
Promising native forage options for semi-arid prairies of western Canada

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Abstract

There is growing interest in native plant species for their use as forage, pasture, energy crop, and as land reclamation and revegetation materials. This article reports the results of population improvement work on northern wheatgrass (NWG), purple prairie clover (PPC), white prairie clover (WPC) and plains rough fescue (PRF) carried out at Swift Current Research and Development Centre - Agriculture and Agri-Food Canada. Substantial selection differential were achieved in all species in terms of growth vigour, plant health, biomass and seed yield in all species. This suggests ample scope for selection gain for the desirable traits. Seed shattering is one of the challenges facing the domestication and commercialization of these native plant species.

Introduction

Evaluation of native and introduced forage species has been an on-going program at Swift Current Research and Development Centre since its inception. Some 290 species have been evaluated for their adaptation and possible use as forage crops. Changing social values and increasing ecological knowledge have engendered growing interest in native plant species for forage, pasture and energy crop production as well as land reclamation and revegetation. In Canada, an initiative for promoting the native forage species has been taken through ecovarTM (ecological variety) or Selected Class Pre-variety Germplasm development approach since the early nineties. This article provides a glimpse at the promising native plant materials that are ready for selected class pre-variety releases.

Materials & Methods

The study was conducted at Swift Current Research and Development Centre - Agriculture and Agri-Food Canada from 2011 to 2015. Spaced plant nurseries of NWG, PPC, WPC and PRF were established from 2011 to 2013. The perennial stands were evaluated in the growing season of 2012 to 2015. Plants with superior traits including growth vigour, health, biomass and seed yield were selected. Progenies were produced through polycross mating of selected plants. The native germplasm improvement scheme adopted at Swift Current Research and Development Centre is portrayed in Figure 1.

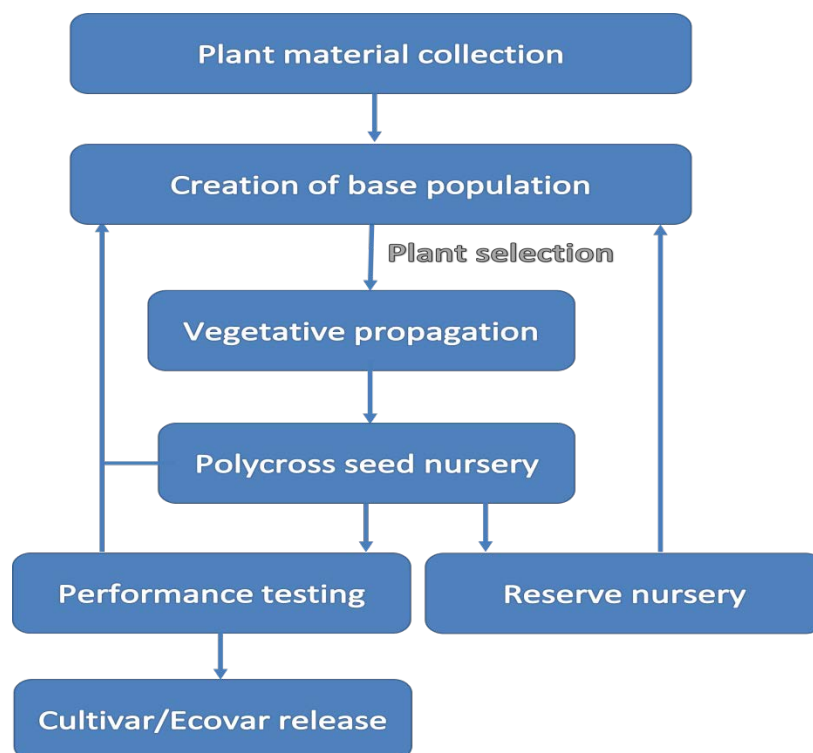


Figure 1: Native germplasm improvement scheme adopted at Swift Current Research and Development Centre.

Results and Discussion

Northern wheatgrass (*Elymus lanceolatus* (Scribn. & J.G. Sm.) [syn. *Agropyron dasystachyum* (Hook.) Scribn.& J.G. Sm.]

NWG is a hardy, long-lived native perennial species. Elbee, developed at Lethbridge Research and Development Centre, is the first cultivar of NWG released in 1980 in Canada (Smoliak and Johnston, 1980). In 2004, an ecovarTM named Polar was released as a composite of 40 collections from Saskatchewan and Manitoba. These materials underwent further selection and were classified into two types namely Fine-leaf and Rough-leaf. Two separate spaced plants nurseries containing 35 selection lines each were established in 2012. In 2014, plants were selected using an index composed of various correlates of productivity and plant health.

In Fine-leaf type, 23 plants of eight different lines were selected for polycross mating in the greenhouse. The selection differentials (values of selected plants above the base population values) in percentage were 136, 90, 56, -39 for the selection index, seed yield, biomass and disease score of the primary crop, and 30 and -50 for the regrowth vigour and regrowth disease score, respectively.

Similarly in Rough-leaf type, 25 plants were selected for polycross mating in the greenhouse. The selection differentials in percentage were 144, 113, 55, -36 for the selection index, seed yield, biomass and disease score of the primary crop, and 20 and -34 for the regrowth vigour and regrowth disease score, respectively

A synthetic population has been developed from the polycross seed. The progeny seedlings are being grown in the greenhouse to establish a breeder's seed plot in the field in 2016 season. The material derived with high selection differentials for desirable traits is ready for release. Breeder's seed will be available for foundation seed production for 2017 season.

Purple prairie clover (*Dalea purpurea* Vent.)

PPC is a native, perennial forage legume with warm-season growth. PPC has one of the highest concentrations of condensed tannins that not only safeguard animals from bloat, but also inhibit *Escherichia coli* O157:H7 activity, thereby lowering the levels of *E. coli* shed in cattle feces (Iwaasa et al., 2014; Li et al., 2014). In 2013, a spaced plant nursery with 49 different progeny lines of earlier selections was established. In the relatively droughty season of 2015, 10.5% plants (82 out of 784) were selected based on their earliness and post-bloom vigour. There was overall 65% plant survival over two winters. These selections resulted in the selection differential of 263.6 and 237.2% for seed and biomass yield respectively.

The selected plants materials were vegetatively propagated for polycross mating in the greenhouse. Pollination mediated by leaf-cutter bees was not very effective in winter season. After providing some rest period for plants under cooler temperature condition, the plants will be rejuvenated for polycross seed production in the 2016 Spring. Breeder's seed plot will be established in 2017 for the release of the cultivar.

White prairie clover (*Dalea candida* Michx. ex Willd, synonym *Petalostemon candidum* Michx. ex Willd)

WPC is a native warm-season, perennial, leguminous forb. It contains higher levels of condensed tannins, crude protein and organic matter digestibility than the popular forage sainfoin (Iwaasa et al., 2014; Li et al., 2014). In 2012, a spaced plant nursery was established with six WPC collections recovered from three prairie provinces. Three populations exhibited relatively prostrate type growth habit, while other three had erect-type plants. After 4 years of establishment, there was overall 78% survival that ranged from 64 to 88% between the populations.

The droughty season of 2015 allowed selection of 43 earlier sprouting and more vigorous plants for polycross seed production. Based on the data of 2014, the selected plants had a selection differential of 45 and 76% for seed yield and biomass, respectively. Polycross seeds were produced in-the-field in 2015 season. The selected plants materials were also vegetatively propagated for polycross mating in the greenhouse. It is planned to establish a breeder's seed plot from the polycrossed seed material of selected plants in 2016 season and some seeds will be available for foundation seed production for 2018.

Plains rough fescue (*Festuca hallii* (Vasey) Piper)

PRF is a perennial, late-seral bunchgrass which is valued for its off-season grazing potential. Once dominant in the prairie grasslands, it is losing grounds from the disturbed habitats due to its narrow environmental plasticity for emergence and seed production (. In 1996, an Ecovar™ 'Roughrider' was created with 14 collections of PRF from Saskatchewan. Series of selections on the Roughrider descendants led to the development of 11 populations.

With the seed harvest of 2010 season from those populations, a new nursery was established in 2011. Selection of 19 plots with higher combined seed yield for 2013-14 resulted in the selection differential of 80% for seed yield and 53% for biomass yield, with no significant impact on forage quality parameters. Seedlings are being raised in the greenhouse to establish breeder's seed plot in 2016 season.

Conclusions

Assuming that the phenotypic characters have reasonable heritability, the large selection differential values suggest ample scope for selection gain for the desirable traits. Seed shattering is one of the challenges facing the domestication and commercialization of the native plant species. Studies are needed to devise plant growth regulation or other agronomic measures for seed production at commercial scale.

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