Replacing Wyethia with Desirable Forage Species

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DENSE stands of wyethia (*Wyethia amplexicaulis* and *W. helianthoides*) now occur on extensive areas of western mountain range lands (Fig. 1A). These plants prefer moist, heavy soils, and consequently are found on some of the most productive sites. An air-dry herbage production of more than 1.5 tons per acre is possible on many of these sites, but when most of this is made up of the relatively unpalatable wyethia, there is only a small amount of usable forage.

Such stands of wyethia may be native on some areas, but on many others it is thought that wyethia has increased as more palatable plants have been reduced by heavy grazing. Wyethia appears to be long lived and a strong competitor, so that its elimination by natural means, if possible at all, is slow. In order to determine what methods might be successful in converting dense stands of wyethia to more desirable plants quickly, studies were begun in 1947 on the Spencer District of the Targhee National Forest in eastern Idaho.

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Dry Creek Study

Methods

A 14-acre area on Dry Creek, approximately 6,500 feet in elevation and sloping gently to the southeast, was selected in 1947. The annual precipitation is probably between 20 and 25 inches, and the soil is a heavy, black loam. Prior to treatment, the area supported a dense stand of wyethia (mostly *W. amplexicaulis* but some *W. helianthoides*) with a small amount of geranium (*Geranium viscosissimum*), cinquefoil (*Potentilla* sp.), dock (*Rumex* sp.), mountain brome (*Bromus carinatus*), slender wheatgrass (*Agropyron trachycaulum*), bluegrasses (*Poa* spp.), oniongrass (*Melica* sp.), and several other grasses and forbs.

Five methods of cultivation were used on duplicated 1-acre plots in September, 1947: moldboard plowing to 10 inches, wheatland plowing to 3 and 6 inches, and offset (2-way) disking to 3 and 5 inches. Two plots were reserved as untreated checks.

In June, 1948 one plot was plowed with a moldboard plow to a depth of 6 inches. In addition, one uncultivated plot was divided into 10 sections, and four chemicals were applied with a hand sprayer to duplicated 0.1-acre sections. Ammonium sulfamate was applied at the rate of 25 pounds per acre, ammonium 2,4-dichlorophenoxyacetate at 3 pounds per acre, a mixture of diesel oil and creosote at 45 gallons per acre, and kerosene at 45 gallons per acre. The two remaining sections were left as untreated checks.

Plots cultivated in the fall of 1947, as well as the untreated check plots, were broadcast to a mixture of smooth brome (*Bromus inermis*), slender wheatgrass, timothy (*Phleum pratense*), and orchardgrass (*Dactylis glomerata*) at the rate of 10 pounds per acre immediately after cultivation. The spring-plowed plot and the chemically treated sections were drilled to the same mixture in the fall of 1948.

1). In 1948 it appeared that plowing in the spring was considerably more effective than in the fall, but these initial differences had mostly disappeared by 1950. Although there was only a slight difference in favor of spring plowing in 1950, cultivation at this season may actually be more effective as these results were accomplished by plowing at a 6-inch depth, whereas the fall plowing was at 10 inches. Disking with a wheatland plow

TABLE 1

Effects of cultural and chemical treatments on numbers of wyethia and air-dry production of wyethia and grass, Dry Creek

TREATMENT AND SEASON	WYETHIA PLANTS PER SUBPLOT (*Percent of check*)			HERBAGE PRODUCTION (*Percent of check*)			
				Wyethia		Grass	
	1948	1949	1950	1949	1950	1949	1950
Plowing:							
Spring moldboard, 6-inch depth	17	25	24	19	18	75	53
Fall moldboard, 10-inch depth	44	39	26	20	23	749	1365
Fall wheatland, 6-inch depth	102	107	175	128	126	62	66
Fall wheatland, 3-inch depth	122	111	156	113	110	73	80
Fall offset disk, 5-inch depth	92	85	109	101	80	93	100
Fall offset disk, 3-inch depth	125	114	161	124	122	82	104
Untreated check (number and lbs. per acre)	47	46	44	2069	1376	186	167
Chemical treatment:							
2,4-D[1]	—	58	36	22	31	171	326
Kerosene	—	87	98	79	107	92	74
Creosote and diesel oil	—	87	93	85	95	63	86
Ammonium sulfamate	—	83	101	77	96	130	162
Untreated check (number and lbs. per acre)	—	56	58	3080	1612	100	129

[1] Ammonium 2,4-dichlorophenoxyacetate.

Wyethia plants were counted on circular 48-square-foot subplots within each acre plot during late summer of 1948, 1949, and 1950. Weight estimates were made of both wyethia and reseeded grasses in 1949 and 1950.

Results

Moldboard plowing was the only method of cultivation which caused an appreciable reduction in wyethia (Table

and an offset disk was not effective at either depth. As a matter of fact, wheatland plowing at both depths and shallow offset disking resulted in a substantial increase in plant numbers and a similar, though less pronounced, increase in wyethia herbage. Apparently the disks cut the taproot so shallowly that in many cases both sections of root continued to grow, producing two plants instead of one. The inadequacy of offset

disking was further substantiated by poor results obtained from disking a 5-acre area on West Camas Creek in the spring of 1949.

A critical examination of data in Table 1 shows certain variations between years for which no explanation is readily apparent. It is thought that these minor variations are attributable to sampling error resulting from use of different sample subplots each year.

bers were essentially the same as on the untreated checks.

Of the grasses broadcast in the fall of 1947, a successful stand was obtained only on the fall moldboard-plowed plots, i.e., only where wyethia had been greatly reduced. Grass production on these plots was over seven times that of the untreated plots in 1949 and over thirteen times, in 1950. Total grass production was decreased on all other plots, but

FIGURE 1. Methods of replacing wyethia. A. Dense wyethia stand, West Camas Creek. B. Dry Creek study, 3 years after treatment: (left) fall wheatland plowing, (right) fall moldboard plowing. C. Effective kill from heavy rate of application of 2,4-D and 2,4,5-T mixture, at half bloom. D. Profuse flowering of wyethia on untreated strip between plots treated with 2,4,5-T.

Wyethia herbage production was greatly reduced the year following treatment with 2,4-D (Table 1), and numbers of plants continued to decrease the second year after spraying. Both herbage production of wyethia and numbers of plants were slightly decreased by the other chemical treatments, but these decreases were only temporary, for in 1950 both wyethia herbage yield and plant numthose treated with the offset disk had recovered sufficiently to produce as much as the untreated plots by 1950. Three years after fall moldboard plowing and reseeding, grass production was over 1 ton of air-dry herbage per acre, whereas wyethia was producing less than 14 percent of this amount. This relatively small amount of wyethia grew in rows at the edges of furrows where roots were not

completely sheared and turned. In contrast to this, other fall cultivated plots were producing between 1,000 and 2,000 pounds of wyethia and less than 200 pounds of grass. These differences are well illustrated in Figure 1B.

Although a good kill of wyethia was obtained on the spring moldboard-plowed area, the establishment of grass was unsuccessful. This grass failure was probably not related to season of plowing but perhaps to less favorable weather following the 1948 planting or too deep seed covering through drilling.

Grass production was greatly increased on the sections treated with 2,4-D, and to a lesser extent, on those treated with ammonium sulfamate. This increase, in contrast to that on the fall moldboard-plowed plots, was mostly due to an increase in native grasses, rather than to establishment of reseeded species. Apparently the hard, uncultivated ground was such a poor seedbed that reseeded grasses were unable to become established even where competition of wyethia was greatly reduced. Grass yield on plots treated with kerosene and creosote-diesel oil was slightly decreased.

West Camas Creek Study

Methods

The study area selected on West Camas Creek is very similar to the one on Dry Creek, having about the same elevation, annual precipitation, soil type, and vegetation. The land slopes gently northeast, however, and the dense stand of wyethia prior to treatment was chiefly *W. helianthoides*. In addition to wyethia, the area supported bluegrasses, Idaho fescue (*Festuca idahoensis*), alpine timothy (*Phleum alpinum*), meadow barley (*Hordeum nodosum*), needlegrass (*Stipa* sp.), slender wheatgrass, mountain brome, sedges (*Carex* spp.), redtop (*Agrostis* sp.), dock, geranium, cinquefoil, dandelion (*Taraxacum officinale*), yarrow (*Achillea lanulosa*), yampa (*Perideridia gairdneri*), and others.

Effectiveness of three herbicides for wyethia eradication were tested at two rates of application at two dates (growth stages). In order that regular field methods of spraying could be employed, 0.5-acre plots, each 1 by 5 chains, were used. All treatments were duplicated and there were four untreated check plots. Treatments were assigned at random to the plots within each replication.

Commercial formulations were used throughout. These consisted of a 2,4-D ethyl ester, a 2,4,5-T butoxy ethanol ester, and a mixture of two parts 2,4-D and one part 2,4,5-T in butoxy ethanol ester form. Rates of application were 1 and 2 pounds acid equivalent per acre, and application was made at two growth stages, when the wyethia was about half way through blooming (June 7) and when blooming was over (June 20, 1949). Chemicals were applied in a water solution with a boom sprayer mounted on a pick-up truck. The sprayer was so regulated that approximately 25 gallons of water were required per acre.

Prior to any treatment (May 28, 1949) and approximately 1 year afterwards (July 7, 1950), wyethia counts and weight estimates were made of the vegetation on five circular 96-square-foot subplots within each 0.5-acre plot.

In September of 1949, one replication of the study was drilled to a mixture of crested wheatgrass (*Agropyron cristatum*), slender wheatgrass, intermediate wheatgrass (*Agropyron intermedium*), smooth brome, and timothy, at the rate of 12.5 pounds per acre. The other replication was left unseeded to determine rate of recovery from natural revegetation following wyethia eradication.

Results

Wyethia on all of the sprayed plots began to show effects of the herbicides within a few hours. Herbage of wyethia treated early (half bloom) was completely dry in approximately 1 month, but that treated later (blooming over) retained some life most of the summer. Differences resulting from chemicals or rates of application were not readily apparent in 1949.

It was obvious the year after spraying that all herbicides had caused considerable reduction in wyethia (Table 2). Subplots on the untreated areas contained an average of 150 plants, whereas all but one of the chemical treatments reduced wyethia to less than 100 plants. Average air-dry herbage production of wyethia on the check plots was over 1,000 pounds per acre; all but one of the chemical treatments reduced wyethia herbage yield to less than 400 pounds per acre. In most cases reductions in numbers and in yield were statistically significant. The 2,4-D and mixture applied at the 2-pound rate when wyethia was in half bloom, were the most effective treatments, and were fairly comparable in degree of wyethia kill (Fig. 1C; note wyethia on untreated plot in left background). The former reduced wyethia to 54 pounds per acre and 28 plants per subplot, while the latter reduced wyethia to 56 pounds per acre and 10 plants per subplot.

Comparison of the various treatments is most easily made when herbage production and plant numbers are expressed as a percentage of the untreated checks (Table 2). Percentages may be converted to actual weight in pounds per acre from the weights given for the untreated check plots. Both the mixture and 2,4-D were definitely superior to 2,4,5-T in eradicating wyethia. It is also obvious that ap-

TABLE 2

Effects of chemical treatments on numbers of wyethia and on air-dry herbage weight of wyethia, grasses, and forbs, together with estimated costs, West Camas Creek, 1950[1]

CHEMICAL	RATE[2]	GROWTH STAGE	WYETHIA PLANTS PER SUBPLOT (Percent of check)	HERBAGE PRODUCTION (Percent of check)			COST (Dollars per acre, approx.)
				Wyethia	Grass	Forbs	
2,4-D	2	Half bloom	19	5	136	29	2.90
Mixture	2	Half bloom	7	5	235	146	4.70
2,4-D	2	Blooming over	33	7	145	88	2.90
Mixture	2	Blooming over	21	10	102	59	4.70
2,4-D	1	Half bloom	40	13	142	68	1.70
Mixture	1	Half bloom	21	10	197	107	2.60
2,4-D	1	Blooming over	41	20	98	44	1.70
Mixture	1	Blooming over	55	28	146	99	2.60
2,4,5-T	2	Half bloom	47	32	201	93	6.50
2,4,5-T	2	Blooming over	58	30	166	96	6.50
2,4,5-T	1	Half bloom	52	36	162	76	3.50
2,4,5-T	1	Blooming over	75	73	136	96	3.50
Untreated check (number and lbs. per acre)			150	1083	149	82	—

[1] Production figures adjusted to original production by covariance analysis.

[2] Acid equivalent in pounds per acre.

plication at the rate of 2 pounds per acre was far more effective than 1 pound, and that spraying at the half bloom growth stage was much more effective than at the blooming over stage.

All of the herbicides used had a definite physiological effect upon wyethia plants not killed. Scarcely any flower stalks were produced on sprayed areas, whereas wyethia flowered profusely on untreated check plots. Even the least effective treatment, 2,4,5-T applied late at 1 pound per acre, prevented flowering (Fig. 1D), though the remaining plants were vigorous and showed no deformity like that caused by 2,4-D.

Dry Creek study where wyethia numbers dropped from 58 percent of the check in 1949, 1 year after treatment with 2,4-D, to but 36 percent of the check in 1950 (Table 1). Erickson, *et al.* (1948) noted that 2,4-D usually acts much more slowly than other weedkillers.

Grass production increased on nearly all treated plots, but these increases came from recovery of native grasses rather than from growth of artificially seeded species. As a matter of fact, average grass production was higher on the replication which was not seeded. Although grass yields from several of the treatments were significantly higher than

FIGURE 2. Wyethia plants deformed and dwarfed, 1 year after application of 2,4-D.

There was little difference in effectiveness of 2,4-D and the mixture in reducing wyethia herbage yield, but the mixture caused a more immediate reduction in plant numbers. Most of the plants remaining on the areas treated with 2,4-D were small and deformed, however, and many of these will probably die (Fig. 2). This actually happened in the those of the checks—notably applications at half bloom of the mixture and 2,4,5-T —they followed no regular pattern. It is assumed that the increase in grass reflects release from wyethia competition, but grass yield does not appear to be closely correlated with degree of wyethia kill. Grass yield on plots sprayed at half bloom with the mixture at 2 pounds per

acre was increased to 235 percent of the untreated check, whereas yield on plots sprayed with 2,4-D at the same rate and date was only 136 percent of the check. In most cases increase of grasses sprayed with 2,4-D was less marked than with the other chemicals, which suggests that 2,4-D may have injured the grasses to some extent.

Forb production after spraying was generally lower than on the unsprayed plots, although so much variation exists between plots that it is difficult to assess significance. Again, there is a suggestion that forbs were more greatly reduced on the plots sprayed with 2,4-D than with the other chemicals. Had the stand of wyethia been less dense, sheltering other species less effectively, it seems likely that harmful effects of the chemicals would have been more evident. For the most part, reductions in forb yield in these tests were not pronounced and were offset by increases in grass. Although records were not kept of individual forb species, inspection of treated and untreated plots indicated that the more desirable species were not disproportionately reduced.

Discussion

It is evident that competition from wyethia must be reduced in order to obtain a heavy stand of either native or reseeded grasses. Moldboard plowing was the only cultivation method that satisfactorily reduced this competition. This means of eradication, however, is not only expensive but is also limited to areas of deep soil without numerous rock outcrops which would cause excessive breakage in equipment. Moldboard plowing must be followed with reseeding as all perennial vegetation is destroyed. Because of these limitations and its high cost, this method cannot be widely used as a means of eradicating wyethia.

The mixture of 2,4-D and 2,4,5-T and the 2,4-D alone were both successful in eradicating wyethia when applied at 2 pounds per acre at the half bloom growth stage. These chemical treatments have certain advantages over moldboard plowing in that they do not destroy the natural understory of grasses and other forbs, nor are they limited to specific types of terrain. The tests indicate the importance of applying the weedkillers in sufficient concentration and at an early date. It is thought that even better wyethia kill might be secured from earlier spraying while the plants are more actively growing—perhaps when they first begin to bloom. In similar studies with herbicides on other species (Egler, 1949; McIlvain, 1949; Offord, 1949), increased effectiveness of application during the vigorous growth period before plant maturity has been observed.

Although the mixture and 2,4-D were almost equally effective in reducing wyethia, the cost of the chemicals differed greatly. The cost of treatment with 2,4-D at 2 pounds was approximately $2.90 per acre, whereas the mixture at 2 pounds cost approximately $4.70 (Table 2). Expenses can undoubtedly be reduced if the operation is on a large scale, especially if spraying is done by airplane. The 2,4-D may be more injurious to forbs and grasses than the mixture, but this disadvantage does not appear to offset the advantage of its lower cost. Spraying with 2,4-D ethyl ester at 2 pounds per acre appears to be the most economical means of eradicating wyethia.

Reseeding of the sprayed area is not necessary if a grass understory is present. In fact, a residual stand of grasses and forbs will probably prevent establishment of a successful stand of reseeded species. If a suitable understory is not present, reseeding will be necessary to

prevent reinvasion by wyethia. In such cases, seedbed preparation may be necessary on some areas to assure successful reseeding.

Conclusions

1. Moldboard plowing is an effective, though expensive, means of eradicating wyethia. This method is limited to accessible areas with deep, rock-free soils that will not cause excessive breakage in equipment.

2. 2,4-D ethyl ester applied at 2 pounds acid equivalent per acre between first and half bloom is a comparatively economical and thorough means of eradicating wyethia. With adequate facilities it can be used on any site.

3. Reseeding of moldboard plowed areas is necessary to obtain desirable forage species. Plowing destroys all perennial vegetation; unless an adequate stand of desirable perennials is produced the area will be subject to immediate reinvasion by wyethia.

4. The suggested application of 2,4-D does not greatly injure the native grasses; reduced competition from wyethia after treatment will allow a rapid increase in yield of other species. Reseeding, therefore, is necessary only on areas that lack a fairly abundant and well-distributed understory of other species.

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