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Thickening and Spread of Crested Wheatgrass Stands on Southern Idaho Ranges[1]

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Highlight

Crested and fairway wheatgrass stands thickened and plants spread to adjacent areas from 1954 to 1966 on six experimental areas in southern Idaho. Drilling produced 10 times more seedlings than broadcasting, and stands reached full production much sooner. Plant survival and final numbers were greatest on the plowed, burned, and untreated seedbeds, in that order.

In the early days of range seeding, many land administrators and some research workers asserted that crested wheatgrass (*Agropyron desertorum* (Fisch. ex Link) Schult.)[2] in the Western States would not spread to adjacent areas, or thicken up between rows. They stated that it would be confined to the original plants even after a considerable lapse of time.[3]

In more recent years, the ability of crested wheatgrass to thicken and spread in areas to which it is adapted is being acknowledged. For example, Weintraub (1953) in summarizing seeding results on western ranges concluded that crested wheatgrass reseeds itself well. Hull and Klomp (1966) found that 20 to 30-year-old seedings of crested wheatgrass in southern Idaho were growing well and that plants had spread far beyond the original seeded areas.

Periodic examinations and recorded data from 1954 seedings on six areas in the sagebrush-grass type in southern Idaho revealed the thickening and spread of crested and fairway wheatgrass stands over a 12-year period. These seedings were designed mainly to compare airplane and hand-broadcasting of pelleted and unpelleted seed with drilling. The results, together with a description of the sites, were reported by Hull (1959).

This study was undertaken to determine the thickening and spread of crested wheatgrass on seeded plots and to determine factors which were associated with this spread. As this paper is concerned only with the thickening and spread of wheatgrass, it does not include those phases of the original study which compared pelleted with unpelleted seed, and airplane broadcasting with other seeding methods.

Experimental Areas and Methods

Elevation and precipitation of the six areas in the present study are given in Table 1. Symbols used in tables, together with site descriptions follow.

S1—*Summit 1* is 20 miles north of Shoshone. Vegetation is mainly big sagebrush (*Artemisia tridentata* Nutt.) with a bluebunch wheatgrass *Agropyron spicatum* (Pursh) Scribn. & Smith) and a bluegrass (*Poa* spp.) understory and frequent plants of Great Basin wildrye (*Elymus cinereus* Scribn. & Merr.).

S2—*Summit 2* is 21 miles north of Shoshone. Vegetation is mixed big and low sagebrush (*Artemisia arbuscula* Pursh.) with an understory of bluebunch wheatgrass, Idaho fescue (*Festuca idahoensis* Elmer), bluegrasses and frequent plants of Great Basin wildrye, especially on the hummocks.

D—*Dubois* is 13 miles north of Dubois. Vegetation is mainly big and three-tip sagebrush (*Artemisia tripartita* Rybd.) with an understory of bluebunch, thick-

Table 1. Elevation, precipitation, and soil texture at the 0-2 inch depth for the six experimental areas in southern Idaho.

Location	Elevation (ft.)	Annual Precipitation (inches)	Mechanical composition (%) Sand	(%) Silt	(%) Clay	Texture
S1	5000	14	30	48	22	loam
S2	5000	14	35	42	23	loam
D	6000	16	46	30	24	loam
S	4450	10	83	7	10	loamy sand
B1	4700	11	57	31	12	sandy loam
B2	4700	11	83	7	10	loamy sand

[1] *Cooperative research investigations of Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture; Bureau of Land Management and Bureau of Indian Affairs, U.S. Department of the Interior; University of Idaho Forest, Wildlife and Range Experiment Station; and Utah Agricultural Experiment Station, Utah Agr. Exp. Sta. Journal Paper 606. Thanks go to personnel of the cooperating agencies who assisted with the field work, and to those who made helpful comments on this paper.*

[2] *Early seeded stands often contained fairway wheatgrass* (A. cristatum (L.) Gaertn.). *In this discussion, except where specifically mentioned, both species will be referred to as crested wheatgrass.*

[3] *Unpublished reports and personal communications.*

spike (*Agropyron dasystachyum* (Hook.) Scribn.) and streambank (*Agropyron riparium* Scribn. & Smith) wheatgrasses, forbs, and frequent plants of Great Basin wildrye.

S—*Sand* is 3 miles north of the Fort Hall Indian Agency. This area supports scattered plants of big sagebrush and rabbitbrush (*Chrysothamnus* spp.) with considerable skeletonweed (*Lygodesmia spinosa* Nutt.), needleandthread (*Stipa comata* Trin. & Rupr.), sand dropseed (*Sporobolus cryptandrus* (Torr.) A. Gray), and cheatgrass (*Bromus tectorum* L.). The soil is an alluvial loamy sand which blows readily.

B1—*Buckskin 1* is 7 miles eastnortheast of the Fort Hall Agency. Tall plants of big sagebrush form dense to open stands. Where sagebrush stands are open there is a dense understory of needleandthread and cheatgrass.

B2 — *Buckskin 2* is 8 miles northeast of the Fort Hall Agency. Douglas rabbitbrush (*Chrysothamnus viscidiflorus* (Hook.) Nutt.) is fairly abundant, with some big sagebrush and a fair understory of needleandthread, sand dropseed, bluegrasses and cheatgrass. The soil is a deep loamy sand which blows readily.

Soils on the experimental areas were analyzed for bulk density, moisture holding capacity, organic matter, pH, soluble salts, and texture. The characteristics which seemed to affect the thickening and spread of seeded plants were the texture and the surface roughness. The texture of the 0-2 inch depth is listed in Table 1.

The seeding procedures were as follows:

3 methods of seedbed preparation; plow, burn, no treatment.

2 methods of seeding; drill (symbol-Dr), hand broadcast (symbol-Br).

3 rates of seeding; 1, 6, 12 lb/A (1 and 12 lb on 3 areas only).

Check; seedbed preparation treatments made, but not seeded.

Experimental areas were 300 by 520 ft. Each was divided lengthwise into three strips 100 ft wide on which the three methods of seedbed preparation were applied. Most seeding treatments were applied. Most seeding treatments were 40 ft wide and crossed the area at right angles to the three seedbed preparation strips. Thus, each seeding treatment in each preparation strip was 40 x 100 ft.

Areas were fenced and livestock excluded for the 12 years. Rabbits, gophers, or mice were not controlled. Rodents damaged some plants, but we thought their impact on seeded plants was low.

Table 2. Success ratings for crested wheatgrass drilled and hand broadcasted at three rates per acre on a plowed seedbed in 1954.

Method[1], rate, and location			1955	1956	1958	1960	1962	1964	1966
Dr	1	S	6*	5	6	6	7	8	10
		B1	7	7	7	9	9	10	10
		B2	8	5	6	8	9	10	10
	Ave		7.0	5.7	6.3	7.7	8.3	9.3	10.0
Dr	6	S1	8	8	9	9	10	10	10
		S2	9	10	10	10	10	10	10
		D	10	8	9	10	10	10	10
		S	8	7	8	10	10	10	10
		B1	9	9	9	10	10	10	10
		B2	3**	1**	1*	3	5	8	9
	Ave		7.8	7.2	7.7	8.7	9.2	9.7	9.8
Dr	12	S	10	9	10	10	10	10	10
		B1	10	10	10	10	10	10	10
		B2	10	10	10	10	10	10	10
	Ave		10.0	9.7	10.0	10.0	10.0	10.0	10.0
Dr	Ave		8.2	7.5	7.9	8.8	9.2	9.7	9.9
Br	6	S1	2	2	8	10	10	10	10
		S2	2	4	8	8	9	9	10
		D	2	3	7	9	10	10	10
		S	2	1	3	5	7	8	10
		B1	3	2	6	8	8	10	10
		B2	1**	1**	2	4	6	9	10
	Ave		2.0	2.2	5.7	7.3	8.3	9.3	10.0
Br	12	S1	8	5	8	8	9	10	10
		S2	7	3	6	8	9	10	10
		D	5	6	9	10	10	10	10
		S	3	4	7	8	10	10	10
		B1	4	3	5	8	9	10	10
		B2	1**	1*	4	7	9	10	10
	Ave		4.7	3.7	6.5	8.2	9.3	10.0	10.0
Br	Ave		3.4	2.9	6.1	7.7	8.8	9.6	10.0
Plow	Ave		5.8	5.2	6.8	8.2	9.0	9.7	10.0

* Moderate soil blowing ** Severe soil blowing
[1] Dr = Drill; Br = Broadcast.

In addition to the experimental plots, 14,000 acres of large-scale seeding was done on 5 areas, either surrounding or adjacent to the experimental plots.

Experimental and large-scale treatments were carried out in 1954. Burning was done in August at Summit 1 and 2 and Dubois, and late October at Sand and Buckskin 1 and 2. Plowing was done during late October and early November. All areas were seeded between November 2 and 17.

We counted plants on all treatments in 1955-56, and obtained herbage yields in 1956. Although Tables 2 and 3 show only even years, we rated success from 1955 to 1966. Most figures are the average of two plots. The rating

Table 3. Success rating for crested wheatgrass drilled and hand broadcasted at three rates per acre on an untreated seedbed in 1954.

Method, rate, and location		1955	1956	1958	1960	1962	1964	1966
Dr 1	S	4	1	1	1	1	1	2
	B1	2	1	1	1	1	1	2
	B2	5	1	1	1	3	3	5
Ave		3.7	1.0	1.0	1.0	1.7	1.7	3.0
Dr 6	S1	8	1	1	1	2	2	4
	S2	6	1	1	1	1	2	2
	D	5	1	3	4	5	8	9
	S	7	2	1	1	1	2	3
	B1	3	1	1	1	1	2	3
	B2	6*	2*	1	1	2	4	5
Ave		5.8	1.3	1.3	1.5	2.0	3.3	4.3
Dr 12	S	9	1	1	1	2	3	5
	B1	7	2	1	1	2	2	3
	B2	9	2	1	2	5	7	9
Ave		8.3	1.7	1.0	1.3	3.0	4.0	5.7
Dr Ave		5.9	1.3	1.1	1.3	2.2	3.1	4.4
Br 6	S1	1	1	.1	.1	1	1	2
	S2	1	.1	.1	1	1	1	2
	D	1	.1	.1	1	1	4	5
	S	1	.1	.1	.1	1	1	2
	B1	1	.1	.1	.1	1	1	2
	B2	1	.1	.1	.1	1	4	5
Ave		1.0	.2	.1	.4	1.0	2.0	3.0
Br 12	S1	1	1	.1	.1	1	4	5
	S2	1	1	.1	1	1	3	3
	D	1	.1	.1	1	1	3	6
	S	1	.1	.1	.1	1	1	2
	B1	1	.1	.1	1	1	1	2
	B2	1	.1	.1	.1	2	5	6
Ave		1.0	.4	.1	.5	1.2	2.8	4.0
Br Ave		1.0	.3	.1	.4	1.1	2.4	3.5
Untreated Ave		3.5	.8	.6	.9	1.6	2.7	4.0

*Moderate soil blowing

Table 4. Plants per ft² in 1955, 1956, and 1965 for crested wheatgrass drilled and handbroadcasted at three seeding rates on plowed and untreated seedbeds at 3 or 6 locations in 1954.

Seeding method and rate	Plowed seedbed			Untreated seedbed		
	1955	1956	1965	1955	1956	1965
Dr 1*	1.1	.8	1.1	1.9	0	.2
Dr 6	3.1	1.2	1.3	4.3	.06	.4
Dr 12*	6.7	2.0	1.5	10.6	.07	.5
Dr Ave.	3.5	1.3	1.4	5.3	.04	.4
Br 6	.9	.4	1.2	1.0	.01	.3
Br 12	1.2	.5	1.1	.2	.02	.4
Br Ave.	1.1	.5	1.2	.6	.02	.4
Dr and B Ave.	2.3	.9	1.3	3.0	.03	.4

*Average of 3 locations, others average of 6 locations.

system was described by Hull (1954) and indicates the success of an established stand or the potential of a seedling stand as follows: 9-10, excellent; 7-8, good; 5-6, fair; 3-4, poor; 1-2, very poor; zero, failure. A rating of 0.1 indicates a stand far below 1 but not a complete failure. Success ratings were associated with plant numbers and were little influenced by plant size. Counts are in plants per ft² (Table 4). Herbage yields in air-dry lb/acre were determined by clipping, drying, and weighing.

Each year the seeded stands became noticeably thicker. Therefore, in 1965, ratings, plant counts, and plant yields were taken again. The earlier results and the 1965 and 1966 data form the basis for this paper.

Results

Success ratings were high the 1st year, and usually declined the 2nd or 3rd year, after which the stands improved and the ratings increased to the 12th year. Plant numbers were generally highest the 1st year. Subsequently many seedlings died, then natural seeding took place and numbers increased (Fig. 1).

During 1955, the seedlings which survived grew well. Many produced seed, which in turn produced seedlings. These new plants either thickened the original stand or spread to surrounding areas, or both. Thickening and spreading continued on all treatments over the 12-year period. On all areas, seeded grass has spread into unseeded areas such as the 40 x 100 ft check plots. Factors which influenced initial plant establishment and subsequent natural seeding are discussed below.

Seedbed Preparation and Plant Competition

Planting methods which covered the seed gave the best seedling emergence. Seedlings survived best where seedbed treatments eliminated the competing plants. Averaging all seeding rates, methods, and locations, the plowed seedbed commenced with a success rating of 5.8 and ended with 10. The burned seedbed started with 4.1 and ended with 6.5. The untreated seedbed commenced with 3.5, dropped to 0.6, and 12 years later had improved to 4.0. Averaging all treatments and locations, grass yields during 1965 were as follows:

Treatments	*lb/acre*
Plowed	1,085
Burned	564
No treatment	267

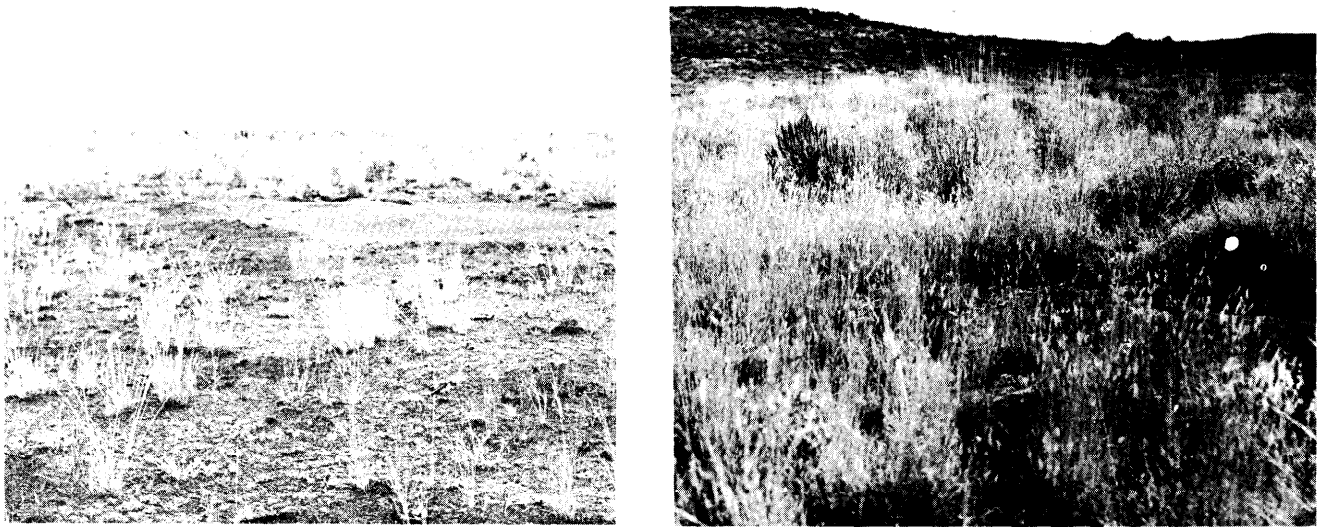

FIG. 1. Seeded crested wheatgrass at Summit 2 increased from very few plants in 1956 to a good stand in 1965. Left—Burned and broadcast at 6 lb/A, there were only 0.05 plants per ft^2 in 1956 and the stand had a success rating of 1. Practically all grass in this photo is native. Right—In 1965 there was one seeded plant per ft^2 with a success rating of 7.

Where all woody plants were burned, the burned plots produced as much grass as did the plowed plots. The moderate ratings (Table 3) and the low yield listed above for the untreated seedbed indicate that enough plants were present for a fair stand, but that vigor and yields were low. Low yields are common where seeded species grew among competing plants.

Plowing.—A 6-inch plow depth killed most of the sagebrush and the shallow rooted plants, but was not effective on rhizomatous grasses and root-sprouting shrubs and forbs. Plowing provided a weed-free but loose seedbed. As the plowed surface was rough, even after the first year, natural seeding was more rapid, and full stands were reached quicker than on the other seedbeds. The poor stands on some plowed seedbeds at Buckskin 2 were the result of severe soil blowing. Where cheatgrass and perennial plants competed with seeded grass, full stands of grass developed slowly.

Burning. — Where burning killed competing vegetation it equaled plowing for seedbed preparation. Since burning killed competing plants on only three of the six areas, seeding results on burned seedbeds on the experimental areas are not included. On both experimental and large-scale seedings, seedling numbers and success ratings decreased for the first two or three years. Plants then increased on the burned and broadcast areas where initial establishment was poor. Plant numbers continued to decrease on some burned and drilled areas where the initial seedling establishment was high. Some of this decrease could have been merging of individual plants.

Following is the average number of crested wheatgrass plants per ft^2 for burning and drilling and burning and broadcasting on four large-scale seedings at Summit 1, Dubois, Sand, and Buckskin 2:

Treatment	*1955*	*1956*	*1961*	*1966*
Burned and drilled	7.2	3.0	1.6	2.2
Burned and broadcast	.08	.04	0.06	.28

Untreated seedbeds. — Drilling untreated seedbeds averaged 5.3 seedlings ft^2 as compared to 3.7 seedlings on plowed and drilled seedbeds. On the untreated seedbed, however, only 0.8% of the seedlings lived one year as compared to 37% survival on the plowed seedbed.

On the untreated seedbed, plant numbers and ratings dropped for 2 to 4 years but were still increasing in 1966. Greatest increases were at Dubois and Buckskin 2. Dubois is a south-facing slope and Buckskin 2 is near watering troughs. Both areas had been depleted by heavy use and there were unoccupied soil areas where seeded plants could obtain a foothold.

Soil Texture and Movement

A slight roughness of the soil surface, followed by soil sloughing or a slight movement of soil by wind or water helps cover seeds. Three areas had these conditions. The soil at Dubois was a loam with considerable surface roughness. This roughness provided depressions and lodging places where seed fell and was subsequently covered by soil sloughing. This helped seeded species thicken and spread on experimental and large-scale seedings in this area. Buckskin 2 had a fine loamy sand which blew readily. Where blowing was severe, it reduced plant numbers and yields during the early years (Tables 2 to 4). As

the soil became partially stabilized, the blowing helped cover seed and caused a rapid increase in seedling numbers. As crested wheatgrass thickened, the soil movement decreased.

Soil movement for seed coverage resulted in increased plant numbers on experimental and large-scale seedings at Sand. Soil surface roughness, combined with light trampling by cattle, provided seed covering which resulted in an increase in plant numbers on the large-scale burned and broadcast seeding at Summit 1.

Method of Seeding

Drilling was better than broadcasting, mainly because it covered the seed. Averaging all seedbeds, drilling produced 4.7 seedlings ft^2 and broadcasting produced 0.7. Thus 21% of the seeds from drilling produced seedlings as compared to only 2% from broadcasting. After 11 years of protection, drilling and broadcasting had similar numbers of plants, but drilled plots averaged 745 lb/acre as compared to 530 lb for broadcasting. Stands from drilling reached full production much sooner and kept out weedy competing plants better than broadcasting stands.

Rate of Seeding

Seedling emergence on the plowed and burned seedbeds was roughly proportional to the amount of seed sown. At the end of 11 to 12 years, plant numbers, success ratings, and grass yields from all rates were nearly equal, though still slightly higher at the heavier rates. Low rates eventually produced a satisfactory stand but the higher rates controlled weeds and gave a satisfactory stand much sooner. Also the reinvasion of sagebrush was greatest where good stands of grass established slowly.

Species

At Summit 1 and 2 and Dubois, seed for the experimental plots was fairway wheatgrass, except one plot at each location seeded to crested wheatgrass. Buckskin 1 and 2 and Sand plots were seeded with crested wheatgrass with one plot at each location seeded to fairway. These single plots of crested wheatgrass at the first three locations, and the fairway at the last three are omitted from Tables 2 to 4, thus each location is represented by one species only. Comparing similar treatments, the fairway wheatgrass thickened faster and spread further than the crested wheatgrass. This agrees with Weintraub (1953) and with previous work in Idaho (Hull & Klomp, 1966).

Discussion

This and other studies indicate that crested wheatgrass is well adapted to the sagebrush type in southern Idaho, and that when some plants are established that it will thicken and will also spread to adjacent areas. Studies also indicate a high seedling mortality during the first one or two growing seasons.

On new seedings, high seedling numbers and high mortality are common. Seeding 6 lb/acre of crested wheatgrass with normal seed viability and purity provides 23 good seeds/ft^2. On the average, 25 to 75% of these seeds germinate and plants emerge, but then most of the seedlings die. Loss of seedlings is not serious because they are usually more than needed for the final stand.

In this study, the best seeding emergence resulted from methods which covered seed to the proper depth. Competition with existing plants was the major cause of seedling mortality. Factors which favored plants to increase in numbers on seeded plot and to spread to new areas were: lack of competing vegetation, a rough soil surface, soil movement, and fairway wheatgrass as compared to crested wheatgrass.

This study indicates that a thin seeded stand might become a good stand if favorable conditions exist, and if enough years elapse. However, considering time and uncertainties, the most profitable seeded stands will undoubtedly be obtained by good methods of seedbed preparation and seeding.

Summary

We studied six experimental areas from a 1954 seeding to determine factors which affected thickening and spread of fairway and crested wheatgrasses.

Success ratings and plant numbers were high for seedling stands. Ratings and plant numbers decreased as plants died, and then increased as natural seeding took place.

Plant survival and final numbers were greatest on the plowed seedbed, mainly because plant competition was lacking. Also a slight roughness in the plowed soil surface, followed by soil sloughing or a slight movement of the soil by wind or water helped cover seeds and caused thickening of stands and spread to adjacent areas.

The plowed seedbed started with a success rating of 5.8 and ended with 10. The burned seedbed had 4.1 and ended with 6.5, and the untreated seedbed commenced with 3.5, dropped to 0.6 and 12 years later had improved to 4.0. Where burning was effective, it was comparable to plowing.

Averaging both seedbeds, drilling produced 7 times more seedlings than did broadcasting, mainly because it covered the seed. At the end of 11 years of protection, plant numbers and success ratings were similar, but drilled stands reached full production much sooner.

Comparing the 1, 6, and 12 lb seeding rates, seedling emergence was roughly proportioned to the amount of seed sown. Heavier rates controlled weedy plants and invading brush, and gave a satisfactory stand sooner than lower rates.

Fairway wheatgrass stands thickened sooner and spread more than crested wheatgrass.

Though crested wheatgrass plants in thin stands eventually will thicken and will also spread to adjacent areas, the most profitable seeded stands will undoubtedly be full initial stands obtained by good methods of seedbed preparation and seeding.

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