	80	11	22	33	3	2	5	85
2,4-D amine + Wet	20	20	12	32	7	3	10	69
" " "	No	15	16	31	3	1	4	77
" " "	60	9	8	17	3	0	3	82
" " "	80	11	5	16	2	7	9	44
2,4-D ester	20	13	4	17	2	2	4	71
" "	No	18	7	25	6	11	17	32
" "	60	21	17	38	4	7	11	77
" "	80	21	15	36	2	7	9	75
A.T.A.	5	14	18	32	2	17	19	41
A.T.A.	10	7	23	30	2	5	7	77
A.T.A.	20	8	27	35	6	8	14	60
	Lb./sq. rod							
D.B. Granular 2/	1.65	10	12	22	4	5	9	59
" "	3.3	12	11	23	5	6	11	56
" "	4.95	9	13	22	3	4	7	68
" "	6.7	18	14	32	5	2	7	78

1/ Plots 1/2 sq. rod in size, replicated twice.

2/ Mixture of borax and 2,4-D (90.5% borax, 7.5% 2,4-D).

3/ Counts taken at time of chemical application and one year after initial application. Counts made in three-foot quadrats located diagonally across plots.

(Wyoming Agricultural Experiment Station)

Canada thistle control by cropping, cultivation, 2,4-D and fertilizer. McKay, Hugh C. and Ames, Gerald.

This experiment was set up in the irrigated area of southeastern Idaho in 1953 to evaluate the effect of crops, 2,4-D treatments, cultivation and nitrogen fertilizer, separately and in combinations in reducing or eradicating established stands of Canada thistle.

The area chosen for the test showed an average Canada thistle population of 26 stems per square yd. This has since increased to 44 on the check treatments. The plots are one-tenth acre in size and there are four replications of each treatment.

The stands of thistles were determined by making stem counts on sixteen square yards per plot. The square yards were marked permanently and the counts taken each year on the same locations. The stem counts in the following table are a total of the sixteen sample areas for the four replications.

Details of the various treatments and results to date are given in the following table. Treatments are listed in order of best thistle control.

Treatment	Decrease or increase of thistles — Stem counts 1953	Stem counts 1956	Percentage	Ave. yield 1953 to 1956
1. Cultivation + 2,4-D in 1953 Spring wheat + 80 lb N + 3 lb. 2,4-D, 1954, 1955, 1956	1123	10	-99	46.9 bu/A
2. Cultivation in 1953. Spring wheat + 80 lb N + 3 lb 2,4-D, 1954, 1955, 1956.	1804	7	-99	42.1 bu/A
3. Alfalfa grass seeding 1953. No treatment. Potatoes 1956.	1252	25	-98	3.2 ton/A
4. Pasture seeded 1953 + fert. + 2,4-D, 1954, 1955, 1956.	880	30	-97	2.9 ton/A
5. Spring wheat + 80 lb N + 3 lb 2,4-D in spring each year.	686	53	-92	59.1 bu/A

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Treatment	Decrease or increase of thistles Stem counts 1953	1956	Percentage	Ave. yield 1953 to 1956
6. Spring wheat + 80 lb N + 3 lb 2,4-D in spring and fall each year.	752	88	-88	58.0 bu/A
7. Spring wheat + 3 lb 2,4-D only.	1365	790	-42	27.0 bu/A
8. Spring wheat + 80 lb N only.	908	1432	+37	43.8 bu/A
9. Check - spring wheat, no treatment.	1632	2660	+39	22.1 bu/A

The best control of thistles, 99 percent, was obtained by clean cultivation the first year followed by grains with 2,4-D and fertilizer application each year afterward. Permanent seedings of alfalfa-grass or pasture gave the next best control of 98 and 97 percent respectively. It was not until the second crop year that any reduction of thistles was noted in the alfalfa-grass treatment.

Where spring wheat was grown continuously each year with the application of 80 pounds of actual nitrogen fertilizer and three pounds of 2,4-D per acre, 92 percent reduction in thistles was obtained.

The application of 2,4-D only resulted in a 42 percent reduction in thistles, and this did not occur until after the third year of treatment. When fertilizer only was used, there was a 37 percent increase in thistle stand, while on the check plots a 39 percent increase was noted.

Fertilizer also gave a considerable increase in yield as well as better thistle control when used in conjunction with 2,4-D. Eighty pounds of actual nitrogen plus 2,4-D brought wheat yields to 59.1 bu. per acre, as compared with 27 bu. for 2,4-D only treatments and 22.1 bu. for the check plots. (Idaho Agricultural Experiment Station)

2,3,6-TBA for morning glory control. Swan, D. G. A promising chemical for the control of morning glory (Convolvulus arvensis) is 2,3,6-trichlorobenzoic acid. Applications of TBA and various other chemicals were made at the bloom stage in July, 1955 at two locations. Data taken in July, 1956 showed that three pounds active material per acre of TBA controlled 49 percent of the morning glory compared to 20 percent for three pounds of 2,4-D amine. At heavier rates, 40 pounds per acre of TBA controlled 99 percent of this weed compared to 95 percent with 80 pounds of 2,4-D amine. Indicator rows of fall wheat were seeded in the plots to determine if injury from residual chemical might occur. No reduction was observed in stand or vigor of the wheat planted in the plots that had been sprayed with the TBA. (Oregon Agricultural Experiment Station)

Use of amino triazole and 2,4-D for control of leafy spurge. Baker, Laurence O. Amino triazole (ATA) and 2,4-D were applied to a dense stand of leafy spurge (Euphorbia esula) and native grasses June 30, 1955, alone and in combinations. Plots were one rod square and were triplicated. Application was made using a rate of 80 gallons of water per acre. All treatments caused complete topkill of leafy spurge. There was no fall regrowth on these plots which may have resulted from a lack of soil moisture. Leafy spurge growth in the spring of 1956 was mostly chlorotic on those plots receiving ATA, although some normal plants were present on all plots. Grasses were injured by ATA, but in no case were they eliminated. A great many leafy spurge seedlings were developing where the old spurge stand was thinned.

Treatments made in 1955 and the percent reduction of leafy spurge by June 28, 1956 are given in the following table:

Chem.	Rate	Chem.	Rate	Percent Reduction of Leafy Spurge Stand
ATA	5 lbs.			58
ATA	10 lbs.			68
ATA	5 lbs.	2,4-D	3 lbs.*	63
ATA	10 lbs.	2,4-D	3 lbs.*	65
ATA	5 lbs.	2,4-D	3 lbs.**	60
ATA	10 lbs.	2,4-D	3 lbs.**	57
2,4-D	3 lbs.	ATA	5 lbs.***	0
2,4-D	3 lbs.	ATA	10 lbs.***	0
2,4-D	3 lbs.			0

* 2,4-D was applied as a separate operation immediately following the ATA application.
** 2,4-D was applied 14 days after the ATA.
*** ATA was applied 14 days after the 2,4-D.

Repeat treatments were made on these same plots June 28, 1956. By September 5, 1956 regrowth had occurred on all plots. However, there was less regrowth where ATA and 2,4-D were applied one following the other. 2,4-D alone was almost as effective in preventing fall regrowth. Where no treatments were made in 1956 leafy spurge was recovering.

In a separate test two consecutive fall applications of several substituted phenoxy compounds at a rate of 30 lbs. active ingredient per acre has failed to give complete control of leafy spurge. Leafy spurge regrowth averaged about 10 percent under all treatments. No formulation was significantly better than another. Kuron and 2,4,5-T were more injurious to grass and provided the longest residual effect on spurge seedlings and other associated plants. (Montana Agricultural Experiment Station, Bozeman, Montana)

Chemical control of russian knapweed. Alley, H. P. An area of relatively young stand of Russian knapweed (Centaurea picris) was selected in the spring of 1955. An experiment was designed to determine the effectiveness of several herbicides in controlling this weed. The ester and amine formulations of 2,4-D, ATA 3-amino-1, 2,4-triazole, CDT 2-chloro-4, 6-bis (diethylamino) S-triazine, D.B. granular (90.5% borate, 7.5% 2,4-D) were used in this test. The materials were applied when the knapweed plants were in the early-bud stage of growth. They were applied by an experimental plot sprayer in 40 gpa of water.

Stand counts were made at time of chemical application and one year following treatment. The counts were made in three-square foot quadrats located diagonally across the plots.

Stand counts show relatively no difference in percentage control between the 20 lb. 2,4-D amine and the 80 lb. 2,4-D amine/A rate. The ester formulation of 2,4-D gave equally as good weed control as the amine formulation. The addition of a wetting agent (2 percent by volume) increased the percentage of weed control on all chemical plots where it was used. ATA at 5, 10, and 20 pounds active/A gave relatively no control. D.B. granular applied as equivalent rates of 2,4-D gave as good weed control as heavy rates of 2,4-D. However, grass stand was reduced measurably, and toxicity toward crop plants (beans, oats) was measured one year after the application in the D.B. granular plots.

(Continued on next page)

Chemical Treatment	Rate/A	1955 Rep I	1955 Rep II	1955 Total	1956 Rep I	1956 Rep II	1956 Total	% Cont.
2,4-D Amine	20	29	31	60	0	2	2	97
" "	40	30	24	54	1	1	2	98
" "	60	29	37	66	0	0	0	100
" "	80	28	24	52	0	0	0	100
2,4-D Amine + Wet	20	32	22	54	4	0	4	93
" " "	40	24	25	49	0	0	0	100
" " "	60	19	21	40	0	0	0	100
" " "	80	19	31	50	0	0	0	100
2,4-D ester	20	20	32	52	2	2	4	92
" "	40	17	20	37	0	0	0	100
" "	60	22	26	48	1	3	4	92
" "	80	35	26	61	2	0	2	97
C.D.T.	20	20	27	47	24	23	47	0
C.D.T.	40	22	22	44	31	25	45	0
A.T.A.	5	30	22	52	36	14	50	4
A.T.A.	10	33	20	53	30	16	46	13
A.T.A.	15	28	17	45	55	29	84	0
	Lb./sq. rod							
D.B. Granular	1.65	16	17	33	0	0	0	100
" "	3.3	16	15	31	0	0	0	100
" "	4.95	12	16	28	2	0	2	93
" "	6.71	21	18	39	0	0	0	100

1. Plots 1/2 sq. rod in size, replicated twice.

2. Counts taken in 1955 at time of chemical application and 1956, one year after application. Three sq. foot quadrats taken diagonally across each plot.

(Wyoming Agricultural Experiment Station)

<u>The performance of several herbicides for the control of quackgrass.</u> Erickson, Lambert C. Numerous reports and considerable advertising appeared in early 1956 indicating that certain compounds were very effective in the control or eradication of quackgrass *Agropyron repens*. Some of these reports suggested that herbicide toxicity was increased in the presence of high nitrogen levels.

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As a consequence, it appeared highly desirable to rescreen several herbicides which had been tested in previous years with variable results. A dense uniform stand of quackgrass was selected and a series of 11 fertilizer replications of plots were included on the basis: fertilizers x herbicides. On April 17 the following nitrogen rates and formulations were applied: nitrogen at 0, and 40 pounds per acre as: ammonium sulfate, ammonium nitrate, urea, and calcium nitrate. The nitrogen response became evident in about a week; the ammonium sulfate plots giving the greatest growth-height response.

The herbicides were applied with a knapsack sprayer on May 11 or two weeks after applying the fertilizers. On June 1, the entire area was plowed, and thoroughly disced and harrowed. The regrowth readings, based upon percentage of soil surface covered by quackgrass, were made on July 3. These data were obtained by taking 5-1 foot square samples per square rod plot.

Dalapon, MH, and ATA were superimposed upon the previously fertilized and non-fertilized plots at four and eight pounds per acre. These gave mean regrowth reductions of 85 and 97, 19 and 28, and 23 and 8 percent respectively at the above rates when they were applied just prior to a rain. When applied in dry weather, the effectiveness of Dalapon remained the same; but the toxicity of MH and ATA improved. However, Dalapon remained the best quackgrass inhibitor. Nitrogen tended to stimulate the regrowth of quackgrass. In all except ammonium sulfate this stimulation was significant at least at the 5 percent level.

On July 7, the entire area was cultivated again. Regrowth appeared rapidly on all plots in almost equal quantities within 10 days, except on the plots treated with Dalapon. Regrowth on the latter at 8-pound rate was relatively sparce, chlorotic and abnormal. The growth on remaining plots was so uniform and uninhibited that taking further data was unjustified.

Subsequent cultivations and quackgrass regrowth indicated single applications of these herbicides could not be economically justified. Dalapon continued to give the greatest growth depression throughout the season. (Idaho Agricultural Experiment Station)

<u>Quackgrass control with herbicidal foliage treatments.</u> Weldon, L. W. and Alley, H. P. A preliminary test was established in August 1955 using various rates and combinations of ATA (3-amino-1, 2, 4-triazole), Dalapon (2,2-dichloropropionic acid) and TCA (trichloroacetic acid). Treatments were duplicated on 8 by 17-ft. plots. The quackgrass was 6 to 8 inches tall, sod-bound, and growing under semi-arid conditions.

Chemical treatments, rates of application, and average percentage of reduction in quackgrass stand are presented in the table. Percentage reduction in stand was determined by the point-transect method. One hundred counts were made in each plot at time of chemical application and 12 months after chemical application.

As seen in the table, when used alone 8 lb./A of ATA or 100 lb/A of TCA were required to give 100 percent control of the quackgrass. Dalapon used alone did not give complete control. The addition of ATA to the lighter rate of Dalapon gave an increased effectiveness as compared with Dalapon alone at that rate. The same was true for TCA treatments where 25 lb/A of TCA plus 4 lb/A of ATA gave 100 percent control.

A strip across each plot was thoroughly disked two weeks after treatment. The activity of all treatments was greatly increased by the one disking. Another experiment was initiated in 1956 using the most promising treatments of the 1955 tests. Two methods of tilling the chemically treated plots (plowing and disking, disking alone) as compared with foliage applications and competitive cropping were incorporated into the 1956 test.

Chemical and Rate of Application	Percent Reduction in Quackgrass Stand
Dalapon 10 lb/A	31
Dalapon 10 lb/A + ATA 2 lb/A	65
Dalapon 10 lb/A + ATA 4 lb/A	70
Dalapon 20 lb/A	94
Dalapon 20 lb/A + ATA 2 lb/A	82
Dalapon 20 lb/A + ATA 4 lb/A	91
Dalapon 40 lb/A	71
TCA 50 lb/A	90
TCA 100 lb/A	100
TCA 25 lb/A + ATA 2 lb/A	94
TCA 25 lb/A + ATA 4 lb/A	100
ATA 2 lb/A	43
ATA 4 lb/A	56
ATA 8 lb/A	100
ATA 12 lb/A	100

(Wyoming Agricultural Experiment Station)

The effect of watertable on foxtail (Hordeum jubatum) in a native pasture sod. Cords, H. P. In the spring of 1955 a number of field phytometers measuring 26 inches in diameter and 32 inches in depth were fitted with automatic watertable level controls. Fourteen of these were used for a study of the effect of various stationary and fluctuating watertable levels on a native sod containing spikesedge (Eleocharis sp.) heavily infested with foxtail. The watertable levels were: (1) at the surface, (2) stationary at three inches, (3) stationary at 18 inches, (4) stationary at 24 inches, (5) complete drainage, (6) fluctuating from surface to 18 inches, and (7) fluctuating from surface to 24 inches. The fluctuating levels were established at the surface in the spring and gradually lowered during the summer to the lower levels. All were given frequent surface irrigation. These phytometers were clipped three times during the season, the various species present were separated, oven dried and weighed.

Analysis of the results showed that complete drainage and the lower stationary levels resulted in drastically lowering the amount of spikesedge present in the phytometers. The percent foxtail present, however, was not significantly or consistently changed by altering the watertable levels, even though total yields of dry matter remained relatively constant at all levels. In some of the low-watertable level phytometers, annual species invaded and made up the bulk of the harvested material, while in others, foxtail increased to the point where it was the predominate species. The composition of vegetation in the phytometers with fluctuating watertable levels did not change significantly from those where the watertable remained at the surface.

These results indicate that drainage in itself will not control foxtail in native pastures of this type. Seeding to more mesic species is essential if a high level of competition with foxtail is to be obtained. (Nevada Agricultural Experiment Station, Reno)

The effect of watertable on foxtail (Hordeum jubatum). Cords, H. P. This is a continuation of studies, the first phase of which was reported in the 1956 Research Progress Report.

A greenhouse experiment was started in January, 1956 to find the effect of watertable on top and root development of foxtail growing in two soils, one saline and the other non-saline. The watertable depths were 1, 6, 12 and 18 inches below the soil surface. Foxtail seeds were germinated on blotters in petri dishes and two vigorous seedlings were transplanted to each cylinder. The soil was saturated with water just prior to this time and no more water was added to the surface of the cultures until the plants were harvested in mid-April. Harvest was accomplished by carefully washing out the roots and cutting off the tops at the crown. Both roots and tops were oven-dried and weighed.

Analysis showed that both watertable and salinity were significant factors in the growth of both roots and tops. In the case of watertable, this difference was caused by the greatly reduced growth at the 18 inch level. The means of other depths were not significantly different. The plants at the 18 inch watertable level were either dead or dying at harvest. Growth in the saline soil was uniformly less than in the non-saline soil. The watertable x salinity interaction was not significant. (Nevada Agricultural Experiment Station, Reno)

The effect of watertable and salinity on foxtail (Hordeum jubatum) growing in competition with seeded forage species. Cords, H. P. Twelve phytometers 26 inches in diameter and 32 inches deep were fitted with automatic watertable level controls and seeded in the spring of 1956. Fifty seeds each of foxtail, tall fescue and tall wheatgrass and 100 seeds of strawberry clover were planted in each. Half of the phytometers contained a saline-alkaline soil (electrical conductivity, 10.0 millimhos per cm., pH 8.8). The other half contained a soil whose electrical conductivity was 0.8 millimhos per cm. and whose pH was 6.9. Watertable levels were fixed at 3, 6 and 12 inches giving a total of six treatments, each randomized in two blocks. Measurements made on this series of phytometers were: (1) establishment by counting the seedlings of each species two months after planting; and (2) yield of each species by clipping each separately in each phytometer and recording oven dry weight.

Analysis of the establishment data revealed that foxtail was the only grass whose establishment was significantly reduced in the saline-alkaline soil as compared to the non-saline soil. However, no plants of strawberry clover became established on the saline-alkaline soil. Tall fescue was the only species whose establishment was affected by watertable conditions. Significantly fewer plants of this species became established at the three inch watertable level.

The clipping data were analyzed on the basis of percent foxtail harvested per phytometer. On the first clipping date (August) all treatments averaged more than 50 percent foxtail, the range being from 52 to 80 percent. While this difference was significant, no trends reflecting the effects of watertable of salinity were detectable. On the second (October 1) clipping date, however, the effects of salinity and the interaction between watertable and salinity were both significant. This was particularly noticeable at the six and twelve inch watertable levels. At these levels, the percentage foxtail was much higher on the saline soil than on the non-saline soil. At the three-inch watertable level, however, the percent foxtail was uniformly high regardless of soil.

This experiment indicates that reseeding as a means of pasture improvement in areas where high watertable conditions and salinity have resulted in heavy foxtail invasion should be preceded by drainage and correction of salinity conditions if maximum success is to be realized. (Nevada Agricultural Experiment Station, Reno)

The effect of salinity and fertilizers on foxtail (Hordeum jubatum). Cords, H. P. In order to gain some preliminary information about the effect of pasture improvement in areas where foxtail has become the predominate species, a greenhouse study was begun in September 1955 involving foxtail planted in competition with tall wheatgrass and tall fescue. Two soils, one saline (electrical conductivity = 10 millimhos per cm.) the other non-saline (electrical conductivity = 0.8 millimhos per cm.) each at four fertility levels (nitrogen added, phosphorus added, nitrogen and phosphorus added, and no fertilizer added) were used. The equivalent of 100 lbs per acre of N and/or P_2O_5 was added to the appropriate pots. Both soils tested low in nitrates and phosphates. The saline soil classed as a coarse sandy clay, and the non-saline soil as a coarse sandy loam. The pH was 8.8 and 6.9 respectively.

On the basis of germination tests, enough seeds of each species were planted in each pot to furnish approximately 20 seedlings of each. Counts made one month after emergence showed the following average stands: foxtail, 6.0; tall fescue, 16.8; and tall wheatgrass, 17.0. The original plan called for thinning so that the pots would contain an equal number of each species. The poor emergence of the foxtail made this undesirable. Consequently the original stand was allowed to remain. Since the total stand and the stands of tall fescue and tall wheatgrass were very uniform between pots, the data were analyzed on a per plant basis. The data were obtained by clipping and weighing each species separately. The pots were clipped December 5, and February 5.

Analysis of the results from the December clipping showed that the three species responded about equally to nitrogen fertilizer, the average increase approximately 200 percent. Similarly, all species produced considerably more dry weight on the non-saline soil, but here the differences were not equal. Tall fescue produced more than three times as much on the non-saline soil, while foxtail and tall wheatgrass produced 1.6 and 1.3 times as much respectively. Only foxtail responded to phosphate and this response was not nearly as great as with nitrogen. This response was limited to the pots also fertilized with nitrogen.

Similar results were obtained from the February clipping except that both foxtail and tall wheatgrass produced as much dry weight on the saline as on the non-saline soil.

The over-all results indicate that foxtail has about the same tolerance to salinity as tall wheatgrass and that these two species have considerably greater salinity tolerance than tall fescue. Also, nitrogen fertilization cannot be expected to favor these competing species at the expense of foxtail as had been hoped. (Nevada Agricultural Experiment Station, Reno)

The effect of storage conditions on germination of seed of foxtail (Hordeum jubatum). Cords, H. P. Field observations have indicated that foxtail commonly produces a very heavy seedling crop in the fall or late summer while only a few seedlings emerge in the spring. A series of tests was designed to find the reasons for this phenomenon.

The first test was designed to find the presence and extent of post-harvest dormancy. Month old seed was subjected to cold, moist storage for one week, then germinated, and this was compared to untreated seed. Under these conditions, the cold, moist storage resulted in a 15 percent increase in germination. The actual percentages being 75 for this treatment versus 60 for the untreated lots.

The second test, seed stored for 15 months under laboratory conditions was found to be about 20 percent viable. Three months after harvest, seed from this lot had averaged 40 percent germination.

The third test used seed three months from harvest and involved 18 different storage treatments. Two different storage temperatures were used - 35 degrees F. and 10 degrees F. Four 100 seed lots were used for each treatment and the treatments included dry storage, storage in water and storage in wet sand at each of the above temperatures. Three durations of storage were used for each of the above conditions - one, two, and four weeks.

The only treatments affecting germination were those involving storage in either frozen sand or ice. Under these conditions, regardless of duration of treatment, germination was reduced from approximately 40 percent to less than 10 percent. There was no increase in germination of three month old seed from cold moist storage (moist sand at 35 degrees F.).

These tests indicate that (1) foxtail seed has a very short period of post-harvest dormancy, (2) foxtail seed loses its viability rather rapidly under laboratory conditions, (3) under northern Nevada conditions, seed overwintering in the soil probably has a much reduced viability. (Nevada Agricultural Experiment Station, Reno)

The effect of rate and time of application in the control of Johnson grass with 2,2-dichloropropionic acid (dalapon). Arle, H. Fred and McRae, George N. 1/ During 1955 an experiment was conducted to determine the effectiveness of the sodium salt of 2,2-dichloropropionic acid (dalapon) in controlling Johnson grass growth along irrigation canals. (Final results were not available for inclusion in the 1956 report).

Applications of dalapon were made at 10, 20, 30, and 40 pounds per acre (74 percent acid equivalent). Initial applications were made at four dates during the growing season and retreatments were applied as necessary. The initial series of plots was treated on April 11, and the second series on June 24. These required three and two retreatments respectively, at the original rates, to maintain grass control throughout the season. Some regrowth was present on all plots at the time of first frost. Less regrowth was evident when active growth was resumed during the spring of 1956. It was very limited on all plots with no apparent difference between rates of application or date of initial treatment. Periodic spot applications of an aromatic oil controlled the surviving grass during 1956.

The plots which were first treated on September 2, or October 27, did not develop regrowth prior to first frost. Complete kill was obtained at all rates, except the lowest. Normal regrowth was delayed for several weeks during the early part of 1956 but the need for additional treatment soon became evident. Considerable regrowth with little difference between rates of treatment was noted. Single applications of dalapon have not effectively controlled Johnson grass growth. (Contribution from the Field Crops Research Branch, ARS, USDA, and the Arizona Agricultural Experiment Station cooperating). 1/ Plant Physiologist and Agronomist, ARS, respectively.

The control of Johnson grass with L. P. gas burning equipment. Arle, H. Fred and Hamilton, K. C. 1/ During 1955 an experiment was conducted to determine the frequency of treatments for best results when liquified petroleum gas burning equipment is used. Plots which were each 100 feet in length were established along a cement lined canal. Burning was repeated at intervals of two, three and four weeks with three replications for each treatment.

Johnson grass which was burned eleven times at two-week intervals did not develop any regrowth after September 6. A few rhizomes could be found which still appeared viable; however, there was no regrowth on these plots during 1956.

Burning was also continued at the three and four week intervals until first frost. On these plots, grass population was somewhat less after growth was resumed in the spring of 1956 than it was in the fall of 1955. Ten burnings were required at the three-week interval to achieve 90 percent control. When burning was repeated at intervals of four weeks, grass usually reached heading stage (seeds not mature) before being destroyed. These plots were burned eight times during the season. When growth resumed in 1956, it was indicated that 80 percent of the original population had been killed.

During 1956, a similar experiment was conducted on Johnson grass growth along an unlined canal. Grass was somewhat more resistant under this condition. The burning schedule was started April 17. At the two-week interval the final treatment was made October 9. These plots were burned 14 times. At the three and four week interval, grass was burned eleven and nine times, respectively, prior to first frost on November 1. Survival readings will be made during April 1957. (Contribution from the Field Crops Research Branch, ARS, USDA and Arizona Agricultural Experiment Station, cooperating). 1/ Plant Physiologist, ARS and Agronomist, University of Arizona, Respectively.

An evaluation of dalapon for control of four perennial grasses at varying application rates and dates. McHenry, W. B. Field trials were initiated in 1956 at four locations in California to improve recommendations for eradication of Johnson grass (Sorghum helepense), bermuda grass (Cynodon dactylon), dallis grass (Paspalum dilatatum), and knot grass (Paspalum distichum). The current recommendation is 20 lb of Dowpon (85% 2,2-dichloropropionic acid, sodium salt) per acre, applied at least twice the first growing season and repeated the second season as regrowth dictates.

Dalapon was used in the Johnson, bermuda, and dallis grass studies, at 10, 15, 20, 25, and 30 lb (commercial material)/A on three dates in seven combinations offering single, double, and triple applications (early season, mid-season, late season, early + mid, early + late, mid + late, and early + mid + late season). In the knot grass trials dalapon was applied at acre rates of 10, 15, and 20 lb at early season, mid-season, and early + mid-season. To insure adequate wetting Colloidal X-77 was added to the spray solutions at the rate of 6.8 fluid oz per 100 gal (2 ml/gal). The dalapon was applied to sq-rod plots in one gal of water (160 gpa). The treatments were evaluated in November entirely on visual observations of regrowth, or lack of it, and changes in relative plant vigor. More conclusive data will be sought when growth resumes in the spring of 1957.

Johnson grass trials: All rates applied once at early, mid, or late season proved to be equally ineffective. Early season treatments at all rates resulted in near 100% regrowth, although vigor was markedly reduced.

Of the three double treatments (early + mid-season, etc.) the combination of mid-season + late season sprayings gave the best evident control. The 30 lb rate was superior to the other four rates.

All rates applied three times (early + mid + late-season) were superior (no regrowth) to either single or double sprayings. All five rates appeared to be equally effective.

Bermuda grass trials: Very similar trends were noted in the bermuda grass trials. Double sprayings were generally superior to single treatments; three applications appeared superior to either one or two. The distinctions between rates and dates were not as evident in the bermuda grass trials as in the Johnson grass tests.

Dallis grass trials: An extremely dense and continuous stand of dallis grass occurred side by side with Johnson grass on one of the ditchbank trial areas. In contrast to the other perennial grasses dallis grass appears to be very sensitive to dalapon. No fall regrowth was observed in any of the plots, even the 10 lb/A applied at early season which was the least effective treatment on the other species.

Knotgrass: Mid-season and early + mid-season treatments were superior to early-season applications but all showed considerable regrowth. There was no clear evidence of rate distinction. This grass appears to be distinctly more difficult to wet. The arbitrary standard of 2 ml Colloidal X-77 per gal was used on dallis grass to maintain a comparable basis with the other trials on the Johnson, bermuda, and dallis grasses.

Final evaluations will be made when these perennial grasses resume growth in the spring of 1957. (University of California Agricultural Extension Service)

Affect of spray volume on the effectiveness of dalapon for Johnson grass control. McHenry, W. B. Johnson grass averaging 30 in. high was sprayed with dalapon (85% 2,2-dichloropropionic acid, sodium salt) at 20 lb/A applied as single and double applications (August 13 and September 25, 1956) in 40, 80, 160, 320, and 640 gpa to measure effect of spray volume. The ten treatments were applied to square rod plots in three replications. Colloidal X-77 was added to the spray solutions at the rate of 6.8 oz per 100 gal.

Preliminary observations based only on top kill indicate low volumes to be superior to high volumes. Twenty lb of dalapon applied in 80 and 160 gal of water appeared to be superior to the same amount of dalapon applied in large volumes. The 40 gal rate appeared approximately equal to 160 gal per acre, however, distribution of the spray on the plots at this rate may have been lacking in uniformity.

It would seem reasonable to expect that higher concentrations resulting from volume reduction would cause symptoms to appear more quickly and be more severe. The affect of volume and concentration as used in these trials will be better understood when regrowth observations are made in the spring of 1957. (University of California Agricultural Extension Service)

The effect of rate and date of application of 2,2-dichloropropionic acid (dalapon) on the control of Johnson grass. Wilkerson, James, A. and Miller, John H. During 1956 the effect of different rates of dalapon applied at various times throughout the growing season to established stands of Johnson grass was studied. Plots (1 sq rod in size and replicated 3 times) were established on May 15, along a Tulare Co. irrigation canal, heavily infested with Johnson grass that was 2 to 4 feet tall and beginning to flower. The ditch carried a normal flow of water until mid-September.

Later dates of initiation of treatments were July 18, September 26, and October 16. A similar vegetative growth stage was maintained at each initial application date. This was accomplished by burning with LP gas, approximately 30 days prior to treating. All dalapon treatments were applied as water sprays at the rate of 480 gpa, with 0.3 cc of "Dynawet" added per gallon of water to insure better wetting. Table 1 shows the various rates and dates of application. Treatment 10 (check) was burned monthly from May to October, while treatment 12 (check) was oiled monthly with "Richfield A" for five months at the rate of 160 gpa. It was used in the experiment to give a comparison of the effectiveness of oiling, including costs, with chemical methods of control. In general, oiling and mowing are the most commonly used methods by most growers and irrigation districts for Johnson grass control along main ditches and laterals.

Early observations made on the May treated plots showed that the terminal height growth of the grass was inhibited. On July 17, considerable dalapon symptoms were still evident, but most treated plots showed considerable regrowth. Treatment 1, which had received two previous applications of dalapon, showed good control at this date. However, due to some regrowth in one replication, it was retreated. Also, in these earlier observations, the split ten-pound application (Treatment 11) showed control as good as other treatments. This viewpoint was also re-affirmed on August 10, when this same treatment, which had now received three 10-pound applications, provided as good control as any treatment.

During the week of August 15, all plots were mowed off by the Irrigation Dist. Personnel without consulting research workers. This was not according to plans and may have affected the results of some of the treatments. The debris was raked off and the August treatments were postponed about two weeks to permit sufficient regrowth to spray. Late season regrowth from plots which had received all their treatments in early season was excessive.

A weed control rating was made on November 9 just prior to frost. As shown in Table 1, treatments made in mid or late season gave superior control of Johnson grass. Treatments 1 and 11 which appeared very promising earlier, failed to provide seasonal control. Non-selective oiling (treatment 12) gave control comparable to that of dalapon. However, as shown in Table 1, the costs of material and labor for oiling were considerably higher than those for dalapon. These figures were obtained from the actual costs of material plus estimated labor costs of $10 per acre per application.

Although final stand readings cannot be made until regrowth develops next season, the results indicate better control is obtained when at least part of the material is applied in late season.

Table 1. Rates, dates and costs of applying dalapon and other treatments and their effects on Johnson grass. Tulare Co., California, 1956.

Treatment	Rate(Lb/A)& Date Application						Total	Weed	Est. Cost
	May	June	July	Aug.	Sept.	Oct.	(Lb/A.)	Rating 1/	($/A.)
1	20	10	10	--	--	--	40	2.8	83.20
2	--	--	20	10	10	--	40	9.7	83.20
3	--	--	--	--	20	10	30	8.4	59.90
4	--	--	--	--	--	20	20	7.9	36.60
5	20	--	20	--	--	--	40	4.2	73.20
6	--	--	20	--	20	--	40	9.7	73.20
7	--	--	--	--	--	40	40	8.0	63.20
8	20	--	20	--	20	--	60	8.6	109.80
9	20	--	20	--	10	--	50	7.2	96.50
10	*	*	*	*	*	*	--	1.1	290.40
11	10	10	10	--	--	--	30	3.6	69.90
12	**	**	**	**	**	--	--	8.9	194.00
LSD at 5%	-							1.7	
1%	-							2.3	

* Flamed 6 times (estimated 8 gal/hr LP gas consumption)

** Oiled 5 times (160 gal/A per application)

1/ Key to rating: 0 = no control; 10 = perfect control

(Dept. of Botany, Univ. of Calif., Davis & Field Crops Research Br. ARS, USDA)

The effect of various soil sterilants under limited rainfall on three perennial weed species. Miller, J. H., Wilkerson, J. A., and Foy, C. L. Various soil sterilants were applied at three rates to square rod plots infested with either Johnson grass (Sorghum halepense), Russian knapweed (Centaurea repens), or white horsenettle (Solanum eleagnifolium). The three experiments were located on irrigation ditchbanks in the same general locality in Kern Co. The applications were made in February of 1955. The herbicides, rates and volume of water used are shown in Table 1. The plots were scored twice to evaluate weed control. They were first scored in August, 1955 after 1.95 inches of rain and again in April, 1956 after a total of 6.13 inches of rain. This precipitation occurred as light showers, generally of .25-inch or less.

The data show that, under these conditions of limited rainfall, none of the herbicides provided consistent satisfactory control of these three perennial weeds. The best control for each of the three weeds was as follows: Johnson grass by the borate-chlorate complex ("Polybor Chlorate" and "Chlorax"); Russian knapweed by the borate-2,4-D complex ("DB Granular" and "DB Powder"); White horsenettle by the high rates of the borate-chlorate complex ("Polybor chlorate" and "Chlorax") and by 3-(Phenyl)-1, 1-Dimethyl-urea (Fenuron).

All of the herbicides (except TCA) were effective in eliminating annual weeds from among the perennial weeds except in the area immediately adjacent to the water-line in the canals. Near the water-line the differences in solubility of the herbicides were clearly demonstrated. Annual weeds invaded plots treated with the more soluble herbicides, i.e., "Polybor Chlorate", "Chlorax" and Fenuron.

One replication of the Johnson grass plots (data not shown) was accidentally irrigated by sprinkler. Weed control on these plots, when compared to the remainder of the experiment, was greatly improved indicating that sprinkler irrigation offers a method by which soil sterilants may be successfully used in areas of limited rainfall.

(Continued on next page)

Table 1. The effect of various soil sterilants upon three species of perennial weeds.

Herbicides	Rate Lb/A	Volume Gal/A.	Weed Control Rating 1/ Johnson Grass 8/55		Russian Knapweed 8/55		White Horsenettle 8/55	
			8/55	4/56	8/55	4/56	8/55	4/56
Control	----	----	3.4	5.6	1.5	1.5	3.0	3.0
Polybor Chlorate 2/	960	800	3.5	6.8	2.4	4.2	3.8	4.0
" "	1920	1200	4.0	8.8	3.8	4.7	2.0	7.5
" "	2880	1600	4.3	8.2	4.3	5.7	3.8	8.0
Chlorax 3/	640	320	4.3	8.5	4.5	4.3	2.0	2.0
"	1280	640	5.1	9.2	4.3	5.8	5.0	5.5
"	1920	960	5.4	9.3	6.5	6.7	4.8	9.0
Monuron	25	320	2.0	3.7	4.4	5.2	3.8	3.5
"	50	320	2.3	3.7	5.1	4.0	5.0	6.5
"	75	320	2.5	6.0	7.5	5.2	5.2	6.5
Fenuron	25	320	2.8	3.0	3.5	3.0	6.2	7.5
"	50	320	3.3	2.7	5.4	4.5	7.5	7.5
"	75	320	2.9	3.0	8.5	7.7	5.5	7.5
Diuron	25	320	2.4	2.7	2.4	2.7	6.2	2.5
"	50	320	3.1	1.5	4.9	4.3	6.5	2.0
"	75	320	3.3	4.0	6.0	4.0	7.0	4.0
TCA	40	320	3.4	2.7	---	---	---	---
"	80	320	4.1	5.0	---	---	---	---
"	160	320	2.9	4.1	---	---	---	---
Monuron + Amm. Sulfamate	25 + 25	320	2.4	2.1	---	---	---	---
"	50 + 50	320	2.8	4.0	---	---	---	---
"	75 + 75	320	2.5	5.3	---	---	---	---
Monuron + TCA	25 + 25	320	2.4	3.5	---	---	---	---
"	50 + 50	320	3.0	4.0	---	---	---	---
"	75 + 75	320	3.1	6.3	---	---	---	---
2,4-D Acid	20	320	---	---	2.8	3.7	---	---
"	40	320	---	---	4.8	3.7	---	---
"	80	320	---	---	5.5	4.3	---	---

Table 1 (Continued)

Herbicides	Rate Lb/A	Volume Gal/A.	Weed Control Rating 1/ Johnson Grass 8/55	Johnson Grass 4/56	Russian Knapweed 8/55	Russian Knapweed 4/56	White Horsenettle 8/55	White Horsenettle 4/56
Chlorea 4/	400	320	---	---	---	---	6.8	3.0
"	800	320	---	---	---	---	3.8	5.0
"	1200	320	---	---	---	---	3.8	5.0
DB Granular 5/	960	Dry	---	---	8.5	6.3	---	---
"	1920	Dry	---	---	9.5	8.0	---	---
"	2880	Dry	---	---	9.5	9.0	---	---
DB Powder 6/	960	960	---	---	7.0	6.0	---	---
"	1920	1920	---	---	8.0	7.7	---	---
"	2880	2880	---	---	8.0	9.0	---	---

1/ 1955 scores represent an average of 4 observations; while in 1956 there were 6 observations. Plots were scored on the basis of 0 (no control) to 10 (perfect control).

2/ Disodium octaborate 73%, sodium chlorate 25%.

3/ Sodium chlorate 40%; sodium metaborate 58%.

4/ Sodium chlorate 40%; sodium metaborate 58%; monuron 1%.

5/ Disodium tetraborate pentahydrate 55%, disodium tetraborate decahydrate 35.5%; 2,4-D 7.5%.

6/ Boron trioxide 59.5%; 2,4-D 7.0%.

(Contribution of Field Crops Research Branch, ARS, USDA and Botany Department, University of California, Davis).

The effect of method of irrigation upon the rate of disappearance of soil sterilants from the soil. Miller, John H., and Wilkerson, James A. Paired 2-rod square plots were treated with six soil sterilants on May 4, 1956. The herbicides and rates of application are given in Table 1. The rates were those suggested by the manufacturer for the control of deep-rooted perennial weeds. All herbicides were incorporated into the surface three inches of soil by harrowing with a spring tooth harrow. One set of the plots was furrowed on forty-inch spacing, while borders were "thrown up" around the individual plots of the other series. Uniform diameter pipes were used to irrigate the furrowed plots while level V-notch weirs were used for the flooded plots. The irrigation schedule was determined by the needs of an adjacent cotton crop.

The annual grass weeds were counted and removed from the plots on July 2 and again on August 24. These data are shown in Table 1. The most marked difference in numbers of weeds are shown when herbicidal compounds containing substituted ureas are compared to those containing no substituted urea. "Chlorea", monuron, and "Ureabor" treated plots had fewer grass weeds than the other treatments except the flood-irrigated erbon plot evaluated July 2.

Beginning with the second irrigation, a 33-foot row of corn was planted across each plot after each irrigation. These plantings continued for six consecutive water applications. The entire row of corn was harvested October 9 and the green weights were recorded (Table 2). The increased weight from flood irrigated plots show that toxicity was decreased much more rapidly with flood irrigation than it was by furrow irrigation. The data likewise show that the herbicides varied greatly in the rate of disappearance. "D.B. Granular", "Polybor Chlorate", and erbon disappeared more rapidly than monuron, "Ureabor", or "Chlorea".

Using indicator plants (barley and sunflower), an attempt was made to locate toxic residues in the soil profile. Six soil samples were taken at the 2, 3, 4, and 5 foot levels from each of the flooded plots after forty inches of water had been applied. The samples were composited and three replicates each of barley and sunflower were grown in quart tin cans. All water was applied by sub-irrigation. The plants were harvested forty-five days after planting. The green weights in grams per plant are given in Table 3. The data show, using sunflower as a test plant, that distinct green plant weight reductions were evident only with monuron and "Ureabor" at the four to five foot levels. Barley was injured by these same herbicides throughout the area of the soil profile sampled. Green weights of both sunflower and barley were consistently slightly higher from "Polybor Chlorate" treated plots than they were from control plots. No clearly defined differences between the control plot and the "D.B. Granular", or "Chlorea" plots were evident.

On October 10, the entire plot area was seeded to Arivat barley at the rate of 80 pounds per acre. The area was furrowed on forty inch spacings and irrigated. The barley population was sampled on November 14, using the quadrate system. Three samples per plot were taken. Both live and dead plants were recorded. Table 4 shows the number of plants per square foot that emerged and the percentage of these plants that survived. The data show that the emergence and survival of barley was only slightly altered on the flooded plots, but that all herbicides materially reduced the emergence of barley on the furrow irrigated plots. Likewise, a low percentage of the plants survived on plots treated with "Chlorea", monuron, or "Ureabor".

Table 1. Invasion of annual grasses on soil sterilant plots under different methods of irrigation (plants per plot).

Herbicide 2/	Rate Lbs/A	Flood Irrigated		Furrow Irrigated 1/	
		30"(7/2)	44"(8/24)	16"(7/2)	33"(8/24)
Chlorea 3/	871	216	44	32	48
Monuron	50	184	105	3	136
Ureabor 4/	871	168	109	6	250
Polybor Chlorate 5/	1742	1351	269	311	264
Erbon	100	22	195	384	484
D.B. Granular 6/	1307	674	303	191	301

1/ Very few weeds on beds - mostly confined to furrows.

2/ Trade names used for all herbicides except Monuron and Erbon.

3/ Sodium Chlorate 40%, Sodium Metaborate 58%, Monuron 1%.

4/ Disodium Tetraborate Pentahydrate 63%, Disodium Tetraborate Decahydrate 31%, Monuron 4%.

5/ Disodium Octaborate 73%, Sodium Chlorate 25%.

6/ Disodium Tetraborate Pentahydrate 55%, Disodium Tetraborate Decahydrate 35.5%, 2,4-D 7.5%.

(Continued on next page)

Table 2. The effect of method of irrigation with various soil sterilants on corn planted after different amounts of water.

(Green weights lbs/plot - corn harvested 10/9/56)

	Planting Date											
	5/23		6/4		6/18		7/2		7/19		7/30	
Herbicide	Flood	Furrow	Flood	Furrow	Flood	Furrow	Flood	Furrow	Flood	Furrow	Flood	Furrow
Chlorea 1/	17.5	1.5	24.0	0	43.5	10.0	36.0	3.0	38.5	0	28.0	5.0
Monuron	23.0	0	27.5	0	51.0	0	48.0	0	61.0	.5	51.0	11.0
Ureabor 2/	3.0	3.5	28.0	0	24.0	0	51.0	0	53.5	0	49.5	4.5
Polybor Chlorate 3/	81.5	18.0	63.0	29.5	88.0	21.0	90.0	24.0	103.5	27.0	76.0	33.5
Erbon	24.5	16.0	65.0	32.5	71.0	19.0	70.5	50.0	95.0	55.0	95.0	13.0
D.B. Granular 4/	63.0	8.0	63.0	65.0	94.0	85.0	39.0*	40.0	97.5	127.5	96.0	53.0
Total inches of water at planting	13.8	5.0	19.1	8.5	23.7	12.0	29.7	15.5	35.1	22.5	39.7	26.0

* Gopher and rabbit damage.

1/ Sodium Chlorate 40%, Sodium metaborate 58%, Monuron 1%.

2/ Disodium Tetraborate pentahydrate 63%, Disodium Tetraborate Decahydrate 31%, Monuron 4%.

3/ Disodium Octaborate 73%, Sodium Chlorate 25%.

4/ Disodium Tetraborate Pentahydrate 55%, Disodium Tetraborate Decahydrate 35.5%, 2,4-D 7.5%.

Table 3. Green weight of barley and sunflower plants grown in soil taken at different depths from soil sterilant plots (flood irrigated).

Herbicide	Grams Per Plant							
	2nd ft.		3rd ft.		4th ft.		5th ft.	
	Barley	Sunflower	Barley	Sunflower	Barley	Sunflower	Barley	Sunflower
Chlorea 1/	2.0	2.9	2.4	3.3	2.5	4.4	2.9	3.6
Monuron	0.4	2.9	0.9	2.6	1.4	1.7	0.2	0.2
Ureabor 2/	1.2	2.4	1.9	3.6	1.0	2.0	0.4	2.1
Polybor Chlorate 3/	4.6	3.3	4.4	3.9	3.9	3.7	4.4	4.0
Erbon	2.8	2.3	3.8	3.2	3.7	2.2	3.4	3.5
D.B. Granular 4/	2.5	4.4	4.3	3.5	4.5	4.6	2.6	3.9
Control	3.3	2.2	3.0	2.4	3.4	3.1	3.9	3.3

1/ Sodium Chlorate 40%, Sodium Metaborate 58%, Monuron 1%.

2/ Disodium Tetraborate Pentahydrate 63%, Disodium Tetraborate Decahydrate 31%, Monuron 4%.

3/ Disodium Octaborate 73%, Sodium Chlorate 25%.

4/ Disodium Tetraborate pentahydrate 55%, Disodium Tetraborate Decahydrate 35.5%, 2,4-D 7.5%.

Table 4. The effect of method of irrigation with various soil sterilants on the stand of fall planted barley.

	Flood irrigated (53 inches of H2O)		Furrow irrigated (40 inches of H2O)	
Herbicide	No. Plants emerged/sq. ft.	Percent Survival	No. Plants emerged/sq. ft.	Percent Survival
Chlorea 1/	21.67	92.3	7.67	8.2
Monuron	22.92	93.1	16.08	8.7
Ureabor 2/	29.67	89.0	14.58	8.3
Polybor Chlorate 3/	24.10	97.2	9.58	85.2
Erbon	28.50	100.0	10.00	93.3
D.B. Granular 4/	24.67	100.0	13.00	98.7
Control	24.00	100.0	20.75	100.0

1/ Sodium Chlorate 40%, Sodium Metaborate 58%, Monuron 1%.

2/ Disodium Tetraborate Pentahydrate 63%, Disodium Tetraborate Decahydrate 31%, Monuron 4%.

3/ Disodium Octaborate 73%, Sodium Chlorate 25%.

4/ Disodium Tetraborate Pentahydrate 55%, Disodium Tetraborate Decahydrate 35.5%, 2,4-D 7.5%.

(Contribution of Field Crops Research Branch, ARS, USDA and Botany Department, University of California, Davis).

PROJECT 2. HERBACEOUS RANGE WEEDS

Gerard J. Klomp -- Project Leader

SUMMARY

There were thirteen reports this year dealing with progress in herbaceous range weed research. Halogeton (Halogeton glomeratus) is the species concerned in four of these papers and niggerhead (Rudbeckia occidentalis) is the subject of three. Other species involved include Medusa-head rye (Elymus caput-medusa), hoary velvet lupine (Lupinus leucophyllus canescens), falsehellebore (Veratrum californicum), and a group of high elevation perennials which become abundant on heavily grazed ranges.

Following last year's format, the papers will be considered under the headings: (1) introduced range invaders (both poisonous and nonpoisonous), and (2) non-poisonous native species. No papers were submitted this year in group (3) poisonous native species.

Introduced range invaders. Of all introduced plants, halogeton has probably been the subject of more study than possibly any annual. In line with the recognized fact that control of this species eventually will probably best be effected by established native perennials is the paper dealing with the toxicity of several herbicides to perennials. Other halogeton studies deal with various herbicidal aspects. Medusa-head is the subject of two ecological studies, one of which tests the response of this annual to fertilization. We wonder parenthetically if fertilized medusahead will be palatable and, hence, a forage producer. Because of diversity of subject matter treated, no attempt is made to summarize results.

Non-poisonous native species. The use of herbicides as a management tool is becoming more and more important in dealing with ranges which have become infested with weedy natives. While they are a natural constituent of most climax types, weakening or destruction of desirable forage species through past over-use has promoted the increase of the unpalatable and undesirable weedy perennials. Niggerhead is such a species, occupying fertile productive sites. Its control through management alone is a slow, tedious process. The judicious use of herbicides and reseeding techniques restores valuable sites to productivity much more rapidly. This is true also of hoary velvet lupine, falsehellebore, and a host of perennials which multiply on heavily grazed high elevation meadows and pastures. A combination of spraying, mechanical control, and reseeding is being worked out so that many range lands can be reclaimed and restored to producing grasses and other desirable forage plants.

The reports of the individual contributors which follow immediately have been arranged according to the foregoing categories of problem classification.

Introduced range invaders. --

Toxicity of several herbicides to perennial forage plants when applied as pre-emergence sprays for halogeton control. Haas, Robert H. and Morton, Howard L. Studies were initiated in the fall of 1954, and are being continued, to determine the toxicity of several pre-emergence herbicides to halogeton, Halogeton glomeratus, and to perennial forage plants associated with halogeton. Six of these herbicides have been effective in controlling halogeton and have shown varying degrees of selectivity to perennial plants. Preliminary results from several experiments are presented to show the toxicity of these materials to perennial forage plants.

2,3,6-TBA has been very effective in controlling halogeton when applied as a pre-emergence or early post-emergence treatment, but is somewhat toxic to kochia, Kochia vestita; saltsage, Atriplex Nuttallii; and winterfat, Eurotia lanata; but has not shown injury to crested wheatgrass, Agropyron cristatum, at rates up to 4 lbs/A. This material has caused stand reductions of 66 percent to kochia at 2 lbs/A and 43 percent to saltsage at 4 lbs/A. The surviving kochia and saltsage plants were severely stunted and slow to recover from the treatments even under favorable growing conditions.

2-(2,4,5-TP) has also been very effective in controlling halogeton when applied in fall, winter, and early spring. This material is somewhat toxic to saltsage, producing stand reductions ranging from 30 to 63 percent at 4 lbs/A. Yields of saltsage forage on plots treated with 2-(2,4,5-TP) at 4 lbs/A were increased significantly over the untreated check, even though the saltsage stands were reduced 63 percent. This would indicate that the surviving plants recover quickly from the 2-(2,4,5-TP) treatments. Kochia was not injured by 2-(2,4,5-TP) when applied in March at rates ranging up to 6 lbs/A.

Diuron has been effective in controlling halogeton when applied prior to the first germination period. This material has given no injury to saltsage and kochia when applied at rates ranging up to 4 and 6 lbs/A, respectively.

Fenuron, although effective in controlling halogeton when applied in late fall, prior to the first period of halogeton germination, is very toxic to both saltsage and kochia. Fenuron killed all of the saltsage and 91 percent of the kochia plants when applied at 4 lbs/A.

CIPC and 2,4-DEB are relatively effective in controlling halogeton, giving up to 95 and 98 percent control respectively, when applied in late fall and early winter. These materials have caused no apparent injury to established forage plants.

Although these results are preliminary, they point to selective control of halogeton in all major forage types associated with this weed. Unfortunately no single herbicide will give selective control of halogeton in all forage types. Further testing is under way at the present time to determine the influence of the promising pre-emergence herbicides on major forage types associated with halogeton. (Field Crops Research Branch, A.R.S., U.S.D.A., and Idaho Agricultural Experiment Station)

Tolerance of Halogeton glomeratus to post-flowering sprays. Morton, Howard L. and Haas, Robert H. The tolerance of halogeton, *Halogeton glomeratus*, to 2,4-D sprays after this plant passes from the vegetative to fruiting stages of growth is now generally recognized. In 1955 several mixtures of 2,4-D and DNBP were used in an attempt to find a post-flowering spray for halogeton control. In general, these sprays were not effective after the early part of August.

Further investigations to develop a post-flowering spray for halogeton control were conducted in 1956. In this study, ten spray mixtures were used. The following table lists the ten sprays applied in this study and the results (estimated percent halogeton kills) obtained from each spray at four dates of application. The low volatile ester of 2,4-D used in this experiment was a propylene glycol butyl ether ester of 2,4-D. The DNBP was an oil-soluble formulation containing 55 percent or 5.0 lbs/gal of DNBP. The diesel oil was commercial diesel oil obtained from the Utah Oil Company on Idaho State contract.

Average percent halogeton kills produced by ten sprays applied at four post-flowering dates in 1956. Estimates of percent kill made September 29, 1956.

Herbicidal Spray, Rate/A	8/3	8/8	8/14	8/21
1. 4 lbs 2,4-D in 15 gal diesel oil	55	68	23	88
2. 4 lbs 2,4-D and 1 qt DNBP in 7.5 gals water and 7.5 gal diesel oil	98	90	60	95
3. 4 lbs 2,4-D and 1 pt DNBP in 15 gal diesel oil	93	100	77	68
4. 4 lbs 2,4-D and 1 qt DNBP in 15 gal diesel oil	98	100	97	95
5. 4 lbs 2,4-D and 2 qt DNBP in 15 gal diesel oil	98	100	97	100
6. 4 lbs 2,4-D and 4 qt DNBP in 15 gal diesel oil	100	100	98	100
7. 3 lbs 2,4-D and 1 qt DNBP in 15 gal diesel oil	98	100	92	100
8. 2 lbs 2,4-D and 1 qt DNBP in 15 gal diesel oil	98	97	93	98
9. 1 lb 2,4-D and 1 qt DNBP in 15 gal diesel oil	97	98	88	98
10. 1 qt DNBP in 15 gal diesel oil	78	92	87	93
Mean temp. day of spraying (F°)	65.6	66.5	69.4	67.0

The 4-lb/A application of low volatile ester of 2,4-D in diesel oil did not give satisfactory halogeton kills at any of the dates of application. The spray containing 4 lbs of 2,4-D and DNBP in water and oil carrier was very effective on August 3, but was less effective on the two succeeding dates of application. The increase in halogeton kill obtained from the August 21 application is unusual.

Treatments containing at least 1 qt/A of DNBP and 2 lbs/A of 2,4-D in diesel oil were effective in killing at least 90 percent of the vegetative portions of halogeton plants. If the 90 percent halogeton kill is considered as a satisfactory level, sprays containing only 2,4-D in diesel oil, 2,4-D and DNBP in water and oil, 1 lb of 2,4-D and DNBP, and DNBP alone in diesel oil did not produce satisfactory halogeton kills. However, if a 100 percent halogeton kill is considered necessary, no treatment produced satisfactory kills at all dates of application.

This evaluation of the toxicity to halogeton is based on killing the vegetative portions of the plants. Plants were collected from plots treated on August 14 and 21. Viable seed was threshed from plants collected on all of the plots treated at these two dates. Thus, while some of the treatments produced 100 percent vegetative kills, they did not prevent the production of viable seed at these dates of application. The sprays applied at the two latest dates did not prevent seed from developing but they did reduce the amount of seed produced on the plants. If it is recognized that seed production is only reduced and not prevented, such treatments will be valuable in a halogeton control program; however, if eradication of the halogeton plants on a small patch is desired, such treatments should be applied much earlier in the season. (Idaho Agricultural Experiment Station and Field Crops Research Branch, A.R.S., U.S.D.A.)

Halogeton response to several phenoxy herbicide compounds applied as post-emergence sprays. Morton, Howard L. and Haas, Robert H. Herbicidal evaluation studies have shown that low volatile ester formulations were applied to halogeton on June 17, 1955 and June 29, 1956 at rates ranging from 1/2 to 2 lbs/A. However, for the sake of brevity, only the 2-lb/A rates are here reported. All compounds were applied in water equivalent to 15 gpa. The treated plants were in the early lateral branching and late lateral branching stages of growth on June 17, 1955 and on June 29, 1956, respectively.

Results of the eight phenoxy compounds applied in 1955 and 1956 are contained in the following table:

Percent halogeton kills produced by low volatile esters of several chlorophenoxy compounds applied to halogeton in 1955 and 1956. All treatments applied at 2-lb/A rate in June.

Compound	1955	1956	Mean
2,4-D	95	86	90
2,4,5-T	100	75	88
MCPA	87	56	72
4-CPA	53	5	29
2-(2,4-DP)		62	
2-(2,4,5-TP)	96	63	80
4-(2,4-DB)		50	
4-(MCPB)		4	

The halogeton plants were in a more susceptible stage of growth in 1955 than in 1956. The kills obtained from the treatments applied in these two years approach the extreme kills obtained from the application of the same herbicidal treatment in different years.

The acetic acid compounds are arranged in order of decreasing toxicity to halogeton. The toxicity of these four compounds to halogeton is quite accurately represented by the figures in the mean column.

Unfortunately 2-(2,4-DP) has been tested only one year. Toxicity to halogeton. The toxicity of these four compounds to halogeton is quite accurately represented by the figures in the mean column.

Unfortunately 2-(2,4-DP) has been tested only one year. Toxicity of this compound seems to be comparable to 2-(2,4,5-TP), which has proven to be only slightly less effective than 2,4-D during the three years it has been under evaluation.

The low volatile esters of 4-(2,4-DB) and 4-(MCPB) were relatively ineffective in killing halogeton in the 1956 study.

The compounds which were most toxic to halogeton when it was in a susceptible stage of growth were also most toxic over a longer period of time. For post-emergence control of halogeton, the low volatile esters of 2,4-D are the most toxic herbicides yet tested. (Idaho Agricultural Experiment Station and Field Crops Research Branch, A.R.S., U.S.D.A.)

Pre-emergence herbicidal evaluation for control of *Halogeton glomeratus* in southern Idaho. Haas, Robert H. and Morton, Howard L. During the past two years, twenty-eight herbicides have been evaluated for their effectiveness in controlling halogeton, *Halogeton glomeratus*. This study was a preliminary screening of compounds to determine their toxicity to halogeton when applied before, at the time of, or just after germination. All compounds were applied at rates of 4 lbs active ingredient per acre in water equivalent to 100 gpa. with 3 replications of each treatment. Treatments were applied at two dates in each year: in December and March. The December treatments were true pre-emergence treatments and the March treatments were early post-emergence treatments, the halogeton seedlings being in a cotyledon stage of growth at the time of application. Results of the treatments applied in these two years are contained in the following table. Results are reported as percent control of halogeton.

Percent halogeton control obtained from twenty-eight compounds applied as pre-emergence sprays at 4-lb/A rates during two years.

Chemical	1954-55 Trials		1955-56 Trials	
	December	March	December	March
2-(2,4,5-TP)1/	100	100	87	78
2,3,6-TBA2/			100	100
2,3,6-TBA			98	100
2,4-DES	99	23		
NPA	99	70	58	14
NPA2/			37	2
2,4-DEB	98	75		
Diuron	97	28		
Fenuron	95	88		
CIPC	95	41		
DMU3/			92	00
2-(2,4,5-TP)4/			85	83
2-(2,4,5-TP)5/			82	50
TCA	83	77		
Monuron	72	25		
2,4,5-T6/			80	40
2,4-D6/			68	90
4-(2,4-DB)5/			56	6
Dalapon	31	82	52	26
4-(MCPB)5/			45	12
Baron			45	15
4-(2,4,5-TB)5/			32	00
Amizol	35	10		
IPC	28	13		
Polybor			2	0
CDAA			0	2
CDEC			0	0
DB Granular			0	0

1/ Propylene glycol butyl ether ester
2/ Sodium salt
3/ 3-(3,4-dichlorophenyl)-1-methyl urea
4/ Iso-octyl ester
5/ Amine salt
6/ Emulsifiable acid

The December treatments were generally more effective than the treatments applied in March. In the 1954-55 trials, 2-(2,4,5-TP) was the only compound which was 100 percent effective at both dates of application. The 2,4-DES, NPA, 2,4-DEB, diuron, fenuron, and CIPC treatments were also very effective in controlling halogeton when applied in December. All of the compounds, with the exception of 2-(2,4,5-TP), were ineffective when applied in March.

The results of the 1955-56 treatments were similar in pattern to the 1954-55 results. The two 2,3,6-TBA compounds were very toxic to halogeton, both as pre-emergence treatments and as early post-emergence treatments. DMU "Karmex M-1-W", 3-(3,4-dichlorophenyl)-1-methyl urea, was very effective when applied in December, but was completely ineffective when applied in March. The low volatile esters of 2-(2,4,5-TP) were approximately 85 percent effective when applied in December, much less effective than they were in the 1954-55 trials. This may have been due to the greater amount of precipitation received during the 1955-56 trials. Both of the NPA compounds were relatively ineffective in the 1955-56 trials. The other compounds do not appear to be promising for halogeton control.

From the results of these evaluation studies, six compounds look promising for halogeton control. They are: 2,3,6-TBA, 2-(2,4,5-TP), diuron, DMU, CIPC, and 2,4-DES. 2,3,6-TBA and 2-(2,4,5-TP) are also effective as post-emergence herbicidal sprays. Timing applications so that they are applied before halogeton germinates is obviously important in the use of the other four compounds for halogeton control. Further study is necessary, and is now under way, to determine the toxicity of these compounds to desirable forage plants and the optimum rates and dates of application. (Field Crops Research Branch, A.R.S., U.S.D.A. and Idaho Agricultural Experiment Station)

Comparative response of medusa head (Elymus caput-medusae) to fertilization. Major, J. Field tests indicate that medusa head responds strongly to N but not to P or S fertilization. Greenhouse pot tests of fertilizer responses were run on medusa head, soft chess (Bromus mollis), and barley. All species were grown alone, replicated 3x, for 247 days between 10 May and 12 Jan. (even then medusa head never did flower although the other species did normally) at the rate of 20 plants per 7 inch asphalt-painted pot containing 1500 cm. of the 0-10 cm. layer of two contiguous, medusa head dominated soils from Potter Valley in Mendocino Co., California. The blackish soil is acid (pH 5.7 throughout the profile), received seepage during the winter, and has a few relict plants of Danthonia californica; the reddish soil is also acid (pH 5.8 at the surface to 5.3 in the subsoil), has a gleyed, 50 per cent clay B horizon velow 37 cm. depth, and is characterized by relict Stipa pulchra. N was applied at 5 and 15 $g./m.^2$ of the soil as it lay in the field (45 and 134 lbs. N/A.), P at 2.2 $g./m.^2$ (5 g. $P_2O_5/m.^2$) with N_5, and S at 5 $g./m.^2$ with $P_{2.2}$. Analysis of variance showed the variances for soils, species, fertilizer treatments, and all interactions were significantly different from the error variance. The variance due to fertilizers was larger than that due to species on the reddish soil; the opposite condition obtained on the blackish soil.

The standard error of a pot mean dry weight was 0.497 g. and yields varied from 2.4 to 10.5 g. per pot. According to Duncan's multiple range test the following conclusions can be drawn: Comparing species, soft chess yields the same on both soils, medusa head and barley yield 2-3x more on the reddish soil under all conditions tested. Barley gave the lowest and highest yields; soft chess was least variable. Comparing soils, on the blackish soil soft chess always yields most, the other two species the same, except barley is less than medusa head under PS and N_{15}. Within any treatment the trend of increasing yield is barley least, to medusa head, to soft chess most. In contrast, on the reddish soil all species yield the same within a given fertilizer treatment. Comparing fertilizer treatments, checks and PS are the same. NP yields more than the checks. The above hold for all species and both soils. Checks and N_5 are the same on the blackish soil; N_5 yields more on the reddish. On the reddish soil N_{15} yields more for all species, more on the blackish soil only for soft chess which thus seems to have the highest nitrogen requirement of all the species. PS in general yields less than NP. N_5 and NP are the same on the reddish soil for all species but the same only for soft chess on the blackish soil, with NP yields higher for the other two species. N_{15} yields more than N_5 only with soft chess on the blackish soil but for all species on the reddish soil. N_{30} did not yield more than N_{15} with medusa head on the reddish soil. (California Agricultural Experiment Station)

<u>Some ecological studies on medusa-head rye in Idaho</u>. Hironaka, M., and Tisdale, E. W. Tests show that medusa-head seed still retain their viability even after two years of burial in soil under field conditions. Lots of one hundred seeds each were placed in plastic mesh baskets and buried in the ground at the 1/2, 2, and 4-inch depths during the fall of 1954 and recovered in 1956. After a period of 14 days in the germinator the results were 3%, 13%, and 10% respectively as compared to 10%, 9.5%, and 11% for seed buried for a period of one year. Germination percentages jumped to 18%, 38.5% and 46% respectively after the seed were allowed to dry for several days following the 14 day period and replaced in the germinator. This procedure was not followed for seeds recovered in 1955. This response to alternate wetting and drying will be investigated further.

Preliminary study of the root system show that root penetration of medusa-head is much deeper than would be suspected. Medusa-head plants in early April when in the two-leaf stage had roots penetrating to a depth of 8-12 inches. By the mid-boot stage of development (mid-May) roots 24 inches in depth were extracted and in early June when in the mid-dough stage roots were found as deep as 32 inches. At this depth a hard pan was encountered in the study.

Preliminary studies have been initiated to determine the factor(s) that may limit the spread of medusa-head in Idaho. Under laboratory conditions successful establishment of medusa-head was obtained from seed planted in soils of the Raft River Valley that support sagebrush, shadscale, and winterfat. Establishment on soil that support Nuttall's salt bush did not occur.

A similar experiment was conducted under field conditions where precipitation is about 12 inches annually. In this experiment the soils were obtained from the salt desert shrub communities in the vicinity of Mountain Home. Successful germination and emergence occurred on all soils tested. The successful establishment of medusa-head on soil of the Nuttall's salt bush community in this case may be due to the wide variation of the chemical make-up of soils encountered from area to area among similar vegetation communities in the salt desert shrub type.* Preliminary studies on climatic factors will be initiated during the coming year. (Forest, Wildlife and Range Experiment Station, University of Idaho, Moscow, Idaho. December 12, 1956.)

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* Gates, D. H., L. A. Stoddart, and C. W. Cook. 1956. Soil as a factor influencing plant distribution on salt-deserts of Utah. Ecol. Mono. 26(2):155-175.

Non-poisonous native species.--

Niggerhead (Rudbeckia occidentalis) control by spraying with 2,4-D and by mechanical treatment. Klomp, Gerard J. On rangelands in mountainous areas, niggerhead (Rudbeckia occidentalis) is a frequent invader at elevations of 5,000 to 7,000 feet where it is adapted. Usually sites having deep soil and favorable moisture conditions and which have a history of past heavy use by livestock are invaded first. Since niggerhead is not utilized to any extent by livestock, its occupation of a site represents a loss of forage.

Spraying and cultivating, followed by reseeding, were used in an effort to control niggerhead. Spraying with 2,4-D ester at 2 pounds per acre was more effective than cultivation to a depth of 6 inches, using duck foot plows. Reseeding with 10 species of grass by (a) drilling in rows 12 inches apart; (b) broadcasting; and (c) broadcasting and covering was equally effective on sprayed and cultivated areas. Reseeded species after two growing seasons were beginning to exert some control on knotweed (Polygonum spp.) which invaded the site after niggerhead was controlled. The role of the seeded grasses in eventually controlling niggerhead by preventing re-invasion is uncertain in observations to date, and must await further study. (Field Crops Research Branch, ARS, USDA, La Grande, Ore.)

A comparison of different rates of 2,4-D for the control of niggerhead. Klomp, Gerard J. Three rates of 2,4-D isopropyl ester were sprayed on niggerhead (Rudbeckia occidentalis). The spray was applied on replicated plots established in a dense, uniform stand of niggerhead growing on a deep, fertile soil in a cattle range in the open fir type. The plants were sprayed when they had made nearly maximum growth and flowers were beginning to bud, which, at this elevation of nearly 6,000 feet, was July 21.

The rates of 2,4-D isopropyl ester applied with water, 50 gallons per acre, were 1/2, 1, and 2 pounds per acre, compared with untreated check.

After spraying, growth stopped; there was characteristic malformation; and flower development was arrested. Observations the following year (1956) indicated control proportionate to amount of

2,4-D used. The 2 pounds per acre rate gave 99 percent control of niggerhead. The 1 pound rate gave 65 percent control, and 1/2 pound rate gave 25 percent control. There was no sprouting from the roots of dead plants. There were some seedlings, new plants from buried seed or from adjacent plants. These were more numerous on plots with the heaviest rate of kill. (Field Crops Res. Branch, ARS, USDA, LaGrande Ore.)

A comparison of several herbicides in controlling niggerhead (Rudbeckia occidentalis). Klomp, Gerard J. Recent studies have demonstrated the effectiveness of 2 pounds per acre of 2,4-D in controlling niggerhead (Rudbeckia occidentalis) growing on high elevation ranges in eastern Oregon. In this study several herbicides are compared with 2,4-D to evaluate their effectiveness in niggerhead control. On replicated 1/40-acre plots the following herbicides were tested: 4-(MCPB) at 2 and 4 pounds per acre; ATA at 2 and 4 pounds per acre; 4-(2,4-DB) at 2 and 4 pounds per acre; and mixture consisting of 2/3 2,4-D plus 1/3 2,4,5-T at 2 pounds per acre.

Three to four weeks after spraying there was evidence of plant injury with most herbicides used. Most evident was plant injury on the 2,4-D and the 2,4-D plus 2,4,5-T plots. There was evidence of chlorosis and browning on the ATA plots. Least injury was evident in the niggerhead on the 4-(MCPB) and the 4-(2,4-DB) plots. No conclusions can be drawn on the control of this perennial until further seasons' investigations and data. (Field Crops Res. Brch, ARS. USDA, LaGrande, Ore.)

A comparison of different rates of 2,4-D for the control of hoary velvet-lupine (Lupinus leucophyllis canescens). Klomp, Gerard J. Three rates of 2,4-D isopropyl ester were sprayed on hoary velvet lupine on a sheep range at an elevation of 6,800 feet in a subalpine grassland type. The hoary velvet lupine is an undesirable invader of the green fescue (Festuca viridula) type. Scattered remnants of the green fescue will be studied to determine their reaction to spraying and to release when lupine is controlled. The lupine was sprayed while plants were still growing vigorously and flower buds were beginning to appear (July 24).

The rates of 2,4-D isopropyl ester applied with water at 50 gallons per acre were: 0, 1/2, 1, and 2 pounds' acid equivalent per acre.

Lupine responded rather quickly to spraying, the plants beginning to wither and dry within a few days. Flower development stopped immediately and no seed matured. Examination the following year in the summer of 1956 showed the control lupine was proportionate to the level of 2,4-D used. The averages of the plots observed revealed the following:

2,4-D Pounds per Acre	Percent Control
1/2	10
1	40
2	68

Apparently the rate of 2,4-D to control lupine should be heavier than the rates used in this study--probably on the order of 3 or 4 lbs per acre. This would open up the site for indigenous grasses. There was a noticeable increase in grass on the plots where 1 and 2 pounds of 2,4-D was used. (Field Crops Research Branch, ARS, USDA, LaGrande, Ore.)

Effect of spraying on use of grassland drill for range reseeding. Klomp, Gerard J. On many mountain ranges great importance is placed by stockmen on open parks occurring in timbered types. Such parks usually have a predominance of grass with a mixture of perennial forbs completing the community. Disturbance by overgrazing weakens the grasses and undesirable perennial weeds invade. To restore these deteriorated ranges, reseeding is frequently necessary. To eliminate the costly operation of plowing, a drill will be tried which opens a furrow, deposits a band of fertilizer and covers it and drills a row of seed over the fertilizer band.

In this study half of each replicated block will be sprayed and half left untreated. The plots sprayed in 1956 received 2 pounds per acre 2,4-D (isopropyl and butyl esters mixed) and 3/4 pound per acre 2,4,5-T (butaxyelhanol ester). Weeds in these blocks included: western yarrow (Achillea lanulosa), cinquefoil (Potentilla spp.), fleabane (Erigeron spp.), penstemon (Penstemon spp.), and eriogonum (Eriogonum spp.). While all of these showed marked effect of the herbicides used, further observations will be made to determine kill and, eventually, how this affects efficiency of the grassland drill. (Field Crops Research Branch, ARS, USDA, LaGrande, Ore.)

A comparison of 2,4-D and ATA for weed control (Veratrum spp. and Potentilla spp.) on a wet meadow site. Klomp, Gerard J. Wet meadows in the timber type are important to the livestock industry because of the potentially high production on such sites. The climax of grasses with some forbs is destroyed with overgrazing and such invaders as California falsehellebore (Veratrum californicum) and cinquefoil (Potentilla spp.) appear.

On replicated 1/20-acre plots, heavily infested with the two weeds, tests were made to compare 2,4-D (isopropyl and butyl esters mixed) at 3 pounds per acre with ATA at 3 pounds per acre. The respective herbicides were applied in water at 50 gallons per acre with a boom spray at a pressure of 50 pounds per square inch. Three weeks after spraying, the weeds turned brown and curled. Further observations will be made in 1957 to determine actual percentage of kill and degree of control. (Field Crops Res. Branch, ARS, USDA, LaGrande, Ore

A comparison of several herbicides in controlling weeds in high elevation pastures. Klomp, Gerard J. Several herbicides currently being used for weed control will be compared to determine their effectiveness in controlling undesirable weedy perennials in high elevation pastures in openings in the lodgepole pine-fir type. Weedy species in these sites include: western yarrow (Achillea lanulosa), cinquefoil (Potentilla spp.), penstemon (Penstemon spp.), aster (Aster spp.), carrotleaf leptotaenia (Leptotaenia multifida), low larkspur (Delphinium bicolor), arrowhead butterweed (Senecio triangularis), and bistort (Polygonum spp.).

Herbicides to be compared include 2,4-D (isopropyl ester), 2 and 4 pounds per acre; a mixture of 2,4-D plus 2,4,5-T (butoxy-ethanol ester) at a ratio of 2/3 to 1/3 and at rates of 2 and 4 pounds per acre; ATA at 2 and 4 pounds per acre; 4-(MCPB) at 2 and 4 pounds per acre; and 4-(2,4-DB) at 2 and 4 pounds per acre.

Preliminary observations made from 3 to 8 weeks after spraying showed symptoms of injury. Actual control cannot be determined before the 1957 field season.
(Field Crops Research Branch, ARS, USDA, LaGrande, Ore.)

PROJECT 3. UNDESIRABLE WOODY PLANTS

Fred H. Tschirley

Summary

Eight authors presented eleven papers this year on the control of a wide variety of undesirable woody plants. Chemical control received the major emphasis, but mechanical methods and the use of fire were also covered.

Monuron /3-(p-chlorophenyl)-1,1-dimethylurea/ was tested on sprouts of interior live oak (Quercus wislizenii) in California. Treatments were made to 1, 5, and 25 square foot plots at rates of 1, 5, and 25 grams (80 percent active ingredient) for each size plot in order to study the interrelations between dosage and area treated. The results indicated that monuron was more effective when concentrated at the bases of the sprouts. Spreading the same quantity of chemical over 25 times the area had little effect on the sprouts. The action of the herbicide was very slow--most of the actual kill taking 3 and 4 years after treatment.

Another test on interior live oak involved the use of 2,4,5-T amine in hatchet cuts. The interesting aspect of this study was the great increase in plant kill that took place between 3 and 5 years after treatment. The increased plant kill took place because sprouts that had developed around the base of top-killed trees died between the third and fifth years.

Fire sprouts of turbinella oak (Q. turbinella) were treated with a wide variety of chemicals at 1-3 month intervals for one year after a June fire to determine the most effective herbicide and the proper time to treat sprouts following fire. The best results were obtained beginning six months after the fire. The most effective herbicide was the low-volatile ester of 2-(2,4,5-TP) followed, in order of decreasing effectiveness, by the low-volatile esters of 2,4,5-T, 2-(2,4-DP), and 2,4-D.

The control of phreatophytes in the West has long been a problem. To date about 32,500 acres have been aerial sprayed in New Mexico alone. Chemical control has not been the only method of control used, however. During 1956, approximately 4,800 acres were disked one or more times to keep a floodway almost completely free of woody plant regrowth. This practice is extremely expensive, however, and if chemicals can be used effectively, the cost will be greatly reduced.

A study on big sagebrush (Artemesia tridentata) tested the effect of nutrient additives in growth regulator solutions. Some of the additives appeared to increase the effectiveness of the growth regulators slightly, but small increases in the rate of herbicides were more effective and economical.

Various herbicides were tested for the control of green and grey rabbitbrush (Chrysothamnus viscidiflorus and C. nauseosus). Of the 13 herbicides tested on these 2 species, 2,4-D was the best. Good control

was obtained with the butyl ester at 2-3 lbs/A. It was found that big sagebrush and rabbitbrush could be controlled simultaneously with proper timing. A preliminary index to rabbitbrush susceptibility was given on the basis of the vegetal development of companion species.

The rapid growth of brush that overtops and suppresses the growth of ponderosa pine in much of the Pacific Northwest is a major problem, but much progress has been made toward its solution. With proper timing and the correct combinations of herbicide and carrier, the brush can be controlled without seriously damaging the pine. For example, ponderosa pine can tolerate about twice as much 2,4,5-T as 2,4-D and can tolerate about twice as much of either chemical in water as in an oil:water emulsion. Douglas fir (Pseudotsuga menziesii) is more tolerant to both herbicides than ponderosa pine and other pine species. The nonsprouting species of manzanita (Acrtostaphylos spp.) are quite easily controlled with 2,4-D. However, the manzanita sprouters, Ceanothus spp., canyon live oak (Q. chrysolepis), shrub tan-oak (Lithocarpus densiflora var. echinoides), chinquapin (Castanopis spp.) and serviceberry (Amelanchier florida) are variably resistant.

The effect of mesquite (Prosopis juliflora var. velutina) canopy reduction on perennial grass production was studied in Arizona. The results indicate that good initial defoliation and partial top kill by aerial spraying quickly reduce mesquite competition and that resprouting does not eliminate this benefit for at least several seasons.

Fire was studied as a tool for controlling some noxious plants in an annual grass range and a perennial grass range in southern Arizona. On the annual grass range it was found that fire was effective only against burroweed (Aplopappus tenuisectus). Kills on pricklypear cactus (Opuntia engelmanni) were too low to be encouraging and the fire actually promoted the spread of jumping cholla (O. fulgida). Fire on a perennial grass range was also highly effective against burroweed while kills of 28 to 44 percent were recorded for various species of cactus. A reburn of the same area after three years reduced the remaining burroweed by 94 percent. Cactus had invaded rapidly after the first fire and the second fire retarded the rate of increase but did not reduce cactus numbers beyond the original level.

Effect of monuron on live oak sprouts. Leonard, O. A. Interior live oak (Quercus wislizenii) was bulldozed in 1950. An abundance of sprouts developed, which were treated on December 11, 1952 with monuron [3-(p-Chlorophenyl)-1,1-dimethylurea]. The soil type was Sierra clay loam. Monuron was applied at the rates of 1, 5, and 25 grams (80% formulation) per group of sprouts. Applications were made to 1, 5, and 25 square feet in order to study the interrelation between dosage and area treated, on kill. Results recorded in October 1956 are presented in the following table.

Dosage of monuron per group of sprouts	Area Treated					
	1 sq. ft		5 sq. ft.		25 sq. ft.	
	Kill	Grass Stand	Kill	Grass Stand	Kill	Grass Stand
gms.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.
1	0	?	0	100	0	100
5	0	?	0	50	0	75
25	80	0	13	0	0	10

The results from the above study indicate that monuron was more effective when concentrated at the bases of the sprouts. Spreading the same quantity of chemical over 25 times the area had little effect on the sprouts, although enough chemical still remained 4 years after application to influence the growth of grass. The sprouts were very slow in dying, most of the actual kill taking place 3 and 4 years after being treated. These results were similar to some earlier trials on the same soil type.

Similar studies were conducted on interior live oak trees on the Hopland Experimental Range in January 1953. At no time have any of the trees been more than very slightly affected by the treatment. (University of California, Davis.)

Delayed kill of live oak brought about by 2,4,5-T amine applied to cuts. Leonard, O. A. In February 1952, interior live oak (Quercus wislizenii) was treated with two formulations of 2,4,5-T amine. The formulations contained 3 pounds of acid equivalent per gallon and the concentrates were applied to hatchet cuts (one for each 6 inches of circumference). One ml. was applied to each cut. The cuts were made with a single hit with the hatchet, which cut the bark and the wood. About 35 trees and clusters of trees were treated. The clusters of trees resulted from a fire that killed the original trees some time in the past. Sprouts following the fire developed into compact groups or clusters of trees. Such clusters were considered as a single unit. There was no difference between the two formulations, so the data are averaged in the following table.

Effect on	Years after treatment		
	2	3	5
	Pct.	Pct.	Pct.
Top kill	77	77	85
Plant kill	19	23	70
Fallen trees	0	4	54

The interesting aspect of these studies is the great increase in plant kill that took place between 3 and 5 years after treatment. The increase in plant kill took place because live sprouts that developed around the base of many of the top-killed trees died between the third and fifth year after treatment. Although appreciable delayed sprout kill is common with the cut-surface method, the above result represents the greatest amount of delayed kill that the author has observed. The reasons for the delayed kill are not understood. (University of California, Davis.)

Herbicide tests on fire sprouts of turbinella oak (Quercus turbinella Greene) in the Arizona chaparral. Schmutz, Ervin M., and Turner, Raymond M. Fire sprouts of turbinella oak in the Arizona chaparral were sprayed at 1 to 3 month intervals for one year following a burn in June 1955. Each of eight herbicides at the rate of 10,000 ppm in a 1:9 nontoxic oil (S/V Sovaspray 100):water ratio were applied to the point of drip on 10 plants located along a 100-ft. chain. Complete kill and topkill of plants were recorded in 1956 following the summer growing season.

Best results were obtained beginning six months after the June burn. At this time the winter rains had begun and foliage was well developed. After this date there was little difference in kill for dates of application with the best chemicals. In general the low-volatile esters of 2-(2,4,5-TP)/2-(2,4,5-trichlorophenoxy) propionic acid/ were more effective than the low-volatile esters of both 2,4-D and 2,4,5-T. The most effective herbicides and their greatest topkill were:

Herbicide	Pct. topkill
2-(2,4,5-TP) (Kuron)	80
2,4,5-T ester (Esteron 245)	65
2-(2,4-DP) (Dow S-1280)	55
2,4-D ester (Esteron 10-10)	45

The following chemicals gave less than 25 percent topkill:

2,4,5-T triethylamine salt
ATA (3-amino-1,2,4-triazole)
2:1:1 mix. Dalapon (2,2-dichloropropionic acid):2,4-D: 2,4,5-T
2,4-D, dimethylamine salt.

There was practically no complete kill of individual plants. (Arizona Agricultural Experiment Station, Tucson.)

Phreatophyte control in New Mexico. Lowry, Orlan J. Since the efforts to control salt cedar, cottonwood, and willow were initiated in New Mexico by the Bureau of Reclamation, approximately 32,500 acres of mixed bottom land woody plants, comprised of the above mentioned, have been aerial sprayed with various herbicidal formulations. A summary of this work has been given in preceding annual reports, but to sum it up, little kill has been obtained. Complete plant defoliation and retardation have resulted from each spraying, however, which undoubtedly resulted in considerable water savings.

During 1956, 1,800 acres of mixed phreatophytes were aerial sprayed with 2,4-D amine in an oil:water emulsion on the Caballo Reservoir, New Mexico, in April and May. This early season spray resulted in material delay in plant foliation but little plant kill. In early October a 27 mile section of canal on the Tucumcari Project was sprayed by helicopter. In this treatment 2 lbs. of the isooctyl esters of 2,4-D:2,4,5-T in oil was used at a total volume of 2 gpa. Results of this application will not be known until 1957. The use of a helicopter appeared quite effective, however, for there was no evidence of spray drift.

Routine control of woody plants on drain and distribution systems was accomplished by using 2,4-D amine at 2 and 3 lbs./A and 2-(2,4,5-TP) [2-(2,4,5-trichlorophenoxy) propionic acid (Kuron)] at 3 to 6 lbs/A in 30 gallons of solution applied by ground spray. Three sprayings of 2,4-D amine in two years has materially reduced the plant infestation. Applications of 2-(2,4,5-TP) were made beginning after September so complete results are not available, but preliminary results appear very promising.

A common practice adopted in this area is painting or spraying the stumps of all cut woody plants with 1 gallon of a mixture of 2,4-D and 2,4,5-T in 10 gallons of oil. This has resulted in materially less growth.

Mechanical methods of control have been used for control of woody plants on the floodway above Elephant Butte Reservoir, New Mexico. Two or three diskings with a 20-ft Towner Tandem disk have been required to maintain the floodway almost completely free of woody plant regrowth. This practice is extremely expensive. Some 4,800 acres of area have been disked one or more times during the past year with finances furnished by the State of New Mexico. Ground spraying is to be initiated in lieu of some of this work next year.

Continued efforts should be directed toward developing a chemical that can safely, economically, and effectively be used for woody plant control. (Region 5, Bureau of Reclamation.)

Nutrient additives in growth-regulator solutions for the control of big sagebrush (Artemisia tridentata). Hyder, D. N., W. R. Furtick, and F. A. Sneva. Applications of 2,4-D and 2,4,5-T propylene glycol butyl ether esters at 1/2, 3/4, and 1 lb/A acid equivalent were made in 1954 and 1955. Additives of urea, boric acid, iron chelate, copper chelate, zinc chelate, magnesium diacetyl acetone, and MH (maleic hydrazide) were included for comparison with nonadditive solutions. Urea was included at 5 lbs/A of elemental nitrogen, the minor elements were included at

1/2 lb/A of elemental mineral, and MH was included at 1 lb/A of actual MH.

Applications in late May showed that 2,4,5-T was more effective than 2,4-D at the 1/2 lb/A rate (98 and 59 percent respectively) but there was no difference at the 1 lb/A rate (98 and 99 percent).

Urea, boric acid, and copper chelate appeared to increase the effectiveness of the growth regulators (differences not quite significant at .05 probability). This increased effectiveness was not equal on all dates, and suggested that the stage of growth activity was important to the influence of the minor elements. Since the increase in sagebrush mortality with those three additives did not exceed 10 percent, there was no practical value to be gained with them. Small increases in the acid rate of the growth regulators were more effective and economical.

Previous comparisons between 2,4-D and 2,4,5-T at acid equivalent rates of 1 to 3 lbs/A directed preference for 2,4-D because of cost difference. However, the effectiveness of 2,4,5-T increased as rate decreased. The present experiment indicates that with proper timing 2,4,5-T may be used at rates as low as 1/2 lb/A with kills equal to that of the standard recommendation of 1-1/2 lb/A or 2,4-D ester. (Field Crops Research Branch, ARS, USDA and Oregon Agricultural Experiment Station, cooperating.)

Chemical control of rabbitbrush. Hyder, D. N., F. A. Sneva, D. O. Chilcote, and W. R. Furtick. Green and grey rabbitbrush (*Chrysothamnus viscidiflorus* and *C. nauseosus*) were sprayed with various herbicides at acid equivalent rates from 1/2 to 4 lbs/A. Spraying was done in 1950, 1954, and 1955 with timing varying from late dormancy to early flowering of green rabbitbrush. Results from 5 separate experiments are available.

Green and grey rabbitbrush were more susceptible to 2,4-D esters than to any of the other 13 herbicides used. The 2,4,5-T esters were second best and ATA (3-amino-1,2,4-triazole) at 3 lbs/A showed some promise on green rabbitbrush. With 2,4-D butyl ester an acid equivalent rate of 2 to 3 lbs/A gave good rabbitbrush control when applied in water at 10 gpa.

Big sagebrush (*Artemisia tridentata*) and green rabbitbrush were controlled simultaneously with proper timing; although sagebrush susceptibility occurred earlier than did rabbitbrush susceptibility. In drought years, rabbitbrush did not reach the susceptible stage of development. Therefore, proper timing for rabbitbrush control requires the choice of susceptible years as well as stage of development. A preliminary index to rabbitbrush susceptibility is as follows: new rabbitbrush twig growth must exceed 3 inches in length, sandberg bluegrass (*Poa secunda*) must have reached flowering development, deeper-rooted grasses such as squirreltail (*Sitanion hystrix*) and Thurber's needlegrass (*Stipa thurberiana*) must be heading, and sandberg bluegrass herbage must retain some green color. (Field Crops Research Branch, ARS, USDA and Oregon Agricultural Experiment Station, cooperating.)

Chemical control of manzanita and snowbrush in central Oregon. Dahms, Walter G. Brush control is desirable as an aid to reforesting brush-covered forest land or to release young trees long suppressed by brush competition. The major brush species that are a problem in this area are manzanita (*Arctostaphylos parryana* var. *pinetorum*) and snowbrush (*Ceanothus velutinus*) which form large burshfields on old burned-over areas. In sparsely stocked old growth ponderosa pine forests these brush species often form a dense understory that may suppress young trees for several decades.

Experiments to date have shown:

1. Manzanita and snowbrush can be controlled by aerial spraying. Manzanita can be completely killed but snowbrush resprouts.

2. Propylene glycol butyl ether esters of 2,4-D or 2,4,5-T are equally effective on manzanita during May, June, and July. By late September, 2,4-D was definitely superior to 2,4,5-T. 2,4,5-T is more effective on snowbrush.

3. Summer oil emulsified in water at the rate of 1 gpa increased the effectiveness of both 2,4-D and 2,4,5-T on manzanita at all seasons. One-half pound per acre of either chemical in the emulsion carrier was successful in late June but three-fourths pound per acre was required with water only as the carrier. The two types of carriers appear to have a similar effect on snowbrush.

4. Ponderosa pine can tolerate about twice as much 2,4,5-T as 2,4-D and can tolerate about twice asmuch of either chemical in water as in the emulsion carrier.

5. Manzanita and pine trees are both most susceptible to either chemical in late June or early July. They are less susceptible earlier or later.

6. Control of either manzanita or snowbrush, without excessive damage to intermingled pine, is best accomplished with 2,4,5-T. Where selectivity is not important, 2,4-D is definitely cheaper on manzanita.

(Pacific Northwest Forest and Range Experiment Station, Forest Service, USDA.)

Screening tests of herbicides on brush species in southwestern Oregon. Gratkowski, H. J. Brushfields ranging in size from small patches of a few acres to continuous areas as large as 20,000 acres are scattered throughout the forest lands of southwestern Oregon. Many of the brush areas are potentially productive commercial forest lands if an economical method can be found to control the brush. Tests were started in 1955 to determine the effect of herbicides on many of the most important brush and coniferous tree species. Chemicals tested included propylene glycol butyl ether esters of 2,4-D, 2,4,5-T, 2-(2,4-DP), and 2-(2,4,5-TP), sodium salt and oil soluble forms of 2,3,6-TBA, and ATA. Results to date are as follows:

1. Hairy manzanita (Arctostaphylos columbiana), hoary manzanita (A. canescens), and greenleaf manzanita (A. patula) were more susceptible to 2,4-D than to 2,4,5-T. The first two species were easily controlled with low concentrations of 2,4-D; but A. patula sprouted from root burls.

2. The aerial portions of several Ceanothus spp. were easily killed with herbicides, but the treated shrubs sprouted from the roots. Snowbrush (both Ceanothus velutinus and C. velutinus var. laevigatus) and mountain whitethorn (C. cordulatus) were more susceptible to 2,4,5-T than to 2,4-D. Deer brush (C. integerrimus), on the other hand, was more susceptible to 2,4-D. ATA shows some promise for use on Ceanothus spp.

3. Canyon live oak (Quercus chrysolepis), shrub tan-oak (Lithocarpus densiflora var. echinoides), and two forms of chinquapin (Castanopsis chrysophylla and C. chrysophylla var. minor) proved resistant to the herbicides tested. Only portions of the stems were killed. Of those chemicals tested, the chinquapins were most susceptible to 2,4,5-T. Both 2,4-D and 2,4,5-T appeared to be about equally effective on live oak and tan-oak.

4. In general, 2-(2,4-DP) and 2-(2,4,5-TP) were no more effective than the less expensive 2,4-D and 2,4,5-T on the brush species treated with these chemicals.

5. Fifteen months after spraying, the sodium salt of 2,3,6-TBA was less effective than either 2,4-D or 2,4,5-T on deer brush and relatively ineffective on serviceberry (Amelanchier florida).

6. Early results on other tests indicate that Douglas-fir (Pseudotsuga menziesii) is much more resistant to herbicides than ponderosa pine (Pinus ponderosa), sugar pine (P. lambertiana), or knobcone pine (P. attenuata).

(Pacific Northwest Forest and Range Experiment Station, Forest Service, USDA.)

Mesquite-grass competition shown by effects of canopy reduction. Bohning, J. W. The effects of partial elimination of a mesquite overstory are being studied in an area on the Santa Rita Experimental Range where various percentages of the mesquite stand have been removed. The study area supported a heavy stand of mesquite beneath which there was a good residual stand of native grasses. Randomly selected trees on the area were killed with diesel oil by basal application to reduce the area covered by live crowns to 0, 5, 10, 15, 20, 30, 40, 45, 50, and 60 percent of the plot area. Following basal oiling, all trees on half the area were foliage sprayed with 2,4,5-T to simulate aerial spraying which usually gives good initial defoliation and partial top kill. The trees were oiled and sprayed in the spring of 1954. Herbage production records were collected in 1954, 1955, and 1956.

The diesel oil treatment alone had little influence on herbage production during the first growing season. By 1956, however, there was a strong inverse relationship between herbage production and live crown area on the unsprayed plots. This relationship was not strong on the sprayed plots.

In the first year of the study herbage yields for the sprayed plots were almost twice as high as those of the unsprayed plots. Currently, the general level of herbage production for sprayed plots is still well above that for comparable unsprayed plots. These results indicate that good initial defoliation and partial top kills by aerial spraying quickly reduce mesquite competition and that resprouting does not eliminate this benefit for several seasons at least. (Rocky Mountain Forest and Range Experiment Station, Forest Service, USDA.)

Fire as a tool for controlling some noxious plants on annual grass range in southern Arizona. Bohning, J. W. In June 1955, an area on the Santa Rita Experimental Range with a ground cover of annual grasses and an overstory of woody plants and cactus was burned. At the time of burning the fuel was dry, relative humidity low, and temperature high. Prior to burning a plant count showed 75 pricklypear cacti (Opuntia engelmanni), 285 cane cholla (O. spinosior), 90 jumping cholla (O. fulgida), and 1,300 burroweed (Aplopappus tenuisectus) per acre. There was 200 lbs of annual grass per acre.

A preliminary check 4 months after the fire showed 85 percent kill on burroweed, but practically no kill on cactus. One year later, the apparent kill on burroweed was 80 percent, but the kill on cactus varied by species. Fire killed about 15 percent of the pricklypear cactus and 5 percent of the cane cholla, but jumping cholla showed a 66 percent increase following the fire. The increase in numbers of jumping cholla was due to joints that fell off the parent plants during or after the fire and established themselves as new plants.

These findings suggest that on annual grass range, fires are highly effective only against burroweed. Kills on pricklypear are too low to be encouraging, and fire may actually promote the spread of cholla. (Rocky Mountain Forest and Range Experiment Station, Forest Service, USDA.)

Effects of fire on noxious plants on a shrub invaded desert grassland range in southern Arizona. Bohning, J. W. The use of fire to control noxious plants is being investigated on desert grassland on the Santa Rita Experimental Range. Prior to burning there were 3,200 burroweed (Aplopappus tenuisectus), 400 cholla (Opuntia spp.), 110 pricklypear cacti (O. engelmanni), and 70 mesquite (Prosopis juliflora var. velutina) per acre. Herbaceous fuel totaled about 600 pounds per acre on the area. The area was first burned in June 1952 during the hottest, driest part of the year. Two years after the burning, a check showed burroweed mortality to be 88 percent, jumping cholla 44 percent, staghorn cholla 42 percent, pricklypear cacti 28 percent, and mesquite 9 percent. No mesquites larger than 6 inches in stem diameter were killed. All mesquites less than 2 inches in diameter were damaged, but 60 percent sprouted.

Three years after the first fire, half the area was reburned. Burning was again done in June. Of those plants on the area just before reburning, the second fire reduced burroweed numbers by 94 percent and pricklypear cacti by 35 percent. On the other hand, there was a net increase of 18 percent in jumping cholla and 13 percent in cane cholla numbers. On the once-burned plots net increases during the same period were 103 percent for jumping cholla and 47 percent for cane cholla. Obviously, the second fire only retarded the rate of increase of cholla. Burning had caused many cactus joints to fall to the ground where they took root. There was no change in mesquite numbers as a result of the reburn. (Rocky Mountain Forest and Range Experiment Station, Forest Service, USDA.)

Project 4. Annual Weeds in Cereals and Forage Crops

W. Orvid Lee, Project Leader

Summary

Eleven reports were received from six states. Of the eleven reports three were concerned with weed control in cereals, four on legumes, one on pasture renovation, one on turf, and two on miscellaneous weeds.

Cereals. Alley tested ATA, CDT, and erbon for chemical summer fallow in Wyoming. None of these chemicals showed promise. In other summer fallow work it was found that where weeds were controlled chemically soil moisture was highest. An organic mulch had little effect on soil moisture where fall ripping was practiced but was important where no tillage was used. Even though weeds can be controlled chemically some tillage may be necessary for seed bed preparation.

Baker compared thirty-eight chemical summer fallow treatments in Montana. 3Y9, 2,4-D Acetamide, and Gamet showed promise for controlling broadleaved weeds. BCPC was promising on grasses.

In other work in Montana Baker and Leighty reported on the viability of wild oats buried in the soil. After two years it was found that many wild oat seeds remained viable. More good seed were found when buried under grass than when buried in a cultivated field.

Legumes. In work conducted in Oregon, it was found by Howell, Furtick, and Chilcote that 4-(2,4-DB) and 4-(MCPB) could be used to control perennial broadleaved weeds infesting coastal pastures without injury to New Zealand white clover. 2,4-D and 2,4,5-T included in the test eradicated the white clover.

In Washington, Peabody compared 4-(MCPB), 4-(2,4-DB), and 2-(2,4-DP) on ladino and red clover, alfalfa, and birdsfoot trefoil. None of the legumes were seriously injured by 4-(2,4-DB) or 4-(MCPB) at the rates tested. However, 2-(2,4-DP) caused some injury, particularly to ladino clover.

Diuron was applied to alfalfa in Arizona. In one test it caused no injury to African alfalfa when applied at rates to 2.5 lb/A. However; in another test diuron was applied to four alfalfa varieties and caused yield reductions of 10 percent to all varieties at rates of 2 lb/A.

In other work reported from Oregon it was found that 4-(2,4-DB) and 4-(MCPB) gave excellent control of common annual broadleaved

weeds in both seedling and established legumes without serious injury. Temporary injury resulted but was overcome by the end of the season.

Pasture renovation. In pasture renovation work conducted in Washington various chemical and cultural methods of seed bed preparation were compared. Following the preparation a pasture mix of ladino clover and orchard grass was planted with oats as a nurse crop. Oat yields were not affected by chemical treatments but were considerably higher where the land was fall plowed.

Turf. Hamilton reported from Arizona that diuron effectively removed crabgrass from Bermuda grass lawns with no injury to the Bermuda grass. Best results were obtained when the applications were made just prior to emergence of the crabgrass in the spring. 2 lb/A were necessary for season long control.

Miscellaneous. Seeley and Erickson reported on factors which may be responsible for failures in spurry (Spergula arvensis) control. A study has been made of physiological and ecological characteristics of the plant which may be important in a control program.

In other work reported from Idaho Bovey and Erickson screened several new chemicals on five crop plants. Results of this tests indicate that TBA and PBA have a long residual effect and are not injurious to corn.

Results of chemical fallow studies--1956. Alley, H. P. During 1956, chemical fallow studies were expanded to gain a broader working knowledge of the various phases of this program. The effects of chemicals upon yield, seeding problems, moisture uptake and retention, and combination of mechanical and chemical operations were studied. Five and 10-acre plots were initiated with cooperating wheat farmers besides those conducted on the experimental stations.

ATA at $1\frac{1}{2}$ and 3 lb acid/A, CDT at 2 and 4 lb acid/A, and erbon at 8 and 16 lb/A were added to the experiments. These were on smaller 1/4-acre plots as compared to the 5 and 10-acre plots using dalapon and 2,4-D. None of the new chemicals showed promise for this type of work.

Moisture samples taken at 0-6, 6-12, and 12-18 inch levels on mechanical and fallowed land show the chemical fallowed land containing from 2 to 6 percent more moisture at all levels. Infiltrometer readings on "Fall ripped, Chemical fallow" and "All chemical" fallow plots show that mulch is of little importance when land is fall ripped. However, mulch is very important when land is chemical-fallowed. There was no significant difference in moisture intake on "Fall ripped, Chemical fallowed" land between the 2200 lb/A mulch and the 4600 lb/A mulch treatment. The "All chemical" fallowed land showed a proportional increase in water intake at all increased levels of mulch.

Yields of winter wheat on the "All chemical" fallowed land has been less than land which was mechanically fallowed. This is attributed to poor stands rather than chemical effects. Many areas need a mechanical operation to loosen the soil before seeding in the fall.

The effect of various types of mechanical and chemical fallowed land upon intake rates is presented in the following table:

Intake Rates on Various Types of Chemical and Mechanical Fallow Land

	Intake Rates in Inches per Hour		
	1st 30 min.	2nd 30 Min.	Total 1 hr.
Chemical Fallow Ripped in Fall	2.68	2.39	2.53
Chemical Fallow with no Mechanical Tillage	2.69	1.57	2.24
Subsurface Tilled 30" Sweep	2.69	1.57	2.24
Fall Plowed Fallow	2.34	.95	1.64

(Wyoming Agricultural Experiment Station)

Use of various chemicals for weed control on summer fallow. Baker, Laurence O. Several chemicals were applied to winter wheat stubble in the fall of 1955 and in the spring of 1956. When fall treatments were made September 23, soil moisture sufficient to germinate weeds had just been received. No emergence of weeds had taken place. Spring applications were made May 15, at which time broadleaved weeds were up to $1\frac{1}{2}$ inches in height and volunteer grain was about 3 inches tall. Plots were 8.25 x 16.5 feet and were triplicated.

Of the many broadleaved weeds present, which included fanweed (Thalaspi arvense), prickly lettuce (Lactuca scariola), false flax (Camelina sativa), gromwell (Lithospermum arvense), sweet clover (Melilotus alba), and yellow goatsbeard (Tragopogon pratensis); yellow goatsbeard was the most difficult to control. The grassy weeds consisted mostly of volunteer winter wheat with a small amount of oats, wild oats, and downy bromegrass (Bromus tectorum).

RESULTS OF VARIOUS CHEMICALS USED FOR SUMMER FALLOW, BOZEMAN, MONTANA, 1956

Chemical	Rate in lb/A	Date of Treat.	Percent Vegetation Control 6/26	8/16	Supplemental Treat.*	Original Rating** Grasses	Treatment for control of Broadleaves
fenuron	3	9/23	82	80	none	2	2
fenuron	4	9/23	92	95	none	1	1
dalapon	5	9/23	0	--	spray & hoe	10	10
dalapon	7.5	9/23	0	--	spray & hoe	10	10
dalapon	10.0	9/23	10	--	spray & hoe	9	10
erbon	10	9/23	70	70	none	3	4
erbon	15	9/23	85	80	none	2	3
erbon	20	9/23	93	90	none	1	2
check	hoed	6/19, 7/13, 8/16				0	0
erbon	hoed	5/15	67	60	none	4	5
erbon	15	5/15	77	80	none	2	3
erbon	20	5/15	83	85	none	1	2
erbon & 2,4-D	10+1	5/15	83	90	none	1	0
ATA	2	5/15	90	80	none	2	3
ATA	3	5/15	99	85	none	1	2
ATA	4	5/15	99	90	none	1	1
dalapon & 2,4-D	3+1	5/15	82	75	none	3	0
dalapon & 2,4-D	4+1	5/15	90	80	none	2	0
dalapon & ATA	2+1	5/15	91	75	none	3	2
fenuron & 2,4-D	3+1	5/15	78	80	none	3	0
fenuron & 2,4-D	4+1	5/15	78	80	none	3	0

(cont.)
RESULTS OF VARIOUS CHEMICALS USED FOR SUMMER FALLOW, BOZEMAN, MONTANA, 1956

Chemical	Rate in lb/A	Date of Treat.	Percent Vegetation Control 6/26	8/16	Supplemental Treat.*	Original Rating** Grasses	Treatment for control of Broadleaves
NPA Granular 1/	10	5/15	0	--	2,4-D & hoe	10	10
NPA Liquid	6	5/15	20	--	2,4-D & hoe	10	7
NPA Liquid	10	5/15	23	--	2,4-D & hoe	10	6
3 Y 9 2/	4	5/15	50	--	hoed	9	3
3 Y 9	6	5/15	42	--	hoed	8	0
CDAA	8	5/15	43	--	2,4-D & hoe	10	8
CDAA	16	5/15	50	--	2,4-D & hoe	9	5
BCPC	8	5/15	58	--	2,4-D & hoe	5	6
BCPC	16	5/15	87	--	2,4-D & hoe	1	5
2,4-D Acetamide 3/	2	5/15	48	--	hoed	10	0
2,4-D Acetamide	4	5/15	47	--	hoed	10	0
Gamet 4/	1½ gal	5/15	58	--	2,4-D & hoe	10	5
Gamet	3 gal	5/15	60	--	hoed	6	1
ACP-M-103A 5/	3 gal	6/26	--	--	2,4-D	9	7
ACP-M-177	3 gal	6/26	--	--	2,4-D	8	7
ACP-M-186	3 gal	6/26	--	--	2,4-D	9	8
2,3,6-TBA (sodium salt)	3 lb	6/26	--	--	2,4-D	7	6

* Hoed July 13, sprayed with 2 lbs 2,4-D, August 16.
** 0 was considered 100 percent control and 10 was no effect.

1/ Alanap -- sodium salt of N-1-naphthyl phthalamic acid.
2/ 3 Y 9 -- tris-(2,4-dichlorophenoxyethyl) phosphite.
3/ 2,4-D Acetamide -- ACP-L-841.
4/ Gamet -- a combination of MCPA and ATA
5/ ACP-M-103A, 177, and 186 -- polychlorobenzoic acid formulations.

Ratings of "0" or "1" were considered satisfactory for control of weeds. Erbon and spring applied dalapon while not controlling all of the grassy weeds did produce injury symptoms such as a stimulation of tillering. Oats, both tame and wild, and yellow goatsbeard were the most resistant plants to ATA. The favorable results with 3 Y 9, 2,4-D Acetamide, and Gamet on control of broadleaved weeds and BCPC on control of grassy weeds deserves additional study. Rates of dalapon with 2,4-D should be increased. The polychlorobenzoic acid formulations were not received in time to apply them at the same date as other treatments were made. They may have been more effective if applied earlier. Residual effect of these chemical treatments on a small grain crop will be determined in 1957. (Montana Agricultural Experiment Station, Bozeman, Montana).

Survival of wild oat seed buried at various depths. Baker, Laurence O. and Leighty, David H. Seed from a strain of wild oats found to possess an unuaually high degree of dormancy was buried under grass sod and under a cultivated area. The seeds were buried at depths of 2, 6, 12 and 18 inches in November 1954. Enough seed was buried so that 300-seed samples can be removed from each depth for five years. In November of 1955 and 1956 samples were removed from each depth under each treatment. The number of intact seeds remaining of the 300 buried at each depth follows for each year.

	1955			1956		
Depth	Sod	Cultivated	Ave.	Sod	Cultivated	Ave.
2	171	137	154.0	88	19	53.5
6	182	149	165.5	116	28	72.0
12	184	126	155.0	112	45	78.5
18	170	120	145.0	90	39	64.5
Ave.	177	144	154.9	101	33	67.1

When placed under suitable conditions the following number of these seeds germinated.

	1955			1956		
Depth	Sod	Cultivated	Ave.	Sod	Cultivated	Ave.
2	17	64	40.5	32	8	20.0
6	91	55	73.0	42	18	30.0
12	69	76	72.5	31	26	28.5
18	71	93	82.0	44	31	37.5
Ave.	62	72	67.0	37	21	29.0

The seeds which failed to germinate from the 1956 samples were hulled and the endosperms were pricked with a pin. This resulted in almost 100 percent germination of all seeds demonstrating that these seeds were viable, but dormant.

It is not definitely known why more intact seeds were recovered under sod and why these seeds had a higher percentage of dormancy than those under cultivated soil. Two reasons are suggested. Less soil moisture was available under the grass cover and the soil may have had less aeration. (Montana Agricultural Experiment Station, Bozeman, Montana).

Control of dock, Canada thistle and buttercup in mixed clover-grass pastures with 4-(2,4-DB) and 4-(MCPB). Howell, H. B., Furtick, W. R. and Chilcote, D. O. Mixed white clover-grass pastures are often seriously infested with deep rooted perennial weeds. Curled Dock, Rumex crispis and closely related species, Canada thistle, Circium arvensis, and various buttercups, Ranunculus repens and related species are the most common problem species in western Oregon. Exploratory tests were established in 1955 in which the sodium salt formulation of 4-(MCPB) at 3 lb/A was compared with 2,4-D, 2,4,5-T, and MCPA for the control of dock in a coastal pasture primarily meadow foxtail and New Zealand white clover. The pasture was heavily infested with both dock and buttercup. 4-(MCPB) gave seasonal control of both of these species without apparent injury to the white clover. The white clover was eliminated by the 2,4-D and 2,4,5-T applications. The control of dock and buttercup was about the same with all four chemicals.

The work was expanded in 1956 to include Canada thistle. Ester formulations of both 4-(2,4-DB) and 4-(MCPB) were used. The test on Canada thistle in a coastal pasture which was established in August compared rates of 2,4, and 8 pounds per acre of 4-(2,4-DB) and 4-(MCPB) iso-octyl esters. All of these treatments gave top kill of the thistle which permitted grazing of the densely infested area. Clover was not injured. There was a slight stunting (5 - 10 percent) of growth of clover for a short period at the 8 pound rate. The check plots were so heavily infested with Canada thistle that cattle avoided the plot area and no usable forage was produced. This treatment appeared to be a satisfactory method for controlling Canada thistle so that infested areas would produce usuable forage the year of treatment. Buttercups that occurred in the Canada thistle infested field were also controlled by all rates of both materials.

A separate trial was established on the same type of coastal pasture heavily infested with dock. The amine formulation of 4-(2,4-DB) and 4-(MCPB) were compared to the amine formulations of 2,4-D and MCPA at rates of 2 and 4 pounds per acre. All of these treatments gave control of the dock for the remainder of the season. Neither 4-(2,4-DB) nor 4-(MCPB) gave injury to the New Zealand white clover, whereas, both 2,4-D and MCPA almost completely eliminated the legume. These plots will be followed for regrowth in 1957 and re-treatments made after regrowth studies have been completed. (Oregon Agricultural Experiment Station)

Growth-regulating herbicides on pasture legumes. Peabody, Dwight V., Jr. Objectives were to determine the effect of three "new" growth-regulating herbicides on the stand of four different pasture legumes growing with grass; to determine the effect of these herbicides on yield of dry matter from the four different legume-grass swards.

Location was the Northwestern Washington Experiment Station (Puget silt loam) which had previously been planted with row crops: cabbage for seed, sweet corn, etc. All herbicides at the designated rates of application (see Table 1) were applied with a Jeep sprayer in a total volume of water equivalent to 50 gal/A at 40 psi. All herbicides were applied May 30, 1956, five weeks after planting. Herbicides tested were as follows: 4-(MCPB), 4-(2,4-DB), and 2-(2,4-DP). Experimental design was a randomized complete block, replicated three times; plot size was 10 by 25 feet. Prior to seeding, 30-60-60 was broadcast and disked in. The four simple pasture mixes (ladino clover and orchardgrass, Drummond timothy and DuPuits alfalfa, alta fescue and Cascade birdsfoot trefoil, English ryegrass and Kenland red clover) were seeded with a Brillion April 29, 1956. Twice during the summer of 1956 the entire experiment was mowed. In September, 1956, 20-40-40 was applied.

On September 27 and 28, 1956, an estimate of pasture legumes was made with a point quadrat. A ten point quadrat was dropped five times within each plot. Data were recorded as number of "hits" on pasture legumes with each drop. These data were then converted to percentages which, in turn, were transformed by the angular transformation for statistical analysis.

Table 1. Stand of legumes as affected by growth-regulating herbicides. Northwestern Washington Experiment Station, 1956.

Treatment		Point quadrat counts expressed as percentages[2]			
Herbicide	Rate[1]	Ladino clover	Alfalfa	Birdsfoot Trefoil	Red clover
4-(MCPB)	1	96.7	76.8	52.7	80.9
4-(MCPB)	2	94.8	86.3	82.2	77.0
4-(2,4-DB)	1	100.0	80.7	77.9	83.8
4-(2,4-DB)	2	99.4	90.8	88.3	81.1
2-(2,4-DP)	1	38.6	84.9	96.5	77.4
2-(2,4-DP)	2	19.1	81.4	95.1	72.1
Check	-	91.6	82.4	71.1	72.8
$\bar{x}$		84.84	83.58	82.60	78.01
$SE_{\bar{x}}$		1.08	0.38	0.60	0.29
CV		15.2%	9.3%	11.7%	8.7%

1. Rate of application expressed in pounds parent acid per acre.
2. Reconverted means of data transformed by angle = arc sin$\sqrt{\text{percentage}}$.

The entire experimental area was severely infested with annual weeds, principally corn spurry. Due to this extreme competition afforded to the pasture legumes by the annual weeds, check treatment sometimes resulted in a lesser stand of pasture legumes than did the higher rates of herbicides which were also reducing or controlling the annual weed population. Since the effect of the chemical treatments is confounded with the effect of annual weed competition on stand of pasture legumes, it is difficult, if not impossible, to assess the reaction of pasture legumes to herbicidal treatment when differences in percentage stand are not great.

The stand of ladino clover showed no serious reduction from either rate of 4-(MCPB) or 4-(2,4-DB). However, 2-(2,4-DP) at both rates of application seriously reduced the stand. 2-(2,4-DP) even at the higher rate of application did not reduce the stand of birdsfoot trefoil. (Northwestern Washington Experiment Station, Washington State College)

<u>Effect of diuron on alfalfa yield.</u> Hamilton, K. C., Arle, H. F., and McRae, G. N. During 1956 diuron was tested as a herbicide in established alfalfa. Two tests were conducted at Mesa on a Laveen clay loam soil.

In the first test diuron was applied to African alfalfa at five rates on two dates. The alfalfa had been planted in October, 1955. After the first cutting (4/24) diuron was applied at rates of 1/2, 1, $1\frac{1}{2}$, 2, and $2\frac{1}{2}$ lb/A. The same rates of diuron were applied to another series of plots after the third cutting (6/26). Each treatment was replicated 4 times in a randomized complete block design. In this test, applications of diuron did not significantly reduce the yield of alfalfa hay.

In the second test diuron was applied at rates of 0, 1, and 2 lb/A to four varieties; Ranger, Lahontan, Chilean, and African, after their first cutting (4/24). Each treatment was replicated six times. The table gives the hay yield for four cuttings.

Variety	Hay yield in lb/A of untreated check	Yield - as percent of check of the same variety.	
		Diuron 1 lb/A	Diuron 2 lb/A
Ranger	10,947	100	86
Lahontan	13,270	97	93
Chilean	9,512	96	91
African	12,145	103	91
L.S.D. .05 for herbicide treatment = 9	Average	99	90

The 2 lb/A of diuron caused a 10 percent decrease in yield of alfalfa hay. The major portion of this decrease occurred in the first cutting after diuron was applied. The response to diuron of the four varieties was very similar. (Arizona Agricultural Experiment Station and Field Crops Research Branch, Agricultural Research Service, U. S. Department of Agriculture, cooperating)

Broadleaf weed control in legume crops with phenoxy butyric acids. Furtick, W. R. and Chilcote, D. O. Preliminary tests in 1955 indicated that 4-(2,4-DB) and 4-(MCPB) were effective for the control of common broadleaf weeds, including various Brassica species, pigweed and lambsquarter. Trials were undertaken in the spring and summer of 1956 to determine the tolerance of alfalfa, red clover, ladino clover and Lotus to these two materials. Trials were established on both seedling and three year old stands of these four crops.

The three year old stand of legumes were sprayed in April after the legumes had an abundance of new growth. The two phenoxy butyric acid materials were compared with 2,4-D and MCPA at the rates of 3/4 and $1\frac{1}{2}$ lb/A for each of the four materials. The stands were rated for growth on June 6, at the time hay cutting would normally be made. Red clover and ladino clover were not injured by either 4-(2,4-DB) or 4-(MCPB). Both of these crops were severely injured by applications of 2,4-D particularly at the $1\frac{1}{2}$ pound rate. Slight injury occurred on both crops with MCPA, particularly at the $1\frac{1}{2}$ pound rate. Alfalfa was not injured by 4-(2,4-DB) at either rate compared to complete kill with 2,4-D. The 4-(MCPB) gave slight injury, reducing the amount of growth and caused some yellowing of the alfalfa compared to nearly complete kill with MCPA. Lotus was injured by all four materials. 2,4-D and MCPA both gave total kill at both rates. 4-(2,4-DB) and 4-(MCPB) both severely injured Lotus reducing the growth by more than 50 percent. Severe chemotropism occurred but recovery was apparent by June.

The primary broadleaf type weed in these trials was sheep sorrel, Rumex acetosella. None of the materials were effective in killing this perennial weed. The most effective compound was MCPA at $1\frac{1}{2}$ lb/A. It gave a high percentage of distortion and partial top kill. 2,4-D and 4-(2,4-DB) were not effective on this weed. 4-(MCPB) gave some distortion but to less extent than MCPA.

Additional trials were established in July on a late May planting of these same legumes. The seedling legumes were in the three to five true leaf stage at the time of application. The primary weed present was redroot pigweed, Amaranthus retroflexis. The pigweed was in the four to five leaf stage, approximately six inches tall, at the time of application. 4-(2,4-DB) and 4-(MCPB) amines were compared with esters at the rates of $\frac{1}{2}$ and 1 lb/A. No injury was noted on alfalfa, ladino clover or red clover by any of these materials. Alfalfa was sprayed only with 4-(2,4-DB) since previous work had shown it sensitive to 4-(MCPB).

Lotus was noticeably retarded by both 4-(2,4-DB) and 4-(MCPB). The initial retardation was rapidly outgrown and normal growth comparable to the check was apparent by August. The ester formulations were much more effective than the amine formulation in all cases. This was true of both 4-(2,4-DB) and 4-(MCPB). The following table summarizes the results:

AVERAGE PIGWEED CONTROL COMPARED TO CHECK

Material	Rate Per Acre	Percent Control
4-(2,4-DB) amine	½ pound	20
4-(2,4-DB) ester	½ "	80
4-(2,4-DB) amine	1 "	65
4-(2,4-DB) ester	1 "	98
4-(MCPB) amine	½ "	15
4-(MCPB) ester	½ "	85
4-(MCPB) amine	1 "	45
4-(MCPB) ester	1 "	98

The results of these trials would indicate that 4-(2,4-DB) and 4-(MCPB) are highly promising for eliminating common broadleaf weeds as an aid in the establishment of perennial legume crops and for controlling certain broadleaf species that might occur in established stands. Additional work is suggested on the value of using chemicals to control weeds during the establishment year of perennial legumes rather than the standard procedure of mowing. (Oregon Agricultural Experiment Station.)

Cultural and chemical methods of pasture renovation. Peabody, Dwight V., Jr. and Austenson, Herman M. The objective was to evaluate the use of chemical herbicides and various cultivation practices in re-establishing pastures.

The experiment was located at the Northwestern Washington Experiment Station on Puget silt loam. Previous management was pasture land for eight years. All herbicides at the designated rates and times of application (see Table 1) were applied with a Jeep sprayer in a total volume of water equivalent to 50 gal/A at 40 psi. Fall spray treatments were applied September 30, 1955. Fall cultural preparation treatments were applied November 7, 1955. Spring spray treatments were applied April 12, 1956. Spring cultural preparation treatments were applied April 26 and 27,1956. Herbicides tested were as follows: dalapon, and ATA. Experimental design was a split plot with four replications. Whole plots - cultural preparation, subplots - herbicidal sprays. Plot size was 16 by 25 feet with 33 square feet harvested for record.

In the designated plots ladino clover-orchardgrass and Victory oats were seeded May 4, 1956. The grass legume seeding received 30-60-60 broadcast before planting. Areas seeded to Victory oats received no fertilizer. When ladino clover had two to four true leaves, all plots were sprayed with dinitro amine for annual weed control. Oats were harvested for grain September 1, 1956.

Table 1. Scheduel of treatments.

Main Plots

A	Plow	Fall 1955 work	Oat, spring 1956; work fall 1956; plant pasture in spring 1957
B	Plow	Fall 1955 work	Pasture, spring 1956
C	Plow	Spring 1956 work	Oat, spring 1956; work fall 1956, plant pasture in spring 1957
D	Plow	Spring 1956 work	Pasture
E	Disk	(as A)	
F	Disk	(as B)	
G	Disk	(as C)	
H	Disk	(as D)	

Subplots

1	No chemical	
2	Dalapon 17 lb/A + 2,4-D 4 lb/A	Fall
3	Dalapon 17 lb/A + 2,4-D 4 lb/A	Spring
4	Dalapon 17 lb/A + 2,4-D 4 lb/A	Fall and spring (8½ lb/A dalapon + 2 lb/A 2,4-D fall and 8½ lb/A dalapon + 2 lb/A 2,4-D spring)
5	Amino triazole 6 lb/A	Fall
6	Amino triazole 6 lb/A	Spring
7	Amino triazole 6 lb/A	Fall and spring (3 lb/A fall - 3 lb/A spring)

Table 2. Effect of cultural preparation on oat yields.

Cultivation	Bu oats/acre
Fall plowed	107.4
Spring plowed	106.7
Spring disked	93.4
Fall disked	81.7
Mean	98.3
LSD 5%	10.1
CV	17.0%

There were no significant differences among the chemical treatments. However, spring applications of dalapon appeared to injure the oats and proabley should not be recommended. Plowing resulted in better oat yields than disking, especially when land preparation was started in the fall. (Northwestern Washington Experiment Station and Western Washington Experiment Station, Washington State College)

Urea herbicides for crabgrass control in Bermuda grass turf. Hamilton, K. C. Study of urea herbicides for controlling crabgrass (Digitaria sanguinalis and D. ischaemum) was continued in 1956. The test was located at Tucson for an athletic field which had about 40 percent of the ground covered by crabgrass in 1955. During 1956 diuron, monuron, and neburon were applied at several rates and dates. Plots were 15 by 40 feet. Each treatment was replicated eight times in a randomized complete block design.

At weekly intervals during the growing season estimates were made of percent of ground covered by crabgrass, Bermudagrass, and other plants. The table indicates the effect of several treatments on crabgrass.

TREATMENT				percent of ground covered by crabgrass in: (each figure is the average of 4 estimates)							
Herbicide	Rate	Date applied		May		June	July		August	Sept.
untreated check				3		22	33		42	46
diuron	2 lb/A	3-29	*	0		0	0		Trace	Trace
diuron	2 lb/A	5-28		6	*	3	4		6	8
diuron	2 lb/A	8-1		3		18	29	*	0	0
diuron	1 lb/A	3-29	*	0		1	3		5	8
diuron	1 lb/A	3-20	*	0		1	2	*	0	0
And	1 lb/A	8-1								
monuron	2 lb/A	3-29	*	0		2	6		9	10
monuron	1 lb/A	3-29	*	0		3	10		16	20
neburon	5 lb/A	3-29	*	0		1	4		5	5

* Indicates approximate time of application

The best control was obtained from applications of diuron prior to the emergence of crabgrass in April. Postemergence applications of diuron, made when moisture conditions were unfavorable, as in June, were less successful than applications made in August when growing conditions were optimum. A single pre-emergence application of 1 lb/A of diuron did not control crabgrass for the entire growing season.

For crabgrass control, a given amount of diuron was about 250 percent more effective than the same amount of monuron. Applications of diuron gave excellent control of other turf weeds, such as, white clover, bur clover and annual bluegrass.

The best stands of Bermuda grass developed where diuron had been applied in March. Where diuron was applied early in the growing season before the crabgrass became well established, Bermuda grass soon covered the bare spots created when the crabgrass was destroyed. When diuron application was delayed until crabgrass was well established, it was several weeks before Bermuda began to cover over the adjacent bare spots. When diuron and monuron were applied during the growing season a temporary yellowing of the Bermuda grass sometimes developed. (Arizona Agricultural Experiment Station)

Investigations on the control of spurry. Seely, C. I. and Erickson, Lambert C. The high in spurry *Spergula arvensis* control by conventional post-emergence herbicide treatments stimulated a series of detailed studies on factors in its control. Infestations of spurry in Idaho are limited to acid soils usually ranging in pH from 5.5 to 6.5 and at present infesting about 50,000 acres. Dense stands produce 100 to 1,000 seedlings per square foot. The plants reaching maturity shatter seeds in such abundance that they literally coat the soil surface. Their size (1 mm diam) precludes their ability to sprout from depths normally exceeding $\frac{1}{4}$ inch. This suggests that 100 to 1,000 seedlings per square foot are the result of a furrow slice infestation of approximately 2,400 to 24,000 germinable seeds per square foot. Fresh seeds are about 80 percent dormant. The presence of dormant seed is dramatically demonstrated by the continued germination throughout the first half of the growing season.

Pre- and post-emergence herbicide applications, herbicide and nitrogen level interactions, and plant development, and corollary resistance studies have revealed a number of factors why conventional post-emergence herbicide applications have failed. The plants early herbicidal resistance may be due at least in part to its early development of broad zones of large celled endodermis and smaller celled mechanical tissue, protected by a thick cuticle; also by the apparent absence of secondary thickening and, thereby, limited rupturing or thinning of the cuticle as growth progresses.

The above factors may influence herbicide resistance but other factors influence its ultra competative ability: to enumerate; (a) emergence precedes the crop by several days, (b) greater efficiency in utilizing soil nutrients and moisture, and (c) the distinct possibility of a species selective inhibitor.

Results of present investigations indicate the following: (1) Harrowing on the day of crop emergence will give almost complete destruction of the then existing spurry seedlings, but the continuing spurry germinations will practically negate the temporary benefits. (2) Various contact herbicides applied pre emergence give similar results. (3) Several growth regulating or "several growth regulating or "selective" type herbicides have given economic returns when applied with or without supplemental fertilizers. (4) The success of pre-emergence treatments is wholly dependent upon the duration of their selective residual toxicity. (5) Applications of commercial nitrogen alone are not economic. (6) Several pre-emergence treatments have proven practical and economical, but none to date have been satisfactory in maintaining selective residual toxicity to prevent spurry seed production. (Idaho Agricultural Experiment Station)

The efficiency and selectivity of several pre-emergence herbicides. Bovey, R. W. and Lambert C. Erickson. The objectives of this study were threefold: (1) To determine the relative residual toxicity of several new herbicides, and to determine their relative selectively to (2) weeds and to (3) crops.

The annual broadleaf weed infestation was quite heavy. The predominant species were Amaranthus spp., Solanum nigrum, Lamium amplexicaule, and Capsella bursa pastoris. Also present to a lesser degree were Chenopodium album, Anthemis cotula, Sangiusorbia occidentalis, and Malva rotundifolia.

Eight rows of each of the following crops, Pontiac potatoes, Laxton peas, Birdsfoot trefoil, and Span cross yellow hybrid sweet corn, were planted June 5, 1956. Of the five crops planted, only the potatoes and corn survived all the treatments to a degree to justify harvesting.

The herbicides were applied June 7, 1956, as pre-emergence treatments. Two measurements were used to determine the relative toxicity of the various herbicides as pre-emergence sprays. The first, giving the number of weeds per square foot, two and one half weeks after treating. The second, an estimate of the total percent soil covered by the weeds present three and one-half weeks after treating. The two methods thereby measure the immediate and residual toxicity of each herbicide respectively.

Six general groups of herbicides were used which include various formulations of IPX, TBA & PBA, MCPA, 4-(MCPB), 2,4-D, and 4-(2,4-DB). Two weeks after treating the weed counts per square foot of soil were: 2,4-D-22, MCPA-23, TBA-41, PBA-55, Na. IPX-94, K. IPX-88, 2,4-D amide-28 and the check-63. The residual effect was quite different in that one and one-half weeks later, the percentage of soil covered by weeds for the above treatments was: 2,4-D-8, MCPA-13, TBA-9, PBA-10, Na IPX-43, K. IPX-36, 2,4-D amide-14, and the check 47. Apparently the IPX formulations had lost their toxicity before the weed seedlings emerged. As the season progressed, the IPX appeared to stimulate growth of both weeds and crops.

The herbicides that showed the most promise as compared to the check values in this experiment in descending order based on weeds per square foot were: MCPA amine 10, 2,4-D amine-13, 4-(2,4-DB)-24, 4-(MCPB) ester-24, 2,4-D amide-28. Those showing the greater duration of residual toxicity as indicated by the percent soil weed cover were: TBA-9, PBA-10, 2,4-D amine 6, and MCPA amine 7.

TBA and PBA had much greater residual toxicity than the 2,4-D and MCPA formulations as later measurements were taken. They were similarly toxic to the crop plants and weeds. This resulted in almost complete eradication of the beans, peas, and trefoil. However, the corn survived well, probably because the deeper root system of the corn was beyond the toxic zone. The potatoes looked very sickly during the entire growing season but in spite of their seemed adversity they made a fairly decent yield. These two chemicals may show some future promise as pre-emergence treatments for sweet corn. (Idaho Agricultural Experiment Station)

PROJECT 5. WEEDS IN FRUITS, VEGETABLES, AND ROW CROPS

E. R. Laning Jr., Project Leader

SUMMARY

Applications of monuron and diuron made from the time of the first irrigation through the lay-by stage on cotton are reported to give excellent weed control. Cultivation practices carried on in combination with monuron and diuron treatments appeared to destroy the effectiveness of the herbicides. However, indications are that the rate of application of these herbicides is rather critical. Not only may cotton be injured by overdosage, but small grains planted after cotton may be severely damaged by residues in the soil. There is also some evidence that different varieties may show varying degrees of susceptibility to monuron and diuron.

With the provision that grass had not emerged Alanap-3 provided excellent control when applied at various growth stages of cotton. Again, some danger to cotton was reported.

Although weed control in sugar beets may be practical with such materials as DCU or dalapon, the sensitivity of table or canning beets to most herbicides developed so far prevents general usage as yet.

Reports concerning field and sweet corn indicate the promise of excellent weed control with pre-emergence applications of Simazin, and combinations of either 2,4-D with CDAA, or dinitro amine plus either CDAA or CDEC. With all of these treatments both grassy and broadleaf weeds were controlled. Under furrow irrigation conditions in eastern Oregon 2,4-D controlled grasses as well as broadleaf weeds.

All annual weeds were controlled in snap beans with ATZ and with combinations of dinitro amine and CDAA or CDEC under sprinkler irrigation in Oregon. However, under dry land conditions in Wyoming several materials which are usually effective pre-emergence herbicides failed to control weeds when no rain fell after applications were made. On the other hand some injury to beans was noted as a result of a rain following fairly heavy applications of some chemicals.

CDEC appears very promising as a pre-emergence type herbicide for use on lettuce and on broccoli and cauliflower. Several different species of weeds were effectively controlled without yield reduction in all three crops.

In both direct seeded and transplanted tomatoes neburon gave promising results in regard to weed control and the lack of injury to the crop. Neither 2,4,5-TES nor DCU controlled weeds satisfactorily under the conditions of the experiment reported.

Where sufficient moisture can be assured for activation of NPA in the soil after pre-emergence applications, this herbicide provides excellent weed control without injury to cucumbers, and with only slight reduction in yield of squash. NPA as Alanap-3 and as a 20 per cent

granular formulation showed equally effective weed control. The granular form appears to be safer to use with many crops in addition to the cucurbits.

On processing peas a granular form of DNBP provided just as effective weed control and crop yield as did the regular formulation of DNBP when both were applied prior to crop emergence.

The only report concerning ornamentals indicates that pre-emergence applications of monuron made in November to various bulbs provide excellent weed control through the harvest period late in the following summer. Although the pre-emergence treatments did not reduce the yield or grade of tulip, iris, or narcissi, post-emergence applications of monuron as well as diuron and neburon did result in decreased yield of salable tulip bulbs.

Monuron and diuron for the control of annual weeds in cotton. McRae, G. N., Hamilton, K. C., and Arle, H. F. Study of factors influencing the effectiveness of urea herbicides for cotton weed control was continued in 1956. Acala 44 cotton used in the following tests.

A given rate of monuron was applied in varied amounts of spray solution at Marana on a Gila loam soil. One and one-fourth lb/A of monuron was applied in water equivalent to 13, 27, 40,53, 67, and 80 gal/A at cotton layby on July 10. All treatments were replicated 6 times in a latin square. Varying the amount of water in which monuron was applied did not influence the effectiveness of the herbicide. Weed control, estimated 2 months after treatment, ranged from 93 to 96 per cent.

Monuron was applied at layby at rates of 0, 3/4, 1, 1 1/4, 1 1/2, and 2 lb/A at two locations: Marana and Yuma (Gila silty clay loam). All treatments were replicated 6 times in latin square designs. The initial weed control was excellent with all treatments. However, in the Marana test, 3/4 lb/A of monuron failed to give complete control of weeds until harvest.

Monuron was tested at Marana in combination with various cultivation practices: (1) normal cultivation, (2) cultivation plus flaming, (3) cultivation plus rod weeders, (4) cultivation plus flaming and rod weeders. Cultivation treatments were replicated 6 times in a randomized complete block design. Paired plots were established in each cultivation plot and 1 1/4 lb/A of monuron applied to one plot at layby, July 10. Weed control was estimated in September. Cultivation plots became infested with weeds after layby. No difference was observed between the cultivation treatments. All plots treated with monuron remained free of weeds until harvest.

In a test of date of application at Mesa (Laveen clay loam soil) diuron was applied at 1 1/4 lb/A prior to the first (5/29), second (6/12), third (6/26), fourth (7/9), or first and fourth irrigation. Each treatment was replicated 4 times on 2 varieties: Pima S-1 and Acala 44. Weed control on treated plots was excellent, although late in the season a few weeds became established on plots treated at the first and second irrigations. The stand of Pima S-1 cotton was reduced by the application of diuron at the first irrigations.

In a second test at Mesa to determine the effect of various rates of application, diuron was applied at rates of 0, 3/4, 1, 1 1/4, 1 1/2, and 2 lb/A at layby on July 9. Each treatment was replicated 6 times on two varieties (Pima S-1 and Acala 44) in a latin square design. Diuron applied at 1 to 2 lb/A gave excellent control of weeds for the remainder of the growing season. Application of 3/4 lb/A of diuron failed to give complete control.

In these six tests, yield of seed cotton, fiber properties, and boll components were not affected by the various herbicide treatments. (Arizona Agricultural Experiment Station and Field Crops Research Branch, Agricultural Research Service, U.S. Department of Agriculture, cooperating)

Response of cotton varieties to Monuron and Diuron. McRae, G. N., Hamilton, K. C., and Arle, H. F. Cotton varieties differ in their response to monuron. In 1955 six lines of Acala-type cotton showed different amounts of chlorosis (foliage yellowing) following a layby application of monuron. The variation in resistance of the lines appeared correlated with their resistance to Verticillum Wilt.

In 1956 four Acala-type cotton varieties were treated with monuron and diuron in a test at Mesa on a Laveen clay loam soil. The herbicides were applied to the soil at rates of 2 lb/A at layby on July 9. Each treatment was replicated 4 times in a split plot design with herbicide treatments as main plots and varieties as subplots.

Within a few weeks the foliage of all plants treated with monuron developed the typical chlorosis. On July 31 and August 17 the degree of chlorosis was estimated.

Variety	Wilt rating	Chlorosis* 7/31	8/17	Yield of seed cotton-lb/a Monuron	Check	Diuron
A-1517 C	susceptible	4.9	6.5	2300	2698	2742
A-44	susceptible	5.0	5.2	2533	2812	2801
A-44 WR	some tolerance	3.7	3.0	2533	2853	2824
A-4-42	medium tolerance	2.2	2.2	2595	2880	2777

* Estimated 0 = none 10 = complete

In this test the degree of monuron induced chlorosis on the foliage was related to the susceptibility of the varieties to Verticillium Wilt. The variety, A-1517C, often shows a "quick decline" or sudden leaf shed when attacked by wilt. A-1517C was the only variety partially defoliated by the monuron treatment.

In yield of seed cotton the four varieties responded very similar to herbicide treatment. The yield of all varieties was reduced 10-15 per cent where treated with monuron. Yield was not reduced by the application of diuron. The applications of monuron and diuron had no effect on cotton fiber properties or boll components. (Arizona Agricultural Experiment Station and Field Crops Research Branch, Agricultural Research Service, U.S. Department of Agriculture, cooperating)

Effect on small grains of residues from monuron applied on the previous cotton crop. McRae, G. N., Hamilton, K. C., and Arle, H. F. Severe damage may occur when small grains are planted after cotton treated with monuron at layby. When monuron has not been inactivated, the residue from as little as 1 lb/A applied six months previous has reduced the stand and yield of wheat and barley. Tests were conducted in 1956 to determine if methods of seedbed preparation for small grains might influence the inactivation of monuron residue.

One test was at Mesa on a Laveen clay loam soil. Monuron had been applied at cotton layby in July, 1955 as rates of 0, 3/4, 1, 1 1/4, 1 1/2, and 2 lb/A. After cotton harvest in December, alternate replications were plowed with moldboard and disk plows. Arivat barley, Palestine oats, and Amed Onas wheat, one drill width of each, were planted the length of each replication. In this test the residual monuron, if any remained, had no effect on the small grains on either the plowed or disked seedbeds.

A second test was at Safford, on a Cajon sandy loam soil. Monuron was applied at cotton layby in July at 0, 1, and 2 lb/A. After cotton harvest alternate replications were worked with moldboard and disk plows and the three small grains, one drill width of each, seeded the length of each replication. The stand of barley, wheat, and oats was reduced on plots where 1 lb/A of monuron had been applied and destroyed on the plots treated with the 2 lb/A treatment. The damage to small grain occurred on both the plowed and disked seedbeds.

In the greenhouse barley was planted in soil samples taken from various treatments in the Safford test. Barley showed few symptoms of monuron injury when planted in soil which had been worked with the moldboard plow. Barley was severely injured when planted in soil that had been worked with the disk plow. (Arizona Agricultural Experiment Station and Field Crops Research Branch, Agricultural Research Service, U.S. Department of Agriculture, cooperating)

Effect of rate and date of application of Alanap-3 on cotton. McRae, G. N., Hamilton, K. C., and Arle, H. F. A test was conducted at Mesa (Laveen clay loam soil) to determine how rate and date of application of Alanap-3 influenced its effectiveness for controlling annual grasses in cotton. Alanap-3 was applied to Pima S-1 and Acala 44 cotton at rates of 3 and 6 lb/A prior to the first (5-23), second (6-12), and fourth (7-9) irrigations. Treated plots received no cultivation after the herbicide was applied. All treatments were replicated four times.

Applications of 3 and 6 lb/A of Alanap-3 before grass seedlings emerged gave excellent control of annual grasses for 6 to 8 weeks. When grass seedlings emerged before Alanap-3 was applied, weed control was poor. Alanap-3 was less successful in control of annual broadleaved weeds than annual grasses.

Applications of Alanap-3 at the first irrigation caused a marked stunting of both Pima S-1 and Acala 44 cotton. For the remainder of the growing season, plants given this treatment were considerably shorter than plants on the untreated checks.

Application of Alanap-3 made at the first and second irrigations reduced the yield of seed cotton of both varieties as shown in the following table.

Treatment		Yield of seed cotton expressed as a per cent of the untreated check	
Date	Rate of Alanap-3	Acala 44	Pima S-1
Untreated check		100	100
7- 9	3 lb/A	101	102
7- 9	6 lb/A	93	93
6-12	3 lb/A	88	87
6-12	6 lb/A	88	87
5-23	3 lb/A	85	72
5-23	6 lb/A	80	68

Yield of the check in pound of seed cotton 3950 lb/A   3515 lb/A

In this test Alanap-3 had no effect on fiber properties or boll components of either cotton variety. (Arizona Agricultural Experiment Station, and Field Crops Research Branch, Agricultural Research Service, U.S. Department of Agriculture, cooperating)

Experiments to determine economics of chemical weed control in sugar beets. Alley, H. P. An experiment was conducted during the 1956 growing season to determine comparative costs of chemical versus hand weeding of weeds in sugar beets. One-acre plots, using the chemicals and rates presented in the attached table, were established. Incorporation and surface applications were studied. Incorporation trials were accomplished by using a Howery-Burg Tiller. The chemical was sprayed in 6-inch bands, incorporated into the soil and beets planted all in the same operation. Surface application of DCU was made in 6-inch bands directly over the planted beets. Complete coverage was made with dalapon when beets were in the 4 - 6 leaf stage of growth. Both monogerm and multigerm beet seed was included in the experiment.

Original plans were to have no hand labor involved in the chemical plots. However, annual broad-leaved weeds needed one hand-hoeing late in the growing season. This added measurably to the cost of chemical control. Check plots were hand-thinned and weeded, having no mechanical operation involved.

The attached table shows the multigerm seed outyielding the monogerm seed in all cases. The yield of multigerm seed, both in tons of sugar beets per acre and tons of sugar per acre on the chemical-treated plots was equal to or greater than on the non-treated land.

Comparing data obtained from 1956 data, indications are that chemical control of weeds may be considerably cheaper than other methods being used. On many farms the $9.50 for weeding of broad-leaved weeds would not be necessary, thereby reducing costly chemical treatments considerably.

(Wyoming Agricultural Experiment Station)

Chemical Treatment	Rate/A	Depth Inc.	Yield 3/ Ton Beets/A Mono.	Multi.	Lbs. Sugar/A Mono.	Multi.	Cost/A 4/
DCU 1/	7.3	3"	19.4	20.0	6,800	7,500	16.00
DCU	7.3	2"	17.8	24.3	7,460	7,640	16.00
DCU	14.6	(Surface)	15.6	23.3	6,100	8,980	18.50
Dalapon 2/	6	(Surface)	18.6	21.1	7,060	8,100	19.50
Check	-	-	20.0	20.0	7,620	7,600	23.00

1/ DCU (dichloral area) Pre-emergence application

2/ Dalapon (2,2-dichloropropionic acid) Post-emergence application

3/ Yields adjusted to a 20-ton check yield. Monogerm and multigerm seeds were used in equal-sized plots under all treatments.

4/ Costs include the chemical, $3.00/A for mechanical thinning, $9.50 for weeding of broad-leaved weeds in all chemical-treated plots, and $1.00/A for applying the chemical. Check plots include $13.50/A hoeing and thinning, $5.50/A first hoeing, $4.00/A second thinning.

Control of annual weeds in canning beets. Peabody, Dwight V., Jr. The presently recommended saturated salt solution applied as post-emergence spray for annual weed control leaves much to be desired. There is no satisfactory chemical weed control method for selectively removing annual weed species from canning beets, especially in the seedling growth stages. In this experiment nine different herbicides were evaluated as pre-emergence treatments on canning beets. This experiment was carried out at the Northwestern Washington Experiment Station on a silt loam soil with a pH of approximately 6.0. On May 3, 1956 Detroit Dark Red table beets were planted in rows 21 inches apart. Nine days later nine different herbicides, each at two rates of application (see Table I), were applied with a hydro-pneumatic plot sprayer in a total volume of water equivalent to 100 gallons per acre at 30 psi pressure. The experimental design was a randomized complete block, replicated three times. Plot size was three rows each 20 feet long.

Approximately one month after herbicidal treatments had been applied, an estimate of broadleaved annual weed cover was made with a 100 square grid-quadrat, 12 inches by 50 inches. This quadrat was dropped twice in each plot, data being recorded as total number of squares containing weeds. These data were then converted to percentages which, in turn, were transformed by the angular transformation for statistical analysis. Principal broadleaved annual weed species present in order of their importance were: Polygonum pennsylvanicum L., smartweed; Capsella bursa-pastoris Medic., shepherds-purse; Chenopodium album L., lambs-quarters; Stellaria media C., chickweed; Senecio vulgaris L., groundsel. In early August all beets in the center row of each plot were pulled, tops removed and the total fresh weight recorded. No attempt was made to size beets.

The following conclusions can be drawn from the data presented in Table I.

1. Any herbicide which resulted in good annual weed control also caused some yield reduction of canning beets.
2. CCPC and neburon were the most promising treatments and should be tried again at higher rates of application.

(Northwestern Washington Experiment Station, Washington State College)

YIELD OF CANNING BEETS AND PERCENTAGE ANNUAL WEED COVER
OF 1956 WEED CONTROL TRIAL

Treatment		Yield of Canning Beets	Broadleaved Annual Weed Cover[2]
Herbicide	Rate[1]	Tons/A	%
CCPC	1.0	11.75	44.1
CCPC	2.0	10.35	46.3
CIPC	1.0	8.52	31.0
CIPC	2.0	6.50	40.1
DCU	7.3	7.78	99.8
DCU	14.6	6.73	94.0
monuron	0.8	7.78	21.8
monuron	1.6	2.06	1.3
diuron	0.2	7.58	64.8
diuron	0.4	8.75	35.1
neburon	0.8	6.53	84.6
neburon	1.6	6.73	62.3
endothal	2.0	8.71	92.0
endothal	4.0	6.30	86.8
dalapon	4.25	7.20	76.6
dalapon	8.5	3.54	70.8
$Mg(ClO_3)_2$	5.0	7.58	75.8
$Mg(ClO_3)_2$	10.0	3.35	95.7
check - hoed		5.25	95.6
check - not hoed		1.91	95.8
	$\bar{x}$	6.734	69.55
	$SE_{\bar{x}}$	1.395	2.81
	CV	36%	30%

1. Rate of application expressed in pounds active ingredient per acre.

2. Reconverted means of data transformed by angle = arc sin $\sqrt{\text{percentage}}$.

Weed control in canning beets. Laning, E. R., Jr. Through several years many chemicals have been applied to canning beets in an attempt to find an effective weed killer which does not reduce the crop yield or quality. In contrast to sugar beet production, small size in table beets is necessary for quality processing.

In 1956 a yield trial using Detroit Dark Red table beets was conducted to study three chemicals at two rates each. Endothal and CC 7355 were applied as pre-emergence treatments, and a combination of CC 7355 and DCU was applied and worked into the upper three inches of soil one day prior to planting the beets. About one-half inch of water was applied by means of sprinkler irrigation one day after planting.

A summary of yield and weed control data is presented in the following table.

Chemical	Rate Lbs/A	Weed control 5 weeks	Tons/A	% Under 2"	% 2-3"	% 3-4"	% Over 4"
Endothal	4	0.9	17.7	26.6	52.5	19.2	1.7
Endothal	8	1.2	16.9	21.3	52.7	23.1	2.9
CC 7355	3	2.6	16.2	14.8	38.3	33.3	13.6
CC 7355	6	3.1	19.1	7.3	35.6	45.0	12.1
CC 7355 DCU	6	2.9	16.7	16.8	47.9	28.1	7.2
CC 7355 DCU	12	3.6	18.0	12.8	45.0	32.8	9.4
Control	-	0	15.3	30.7	51.0	17.0	1.3

All data are averages of 5 replicates.
Weed control based on 0-4; 0 = No control, 4 = Complete control

It is apparent that as weed control was provided the stand of beets was reduced so that larger sized beets were produced. (Oregon Agricultural Experiement Station)

Weed control in field corn. Chilcote, D. O., Furtick, W. R. and Fore, R. E. An evaluation trial was conducted at Corvallis, Oregon, 1956, comparing various rates of 14 new herbicides applied pre-emergence in comparison to dinitro amine for control of weeds in field corn. The field corn was hand planted April 28, and sprayed pre-emergence May 1. Each plot consisted of four rows of corn, 36 feet long. In order to insure a dense weed population, lambsquarter and ryegrass were seeded over the experimental area. Observations were taken on June 14, 1956 and again at the close of the growing season. Yields were determined on the basis of 15 hills from each of the two center rows. Although several of the materials evaluated gave good weed control, Simazin was outstanding for both weed control and yield of corn. Simazin was used at the rate of three pounds and six pounds per acre. Average yields were 47 pounds and 48 pounds respectively for three-and six-pound rates of Simazin. The untreated check yielded an average of 35 pounds per plot. Both rates gave essentially complete control of annual grass and broadleaf weeds. At the six-pound rate quackgrass was controlled. Standard cultivation practices were followed excepting on one replication of Simazin at six pounds per acre which was not cultivated at any time during the growing season. This treatment remained weed free all season. This would indicate cultivation may not be necessary in the production of field corn in the Willamette Valley.

Since the area was located on a sandy loam soil subject to overflow, a ryegrass and turnip cover crop was seeded in the area after harvest. This cover crop made normal fall growth on the six-pound Simazin treated plots. (Oregon Agricultural Experiment Station)

Chemical weed control in corn under conditions of furrow irrigation. Anderson, W. Powell, Hoffman, E. Neil, and Furtick, William R. Corn, in Eastern Oregon, is grown under irrigation with the water being distributed over the fields in furrows located between the corn rows. The principal weeds in the area are: watergrass, green foxtail, lambsquarter, redroot pigweed, and hairy nightshade. Of these, watergrass is of greatest importance in the area where the following test results were obtained. Climatic conditions during the growing season are: low humidity, little rainfall (2-4 inches), high day-time and low night-time temperatures. In 1956, experiments were conducted to determine the effectiveness of herbicides under these conditions when applied pre- and at-emergence to corn.

Of the materials tested, the most effective grass and broadleaf weed control was obtained with Dinitro General and with combinations of CDAA and 2,4-D when applied at-emergence. Equally effective were combinations of CDAA and 2,4-D applied pre-emergence (Dinitro General was not tested pre-emergence). Dinitro General, at rates of 3 and 6 lbs/A, gave 80-90 per cent grass control and 100 per cent broadleaf control. CDAA, at rates of 4, 6, and 8 lbs/A, in combination with $1\frac{1}{2}$ lbs/A of 2,4-D (butoxy ethanol ester) applied pre-emergence, or in combination with 3/4 lb/A of 2,4-D (dimethylamine salt) applied at emergence, gave 90-100 per cent grass control and 100 per cent broadleaf control.

An additive or synergistic effect was obtained with combinations of CDAA and 2,4-D when applied either pre- or at-emergence. This effect was expressed as a marked increase in the degree of control of both grass and broadleaf weeds over that obtained with either material used alone.

CDAA was a more effective herbicide under the test conditions than was CDEC when each was applied at the equivalent rates of 4, 6, and 8 lbs/A.

TCB gave 100 per cent control of broadleaf weeds at the lowest rate ($\frac{1}{2}$ lb/A) used. However, essentially no grass control was obtained with this material.

2,4-D was an effective grass herbicide as well as a broadleaf herbicide. Applied pre-emergence at rates of 1-2 lbs/A, the butoxy ethanol ester of 2,4-D gave 80 per cent grass control, while the dimethylamine salt of 2,4-D, applied at-emergence at rates of 3/4-1 lb/A gave 70 percent grass control. Both materials gave 80-100 per cent broadleaf control. The effective residual life of the ester was greater than was that for the amine.

Highest yields were obtained when both grass and broadleaf weeds were adequately controlled. However, since the grass weed problem was considerably greater than the broadleaf weed problem, high yields were also obtained from those treatments giving 80-100 per cent control of grass weeds, irrespective of the degree of broadleaf weed control. In contrast, treatments, such as TCB, giving as much as 100 per cent control of broadleaf weeds, with little or no grass control, resulted in greatly reduced yields.

Chemical weed control in pole beans and sweet corn. Laning, E. R., Jr. Although dinitro amine has been successfully used for pre-emergence broadleaf weed control in snap beans and sweet corn for the past few years, grasses infesting these crops continue to present a mechanical and hand cultivation problem.

During 1955 it was found that pre-emergence applications of ATZ, CDAA, and CDEC provided effective control of several annual grasses providing that surface soil moisture was present when the spray was applied. Neither yield nor quality of pole beans or sweet corn were adversely influenced by these herbicidal treatments.

In large yield trails conducted with Blue Lake type FM-1 pole beans and Golden Cross Bantam sweet corn ATZ, CDAA, CDEC, DN amine, and combinations of DN amine and CDAA and CDEC, along with other potential herbicides, were applied as pre-emergence treatments. Approximately one-half inch of water was supplied through sprinkler irrigation within one day after the applications were made. The beans were picked at four-or five-day intervals through eight pickings and the sweet corn was harvested over a four-day period after examination of the maturity of each plot.

The data regarding the better treatments with appropriate comparisions are summarized in the following table. Weed control data were determined on a basis of 0 to 4 with 0 equal to no control and 4 equal to virtually complete weed control.

Chemical	Rate Lbs./A	Bean yield Tons/A*	Corn yield Tons/A*	Weed control** 5 weeks	7 weeks
DN Amine	3	11.1	10.4	2.6	0.5
CDAA	4	10.8	10.3	2.0	0
CDEC	4	10.9	10.9	2.0	0
DNA+CDAA	1.5+2	10.4	9.8	3.1	2.4
DNA+CDAA	3+4	10.9	10.3	4.0	3.6
DNA+CDEC	1.5+2	9.9	10.5	2.9	1.0
DNA+CDEC	3+4	10.7	10.7	3.9	3.3
ATZ	4	10.1	10.7	2.8	0.5
ATZ	8	11.3	10.5	3.8	3.3
Control		9.4	9.9	0	0

* Average of 4 replicates. ** Average of 8 replicates.
(Oregon Agricultural Experiment Station)

Chemical control of annual weeds in dry beans. Weldon, L. W., Timmons, F. L., and Lee, W. O., Research Agronomists, ARS. Chemicals that showed promise of controlling annual weeds in beans in the 1955 evaluation test were more intensively studied in 1956 at two locations in Wyoming. A total of 29 pre-emergence treatments comparing 10 different compounds at various rates were applied at Torrington and 18 treatments comparing 6 of these compounds were applied at Powell. The beans were grown under irrigation at both stations.

The treatments were made on plots consisting of 4 rows of beans spaced 22 inches apart and 25 feet long. Immediately after treatment a crust breaker was run over the 2 center rows to incorporate the chemicals into the heavy sandy clay loam soil to a depth of 2 inches on the Powell station. Natural precipitation was depended upon to move the chemicals into the fine sandy loam soil at the Torrington station.

There was no appreciable rainfall for the entire growing season at Powell. Showers amounting to 1.36 inches of rain fell within 6 days after treatments were made at Torrington.

PCP (Pentachlorophenol), the sodium salt of NPA (N-1 naphthyl phthalamic acid), CDEC (2-chloroallyl diethyldithiocarbamate), CIPC (isopropyl N-(3-chlorophenyl)-carbamate), and diuron (3-(3,4-dichlorophenyl)-1,1-dimethylurea) gave excellent early season weed control at all rates at Torrington. Neburon (3-(3,4-dichlorophenyl)-1-methyl-1-1-n-butylurea) at 4 pounds and the alkanolamine salt of DNBP (4,6-dinitro-o-sec-butylphenol) at 12 pounds also gave good early season weed control but lighter rates were less effective. CIPC and the sodium salt of NPA at all rates caused considerable damage to the beans as did the 1-lb rate of diuron. The damage caused by CIPC was probably due to the rain on the light soil soon after treatment, leaching the chemical into the soil around the germinating beans. The 12-lb rate of DNBP reduced the yield of beans. Diuron at 0.75 pound and neburon at 4 pounds were the only treatments that controlled the late season weeds. Other compounds appearing less effective in controlling weeds included MCPC (methyl N-(3-chlorophenyl) carbamate), CDAA (2-chloro-N,N-diallyl-acetamide), and CDT (2-chloro-4,6-bis (diethylamino)-s-triazine).

Results at Powell were similar to those obtained at Torrington except that CIPC caused no injury to beans at Powell. The NPA sodium salt was the only chemical to consistently reduce bean yield at Powell. CDEC at 8 and 10 pounds and CIPC at 8 pounds per acre gave good season-long weed control with no injury to beans. Of special interest was the fact that CDAA, which gave excellent season-long weed control at Powell in 1955, was quite ineffective under similar conditions in 1956. (Contribution from the Field Crops Research Branch, ARS, USDA, and the Wyoming Agricultural Experiment Station, cooperating.)

<u>Annual weed control in broccoli and cauliflower</u>. Peabody, Dwight V., Jr. Present practices in growing cauliflower and broccoli for processing are somewhat involved and time consuming. At the present time seed is sown in beds, and when these plants are four to eight inches high, they are then transplanted to producing fields. One of the principal reasons for this practice is the lack of an inexpensive and effective method of weed control. If a pre-emergence herbicidal treatment could be found, then plant bed-transplant operations might be done away with and broccoli and cauliflower could be planted directly in producting fields. Therefore, an herbicide evaluation trial was undertaken this year in order to determine the effect of pre-emergence applications of several herbicides on the growth, vigor and yield of broccoli and cauliflower grown from seed.

This experiment was located at the Northwestern Washington Experiment Station on a silt loam soil of approximately 6.0 pH. On May 18, 1956, broccoli (variety Waltham) and cauliflower (variety Snowball Y) were planted in rows three and one-half feet apart. Four days after planting, eight different herbicides, each at two rates of application (see Table I), were applied to both crops. Experimental design was a randomized complete block, replicated three times. Plot size was one row 25 feet long. All treatments were applied with a hydro-pneumatic sprayer in a total volume of water equivalent to 100 gallons per acre at 30 psi pressure. When plants were from four to six inches high, they were thinned to a spacing of one foot within the row. Approximately one month after treatments had been applied, an estimate of broadleaved annual weed cover was made with a 100 square grid-quadrat, 12 inches by 50 inches. Principal broadleaved annual weed species present in order of their importance were: <u>Polygonum pennsylvanicum</u> L., smartweed; <u>Chenopodium album</u> L., lambs-quarters; <u>Polygonum aviculare</u> L., knotweed; <u>Senecio vulgaris</u> L., groundsel; and <u>Polygonum convolvulus</u> L., black bindweed. After these weed estimates were made, the entire experiment was cultivated and hoed at weekly intervals until harvest. As the center heads of broccoli reached marketable size and quality, they were cut and weighed to the nearest ounce. When cauliflower heads reached a size of approximately six inches in diameter, they were cut and weighed to the nearest ounce. Yield data on broccoli developed from side shoots were not recorded and cauliflower was not banded.

The following conclusions can be drawn from the data presented in Table I:

1. The high coefficients of variation in this trial indicate a large amount of field variation present; hence, conclusions drawn should only be tentative.
2. CDEC looks extremely promising as a selective pre-emergence herbicide in broccoli and cauliflower.
3. Dalapon, hydrogen cyanamid and 2,3,6-trichlorobenzoic acid also exhibit some selectivity in these two crops.
4. All other chemicals tested in this trial either resulted in extensive crop injury or poor weed control, or both.

(Northwestern Washington Experiment Station, Washington State College)

YIELD AND ANNUAL WEED COVER OF 1956 WEED CONTROL FIELD TRIAL IN BROCCOLI AND CAULIFLOWER

Treatment		Broccoli		Cauliflower	
		Yield[2]	Brdl. ann. weed cover[3]	Yield	Brdl. ann. weed cover[3]
Herbicide	Rate[1]	Tons/A	%	Tons/A	%
H_2CN_2	2.2	1.6	8.8	3.8	13.6
H_2CN_2	4.4	2.0	10.0	6.0	17.3
Neburon	0.8	1.0	13.4	2.3	9.6
Neburon	1.6	0.4	6.9	0.0	9.0
CIPC	1.0	1.7	11.3	5.5	8.0
CIPC	2.0	1.0	7.6	3.2	12.4
BCPC	1.0	1.8	41.5	5.5	22.1
BCPC	2.0	1.1	22.0	3.5	10.6
CCPC	1.0	1.3	27.1	4.9	12.8
CCPC	2.0	1.0	15.2	3.5	11.2
CDEC	5.0	1.6	16.2	6.5	42.2
CDEC	10.0	1.7	7.4	6.4	7.3
2,3,6-TBA	0.5	1.9	6.9	5.7	16.8
2,3,6-TBA	1.0	1.4	5.6	1.9	6.2
Dalapon	2.55	1.2	29.0	6.2	35.5
Dalapon	5.1	1.4	12.6	5.1	25.7
Cultivated check		1.5	21.0	4.7	83.2
	$\bar{x}$	1.38	14.43	4.39	18.67
	$SE_{\bar{x}}$	0.24	1.69	0.73	2.29
	CV	30%	58%	29%	59%

1. Rate of application expressed in pounds active ingredient per acre.
2. Mean yields of center heads only.
3. Reconverted means of data transformed by angle = arc sin $\sqrt{\text{percentage}}$

Pre-emergence control of Purslane (Portulaca oleraceae) in lettuce. Arle, H. Fred and Pew, W. D. During the past several years, purslane (Portulaca oleraceae) has become an increasing problem in growing fall lettuce in Arizona. Fall lettuce is planted during late August and early September, a period normally conducive to rapid development of the purslane seedling. During previous years, post emergence applications of various selective herbicides were attempted without success.

During August 1956, experiments were conducted in which several herbicides, which had previously shown some selectivity to lettuce, were applied in areas where purslane was a known problem. The applications were made immediately after lettuce was planted on beds and just prior to the first irrigation. Materials included in the experiment and their rates of application were as follows: 2-chloroallyl diethyldithiocarbamate (CDEC) at 5.0 and 7.5 pounds per acre; 2-chloro-N,Ndiallylacetamide (CDAA) at 5.0 and 7.5 pounds per acre; Isopropyl N-(3-chlorophenyl) carbamate (CIPC) at 5.0 and 7.5 pounds per acre and an amine formulation of 2 - (2,4,5-trichlorophenoxy) propionic acid 2(2,4,5-TP) at 1.0 pound per acre.

Best results were obtained with CDEC. Lettuce showed no adverse effect and purslane was almost completely controlled in the seed row. Less control of purslane was obtained in the irrigation furrow below the water line. CIPC was also very effective in controlling purslane; however, there was some reduction in lettuce emergence and also a temporary retardation in growth and development of the young lettuce plants. CDAA had no apparent effect on lettuce or purslane. 2(2,4,5-TP) temporarily retarded lettuce vigor but did not delay or reduce yields; however, it was not effective against purslane. (Field Crops Research Branch, ARS, USDA and Arizona Agricultural Experiment Station, cooperating).

Chemical weed control in tomatoes. Shadbolt, C. A. Neburon (3-(3,4-dichlorophenyl)-1-methyl-1-n-butylurea), when applied immediately after planting direct seeded tomatoes, and before irrigation, showed considerable promise as a selective herbicide. In the first experiment, practically complete control of broadleaf weeds was obtained with 3 and 6 lb/A. In further experiments, using rates of 0.5, 2.0, 3.5, 5.0 and 6.5 lb/A of neburon stands were significantly reduced by the three higher rates, but the tomatoes which remained appeared normal. Weed control varied from 75% at the lower rate to 100% at the 5 and 6.5 pound rates. Monuron (3-(p-chlorophenyl)-1, 1-dimethylurea) at 0.5, 1, and 1.5 pounds was applied as a comparison with neburon, and this chemical showed severe stand reduction at the higher rate and showed 80-85% control of weeds. 2,4,5-TES (sodium 2,4,5-trichlorophenoxyethyl sulfate) at 2,4, and 6 pounds and DCU (dichloral urea) at 10, 15, and 20 lbs/A showed unsatisfactory weed control, but no injury to the tomatoes was observed.

In preliminary tests using neburon, at 2.5, 5.0 and 7 lbs/A one month after transplanting tomatoes, practically 100% control of broadleaf weeds was obtained at the two higher rates without crop injury. 2,4,5-TES at 2, 4.5 and 7 lbs/A gave unsatisfactory weed control. (University of California, Riverside)

Chemical weed control in cucumbers and squash. Laning, E. R. Jr. In preliminary evaluation trials conducted during 1954 and 1955 pre-emergence applications of amino triazole provided excellent weed control without apparent injury to cucumbers or squash. In these preliminary trials the plot area was irrigated immediately after planting, and then sprayed while the soil surface was still moist.

During 1956 amino triazole and Alanap-3 were compared at rates of 4, 6, and 8 pounds per acre as pre-emergence treatments on MR-17 cucumbers and on Golden Delicious squash. It was planned to sprinkler irrigate the plots after treatment, but this was obviated since 0.9 inches of rain fell in the two days following herbicidal application.

The cucumbers were picked regularly to obtain the greatest number of fruit approximating dill pickle size. The squash were all harvested at the end of the growing season.

Weed control, yield, and number of fruit data are summarized in the following table.

Chemical	Rate lb/A	Cucumber Yield tons/A	Cucumber No. fruit	Squash Yield tons/A	Squash No. fruit	Weed control 7 weeks
ATZ	4	21.9	529	17.6	19.4	1.9
ATZ	6.	20.7	470	18.0	19.2	2.6
ATZ	8	17.6	438	17.3	17.2	3.2
Alanap-3	4	22.3	557	17.2	19.8	2.6
Alanap-3	6	22.0	473	18.0	21.0	2.8
Alanap-3	8	22.3	570	15.8	18.4	3.2
Control	-	18.1	450	21.6	19.4	0

Yields and number of fruit represent average of 5 replicates.
Weed control data represent average of ten plots.
Weed control data based on: 0 = no control to 4.0 = complete control.
(Oregon Agricultural Experiment Station)

Developments with a granular formulation of NPA. Corkins, Jack P. During the summer of 1955 in the pursuance of a development program using NPA (ALANAP) as a selective herbicide in cotton, the possibilities of a granular formulation were investigated. Preliminary tests looked promising and this granular phase of the program was further explored in 1956.

An herbicide in a granular form has the obvious advantage of physical selectivity when applied post-emergence provided that the herbicide is not readily taken up through the root system of the crop plant. This was found to be generally true with a granular form of NPA on several row crops. Some of these row crops are quite sensitive to NPA in a spray form.

It had previously been noted by Miller, Foy and others that a pre-emergence application of the sodium salt of NPA applied as a water spray followed by a rain could result in some plants showing negative geotropism, reduced stand, stunting, and reduced yields. It was theorized that a granular form might slow down movement into the soil and reduce or eliminate these adverse effects. Twenty per cent active sodium salt NPA granules were compared to a spray in a series of plots that were sprinkler irrigated to simulate rain. The results of this test were that little or no difference could be detected between the spray and granular treatments. In both cases appreciable stunting and reduced stands were noted along with excellent weed control. Post-emergence tests on cotton showed a high degree of safety of the granules to the cotton. No phytotoxic effects to the cotton were noticed when as much as 2,400 lb/A of 20 per cent active granules were used.

Some melon growers in the Southwest have indicated a desire to use NPA post-emergence to the melons just after thinning. Several tests of this type where a sodium salt of NPA was applied as a spray have shown mild phytotoxic effects under typical Southwest hot weather conditions. The granular form was therefore tested on cantaloupes and resulted in good to excellent weed control, no apparent phytotoxic effects, and excellent yields.

Small plot tests were also conducted on such row crops as tomatoes, lettuce, celery, sugar beets, and strawberries. Except in the case of strawberries, no phytotoxic effects were apparent in these tests when the NPA granules were applied at herbicidally active rates, i.e., 20 to 30 lb/A of 20 per cent sodium salt of NPA granules. In the case of strawberries, darkening of the foliage and stunting occurred.

These preliminary tests indicate the possibility that NPA granules may be of value in many row crops as a pre-emergence herbicide applied post-emergence to the crop at a time when the field has been rendered weed free.

In preparing for commercial usage of NPA granules on cotton and melons, several different granular carriers were tested and compared. These were 30-60 mesh Attaclay, No. 2 Vermiculite, and No. 4 Vermiculite. No differences in biological activity were detected in these tests. Airplane distribution pattern tests were conducted flying the aircraft at approximately 20 feet altitude under calm wind conditions. A standard Steerman dust plane was used with a normal usable swath width of 33 feet. The following data from this test cover an average rate of application of 20 lb/A:

	Total width of single swath	33 ft. Swath with overlap Low	High
30-60 Mesh Attaclay	54 ft.	3 lb/A	55 lb/A
#2 Vermiculite	57 ft.	7 lb/A	47 lb/A
#4 Vermiculite	66 ft.	11 lb/A	29 lb/A

(Naugatuck Chemical Division of the United States Rubber Company)

Control of annual weeds in processing peas. Peabody, Dwight V., Jr. Five new organic herbicides were compared to the standard recommended DNBP treatments for weed control in peas. This experiment was carried out at the Northwestern Washington Experiment Station on a Puget silt loam soil with a pH of approximatley 6.0. Pea seed was drilled in rows seven inches apart in early May; 300 pounds of treble superphosphate an acre being applied with the seed. Pea variety used was Darkskin Perfection.

Experimental design was a six by six Latin square with a plot size of 11 feet by 25 feet. Six different pre-emergence herbicidal treatments (see Table I) were applied to peas six days after planting. All spray treatments were applied with a hydro-pneumatic plot sprayer in a total volume of water equivalent to 50 gallons per acre at 30 psi pressure. One month after pre-emergence herbicidal applications had been made, an estimate of broadleaved annual weed cover was made with a 100 square grid-quadrat 12 inches by 50 inches. This quadrat was dropped at random four times in each plot, data being recorded as total number of squares containing weeds. These data were then converted to percentages which, in turn, were transformed by the angular transformation for statistical analysis. Principal broadleaved annual weed species present in order of their importance were: Polygonum pennsylvanicum L., smartweed; Chenopodium album L., lambsquarters; Senecio vulgaris L., groundsel; Capsella bursa-pastoris Medic., shepherds purse; Stellaria media C., chickweed. On August 30, 1956, peas were harvested from a swath six feet by 11 feet from the center of every plot. This sample was run through a large field viner, and weight of shelled peas obtained was recorded to the nearest 1/100 of a pound.

The granular formulation of DNBP at six pounds per acre gave as good weed control as the standard DNBP spray treatment. The other four herbicidal treatments resulted in very poor weed control. The reduction in pea yield measured from plots receiving these treatments was due to the intense weed competition and not to phytotoxicity. These four herbicides should have been tested at higher rates of application. (Northwestern Washington Experiment Station, Washington State College)

YIELD AND PERCENTAGE ANNUAL WEED COVER OF 1956 PRE-EMERGENCE HERBICIDE EXPERIMENT IN PROCESSING PEAS

Treatment		Yield of Processing Peas	Broadleaved Annual Weed Cover[2]
Herbicide	Rate[1]	Tons/A	%
DNBP	3	4.1	0.0
DNBP gran.	6	4.0	0.0
chlorazin	2	3.1	77.2
MCPB	0.5	2.9	98.5
2,4-DEP	2	2.7	97.3
CCPC	2	2.6	93.4
	$\bar{x}$	3.23	59.05
	$SE_{\bar{x}}$	0.14	13.78
	CV	11%	23%

1. Rate of application expressed as pounds active ingredient per acre.

2. Reconverted means of data transformed by angle = arc sin $\sqrt{\text{percentage}}$.

Control of summer annual weeds in ornamental bulbs (tulips, iris, and narcissi). Peabody, Dwight V., Jr. From results of the weed control experiments undertaken the past five years, a safe, effective and inexpensive method of annual weed control has been developed for use in ornamental bulbs. The experiment this past season (1955-1956) has been a continuance of this series of trials. The objective this past season was to determine the effect of several different herbicidal treatments on yield of bulbs, as well as on the annual weed populations present.

This experiment was located at the Northwestern Washington Experiment Station on a Puget silt loam soil having a pH of 5.8 to 6.2. All herbicides at the designated rates and times of application (see Table I) were applied with a hydro-pneumatic plot sprayer at 30 psi pressure in a total volume of water equivalent to 100 gallons per acre. Pre-emergence applications were made in early November of 1955, and post-emergence applications were made in early May, 1956. The experimental design was a randomized complete block, replicated three times. Plot size was one row 20 feet long. Equal weights of bulbs of the same size were planted in each plot. Varieties used were as follows: Wedgewood iris, Carlton daffodils, and Paul Richter tulips. All bulbs were planted in late September of 1955 in furrows five to six inches deep and then covered and hilled four to five inches high. No fertilizer was used and no fungicidal treatments were applied. During the month of April all plots were cultivated three times without disturbing the hills. No hoeing or hand-weeding was done at any time.

One month after post-emergent treatments were applied, an estimate of broadleaved annual weeds was made with a point quadrat. A ten point quadrat was dropped four times within each plot. Data were recorded as number of "hits" on annual weeds with each drop. These data were then converted to percentages which, in turn, were transformed by the angular transformation for statistical analyses. All plots were kept separate at digging time as well as when sorted shortly thereafter. Narcissi were not separated as to size; yield data being recorded as total weight of bulbs per plot. Tulips were separated as to size into two groups and weighed separately: (1) 10 cm. and larger (salable) and (2) 9 cm. and smaller. Iris were separated as to size into two groups and weighed separately (1) 9 cm. and larger (salable) and (2) 8 cm. and smaller.

Principal broadleaved annual weed species present in order of their importance were as follows: *Polygonum pennsylvanicum* L., smartweed; *Stellaria media* Cyrill, chickweed; *Chenopodium album* L., lambsquarters; *Senecio vulgaris* L., groundsel; and *Polygonum aviculare* L., knotweed.

Pre-emergence application of a relatively high rate (3.6 pounds per acre) of monuron resulted in excellent annual weed control up to harvest time with little or no yield reduction. Pre-emergence application of DNBP did not control summer annual weeds. The presently recommended combination treatment of DNBP and CIPC applied prior to bulb emergence resulted in fair summer annual weed control and caused no significant yield reduction of tulips, iris and narcissus bulbs. Post-emergence applications of monuron, diuron and neburon decreased the yield of salable tulip bulbs and resulted in only fair annual weed control at the rates tested here. (Northwestern Washington Experiment Station, Washington State College)

YIELD OF TULIP, IRIS AND NARCISSUS BULBS AND PERCENTAGE WEED COVER OF 1955-1956 WEED CONTROL TRIAL (I)

Treatment			Mean bulb yield			Broadleaved annual weed cover[5]		
Herbicide	Rate of applic.[1]	Time of applic.	Tulips[2]	Iris[3]	Narcissi[4]	Tulips	Iris	Narcissi
			lbs./plot	lbs./plot	lbs./plot	%	%	%
DNBP	4.5	pre-em.	8.51	6.73	17.46	68.3	63.4	52.5
DNBP+CIPC	4.5+4.0	pre-em.	9.18	6.05	19.73	33.3	12.1	5.8
Monuron	3.6	pre-em.	9.25	8.45	16.81	15.4	8.4	0.9
Monuron	0.8	post-em.	7.99	7.40	16.80	16.0	25.6	21.0
Diuron	0.2	post-em.	5.81	7.03	17.02	38.3	21.7	3.7
Diuron	0.4	post-em.	4.08	6.30	15.30	17.5	26.3	11.9
Neburon	0.2	post-em.	7.17	7.04	18.21	32.3	40.6	13.3
Neburon	0.4	post-em.	7.71	8.55	18.31	17.7	20.7	10.7
Neburon	0.8	post-em.	6.45	7.13	18.80	30.2	38.8	25.9
	$\bar{x}$		7.350	7.186	17.606	29.04	27.43	13.68
	$SE_{\bar{x}}$		0.548	0.614	0.742	0.82	1.38	1.65
	CV		13%	15%	7%	28%	37%	59%

1. Rate of application expressed in pounds active ingredient per acre.

2. Tulip yields are salable bulbs only (10 cm. and larger).

3. Iris yields are salable bulbs only (9 cm. and larger).

4. Narcissus bulbs were not sized; weights are mean yields of all bulbs.

5. Reconverted means of data transformed by angle = arc sin $\sqrt{\text{percentage}}$.

PROJECT 6

AQUATIC WEEDS; SUBMERSED AND EMERGENT

H. Fred Arle, Project Leader

SUMMARY

Five abstracts pertaining to the control of aquatic weeds were received from four contributors. Only one regarded the control of submersed aquatic weeds and four described experimental work on cattail and sedge.

In Wyoming applications of sodium 2,2 dichloropropionate (dalapon) and 3-amino-1,2,4-triazole (ATA) resulted in good control of sedge (Carex aquatilis) during the remainder of the season following treatment. Retreatments, however, were necessary the following season. Of seven soil sterilant treatments applied after the 1955 growing season or early in 1956, 2,4-D applied at 160 pounds per acre showed more promise than erbon and was considerably more effective than monuron or mixtures of borates and monuron. Fortified aromatic oils and propane burning gave adequate seasonal control but little or no stand reduction.

In California, a screening program to evaluate chemicals which might be effective against cattail was initiated during 1956. In one experiment two polychloro benzoic acid formulations and an MCP salt of ATA showed best control of cattail growth in irrigation drainage systems. Summer growth of cattail and willows along the shorelines of farm ponds has been controlled by treating with monuron during the previous fall.

Aerial applications of dalapon at 20 and 30 pounds per acre showed best control of cattail where they were growing on marshy ground rather than in standing water.

Good control of submersed water weeds in farm ponds was obtained with repeated applications of a pelletted 10-10-10 fertilizer. A secondary effect was an improved stand of shore line grass which minimized erosion.

The control of water sedge growing along irrigation channels. Timmons, F.L., Weldon, L.W., and Lee, W.O., Research Agronomists, ARS. Eight chemical treatments and one propane weed burner treatment were made July 12, 1955, on water sedge (Carex aquatilis).

Sodium 2,2-dichloropropionate (dalapon) at 20 and 40 pounds per acre, 3-amino-1,2,4-triazole (ATA) at 10 and 20 pounds, 2-chloro-4,6-bis (diethylamino)-s-triazine (CDT) at 20 pounds per acre were applied in 115 gallons of water plus 5 gallons of diesel oil and emulsifier per acre. Three pints of DNBP in 120 gallons diesel oil, a dinitro-fortified aromatic oil concentrate in a 1 to 10 oil-water emulsion for a total volume of 120 gallons, a commercial aromatic weed oil at 120 gallons per acre, and propane weed burning 3 minutes per square rod were the other treatments. The replicated square rod plots included both sides and the bottom of the irrigation canal. Chemical treatments were made with a single-nozzle wand type knapsack sprayer.

ATA at 10 and 20 pounds per acre controlled 93 and 94 percent of the sedge. Dalapon at 20 pounds per acre showed 69 percent topkill the first year, and 40 pounds showed 71 percent topkill. Propane weed burning gave complete topkill with 63 percent regrowth during the remainder of the growing season. CDT and the 1 to 10 oil-water emulsion gave little topkill with practically full recovery of the sedge. The aromatic oil gave only partial temporary control.

Seven soil sterilant treatments were applied after the 1955 growing season and early in the 1956 growing season. 3-(p-chlorophenyl) -1,1-dimethylurea (monuron) at 40 and 80 pounds per acre and a mixture of borates and monuron at 2.7 and 5.5 pounds per square rod were applied on October 21, 1955 after the growing season. 2-(2,4,5-trichlorophenoxy) ethyl 2,2-dichloropropionate (erbon) at 80 and 160 pounds per acre and 2,4-D amine at 80 pounds per acre were applied May 24, 1956. Erbon and 2,4-D plots were retreated at the same rates as the original treatments on July 18, 1956. Erbon gave better control of the sedge than either monuron or the borate-monuron mixture but was less effective than 2,4-D. A total of 160 pounds of 2,4-D controlled 75 percent of the sedge growing on the ditchbank as compared to 80 percent control obtained with 320 pounds of erbon. However, at the waterline erbon controlled only 10 percent of the sedge as compared to 50 percent controlled by 2,4-D.

Plots treated in 1955 with 20 and 40 pounds per acre of dalapon were retreated twice in 1956. The first treatment was made at one-half the original rate, and the second was made at the same rate as the original application, giving a total of 30 and 60 pounds per acre applied in 1956. The heavier rate controlled 65 percent of the sedge on the bank and 20 percent at the waterline. Plots treated with 10 and 20 pounds per acre of ATA were given one retreatment in 1956 of 5 and 10 pounds. The light rate of ATA controlled 65 percent of the sedge on the bank and 75 percent at the waterline, while the heavier rate controlled 85 percent on the bank and 90 percent at the waterline.

The DNBP-fortified diesel oil treated plots were retreated twice in 1956 with the same concentration as the 1955 treatment. The burned plots were reburned twice in 1956. Both gave adequate seasonal control of growth but little reduction in stand of sedge. The fortified diesel oil treatment appeared to give slightly better control than the burning treatment.

A second experiment was initiated May 25, 1956, to test the effectiveness of three rates of ATA in controlling in water sedge. ATA at 3, 6, and 9 pounds per acre was applied to water sedge 6 to 10 inches high in 115 gallons of water plus 5 gallons of diesel oil and emulsifier per acre. The plots were retreated August 16 at the same rate to give a total of 6, 12 and 18 pounds per acre of ATA. The average control at the end of the first growing season was 60, 78 and 92 percent for each of the treatments, respectively. (Cooperative contribution from the Field Crops Research Branch, ARS, USDA, and Wyoming Agricultural Experiment Station, cooperating.)

Soil treatment with monuron for control of cattail and willows. Baranek, Paul P. Farm ponds that have a receding shoreline during the summer months and are infested with willow and cattail can now be improved by using a soil treatment of monuron. After two years of testing in the eastern foothills of Madera County on farm ponds, 100 percent control has been obtained.

In the fall before winter rains begin, the willows are cut at ground line with pruning shears and the cattail are chopped with a hoe or shovel and then removed from the area to be treated. Monuron is sprayed on the cleaned area at the rate of 80 pounds per acre in 150 gallons of water. Winter rains fill the farm ponds so that water (as much as 8 feet) will stand over the treated areas for at least 5 months. As the water line recedes during the following summer the treated area remains free of trash or weed growths.

It is not recommended that the entire shoreline be treated with this method but it does provide a means of opening areas to fishing from the shore. It also provides an entering wedge for cheaper methods of control. Only areas having a low erosion potential should be so treated. (Cotributed by the University of California Agricultural Extension Service from Mader County.)

Cattail eradication trials with 2,4-D, ATA, dalapon, two polychloro benzoics, and MCP salt of ATA. McHenry, W.B. Cattails continue to be a major impediment to efficient water flow in California irrigation and drainage systems. The present recommendation of 2 pounds of low volatile ester of 2,4-D plus one gallon of diesel oil in 100 gallons of water while reasonably effective has little place in the 2,4-D-restricted crop areas of the state. Field trials were initiated during the summer of 1956 to evaluate herbicides that might be useful for cattail eradication both in and out of the 2,4-D restricted areas.

On May 28th amino triazole (3-amino-1,2,4-triazole) was applied to narrow-leaf cattails, early bloom stage) at the rate of 1, 2, and 3 pounds (active) per 100 gallons of water. Colloidal X-77 was added at the rate of 6.8 fluid ounces per 100 gallons of spray. By October 17 (16 weeks later) all treated plots indicated 75-85 percent regrowth.

On May 31st the following combination ATA and dalapon (2,2-dichloropropionic acid , 85 percent sodium salt) treatments were applied to narrow-leaf cattails, early bloom stage.

Treatments	Percent regrowth Oct. 17, 1956			
	Sprayed 5/31/56		Sprayed 5/31 ≠ 9/20/56	
	Rep. I	Rep. II	Rep. I	Rep. II
.5 # ATA ≠ 2 # dalapon /100 gal.	25	30-50	5	5
1 # ATA ≠ 4 # dalapon/100 gal.	50	75	5	5
1# ATA ≠ 4# dalapon ≠ 1 qt. diesel	50	30-50	5	5
2# ATA ≠ 8# dalapon	10	30	0	Trace

A scheme of monthly amino triazole treatments on narrow-leaf cattails was started in June, 1956 and repeated in August, September and October to verify the suggestion of other worker that cattails were more susceptible to ATA near the end of the growing season. The repeated ATA rates were .25, .50, 2.0, and 3.0 pounds per 100 gallons of water, 6.8 fluid ounces of Colloidal X-77 was again added to the spray. In October all previously treated plots were showing regrowth.

A herbicide screening trial on narrow-leaf cattails was instituted in July, 1956 including these materials: ACP*-177 (approximately 80% 2,3,6-TBA) and ACP-103* (mixture of chlorobenzoics) both at 4, 8, and 16 pounds per acre; dalapon at 10, 20 and 30 pounds per acre; Gamet (MCP salt of ATA) 1.5 pounds per 100 gallons, ATA 2 pounds (active) per 100 gallons and 2,4-D low volatile ester 2 pounds ≠ 1 gallon of diesel oil per 100 gallons of water.

On October 17, 13 weeks after spraying, plots treated with either benzoic material or Gamet showed no regrowth. The other treatments had green tissue remaining in the sprayed cattails or showed regrowth. (University of California Extension Service) * Code designation by American Chemical Paint Company.

<u>Aerial applications of 2,2 dichloropropionic acid for the control of cattail (Typha angustifolia)</u> Arle, H. Fred and Bowser, C.W. Plant Physiologist, ARS. and Agronomist, U.S. Bureau of Reclamation. Airplane applications of 2,2-dichloropropionic acid (dalapon) were made on June 12 to cattails which were in the heading stage of growth. Four unreplicated plots, each of which was 870 feet long, and 200 feet wide (4.0 acres) were laid out so that a portion of each included cattails growing in shallow lake water and the remainder of the plot not being submerged. Four treatments were included; 20 pounds dalapon (85 % sodium salt) in 7.5 and 10.0 gallons solution (water carrier) per acre and 30 pounds dalapon in 7.5 and 10.0 gallons of solution per acre. Some difficulty with excessive foamingwas experienced while preparing the solutions prior to loading them on the airplane. Reduced agitation minimized this problem. The spray plane covered 40 feet per swath and made 5 passes lengthwise per plot.

At 7.5 gallons per acre, the top 25-33 percent of cattail foliage

was wet by the spray solution. At 10 gallons per acre, coverage was somewhat better, the top 33-50 percent was adequately covered. Ten days after treatment it was noted that growth which was thoroughly wetted by the spray was was most severely affected. One to four feet of top foliage was becoming dry. There was a definite tendency toward cattail recovery during the following weeks, especially where cattails were standing in water. It also appeared that the volume of water will become an important consideration. Results were somewhat better when dalapon was applied at 10 gallons per acre. (Cooperative dontribution from the Field Crops Research Branch, ARS, USDA and the U.S. Bureau of Reclamation, USDI.

<u>Control of pondweeds with fertilizer.</u> Baranek, Paul P. After two years of control of pondweeds in Madera County using a pelletted 10-10-10 fertilizer, a summary can be made of the results:

1. Submersed pondweeds can be controlled satisfactorily with pelletted 10-10-10 fertilizer in the eastern foothill area at a cost of $25 per surface acre. It will require from 6 to 8 applications per season using 100 to 200 pounds of fertilizer per surface acre per application.

2. Best results were obtained when fertilizer was applied from a boat and broadcast from the shoreline.

3. Apparently control is obtained by two methods - (1) shading, because of the increase algae blanket and (2) a toxic effect because of direct contact with the fertilizer.

4. The fertilizer improved the grass stand on the bank as the waterline receded providing better erosion control.. (Contributed by the University of California Agricultural Extension Service from Madera County.)

PROJECT 7. CHEMICAL AND PHYSIOLOGICAL STUDIES

Herbert M. Hull, Project Leader

SUMMARY

A total of 9 project reports dealing with chemical and physiological studies were received. These reports represented 11 authors from the states of Arizona, California, and Oregon.

Studies reported for the year 1956 fall essentially into two categories: (1) Herbicidal absorption and translocation, and (2) Activation and decomposition of herbicides in soil.

Herbicidal Absorption and Translocation

California investigators, utilizing C^{14} tagged 2,4-D, 2,4,5-T, MH, ATA, and monuron, have demonstrated differential translocation in Tradescantia by means of radioautography. Application to a single leaf indicated translocation in the following decreasing order: MH, ATA, 2,4-D, 2,4,5-T, monuron. Applied to potato tuber sections, MH, ATA, and 2,4-D demonstrated a tendency to move in a similar order to that above. It appears likely that limited transport is associated with retention by living cells at or near the point of application. The pattern of accumulation in this manner was shown to be dependent upon the state of activity of the plant.

By application of a fluorescent nontoxic dye to the upper or lower surfaces of Zebrina pendula leaves, it was shown that the dye remained confined to the cell walls unless the cells were injured or dead. Absorption took place through the upper (stomata-free) leaf surface, as evidenced by the dye pattern of the anticlinal walls; and in addition, penetration through the lower surface was increased under conditions that favored open stomata. Surfactants increased both the cuticular and stomatal components, and appeared to be most effective in promoting penetration if they were toxic to some extent.

Oregon workers have developed a method whereby an index of foliar absorption can be determined and expressed as a constant for a specific herbicide. By measuring the actual mass of herbicide disappearing from the leaf surface (due to absorption) during specific time periods, it was shown that the absorption rates of systemic herbicides over a period of time followed an exponential curve. Absorption rates were determined and the corresponding absorption constant calculated for ATA, MH, 2,4-D, and monuron.

Also studied was the effect of surfactants on herbicide absorption. The foliar absorption of ATA by bean plants was followed over a 117-hour period. Addition of 0.1 percent surfactant to ATA increased the percent absorbed from 55 to 87. Marked differences in absorption of ATA resulted from the use of different forms of surfactant, all at 0.05 percent

concentration; and no direct correlation of surface tension and absorption was evident among the forms used.

Because of the marked effect of emulsifier concentration upon absorption of 2,4,5-T by seedling velvet mesquite shown in Arizona experiments, a field study with this variable in mind was installed. An amine and ester of 2,4,5-T were each carried in a diesel oil or nontoxic oil emulsion, the four combinations each being emulsified at five concentration levels of an anionic surfactant. Observation one and two years later indicated a highly significant negative correlation between emulsifier concentration and percentage of foliage regrowth for the ester-diesel oil emulsion group. Effect of emulsifier concentration was less evident in the other three groups.

The absorption of oil by bark of different species has been investigated in Oregon. The area on the bark surface to which a diesel oil drop of known volume would spread was measured, as well as the grams absorbed per cc of bark. Apparent differences in structure and chemical properties of the various barks resulted in different degrees of absorption. A high degree of absorption apparently inactivated the herbicide, since a negative correlation was found between herbicidal sensitivity and degree of absorption.

Activation and Decomposition of Herbicides in Soil

California investigators have followed the detoxification rate of four phenylurea herbicides in a number of different soils. After a single soil application of a concentration range (0-121 ppmw) of the herbicides, seven successive oat crops were grown in the mixtures. Determination of the original concentration required to produce a 50 percent growth repression of each of the seven crops indicated diuron to be most residual and fenuron to most rapidly lose its toxicity. Fenuron and monuron were originally most toxic.

Studies involving the rate of detoxification of IPC and CIPC in soils held at different temperatures have been undertaken at Oregon. By determination of the herbicidal concentrations remaining after specific time intervals, the heat of activation necessary to initiate chemical breakdown was calculated, and a parameter determined which could be applied to a specific herbicide under a specific set of conditions. Mathematical expression in this manner should be valuable in estimating the residual life of different herbicides.

Activation by moisture of mylone (3,5 dimethyl tetrahydro-1,3,5, 2H thiadiazine-2-thione) has been described. This chemical was first used as an industrial fungicide, but evidence has accumulated showing it to be of value against a number of annual and perennial weeds, including grasses. It is apparently nonspecific and nonsystemic as a temporary soil sterilant and undergoes a complex degradation in the soil upon activation by moisture. The final products include methyl amine, ammonia, hydrogen sulfide, carbon dioxide, and water.

REPORTS OF INDIVIDUAL CONTRIBUTORS

Comparative studies on herbicide transport. Crafts, A. S., Yamaguchi, S. and Ashton, F. M. A series of experiments were conducted comparing the translocation of 2,4-D, 2,4,5-T, MH, ATA, and monuron. The molecules were tagged with radioactive C^{14} and the applied solutions were prepared so that equal molar solutions contained equal radioactivity per unit volume. Radioautographic techniques were used to determine the distribution patterns of the herbicide after specific periods of time.

The results indicate that when the herbicide is applied to a single leaf MH is the most freely moved and moves through the mesophyll to the phloem and thence throughout the plant; ATA is also readily mobile but to a less degree than MH; 2,4-D and 2,4,5-T are accumulated by living cells and are less thoroughly distributed; monuron moves only acropetally in the treated leaf and is not transported downward by the phloem. Stem applications of MH, ATA, and 2,4-D to Tradescantia confirm their relative mobility.

When MH, ATA, and 2,4-D are applied to potato tuber sections the 2,4-D movement is slight, ATA moves to a somewhat larger area, and MH to a much larger area. These differences in the transport pattern indicate that the limitation in distribution of these chemicals relates to their relative retention by living cells at or near the point of application and not to any inherent differences in the transport mechanisms.

MH, ATA, and 2,4-D do not move out of chlorotic leaves of Tradescantia but do move out of green leaves of this species. These herbicides accumulate in both chlorotic and green young growing shoots when applied to green leaves.

Plants in various states of activity treated with 2,4-D have different distribution patterns for this herbicide. Apparently the ultimate location of 2,4-D in a plant depends upon the relative rates of accumulation and phloem transport. In the absence of active transport accumulation predominates, in the presence of active transport the 2,4-D moves rapidly along the transport gradient. (Department of Botany, University of California, Davis.)

Pathways of foliar penetration. Currier, H. B., and Dybing, C. D. Systemic herbicides applied to leaves must move from the leaf surface to uninjured phloem in sufficient quantity to be translocated throughout the plant. Penetration is known to be influenced by (1) environmental conditions (light, temp., humidity, wind), (2) internal plant factors, e.g., water balance, (3) concentration, (4) nature of spray solution (solvent, pH, additives), and (5) mechanical disruption of cuticle. Surfactants are commonly used to increase penetration of herbicides.

Absorption pathways are cuticular and stomatal. The cuticle, a permeable structure, is nonetheless a strong barrier to rapid penetration. Cracks and perforations increase its permeability. Several possibilities exist as to the pathway of movement from leaf surface to the phloem:

a. Across cuticle, then (1) anticlinal walls of epidermis and mesophyll, especially those of the bundle sheath extensions, or (2) via plasmodesmata in the outer periclinal epidermal wall, and symplast (interconnected protoplasts) to the phloem, or (3) a combination of 1 and 2.

b. Through stomata, then (1) across internal cuticle, thence wall channels, (2) across internal cuticle, then plasmodesmata and symplast, (3) in intercellular spaces, spreading along wall surfaces, or in bulk, to vascular bundles, (4) combination of these.

We have used the fluorescent dye tracer method to study these pathways. The nontoxic dye sodium 3-hydroxy-5,8,10-pyrenetrisulfonate (PTS) is useful. Following are some of the results. (1) Since PTS will not enter normal protoplasts, it is confined to the cell walls unless the cells are injured or dead; (2) cuticular absorption is evidenced by a bright pattern of anticlinal walls, on both upper (no stomata) and lower surfaces of Zebrina pendula leaves; (3) the stomatal component of absorption is increased under conditions favoring open stomata; (4) surfactants increase both the cuticular and stomatal component. Aqueous solutions lacking surfactants do not appear to enter the substomatal cavity; oils go in readily.

Various factors may influence the pathway. Chemical stimulation is known to cause movement of plasmodesmata into and out of the external epidermal wall, to induce callus formation in cell walls, and to increase permeability of plasma membranes. The presence of a toxic additive in the solution may promote penetration by increasing permeability through trauma, and/or by local killing of cells that become reservoirs of chemical. Such cells appear solidly fluorescent in our method. Study of a number of surfactants as they influence the absorption of MH by barley plants showed that all improved foliar penetration but only a few enhanced root penetration of MH in a standard root-dip technique. Here there was a close relation between toxicity of surfactant and additive effectiveness. One may suggest, then, that among desirable properties of surfactants, a physiological property - toxicity - might act to enhance foliar penetration of an herbicide under proper conditions. Toxicity studies of surfactant effects on leaves are of interest in this connection. (Department of Botany, University of California, Davis).

A new aspect of foliar absorption of herbicides. Freed, V. H. and Montgomery, M. Cuticular absorption is a process of fundamental importance in the use of herbicides. An increasing interest regarding the phenomenon of absorption and the factors that influence it is being shown. In order to make exact evaluation of the rate of absorption of herbicides it is necessary to devise some method of comparing results obtained with different materials.

Absorption is a process which results in a transfer of mass with time. If we let the mass on the leaf surface at time zero equal m_o then after a period of absorption the mass left on the leaf will be equal to

m_t at time t. The difference as shown in equaltion 1 is the amount of disappearing with time.

$$(1)\quad m_t - m_o = -\Delta m$$

We can now write an expression for this phenomenon shown in equation 2.

$$(2)\quad \frac{-\Delta m}{dt} = km_o$$

The parameter k in this expression gives us an index of absorption which can be compared to similar parameters determined from other sets of experimental data.

Studies on rates of cuticular absorption by herbicides have shown that with the systemic herbicides the amount of material absorbed over a period of time follows an exponential curve. This is characteristic of what is known as a first order reaction and is in agreement with the behavior predicted by theory.

The constant k was determined for ATA, MH, 2,4-D, and monuron from absorption data. This information is given in Table 1.

Table 1

Compound	m_o γ/leaf	k(hrs^{-1})
ATA	250	6.6×10^{-3}
MH	200	4.62×10^{-3}
2,4-D (sodium salt)	50	4.5×10^{-3}
Monuron	20	1.75×10^{-2}

The value of the parameter k agrees fairly well with observations on the rate of absorption of the herbicides given in the table. It thus appears that we have a new tool to aid in the evaluation of absorption of various materials. (Agricultural Chemistry Department, Oregon Agricultural Experiment Station, Corvallis.)

The influence of surfactants on herbicide absorption. Freed, V.H. and Montgomery, M. Absorption of applied chemicals is of paramount interest in the use of systemic herbicides. It is only as this process is understood and turned to advantage that the efficiency of the applied chemical can be increased.

The use of surfactant to increase the area of contact between insecticides and foliage has long been used as a means of providing better protection against insects. It has only been in recent years that there has been any interest in surfactants to increase the effectiveness of herbicides. The reduced contact angle resulting from the use of surfactants in herbicide sprays should increase the ease of absorption of the applied materials. In order to study this phenomenon, the absorption of ATA was followed both in the presence of a surfactant and without it. Table 1 presents the data obtained for comparing the absorption of ATA by bean plants with and without surfactant.

Table 1

Solution	Percent ATA Absorbed in 117 hrs
ATA	55.4
ATA ≠ 0.1 percent surfactant	87.3

It is very apparent that the surfactant materially increases the amount of ATA absorbed.

In order to determine whether any surfactant was equally effective, three different ones were tested at a level of 0.05 percent. The data obtained from this study is presented in Table 2.

Table 2

Solution	Surface tension, dynes/cm.	Pct. ATA absorbed in 24 hrs
ATA	69.6	13.1
ATA ≠ 0.05 percent Multifilm C	50.3	18.8
ATA ≠ 0.05 percent Multifilm L	59.1	25.5
ATA ≠ 0.05 percent X-77	33.3	77.8

It is apparent from this table that surface tension alone is not the sole criterion governing the increased absorption of herbicide in the presence of a surfactant. Such factors as the interfacial tension as measured by contact angles on the leaf are important. Perhaps of prime importance is the surface attraction of the surfactant for the leaf itself. (Agricultural Chemistry Department, Oregon Agricultural Experiment Station, Corvallis.)

Greenhouse and field studies involving the effect of emulsifier concentration on herbicidal control of velvet mesquite. Hull, Herbert M. After a survey involving the use of 29 different emulsifying agents as adjuvants to the triethylamine salt of 2,4,5-T, two emulsifiers (anionic and anionic-nonionic blend) were selected for further study at a range of concentrations. The four central leaves of greenhouse-grown seedlings were treated with the above formulation of 2,4,5-T (5,000 ppmw) carried in water only, or a 1:4 emulsion of nontoxic oil in water. Each of the emulsifiers was added at 0.0, 0.1, 0.4, and 1.5 percent (v/v). Although the emulsifiers without herbicide were not visibly phytotoxic at 1.5 percent, when added to the herbicide there existed a direct correlation between emulsifier concentration and contact injury to the leaves. Also, the higher concentrations of emulsifier generally resulted in callus formation on the stem adjacent to nodes of the treated leaves. When this occurred, the apical and basal nontreated leaves failed to develop chlorosis or to show other formative effects, suggesting an inhibition of herbicidal transport beyond the calloused region. With a lower emulsifier concentration (0.1 percent), little or no callus developed, but ultimately all foliage on the plant showed severe injury.

The marked effect of emulsifier concentration in the above and other experiments suggested the installation of a field study with this factor in mind. Two formulations of 2,4,5-T were used at 12,000 ppmw acid equivalent, the butoxyethanol ester and the triethylamine salt. Each was carried in a 1:4 emulsion of either nontoxic oil in water or diesel oil in water, making four basic classes. Each class was emulsified at five concentration levels, namely 0.0, 0.1, 0.4, 0.8, and 1.2 percent (v/v), utilizing an anionic emulsifier. Application to 400 trees was accomplished with a hand sprayer at the rate of 1 gallon per 10 trees. Observation during the summers of 1955 and 1956, 1 and 2 years after application, indicated least regrowth of foliage in the class receiving the ester of 2,4,5-T in a diesel oil emulsion. Within this class there was also a significant negative correlation between emulsifier concentration and percentage of foliage regrowth. For example, the 1956 observation showed the mean percentage of foliage remaining on the trees to be 44, 43, 33, 34, and 18 at the five respective emulsifier concentrations.

The fact that by far the best results were achieved at the highest emulsifier concentration (1.2 percent) indicates that even a higher rate would be desirable in future work. In endeavoring to explain the results of this test and the failure of the data to correlate with the greenhouse results, it should be recalled that application was made in September, which is about four months after optimum time for field application as determined by frequent-interval tests. Microscopic examination of mesquite leaves has indicated a definite thickening of the cuticle with advancing age. Because of this change in cuticle thickness, as well as other physiological changes which occur within the tree with the advancing season, it is conceivable that the exact herbicidal mixture (or emulsifier concentration) which is optimum at a certain time of year may not be optimum later in the year--even for the same plant. To test this possibility, and to find the effect of even higher concentrations of emulsifier than previously used, a field experiment was installed during 1956 in which trees were sprayed at four dates ranging from April to October, with three concentrations of emulsifier being used at each date, namely 0.2, 1.2, and 2.2 percent. (Field Crops Research Branch, Agricultural Research Service, USDA, Box 5735, Tucson, Arizona.)

<u>The behavior of oil solutions on bark of different species</u>. Freed, V. H., and Montgomery M. Basal application of an oil solution of 2,4-D and 2,4,5-T is commonly used for control of brushy plants. Considerable variation in effectiveness is experienced between different species and even on a single species of different age classes. Among other factors that might influence such a treatment, a bark thickness and characteristic are undoubtedly important.

This study was initiated to determine the behavior of oil on and in the bark of different species and the ability of bark of different species to absorb oil. The retention and spread of oil on bark of different species were first considered. Here droplets of diesel oil of known volume were applied to bark of different species of comparable age. The area covered by this droplet of known volume was measured. Table 1 presents this information.

Table 1.--Retention of oil by different barks.

Species	Area covered by 0.01 ml drop
Alder	12.4 cm^2
Vine maple	11.5 cm^2
Big leaf maple	9.6 cm^2

It is probable that differences of structure and chemical property of bark from different species would result in greater or lesser absorption of oil. The weed killer could be inactivated by absorption in the bark. Thus with the same surface load of herbicide, the bark permitting greatest entry and absorbing the least material would probably result in the highest kill to the plant. In order to determine whether there was a significant difference between species,bark of comparable age from three different species was studied as to their ability to absorb oil. Table 2 presents this information in terms of the grams of oil absorbed per cc of bark.

Table 2.--Absorption of oil by bark of different species

Species	Grams oil absorbed/cc of bark
Alder	.0825
Maple	.1420
Oak	.1410

It is thought that absorption might play a significant role in determining the effectiveness of basal treatment on different species of plants. Certainly the data presented in Table 2 would tend to bear this out. It is interesting to note that the degree of absorption by the bark correlates significantly well with the species response, the alder being the much easier of the species to control with herbicide. (Agricultural Chemistry Department, Oregon Agricultural Experiment Station, Corvallis.)

<u>Soil toxicity studies with four phenylurea herbicides.</u> <u>Sheets, T. J.</u>, and Crafts, A. S. The initial and residual toxicities of monuron, diuron, fenuron, and 3-(3,4-dichlorophenyl)-1-methylurea (DMU) were investigated in 17 soil types. The soils were treated with 0, 0.167, 0.5, 1.5, 4.5, 13.5, and 121.5 ppmw of the herbicides; the dry chemicals were thoroughly mixed with the dry soils. Each culture consisted of 500 gms of treated oven-dry soil contained in No. 2 metal cans. The experimental design was a randomized split block with three replications.

Immediately after treatment all cultures were watered to field capacity and 13 oat seeds planted in each. At the end of one month fresh weights were determined and the data used as a measure of the initial toxicity. The cultures were allowed to dry for one month. At the end of this period all cultures were pulverized, the crop residues were returned to the soil, water was added to bring the cultures to field capacity, and oats seeded again. This system of testing, with oats as the indicator crop, was continued for a total of seven crops.

The initial toxic level of the herbicides varied widely with soil type. Lighter soils generally required less chemical to produce injury or death of the plants. The dosage of monuron and fenuron, required to produce a given level of phytotoxicity, varied much less from soil to soil than did the dosage of diuron and DMU. When compared across all soils, the relative initial toxicity was as follows: monuron > fenuron > diuron > DMU. The residual toxicity of the compounds after seven croppings (13 months) was as follows: diuron > monuron > DMU > fenuron.

Table 1.—Original chemical concentration (ppmw) required to produce a 50 percent reduction in fresh weight of the oat crop indicated. Each mean is an average of 17 soils and 3 replications.

Herbicides	Number of croppings							Difference
	1	2	3	4	5	6	7	crop 7–crop 1
Fenuron	.6	2.4	6.2	7.6	15.5	21.9	28.1	27.5
Monuron	.5	1.1	2.5	2.8	3.8	4.6	5.7	5.2
DMU	2.5	2.7	4.4	5.4	5.3	6.8	7.6	5.1
Diuron	1.2	1.7	2.5	2.8	3.0	3.8	4.1	2.9

The rate of detoxification of the four herbicides varied. Fenuron toxicity was lost far more rapidly than toxicity of the other three. Detoxification rates of monuron and DMU were about equal. Diuron was the most residual of the four herbicides.

It should be noted that this summary is based on an average of all soils studied and that these results vary somewhat among the individual soils. (Field Crops Research Branch, ARS, U.S.D.A., and California Agricultural Experiment Station, Davis, cooperating.)

Soil decomposition of herbicides. Burschel, Peter, and Freed, V.H. The decomposition of herbicides in the soil is known to be a function of time and conditions. That it is also a function of the original concentration is obvious from the inspection of published data. This permits us to express the concentration at any time t in terms of concentration at o time C_o by formula 1.

$$(1) \quad C_t = C_o e^{-Kt}$$

It should be possible, by determining the temperature influence on the parameter k, to devise a means of estimating the amount of chemical remaining after a length of time under given conditions. This would be of considerable value in estimating the safety of planting crops following a treatment or in evaluating the length of soil life of a sterilant. The relationship of k, which is rate constant, may be shown to take the form of formula 2, where ΔH_a is the heat of activation necessary to initiate the breakdown of the chemical or is equal to 1.97 calories, and T is temperature.

$$(2)\ \log \frac{k_2}{k_1} = \frac{\Delta H_a}{2.3R} \left(\frac{T_2 - T_1}{T_2 T} \right)$$

IPC and CIPC were selected for study in terms of breakdown in the soil. These chemicals were mixed with soil at appropriate levels; the soil made up to the desired moisture level and stored at predetermined temperatures. At intervals of time, samples of the soil were withdrawn and assayed for the level of concentration which was compared to standard treatments.

Table 1 presents data obtained in this study at two temperatures using the chemicals at 4 ppm. Concentration in this table is expressed in terms of percent of the original remaining after each interval.

Table 1

Compound	Temp. °C.	Conc., ppmw	Percent of original remaining after no. of days indicated			
			4	8	12	16
IPC	15	4	100	100	46.5	44.3
	29	4	100	42.5	24.3	8.8
			weeks			
			1	3	5	7
CIPC	15	4	100	100	82.5	68.8
	29	4	95.0	55.0	32.5	0.0

After making suitable transformations so as to be able to make the necessary calculations, the parameter k was calculated for the two temperatures and the heat of activation calculated for the two compounds. This information is presented in table 2.

Table 2

Compound	Temp. °C.	$R(day^{-1})$	ΔH_a Cal/Mol.
IPC	15	6.4×10^{-2}	
	29	11.9×10^{-2}	7720
CIPC	15	5.28×10^{-3}	
	29	2.98×10^{-2}	21520

These data are in good agreement with the well known information concerning the relative length of residual life of IPC and CIPC. It thus appears that this method may have some value in comparing residual lives of chemicals. (Agricultural Chemistry Department, Oregon Agricultural Experiment Station, Corvallis.)

Activation of Mylone, a temporary soil sterilant. McKenzie, Robert E. Mylone (3,5 dimethyl tetrahydro-1,3,5,2H thiadiazine-2-thione) is a white, crystalline powder. It was synthesized by Carbide and Carbon Chemicals Company research laboratories and first put to use as an industrial fungicide.

Hershler (2) reported on its effectiveness as a slimicide in the pulp and paper industry. He concluded that the lag from time of addition of Mylone to the pulp slurry to the time of maximum kill was greater than 24 hours. Anderson and Okimoto (1), in a paper presented before the AIBS meeting, reported that Mylone suspended above cultures of *Phytophora cinammoni* was 40 times more toxic when wetted as compared to the air-dry chemical.

Recent work by Ruch and Johnson (3) has confirmed the observations of the above authors and given us a better understanding of how Mylone is activated in the soil. The activation or degradation is dependent upon the presence of moist soil or free water and like any organic chemical reaction is a function of time and temperature. Formaldehyde is the first breakdown product that appears and is detected within 15 minutes after Mylone is placed in soil at room temperature. The release of formaldehyde seems to be a slow and steady process as the concentration will remain at the same level for several days. Methyl amino methyldithiocarbamate appears next and continues the activation process by forming monomethyl amine, methyl isothiocyanate and hydrogen sulphide. Monomethyl amine and hydrogen sulphide being very reactive chemicals react with some of the available formaldehyde to form methyl amino methanol, dimethyl amino methane and 1, 3, 5 trithio cyclohexane. Eventually this reaction proceeds to carbon dioxide, ammonia, sulphur dioxide and water. The methyl isothiocyanate reacts with water to yield carbon dioxide, hydrogen sulphide and methyl amine. The methyl amine again reacts to yield carbon dioxide and ammonia.

It appears that the interaction of these reactive breakdown products at the site of the organism to be controlled is responsible for the high biocidal properties of this chemical. Its herbicidal action is nonspecific and nonsystemic. Considerable evidence has been accumulated to show that it is effective against such annual weeds as crabgrass, foxtail, purslane, chickweed, carpetweed; such perennial weeds as bindweed, Bermuda grass, Johnson grass and nutgrass. It is suggested for further tests as a temporary soil sterilant in areas where the toxicity or noxious fumes of other fumigants such as methyl bromide or chloropicrin cannot be tolerated. (Carbide and Carbon Chemicals Co., San Francisco 6, California.)

Literature Cited

(1) Anderson, A. J., and Okimoto, M. 1953. Laboratory studies of effectiveness of 3,5-dimethyl tetrahydro-1,3,5,2H thiadiazine-2-thione against certain plant parasitic fungi and nematodes. Phytopathology 43: 465.

(2) Hershler, R. J. 19__. Microbiological control studies; evaluation of a new biocide. Crown Zellerback Corp. Publ.

(3) Ruch, J. E. and Johnson, J. B. 1956. Unpub. data. Carbide and Carbon Chemicals Co., South Charleston, West Virginia.

PROJECT 8. RESEARCH TECHNIQUES

J. W. Whitworth, Project Leader

SUMMARY

Reports were received from three states.

Colorado submitted one paper on methods used in making a weed survey. The methods included field trips, mapping according to information from herbarium specimens and from the information taken from questionnaires sent to county agricultural agents. Data from these sources have indicated the invasion of new species, location of weeds that have general distribution, and the extent and location of weeds poisonous or injurious to livestock. Such detailed information should make possible more efficient planning for control of troublesome species of general distribution and erradication of isolated patches of invading species.

A second paper from Colorado consisted of a report of preliminary findings of the weed survey made in the first paper. In a proposed pest control district east of Loveland, Convolvulus arvensis, Cirsium arvense and Franseria discolor were the most abundant and widely distributed of the perennial species encountered. However, more money for weed control appeared to be spent on annual weed species than on perennials.

Weed control efficiency of various herbicides applied as post-emergence or early lay-by applications in cotton were measured by three methods in a report by New Mexico. There was close agreement among the three methods, and the visual estimate method would be preferable where such data is acceptable. Where detailed enumeration data is desired, the weight per square foot of harvested weeds would be cheaper to determine than stand count. Yields of cotton were depressed by some treatments because of poor weed control as well as by toxicity of the herbicide. Under such conditions, the weight of the competing weeds did not separate these two effects any more effectively than did the stand count of the remaining weeds.

Oregon submitted a paper on methods for culturing perennial weeds for weed gardens. Some test species were best handled by transplanting from plant bands after seeding and transplanting in the greenhouse, others could be directly seeded into the field by seedlings or rootstock. Field bindweed (Convulvulus arvensis) which did not transplant in the field by use of rootstock under Oregon conditions has been successfully handled in New Mexico when the rootstock was of adequate size and age. Weed control in the perennial weed garden was successfully carried out by the use of CIPE combined with DNBP and diuron applied during the dormant season.

REPORTS OF INDIVIDUAL CONTRIBUTORS

Study on the distribution of weeds in Colorado. Harrington, H. D., Thornton, Bruce, Klinger, Bruno, and Klein, William. A study of the distribution of each of the important weeds in Colorado was carried out during the growing seasons of 1954, 1955 and 1956. The weeds selected were usually perennial plants with horizontal creeping rootstocks; the majority of them appear on the primary or secondary noxious weed list as indicated in the Colorado Seed Law. Information on their distribution was obtained in three ways.

1. Numerous field trips were made to the major agricultural areas of Colorado. Patches or infestations of these weeds were noted from the highways and roads, and this information was transposed on enlarged county maps. The main highways and selected side roads were checked in this way. Information obtained from an intensive check of a limited area indicates that roadside surveys give a reasonably complete picture of the weeds present in an area.

2. When the senior authors "Manual of the plants of Colorado" was prepared, maps recording the location of the herbarium specimens of each species in the state were used as part of the background material. The maps relative to weed species are yielding valuable information relative to this problem. In addition, the specimen labels often indicate relative importance or abundance of the weed in the area.

3. As part of this project interested and informed workers were located for oral discussions as to the presence and importance of serious weeds in their local areas. The County Agricultural Agents were usually the ones so contacted. A questionnaire asking for such detailed information was sent to each of these field men in 1956, and the data are now being tabulated.

The general purpose of this survey was twofold. First, to locate the initial infestation of certain weeds in new areas. For example, Blueweed (Helianthus ciliaris) and Rush pea (Hoffmanseggia densiflora) are appearing in isolated patches in southeastern Colorado. It is hoped that control measures can be instituted to prevent their spread. Secondly, as detailed information accumulates, one can better evaluate the actual importance of certain relatively common weeds such as Field Bindweed (Convolvulus arvensis) or Canada Thistle (Cirsium arvense) in each of the agricultural areas of the state.

A second phase of the general problem was a study of those plants causing poisoning of livestock. From the survey information obtained, the location and severity of infestation of plants more or less poisonous or injurious to stock are being noted on suitable maps. A small part of the less accessible mountain area has been surveyed, noting especially the occurrence of larkspurs and of false hellebore. Intensive survey and careful mapping of an infestation and the spread of Hypericum perforatum from Boulder southward has been made. A preliminary survey of distribution of Alta Fescue (cause of Fescue Foot) has also been accomplished.

Ranchers and federal and state service employees rate tall larkspur as the poison plant needing first attention, while in restricted areas, Alta Fescue is rated as most damaging.

When such detailed information on weeds in cultivated areas and poisonous plants on the ranges is reasonably complete, it should be possible to more efficiently plan the overall control program for Colorado. (Colorado Agricultural Experiment Station)

Some preliminary findings of an intensive weed survey. Klein, William M. During the summer of 1956, an intensive weed survey was made in an area designated as a 'Proposed Pest Control District' east of Loveland, Colorado. The object of this survey was to obtain information as to the nature and magnitude of existing weed problems.

This area supports a diversified type of agriculture and includes both irrigated and non-irrigated lands. On the dry-land areas, where wheat is the principle crop, the annual weeds create the greatest problem. These include *Kochia scoparia*, *Amaranthus retroflexus* and *Salsola kali*, which were present in practically all of the fields examined. Of the perennial creeping weeds, *Franseria discolor* was the most frequently encountered. The most important crops in the irrigated portion of the area are alfalfa, corn, barley, beets, and beans. The data which has so far been summarized indicate a much greater variety of both annual and perennial weeds than was found in the dry-lands. Some of the annual weeds are *Kochia scoparia*, *Setaria* sps., *Amaranthus retroflexus* and *Avena fatua*. These appear to be causing the greatest losses and probably consume more of the money used for weed control than do the perennials. Of the creeping perennial weeds, *Convolvulus arvensis*, *Cirsium arvense* and *Franseria discolor* are the most abundant, being widely distributed throughout the entire area. (Colorado Agricultural Experiment Station)

Methods for evaluating the effect of herbicides on annual grasses infesting cotton. Whitworth, J. W. Is a visual estimate an adequate method for evaluating the weed control effectiveness of various herbicides? A comparison of this method vs stand count and weight of weeds is shown in figure 1. Even though the visual rating was made only four weeks after the application of the treatments as compared to four months for the other methods, there is general agreement amoung the three methods. Because of this time difference, the three slow acting chemicals -- monuron, fenuron, and diuron -- do not fall in line with the readings established by the other methods.

A visual estimate appears to be an adequate measure of the control of weeds under the conditions of this experiment. The sampling of the weed stand by weight per unit area was more rapid than the stand count method and would be preferred where detailed enumeration data are required. However, it failed to be any more effective in pointing out differences in

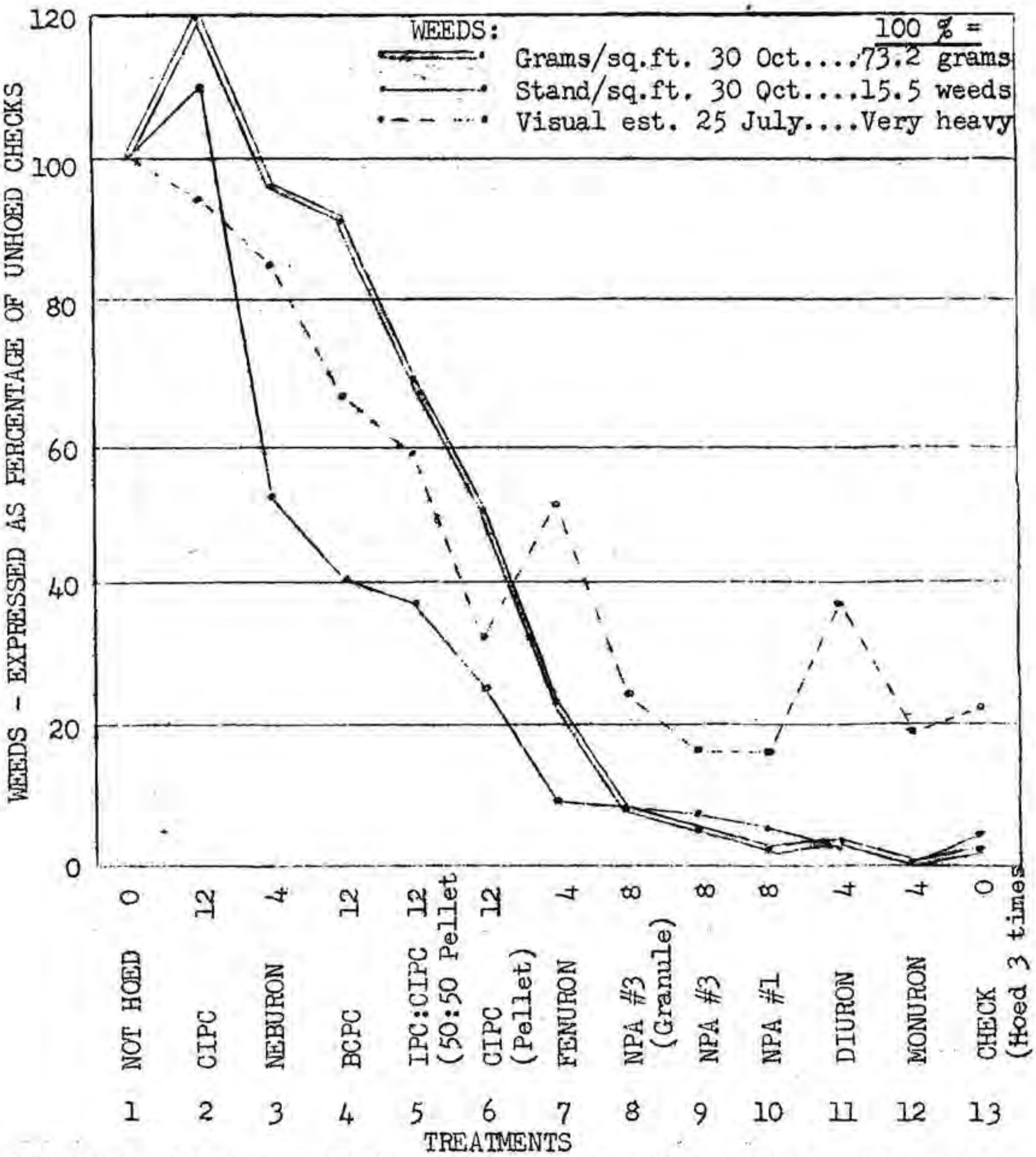

FIGURE 1. Stand and weight of annual weeds(grasses) expressed as a percentage of unhoed check plots following lay-by applications of herbicides applied on 28 June 1956. (Av. of 9 replications)

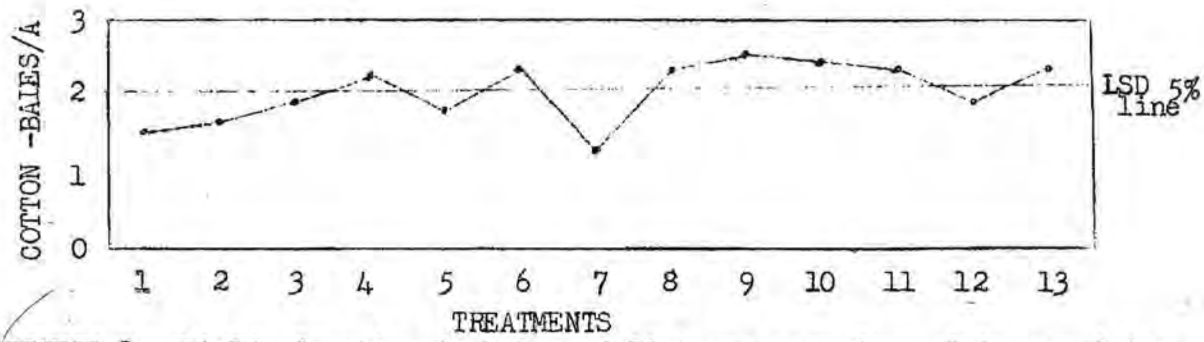

FIGURE 2. Yield of cotton in bales of lint per acre from plots receiving lay-by applications of herbicides corresponding to the treatment numbers in figure 1.

weed competition that might have influenced yield of cotton, see figure 2. Oft times, it would appear that a weed count per unit area fails to reflect the competitive effect of the remaining weeds as well as plant weight of the weeds. If this were true, apparently the variation in competition was not pronounced enough to show such a difference in the two methods. (New Mexico Agricultural Experiment Station)

Culturing perennial weeds for weed gardens. Furtick, W. R. and Chilcote, D. O. One of the major problems faced in perennial weed control research is obtaining uniform perennial weed populations on which to conduct trials. Even where uniform perennial weed stands exist, it is often difficult to find them on land that can be used with the assurance that plots will be maintained in the manner required for the experiment established.

In order to overcome some of these handicaps, the Farm Crops Department of the Oregon Agricultural Experiment Station established a perennial weed garden on their experimental farm in 1952. Since that time studies have been made on the best methods of transplanting or seeding perennial weeds. The most effective method for culturing most perennial weeds is to either transplant seedling weeds where seedling populations can be found under natural conditions, or to transplant materials started in plant bands in the greenhouse either from seedlings, cuttings or crown divisions. The big advantage of using greenhouse transplants or direct field transplants over seeding is the ease of weed control. Many perennial weeds have small seeds and weak seedlings. The control of annual weeds in a weed garden is very expensive and difficult. Direct comparisons of field transplanting compared to greenhouse crown divisions were made with yellow toadflax, Lanaria vulgaris, in August 1956. Plant material was obtained from a dense infestation of yellow toadflax. Crowns were divided so that a single stem with attached root system was transplanted in the field, space planted on a thirty-six inch check. Each plant was well watered and fertilized at the time of transplanting. In addition, 500 plants were transplanted in the same manner using plant bands in the greenhouse. The mortality under field conditions, in spite of repeated watering, was 95%. The mortality under greenhouse conditions was less than 5%. Plants in the greenhouse established rapidly and after new shoot and root development was progressing rapidly, the material was transplanted into the field without mortality.

Preliminary work has indicated that certain perennial weeds can be readily cultured from seed under greenhouse conditions by planting the seed in flats and then transplanting into plant bands for additional growth. Test species that have been readily cultured under greenhouse conditions are: curled dock, Rumex crispis, sheep sorrel, Rumex acetosella, English daisy, Bellis perrenis, and False dandelion, Hypochoeris radicata.

Direct field transplanting has been highly successful with seedlings of tansy ragwort, Senecio jacobia,. Canada thistle, Circium arvense root stock has been successfully field transplanted. Field transplant with root stock of perennial morning glory, Convulvulus arvensis was not successful.

Direct seeding in the field has been successful with wild garlic, Alium vineale. The aerial bulblets were used in this seeding.

Control of annual weeds in the weed garden has been important in the establishment of stands. It has been most satisfactory to plant the perennial weeds in rows on a check so that they can be cultivated. In addition, during rainy periods when cultivation is not possible, CIPC combined with DNBP and diuron have both been highly effective for weed control when applied during dormancy. (Oregon Agricultural Experiment Station.)

PROJECT 9. ECONOMIC STUDIES OF WEED PROBLEMS AND CONTROL

D. C. Myrick, Project Leader

SUMMARY

Two abstracts were received, the start of one project and the completion of another. In Arizona a study of the economic implications of the several methods that have been used to control pinyon-juniper is being undertaken cooperatively by the Arizona Agricultural Experiment Station and the Agricultural Research Service, U.S.D.A. Canada thistle control studies in Montana show that with intense infestations the potential returns from control approach $40. per acre, while with light infestation the direct returns are marginal.

For the third successive year the study in Oregon of the control of tarweed in wheat, physical difficulties upset the experiment in the phase dealing with varying intensities of infestations. The project is being continued.

REPORTS OF INDIVIDUAL CONTRIBUTORS

Economic consequences of 2,4-D in controlling Canada thistle in irrigated spring wheat. Baker, Chester B., and Infanger, Carl. (Abstract of M.S. thesis by Carlton A. Infanger, Montana State College, July, 1956.) The problem of this research is to develop returns estimates from applying 2,4-D to Canada thistle in spring wheat. In exploring the problem area, an analytic model is constructed in which the returns from a given spray treatment with 2,4-D are expressed as a function of (1) thistle infestation, (2) rate of reduction in thistle count, (3) rate of crop reduction from non-selectivity in the spray, (4) subsequent crop response from reduced thistle count and (5) price received for the crop. The establishment of relevant assumptions necessitated a development of relationships between the chemical properties of 2,4-D and the physiological and ecological properties of weeds and crops.

In developing the problem, two restraints were used: (1) the quantity of 2,4-D per treatment is fixed at 3/4 pounds per acre; and (2) agronomic practices were taken as given according to practices commonly used in the Gallatin Valley on irrigated crops.

The findings suggest that the operator's decision is sensitively related to the rate of thistle infestation. Within limits set by the problem it appears that he can afford to pay from $1.22 per acre to $38.40 per acre as thistles vary from 2.84 to 38.20 shoots per sixteen square feet of area, if spring wheat sells for $2.00 per bushel. A more productive production environment or a lower price for wheat would lower these maxima in costs; lower productivity or higher prices would raise the maxima. These qualifications stem from the small non-selective properties of 2,4-D and require further evidence for conclusive substantiation.

Economic study of pinyon-juniper control in northern Arizona.

Stubblefield, Thomas; Upchurch, M. L.; Cotner, Melvin. This cooperative study was initiated in 1956 to evaluate the costs and returns resulting from the control of pinyon-juniper on northern Arizona rangelands. The general objective is to develop information which will help ranchers, land administrators and others interested in land resource use to make rational management decisions in improving their land for domestic livestock grazing. More specifically, net returns will be determined for the various methods of control for selected pinyon-juniper range sites. The range and livestock management practices necessary to obtain maximum forage production will be considered in determining net income.

Pinon-juniper is the dominant vegetative cover on about 30 million acres of Arizona and New Mexico land. These lands lie roughly between 4,500 and 7,000 feet in elevation below the higher forested mountains in Arizona and the surrounding states. Pinyon-juniper sites vary with some having dense mature trees to others with few young invading trees. Stem diameters range up to 30 inches or more. One species of juniper--Alligator Bark (J deppeana)--sprouts from the root crown.

Through 1956 approximately 500,000 acres of pinyon-juniper have been controlled in northern Arizona. Mechanical methods, fire and chemicals have been used. Hand axes and grubbing hoes frequently are used on young invading stands and on projects following other methods when the desired kill was not obtained. Large crawler tractors equipped with hydraulic tilting dozer blades are used. The hydraulic blade tilted permits the tree to be removed with the least disturbance of the soil. Either corner of the blade may be tilted resulting in less maneuvering of the tractor. Blade extensions or prongs are sometimes attached to each corner of the blade to facilitate the operations. Some tractors are equipped with a pusher bar in front of the tractor to push larger trees in order that the tree may be uprooted in one forward motion. Cable and chain drags are used between two large crawler tractors and are effective in pulling over even-aged, mature stands on level terrain. Swaths up to 125 feet in width can be taken at top speed depending upon the size of tractor, surface rock, tree density and stem diameter, terrain, soil moisture and soil type. Prescribed broadcast burning and individual tree burning with a butane torch have been used. Bait and burn is a method where the small trees are cut by hand and piled under larger trees for burning. Various chemical methods have been tried but desired standards of control have not been reached. Reseeding is recommended following broadcast burning while reseeding is not necessary after other control methods,providing natural revegetation can take place.

Control of pinyon-juniper will increase forage production on sites where forage is crowded out by dense trees. Control of young invading trees serves to protect against forage loss if the trees were to mature. Only fragmentary work has been done by various agencies on the physical inputs and returns for this range improvement practice. Ranchers and technicians have voiced concern about the total net benefits from control particularly on low-potential sites. (Arizona Agricultural Experiment Station and the Production Economics Research Branch, ARS, USDA.)

PROJECT 10. VEGETATION CONTROL ON RIGHTS-OF-WAY AND INDUSTRIAL SITES

L. E. Harris, Project Leader

A total of three reports were received from the three different states.

Soil sterilization with various chemicals. Baker, Laurence O. The ability of several herbicides to cause soil sterilization was studied in an experiment begun in 1955. Vegetation was composed primarily of Canada thistle and Kentucky bluegrass, although some other plants were present. The treatments listed in the following table were made in triplicate to 10 feet x 10 feet plots (100 square feet). Before the chemicals were applied on October 12, 1955, the plot area was mowed and the topgrowth removed.

The chemicals used, their rate of application and the relative proportion of each follows:

Treatment No.	Chemical	Rate Per 100 sq ft	Amount of each chemical $NaClO_3$	B_2O_3	Monuron*	Erbon**	Tot
1	Sodium chlorate	3 lbs	3.0				3.0
2	Polybor-chlorate	4	1.0	1.96			2.96
3	Monobor-chlorate #1	2 gal	1.98	1.03			3.01
4	Chlorea	4 lbs	1.6	.5756	.87		3.05
5	Monuron	.1377 lbs			2.99		2.99
6	Ureabor	2.34 lbs		.9688	2.0347		3.003
7	Concentrated borascu	4.88 lbs		3.001			3.001
8	Erbon	.2755 lbs				3.0	3.0
9	Sodium chlorate	1.71 lbs	1.71				
	Concentrated borascu	2.11 lbs		1.30			3.01
10	Concentrated borascu	3.25 lbs		1.999			
	Monuron	.0597			1.298		3.298
11	Concentrated borascu	8.0 lbs		4.88			4.88
12	Ureabor	1.5 lbs		.621	1.30		1.92

* Amount applied in pounds divided by .046. Applied at an actual rate of 60 pounds active ingredient per acre.

** Amount applied in pounds divided by .0918. Applied at an actual rate of 120 pounds active ingredient per acre.

About 9 inches of precipitation was received on the plot area between the time of treatment and May 1 when the first spring observations were made. At that time, the grasses had been controlled on all plots receiving boron trioxode, sodium chlorate or erbon; monuron was less effective at that date. Some annual weeds and sweetclover were begining to germinate on all plots receiving only boron trioxode, chlorate or both.

By June 14 no Canada thistle shoots had appeared on treatments 1, 2, 3, 4, 9 and 11. However, thistle seedlings, lots of sweetclover and several annual weeds were growing on each of these treatments except No. 4. All other plots had some thistles surviving, although most of them were injured. Treatments 10 and 12 were somewhat less efective in controlling thistle than the other treatments.

Observations made September 1956 showed treatment 4 to be almost free of all vegetation. Some Canada thistle, dandelion and wild rose plamts were surviving on plots receiving treatments 5 and 6; however, they all showed urea-type leaf burn. Treatments 2, 3 and 9 containing both boron and chlorate.produced about equal total results, although more sweetclover grew under treatment 3. A few Canada thistle survived under all three treatments.

Treatments 1 and 7 were approximately equal for controlling all plants except Canada thistle which was controlled better by treatment 1. Both treatments were less effective than where other chemicals were combined with them.

Treatment 8 permitted a considerable number of Canada thistle plants to survive but caused the flower buds to abort. Snowberry appearing on one plot was not affected. No annuals survived this treatment.

Treatments 10, 11 and 12 were not applied at the same rate of active chemical per acre and are not exactly comparable. Treatment 10 controlled all plant growth except Canada thistle and on one plot wild rose. All surviving plants were injured. Treatment 11 was more effective in controlling thistle, but permitted sweetclover and annuals to grow. Treatment 12 permitted considerable Canada thistle to survive and on one plot wild rose, snowberry and skeleton weed were not killed but were injured. All annuals were controlled, however. (Montana Agricultural Experiment Station, Bozeman, Montana)

Comparisons of eleven soil sterilants under varying conditions of soil, precipitation, and weed complex. McHenry, W.B. A study was initiated during the 1955-56 winter to evaluate a number of soil sterilants in side-by-side comparisons under field conditions. The herbicides and rates are included in the following table:

Herbicide	lb of commercial material/A				
Karmex W	10	20	40	60	
Karmex DW	10	20	40	60	
Karmex FW	10	20	40	60	
Ureabor	218	436	871		
Chlorea	436	871	1306		
Polyborchlorate	436	871	1306	1742	
Chlorax 40	436	871	1306	1742	
DB Granular	436	871	1306	1742	
2,4-D Amine	10	20	40	80	160
2,4-D Acid paste	10	20	40	80	160
Baron (erbon)	40	80	120		

The materials were applied to 3 sq-rod plots in 3 replications on 5 ditchbank locations in California. Each test site represents a differant soil varying in texture (sandy-loam to adobe clay), fertility, and plant cover. Average annual precipitation varies from 9 inches (Fresno County) to 35.5 inches (Mendocino County).

Three additional ditchbank sites were added to this study during the 1956-57 winter since the previously established plots had received inadequate precipitation to activate the chemicals. The same materials and rates were used; at two locations Urox at 50, 100, 150, 200 lb/A was included; at one site Simazin at 10, 20, 40, 60 lb./A was added. In addition, one-third of the area in the 1955-56 plots were treated in 1956-57 with the same respective herbicide at one-half the original acre rate.

It is intended that these various plots shall be retreated in part over the next several years to better understand the relative merits of these sterilants when subjected to such varying conditions as may be found from one location to another in California.

Observations to date are inconclusive because of inadequate precipitation to carry the less leachable materials into the soil. However, Chlorea and Baron have been consistently effective on Johnson grass even under low rainfall.
(University of California Agricultural Extension Service)

The control of miscellaneous weeds growing along ditchbanks. Timmons, F. L., Weldon, L. W., and Lee, W. O. Seven chemical treatments and one burning treatment were made to miscellaneous weeds causing obstruction to water passage along a ditch June 16, 1955. The vegetation consisted mostly of barnyard grass (Echinochloa spp.), foxtail grass (Setaria spp), bromegrass (Bromus spp), pigweed (Amaranthus retroflexous), and smartweed (Polygonum pennsylvanicum). The initial treatments included 20 and 40 pounds of sodium 2,2,-dichloropropionate (dalapon), 10 and 20 lbs. of 3-amino-1,2,4-triazole (ATA), 20 pounds of 2-chloro-4,6-bis (diethylamino)-s-triazine (CDT), 3 pints of DNPB in 120 gallons of diesel oil, and propane weed burning, 3 minutes per square rod.

During the 1955 growing season the 10 and 20-pound rates of ATA keptthe ditch free from obstruction for 9 weeks after treatment. Dalapon at 40 pounds per acre kept the ditch free from obstruction for 6 weeks, while 20 pounds of CDT gave good control for only one month. Three burnings during the growing season were necessary for satisfactory weed control. Three sprayings with the DNBP-fortified diesel oil gave good weed control with little regrowth.

2,4-D was applied early in 1956 to plots treated in 1955 with dalapon, ATA, and CDT to kill the broad-leaved annual weeds. No grasses had survived the treatments. These plots did not need retreating until August 2, 1956. Instead of the original 20 and 40 pounds per acre of dalapon, 5 and 10 pounds with 2 pounds of 2,4-D were applied in 1956. The light rate of dalapon appeared to give as good control as that obtained with the heavier rate. ATA was applied at 5 and 10 pounds per acre instead of the original 10 and 20 pounds per acre. Instead of complete vegetative removal these treatments have tended to inhibit vegetative growth, and at the same time kept the ditch free of plant obstruction to water movement.

Three burnings in 1955 followed by two burinings in 1956 have given good weed control. Regrowth was slower and the vegetation much sparser after each burning. Plots treated 3 times with DNBP-fortified diesel oil in 1955 were retreated 3 times during 1956 at the same rate. The DNBP-fortified diesel oil treatment has given results comparable to that of the propane weed burner.
(Contribution from the Field Crops Research Branch, USDA, ARS, and the Wyoming Agricultural Experiment Station, cooperating.)