Developing improved native and tame forage varieties for Western Canada

Project Code: FRG.08.13
Completed: *March 2018*

Project Title:

Development of plant material (grasses, legumes) and mixtures for forage production in the Prairie region

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Published:

- The potential of seven native North American forage Species to suppress weeds through allelopathy.
- RNA-Seq analysis of gene expression for floral development in crested wheatgrass (Agropyron cristatum L.).
- Genotyping-by-sequencing data of 272 crested wheatgrass (Agropyron cristatum) genotypes.
- Genetic Diversity of Northern Wheatgrass (Elymus lanceolatus ssp. lanceolatus) as Revealed by Genotyping-by-Sequencing.
- Agro-morphology and forage nutritive value of white prairie clover (Dalea candida (Michx.) Willd.) populations native to Canadian prairies.
- Drought weakens the positive effects of defoliation on native rhizomatous grasses but enhances the drought-tolerance traits of native caespitose grasses.

Background

Tame forages are generally more productive than native forages under optimal growing conditions. But when grown in the more environmentally challenging conditions they evolved in, native forages tend to outperform tame ones. Researchers in Swift Current have been working on breeding native forages as well as looking into ideal growing conditions for native forages. This project builds on perennial forage breeding research initiated under the first Beef Science Cluster (ERG.01.09).

Objectives

To provide industry with improved forage varieties and a better understanding of native forages.

What they did

This project had several components:

Native forage breeding: Both traditional selection techniques and advanced genomic tools were used to develop improved tame and native forages using plant nurseries and plots established in Lethbridge, Swift Current, Saskatoon and Brandon.

Evaluation of mixtures vs. monocultures: Small (4 x 8 m) plots of five native grasses (bluebunch wheatgrass, nodding brome, western wheatgrass, little bluestem and side oats gramma) and two legumes (purple prairie clover and white prairie clover) were seeded at AAFC Swift Current in 2010. Each grass or clover was seeded on its own (seven monocultures), as well as with each of the other grasses and legumes (21 binary mixtures). No fertilizers or herbicides were used. From 2011 through 2016, the plots were clipped at ground level in early July and late August and assessed for yield, crude protein, acid detergent fiber and neutral detergent fiber levels.

Evaluation of genomic tools for forage breeding: The original intent was to develop genomic tools based on the genomic sequence of crested wheatgrass. However, this sequencing took longer than expected, so proof of concept genomic tools were instead developed using soybean, which was already very well characterized. A computer simulation was performed based on existing data to determine which of the three tested genomic selection models was more accurate and if new technology (function-associated specific trait (FAST) markers) are more informative to genomic selection than genome-wide random SNP markers (what has previously been done).

Weed suppression by native species: Three greenhouse studies were conducted to look at seven different native forages and if they had the ability to suppress dandelion, scentless chamomile, and foxtail barley.

Optimum sainfoin/grass seeding ratios: Two sainfoin cultivars (Melrose and AAC Mountainview) were grown in pure stands and in binary mixtures with three different grass species (crested wheatgrass (AC Goliath), meadow bromegrass (Armada), and hybrid bromegrass (AC Knowles)). The sainfoin and grass mixtures were grown in three seeding ratios to determine optimum seeding rates for each soil zone. The seeding ratios of the mixtures as a percentage of the recommended seeding rates were: 70% sainfoin 30% grass, 50% sainfoin 50% grass, and 30% sainfoin 70% grass. A popular producer mixture of 15% alfalfa and 85% meadow bromegrass were also included as a control. Each mixture was grown under a one-cut system and a two-cut system.

Grazing behavior and condensed tannins in legumes: Seven different tame and native forb species were seeded in small plots in the spring of 2014 in a completely randomize block design with four replications. Researchers evaluated the grazing behavior and preference of beef yearling steers grazing these tame and native forbs at the flowering stage. Researchers also evaluated the extractable condensed tannin concentrations of whole plant portions of the different tame and native forbs at the flowering stage.

What They Learned:

Native forage breeding: This project has developed new breeding lines of purple prairie clover, white prairie clover, northern wheatgrass, side oats grama, bluebunch wheatgrass, winterfat, alfalfa, hybrid brome (S9616, S9478Q, S9478O, S9607, and S9608), three new breeding lines of crested wheatgrass (S9605, S9603, S9611), and three new lines of hybrid wheatgrass (S9600, S9604, S9615). These breeding lines are currently being evaluated in replicated plot trials for forage yield, seed yield and quality. The most promising lines will be further developed as new cultivars in Canada.

Evaluation of mixtures vs. monocultures: Forage mixtures frequently produced greater dry matter than monocultures. Mixtures with western wheatgrass yielded best. Mixtures of cool season and warm season grasses generally produced higher forage yield. Adding little bluestem to the mixture can increase the potential for late-season productivity. These patterns were robust over a wide variety of climate conditions, as this study included both one of the driest and wettest years in the history of the region. No significant differences in forage production was observed when researchers compared the dry to wet year, demonstrating the suitability of native species in a variable climate.

Evaluation of genomic tools for forage breeding: researchers found very little difference in prediction accuracy among the three methods tested, although prediction accuracies were lower for traits with lower heritability. Researchers did find that there would be potential gain in prediction accuracy from the application of FAST SNP markers in molecular breeding Now that this concept has been proven, it can be applied to crested wheatgrass (and other forage species) once their genomic sequences have been established.

Weed suppression by native species: Researchers found that, of the seven native forages tested, western wheatgrass, little bluestem and side-oats grama can reduce the aboveground and belowground growth of weeds.

Optimum sainfoin/grass seeding ratios: Mixtures with hybrid bromegrass yielded highest, followed by crested wheatgrass and then meadow bromegrass. In Swift Current, AAC Mountainview yielded highest. Mixtures with Armada and AC Knowles yielded higher than AC Goliath. At all sites sainfoin monocultures seeded at 100% of the recommended seeding rate yielded similarly to monocultures seeded at 50% of the recommended seeding rate. This means that seeding rate of sainfoin can potentially be reduced by as much as 50% to save on seed costs while maintaining yield.

Grazing behavior and condensed tannins in legumes: Due to poor growing conditions only 3 of the legumes grew well enough to be evaluated for grazing preference, they were cicer milkvetch, Canadian milkvetch, and slender milkvetch, Researchers found no difference in grazing preference. The researchers found no effect of the condensed tannins of purple or white prairie clover on ruminal methane production despite their high concentrations in these forages. Increasing the amount of purple prairie clover in the stand did result in an increase in DM, NDF, and CP, with the greatest effective degradability observed with ratios between 50:50 and 75:25. These results suggest that pastures that contain from 50-75% of PPC in full flower would have the highest nutritive value.

What it Means:

The results from this study are valuable for producers when considering establishing or rejuvenating pastures. They also provide researchers with a path forward to continue breeding and improving native forages.

Proudly Funded By:

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The Beef Cattle Industry Science Cluster is funded by the Beef Cattle Research Council, a division of the Canadian Cattlemen's Association, and Agriculture and Agri-Food Canada to advance research and technology transfer supporting the Canadian beef industry's vision to be recognized as a preferred supplier of healthy, high quality beef, cattle and genetics.

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