GENETIC DIVERSITY AS AFFECTED BY SELECTION METHODOLOGY IN NATIVE GRASS SPECIES

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ABSTRACT
The utilization of native grasses for widespread plantings is limited by availability and cost of adapted seed sources. The objectives of this study were to assess the genetic diversity of locally collected blue grama (*Bouteloua gracilis*) and little bluestem (*Schyzachyrium scoparium*) populations and to examine potential shifts in genetic diversity using two selection methodologies. The ecovar method involved selection of the 20% highest seed yielding genotypes with equal representation from all populations while the 'cultivar' method involved selecting the highest 5% based on overall rank. Phenotypic variability was observed for morphological and reproductive traits between collected populations of both species. The ecovar and cultivar selection strategies improved seed yield potential in both species. For little bluestem, the ecovar method improved seed production potential without affecting other morphological traits. Preliminary results suggest that genetic diversity can be maintained while improving seed yield in native grass species.

KEYWORDS
Blue grama, *Bouteloua gracilis*, Little Bluestem, *Schyzachyrium scoparium*, Genetic Diversity, Selection Methodology, Seed Production, Ecovar.

INTRODUCTION
The increased interest in planting native grasses for both soil conservation and wildlife habitat, as well as ecological and aesthetic reasons, has resulted in an increased demand for seed. In Canada, such demand is usually satisfied by importing cultivars developed in the U.S. Warm season species from southern locations moved beyond 320 kilometers north of their point of origin often do not mature and suffer winterkill. Currently, many adapted seed sources are obtained by harvesting seed from remnant native stands, but this practice is prohibitively expensive.

Little bluestem (*Schyzachyrium scoparium*) and blue grama (*Bouteloua gracilis*) are important native grass species in the western U.S. and Canada. They are identified as predominant warm season grasses of the mixed and shortgrass prairie (Hitchcock, 1953). Their value in stabilizing soil against erosion has long been recognized (Cornelius, 1946). Despite their potential use for soil reclamation and wildlife habitat, there has been little selection for improved seed production of either species in the northern Great Plains.

The objectives of this study were to assess the genetic diversity of locally collected blue grama and little bluestem populations, and to compare shifts in genetic diversity using two selection methodologies designed to improve seed yield. One of the selection methods, termed 'ecovar selection', attempts to maintain genetic diversity while making improvements for a specific agronomic trait.

MATERIALS & METHODS
In 1992, live plants of blue grama and little bluestem were collected from 11 and 14 locations in southern Manitoba, respectively. The collection sites were at least 30 km apart with the exception of Hartney (HTY & HTY-S) and Goodlands (GDL-1 & GDL-2) which differed in soil salinity and site elevation, respectively.

The collections were transplanted in Winnipeg in early August 1992 into a randomized complete block design consisting of 9 blocks for blue grama and 7 for little bluestem. Collection sites served as treatments and were represented by a row of 5 individual plants planted on 1 m centers for a total of 495 plants for blue grama, and 490 for little bluestem. Field measurements were initiated in 1994 following successful stand establishment.

All data was collected on an individual plant basis. Recorded data included morphological and seed production traits. Fertility index was the main criteria used for selection and was incorporated into selection indexes for each species. Wilson et al. (1991) indicated that sufficient variability was present in caryopsis (kernel) weight in blue grama for effective selection.

$$\text{Fertility Index (FI)} = \frac{\text{kernel yield (g)}}{\text{unthreshed seedhead weight (g)}} \times 100\%$$

Blue grama selection index = FI x seedyield (g).

Little bluestem selection index = FI x Harvest index.

Harvest index was based on total dry weight harvested at an 18 cm stubble height.

The 'cultivar' method involved selection of the best 25 individuals based on overall rank, regardless of collection site, resulting in a 5% selection intensity. The 'ecovar' selection method involved selecting the best plant from each collection site within each block for a total of 98 and 99 plants for little bluestem and blue grama, respectively, resulting in a 20% selection intensity. The selections were then planted into isolated crossing blocks for cultivar and ecovar seed production in 1996. All data analysis was performed using SAS (SAS Institute 1988).

RESULTS AND DISCUSSION
Phenotypic Diversity. Total phenotypic variability for morphological and reproductive traits were partitioned into between- and within- collection contributions (Figure 1). For all traits in both species, most of the observed variability was attributed to differences between collected populations, which comprised approximately 80% of the total genetic diversity. In blue grama, the within-population contribution to variability was highest for reproductive traits including fertility index (FI), kernel weight, and tiller number. In little bluestem, within-population variability was highest for kernel weight. These results suggest that improvement of some reproductive traits may be possible using selection within populations, but that expected gains from selection of all traits would be greatest when selecting across locations.

Blue grama and little bluestem showed differences in mean seed yield per plant across all collected populations. Seed yield for blue grama populations ranged from 7.28 g to 21.17 g per plant. In little bluestem, population seed yields ranged from 9.49 g to 32.25 g per plant. The populations collected from the northern RSL site were the earliest to flower for both species and also produced the lowest mean seed yields per plant. Conversely, populations of blue grama and little bluestem that showed later flowering had the highest seed yields. Surprisingly, the blue grama population from the most southern site also showed early flowering and low seed yields. In little bluestem, populations from the two most southern sites showed

contrasting flowering dates. This data suggests that latitudinal differences in southern Manitoba may not be sufficient to produce expected differences in plant maturity as reported by Larsen (1947).

Potential Effect of Selection on Plant Characteristics. Although seed has not been produced from the ecovar and cultivar selections, the potential effect of selection on phenotypic traits may be predicted by comparing the means of the selected parents with those of the original population (Table 1). These comparisons indicate that both ecovar and cultivar selection strategies should be successful in increasing seed yield and FI in both blue grama and little bluestem. The ecovar approach should be successful with little bluestem since selection had no apparent effect on the traits examined, with the exception of the expected increase in FI. The cultivar selection for little bluestem resulted in a slight decrease for mean tiller height, probably because harvest index was incorporated in the selection criterion for this species. For blue grama, significant shifts were observed for several morphological traits with the ecovar selection and even more so with the cultivar selection. These shifts can be attributed to significant correlations between selected and unselected characters.

These results indicate that blue grama and little bluestem populations collected in southern Manitoba possess significant differences in seed production which may be improved by selection. Phenotypic data suggests that yield of viable seed may be improved using the proposed ecovar strategy with minimal influence on other traits. This research is ongoing with examination of genetic shifts at the molecular level using RAPD (Random Amplified Polymorphic DNA) analysis.

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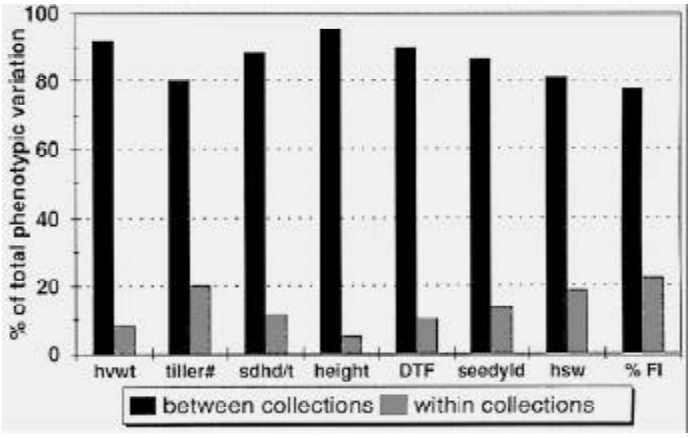
Figure 1
Phenotypic variation between and within collections of blue grama for morphological and reproductive traits. hvwt = harvested dry weight to an 18 cm stubble; sdhd/t = no. of seedheads per tiller; plant height was measured at reproductive maturity; DTF = no. of days to first anthesis from 1 May; HSW = 100 kernel weight; %FI = kernel yield per unthreshed seedhead weight x 100%.



Data for the figure:

	% of total phenotypic variation							
	hvwt	**tiller#**	**sdhd/t**	**height**	**DTF**	**seedyld**	**hsw**	**%FI**
Between collections	91.87	79.95	88.35	95.12	89.92	86.12	81.15	77.6
Within collections	8.13	20.05	11.65	4.88	10.08	13.88	18.85	22.4

Table 1
Mean comparisons between blue grama and little bluestem selections with their original populations for tiller number, tiller (plant) height, seedheads per tiller, seed yield, fertility index and 100 kernel weight.

	Group Mean*					
Little Bluestem	Tiller#	Tiller ht (cm)	Sdhds/tiller+	Seed yld (g)	Fertility Index %	100 krnl wt (mg)
Original	214 a	69.0 a	7.0 a	19.43 a	17.71 c	97.90 a
Ecovar	219 a	69.8 ab	7.0 a	21.42 a	23.39 b	109.49 a
Cultiva	205 a	65.8 b	7.0 a	20.36 a	28.82 a	111.76 a
Blue Grama						
Original	187 c	46.2 b	2.1 c	16.37 c	29.70 b	46.14 b
Ecovar	267 b	47.6 ab	2.2 b	25.43 b	33.66 a	47.61 a
Cultivar	355 a	49.8 a	2.3 a	40.29 a	35.58 a	49.73 a

* Means followed by the same letter are not significantly different (LSD P=0.05).
+ sdhds/tiller: number of seedheads per tiller; Little bluestem was based on counts of 20 or more tillers; Blue grama is seedheads per 20 tillers.