Interseeding Shrubs in Cheatgrass with a Browse Seeder-Scalper

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Highlight: *Four browse species and a mixture of the four were interseeded into a uniformly dense cheatgrass stand with a browse seeder-scalper on deer winter range south of Manti, Utah. Four different width–4-, 8-, 16-, and 24-inch–scalping attachments were used to determine their relative effectiveness in reducing competition between cheatgrass and developing shrub seedlings. Scalping with the wider attachments resulted in substantial increases in shrub seedling survival. Reduction of cheatgrass density was most marked during the first growing season following planting. Thereafter, cheatgrass fully reoccupied first the narrower and then the wider scalps. In terms of numbers of plants surviving after 5 years, antelope bitterbrush, Nevada ephedra, and the mixture proved most responsive to increases in scalp width. Cliffrose and fourwing saltbush were less so. Herbage production of individual shrubs regardless of species showed no response to increasing scalp width. However, production for an entire plot where the effect of number of plants was included increased markedly with increases in scalp width. Cheatgrass competition, although it limited growth of all the planted shrubs, was less limiting to fourwing saltbush than to the other three shrubs.*

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Establishing shrubs on wildland ranges in Utah by direct seeding is often difficult. Although failures are traceable to a variety of factors, inadequate soil moisture at the time of germination and during the initial growth period is probably the most important (Holmgren, 1956). Consequently, it is important to use seeding or site preparation methods that eliminate competition and make additional moisture available for shrub growth.

Over much of temperate western United States, cheatgrass brome, (*Bromus tectorum*) is a prolific invader where perennial cover has been eliminated or reduced. Normally a fall or winter germinating annual, cheatgrass can be a serious spring competitor with developing shrub seedlings due to its advanced state of development at the time shrub seeds germinate. Cheatgrass uses most of the available moisture in the upper soil layers prior to shrub seed germination (Holmgren, 1956; Stewart and Hull, 1949; Hull and Stewart, 1948).

Although a number of techniques are available for direct seeding of shrubs, not all of them effectively reduce competition from undesirable herbs and grasses. One method for establishing antelope bitterbrush (*Purshia tridentata*) is to hand plant seeds in prepared scalps made with a hoe designed for this purpose (Holmgren and Basile, 1959). This scalping removes existing cheatgrass and other plants, prepares a favorable seedbed, and removes any ungerminated seeds from the scalp. Hand scalping has proven particularly useful on steep or rugged terrain not suited to mechanical methods (Holmgren and Basile, 1959; Plummer et al., 1968). However, hand scalping is slow and expensive, and should not be practiced where the terrain permits use of a mechanical method of equal effectiveness.

This study was designed to test the effectiveness of four different width scalping attachments available for a browse seeder-scalper (U.S. Dep. Agr., 1965) in removing cheatgrass competition and establishing seedlings of four different shrub species and a mixture of the four.

Methods and Materials

In December of 1966 a study site was selected on deer winter range south of Manti, Utah. Before 1961, this area was occupied by a rather dense stand of Utah juniper (*Juniperus osteosperma*) and pinyon (*Pinus edulis*). In November of 1961, the juniper-pinyon forest was anchor-chained and seeded to a mixture of grasses, forbs, and shrubs. The study site had been an opening of approximately 2 acres within the juniper-pinyon stand. This clearing for many years had been a sheep bedding ground and was infested with cheatgrass and bur buttercup (*Ranunculus testiculatus*). Sheep bedding continued for 2 to 3 years after the chaining, and as a result, the seeded perennial species failed to become established. At the time this study was initiated, a uniformly dense stand of cheatgrass, more than 200 plants per square foot, dominated the site.

Elevation at the study area is approximately 5,700 ft, and annual precipitation averages about 11 inches. The soil is a clay loam derived from limestone parent material.

Four browse species thought to be adapted to the site were chosen for the experiment. These species were antelope bitterbrush, cliffrose (*Cowania mexicana stansburiana*), fourwing saltbush (*Atriplex canescens*), and Nevada ephedra (*Ephedra nevadensis*).

All species were planted singly and in a four-species mixture of approximately equal parts on December 1, 1966. A browse seeder-scalper, equipped with four sizes of scalping attachments (4-, 8-, 16-, and 24-inch widths) was used for the planting operation. This device is designed to simultaneously open a furrow, remove the top 2 inches of soil on either side, and plant seed at a preset rate. A small packing wheel covers the seed. For this experiment, the seeding mechanism was adjusted to disperse seed at a rate of approximately 24 seeds per linear ft. Figure 1 depicts the planting operation.

Seeds were planted in 80 parallel rows approximately 120 ft long. Hundred-foot segments in the centers of each row were marked as study plots.

Fig. 1. *The browse seeder-scalper fitted with 24-inch double moldboard scalper blade opening furrows in a cheatgrass stand.*

Four replications of each of 20 combinations of species and scalp width were employed. These were arranged and randomized in four blocks, suitable for a split-plot experiment (Snedecor, 1956). This design was selected to achieve relatively high sensitivity in evaluating the effects of scalping widths and the interaction of scalping widths with species, as determined by establishment and survival of the seeded shrubs. The effect of species alone was of secondary importance. Covariance analysis was employed to detect trends that might result from a regression effect.

Treatments were evaluated both by the number of surviving plants and by annual production in grams of green herbage. Production was determined by the weight estimate technique described by Pechanec and Pickford (1937). Data were collected during the summer of 1971.

Deer and rabbits made light to moderate use of planted shrubs during the course of the study. The significance of animal use is difficult to assess as seasonal grazing intensities were not recorded. To some degree, grazing was a source of uncontrolled variation. Whatever this may have been, it is assumed that all plots were uniformly affected.

Results and Discussion

Cheatgrass Density.

Hull and Stewart (1948) found that undisturbed cheatgrass stands in southern Idaho averaged about 570 plants/ft^2. Their studies indicate that if cheatgrass density can be reduced to less than 100 plants/ft^2, seeded perennial grasses have a good chance to become established.

Cheatgrass density on the Manti site was estimated to be well over 200 plants/ft^2. The method used in this study to reduce cheatgrass density (a browse seeder-scalper) is analogous to the moldboard plowing that Hull and Stewart found most effective.

In the early summer of 1967, the year immediately following planting, cheatgrass was virtually absent from the 16- and 24-inch scalps. Moderately dense stands (50 to 80 plants/ft^2) were present on the narrower scalps. Except for fourwing saltbush, two to six shrub seedlings per ft were present on all scalps. Fourwing saltbush was more erratic and generally poorer in emergence than the other species. This was true in mixture plots, as well as in single-species plots.

By 1968, cheatgrass brome had fully reoccupied all scalps. Cheatgrass density was again more than 200 plants/ft^2, and little difference was apparent among different width scalp rows or between scalp rows and undisturbed areas (Fig. 2). Additionally, it was observed that there was an increased occurrence of Russian thistle (*Salsola kali*) on the wider scalps as compared to narrower scalps or undisturbed areas.

Shrub Establishment and Survival.

Scalp width had a highly positive effect on numbers of shrubs surviving after 5 years. However, results varied among species (Table 1). Bitterbrush, ephedra, and the mixture showed the greatest response to increasing scalp

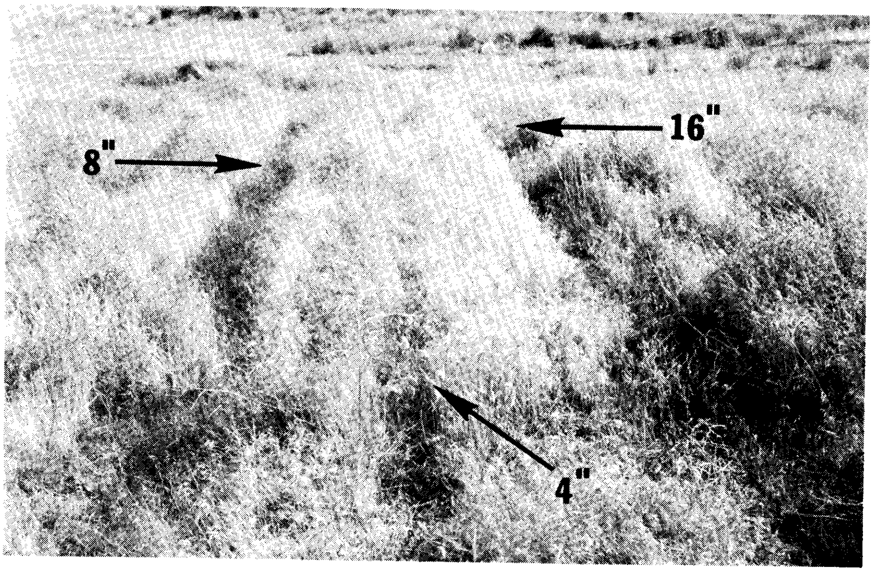

Fig. 2. *The scalped study plots in 1968. Note recovery of cheatgrass on scalped rows indicated by arrows. Such cover offers heavy competition for shrub seedlings.*

width.

Analysis of variance showed that species, scalp width, and the species X scalp width interaction were all significant ($P<.05$) (Table 2). To refine these findings, particularly the effect of scalp width and its interaction with species, the number of plants per 100 ft of row was regressed over scalp width and forced through the origin. Results indicate no significant slope differences existed among bitterbrush, ephedra, and the mixture. That is, all of these species responded to increasing scalp width positively and in approximately the same relative magnitude. The average slope for this group (5.43) was both higher than and significantly different from that of cliffrose (2.01). Fourwing saltbush showed the smallest response to increasing scalp width with a slope of 0.536, which is significantly less than that of cliffrose. None of the computed regression lines can be classed as reliable predictors as the r^2 values were relatively low, ranging from 20 to 51. Nonetheless, the beneficial effect of wide scalps is apparent, as a 670% increase in saltbush survival was realized in going from 4- to 24-inch scalps. Fourwing saltbush normally grows more rapidly than the other species, and may compete with itself more severely, thus producing a greater self-thinning effect (Fig. 3).

Holmgren (1956) found that hand scalps of at least 30-inch diameter were necessary to nullify the competitive effect of cheatgrass. Hubbard et al. (1962) discovered that competition from perennial grasses such as standard crested wheatgrass (*Agropyron desertorum*) also was severe. The competitive effect of this grass was evident within 2 feet of bitterbrush plants. Thus, our 24-inch scalp probably did not completely overcome the competitive influence of cheatgrass. However, the 24-inch scalp provided an adequate stocking of all the tested shrubs.

Table 3 presents a summary of mixture plot data for species survival and percent of the total composition each species comprised on each scalp width plot. Although each species in the mixture showed gains in numbers of plants with increasing scalp width, percent composition changed markedly between the 4- and 24-inch scalps. As with the single species plots, bitterbrush proved most responsive and fourwing saltbush least responsive to increases in scalp width. Fourwing saltbush decreased in terms of percent composition as scalp width increased, but the increase in actual numbers of saltbush plants apparently provided more favorable conditions for the other species.

Herbage Production.

Herbage production on a per plot basis increased with increasing scalp width, but was primarily a function of the number of plants in the plot (Table 4). The analysis of variance showed that species, scalp width, and the interaction were all significant. However, only the species effect was significant in an analysis based on weight in grams of an average-size plant (Table 5). The species difference was expected because fourwing saltbush grows more rapidly than the other species.

Table 1. Average numbers of shrubs surviving per 100 linear feet after 5 years (1966–1971) in various width scalp plots.[1]

Species	Scalp width (inches) 4	8	16	24
Fourwing saltbush	2	10	3	15
Antelope bitterbrush	20	48	84	156
Nevada ephedra	11	62	70	115
Cliffrose	5	13	19	59
Mixture	32	48	69	137

[1] Figures are a mean of four replications.

Table 2. Results of analysis of variance of plant survival for four seeded shrub species and a mixture of the four, 5 years after planting in four different 100 linear foot scalp width plots.

Source of variation	Degrees of freedom	Mean squares	F
Main plots			
Species	4	15,469	8.43*
Blocks	3	9,337	5.09*
Main plot error	12	1,834	
Subplots			
Scalp width	3	24,260	25.18*
Species X scalp width	12	1,980	2.06*
Subplot error	45	963	
Total	79		

*Significant at $P < .05$.

Fig. 3. *The scalped study plots in 1971. Note the dominance of fourwing saltbush. Bitterbrush, Nevada ephedra, and cliffrose are not visible because of their small size.*

Table 3. Average number and percent composition of shrubs after 5 years (1966–1971) as they occurred in 100 linear foot mixture plots of various scalp widths.[1]

	Scalp width (inches)							
	4		8		16		24	
Species	No.	Comp.	No.	Comp.	No.	Comp.	No.	Comp.
Fourwing saltbush	40	32	40	21	45	16	80	15
Antelope bitterbrush	31	24	35	18	76	28	178	33
Nevada ephedra	33	26	69	36	75	27	140	25
Cliffrose	23	18	48	25	78	29	150	27
Totals	127	100	192	100	274	100	548	100

[1] Numbers are average of species subtotals from four replications of mixture plots.

Table 4. Green herbage production in grams per 100 linear foot plots after 5 years (1966–1971) of shrubs in various width scalp plots.[1]

	Scalp width (inches)			
Species	4	8	16	24
Fourwing saltbush	1,083	5,403	1,063	12,725
Antelope bitterbrush	66	154	199	894
Nevada ephedra	29	219	193	429
Cliffrose	4,523	2,555	3,188	15,659

[1] Figures are mean of four replications.

Table 5. Green herbage production in grams per plant of mean plant size for four shrub species after 5 years (1966–1971) in various width scalp plots.[1]

	Scalp width (inches)			
Species	4	8	16	24
Fourwing saltbush	333	620	288	725
Antelope bitterbrush	3	4	3	3
Nevada ephedra	5	3	3	4
Cliffrose	5	3	5	4

[1] Mean plant size determined by height and crown diameter measurements.

Although fourwing saltbush and the mixture showed significant regression effects with respect to per plot production, the predictor was extremely weak. Standard error of the estimate was about 127% of the mean response. When one considers the effect of scalp width solely on production or growth, there is no apparent benefit in increased scalp width. Increased seedling survival is the primary benefit. Utilization by game probably had some influence on production. Since all of the plots were open to browsing and trampling by deer and rabbits, this factor may be at least partially responsible for keeping seedlings at a relatively uniform size on the various scalp plots.

The mixture showed a significant regression solely because of the inclusion of fourwing saltbush. Established plants of this species grew much more rapidly and thus tended to mask effects resulting from the other species.

Summary and Conclusions

Scalping is an effective method for establishing shrubs in cheatgrass stands and the browse seeder-scalper used in this study proved to be an efficient planting device to reduce competition.

The effect of scalping on cheatgrass density was most evident during the growing season immediately following planting. Thereafter cheatgrass tended to reoccupy the site. The essential element is to provide a release from competition during the critical first year of seedling growth.

In terms of numbers of plants surviving to 1971, bitterbrush, ephedra, and the mixture reacted most positively to increased scalp width. Cliffrose and fourwing saltbush responded to respectively lesser degrees.

The 24-inch scalp width proved superior in terms of survival for all four shrubs. This width scalp was adequate to achieve satisfactory stocking. However, other research indicates that a 30-inch or larger scalper blade might produce even higher survival.

Forage production on a per plant basis had no significant relationship to scalp width. Increased production was almost totally a function of numbers of plants in a plot. Seedling establishment, but not subsequent growth, benefited from increased scalp width.

In mixture plots, fourwing saltbush, an inherently fast-growing species, attained a much greater size than the other shrubs, but comprised an increasingly smaller percentage of the shrub composition as scalp width increased.

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