Sagebrush Seedling Production as Related to Time of Mechanical Eradication

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Reduction of competition from big sagebrush (*Artemisia tridentata*) is a basic requirement for effective revegetation on depleted sagebrush-grass ranges in the Intermountain region. Available moisture is the factor for which plant competition is usually greatest, especially in the semiarid regions where the subsoil is permanently dry (Clements *et al.*, 1929 and Piemeisel, 1938). The root system of sagebrush not only has highly developed laterals for absorption from shallow soils but a deep taproot (Weaver and Clements, 1938 and Robertson, 1943). Robertson (1947) reported that yields of crested wheatgrass near sagebrush were only one-fourth to one-third as high as in the absence of sagebrush.

Re-invasion by sagebrush has been quite general on reseeded ranges and has frequently lessened or nullified the land manager's efforts at range improvement. Rapidity and extent of re-invasion is largely determined by the supply of viable seed and competition afforded by other vegetation. Blaisdell (1949) concluded that the effect of competition between reseeded grasses and sagebrush depends chiefly upon their relative ages as follows: (1) Grasses established concurrently with sagebrush have an initial advantage and suppress the sagebrush seedlings. Sagebrush eventually gains a prominent position in the stand. (2) Good stands of reseeded grasses established prior to sagebrush suppress the sagebrush seedlings or entirely prevent sagebrush establishment. (3) Sagebrush seedling stands may allow establishment of satisfactory grass stands, but they suppress the grass and reduce its yield. Robertson and Pearse (1945 and 1946) concluded that well-established, undisturbed stands of sagebrush are essentially closed to artificial revegetation.

In the Intermountain region sagebrush blooms during late summer and early fall depending on elevation and current climatic conditions. Ripe seed has been produced by mid-September at high elevations, but at low elevations seed may not ripen until the latter part of November.

Methods of sagebrush control which uproot, break off or mash down brush are most effective during the late summer and fall when the brush is dry and brittle. Methods which cut or tear up the brush are effective year long if the soil conditions and weather permit operation (Pechanec *et al.*, 1944). Several investigators have recognized the desirability of destroying sagebrush before it produces seed, but so far as is known a quantitative evaluation of the influence of season of eradication has not been made. It is the purpose of this paper to provide such an evaluation. The effects of brush eradication at various seasons on survival of original sagebrush plants and production of sagebrush seedlings are described.

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Experimental Procedure

Sagebrush eradication and grass seeding were done on two adjacent projects in Paradise Valley, Humboldt County, Nevada during 1952. These projects encompassed over 10,000 acres of federal range administered by the Bureau of Land Management. This area was representative of much of the depleted sagebrush land in this section of Nevada. The elevation is approximately 4,500 feet and the average annual precipitation is about 8 inches. Precipitation is distinctly of the winter and spring pattern, no effective moisture being expected from July to November. The shrubby vegetation was an old deteriorating stand of big sagebrush with occasional plants of spiny hopsage (*Grayia spinosa*). A few plants of shadscale (*Atriplex confertifolia*) and black greasewood (*Sarcobatus vermiculatus*) were also found on one area. Openings among sagebrush plants were usually devoid of vegetation and those grasses and forbs observed were generally confined to the protected areas under the sagebrush.

Offset disk harrows and wheatland-type plows were used to eradicate the brush. On one project, brush eradication was started in the latter part of April, 1952, and completed in early September. On the other project eradication was started in early September and continued until the middle of November when work was stopped by winter storms. These areas were seeded to crested wheatgrass (*Agropyron cristatum*) at an average rate of 6.4 pounds per acre in the late summer and fall of 1952.

Plant counts were made during late August of 1953 on areas which had been cleared of brush during the following periods in 1952: April–May, July–August, August–September, late September, early October and October–November. Two separate areas cleared in the October–November period were sampled.

Sagebrush and crested wheatgrass seedlings were counted on 10-square-foot plots and original sagebrush plants surviving eradication were counted on 100-square-foot plots. Sample plots were located at 50-foot intervals on random transsects and plant counts were made on one hundred plots in each area sampled.

Results and Discussion

Surviving Sagebrush

The proportion of original sagebrush plants surviving brush clearing operations was greatest on the April–May (spring) work area, declined as the work progressed through the summer months, but increased again on the areas worked in the fall. The April–May work area had an average of 2.26 plants per plot (100 square feet) as compared with an average of 0.38 plants per plot on the August–September work area (Table 1). The high survival of brush on areas worked in the spring probably resulted from greater flexibility of the brush, a good supply of residual soil moisture and favorable climatic conditions. Conversely, the low survival of sagebrush on areas worked in the summer probably resulted from increased brittleness of the brush, a depleted supply of soil moisture, relatively high temperatures, drying winds and a relatively high rate of transpiration. The increased survival with fall clearing probably resulted from lower temperatures and a lower transpiration rate.

On other reseeding projects, summer brush eradication following a heavy summer storm has resulted in high survival of sagebrush. Wheatland-type plows and offset disk harrows cut or tear the brush out but often re-cover part of this brush with soil. Many of these plants still have part of their original root system, and plants with roots buried in moist soil have become re-established. Available moisture appears to be the principal requirement for re-establishment of these plants.

Season of brush eradication had a pronounced effect on subsequent growth and appearance of surviving plants. Many of the surviving sagebrush plants on the April–May (spring) work area had an upright appearance, made rapid growth during the balance of spring and summer and also produced numerous seed stalks. In contrast, sagebrush plants surviving on the areas worked during the summer and fall had a prostrate appearance, were usually low in vigor, and made little growth following brush clearing operations. Many of the surviving plants on all areas made rapid growth and produced flower stalks during the following year, 1953, but plants on areas worked during summer and fall still had a prostrate appearance.

Brush eradication in the April–May period followed by summre fallowing favored a rapid increase in cheatgrass brome (*Bromus tectorum*), pepperweed (*Lepidium* spp.) and other annuals. Plants surviving or germinating shortly after brush eradication made rapid growth; the annuals produced a seed crop which in turn produced a heavy stand of annuals in the 1953 growing season. On areas treated at other seasons, thin stands of annuals were general, but moderate to heavy infestations of annuals occurred in scattered patches.

Heavy stands of annuals were also found on areas adjoining roads, fences or where other disturbance of soil and vegetation had occurred in the past. For example, very heavy stands of annuals were present on an area that reverted to sagebrush after a wild burn in 1942 and on 300 acres that were plowed in November of 1951 and replowed in the spring of 1952.

Table 1. Average numbers of sagebrush and crested wheatgrass seedlings and surviving sagebrush plants on sample plots in areas cleared of brush at various periods in 1952

Time of eradication	Sagebrush		Crested wheatgrass
	Survivors	Seedlings	Seedlings
	No. per 100 sq. ft.	*No. per 10 sq. ft.*	*No. per 10 sq. ft.*
April–May	2.26	0.33	6.24
July–August	1.28	0.01	7.77
August–September	0.38	0.01	12.23
Late September	0.54	0.04	13.10
Early October	1.24	0.20	9.19
October–November (first area)	0.81	2.17	9.89
October–November (second area)	0.94	6.00	10.95

Seedlings

Numbers of crested wheatgrass or sagebrush seedlings did not appear to be greatly influenced by the presence of each other. However, fewer seedlings of crested wheatgrass and sagebrush were found in dense stands of cheatgrass brome, pepperweed , and other annuals. Similarly, Robertson and Pearse (1945 and 1946) concluded that well-established stands of cheatgrass brome are essentially closed to mass invasion.

Numbers of crested wheatgrass plants per 10-square-foot plot varied from 0 to 42; 97 percent of all sample plots contained at least one seedling. Crested wheatgrass seedlings were generally well established and had an average height of 5.6 inches in August, 1953. Number and distribution of these plants were considered adequate for development of fair to good stands. The April–May work area had the lowest number of crested wheatgrass seedlings per plot, 6.24, and the largest percentage of plots devoid

of crested wheatgrass, 9 percent. Strong competition was afforded by the dense stands of annuals and the original sagebrush plants remaining on this area.

Few sagebrush seedlings were present on areas where brush was eradicated during July, August or September. Markedly more sagebrush seedlings occurred on areas worked either in April–May or in early October, and a great many more on areas cleared in the latter part of October and November. The number of sagebrush seedlings ranged from 0.01 per plot on the areas eradicated during July, August and early September, to 6.00 plants per plot on one of the areas cleared in October–November. The differences in number of seedlings on summer-cleared areas as compared with spring- or fall-cleared areas were highly significant by chi-square analysis.

Season of brush eradication influenced the number of sagebrush seedlings by determining the quantity of sagebrush seed on each area in the fall of 1952. The general absence of sagebrush seedlings on areas cleared in the summer months is ascribed to a scarcity of viable sagebrush seed in the fall of 1952. Conversely, the large number of sagebrush seedlings on both areas worked in October–November is attributed to a large crop of well developed seed at the time of brush eradication. The difference in number of seedlings on the two areas worked in the October–November period cannot be fully explained. Differences in site and performance of equipment may be responsible since these areas are approximately three miles apart and brush clearing was done by different crews and equipment. Sagebrush seedlings were frequently clustered at or near the crowns of dead sagebrush plants which had been cut or uprooted.

Apparently sagebrush seed had not fully developed by early October, since only a moderate number of sagebrush seedlings was found on this eradication area. Seedlings on the area worked in the April–May period apparently originated from a relatively large seed crop on the surviving sagebrush plants.

Season of brush eradication also influenced survival of original sagebrush plants which subsequently competed with the crested wheatgrass seedlings.

The most favorable period for reinvasion by sagebrush is after competition has been reduced by brush eradication and before newly established plants fully occupy the space. Satisfactory grass stands may become established among sagebrush seedlings but the sagebrush eventually gains a prominent position on the range and causes a great reduction in yield of grass. Plans for artificial revegetation of depleted sagebrush range should include the methods which will result in a high sagebrush kill, give reasonable assurance of a good stand of desired plants and minimize re-establishment of sagebrush.

Summary and Conclusions

The effects of season of brush eradication on production of sagebrush seedlings, the survival of original sagebrush plants and the establishment of crested wheatgrass seedlings were studied on two adjoining reseeding projects in Humboldt County, Nevada. The evaluations were made in the summer of 1953 on more than 10,000 acres of sagebrush lands administered by the Bureau of Land Management and cleared with offset disk harrows and wheatland-type plows over the period from April to November, 1952. These areas were planted to crested wheatgrass during late summer and fall of 1952.

The number of mature sagebrush plants remaining after treatment was greatest on areas worked during the spring. The proportion of surviving plants decreased on summer-cleared lands but increased markedly on areas worked in October and November.

A moderate number of sagebrush seedlings developed on the area cleared during the spring months, probably from seed produced by plants surviving eradication. Seedling establishment was negligible on summer-cleared areas but large numbers were found on areas cleared after mid-October.

It is concluded that season of mechanical eradication has important effects on survival and regeneration of sagebrush as follows: (1) Eradication early in the spring when plants are flexible and conditions are favorable for plant growth may give a low kill of old plants and result in a stand of vigorous survivors capable of producing seed during the following summer and fall. This may result in a large crop of sagebrush seedlings the following spring. (2) Eradication during the summer when the soil is dry and firm and before sagebrush seed has matured will probably give a high kill of old plants and probably repress or curtail production of seed by survivors that year. (3) Eradication in the fall, after sagebrush seed has matured, serves to scatter and to plant the seed in the disturbed ground. This tends to insure a very large crop of sagebrush seedlings the following year.

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