

Effect of 2,4-D on Forbs and Shrubs

Associated with Big Sagebrush

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In recent years considerable attention has been given to the control of big sagebrush (*Artemisia tridentata*) by spraying with 2,4-D. In California, Cornelius and Graham (1951) obtained an 85-per-cent kill of big sagebrush and a large increase in native perennial grasses through application of one pound of 2,4-D butyl ester per acre in late June. Studies in Wyoming (Hull *et al.*, 1952) indicate that at least 75 percent of a big sagebrush stand can be killed by application of two pounds of 2,4-D isopropyl ester per acre, thus allowing native grass production to double or triple. Hyder (1953) reported that a May application of from one to three pounds of 2,4-D butyl ester per acre in eastern Oregon caused the death of about 85 percent of the sagebrush. Unpublished studies by the authors in eastern Idaho have shown that both ethyl and butoxy ethanol esters of 2,4-D are also effective in sagebrush control, often killing more than 90 percent of the plants when applied at 1½ or 2 pounds per acre in late May or early June. It is apparent, then, that various esters of 2,4-D when applied in sufficient quantity

at the proper season can effectively thin a stand of big sagebrush and allow a substantial increase in native grasses.

Despite the fact that many sagebrush-grass ranges also support considerable amounts of forbs and other shrubs that are valuable as forage, especially for sheep and big game, little is known about the effect of 2,4-D on these associated species. Bohmont (1954) has reported the effects of this chemical on a few forbs growing with sagebrush in northern Wyoming, but no information is available on shrubs or on many forbs important in other areas. Such information is urgently needed because of the current popularity of sagebrush control by spraying with 2,4-D. For example, in Clark County, Idaho alone, approximately 15,000 acres of rangeland have been sprayed since 1951. Although much good has been accomplished, damage to some of the desirable forage species has been severe. In order to provide a basis for more effective range improvement through the use of herbicides, an effort was made during the summer of 1954 to learn the effect of 2,4-D on forbs

and shrubs commonly associated with big sagebrush in eastern Idaho. The authors are indebted to personnel of the Targhee National Forest, particularly Ranger Lyman L. Richwine, and to several Clark County ranchers for making the sprayed areas available for study.

Methods

Since extensive areas of recently sprayed sagebrush range were readily accessible, it was possible to select a number of areas that could be directly compared with adjacent unsprayed range. Most of the areas selected were several hundred acres in extent and had been sprayed within the last three years. In these large-scale aerial sprayings, both ethyl and isopropyl esters of 2,4-D had been used at rates of 1½ and 2 pounds acid equivalent per acre. Ethyl and isopropyl esters of 2,4-D were apparently equally effective in killing sagebrush, and 2 pounds of 2,4-D was usually more effective than 1½ pounds. Sites selected for sampling were restricted to those areas where at least two-thirds of the sagebrush plants were judged to have been killed. Thus the effect on associated species was observed only on those sprayed areas where there was a satisfactory kill of sagebrush.

In all, 12 separate areas were examined. On 7 of these, both live and dead plants were counted on belt transects or circular plots on both sprayed and unsprayed portions so that a minimum of 1,000

Table 1. Mortality of forbs on 12 areas in eastern Idaho sprayed with 2,4-D to control big sagebrush.

Species	Areas*												Summary	
	1	2	3	4	5	6	7	8	9	10	11	12		
<i>Achillea lanulosa</i>	U	U	...	M	U	...	...	U	U	U	U	U	U	Unharmed
<i>Agastache urticifolia</i> .....	...	...	...	L	...	...	...	...	...	...	...	...	...	Light
<i>Agoseris</i> spp. ....	...	...	...	H	H	...	...	...	...	...	...	U	...	Moderate
<i>Antennaria microphylla</i>	M	...	U	...	...	...	...	U	...	...	...	...	...	Light
<i>Aplopappus</i> sp. ....	...	...	...	...	...	...	...	U	...	...	...	...	...	Unharmed
<i>Arnica fulgens</i>	L	...	...	...	...	...	...	...	...	...	...	...	...	Light
<i>Astragalus convallarius</i>	U	...	...	...	...	...	...	...	...	...	...	...	...	Unharmed
<i>Astragalus miser praeteritus</i>	U	U	...	...	...	...	...	...	...	...	...	...	...	Unharmed
<i>Astragalus salinus</i>	U	...	...	...	...	...	...	...	...	...	...	...	...	Unharmed
<i>Astragalus stenophyllus</i>	H	...	...	...	...	...	...	...	...	...	...	...	...	Heavy
<i>Balsamorhiza sagittata</i> .....	...	H	...	H	...	...	...	...	...	H	...	...	...	Heavy
<i>Calochortus macrocarpus</i> .....	...	...	...	...	...	...	...	U	...	...	...	...	...	Unharmed
<i>Castilleja</i> spp.	H	H	H	...	...	...	...	...	...	...	...	...	...	Heavy
<i>Comandra umbellata</i>	U	M	...	...	...	...	...	...	...	...	...	...	...	Light
<i>Crepis acuminata</i>	U	U	...	U	...	...	...	...	...	...	...	...	...	Unharmed
<i>Delphinium depauperatum</i> .....	...	...	...	...	...	...	...	U	...	...	...	...	...	Unharmed
<i>Delphinium glaucescens</i> .....	...	...	...	...	...	U	...	...	...	...	...	...	...	Unharmed
<i>Eriogonum corymbosus</i>	L	...	...	U	U	...	...	...	...	...	...	...	...	Light
<i>Eriogonum heracleoides</i>	U	L	M	M	U	...	...	M	U	...	...	...	U	Light
<i>Eriogonum ovalifolium</i>	U	...	...	...	...	...	...	...	...	...	...	...	...	Unharmed
<i>Geranium viscosissimum</i> .....	...	...	...	U	...	...	...	U	U	...	...	...	...	Unharmed
<i>Helianthella uniflora</i> .....	...	H	...	H	...	...	...	...	H	M	...	...	...	Heavy
<i>Linum lewisii</i> .....	...	...	...	...	...	...	...	U	...	...	...	...	...	Unharmed
<i>Lithospermum ruderales</i> .....	...	M	...	...	...	...	...	...	...	...	...	...	...	Moderate
<i>Lupinus caudatus</i> .....	...	H	H	H	H	H	...	...	H	M	M	L	...	Heavy
<i>Lupinus leucophyllus</i>	M	...	...	...	...	...	...	...	...	...	...	...	...	Moderate
<i>Mertensia oblongifolia</i>	H	...	...	...	...	...	...	...	...	...	...	...	...	Heavy
<i>Penstemon radicosus</i>	U	L	...	...	...	...	...	...	...	...	...	...	...	Light
<i>Penstemon</i> spp. ....	...	...	H	...	...	...	...	...	...	...	...	...	...	Heavy
<i>Perideridia gairdneri</i> .....	...	...	...	...	...	...	...	U	...	...	...	...	...	Unharmed
<i>Phlox canescens</i> .....	...	...	...	...	...	...	L	...	...	...	...	...	...	Light
<i>Potentilla</i> spp. ....	...	...	H	H	...	...	...	H	H	H	U	...	...	Heavy
<i>Rumex</i> sp. ....	...	...	...	...	U	...	...	...	...	...	...	...	...	Unharmed
<i>Senecio integerrimus</i>	U	U	L	M	...	...	...	...	...	...	U	...	...	Light
<i>Sieversia ciliata</i> .....	...	...	H	H	...	...	...	...	...	...	...	...	...	Heavy
<i>Solidago</i> sp. ....	...	...	U	L	...	...	...	U	...	...	...	...	...	Unharmed
<i>Viola</i> spp. ....	...	...	U	L	...	...	...	...	...	...	...	...	...	Light
<i>Zigadenus paniculatus</i>	H	...	...	...	...	...	...	...	H	...	...	...	...	Heavy

*Results on areas 1 to 7 based on quantitative data, those on areas 8 to 12 based on qualitative ratings.

square feet was included in each sample. On the remainder, injury to the various species was described by adjective ratings after carefully observing sprayed and adjacent unsprayed areas.

Results and Discussion

Effects of 2,4-D on forbs and shrubs associated with big sagebrush are indicated in Tables 1 and 2. For ease in interpretation, adjective ratings have been substituted for quantitative data so that degree of damage on all areas is recorded as: unharmed, light

(1- to 33-percent kill), moderate (34- to 66-percent kill), and heavy (67- to 100-percent kill). No attempt was made to segregate species that may have benefited from the treatment; these are included in the "unharmed" category.

Of the 38 forbs occurring on the study areas, 15 were generally unharmed, 10 were lightly damaged, 3 were moderately damaged, and 10 were heavily damaged (Table 1). Although there were some discrepancies between areas, most of the results were fairly con-

sistent. Among those species moderately or severely damaged are such important forage species as arrowleaf balsamroot (*Balsamorhiza sagittata*), milkvetch (*Astragalus stenophyllus*), oneflower sunflower (*Helianthella uniflora*), lupines (*Lupinus caudatus* and *L. leucophyllus*), and bluebell (*Mertensia oblongifolia*). Hawksbeard (*Crepis acuminata*), geranium (*Geranium viscosissimum*), matroot penstemon (*Penstemon radicosus*), and groundsel (*Senecio integerrimus*) are also important forage plants, but these were unharmed or only slightly damaged. Groundsel, however, is a species that matures and dries very early in the growing season, and it is possible that earlier spraying might be very injurious. Of the major poisonous species, deathcamas (*Zigadenus paniculatus*) was severely damaged by 2,4-D, whereas larkspurs (*Delphinium depauperatum* and *D. glaucescens*) were apparently unharmed. It is worthy of note that wyethia (*Wyethia amplexicaulis* and *W. helianthoides*), an undesirable forb often associated with big sagebrush in mountainous areas, can be effectively eradicated by spraying with 2,4-D (Mueggler and Blaisdell, 1951).

Mortality of shrubs and trees was much lower than that of forbs (Table 2). Twelve of the 15 species associated with big sagebrush were unharmed or but lightly damaged, and only three were injured severely. Damage to serviceberry (*Amelanchier alnifolia*) and three-tip sagebrush (*Artemisia tripartita*) was heavy, and damage to silver sagebrush (*Artemisia cana*) was moderate. Silver sagebrush showed greater resistance to 2,4-D than did other species of *Artemisia* which agrees with observations by Cornelius and Graham (1951). As previously mentioned, at least two thirds of the big sagebrush plants were killed on all areas examined; kills on sites 1 to 5 where quantitative data were collected being 66, 92, 100, 99, and 86 percent, respectively.

Actual damage to many shrubs was much greater than indicated

in Table 2 because the data refer only to percent of plants completely killed. Almost all the aerial portions of snowbrush (*Ceanothus velutinus*), downy rabbitbrush (*Chrysothamnus puberulus*), aspen (*Populus tremuloides*), chokecherry (*Prunus virginiana*), willows (*Salix* spp.), and snowberry (*Symphoricarpos oreophilus*) were killed by spraying. Although a high proportion of these species sprouted vigorously, production of herbage and seed will be greatly reduced for a period of several years.

Bitterbrush (*Purshia tridentata*), a particularly valuable forage species for both livestock and big game, was apparently little affected by spraying. On one area a few dead plants were found, but grazing pressure was very heavy here and probably was the cause of the bitterbrush mortality, since no damage was noted on four other areas. Douglas-fir (*Pseudotsuga taxifolia*) showed no damage whatsoever, but portions of many crowns of lodgepole pine (*Pinus contorta*) were injured and an occasional plant was killed outright. The two least desirable species, prickly pear (*Opuntia polyacantha*) and horsebrush (*Tetradymia canescens* var. *inermis*) were completely unharmed by the 2,4-D.

The differences in response of various associated forbs and shrubs indicate a need for careful consideration of vegetal composition when planning range improvement by spraying with 2,4-D to control big sagebrush. Indiscriminate spraying may entirely destroy many desirable species and allow their replacement by inferior species not damaged by 2,4-D, or by invasion of undesirable annuals. In such cases, artificial seeding may be necessary to insure satisfactory results. Also, total forage production may be seriously reduced for a period of several years. This is especially probable on sheep ranges where forbs supply a large portion of the forage or on winter big-game range where tops of shrubs are killed and the sprouting portions are buried be-

Table 2. Mortality of shrubs and trees on 12 areas in eastern Idaho sprayed with 2,4-D to control big sagebrush.

Species	Areas*												Summary	
	1	2	3	4	5	6	7	8	9	10	11	12		
<i>Amelanchier alnifolia</i>		H		M										Heavy
<i>Artemisia cana</i>								M						Moderate
<i>Artemisia tripartita</i>							H							Heavy
<i>Ceanothus velutinus</i>				U								U		Unharmed†
<i>Chrysothamnus puberulus</i>	M	L		U		L	U							Light†
<i>Opuntia polyacantha</i>												U		Unharmed
<i>Pinus contorta</i>								L						Light
<i>Populus tremuloides</i>								L	L					Light†
<i>Potentilla fruticosa</i>								U						Unharmed
<i>Prunus virginiana</i>				L										Light†
<i>Pseudotsuga taxifolia</i>				U				U						Unharmed
<i>Purshia tridentata</i>	U	U		L			U					U		Unharmed
<i>Salix</i> spp.....								L						Light†
<i>Symphoricarpos oreophilus</i>		L		L										Light†
<i>Tetradymia canescens inermis</i>	U	U					U					U		Unharmed

*Results on areas 1 to 7 based on quantitative data, those on areas 8 to 12 based on qualitative ratings.

†Severe damage to aerial portions, but few plants completely killed—almost all sprouted profusely.

neath the snow. At any rate, vegetal composition, class of animals using the range, and season of use are all important factors that should receive attention before spraying.

Summary

In order to provide information on the effect of 2,4-D on forbs, shrubs and trees commonly associated with big sagebrush, 12 large areas of sprayed sagebrush range in eastern Idaho were examined during 1954, and these were compared with adjacent unsprayed range.

Thirteen of the 38 forbs occurring on the study areas were moderately or severely damaged. Among these were such important forage species as arrowleaf balsamroot, milkvetch, oneflower sunflower, lupines and bluebell. Hawksbeard, geranium, penstemon and groundsel, also important forage plants, were unharmed or only slightly damaged.

Of the 15 shrubs and trees present, only serviceberry, threetip sagebrush and silver sagebrush (in addition to big sagebrush) suffered moderate or heavy mortality. Aerial portions of snowbrush, downy rabbitbrush, aspen, choke-

cherry, willows and snowberry were mostly killed, but a high proportion of these species sprouted profusely. Bitterbrush, a particularly valuable forage species, was unharmed or only slightly damaged.

Because of the differences in response of various associated forbs, shrubs and trees, vegetal composition should always be considered when planning sagebrush control by spraying with 2,4-D. The range manager should be aware of possible deleterious effects of spraying upon desirable species and balance this against the probable benefits resulting from sagebrush control.

LITERATURE CITED

- BOHMONT, DALE W. 1954. Chemical control of big sagebrush. Wyo. Agr. Expt. Sta. Mimeo. Circ. 39. 9 pp.
- CORNELIUS, DONALD R. AND CHARLES A. GRAHAM. 1951. Selective herbicides for improving California forest ranges. Jour. Range Mangt. 4: 95-100.
- HULL, A. C. JR., N. A. KISSINGER AND W. T. VAUGHN. 1952. Chemical control of big sagebrush in Wyoming. Jour. Range Mangt. 5: 398-402.
- HYDER, DONALD N. 1953. Controlling big sagebrush with growth regulators. Jour. Range Mangt. 6: 109-116.
- MUEGLER, WALTER F. AND JAMES P. BLAISDELL. 1951. Replacing wyethia with desirable forage species. Jour. Range Mangt. 4: 143-150.