Contrasting Effects of Big Sagebrush and Rubber Rabbitbrush on Production of Crested Wheatgrass

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Big sagebrush *(Artemisia tridentata)* and rubber rabbitbrush *(Chrysothamnus nauseosus)* have increased greatly under all grazing treatments on the Benmore Experimental Range in west central Utah (Frischknecht *et al.* 1953). Whereas it is generally considered that both species reduce grass yields, this paper reports results of three correlated studies of grass clipping showing that they differ markedly in their effects upon production of crested wheatgrass. In a general way, results are related to differences in brush root systems and growth habits.

The competitive relationship between big sagebrush and grass is well documented. Nearly 20 years ago Pechanec *et al.* (1944) and Robertson and Pearse (1945) recognized that successful establishment of artificial seedings depended upon successful eradication of sagebrush. Blaisdell (1949) observed that when grass and sagebrush became established at the same time, grass had the initial advantage but sagebrush eventually gained a prominent place in the stand. Sagebrush had the advantage from the start when it became established before grass.

Less information is available about competition between rubber rabbitbrush and grass. McKell and Chilcote (1957) observed that growth and seed production of rubber rabbitbrush increased when competing vegetation was removed. Plummer *et al.* (1955) listed both rabbitbrush and sagebrush among the undesirable competition to be eliminated to assure success of introduced grass in range seedings. They reported that successful plantings had been made into thin stands of rabbitbrush. These authors and others have emphasized that rubber rabbitbrush is more difficult to control than big sagebrush because it habitually resprouts.

Effects of big sagebrush and rubber rabbitbrush upon productivity of crested wheatgrass were studied on caged plots during two years of spring cattle grazing and from open plots a third year when there was no spring grazing. Ring counts showed that these brush plants had invaded over the years after grass was seeded.

Study No. 1

On April 16, 1957, before the first spring grazing, pairs of sagebrush and rabbitbrush plants of comparable size in each of 24 experimental pastures were selected for study of understory grass yields. One brush plant of each pair was selected at random, cut and removed. A cage of the type described by Robertson (1954) was placed over each brush stump and over each remaining brush plant. The cages protected grass from being grazed on circular plots 9.6 square feet in area, centered at the brush stems; plot size was selected largely for convenience in expressing yields in pounds per acre (Frischknecht and Plummer, 1949). In addition, two nearby randomly located grass plots without brush were similarly protected from grazing in each pasture. Three months later, after spring growth was completed, grass on each plot was hand-clipped, air-dried, and weighed. Simple "t" tests were applied to yield data.

Grass yields and numbers of seed heads were less under sagebrush but greater under rabbitbrush than on brush-free plots (Table 1). The responses to removal of shrubs early in the growing season (April 16) probably provide the most critical measures of competitive (and shading) effects in this preliminary study. Removal of sagebrush increased grass yield nearly 20 percent, whereas removal of rabbitbrush had little effect. Numbers of grass seed heads increased about 20 percent following early removal of both brush species. Height growth was less after removal of brush shade, and least where there had been no brush at the outset.

Study No. 2

In 1958, grass yields were weighed around brush plants of

Table 1. Herbage yield, seed heads, and height of crested wheatgrass in mid-July, 1957, on 9.6 sq. ft. plots without brush initially, with brush removed early in the growing season, and with brush remaining.

Plot variable	Herbage yield[1] (air dry) (Pounds/A.)	Seed heads (Number)	Ave. Culm height (Inches)
No brush	958[a]	213	15.3
With sagebrush:			
Removed April 16	842[a]	130	17.4
Not removed	705[b]	107	19.7
With rabbitbrush:			
Removed April 16	1,624[c]	308	18.3
Not removed	1,548[c]	261	20.1

[1] Means with same superscript are not significantly different at the 5-percent level (based on "t" tests).

Table 2. Grass and associated brush measurements on two grazing units in 1958.[1]

Sampling unit	Grass Yield[2]	Grass Height	Brush Height	Brush Crown diameter	Age
	(Pounds/A.)	— — — (Inches)	— — —	—	(Years)
Lightly grazed pastures:					
Big sagebrush plots	557[a]	16.8	23.1	20.7	11
Rubber rabbitbrush plots	969[b]	16.8	19.5	17.6	8
Brush-free plots	858[b]	15.4	....	....	....
Heavily grazed pasture:					
Big sagebrush plots	294[c]	13.1	20.9	21.7	12
Rubber rabbitbrush plots	586[d]	13.6	19.4	19.2	9
Brush-free plots	669[d]	12.5	....	....	....

[1] Data are means of 30 plots.
[2] Means with same superscript are not significantly different at the 5-percent level.

a greater size range than those of the previous year. Effort was confined to only two experimental range pastures where grass had been utilized relatively lightly (about 50 percent by weight) and heavily (80 percent) by cattle for 10 consecutive spring seasons. In each pasture 30 plants of big sagebrush were paired for size with 30 nearby plants of rubber rabbitbrush, and all were caged during early growth and before grazing started the last week in April. A brush-free plot, chosen at random, was caged in the vicinity of each pair of brush plants. Data on grass yields and brush measurements were obtained during the first week of July, when grass had completed spring growth. Analysis of variance was used in testing effects of experimental variables on grass yields.

Again, grass yield was much less on the sagebrush plots than on the rabbitbrush plots and brush-free plots in both pastures (Table 2). Differences in yield between rabbitbrush plots and brush-free plots, however, were much smaller than in 1957, perhaps because brush plants were smaller (they averaged approximately eight inches, or about 30 percent, less in crown diameter). The effects of brush size on grass yield were highly variable and inconclusive. Presumably, the plots were not large enough to measure adequately the effect of large brush plants.

The heavily grazed pasture was located 200 feet lower and about 2½ miles north of the other pasture. This heavily grazed pasture receives an average of 11 percent less precipitation annually. This in addition to differences in past use may have contributed to the lower grass yields.

Study No. 3

The study in 1959 was more comprehensive than the first two. Cages, which had restricted plot size in previous studies, were unnecessary since the experimental ranges were not grazed in the spring. A minimum of 10 brush plants per species was sampled in each of eight crown-diameter classes and extra sampling in the most common classes brought the total to 120 plants per brush species. Grass yields were measured throughout the zone of brush influence by clipping concentric areas in increments of one-foot radii from the brush stem. Small brush plants sampled were at least six feet apart, and large brush eight to ten feet apart, to eliminate effects of adjacent plants.

The 120 plants of each species were equally divided between two sites similar in types of soils and amount of precipitation received but differing in grazing history. One was in the lightly grazed pasture sampled in Study No. 2; the other was in a nearby pasture where spring grazing had been heavy (approximately 80-percent utilization) but had started ten days later in the spring. The main differences in grass yields around shrubs in the two pastures were not statistically significant (Table 3); so the data were combined for other interpretations.

Grass yields per unit area increased as crown diameter of associated rubber rabbitbrush

Table 3. Analysis of variance of grass yield means for (1) plot radius from brush stem, (2) brush species, (3) brush crown diameter, and (4) intensity of previous grazing of pasture.

Source of variation	Degrees of freedom	Mean square	F value
Species of brush (S)	1	22,814	100.946**
Past grazing intensity (I)	1	250	1.106
Brush diameter class (C)	7	516	2.293*
Radius zone from stem (R)	2	5,975	26.438**
S X I	1	704	3.115
S X C	7	1,840	8.141**
S X R	2	2,054	9.088**
I X C	7	89	0.394
I X R	2	842	3.725*
C X R	14	800	3.540**
Error	51	226	
Total	95		

*Significant at the 5-percent level.
**Significant at the 1-percent level.

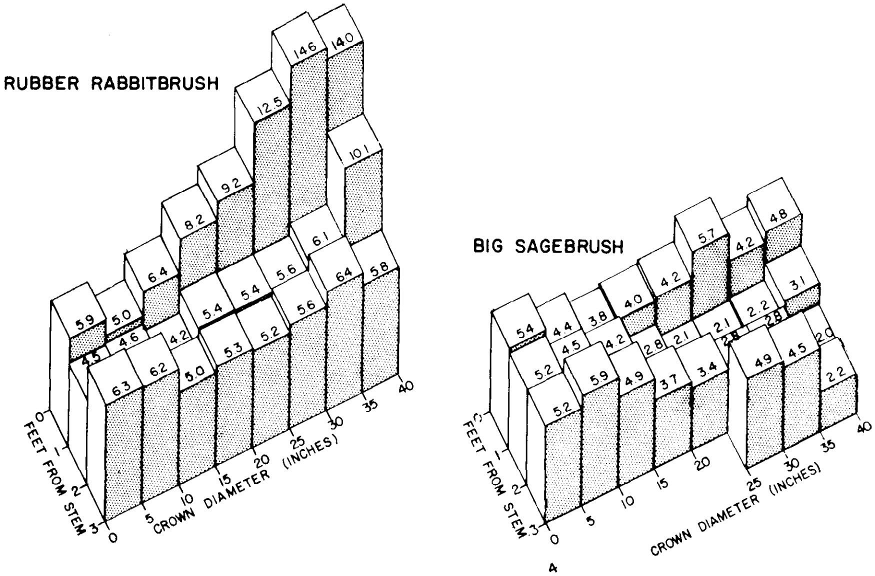

FIGURE 1. Herbage yield (grams per square foot, air dry) of crested wheatgrass in concentric one-foot plots around individual sagebrush and rabbitbrush plants of eight crown-diameter classes (1959). The three- to four-foot zone was sampled only for sagebrush having crown diameters greater than 25 inches. The total sample included 120 plants of each species—10 to 20 for each diameter class.

plants exceeded 15 inches (Figure 1). This was most marked in the area within a one-foot radius around the brush stem. Beyond this distance rabbitbrush usually influenced grass yields very little; however, the largest plants (35 to 40 inches in diameter) showed increased yields in the one- to two-foot zone.

Conversely, grass yields per unit area around sagebrush decreased as shrub size increased. Yields of grass in the one-foot zone around sagebrush stems were essentially unaffected by sagebrush size, but yields in the one- to 2- and 2- to three-foot zones decreased greatly as sagebrush increased in size, especially when sagebrush crowns exceeded 15 inches' diameter. Unlike rabbitbrush, the largest sagebrush plants affected grass yields markedly beyond the three-foot zone. None of the plants sampled appeared to influence grass yields beyond the four-foot zone; hence plots were not extended further.

Discussion of Related Factors

Snow Accumulation

Under conditions at Benmore, both brush species increase deposition of drifting snow; this results in increased moisture around brush plants in early spring. Rabbitbrush appears to be the more effective of the two because it has a less dense crown and loses proportionately more of its leaves in winter; this permits more snow to reach the ground. Although leaves of both species contribute to surface litter, soil organic matter, and improved soil-water relations, the situation appears accentuated under the more open crowns of rabbitbrush.

Root Systems and Growth Periods

Comparison of root systems of big sagebrush and rubber rabbitbrush further accounts for their contrasting effects upon grass production. Lateral roots of big sagebrush become more highly developed than laterals of rubber rabbitbrush in the surface soils—the zone where grass roots are most numerous. This is especially true on soils having a calcareous hardpan—characteristic of the areas sampled—or a heavy clay subsoil or a layer of high salt accumulation. Such subsoils restrict sagebrush taproots more than taproots of rubber rabbitbrush (Figure 2).

The abundant, shallow roots of big sagebrush compete intensely with the roots of crested wheatgrass for soil moisture because these two species grow actively at the same time. On the other hand, crested wheatgrass is usually headed out by the time rabbitbrush is most active, and the secondary rabbitbrush laterals seemingly offer little competition to the grass. Taproots of both brush species draw moisture from deeper sources than the main root system of wheatgrass; but where the sagebrush has poorly developed taproots it must derive moisture from the same level as the grass does.

Crested wheatgrass appeared to have a competitive advantage over rubber rabbitbrush in both time of growth and type of root system, and to inhibit rabbitbrush more than rabbitbrush inhibited grass. This premise is supported in part at least by McKell and Chilcote (1957), who found that removal of competing native vegetation greatly increased growth of rubber rabbitbrush.

Grass Utilization

At Benmore, in early spring, grass grows more rapidly underneath brush than in the open. Usually it is four to six inches taller than grass in the open at the beginning of spring grazing in April. The taller understory growth appears less preferred by cattle; at least it tends to be grazed later in the season than grass growing in the open, even where brush provides little obstruction to animals. Of course, as mechanical obstruction becomes more pronounced, understory grass is more lightly used—even under heavy stocking where cattle graze closer to brush than under light stocking. In effect, the delayed and/or lighter spring use should contribute to improved vigor of

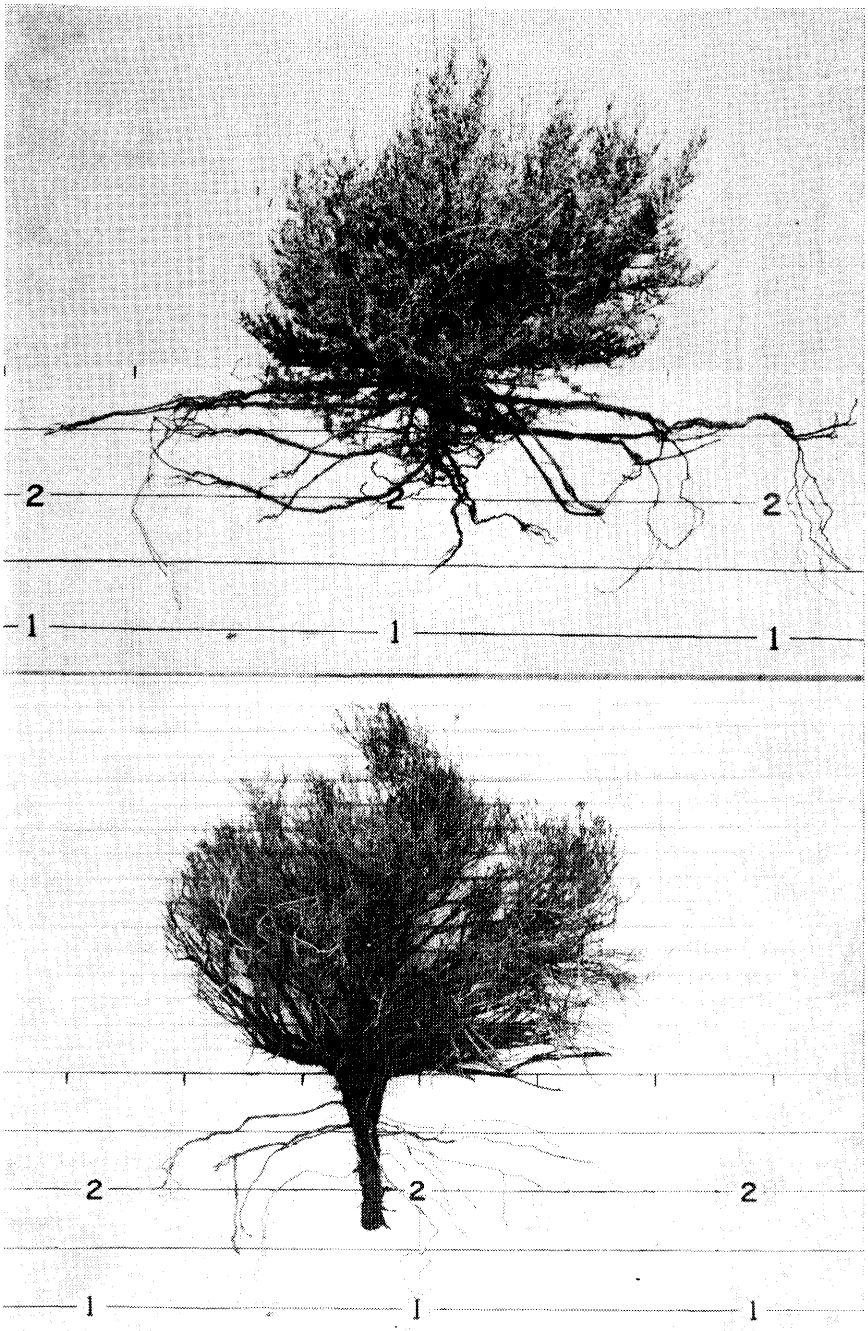

FIGURE 2. Upper: Main root system of this sagebrush plant is chiefly lateral roots in the upper 14 inches of soil. One lateral root was followed for six feet from the brush stem. The poorly developed taproot extended only 16 inches deep, where apparently it was restricted by a calcareous layer. Lower: Most lateral roots of this rubber rabbitbrush plant, which grew within 20 feet of the sagebrush plant above, turned downward within two feet of the brush stem. Judging from other excavations, it is likely that this thick taproot, which was cut at 16 inches, extended to great depth.

grass under brush.

These and other possible beneficial influences may account for increased grass yields associated with rabbitbrush. With sagebrush, however, adverse competition evidently outweighs the beneficial influences. Spring grazing, by further reducing grass vigor and yield, gives the sagebrush still greater advantage (Figure 3).

Fall Grazing Improved by Rabbitbrush

In four years of fall grazing, cattle have been observed to forage more around and under rabbitbrush plants than elsewhere, except in swales where moisture accumulates. Mechanical obstruction of brush to animals was much less of a problem than it had appeared to be in the spring. This is explained by the additional observation that crested wheatgrass remained more succulent under rabbitbrush throughout the summer. Also, late summer and fall regrowth of grass was more lush under rabbitbrush than under sagebrush or in the open. Thus, under conditions at Benmore, the presence of rabbitbrush increased the value of crested wheatgrass range for fall grazing.

Present information suggests that little effort is justified for controlling rubber rabbitbrush on crested wheatgrass range, particularly where fall grazing is practiced. On the other hand, control of big sagebrush on such range for cattle appears to be a worthwhile objective.

Summary and Conclusions

Removal of big sagebrush plants in mid-April 1957 increased grass yields by July 16 about 20 percent. Early removal of rubber rabbitbrush had little effect on grass yields. Numbers of grass seed heads increased about 20 percent following early removal of both brush species, but culm height was about two inches shorter.

In each of three years, grass yields were greater under rabbitbrush plants than under sagebrush plants. The effect of size of brush on grass yields was inconclusive in two of the years when cages restricted plot size. More intensive study in the third year showed that grass yields per unit area increased as rubber rabbitbrush crown diameters ex-

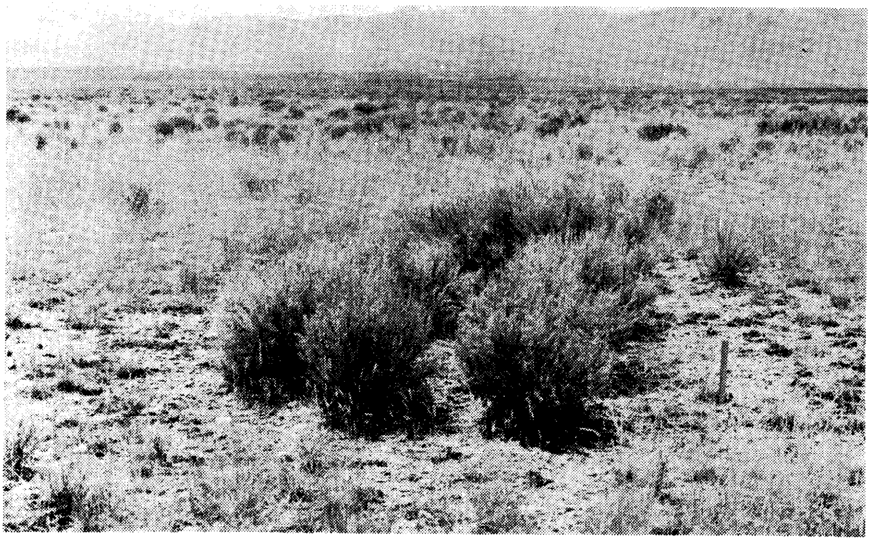

FIGURE 3. Bare "halo" areas develop around big sagebrush plants as grass plants weaken and die.

ceeded 15 inches. The increase was greatest within a one-foot radius from brush stems, but it extended to the two-foot radius when brush crown diameter approached 35 inches. In contrast, grass yields usually decreased as crown diameter of sagebrush plants reached about 15 inches. Sagebrush influenced grass yields markedly to the three-foot radius in large plants.

Depressed yields of grass around big sagebrush plants are associated with highly developed lateral brush roots in the grass-root zone. In contrast, relatively few lateral roots of rubber rabbitbrush occur in this zone. Also, the most active growth periods of crested wheatgrass and big sagebrush coincide, whereas crested wheatgrass makes most of its growth prior to the most active growth of rubber rabbitbrush.

The presence of rabbitbrush improved fall grazing because the understory grass remained more succulent and fall regrowth was more abundant under rabbitbrush than in the open or near sagebrush. Control of big sagebrush on crested wheatgrass range for cattle is a worthwhile objective. Just how much effort is justified in controlling rubber rabbitbrush is questionable, particularly where fall grazing is practiced.

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