

Plant Materials for Crested Wheatgrass

Seedings in the Intermountain West

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ABSTRACT: Eight cultivars of crested wheatgrass have been released for commercial production and use in the United States and Canada since 1927. Four are fairway types, two are standard types, one a Siberian wheatgrass, and the most recent a cross between fairway and standard. 'Fairway' and 'Nordan' have been produced commercially far more than the other cultivars. Certified seed production has averaged less than 10 percent of the total annual production. Common seed consists primarily of mixed seed from the 1906 introductions including uncertified Fairway and Nordan. Understory grasses should be considered for mixtures with crested wheatgrass, despite the competitiveness of the wheatgrass. 'Hycrest' and 'Ephraim' cultivars offer good potential in the next decade.

INTRODUCTION

Crested wheatgrass is a very popular grass for seeding rangelands, returning abandoned cropland to grass cover, revegetating highway slopes, planting low maintenance turf, seeding burns, and reclaiming a variety of disturbed areas in the Intermountain West. As noted elsewhere in these proceedings, most available seed on the commercial market traces to a relatively few introductions from the USSR during the early part of this century. There currently are eight cultivars of crested wheatgrass that are, or soon will be, available and are adapted in the Intermountain area. This paper will briefly review the genetic makeup, attributes, and seed production of each. The references used in this review include Hanson 1972, Dillman 1946, Swallen and Rogler 1950, Rogler 1954, Knowles 1956, USDA Extension Service 1978, Stevens et al. 1982, and Asay et al. 1985.

As is well known, crested wheatgrasses can be competitive to the point of excluding invading weeds or native plants and suppressing companion species in a mixture. This paper also will review three

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studies in Oregon and Washington that provide some clues to the role of companion species with crested wheatgrass.

CRESTED WHEATGRASS CULTIVARS

Fairway Crested Wheatgrass (*Agropyron cristatum* (L.) Gaertn.)

'Fairway'.--This was the first cultivar of crested wheatgrass developed in North America, released in 1927 by the Saskatchewan Research Station, with the first seed crop licensed in 1932. 'Fairway' originates from accession PI 19536, introduced in 1906 from the Samara Province of western Siberia. It was the result of a mass selection for fine leafy plants during 1925, followed by direct seed increase. 'Fairway' is more persistent than standard types in Canada where winters are harsher than in the United States. It is shorter and somewhat less productive, but better suited for turf and erosion control.

Certified production of 'Fairway' has averaged about 200,000 pounds (91,000 Kg) in the past five years. Highest production was 1,084,000 pounds (493,000 Kg) in 1939; 676,000 pounds (307,000 Kg) were produced as recently as 1973. Production has been cyclic, influenced by government programs to retire cropland from production or to seed abandoned land. 'Fairway' plantings also are a primary source for harvest of common seed lots that dominate the Canadian commercial market. Most seed production is in Canada.

'Parkway'.--The Saskatchewan station released this cultivar in 1969 as an improvement over 'Fairway'. It is a 16-clone synthetic, derived from the older variety after several cycles of recurrent selection for forage and seed production. 'Parkway' is more vigorous and 2-3 inches (5-8 cm) taller with at least 10 percent more seed and forage production. It is somewhat less leafy than 'Fairway' but more lodging resistant. It is well suited for hay production.

'Parkway' is produced in Canada and 50-100,000 pounds (20-50,000 Kg) of certified seed are

available annually. Production has leveled off after a high of 183,000 pounds (83,000 Kg) in 1973. As older 'Fairway' fields are plowed out or no longer harvested, 'Parkway' could gradually replace it as the premier variety.

'Ruff'.--This cultivar is the product of three cycles of recurrent selection by the USDA Agricultural Research Service (ARS) and Nebraska Agricultural Experiment Station (AES). Released in 1975, it originates from 'Fairway', or PI 19536. Its forage yield is equal to 'Nordan', and it is a better sod former than 'Fairway'. Certified seed production has varied from 3-15,000 pounds (1.5-7,000 Kg) each year and currently is in limited supply.

'Ephraim'.--This cultivar is the first of the Fairway type with a different germplasm source, originating from PI 109012 collected near Ankara, Turkey by the Westover-Enlow expedition in 1934. 'Ephraim' was released by the USDA Forest Service (USFS), Utah Division of Wildlife Resources, USDA Soil Conservation Service (SCS), and other agencies in 1982. It is a result of mass selection for rhizomatous plants conducted by the USFS Shrub Sciences Laboratory in Utah. Superior rhizome development compared to 'Fairway' is found in seedlings on pinyon-juniper and sagebrush-grass sites in the Intermountain area. It was selected primarily for its erosion control potential. The first commercial seed crops were harvested in 1984.

Standard Crested Wheatgrass (*Agropyron desertorum* (Fisch.) Roem. and Schult.)

'Nordan'.--This first cultivar of the standard type was released in 1953 by ARS, North Dakota AES, and SCS. 'Nordan' consists of selections from an evaluation nursery established in 1937 at Dickinson, North Dakota. It is probable that much of the germplasm traces to PI 19537-41, introduced from the Samara Province of western Siberia in 1906. 'Nordan' was increased from seven superior plants after two cycles of mass selection for more compressed, dense, awnless seedheads, uniformity, and improved forage production over the common type.

'Nordan' currently exceeds all other cultivars in production, ranging from 250-400,000 pounds (115-180,000 Kg) certified seed annually in recent years. Highest production was 1,682,000 pounds (765,000 Kg) in 1972. 'Nordan' plantings also are a large source for uncertified production. With 'Fairway' and common sources of similar parentage, they account for well over 95 percent of the total production. Most 'Nordan' production is in Canada.

Prior to the release of 'Nordan', common standard crested wheatgrass was produced in quantity, as much as 17,000,000 pounds (7,700,000 Kg) in 1944. Much of the seed was used for cropland retirement sponsored by the Agricultural Adjustment Administration in the United States. Nearly all of this seed originated from an increase of PI lines 19537-41 at Dickinson, North Dakota in 1927. The first commercial seed appeared in Bismarck in 1929. Common standard is the most available source of crested wheatgrass today. However, its original identity has been so obscured by uncertified 'Nordan' production that many consider 'Nordan' the source of most supplies. The question is somewhat

academic since both germplasm sources are similar if not identical.

'Summit'.--The Saskatchewan Research Station released this cultivar in 1953, selected from an introduction to Canada from the Omsk Experiment Station in western Siberia. This introduction may be similar to PI 63800 and 98524, introduced to the United States from the Omsk Station in 1925 and 1929, respectively. 'Summit' is the result of mass selection for uniformity, higher seed yield and quality. Another round of selection, yielding 40 plants, provided for the increase and release of 'Summit 62' in 1962. However, this new name was short-lived, and all production since the late sixties has been sold as 'Summit'.

As much as 454,000 pounds (206,000 Kg) were produced in 1960, but production generally has declined since the mid-sixties. Some common seed may have 'Summit' as its source. All production is in Canada.

Siberian Wheatgrass (*Agropyron fragile* (Roth.) Nevski)

'P-27'.--The only cultivar of Siberian wheatgrass, 'P-27', was released in 1953 by SCS and Idaho AES. It was selected from PI 108434, collected in the mid 1930's by the Westover-Enlow expedition in Kazakhstan, USSR. Selections were for narrow, awnless seedheads, leafiness, and superior performance on coarse textured, droughty soils.

Very limited data is available on the commercial seed production of 'P-27'. Since 1977, production has ranged from 12-35,000 pounds (5-16,000 Kg), with a high of 35,000 pounds (16,000 Kg) in 1982. Production, since release in 1953, has been sporadic, seldom exceeding 50,000 pounds (23,000 Kg) a year. Nevertheless, 'P-27' has filled a need for a crested wheatgrass type on coarse-textured soils.

Fairway x Standard Hybrid

'Hycrest'.--The newest cultivar of crested wheatgrass was released by ARS, SCS, and Utah AES in 1984. Developed by the ARS Crops Research Laboratory at Logan, Utah, 'Hycrest' is described elsewhere in this publication. It represents the most intensively bred line of crested wheatgrass and is a significant step forward. Substantial progress has been made in seedling establishment on arid sites and in forage production.

TREND IN COMMERCIAL SEED SUPPLIES

Although there are some gaps in the data, seed production and marketing reports from Canada and the United States¹ permit a general assessment of supply and demand for crested wheatgrass during the past 50 years. Figures 1a and 1b compare annual total production with certified production. Between 1939-

¹Association of Seed Certifying Agencies 1955-83, Canadian Seed Growers Association 1932-83, Canadian Seed Growers Association 1965, USDA Bureau of Agricultural Economics 1948, USDA Bureau of Plant Industry 1906-40.

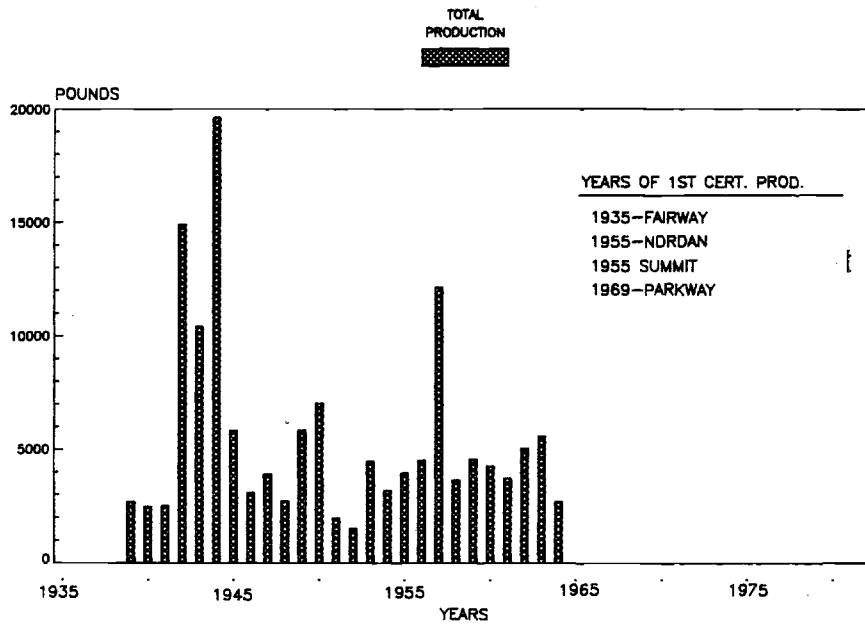


Figure 1a.--Total production of crested wheatgrass: 1935-1964.

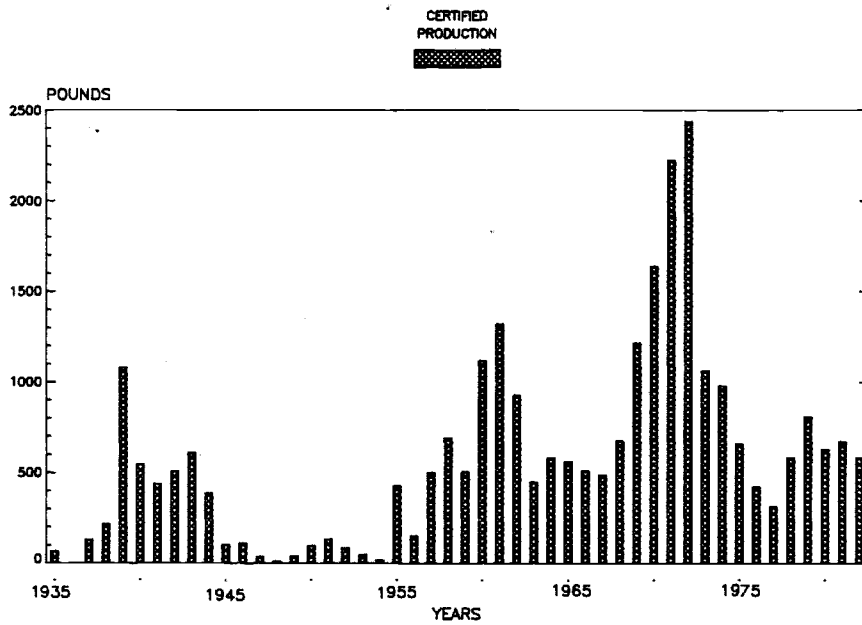


Figure 1b.--Certified production of crested wheatgrass: 1935-1982.

1964, certified seed accounted for 7.7 percent of the total production. Percentages ranged from lows of 0.5 percent in 1948 and 0.6 percent in 1954 to highs of 34.8 percent in 1961 and 39.9 in 1939.

Figure 1b shows that peak production occurs after the release of new cultivars: in the late thirties following 'Fairway', the mid-fifties following 'Nordan' and 'Summit', and a large surge corresponding with the release of 'Parkway'. The sharp increase from 1970-73 probably is incidental to the release of 'Parkway'. It is more likely attributable to higher seed prices, government land retirement programs, and reclamation efforts. However, the two earlier peaks clearly are the result of new releases.

The releases of 'Fairway', 'Nordan', and 'Summit' also appear to have stimulated overall production during 1940-45 and 1955-60. Figure 1a strongly suggests that increased total yield a few years after release come primarily from harvest of plantings made with the new cultivars, particularly in the case of 'Fairway'. Although total yield figures are not available beyond 1964, a large rise in crested wheatgrass imports to the United States from 1972-75 (USDA Agricultural Marketing Service 1956-78) probably reflects a major increase in total production during that time similar to the rise in certified production just a few years before.

Figure 2 shows the relative production of five cultivars of crested wheatgrass for which yield

figures are available. As previously discussed, 'Nordan' and 'Fairway' continue to be the cultivars most in demand.

COMPANION SPECIES FOR SEED MIXTURES

Crested wheatgrass forms the backbone of many arid-land seed mixes, because it can be counted on to establish readily and persist under adverse conditions. But it can compete vigorously with other components in the seed mixture, even crowding them out. As a result, is seeded alone, especially for forage, more often than it should be. However, several studies have shown that other species should be considered for inclusion in crested wheatgrass seedings.

A grass mixture study at Squaw Butte, Oregon (11 inches or 29 cm mean annual precipitation) demonstrated the competitiveness of crested wheatgrass (Hedrick et al. 1964). Table 1 shows the relative yields in mixed stands of overstory and understory grasses. Standard crested wheatgrass was much more competitive than bluebunch wheatgrass (*Pseudoroegneria spicata* [Pursh] A. Love) or big bluegrass (*Poa ampla* Merr.) growing with two understory grasses, canby bluegrass (*Poa canbyi* (Scribn.) T. Howell) and streambank wheatgrass (*Elymus lanceolatus* [Scribn. & J. G. Smith] Gould). However, note in Table 2 that the combination of streambank and crested wheatgrasses was more effective than crested alone in suppressing brush invasion.

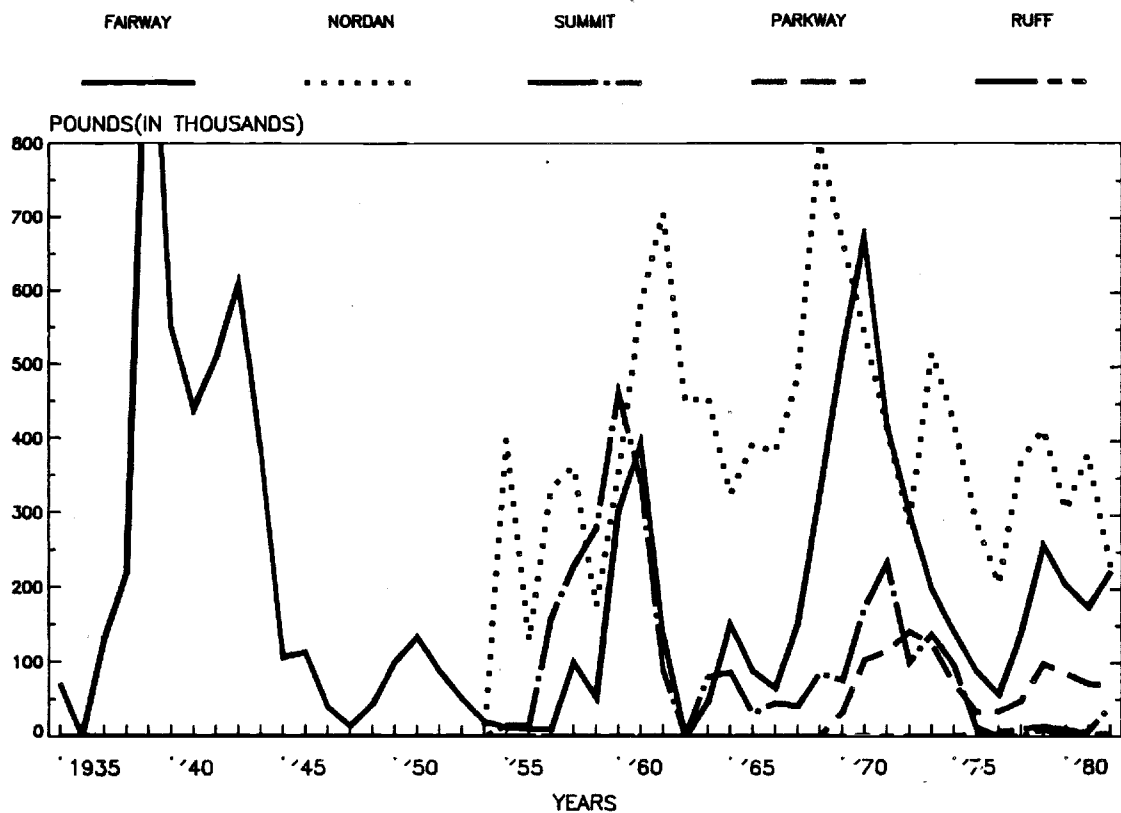


Figure 2.--Certified production of five crested wheatgrasses (1935 thru 1982).

Table 1.--Relative yields of grasses seeded in mixtures at Squaw Butte Agricultural Experiment Station, Harney County, Oregon, from 1956-62.¹

Seeded species		Relative yields in mixed stands ²		
Overstory species	Understory species	Overstory grass	Understory grass	Sum
-----%-----				
crested wheatgrass	canby bluegrass	90	10	100
crested wheatgrass	streambank wheatgrass	82	14	96
bluebunch wheatgrass	canby bluegrass	79	41	120
bluebunch wheatgrass	streambank wheatgrass	47	49	96
big bluegrass	canby bluegrass	74	34	108
big bluegrass	streambank wheatgrass	42	51	93
Mean		71	36	107

¹Excerpt from Hedrick et al. 1964.

²Yields by species in mixed stands were expressed in percent of corresponding yields in pure stands. Three years of seeding, each with three replications, two nitrogen fertilization rates, and three consecutive years of harvest are included.

Crested wheatgrass appears to be even more competitive at lower precipitation. In a study by the SCS Pullman Plant Materials Center (Carlson et al. 1978), 'P-27' Siberian wheatgrass maintained excellent stands for six years at Moxee, Washington where precipitation averages 7 inches (18 cm) per year (Table 3). It greatly suppressed its companion species, 'Whitmar' bluebunch wheatgrass, as well as cheatgrass (Bromus tectorum L.).

Dryland alfalfa and crested wheatgrass have been successfully planted together at Moro, Oregon with 11 inches (29 cm) mean annual precipitation. In a 4-year test, 'Ladak' alfalfa and 'Fairway' crested wheatgrass produced 3,065 pounds of forage per acre (3465 Kg/ha) and 6,530 pounds (7380 Kg/ha) of roots in the upper 8 inches of a Walla Walla silt loam. Alfalfa alone produced 3,870 pounds (4370 Kg/ha) of hay but only 4,310 pounds (4870 Kg/ha) of roots. Crested wheatgrass contributed 27 percent of the hay mixture but 65 percent of the roots (Hafenrichter et al. 1968).

Also at Moro, Oregon (USDA Soil Conservation Service 1976), 'Fairway' and bluebunch wheatgrass were compared in mixtures with understory grasses in a 15-year study. Throughout the study, 'Fairway' seeded alone produced less ground cover and herbage than the mixtures (Table 4). Furthermore, sheep fescue (Festuca ovina L.) and big bluegrass suppressed crested throughout the trial, in contrast to Squaw Butte.

Crested wheatgrass appears to be most competitive in colder, drier areas, below 12 inches (30 cm) precipitation and at plant hardiness zones of 5 (-10° to -20°F or -23° to -29°C) or lower. Harsh winters and dry summers tend to favor early season species such as crested wheatgrass. With milder winters at Moro, (two plant hardiness zones warmer than Squaw Butte), effective moisture is increased and midseason grasses and legumes perform

adequately in mixtures with crested wheatgrass. Even in the harsher environments, it is not wise to rely totally on crested wheatgrass, particularly in erosion control seedings. Highway slopes, borrow pits, and even range sites are not uniform but contain microenvironments not conducive to a complete crested wheatgrass establishment. In such cases, it is advisable to include adapted cultivars of other species to improve total cover.

Several species are suitable for seeding in mixtures with crested wheatgrass under appropriate conditions. Following is a partial list:

'Canbar' canby bluegrass (Poa canbyi (Scribn.) T. Howell).--A low-growing, early season native bluegrass closely related to Sandberg bluegrass (Poa sandbergii (Thurb.) Benth. ex Vasey), and commonly found on shallow soils. Very drought tolerant, it should be considered as an understory component in mixtures with crested wheatgrass, as well as mixtures with other range species.

'Covar' sheep fescue (Festuca ovina L.).--The most drought tolerant fine-leaf fescue available. This low-growing and competitive grass should be considered on soils where Idaho fescue (Festuca idahoensis Elmer) is adapted.

'Sherman' big bluegrass (Poa ampla Merrill).--An early season, native bluegrass similar to canby bluegrass, but much more robust and a good forage producer. It should be seeded only if crested is a relatively minor component of the mixture, or if MAP exceeds 12 inches (30 cm).

'Sodar' streambank wheatgrass (Elymus lanceolatus (Scribn. & J. G. Smith) Gould).--A low-growing, rhizomatous mid-season wheatgrass that can form a tight cover with crested, crowding out weeds and resisting brush invasion. 'Sodar' is not very palatable and generally limited to erosion control seedings.

'Critana' thickspike wheatgrass.--Taxonomically similar to 'Sodar', this variety is well adapted throughout the Intermountain West, particularly east of the Continental Divide where summer rainfall is somewhat more prevalent.

'Ladak' alfalfa (*Medicago sativa* L.).--Dryland alfalfa is the best legume to seed with crested wheatgrass, but only where MAP exceeds 12 inches (20 cm).

In addition, where crested wheatgrass is limited to small percentages in a mixture, suitable companion species may include 'Rincon' fourwing saltbush (*Atriplex canescens* (Pursh.) Nutt.), 'Immigrant' forage kochia (*Kochia prostrata* (L.) Schrad.), 'Appar' lewis flax, (*Linum lewisii* Pursh.), 'Delar' small burnet (*Sanguisorba minor* Scop.), among others.

CONCLUSIONS

'Nordan' and 'Fairway' crested wheatgrasses continue to dominate the commercial seed market for

the species and likely will do so in the next decade. Common seed usually comes from range or land retirement seedings of common or certified 'Nordan' and 'Fairway'. Both cultivars trace back to early plant introductions at the turn of the century. Their success probably attests to a previous association with agriculture in Russia and purposeful or inadvertant selection of superior types. The new cultivars 'Ephraim' and 'Hycrest' offer good potential, but will have to be considerably better if they are to supplant the established two in the long run. 'Summit', 'Parkway', 'Ruff', and 'P-27' have not, and are relegated to specialized uses. 'Hycrest' is the most intensively bred cultivar, shows considerable improvement for range forage seedings, and may offer the best challenge to the old line varieties. 'Ephraim' is well suited for erosion control because of its rhizomatous nature.

Despite the competitiveness of crested wheatgrasses, companion species should be considered for mixtures in almost all cases. This is especially true for erosion control and reclamation seedings.

Table 2.--Brush established in the first four years after seeding plots to various grasses at Squaw Butte Agricultural Experiment Station, Harney County, Oregon from 1956-62¹.

Species planted	Consecutive Years				Grand Mean
	1	2	3	4	
	Number of plants per .4 hectare ²				
none	922	1,162	1,355	2,352	1,470
bluebunch wheatgrass	678	968	1,016	920	895
big bluegrass	411	605	726	750	623
canby bluegrass	169	363	387	774	424
streambank wheatgrass	194	363	363	460	345
crested wheatgrass	387	436	218	242	321
bluebunch wheatgrass-canby bluegrass	218	460	484	508	417
big bluegrass-canby bluegrass	266	508	557	581	478
crested wheatgrass-canby bluegrass	266	629	411	484	448
bluebunch wheatgrass-streambank wheatgrass	436	653	678	678	611
big bluegrass-streambank wheatgrass	290	339	315	315	315
crested wheatgrass-streambank wheatgrass	73	194	145	145	139
Significant ranges ³	(-----158-----)				(233)
Grand mean	336	558	556	687	540
Significant ranges	(-----3-----2-----)				

¹Excerpt from Hedrick et al. 1964

²Includes big sagebrush and rabbitbrush.

³Significant ranges at 5 percent were computed by Tukey's method.

Table 3.--Percent stand¹ ratings for understory grasses seeded or occurring with 'Whitmar' bluebunch wheatgrass at Moxee, Washington over a seven-year period.

Associated species	Sampling date ²							Cheatgrass ³	Whitmar ⁴	
	5-58	6-59	7-60	3-61	10-61	6-62	9-64	6-62	3-61	6-62
	-----percent-----									
Covar sheep fescue	58	13	1	0	0	0	0	83	13	22
Durar hard fescue	95	9	0	0	0	0	0	71	24	25
Sodar streambank wheatgrass	86	65	4	10	5	4	12	87	10	10
Topar pubescent wheatgrass	83	78	28	34	24	33	24	69	9	10
P-27 Siberian wheatgrass	89	86	74	78	91	81	91	13	8	4
P-4874 Bulbous bluegrass	91	71	70	88	96	89	88	49	11	11
Sherman big bluegrass	83	40	5	4	19	21	5	70	10	21
P-851 canby bluegrass	96	65	79	89	82	80	86	23	38	36
P-9012 Russian wildrye	63	25	4	8	5	3	12	84	15	15
Ladak alfalfa	55	16	0	0	0	0	0	86	13	15
Average	80.3	47.0	26.5	31.0	30.0	27.5	31.3			

¹Percent stand on ocular rating comparing the number and condition of plants occurring in the plot to what would be expected where the particular species is successfully established and well adapted. Percent stand for cheatgrass compares number of plants and canopy cover (condition) to what normally occurs in a severe infestation on rangeland in eastern Oregon and Washington (this may be a few robust or numerous less vigorous plants but always providing complete groundcover and severely inhibiting native grasses and forbs).

²LSD_{.01} between species = 16.06 (all years); between years (average of all species means) = 6.33; between years for each species = 20.00

³LSD_{.01} between understory species = 37.14.

⁴Percent stand ratings do not vary significantly at the 5% probability level (observed F = 2.11, required F = 2.25).

Table 4.--Effect of understory grass mixtures with 'Fairway' crested wheatgrass and bluebunch wheatgrass on groundcover and cheatgrass density at Moro, Oregon, 1938-53.¹

Understory species	Fifth-sixth year			Tenth year			Fifteenth year		
	Under-story	Over-story	Cheat-grass	Under-story	Over-story	Cheat-grass	Under-story	Over-story	Cheat-grass
		<u>% cover Fairway</u>			<u>plants/m² Fairway</u>			<u>plants/m² Fairway</u>	
Bulbous bluegrass (<i>Poa bulbosa</i>)	10	33	2	0.1	1.4	none	2.7	2.3	none
Sheep fescue (<i>Festuca ovina</i>)	28	19	13	3.9	0.4	0.1	4.2	0.4	0.1
Big bluegrass (<i>Poa ampla</i>)	25	22	5	2.1	0.2	0.1	2.5	1.7	0.1
None	--	33	20	--	1.9	0.2	--	2.5	0.2
		<u>Bluebunch</u>			<u>Bluebunch</u>			<u>Bluebunch</u>	
Sandberg bluegrass (<i>Poa sandbergii</i>)	9	39	9	1.7	3.4	none	3.2	3.2	none
Idaho fescue (<i>Festuca idahoensis</i>)	39	19	4	4.3	0.6	0.1	3.4	2.7	0.1
Big bluegrass (<i>Poa ampla</i>)	26	27	7	1.6	1.6	0.1	0.3	3.6	0.1
None	--	38	18	--	3.4	0.3	--	5.2	0.1
	LSD _{.01} (cheatgrass) = 11			LSD _{.01} (total cover) = 1.4			LSD _{.01} (total cover) = 2.3		

¹ Excerpt from USDA Soil Conservation Service 1976.

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