

Forage Breeding Update

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Forage crop breeding in Canada

- **Tame**
 - AAFC Saskatoon and U. of Sask. (Bruce Coulman)
 - AAFC Ste-Foy (Réal Michaud)
 - AAFC Lethbridge (Surya Acharya)
 - AAFC Charlottetown (Y. Papadopoulos)
 - Pickseed Canada (Jay Hackney)
- **Native**
 - AAFC Swift Current (Grant McLeod)
 - Alberta Res Vegreville (Jay Woosaree)

Canadian Alfalfa Breeding Programs - Lethbridge

- **Resistance to diseases**
 - **Most recent release is AC Longview, highly resistant to Verticillium wilt**
- **Tolerance to acid and saline soils**
- **Persistence in mixed stands with other legumes and grasses**
 - **Evaluation techniques are not well developed**

Canadian Alfalfa Breeding Programs – Ste-Foy

- **Good track record of developing winter hardy, high yielding varieties**
 - Eg. Apica, AC Caribou
- **Work continues on winter hardiness**
 - Developed techniques for indoor screening which have resulted in significant improvements

Winterhardness of cultivars and selections of alfalfa – Saskatoon, spring, 2005

Cultivar	Hardiness score¹
AC Caribou	3.0
AC Caribou cycle 3	1.9
Evolution	3.1
Evolution cycle 2	2.1
Evolution cycle 4	1.9
Rangelander	2.7

1=no injury; 5=dead

Canadian Alfalfa Breeding Programs – Other

- **Registration and release of AC Yellowhead in 2004**
 - *Medicago falcata*
 - **Yellow flowered, persistent, lower yielding**
 - **Good for long term pasture**

U.S. Alfalfa Breeding Programs

- **Private companies**
 - **New varieties of all dormancy classes**
 - **Multiple disease resistance**
 - **Grazing tolerance**
 - **Leafhopper resistant**
 - **Lower fiber content**

U.S. Alfalfa Breeding Programs

- **Private companies (cont'd)**
 - **Roundup Ready alfalfa**
 - **Hybrid alfalfa**
 - **Dairyland**
 - **Use male sterile gene for hybridization**
 - **Yield advantages have been variable in western Canadian trials**

Roundup Ready Alfalfa

- **Developed by Forage Genetics International (FGI) and Monsanto**
- **Gene from bacteria introduced into alfalfa which gives tolerance to glyphosate**
 - Same gene used in corn, soybean, canola
- **U.S. regulatory approval – June, 2005**
- **Canadian regulatory approval – Sept., 2005**
 - CFIA and Health Canada
 - novel plant safe for food, feed and environment

Roundup Ready Alfalfa

- **First sales in U.S. in August, 2005**
- **No plans to sell in Canada**
 - **No requests made for variety registration nor registration of glyphosate on alfalfa**
 - **Regulatory approval covers possible introduction of hay with adventitious RR alfalfa**
- **Regulatory approval also obtained in Mexico and Japan, as these are markets for U.S. hay**

Present Transgenic Research Relevant to Alfalfa Improvement

- **Development of alfalfa expressing condensed tannins (CTs) in the leaves**
 - **CTs bind to soluble proteins in the rumen**
 - **Alfalfa produces CTs in the seed coat but not in the leaves**
 - **Would be bloat-safe and higher in rumen undegradable protein**
 - **AAFC Saskatoon, Forage Genetics and Noble Foundation**
 - **First lines with low concentrations of CTs have been produced in Saskatoon program**

Present Transgenic Research Relevant to Alfalfa Improvement

- **Reduction of lignin in alfalfa**
 - **Highly indigestible component**
 - **Improve cell wall digestibility**
 - **Collaboration between Noble Foundation, Forage Genetics and USDA Dairy Forage Lab in Wisconsin**
 - **May be the second transgenic alfalfa approved after RR Ready (2012?)**

Red clover (*Trifolium pratense*) breeding

- **Program centred in Charlottetown**
- **Breeding for persistence and high yield**
- **New program to breed for higher concentrations of natural constituents for use as nutraceuticals**

Cicer milkvetch (*Astragalus cicer*) breeding

- **Lethbridge program**
- **Improved seedling vigor and establishment is the main goal**
- **AC Oxley II**
 - **Yield advantage over Oxley**
- **New line being tested in regional trials**

Bromegrass Breeding

Meadow

Hybrid

Smooth

Bromegrass Species

- **Meadow brome (*Bromus riparius*)**
 - pasture type - basal leaves, fast regrowth
 - non creeping
 - $2n = 70$
- **Smooth brome (*Bromus inermis*)**
 - hay type - upright growth, high cut 1 yields
 - creeping
 - $2n = 56$



Meadow bromegrass
Bromus riparius



Smooth brome grass
Bromus inermis

Meadow brome grass breeding

- **Improved seed and forage yield (Saskatoon)**
 - Three lines in regional testing
- **Breeding nurseries in Ste-Foy, Charlottetown**
 - Improve adaptation to eastern Canada
- **Expand genetic base (Saskatoon)**
 - evaluating accessions from world genebanks
- **U.S. breeding programs**
 - Acreage increasing in U.S. – mainly under irrigation
 - Montana and Utah programs

Smooth bromegrass breeding

- **Tiller density and regrowth (Ste-Foy)**
 - Improve yield
 - Improve pasture use
- **Release of AC Rocket**
 - Seed available in 2006
- **Little work on smooth brome in western Canada**
 - More emphasis on meadow and hybrid

Hybrid bromegrass breeding (Saskatoon)

- **Meadow X smooth bromegrass hybrid populations**
- **Dual purpose type of grass**
 - **High first cut yield like smooth**
 - **Fast regrowth like meadow brome**



Hybrid bromegrass
riparius X inermis

Hybrid bromegrass cultivars released from Saskatoon program

- **AC Knowles (2000)**
 - More “meadow-brome like in appearance
 - Seed available since 2004
- **AC Success (2003)**
 - More smooth-brome like in appearance
 - Hybrid backcrossed to smooth
 - Seed available in 2007

Future hybrid brome grass breeding

- **Continue selection in existing populations**
- **Expand adaptation to more humid regions**
 - **New population (S9478) from crosses using “southern” type smooth brome parents**
 - **Evaluated at Saskatoon and Lindsay, ON**
 - **Nurseries in PEI and U.S.**
- **Intercross existing populations**
 - **Four populations have been reselected over many years**
 - **Obtain hybrid vigor**

Orchardgrass (*Dactylis glomerata*) Breeding

- **Good pasture species in more humid areas with milder winters**
- **Winterhardiness is the key breeding goal**
- **Programs at Lethbridge, Saskatoon, Ste-Foy (and Brandon)**

Orchardgrass breeding at Lethbridge

- **Focus on British Columbia and irrigated areas of S. Alberta**
- **Winterhardiness and disease resistance**
- **New varieties resistant to cocksfoot mottle virus**
 - **Major problem in British Columbia**

Other orchardgrass breeding

- **Saskatoon**
 - **“AC Glacier”, a new winterhardy high yielding line, released in 2006.**
- **Brandon**
 - **“AC Killarney” selected for improved persistence and production under grazing released in 2006.**

Timothy (*Phleum pratense*) Breeding

- **Traditional forage grass in eastern Canada**
 - The most widely seeded forage crop
 - Over 1 million kg of seed sold in Québec
- **Use has increased in western Canada**
 - Irrigated and more humid areas
 - Export market for double compressed hay
 - Drought tolerance is limiting factor

Timothy breeding at Ste-Foy

- **Released several new high yielding lines over the past few years**
 - AC Ovation – high yields under irrigation at Outlook, Sk
 - Kara – seed being increased
- **Improve nutritive value**
 - Change ratio of digestible to indigestible fiber
 - Improve quality without yield loss
- **Improve N-use efficiency**
 - More biomass per unit of N

Other timothy breeding

- **Saskatoon**
 - **Program in collaboration with SW Seed**
 - **Select timothy for compressed hay market**
 - **Disease resistant**
 - **Early varieties for irrigation**
 - **Late varieties for dryland**

Crested wheatgrass (*Agropyron cristatum*) breeding

- **Saskatoon program**
- **Release of AC Goliath in 2001**
 - Tetraploid *Agropyron cristatum*
 - Tall, large seeded, narrow crowned
 - Highest yields in regional trials
- **Continue to select in tall tetraploid populations**
- **Preliminary trials of a promising early line from Russia**



Perennial cereal rye (*Secale cereale*) breeding at Lethbridge

- **Perennial version of fall rye**
- **Will persist for several years**
- **Advantage over spring cereals - doesn't have to be planted every year**
- **Productive for silage or grazing under irrigation**

Perennial cereal rye

- **First variety released in 2002 – ACE-1**
- **Being evaluated more widely under dryland areas of western Canada**
 - **Persisted under drought at Saskatoon from 2001 – 2003**
- **Other breeding objectives include forage and seed yield and grazing tolerance**

Native grass breeding

- **Has focused on the development of ecological varieties (Ecovars™)**
 - **Are genetically diverse seed sources adapted to western Canada**
- **Collaborative program between Ducks Unlimited Canada and Agriculture and Agri-Food Canada**

Native grass breeding

- **Ecovars available**
 - Taylor little bluestem (*Shizachyrium scoparium*)
 - AC Pintail awned wheatgrass (*Agropyron subsecundum*)
 - AC Sprig awned wheatgrass
 - AC Mallard green needle grass (*Stipa viridula*)
 - AC Sharptail needle and thread grass (*Stipa comata*)
 - AC Polar northern wheatgrass (*Elymus lanceolatus*)
 - W.R. Poole western wheatgrass (*Elytrigia smithii*)

Ecovars – Recent releases from Saskatoon

- **AC Marten nodding brome (*Bromus porteri*)**
- **AC Marmot richardsons brome (*B. richardsonii*)**
- **AC Fisher fringed brome (*B. cilatus*)**
- **AC Lamour purple prairie clover (*Petalostemum purpureum*)**
- **Several others under development in Swift Current, Saskatoon and Kamloops**

Summary

- **Several active Canadian breeding programs are releasing tame forage varieties on a regular basis**
- **Many alfalfa varieties being released by private U.S. breeding companies**
- **More ecovars to be released over next five years**