

Seeding Sherman Big Bluegrass

PAT O. CURRIE

Range Scientist, Rocky Mountain Forest and Range
Experiment Station,¹ Fort Collins, Colorado.

Highlight

Sherman big bluegrass was successfully established by planting into summer-fallowed land with a double-disc, depth-band drill to control seeding depth at $\frac{5}{8}$ -inch. Planting during July and August into a moist seedbed gave optimum seedling establishment. Weed competition and erosion on the summer-fallowed land was reduced by leaving the ground in rough-plowed condition until immediately before seeding.

Sherman big bluegrass, a selected strain of *Poa ampla* Merr. indigenous to the Pacific Northwest, has been introduced to several areas within the Rocky Mountain Region (McGinnies et al., 1963). For this region, it has been most successful at elevations above 7,000 ft, and where average annual precipitation approaches or exceeds 14 inches. Big bluegrass is a productive bunchgrass, but it frequently has been difficult to establish in its adapted range (Hyder and Sneva, 1963). Because of the establishment problem, some cultural and environmental requirements of this species such as seedbed preparation, seeding depth, and time of seeding were studied at the Manitou Experimental Forest, Colorado, from 1963 to 1965, preliminary to planting it for grazing experiments.

Study Area and Seeding Methods

The Experimental Forest is situated 28 miles northwest of Colorado Springs, Colorado, in the ponderosa pine zone at an elevation of approximately 8,000 ft. Summer temperatures are cool; they seldom exceed 90 F. in the daytime and at night are near freezing. Winters are open, but are cold with temperatures occasionally as low as -40 F. Plant growth usually begins in late March or early April, with the growing season ending in

September or October. However, frosts, which temporarily retard plant growth, are common early or late in the growing season.

Annual precipitation at Forest Headquarters averages 15.5 inches, with approximately three-fourths of it falling during the spring and summer months. Plant growth or forage production, particularly on seeded ranges, is closely associated with the amount of rainfall received during the growing season (Currie and Smith).²

Alluvial soils derived from Pikes Peak granite are characteristic of the area. These soils are sandy loams or sandy-clay loams that are porous when wet and very hard when dry. They are highly erodible and of low fertility, with only moderate amounts of organic material.

Abandoned fields, which were last farmed during the late 1930's, were plowed and seeded to grass for research purposes in the mid 1940's. For the present work, the study areas were plowed with a moldboard plow and cultipacked before seeding, following the recommendations of McGinnies (1962) for firming light-textured soils. Seeds were planted in rows 12 inches apart except for the broadcast treatment. This is the maximum spacing recommended by Hyder and Sneva (1963) for seeding big bluegrass. All treatments were seeded at a rate of 5 lb/acre. The seed was registered Sherman big bluegrass grown near Pullman, Washington, but obtained locally.

Season and depth of planting.—A complete factorial experiment in three replications of randomized blocks was used to evaluate spring and fall planting and three seed placement treatments. The plantings were made on 10- by 25-ft plots at two seasons: fall, October 2-3, 1963, and spring, April 13-14, 1964. Seeds were hand broadcast and raked, drilled to a 0.5-inch depth or drilled to a 1-inch depth. Drilled plots were

planted with a single-row double-disc cone-type seeder.^{3a}

Seedlings on each plot were counted within three random 1- by 5-ft subplots. Where seeds were drilled, the plot frame was placed across adjacent rows and the plants counted in five individual rows. Since seeds planted to the 1-inch depth in the fall germinated and emerged soon after planting, seedlings on this treatment were first counted in November 1963. Seedlings on all trials were counted in June 1964, including plants on the fall-drilled, 1-inch treatment.

Fertilizer trials.—A summer seeding was made during the first week of August 1964, with only a $\frac{5}{8}$ -inch planting depth. Plot size, row spacing, and seeding rate were the same as before, but commercial fertilizers were applied to determine whether they increased grass establishment as reported by Cosper and Alsayegh (1964). At the time of planting, 50 lb/acre of elemental N, P, or K was applied as a top dressing in all possible combinations to plots in three replications. Plant counts were made as described previously.

Field seedings.—In the summer of 1965, two 45-acre blocks were seeded to Sherman big bluegrass for a grazing experiment. One block, plowed during the summer of 1964, was fallowed over-winter and then disked just prior to cultipacking and planting. The small area used for the 1964 fertilizer trials was withdrawn from this block. The other block was plowed in the spring of 1965, fallowed until mid-summer, and then cultipacked immediately before planting. It was not disked except to level furrows or break up old plant clumps that remained on a few isolated areas.

Planting was started the last week in July and continued intermittently until late August. Seeds were drilled to a $\frac{5}{8}$ -inch depth with the double-disc, depth band, grass drill described by Bement et al., (1965).^{3b} These areas were also planted at a rate of 5 lb/acre in rows 1 foot apart. Random counts of the number of seedlings per foot of row on square-foot plots were made throughout the 90-acre seeding in September 1965. Seedlings on 100 plots were counted in each 45-acre block.

Germination tests.—Germination was tested at the U.S.D.A. National



FIG. 1. On plots which received 50 lb/acre of nitrogen (left), plants were taller and more vigorous than those which received no fertilizer (right).



FIG. 2. Sherman big bluegrass planted in late July 1965. Photo October 6, 1965, Manitou Experimental Forest.

Seed Storage Laboratory in Fort Collins, Colorado, to determine the length of time big bluegrass normally requires to germinate and the temperature levels which provide good germination. The tests were made following standard procedures in germinators which controlled light, and the degree and duration of a temperature regime.

Results and Discussion

Environment-Bluegrass Relations—Maximum germination of 79% was obtained with a 12-hr alternating temperature of 15 C (59 F) and 30 C (86 F). This was 1% more than the guaranteed

germination given in the seed analysis. Sixty-six percent of the seed germinated within the first 10 days, and an additional 13% germinated in the next 12 days. The seed was non specific for light, and germinated quickly with favorable moisture and temperatures. It did not have a dormancy problem.

At Manitou, both moisture and temperature were closest to optimum for planting bluegrass during July and August (Table 1). Moisture increases considerably from March to May, then decreases slightly until convection-

al storms in July make this the wettest month. These intermittent storms usually continue into late August or early September. Storm activity then decreases, with a resultant decrease in moisture. Thus, over 6 inches or almost one-half of the average growing-season rainfall is received in July and August, which are also the warmest months.

Season and depth of planting—The differences in number of bluegrass seedlings per ft² on the spring and fall plantings were significant at the 5% level for season, planting treatments, and the interaction of planting treatments within a season. More seedlings came from spring seeding than fall seeding on all planting treatments (Table 2). For the 0.5-inch fall planting, an average of only 2.5 seedlings ft² were counted the following spring; on the 1-inch treatment there was a small decrease in plant numbers from the fall count. These results showed that, to obtain a successful seeding, big bluegrass should be planted only when conditions are favorable for rapid germination and emergence.

Drilling the seed in the spring to a 0.5-inch depth was the most successful planting treatment. It produced almost twice as many seedlings per ft² as the 1-inch depth, and 10 times more than the broadcast treatment (Table 2). Also, the seedlings on the 0.5-inch treatment were rather uniformly distributed, with one or more plants per foot of row, while seedlings in the broadcast treatment were unevenly distributed.

Although more seedlings came from the 0.5-inch depth than from the 1-inch depth, deeper planting had desirable features for seedling survival and subsequent plant growth. For example, the only seeds which germinated and grew the same fall they were planted were those drilled to a 1-inch depth. On this treatment, seedling num-

Table 1. Average precipitation (inches) and maximum-minimum air temperatures (c) from March through September at the Manitou Experimental Forest, Colorado.

Month	Precip. 1941-65	Maxi- mum Temp. 1960-65	Mini- mum Temp. 1960-65
March	0.76	11	-15
April	1.67	18	-9
May	1.83	20	-7
June	1.55	24	-1
July	3.33	29	3
August	2.88	28	2
Sept.	1.03	26	-2

bers averaged 1.8/ft of row in November 1963. By June of 1964, there was an inconsequential reduction in plants, which showed that winter mortality was of minor importance. In addition, the seedlings which overwintered became large, robust plants that produced seedstalks the following summer. Seedlings on the 0.5-inch planting treatment that emerged in the spring grew slowly, however, and did not produce seedstalks that year. This rapid emergence and better plant growth were believed to be responses to higher soil moisture at the deeper planting depth. Thus a compromise, although small, of planting to a $\frac{5}{8}$ -inch depth was used for the fertilizer trials and summer field plantings.

Fertilizer trials—There were no statistically significant differences in the number of big bluegrass plants established as a result of fertilizer treatment, which agrees with results from fertilizer trials in Oregon (Hedrick et al., 1964). Establishment from summer seeding in 1964 was good, even though precipitation during July and August was about 1 inch less than average in each month. By June of 1965, the number of 1-year-old plants averaged 6.5 with a standard error of 0.91/ft of row, and there were noticeable differences in plant growth. As shown in Fig. 1, plants which received nitrogen were larger and much more

Table 2. Average number of Sherman big bluegrass seedlings (per ft²) by season and planting treatment, Manitou Experimental Forest.

Season planted ¹ and date plants counted	Planting treatment ²			Average
	Broadcast	Drilled 0.5-inch deep	Drilled 1-inch deep	
Fall 1963:				
November 1963	0	0	1.8	
June 1964	1.0	2.5	1.5	1.7
Spring 1964:				
June 1964	1.4	13.2	6.4	7.0
Average:				
June 1964	1.2	7.8	3.9	4.3

Significance level $P = .05$

¹ $S_x = \pm 1.41$ plants

² $S_x = \pm 2.46$ plants

vigorous than the others. The benefits of adding either phosphorous or potassium were small, but they too increased vigor and plant growth a small amount.

Field plantings—By applying the information obtained from the several plot trials, good stands of Sherman big bluegrass were obtained on the 1965 field plantings. Moisture in the upper few inches of soil was near field capacity from mid-July through August, when the plantings were made. Because seed was drilled into a moist seedbed with favorable temperatures, much of it germinated and emerged in 7 to 10 days. The rows were uniformly filled, and by the first week in October 1965, the plants averaged approximately 5 inches tall (Fig. 2). Seedling numbers throughout the 90 acres averaged 24/ft of row, and there were no large differences in seedling numbers between the two blocks.

The field plantings showed, however, that invasion of weeds and soil erosion were influenced by land treatment and should be considered in establishing big bluegrass. In July 1964, for example, the area plowed for the field seeding included the plot trial area used for the fertilizer study. This small area was cultipacked immediately, but the remainder was left in a rough-plowed condition. Many undesirable species invaded the cultipacked area, while the adjacent plowed area remained relatively

free of competing vegetation. The fertilizer treatments undoubtedly stimulated weed growth, but the check or unfertilized plots were also occupied by weeds. Fringed sagebrush (*Artemisia frigida* Willd.), which was common on the whole area prior to plowing, was particularly abundant on the small area which was cultipacked soon after plowing but not on the area left rough plowed.

Erosion was not a problem until after the area was cultipacked. The area left rough plowed from July of 1964 until the early summer of 1965 accumulated moisture in the furrows, but there was very little soil movement even during intense storms. After it was cultipacked, rill and sheet erosion became a problem. For control of erosion and weeds, therefore, it is beneficial to leave an area rough plowed until just prior to planting. If summer seeding conditions are favorable, the area can then be cultipacked and planted. With rapid germination and establishment of seedlings, the land is vulnerable to erosion for a minimum amount of time. If summer seeding does not seem feasible because of insufficient moisture, seeding could be delayed until the following spring to take advantage of overwinter moisture accumulation.

Summary and Recommendations

Some cultural and environmental requirements for success-

ful establishment of Sherman big bluegrass were studied at the Manitou Experimental Forest, Colorado, from 1963 to 1965. Recommendations for seeding areas having similar soil and climatic conditions are as follows:

1. Sherman big bluegrass should be planted into a moist seedbed in July or August. The seedlings can be expected to emerge 7 to 10 days after planting and be well established within 2 to 3 months. Bluegrass emergence is poor if the seed must remain in the ground for a prolonged period of time. Although spring seeding is less favorable, it is a possible alternative providing soil moisture is good.

2. On sandy-loam or sandy-clay-loam soils, seed should be drilled as uniformly as possible to a 0.5- or $\frac{5}{8}$ -inch depth. Five pounds per acre at a maximum 12-inch row spacing is a suggested seeding rate. A double-

disc, depth-band or comparable grass drill is recommended for controlling seed placement depth.

3. Leave the soil rough plowed until just prior to seeding to reduce the establishment of weeds and the interval the ground is susceptible to erosion.

¹ Forest Service, U.S. Department of Agriculture, with headquarters at Fort Collins, Colorado, in cooperation with Colorado State University.

² Currie, Pat O. and Dwight R. Smith. Response of seeded ranges to different grazing intensities in the Ponderosa Pine Zone of Colorado. 1966. (In preparation, Rocky Mountain Forest and Range Exp. Sta., U.S. Forest Serv., Fort Collins, Colo.).

³ Special seeding equipment used in the study was obtained from: a) Crops Research Division, Agriculture Research Service, Fort Collins. b) Forestry and Range Section, Colorado Agricultural Experiment Station, Colorado State University, Fort Collins.

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Effect of Grazing on Soil Compaction as Measured by Bulk Density on A High Elevation Cattle Range

WILLIAM A. LAYCOCK AND PAUL W. CONRAD

Plant ecologist and assistant range scientist, at the U.S. Forest Service Intermountain Forest and Range Experiment Station's Forestry Sciences Laboratory, Logan, Utah.

Highlight

Bulk density of the soil in grazed plots was similar to that in ungrazed exclosures both in early summer before grazing and in late summer after grazing. Increases in bulk density during the summer both in grazed and ungrazed areas were attributed to changes in soil moisture. Soils in early summer were moist and swollen and thus weighed less per unit volume than did the dry soils in late summer.

Rotation and rest-rotation grazing systems are now being applied with increasing frequen-

cy on the arid rangelands in the West. These systems require heavy concentrations of livestock during one grazing season or portion thereof, followed by complete rest from grazing during the remainder of the season or the following year. Some land managers fear such concentration of animals may cause serious soil compaction that will not be overcome during the rest period.

Relatively few studies have been made to determine how trampling by grazing animals affects the soil. Studies conducted

in the more humid eastern or midwestern States have found bulk density is higher in grazed areas than in similar ungrazed areas (Lull, 1959; Reynolds and Packer, 1963; Linnartz, et al., 1966). Studies of soil compaction on arid rangelands, however, have produced somewhat conflicting results. Daubenmire and Colwell (1942) and Meeuwig (1965) found no difference in bulk density between grazed and ungrazed areas. Lodge (1954) and Orr (1960) found bulk densities were higher in grazed areas than in ungrazed areas at some locations but that there were no differences at other locations. Reed and Peterson (1961) and Packer (1963) found that bulk densities in grazed areas were consistently higher than those in ungrazed areas. The conflicts in these findings probably are the result of varying soil, moisture, or other conditions. For example, much more force is

¹ In this paper the term "significant" will refer to the 5% level of probability and "highly significant" will refer to the 1% level.