Forage Yield, Phenological Development, and Forage Quality of an *Agropyron repens* × *A. spicatum* Hybrid

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Abstract

Studies were conducted to evaluate the potential of the *Agropyron repens* (L.) Beauv. × *Agropyron spicatum* (Pursh) Scrib. & Smith hybrid as a forage grass. The hybrid was compared with its parental species for phenological development, chemical composition, in vitro dry matter digestibility, and acceptance by sheep. The new species was highly productive, maintained a high nutritional value, especially in its fall regrowth, and was readily accepted by sheep. In most respects it was intermediate to its two parents. Results of these studies indicate the hybrid has potential as a forage species under certain rangeland conditions.

Demand on western rangelands to meet livestock needs within a multiple-use framework has resulted in a more scientific approach to livestock production in order to use the land more efficiently. Introducing more desirable and productive forage plants into appropriate range plant communities is one possibility for intensifying management. Wide hybridization has been successfully used in the past to bring about desirable characteristics in grasses for livestock production (Buckner et al. 1967, 1972). More than 250 interspecific hybrids among Triticeae species (*Agropyron*, *Elymus*, *Sitanion*, et al.) have been produced at Logan, Utah by D.R. Dewey (1976).

One of the most promising of these is the fertile hybrid (*Agropyron repens* (L.) Beauv. (quackgrass) × *Agropyron spicatum* (Pursh.) Scribn. & Smith (bluebunch wheatgrass) (Dewey 1976). The purpose of hybridizing these two species was to combine the plant type, early growth, palatability, and drought resistance of bluebunch wheatgrass with the general vigor and productivity of quackgrass. Considerable variation still exists in the hybrid population used in this study, so it has not been released for general use. A testing and recurrent selection program is in progress on several Utah Range sites to eliminate undesirable variants and produce a genetically stable population.

The objectives of the present study were to evaluate the present form of the hybrid for its potential as a forage species by comparing phenological patterns, productivity, digestibility, chemical composition, and acceptance by sheep with its parental lines.

Materials and Methods

The plants used in this study were located about 5 km (3 miles) north of the Utah State University campus, Logan. The two parents and the hybrid were transplanted from the greenhouse to the field in the spring of 1975 in a randomized and complete block design, with four replicates. Each plot measured 3.34 m^2 and contained two rows of eight plants each. Precipitation for the study area in 1976 and its comparison with the long-term average are shown in Table 1.

Above-ground biomass was harvested on June 28 and September 16, 1976. On each of these dates plots were clipped 2.5 cm above the soil surface, and results were reported on a dry matter basis.

Phenological patterns were recorded using the method outlined by West and Wein (1971). In this method the various identifiable phenologic changes that occur during the plant's life cycle are each identified by numbers ranging from 1 through 17. In vitro dry matter digestibility (IVDMD) was analyzed by the Tilley and Terry technique (1963) as described by Harris (1970). Dry matter and crude protein were analyzed using the A.O.A.C. method (1960). Cell wall contents, lignin, cellulose were analyzed by the Van Soest (1970) method.

Livestock acceptance of the three grasses was tested using four mature ewes placed in individual stalls with three-compartment feeders, so that the animals had equal access to each of the three forages. The four animals were fed alfalfa during a 2-week adjustment period and then offered 0.9 kg of each of the three test species for two consecutive days. The position of each grass species was rotated daily. Salt and water were offered free choice.

Results and Discussion

Primary Production

On the June 28 harvest, quackgrass clearly yielded the most biomass, producing 4.7 times more forage than bluebunch wheatgrass and 1.4 times more than the hybrid (Fig. 1). Quackgrass and the hybrid produced 8,880 and 6,518 kg/ha, respectively, while bluebunch wheatgrass produced 1,884 kg/ha. Differences among the three species were much less at the September 16 harvest. The hybrid's production for this regrowth period was 35% above the average of the parents. Total production for the season was 14,352 kg/ha and 11,421 kg/ha for quackgrass and the hybrid, respectively, and 3,708 kg/ha for bluebunch wheatgrass (Fig. 1).

Phenological Patterns

The significance of phenological patterns becomes apparent when they can be related to the nutritional changes in the plants (Bailey 1973; Cook and Harris 1950, 1968; Lyttleton 1973).

During the first sampling period before the harvest on June 28, bluebunch wheatgrass showed a faster rate of phenological development than quackgrass or the hybrid (Fig. 2). The latter two were quite similar in the development until June 15.

Phenological stage, between June 28 and September 1, which was regrowth following clipping, indicated that bluebunch wheatgrass again showed faster phenological development. Quackgrass and the hybrid attained only the fifth leaf stage

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Table 1. Monthly precipitation (inches) for the study area for 1976 and the long-term average.

	J	F	M	A	M	J	J	A	S	O	N	D	Total
1976	.98	3.08	2.71	3.17	.87	1.98	1.14	1.93	.61	.79	.04	.08	17.38
Long-term average	1.63	1.45	1.74	2.12	1.86	1.78	.34	.87	.94	1.43	1.79	1.64	17.59

while bluebunch wheatgrass achieved the second boot stage during regrowth following the June 28 harvest (Fig. 2).

In Vitro Dry Matter Digestibility—IVDMD

This test does not intend to predict in vivo dry matter digestibility of the three grasses studied, but to provide comparative estimates.

The IVDMD of all three grasses decreased between the May 15 and June 15 samplings (Table 2). This decrease has been observed in other studies and is due apparently to increases in cellulose and other structural polysaccarides and changes in leaf to stem ratios with maturity (Bailey 1973; Cook and Harris 1950). In the period between August 1 and September 1, the IVDMD of quackgrass and the hybrid decreased significantly ($\alpha<0.01$). Bluebunch wheatgrass maintained on IVDMD near 71%. By the September 1 sampling, no significant difference in IVDMD was found between the hybrid and its parental lines (Table 1).

Table 2. In vitro dry matter digestibility (% of dry matter) of the three test grasses at four harvest dates.

Species	May 15	June 15	Aug. 1	Sept. 1
A. repens × A. spicatum	72.8	68.1	63.6	68.4
Agropyron repens	77.4	69.0	59.0	66.8
Agropyron spicatum	74.5	64.5	71.5	70.2

$LSD_{0.01}$ (among grasses within dates) = 2.74.

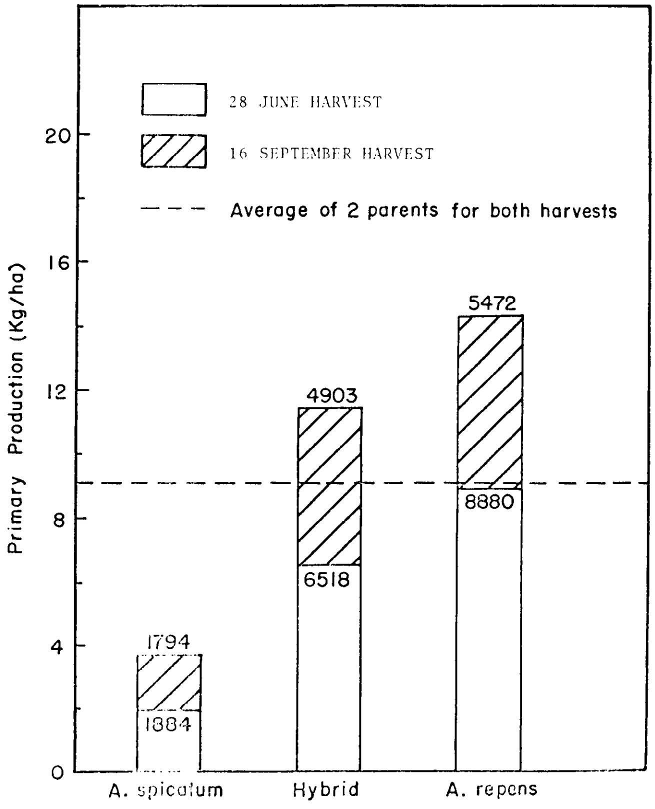

Fig. 1. *Dry matter production of the three test grasses at two dates of harvest.*

The increase in IVDMD found between August 1 and September 1 in the hybrid and quackgrass reflects the extensive fall regrowth of these two grasses (Fig. 2). This increase in IVDMD was also observed in tall fescue by Buckner et al. (1967).

Chemical Composition

The nutritional quality of the three test grasses was measured throughout the growing season in terms of chemical tests that indicate the availability of nutrients and easily digestible components of the forage. These chemical components were: cell-wall contents, cellulose, lignin and crude protein.

Cell-wall Contents—CWC

This portion of the forage dry matter is composed primarily of cellulose, hemicellulose, and lignin and represents a measurement of less digestible plant parts. These substances normally increase with plant maturity (Bailey and Ulyatt 1970; Barnes 1973). Bluebunch wheatgrass had the highest concentrations of CWC (63.5%) for both spring and fall harvests (Table 3). A higher proportion of stems was observed in bluebunch wheatgrass than the other two species and stems have a greater concentration of less digestible structural carbohydrates (Bailey 1973; Mackenzie and Wytam 1957).

Between May 15 and June 15, the CWC of both quackgrass and the hybrid increased significantly but remained lower than

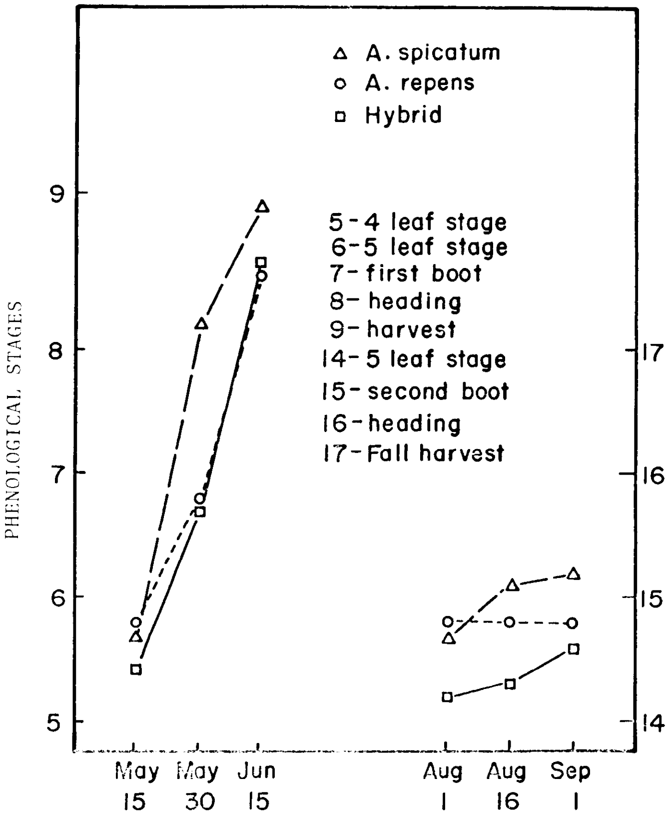

Fig. 2. *Phenological pattern of the three test grasses on three dates, each prior to June 28 and September 16 harvests.*

Table 3. Cell wall content (% of dry matter) of the three test grasses at four harvest dates.

Species	May 15	June 15	Aug. 1	Sept. 1
A. repens × A. spicatum	45.2	61.2	53.9	59.4
Agropyron repens	43.7	58.2	57.4	55.5
Agropyron spicatum	54.2	63.6	50.3	63.5

$LSD_{0.01}$ (among grasses within dates) = 3.95.

bluebunch wheatgrass (Table 3). The was true for the samplings on August 1 and September 1, and the CWC content of the hybrid was not significantly different from that of quackgrass. This similarity indicates similar rates of maturation in both species.

Cellulose

This polysaccharide provides a measure of the digestibility of the cell walls to the grazing animal (Van Soest 1967).

Between the May 15 and June 15 samplings, all three grasses showed a significant increase ($\alpha<0.01$) in cellulose content. This increase in cellulose between the fourth leaf stage and the heading stage is probably due to a greater stem to leaf ratio (Bailey 1973; Burton et al. 1964; Cook and Harris 1968). Bluebunch wheatgrass was the highest in cellulose, the hybrid was intermediate at both dates, and quackgrass showed the lowest cellulose content for these two dates (Table 4).

Table 4. Cellulose content (% of dry matter) of the three test grasses at four harvest dates.

Species	May 15	June 15	Aug. 1	Sept. 1
A. repens × A. spicatum	21.0	30.6	26.9	26.0
Agropyron repens	20.3	28.4	26.8	24.5
Agropyron spicatum	27.2	33.0	33.1	28.8

$LSD_{0.01}$ (among species within dates) = 1.47.

The cellulose content of the three species decreased on the August 1 and September 1 sampling dates. This decrease principally reflects the copious vegetative growth that occurred after the June 28 harvest. A similar decrease in cellulose in the aftermath forage after harvest was noticed by Bailey (1973). Bluebunch wheatgrass remained highest in cellulose on all sampling dates, which would help explain the consistently higher CWC levels observed in this species.

Lignin

This aromatic polymer is deposited throughout the plant as it matures making it less digestible to herbivores (Harkin 1973). The three grasses studied showed no significant difference in lignin content at any of the four sampling dates. Lignin content increased significantly from May 15 to June 15.

Crude Protein

As shown in Table 5, a marked decrease in crude protein content occurred in all three grasses between May 15 and June 15. The sharpest decline occurred in the hybrid. This drop in crude protein with plant maturity has been extensively documented (Cook and Harris 1950; Lyttleton 1973; Wallace and Denham 1970). The hybrid maintained relatively high crude protein content for the samplings on August 1 and September 1 (Table 5), implying a high nutritional value for the fall regrowth of the hybrid. Bluebunch wheatgrass maintained the same level of crude protein on August 1 and September 1, while that of quackgrass decreased.

Table 5. Crude protein content (% of dry matter) of the three test grasses at four harvest dates.

Species	May 15	June 15	Aug. 1	Sept. 1
A. repens × A. spicatum	26.1	13.4	23.2	19.4
Agroypron repens	25.0	15.0	22.9	17.6
Agropyron spicatum	20.9	12.0	17.5	17.5

$LSD_{0.01}$ (among grasses within dates) = 1.44.

Acceptance by Sheep

The plant materials that were harvested on the June 28 and September 16 dates were throughly mixed and offered in compartmented feeders to four sheep. Though inadequate forage was produced during the season to conduct a preference study of sufficient length of time, there was enough plant material to conclude that the three grasses were readily accepted by all four sheep. We could not distinguish a difference in plant preference among the three grasses under the conditions of the study.

Conclusions

The quackgrass × bluebunch wheatgrass hybrid has good productive capabilities, especially in its regrowth following harvest. It is somewhat slower in reaching maturity than bluebunch wheatgrass, and its regrowth is mostly vegetative, of very high nutritional value and digestibility. Results of this work suggest the hybrid has potential as a rangeland forage and merits further testing, especially on dry range sites and under conditions of grazing.

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