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WHITETOP
AND ITS CONTROL

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Cultivation, cropping, and 2,4-D were employed during a 5-year study (1948-1952) of Whitetop control on a severely infested area of irrigated land near Meridian, Idaho. Each of the three practices was tested alone and in various combinations to determine simple farming programs whereby this weed could be controlled and eradicated. The combining of these three methods into a farming program for the control of Whitetop showed definite advantages over the application of any one of the methods used alone.

COVER PHOTO

Whitetop (*Cardaria draba* (L.) Desv.) in full bloom.

Whitetop and Its Control[1]

JESSE M. HODGSON[2]

Introduction

WHITETOP (*Cardaria draba*) is a native of Central Europe and the Mediterranean-Caspian Sea area. The plant is recognized as a weed in many sections of the world, as in Australia (13), New Zealand (14), South America (7), the British Isles (14), and in Canada (5.)

Infestations of whitetop occur in all of the western states. The main source of infestation no doubt has been through importations of seed contaminated with this weed. An imported alfalfa seed sample found in Wyoming (16) in 1942, estimated to be 40 years old, contained 200 whitetop seeds per pound. Rollins (9) reports that the oldest collected specimen is from Yreka, California, in 1876.

Nevada (3) reported a few whitetop infestations over 30 years ago. Colorado (8) reported its first infestation in 1898. By 1920 the plant was widely scattered. Kansas, in 1941, reported whitetop as one of the three most serious noxious weeds of the state. A survey (2) conducted in Idaho in 1951 showed the weed to be present in 38 of the 44 counties, the infestations totalling 122,981 acres. A weed survey (1) of the Columbia Basin in 1952 brought out that 230,768 acres were infested in the area.

The results of many studies giving the effects of cultivation, cropping, and chemical treatments, and combinations of these methods, in controlling whitetop are available. They show varying degrees of success. Seely (11) found that cultivations at intervals of 21 and 28 days resulted in eradication in 27 and 21 months, respectively. Timmons and Bruns (12) reported eradication in 2 years or less by shallow hoeing at intervals of 2, 3, or 4 weeks. Harvey (6) found an alfalfa-corn rotation effective in reducing stands of whitetop in Washington. Fleming and Brennen (3), in Nevada, reported that various mixtures of clovers and grasses that were planted on whitetop infested land, became established in 3 to 5 years and virtually crowded out the whitetop. Rosenfels and Headley (10), also in Nevada, reported that bromegrass, meadow fescue, western wheatgrass and Reed canary planted on whitetop infested land after one season of clean cultivation practically eliminated the whitetop in 5 years. Various clovers were found somewhat less effective. The introduction of 2,4-D in 1945 supplied another potential means of controlling whitetop, especially when used as a supplement to cultivation and cropping methods.

This report presents the results of a 5-year study (1948-1952) conducted at Meridian, Idaho, on a severely infested area of irrigated land

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for control of whitetop in which cultivation, cropping, and 2,4-D were employed. Each of the three practices was tested alone and in various combinations to determine simple farming programs whereby this weed could be controlled and eradicated. The combining of these three methods of weed control into a farming program for the control of whitetop showed definite advantages over the application of any one of the methods used alone.

The soil on the plots where the tests were conducted is Chilcott clay loam, which is light brownish grey with a heavy subsoil and underlain by hardpan. This soil is affected by alkali, or slick spots, which restrict water intake and stunts crop growth. It is noteworthy that the major whitetop infestations in Idaho occur on soils having the general characteristics of the above described soil but this is not to say that whitetop has any specific soil limitations.

Whitetop has certain growth characteristics which make it vulnerable to particular cultural or cropping treatments. Some information on these growth characteristics, or life history of the plant, are presented.

Description of Whitetop

Whitetop is a herbaceous perennial, more or less upright growing plant reproducing by seeds, rootstocks, and creeping roots. The somewhat hairy stems attain a height of 8 to 24 inches, depending upon growing conditions. The leaves are conspicuously dark green, alternate to each other on the stem. They are simple, oval or oblong, with wavy to jagged edges. Typically, the upper leaves have broad clasping bases. Most of the branches arise near the top of the plant and reach the height of the central stem, giving a broad-flat effect, with the flowers appearing in flat-topped clusters. The petals are usually white and showy but may appear rose-colored in the bud stage. The seed-pods are heart-shaped, flattened laterally. The seeds are about the diameter and length of those of red clover, slightly flattened, granular and reddish-brown. The roots, vertical and horizontal, are long and numerous.

A typical cluster of plants is shown on the cover of this publication.

Whitetop is known in various localities by several common names such as: hoary pepperwort, hoary cress, hoary peppergrass, perennial peppergrass, and white weed.

Growth Habit

Whitetop is one of the first plants to start spring growth. In the Boise Valley, growth begins from February 20 to March 31. The course of development of the plants in 1952 is given in Table 1 together with the description of the growth stages, the plant size and percentage of dry weight of the roots. Measurements were made at weekly intervals from emergence to seed maturity. The plant size measurements are based on the average of 30 plants for each date. Plant size was evaluated by multiplying the diameter of the rosettes, the cluster of spreading basal leaves, by the height of the plant in inches.

In 1952, plants began emerging in late March and progressed even under rather low temperature conditions. The average temperature during the first week of observation was 35° F., the maximum was only 57° and the minimum temperature was as low as 17°. The rate of growth with the progressing of the season was closely correlated with temperature conditions. The course of development of the plants is shown

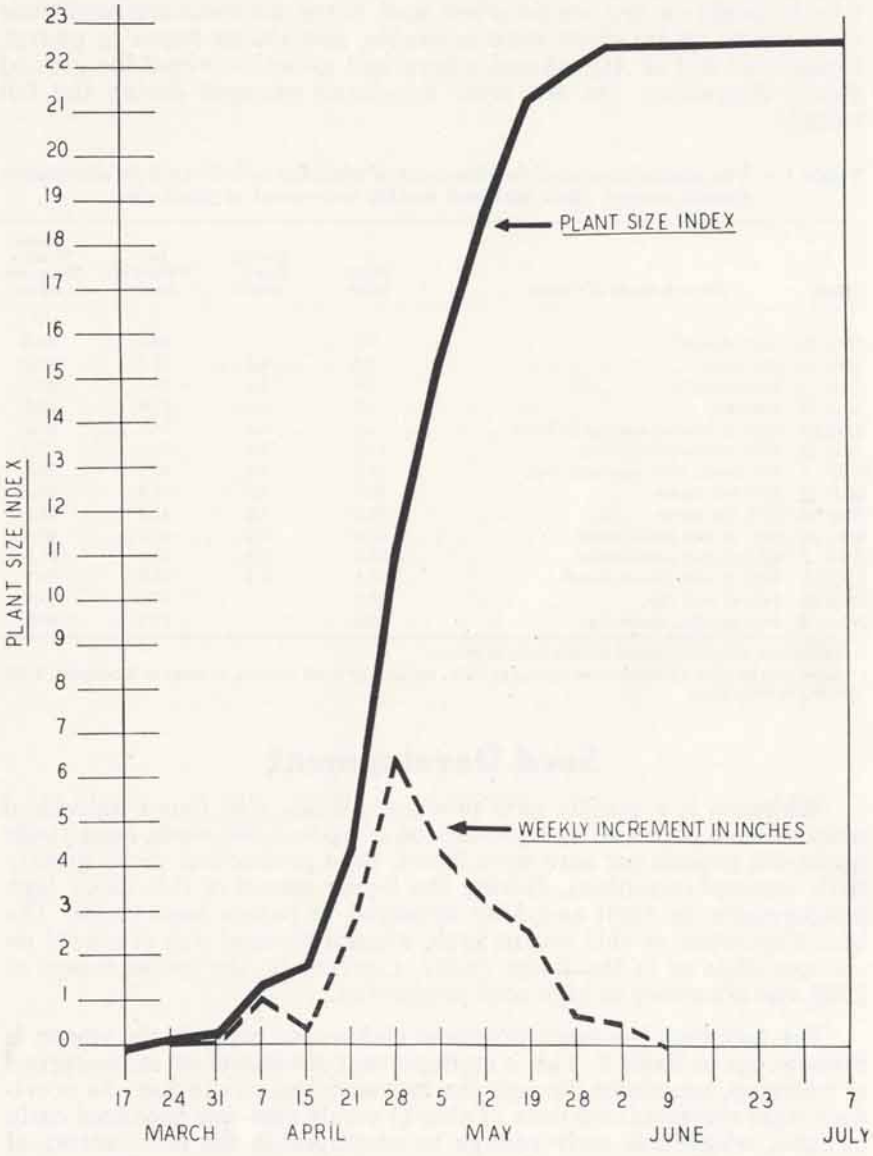

Figure 1.—The annual course of development of whitetop plants as shown by plant size and weekly increment of growth.

graphically in Figure 1. The figure shows that the rate of growth is slow during March, when temperatures were low but progresses rapidly during late April and May when average weekly temperatures ranged from 50° to 60° F.

Whitetop enters a period of summer dormancy upon producing its seed crop in late June to early July. This dormancy will prevail for 6 to 10 weeks on dry, undisturbed land. Since soil moisture conditions on the plots under study were favorable, new shoots began to emerge toward the end of August and a luxuriant growth covered the ground during September. On dry areas no shoots emerged during the fall months.

Table 1.—The annual course of development of whitetop as indicated by successive growth stages, plant size and weekly increment of plant size.

Date	Growth Stage of Plants	Plant Size[1]	Weekly Increment[1]	Dry Weight of Roots[2]	Mean Weekly Temperatures
				%	°F
Mar. 24	Just emerged	0.2	....	39.9	35.0
Mar. 31	Emerged	0.3	0.1	36.0	44.0
April 7	Small rosetts	1.4	1.1	35.2	47.0
April 15	Rosettes	1.8	0.4	34.9	46.7
April 21	70% of rosettes starting to shoot	4.5	2.7	32.9	52.7
April 28	80% of shoots with buds	11.0	6.5	34.0	59.8
May 5	5% bloom, 80% expanded buds	15.4	4.4	32.4	52.7
May 12	50% full bloom	18.7	3.3	37.8	57.4
May 19	85% full bloom	21.3	2.6	41.4	57.2
May 26	80% of seed pods formed	22.0	0.7	40.1	59.4
June 2	95% of seed pods formed	22.5	0.5	50.5	61.8
June 9	50% of seeds in soft dough	22.5	0.0	51.9	70.7
June 23	50% of seed ripe	22.5	....	47.4	60.8
July 7	Seed mature, plants dry	22.5	....	47.1	63.2

[1]Diameter of rosettes times plant height in inches.

[2]Dry weight after 24 hours oven-drying at 60°F. divided by fresh weight. Average of 6 samples, 0-18-inch depth each date.

Seed Development

Whitetop is a prolific seed producer. Willis (15) found individual plants with a potential seed production of up to 3,000 seeds. Seed yields up to 400 pounds per acre were found. Seed production varies greatly with seasonal conditions. During the 5-year period of this study high temperatures in April and May appeared to reduce seed yields. The best illustration of this was in 1949, when little seed was produced on the test plots or in the Boise Valley. Conversely, the cooler season of 1952 was favorable to high seed production.

The fact that the plant produces viable seed early in the season is brought out in Table 2. This is an important consideration in the spread of whitetop, especially through the movement of alfalfa hay. As is evident from the tabulated data (Table 1) viable seed was produced early in June, which was early enough to contaminate the first cutting of alfalfa hay. The seed samples were taken by cutting a major portion of the stems, which were then allowed to dry with the seeds intact.

Table 2.—Weights of whitetop seeds and their ability to germinate as influenced by date of collection. Germination tests were run 18 months after seed collection.

Date of Collection	No. of Days From Opening of First Flowers to Collection	Av. Weight Of 100 Seeds In Grams	Percent Germination by Sample 1	2	3	Average Percentage of Germination
May 28	23	0.040	0	0	0	0.0
June 2	28	0.047	0	2	1	1.0
June 5	30	0.071	0	1	0	0.3
June 9	35	0.116	50	1	18	23.0
June 16	42	0.106	32	35	24	30.3
July 7	63	0.168	80	92	99	90.3
Oct. 1	149	0.174	87	98	96	93.6

It is essential that clipping of whitetop plants be accomplished early in the season to prevent the production of viable seed. Some of the plants produced viable seeds within 28 days after the opening of the first flowers. The weights of the seeds and ability to germinate and produce plants increased rapidly after the first of June.

Root Development and Spread by Rootstocks

Whitetop is not only a prolific producer of seed but spreads rapidly by means of underground rootstocks. Frazier (4) reports that whitetop

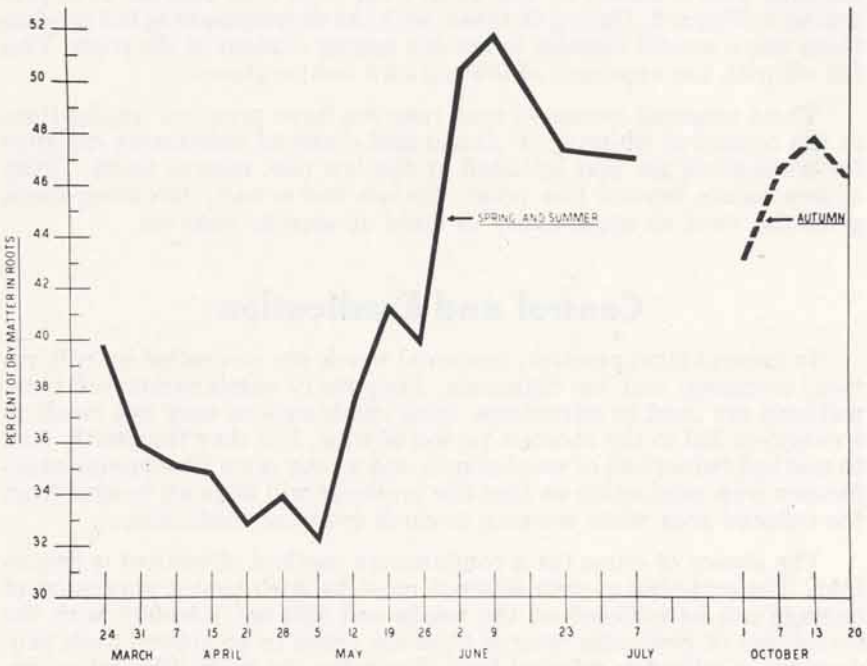

Figure 2.—Percent of dry matter in the roots of undisturbed whitetop plants during spring, summer, and early autumn.

roots may spread 18 inches vertically and 10 inches radially within 6 weeks after emergence as seedlings under favorable conditions of growth where other plants are not competing. These root systems may spread more than 6 feet radially in one growing season and more than 11 feet by the end of the second season. At the end of the second season many of the vertical roots had reached a depth of 10 to 12 feet.

The extensive root system is capable of storing large quantities of organic reserves. This accounts for the long period of time required for eradication by cultural methods.

The trend of the percent of dry matter in undisturbed roots during 1952 is given in Table 1, and shown graphically in Figure 2. Root samples were taken to a depth of 18 inches at weekly intervals from March 24 to July 7; that is, from the time of emergence to the maturity of the plants. Root samples were also taken of four different dates in October following resumption of top growth late in August.

The root sampling data indicate a general downward trend in the percentage of dry weight of the roots from the time growth began in early spring to the seasonal low on May 5, at which time the plants had started to produce flowers. After that stage of development the curve took a sharp upward swing to its seasonal high point on June 9, corresponding to the period when 50 percent of the seeds had reached the soft dough stage. Root reserves decreased during the summer months. This is shown by the trend from June 9 to October 1, as presented in Figure 2. During October, with the development of fall rosettes there was a second increase in the dry matter content of the roots. This fell off with the approach of low autumn temperatures.

These seasonal trends in root reserves have practical applications in the control of whitetop. Cultural and chemical treatments designed for eradication are best initiated at the low root reserve point. Delay of treatments beyond this point, the late bud or early flowering stage, gives the weed an opportunity to build up organic reserves.

Control and Eradication

In general farm practice, perennial weeds are controlled by cultivation, cropping, and by chemicals. Frequently combinations of these methods are used to advantage. Such combinations may not result in a complete kill in the shortest period of time, but they frequently lead to marked reductions of weed stands and at the same time enable satisfactory crop production so that the producer will have an income from the infested area while working towards eventual eradication.

The choice of crops for a combination method of control is important. The cropping system selected must be such that a maximum of damage can be inflicted on the weeds and still not interfere with the realization of profitable returns from the crops to be grown. Corn production on whitetop infested land illustrates the point. Whitetop, because of its tolerance of low temperatures, is able to make its major growth early in the season. Corn, on the other hand, is a high tempera-

ture-loving crop. It is, therefore, planted late in spring. This enables a producer to apply either chemical or cultural treatments designed to weaken whitetop prior to corn-planting time. A cereal crop such as spring wheat obviously does not fit into a program of this type as well as corn. Spring wheat yields would be reduced materially by delayed seeding. Again a cultivated crop like corn offers opportunities for the application of control methods during the growing season, both cultural methods and chemical means of weakening the weed may be used while the corn crop is growing.

Results with Use of 2,4-D

Three formulations, the amine, ester, and sodium salts of 2,4-D, were compared in one experiment. The best time of application was studied, using four variations per season. These were as follows: (a) one spring application at the late bud stage, (b) one fall application at the rosette stage, and (c) one application in spring, followed by a second application that fall, and (d) an initial application in fall followed by a spring application the next season. Two rates of 2,4-D 1.5 and 3.0 pounds of acid equivalent per acre, were used. All treatments were repeated every year during a 3-year period. The results, given in Table 3, were obtained from square rod plots replicated four times on each date of treatment.

Table 3.—The effects of rate, date, and formulation of 2,4-D on the control of whitetop.

Dates of Application		Year	Whitetop Survival in Percentages for Rates of 2,4-D in Pounds Per Acre						Average Per Year
			1.5 Amine	3.0 Amine	1.5 Ester	3.0 Ester	1.5 Sodium Salt	3.0 Sodium Salt	
a. One application in spring.									
5-11		1949	100	100	100	100	100	100	100
5-20		1950	67	32	59	48	65	54	54
5-14		1951	30	13	13	7	42	56	27
5-19		1952	15	2	0.4	0.2	37	21	13
b. One application in fall.									
.....	10-18	1949	100	100	100	100	100	100	100
.....	10-31	1950	44	24	29	45	67	35	41
.....	10-31	1951	27	15	13	15	57	31	26
.....	None	1952	5	3	1	5	15	18	8
c. Two applications—one in spring, one in fall.									
5-11	10-18	1949	100	100	100	100	100	100	100
5-20	10-31	1950	12	8	15	5	22	11	12
5-16	10-31	1951	7	4	4	4	13	9	7
5-19	None	1952	1	2	1	2	7	3	3
d. Two applications—one in fall, one in spring.									
10-18	None	1949	100	100	100	100	100	100	100
10-31	5-20	1950	19	6	6	12	16	8	11
10-31	5-17	1951	7	7	7	5	21	12	10
None	5-19	1952	5	3	1	5	15	18	8
Average of all treatments		1952	7	3	1	3	19	15	...

The survival percentages in the table are averages of four plots and represent the effect of the previous year's 2,4-D treatments.

Several conclusions can be drawn from the results of these tests. While the stands of whitetop were reduced with all the treatments over the 4-year period, complete eradication with the use of 2,4-D was not realized. On a few individual plots the whitetop was completely eliminated but never on all four replications of any one treatment. Undoubtedly, complete elimination would have been obtained with one additional season from some of the treatments. The stands of whitetop were reduced more rapidly with two applications per year than with one; however, the end results did not differ materially.

Although one fall application each year was as effective in reducing the stand of whitetop as one spring application each year, fall applications alone were not satisfactory because surviving plants produced seed each spring. Two treatments the first year in spring and fall are probably worthwhile after which one treatment in the spring of each year should suffice.

Initial stand reductions were higher with the use of 3.0 pounds of actual 2,4-D per acre than where one-half that amount was used. These differences were narrowed down so that almost as many plants were killed by 3 years of treatments with the 1.5 as with the 3.0 pound rate. The 2,4-D applications in this series of tests were made at the early bud stage which proved to be the optimum stage for 2,4-D toxicity to whitetop. Where more mature plants are treated it is necessary to use the higher rate of application but the higher rates are but a poor substitute for proper timing of applications.

The sodium salt of 2,4-D was less effective in controlling whitetop in these tests than the amine and ester formulations.

Combining Corn Production with the Use of 2,4-D and Clean Cultivation for Whitetop Control

The merits of corn as a competing crop with whitetop, or more specifically as a crop utilizing a different portion of the growing season than whitetop, has been indicated previously. The seedbed preparation for the corn crop can be delayed late enough in the spring to allow the delivery of a disabling blow to the weed prior to seedbed production. Good use can be made of 2,4-D in delivering this blow.

Corn was grown on whitetop infested soil under five different cropping systems. Plots 2 rods wide by 8 rods long (1/10 acre) were used. Each treatment was replicated three times on plots arranged in randomized complete blocks.

A. Corn was grown in the customary manner without spraying the whitetop or varying from common methods of production.

B. Soil left undisturbed, whitetop sprayed with 2 pounds per acre of 2,4-D at the bud stage, land plowed 7 days afterwards and seedbed prepared and planted to corn.

C. Corn grown in the customary manner except that a selective spray of 1 pound per acre of 2,4-D was applied when the corn plants were 10-18 inches high.

Table 4.—The effects of combining the use of 2,4-D with corn production, and the effects of two years of clean cultivation, on the survival of whitetop and the yields of corn.

Cropping Practices	Test Series	Stands of Whitetop in Percentages of Original by Years				
		1948	1949	1950	1951	1952
I. Effects of cropping practices on whitetop survival.						
A. Check, continuous corn without special treatments	1	100	55	139	100	102
	2	.....	.....	100	107	51
B. Weeds sprayed at bud stage, seedbed prepared, corn planted	1	100	13	19	1	0.1
	2	.....	.....	100	136	1
C. Seedbed prepared, corn planted, selective spray applied to corn 10-18 inches high	1	100	38	30	7	0
	2	.....	.....	100	54	9
D. Same as C plus an additional spray after corn harvest	1	100	24	9	1	0
E. Clean cultivation for two years followed by corn for three years	1	100	.....	5	1	0
P. 2,4-D spraying only, 2 pounds per acre	1	100	20	149	40	17
	2	.....	.....	100	37	15
Q. Undisturbed check (no cropping or other treatments)	1	100	28	230	245	253
	2	.....	.....	100	236	400
II. Corn yields obtained with the above cropping practices.						
A.	1	44.4	72.9	42.7	47.8	7.4*
	2	.....	.....	77.1	64.3	62.5
B.	1	44.9	84.1	47.3	50.7	9.1*
	2	.....	.....	81.4	81.5	63.8
C.	1	43.6	67.3	48.2	45.1	8.8*
	2	.....	.....	79.4	69.6	70.1
D.	1	46.3	13.1*	18.9*	12.3*	10.2*
E.	1	.....	.....	105.1	60.0	82.1

*Starred figures indicate yields of silage corn in tons per acre, other yields are in bushels per acre.

D. Corn grown in the customary manner, a selective 2,4-D applied at the time the corn was 10-18 inches high and a second application of 2 pounds of 2,4-D made after harvest of the corn crop as silage.

E. The area was clean cultivated at intervals of 2 weeks for 2 seasons, involving 1 plowing and 9 cultivations per year. The area was then cropped to corn for 3 years.

P. The area was sprayed with 2 pounds of 2,4-D at the bud stage of the whitetop and no other treatment given.

Q. Undisturbed check, with no cropping, cultivation or spray treatments.

Three of the above tests were run in two series. Series 1 was started in 1948, series 2 in 1950. This makes available data on all of the cropping practices for a 5-year period and on practice A, B, and C for a 5- and an additional 3-year period.

The data presented shows that corn plus 2,4-D treatments can be used to advantage on heavily infested whitetop land. Practice D, involv-

Figure 3.—Effects of 2,4-D selective sprays on the survival of whitetop applied in growing corn for a period of four years. The plot to the right was sprayed selectively at one pound per acre, as outlined in practice C, the plot to the left received no treatment, practice Q.

ing two spray applications, one a selective spray in the growing corn crop followed by a second application after corn harvest as silage proved to be as effective as practice E, which was made more expensive since it involved 2 years of clean cultivation. Furthermore, practice D yielded five crops as compared to only three corn crops for practice E. Even one selective spray applied in the growing corn, practice C, resulted in good control. Figure 3 gives a comparison of the stands of whitetop on the corn plots subjected to 4 years of selective spraying with 2,4-D in growing corn, practice C, as contrasted to the stands on the untreated plot, practice A.

As may be noted in Table 4, spraying with 2,4-D along with no cropping nor cultivation, practice P, was much less effective in reducing the stand of whitetop than were the cropping practices that utilized 2,4-D spraying. On the untreated check plots where no cropping, cultivation, or spraying treatments were applied, whitetop density increased 253 percent during 5 years in series 1 and 400 percent during 3 years in series 2.

Combining Cereal Production with the Use of 2,4-D in Whitetop Control

The results presented in Table 5 show that wheat, oats, and barley can be produced on severely infested whitetop areas and that the use

of 2,4-D sprays in combination with different cropping practices may be expected to lead to eventual eradication of the weed.

Cereals and especially spring wheat cannot be seeded as late in the season as corn without a considerable reduction in yields. A delay in the date of seeding allows more time to set back the whitetop but is detrimental to the yields of cereal crops.

Cereals were grown in the following cropping practices on plots of the same size and arrangement as for the corn cropping practices:

F. Spring wheat was grown for 5 years with the ordinary soil preparation for that crop. No 2,4-D was applied.

G. Spring wheat grown in the ordinary manner with the addition of 2 pounds of 2,4-D per acre applied after harvest.

H. Spring wheat plus the application of a selective spray of 2 pounds of 2,4-D per acre at the late bud stage of the whitetop plants.

I. Spring wheat plus two applications of 2,4-D at 2 pounds per acre as a selective spray in the wheat, one at the late bud stage of the whitetop and the second application made after the harvest of the wheat crop.

J. Whitetop sprayed with 2 pounds of 2,4-D per acre at the bud stage, the seedbed prepared 7 days afterwards and seeded to barley.

K. The same practice as J except that oats were used.

L. The areas were sprayed with 2 pounds of 2,4-D at the bud stage of the whitetop, then cultivated every 2 weeks until fall and seeded to winter wheat. A selective spray of 1 pound of 2,4-D was applied in the growing wheat in the spring. The area was seeded to alfalfa after harvest. In series 2 the winter wheat crop was followed by corn.

The cereal plots were plowed in fall, the seedbed was prepared in spring. The seeding date for the spring was in April. In the case of practices J and K, the date of seeding of the barley and oats was delayed to allow the whitetop to develop to the bud stage. The land was plowed 7 days after the spray treatment. The seedbed was then prepared and the crops seeded.

As in the corn experiments, a second series of plots for four of the seven practices was initiated in 1950. The tests started in 1948 are designated as series 1, those started in 1950 as series 2.

The most outstanding results were obtained in practices H and J. This indicates selective spraying in the spring wheat each year at the time when whitetop plants reach the bud stage as being effective in the control of the weed. The yields were also increased by the use of the selective sprays. The 5-year average yields under practice H were 29.7 bushels as contrasted to only 22.5 bushels for the check, an increase of 7.2 bushels of wheat per acre for the selective spraying. Practice J shows an excellent reduction in the stands of whitetop. In this practice the

whitetop plants were permitted to reach the bud stage, and were then sprayed with 2 pounds of 2,4-D. Seven days later the plots were plowed, a seedbed prepared and barley seeded. This practice corresponds to the corn cropping systems discussed. The barley yields were only fair, nevertheless good progress towards eradication of the weed was made.

Application of 2,4-D after the harvest of the spring wheat crop, practice G, was discontinued after 3 years. Whitetop reduction was about equal to the reduction where 2,4-D was applied in the spring for the 3 years. However, yields were no better than the unsprayed plots because weeds were not controlled in the spring. Likewise, the extra 2,4-D treatment given in the fall in practice I did not give enough beneficial effect to be practical.

Practice L is interesting from the standpoint of the high yields obtained, especially in series 2 where a winter wheat crop was followed by corn. The precropping treatment, spraying prior to the initiation of the program of summer cultivation, not only had favorable effects on the yields of the following crops, but also resulted in significant reductions in the stands of the weeds.

Table 5.—The effects of combining the use of 2,4-D with cereal production on the survival of whitetop and the yields of cereals in 7 different cropping practices.

Cropping Practices	Test Series	Stands of Whitetop in Percentages of Original By Years				
		1948	1949	1950	1951	1952
I. Effects of cropping practice on whitetop survival.						
F. Check, continuous spring wheat without special treatments	1	100	65	85	57	109
	2	.....	.....	100	98	108
G. Spring wheat, 2,4-D applied after harvest	1	100	37	12	Discontinued	
H. Spring wheat, 2,4-D selective at late bud stage of weed	1	100	39	15	0.3	0
	2	.....	.....	100	28	0.1
I. Spring wheat, same as H plus 2 pounds 2,4-D applied after harvest	1	100	37	7	Discontinued	
J. Weeds sprayed at bud stage, seedbed prepared, barley seeded late	1	100	20	11	7	0
K. Same as J except oats seeded late in season	2	.....	.....	100	42	7
L. Sprayed with 2,4-D, cultivated during summer, seeded to winter wheat, selective spray in the spring followed by alfalfa after wheat harvest	1	100	11	4	3	2
	2	.....	.....	100	32	1
II. Crop yields obtained with above practices.						
F.	1	16.0	19.8	15.4	28.8	32.7
	2	.....	.....	50.2	37.9	43.9
G.	1	16.4	20.3	17.5	Discontinued	
H.	1	29.6	21.4	18.1	38.5	40.9
	2	.....	.....	47.1	36.7	37.8
I.	1	26.5	22.1	21.0	Discontinued	
J.	1	23.2	27.3	25.1	54.6	.....
K.	2	.....	.....	64.6	Lost	60.4
L.	1	.....	43.0	2.1*	4.0*	3.2*
	2	.....	.....	.....	86.1	84.3

*Hay yields in tons per acre, other yields are in bushels per acre.

The addition of fertilizers was not compared in the experiment; however, it would be wise to apply as much nitrogen as the corn or cereals could beneficially use to improve their competitive ability.

Combining Forage Crop Production with the Use of 2,4-D in Whitetop Control

The effectiveness of clovers and perennial grasses in controlling whitetop in Nevada (3, 10) has been mentioned previously. Numerous investigators have reported more recently that perennial weeds in competition with perennial grasses are more easily controlled by 2,4-D spraying than where the weeds are not in competition with grasses. In order to study these relationships under conditions in the Boise Valley of Idaho, three different cropping practices utilizing various perennial grasses and clovers were tested in series 2 during 1950 and 1952. The grass and clover crops were planted in August on seedbeds prepared after spring wheat harvest in two practices, and in May after spring planting in the third practice. In all three practices whitetop was sprayed in the bud stage the first year with 2,4-D at 2 pounds per acre before the forage crops were planted.

Grass and legume crops were grown in the following cropping practices in comparison with no-cropping check treatment:

M. Whitetop sprayed at bud stage with 2,4-D at 2 pounds per acre, seedbed prepared and smooth bromegrass planted in rows 3 feet apart, grass mowed for hay or seed each year, whitetop sprayed at bud stage each year with 2,4-D at 2 pounds per acre.

N. Spring wheat plus selective spraying with 2,4-D at 2 pounds per acre the first year, seedbed prepared after wheat harvest and a pasture mixture of orchard grass, alta fescue, smooth bromegrass and Ladino clover planted in August, whitetop sprayed selectively at bud stage in subsequent years with 2,4-D at 2 pounds per acre.

O. Same as N the first year except red clover seeded in seedbed prepared after wheat harvest, red clover mowed for hay in subsequent years with no 2,4-D spraying.

P. 2,4-D spray treatments only, 2 pounds per acre, no cropping or cultivation.

Q. Untreated check, no cropping, cultivation or spraying treatment.

As shown in Table 6, all three cropping practices reduced the whitetop considerably during the 3-year period and gave satisfactory yields of crops. The perennial pasture mixture, practice N, was the most effective and reduced whitetop slightly more than 2,4-D spraying alone (no cropping), practice P. Red clover cropping, practice O, was the least effective in reducing whitetop. In this instance, 2,4-D treatments were not applied after the crop was planted. None of the three cropping practices, nor 2,4-D spraying alone, approached complete eradication of whitetop in 3 years and it was not possible to predict whether continuation of the practices would eventually have eliminated all of the weed.

It is of interest to note that the untreated check treatment, practice Q, which involved no cropping cultivation or spraying permitted whitetop to increase its stand density 400 percent in 3 years.

Table 6.—The effects of combining use of 2,4-D with forage crops production on survival of whitetop and the yields of forage or seed in three different cropping practices as compared with those in two no-cropping check treatments.

Cropping Practices	Test Series	Stands of Whitetop in Percentages of Original By Years: 1950	1951	1952
I. Effects of cropping practice on whitetop survival.				
M. Smooth bromegrass mowed for seed, 2,4-D at 2 pounds before seedbed preparation and annually thereafter as selective spray	2	100	60	15
N. Spring wheat plus 2,4-D selective 1 year, pasture mixture and 2,4-D selective spray in subsequent years	2	100	93	6
O. Same as N the first year, red clover mowed for hay in subsequent years, no 2,4-D applied	2	100	129	29
P. No cropping or cultivation, sprayed annually with 2,4-D at 2 pounds per acre	2	100	37	15
Q. Untreated check, no cropping, cultivation or spray treatment	2	100	236	400
II. Crop yields obtained with above practices.				
M.	2	1.5*	106 †	440 †
N.	2	35.3‡	1.5*	2.2*
O.	2	45.8‡	4.6*	3.7†

*Hay yields in tons per acre.
†Seed yields in pounds per acre.
‡Wheat yields in bushels per acre.

Summary and Conclusions

1. Whitetop (*Cardaria draba*) is a perennial noxious weed which spreads by seeds and underground rootstocks. It is known under a great variety of common names, such as hoary cress, hoary pepperwort, hoary peppergrass, perennial peppergrass, and white weed. Whitetop is the most commonly used name in the western states.
2. Whitetop is widely distributed and occurs under a wide range of growing conditions. It is especially well adapted to semi-arid, irrigated soils with an alkaline reaction. The weed is more common in the Boise Valley than in any other part of Idaho.
3. The studies reported here were conducted near Meridian, from 1948 to 1952.
4. Whitetop can be controlled by properly timed cultivations over a period of 2 years and by the use of chemicals. However, by taking advantage of the special growth habits of the plant, it was found that combinations of cropping, modifications in seedbed preparations, adjusting the date of seeding, and the use of 2,4-D provided effective means of control over a period of years. A combination of these methods made it possible to use the infested areas for crop production while progress towards eradication of the weed was made.

5. Whitetop starts growth early in spring and grows rapidly. The tolerance of whitetop to moderate temperatures and its early seed production accounts in part for the wide dissemination of the plant. Whitetop will produce mature seed in the first cutting of alfalfa hay unless it is clipped within about 25 days of first opening of buds of the weed. New areas of infestation are often accounted for by the movement of contaminated hay. The low point of the organic reserves in the roots of the plant corresponds with the stage of bud formation. This is the weak point in the course of development of the whitetop and the time at which control treatments are most effective. This critical period in the life history of the weed occurs early enough in the season in southern Idaho so that an application of 2,4-D can be made and an interval of 7 days allowed before plowing the treated area and preparing a seedbed for such crops as corn and the cereals.

6. The data presented show that a combination of applications of 2,4-D, delayed plowing, seedbed preparation, and corn production can be used to advantage on areas heavily infested with whitetop. Spring seeded cereals can also be used in this practice; however, delayed seeding of cereals resulted in greater reductions in yields than corn cropping. The continuous use of cereals for a period of 3 to 5 years resulted in the increase of annual weeds, especially of wild oats. Cereal production can be combined with corn production in alternate years. Also after the whitetop stands have been weakened the infested area may be used for alfalfa. The stand of this crop should not be maintained for more than three seasons. In the third season the field should be plowed after early removal of the first hay crop, the area fallowed and cultivated at intervals of two or three weeks and then seeded to winter wheat late in September. A selective spray of 2,4-D should be applied to the winter wheat the following spring to control any escape plants. Rather effective control of whitetop was obtained by seeding a pasture mixture in August, after the harvesting of a spring wheat crop which had been selectively sprayed with 2,4-D, and where the established pasture was sprayed annually with 2 pounds of 2,4-D at the bud stage of the weed.

7. Whitetop is a prolific seed producer. Even after established plants are eradicated there is continuing danger of re-establishment from seeds remaining in the soil. This calls for the application of control methods for a number of years after the elimination of the old plants to prevent the establishment of seedlings.

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