PROMISING NEW GRASSES FOR RANGE SEEDINGS

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ABSTRACT: New cultivars of range grasses have recently been released by public agencies in the United States and Canada and other promising strains soon will be available. Some advanced generation strains derived through interspecific hybridization have shown promise. Two hybrid germplasms have been released and other strains are being evaluated for possible release.

INTRODUCTION

The improvement of range grasses through breeding has received comparatively little emphasis. In the past, many range reseedings were done with unimproved strains or varieties originally developed for the Great Plains. Breeders working to develop better germplasm have had a limited amount of genetic variability to select from. This problem has been especially serious for introduced grass species. Many cultivars of introduced grasses were derived from a single introduction. Recognizing the need for better cultivars of range grasses, researchers in the United States and Canada have accelerated plant introduction and breeding efforts. This paper discusses some of the new and potentially valuable grass germplasm generated by these programs.

RUSSIAN WILDRYE *Psathyrostachys juncea*

Once established, Russian wildrye provides an excellent source of herbage on arid and semiarid range. The species produces abundant early-season forage, is resistant to cold and drought, and has excellent forage quality. It retains its nutritive value during the late summer and fall better than many other range grasses, such as crested wheatgrass. However, some serious limitations have prevented Russian wildrye from reaching its full potential on Western range. The species has relatively poor seedling vigor and is difficult to establish on range sites. Stand failures are often due to the inability of seedlings to emerge from excessive planting depths. Also, commercial production of Russian wildrye seed is severely hindered by seed shattering problems soon after maturity (Rogler and Schaaf 1963; Smoliak and Johnston 1980b).

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A breeding program was initiated in 1976 by the USDA Agricultural Research Service (USDA-ARS) in cooperation with Utah State University to develop improved cultivars of Russian wildrye. Seedling vigor under drought stress and exploration to expand the available genetic base have been the project's major concern. The most promising source of germplasm in this breeding program was derived from a recently introduced strain from the U.S.S.R. called 'Bozoisky'. Parental clones developed from this and other populations have been included in crossing programs to develop three experimental synthetic cultivars. These plant materials are being evaluated on several range sites and a cultivar release is expected in 1983 or 1984.

Two cultivars of Russian wildrye recently released from breeding programs in Canada are:

'Swift'

'Swift' was released in 1978 by Agriculture Canada at Swift Current, Saskatchewan. The parental materials were selected for improved seedling vigor primarily on the basis of seedling emergence from deep seedings. The cultivar has displayed excellent establishment characteristics in Canadian field trials (Lawrence 1979).

'Cabree'

This cultivar was developed at the Agriculture Canada Research Station at Lethbridge, Alberta. Selection was based primarily on seed retention (resistance to shattering), seedling vigor, forage yield, seed yield, and culm strength. In Canadian field tests, 'Cabree' shattered less seed than other cultivars, including 'Vinall' and 'Sawki' (Smoliak 1976).

ALTAI WILDRYE *Leymus angustus*

Altai, an introduction from the U.S.S.R., is a long-lived perennial that is beginning to gain acceptance in Western Canada and the United States. The species is larger and somewhat coarser than Russian wildrye. Also, the seed is larger and seedlings can emerge from relatively deep seedings better than Russian wildrye. The species cures exceptionally well and retains its nutritional value throughout the season better than most cool-season grasses. Because of these qualities and its erect culms that protrude through the snow, Altai has been proposed for extending the grazing season during the late fall and winter. The grass is reportedly well adapted to the loam and clay soils of the prairies of Manitoba, Saskatchewan, and Alberta (Lawrence 1976).

Altai has been noted for its extensive root system that can reach soil depths of over 10 ft (3 m) (Lawrence 1976; Lawrence and Lodge 1975). Early tests suggest that the salinity tolerance of Altai approaches that of tall wheatgrass (McElgunn and Lawrence 1973). The USDA-ARS at Logan has crossed Altai with related species, basin wildrye L. cinereus and mammoth wildrye L. giganteus. Research has been initiated to develop fertile and genetically stable populations from these hybrids. One new cultivar of Altai wildrye has been released:

'Prairieland'

This cultivar was recently developed and released by the Agriculture Canada Research Station at Swift Current, Saskatchewan, and seed is now becoming generally available. 'Prairieland' was selected from two U.S.S.R. introductions on the basis of high seed and forage yield, freedom from leaf spot, and good seed quality (Lawrence 1976).

CRESTED WHEATGRASS Agropyron cristatum A. desertorum AND A. fragile

This complex, which consists of a series of diploid, tetraploid, and hexaploid species, has been the most widely used grass in revegetation programs on Western range. An estimated 8 million acres (3.2 million ha) have been established with crested wheatgrass in the United States (Newell 1955) and over 2 million acres (1 million ha) in Canada (Lodge and others 1972). Although the quality of crested wheatgrass forage declines rapidly during the summer months, it is still one of our best sources of early spring forage on semiarid range. Most of the research with this species complex in the United States is concerned with the tetraploids, Agropyron desertorum (Standard) and A. fragile (Siberian), and the diploid, A. cristatum ('Fairway').

The tetraploid cultivars 'Nordan' and 'Summit' and the diploid cultivar 'Fairway' have been in common usage for several years. 'Fairway' is considered to be leafier than 'Nordan' or 'Summit,' but it is not as drought hardy as Standard (Knowles and Buglass 1971).

The USDA-ARS at Logan has developed three new synthetic strains of crested wheatgrass derived from Standard, induced tetraploid 'Fairway,' and the induced tetraploid 'Fairway' X Standard hybrid. These experimental cultivars are being evaluated on range sites and a release is expected in 1984. The crested wheatgrass hybrid has shown particular promise. It has excellent vegetative vigor relative to the parental species in both the seedling and mature plant stages. Three relatively new cultivars of crested wheatgrass are:

'Ruff'

This is a diploid cultivar developed cooperatively by the USDA-ARS and the Nebraska Agricultural Experiment Station. The parental germplasm was derived from 'Fairway' and was originally designated as Nebraska 3576. Ruff has a spreading, broad-bunch growth habit and the culms are comparatively leafy and short. It has been recommended for grazing during the early spring in the low precipitation zones of the Great Plains, and for areas such as roadsides, parks, and playgrounds in the drier semiarid regions (USDA Extension Service 1978).

'Ephraim'

This crested wheatgrass cultivar was jointly released in 1983 by the USDA-Forest Service, Utah State Division of Wildlife Resources, USDA-Soil Conservation Service (USDA-SCS), and the Agricultural Experiment Stations of Utah, Arizona, and Idaho. The original parental plant materials were collected near Ankara, Turkey. It is a persistent sod-forming cultivar that is adapted to the arid ranges of the Intermountain West. Extent of rhizome development is influenced by environmental conditions. On most pinyon-juniper and sagebrush-grass sites, rhizomes are reported to develop by the second or third year. Although annual biomass production of 'Ephraim' appears to be similar to 'Fairway,' its culm length is slightly shorter. Wolf plants, which commonly occur in stands of 'Fairway' and Standard, have not been observed in 'Ephraim' (Stevens and others[1/]).

'P-27'

A strain of the Siberian type, 'P-27' was developed by the USDA-SCS and released cooperatively with the Idaho Agricultural Experiment Station in 1953. The original collections were made in Kazakhstan, U.S.S.R. In general, Siberian wheatgrass is similar to Standard in appearance, but the leaves are more lax and narrow. The grass is reportedly adapted to sandy soils (Andreev 1974) and has greater frost tolerance than Standard (Hanson 1972).

INTERMEDIATE WHEATGRASS Elytrigia intermedia

This productive, versatile grass was introduced into North America from southern U.S.S.R. and central Asia. It is more productive, but somewhat less drought resistant than crested wheatgrass. Because of its large seeds and relatively vigorous seedlings, the species is

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[1/] Stevens, R.; Monsen, S. B.; Shaw, N.; McArthur, E. D.; James, G.; Davis, G.; Jorgensen, K. R.; Davis, J. N. Notice of naming and release of 'Ephraim' crested wheatgrass; 1983.

considered one of the easiest range grasses to establish within the limits of its adaptation. It matures from 1 to 2 weeks later and is more productive during the summer period than crested wheatgrass. It has been used successfully in mixtures with alfalfa under dryland and irrigated conditions (Asay and Knowles[2]; Rogler 1973).

Several cultivars of intermediate wheatgrass and its subspecies, pubescent wheatgrass (subsp. trichophora), have been released. 'Greenar,' 'Oahe,' 'Slate,' 'Tegmar,' 'Amur,' 'Chief,' 'Topar,' 'Luna,' and 'Greenleaf' were all released prior to 1970. One cultivar has been released since then:

'Clarke'

This is a new cultivar of intermediate wheatgrass released in 1980 by the Agriculture Canada Research Station at Swift Current, Saskatchewan. 'Clarke' has no visual characters that distinguishes it from other cultivars of intermediate wheatgrass. However, it is described as a cultivar with good drought resistance, winterhardiness, and high seed yield. During its development, improved vigor during establishment, disease resistance, and forage yield were also stressed. In Canadian trials, dry matter yields of 'Clarke' were equal to or higher than 'Chief' or 'Greenleaf.' 'Clarke' yielded substantially more seed than either of these cultivars (Lawrence 1981).

WESTERN WHEATGRASS Pascopyrum smithii

Western wheatgrass is a widely adapted cool-season species that is native to North America. It is resistant to environmental stress, has a rhizomatous growth habit, and is adapted to heavy, alkaline soil (Beetle 1955; Rogler 1973). The species is particularly well suited for reclamation of disturbed sites and soil stabilization. In trials conducted in Wyoming and Montana, Western wheatgrass was one of the most promising of 174 grass, forb, and shrub species tested for reclaiming saline seeps and other problem sites (Scheetz and others 1981). In Nebraska, the grass has recently demonstrated the potential for controlling wind erosion in sand blowouts (Malakouti and others 1978).

The cultivars 'Barton,' 'Rosana,' 'Arriba,' and 'Flintlock' were released in the 1970s and helped alleviate seed shortage problems. Two new cultviars released in 1983 are:

'Rodan'

This cultivar was cooperatively released in 1983 by the USDA-ARS Northern Great Plains Research Center at Mandan, North Dakota, the USDA-SCS, and the North Dakota Agricultural Experiment Station. The parental germplasm was obtained from collections made in North Dakota. Selection was based primarily on vegetative vigor, forage quality, and rust reistance. It was originally tested as Mandan 456 and is considered to be an upland drought resistant type (Barker, R. E., Unpublished).

'Walsh'

This 20-clone synthetic cultivar was developed by the Agriculture Canada Research Station at Lethbridge, Alberta, and was released in 1983. It is apparently adapted to heavy clay soils and is tolerant of drought and salinity. Parental germplasm was selected on the basis of high forage and seed yield, aggressive rhizomes, and resistance to diseases. 'Walsh' is the first Western wheatgrass cultivar to be released in Canada (Smoliak and Johnston[3]).

BLUEBUNCH WHEATGRASS Elytrigia spicata

Bluebunch wheatgrass, a cool-season, perennial bunchgrass, has long been considered one of the most valuable native grasses in the Intermountain region and Pacific Northwest. It is closely related to beardless wheatgrass. Dewey[4] includes both grasses in Et. spicata. Bluebunch wheatgrass has excellent forage quality and often is preferentially grazed over other species in mixed stands. Because stands of this species are often depleted under heavy or untimely grazing, proper management is especially critical to maintain productive stands (Asay and Knowles[2]; Hafenrichter and others 1968).

The cultivar 'Whitmar,' a beardless form released in 1946 has been widely used in revegetation programs (Wolfe and Morrison 1957). One new cultivar has been reported:

'Secar'

This cultivar was recently released by the USDA-SCS in cooperation with the Agricultural Experiment Stations of Washington, Oregon, Idaho, Montana, and Wyoming. The original germplasm was obtained from native stands near Lewiston, Idaho. The name 'Secar', which in Spanish means dry, was chosen to reflect the

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[2]/Asay, K. H.; Knowles, R. P. Ch. 18. In: Barnes, R. G.; Metcalfe, D. S.; Heath, M. E., eds. Forages - the science of grassland agriculture. 4th Edition. The Iowa State University Press, Ames. In Press.

[3]/Smoliak, S.; Johnston, A. Walsh western wheatgrass. Can. J. Plant Sci.: In Press; 1983.

[4]/Dewey, D. R. Historical and current taxonomic perspectives of Agropyron, Elymus, and related genera. Crop Sci. 23: In Press; 1983.

drought resistance of the cultivar. It is a densely tufted bunchgrass, with abundant, narrow leaves, fine stems, relatively small seeds, and divergent awns. It is adapted to the lower elevations of the Pacific Northwest and is reportedly persistent under adverse conditions. 'Secar' has been superior to 'Whitmar' in nearly all trials conducted in areas receiving less than 14 in (350 mm) of annual precipitation (Morrison and Kelley 1981).

THICKSPIKE WHEATGRASS *Elymus lanceolatus*

This sod-forming grass, which is native to North America, has been widely used for soil stabilization on disturbed range sites and other dry areas subject to erosion. When used for grazing, it provides a valuable source of forage during the summer when grasses such as crested wheatgrass are past their productive and nutritional peaks. Although it is morphologically similar to Western wheatgrass, thickspike wheatgrass is more drought resistant and less productive. It is so similar to streambank wheatgrass, both genetically and morphologically, that Dewey[4/] classified them as the same species. Dewey considered streambank wheatgrass to be the glabrous form of thickspike wheatgrass.

'Sodar' streambank wheatgrass and 'Critana' thickspike wheatgrass were released in 1954 and 1971, respectively. Both have been widely used as special-purpose grasses for stabilizing disturbed and eroded range sites (Stroh and others 1972; Douglas and Ensign 1954). One new cultivar is available:

'Elbee'

This cultivar of thickspike wheatgrass was developed by the Agriculture Canada Research Station at Lethbridge, Alberta. It was the first cultivar of thickspike wheatgrass (called northern wheatgrass in Canada) to be released in that country. The cultivar is noted for its excellent seed germination, and vigorous seedlings, resistance to drought, moderate rhizome development, and early spring growth. the original collections, from which the cultivar was derived, were made from the plains regions of Alberta and Saskatchewan (Smoliak and Johnston 1980a).

INTERSPECIFIC HYBRIDS

Over 250 different interspecific and intergeneric hybrid combinations have been developed by the USDA-ARS Cytogenetics Program at Logan. Many of these have limited agronomic merit and most are highly sterile. However, colchicine treatment and selection have yielded some promising breeding populations.

These include: quackgrass (*Elytrigia repens*) X bluebunch wheatgrass, quackgrass X Standard crested wheatgrass, quackgrass X induced tetraploid 'Fairway' crested wheatgrass, bluebunch wheatgrass X thickspike wheatgrass, Altai wildrye X basin wildrye and mammoth wildrye, and *Elytrigia acuta* X intermediate wheatgrass.

The best of these appears to be the quackgrass X bluebunch wheatgrass hybrid (RS hybrid). The initial cross was made by D. R. Dewey in 1962. The F_1 generation produced very little seed, had poor vegetative vigor, and chlorophyll defective plants were prevalent. After eight cycles of selection, a breeding population with characteristics of both parental species has been obtained. The chromosome number has stabilized at 2n=42 and the hybrid is as fertile as either of the parental species. It is best adapted to the 12-18 in (300-450 mm) precipitation zone and in preliminary trials, has shown a surprising tolerance to saline conditions. The hybrid has responded particularly well to repeated clipping or grazing and has displayed exceptional palatability in animal grazing trials. Degree of vegetative spread (rhizome development) is under genetic control and can be successfully altered through selection. Rhizome development ranges from essentially bunch-type to a moderate degree of vegetative spread in the breeding population.

A major objective of the breeding program now is to eliminate undesirable segregates (off-types) that appear in each generation. Two germplasms, designated 'RS-1' and 'RS-2,' were released to other plant breeders and plant scientists in 1980 (Asay and Dewey 1981). Seed-increase blocks consisting of selected F_9 lines (9th generation after the initial cross) were established in 1982. Breeders seed for a possible cultivar release will be produced from these nurseries in 1983.

The quackgrass X Standard crested wheatgrass hybrid has also demonstrated sufficient potential to merit continued breeding work. This hybrid is not as genetically stable as the RS populations and sterility problems are still evident. However, trends indicate that continued selection will yield a fertile new species. A major goal is to develop strains that retain their forage quality longer during the summer months than presently available crested wheatgrass cultivars. Selection for the drought resistance of the crested wheatgrass parent and a moderate degree of rhizome development will also be emphasized.

Although the F_1 generation of the quackgrass X 'Fairway' crested wheatgrass hybrid is highly sterile, it may prove valuable for soil stabilization on problem sites such as mine spoils, roadsides, or rough-turf applications. Because it does not produce seed, vegetative propagation would be necessary. However, limited results from evaluation trials indicate that the hybrid lends itself well to this method of establishment on a limited acreage basis.

The bluebunch wheatgrass X thickspike and *Elytrigia acuta* X intermediate wheatgrass hybrids have performed well on range sites disturbed by surface mining operations. Although these populations are responding favorably to selection, it appears that additional breeding will be needed to achieve the seed fertility and genetic stability necessary for cultivar release.

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