Taxonomic and Agronomic Variation in *Agropyron spicatum* and *A. inerme*

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Highlight: *The main morphological distinction between bluebunch wheatgrass and beardless wheatgrass is the presence of geniculate awns in the former and the absence of awns in the latter. Open pollinate progenies of plants classified as either* A. spicatum *or as* A. inerme *segregated clearly for this trait. This indicates the mere presence or absence of awns does not afford reproductive isolation; thus, the species designation is questionable. In addition, variation for rhizomes was detected in the progenies of bunch type plants, but segregation was not clear cut. Significant variation among progeny means for forage yield was also detected. There is apparent, real potential for varietal development, but care must be exercised in mixing awned and awnless types.*

The forage grass breeder must not only interpret and utilize genetic variation in his breeding stocks, but he must also contend with variation in traits which are of critical importance in identifying taxa within which he is working. This variation frequently obscures precise taxa identification and is a significant problem in many forage grass breeding programs. Before a breeding program can be implemented, questionable breeding stocks must be clearly identified.

In recent years, many new techniques to unravel taxonomic questions have been used. The contributions of cytogenetics in taxa identification cannot be seriously doubted (see, for example, Schultz-Schaeffer and Jurastis, 1962). Similarly, various biochemical techniques have proved useful in approaching certain taxonomic problems (see for example-Lorenz and Schultz-Schaeffer, 1964). However, the forage grass breeder, for practical reasons, generally must depend on the more classical, morphological approaches to taxonomic problems.

We are involved with variety development programs in two closely related species of Agropyron, *A. spicatum* (Pursh) Scribn. & Smith (bluebunch wheatgrass) and *A. inerme* Scribn. & Smith (beardless wheatgrass). Morphologically, these species are separated primarily by the presence or absence of awns (Hitchcock, 1950). From a genetical point of view, evidence suggests that members of these species, based exclusively on morphological criteria, are not reproductively isolated.

Materials and Methods

In 1967, a minimum of eight plants of each of 27 collections of *A. spicatum* and of eight collections of *A. inerme*[1] was established at random in a space planted (1 meter between and within rows) nursery at Bozeman, Mont. In 1968 and 1969 each plant was classified taxonomically according to Hitchcock (1950) and scored for agronomically important traits (yield, growth type, etc.). Both species are described as perennial with bunch type growth habit and spikelets appressed to the axis of the spike. Lemmas are generally not pubescent. In both species other morphological traits may vary. These traits include glume length and degree of involution of leaves. Considering only *A. spicatum* and *A. inerme,* separation is based on the presence of geniculate awns in the former and the absence of awns in the latter.

In 1969, replicated plantings of the open pollinated progeny of 33 of the initial plants were made at Bozeman, Mont. Seedlings were spaced .5m in rows 1.5m apart. A minimum of two replications of six plants each, to a maximum of six replications of six plants each, was planted.

In 1970, infloresence samples of each plant of every progeny were classified to species according to Hitchcock (1950).

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[1]Seed collections were supplied by the Soil Conservation Service Plant Material Center at Bridger, Montana.

Table 1. Taxonomic data and mean plant yields (g, oven dry) for progeny of *A. spicatum* and *A. inerme* plants.

Bozeman plant no.	S.C.S. collection	Maternal plant identification	Awned	Awnless	Rhizomatous	Bunch	Mean yield/ plant progeny
1-7	P6409	*A. spicatum*	12	1	0	13	–
2-1	Wy258	*A. spicatum*	12	7	variable	variable	81.0
2-3	M453	*A. spicatum*	21	2	0	23	27.5
2-8	P7845	*A. spicatum*	12	3	5	10	55.7
2-17	M781	*A. inerme*	0	12	3	9	68.9
3-2	Wy437	*A. spicatum*	13	3	2	11	33.6
4-8	P6409	*A. spicatum*	6	2	0	8	56.3
5-1	M451	*A. spicatum*	8	0	0	8	13.7
5-10	Wy437	*A. spicatum*	3	1	1	3	–
5-16	M788	*A. inerme*	0	23	16	7	88.7
6-18	C138CM	*A. inerme*	0	5	5	0	–
7-2	Wy312	*A. spicatum*	11	6	5	12	17.0
7-4	M177	*A. spicatum*	10	1	0	11	31.5
7-6	M180	*A. spicatum*	14	6	0	20	23.9
7-7	Wy437	*A. inerme*	5	3	0	8	44.5
7-8	P6409	*A. spicatum*	9	1	0	10	47.5
8-6	C29MB	*A. spicatum*	4	4	0	8	36.3
8-18	C138CM	*A. Inerme*	6	15	13	8	95.3
9-2	M451	*A. spicatum*	11	0	0	11	37.8
9-16	M781	*A. inerme*	0	23	0	23	54.3
10-2	C139	*A. spicatum*	9	0	0	9	28.5
10-5	Wy344	*A. spicatum*	3	0	1	3	47.0
10-18	C138CM	*A. inerme*	0	11	variable	variable	74.0
11-2	M180	*A. spicatum*	13	0	0	13	26.0
11-18	M785	*A. inerme*	2	7	3	6	99.2
12-5	P7845	*A. spicatum*	5	2	4	3	55.0
13-5	Wy312	*A. spicatum*	3	2	1	4	–
14-3	M451	*A. spicatum*	10	1	2	9	36.5
14-7	P7845	*A. spicatum*	7	7	10	4	134.4
17-15	Wy437	*A. spicatum*	17	0	4	13	37.3
18-16	P7845	*A. spicatum*	8	0	0	8	27.7
22-13	M788	*A. inerme*	0	9	variable	variable	48.6
23-15	Wy75	*A. inerme*	2	4	0	6	–

Yield of each plant at heading and regrowth yield 3 weeks later were measured. Mean yield (oven dry matter/ progeny plant) was used in the analysis of differences among progeny.

Results and Discussion

Of the 33 progenies analyzed, the seed parents of 23 were classified as *A. spicatum* and those of the remaining 10 were classified as *A. inerme.* Since the presence or absence of awns is a key trait in separating these species, intra-progeny variation for the presence or absence of awns is of immediate interest (Table 1). Progeny of 16 of the 23 *A. spicatum* plants clearly segregated for awned vs. awnless. Only seven progenies were phenotypically stable for this trait, and for one of these the progeny size was very small. Thus, considering only awned vs. awnless, nearly 70% of the progeny of *A. spicatum* plants segregated for *A. spicatum* vs. *A. inerme.* For the same trait, the progeny of four of nine *A. inerme* plants segregated. Limited progeny size precluded estimating allelic frequencies for this trait; thus, no genetic model of its inheritance is proposed. However, it should be noted that segregation is clear cut and that even in small progenies (as low as four individuals in one case) segregation is detected. This strongly suggests that the inheritance of awns is simple in nature. Based on these data and observations, we suggest that there is serious doubt that these species, when separation is based on awned vs. awnless, are reproductively isolated; therefore, from a genetical point of view, they may share a common gene pool and can be treated as the same species.

Both *A. spicatum* and *A. inerme* are described as bunch type grasses. Variation from the bunch type habit is more difficult to score; it is not a simple "plus or minus" trait as is awned vs. awnless. If variation in rhizomes is considered with variation in awns, then the progeny of only three plants of *A. spicatum* (plants 9-2, 10-2, and 11-2) and one plant of *A. inerme* (9-16) conform to their currently accepted description (Table 1). Moreover, rhizomatous forms of *A. inerme* are readily classified as *A. dasytachyum* (Hook.) Scribn. Although the evidence is not as clear, the validity of separating *A dasytachyum* from *A. inerme* (and *A. spicatum*) on a genetic basis might be questioned.

Significant among progeny variation for yield was detected. Mean yields per progeny plant of all progeny ranged from a low of 13.7g to a high of 134.4g (Table 1). The average of all progeny is 51.0g. The average of all progeny of maternal plants classified as *A. inerme,* 66.8g is significantly ($P<0.05$) greater than the mean yield for *A. spicatum* progeny, 43.5g. This may be due to unintentional directional selection of the maternal plants to be included in the progeny test or to the smaller sample of *A. inerme* plants compared to *A. spicatum*, 9 vs. 19, respectively.

There is significant ($P<0.05$) variation in yield of progeny of single plants from the same collection. In four instances the progeny of two or more plants from the same collection were included in the test (Table 1). The extreme variation was detected for SCS collection P7845 (plants 12-5, 14-7, and 18-16, Table 1). Mean progeny yield of these plants ranged from 27.7g to 134.4g.

Up to 50% of the difference between progeny means may be attributed to genetic difference among the maternal plants. The genetic effect of the pollen parent cannot be estimated from our data. Considering the magnitude of difference among progeny means, we conclude significant genetic gain for forage yield can be realized by selecting maternal plants which produce high yielding progeny and isolating these plants in a polycross nursery. Because of the apparently simple segregation of the awned vs. awnless trait, we feel, in our breeding stocks, both *A. inerme* and *A spicatum* type plants could be included in the same polycross block. However, to insure eligibility for certification of varieties of these species, if these plants types are mixed, it will be necessary to carefully specify the allelic frequencies for genes conditioning this trait.

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