An Ultra-Early Wheat Seeding System

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Scott Field Day – July 11, 2018
Outline

• Background – Why an Ultra-early wheat seeding system?
• Project description
  – Experiments completed and currently underway
• Preliminary results
• Future directions
  – Experiments being initiated in 2017
Background

• What is the optimum soil temperature?
  – Alberta Agriculture and Forestry indicates 20° C ([http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex1203](http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex1203))
  – Most studies and crop insurance refer to dates over soil temperature ie. By May 10th for cereals
  – In recent years, there is opportunity to get on land earlier, a trend we expect to continue.
  – Growing degree day requirements are increasing for wheat ie. Longer days to maturity for new higher yielding varieties
Background
Climate Change = Net Positive for Prairies

Potential changes (%) in national cereal yields to 2080 compared to 1990, under the HadCM3 SRES A1F1 with and without CO2. Source: (Parry et al. 2004)
Background

• Increase in atmospheric $\text{CO}_2$.  
  – Increases plant efficiency.

• Temperature increase.  
  – Earlier planting windows  
  – Warmer, drier summers  
  – Effects on grain filling period

• New Genetics (hybrid wheat?) will need to be coupled with progressive agronomy mgmt
Contributions to Yield = Variety + Agronomy + Environment

Y = V + A + Env

The Synergy of GxExM

Y = G x E x M

- Plant Breeding Genotype Phenotype
- Physiology Disease and Pest Resistance
- Growing Degree Days Photoperiod
- Soil type, texture, pH, min. rate, OM
- Integrated Disease, Weed, and Insect Mgmt
- Soil Mgmt Integrated Nutrient Mgmt

- Genomics Cell & Molecular Biology
- Grain chemistry and crop quality
- Lat:Long postion, Frost-free days
- Precip, temp., Rel Humidity, Evaporati on
- Crop Mgmt: Pre-Plant Seeding, In-Crop, Harvest
- Equip Tech, Precision Ag, Big Data, Robotics

Growing Degree Days

Photoperiod

Soil type, texture, pH, min. rate, OM

Integrated Disease, Weed, and Insect Mgmt

Soil Mgmt Integrated Nutrient Mgmt

Genomics Cell & Molecular Biology

Grain chemistry and crop quality

Lat:Long postion, Frost-free days

Precip, temp., Rel Humidity, Evaporati on

Crop Mgmt: Pre-Plant Seeding, In-Crop, Harvest

Equip Tech, Precision Ag, Big Data, Robotics

‘The main drivers of FY progress is the adoption of steadily improving technologies such as new varieties, and new management methods.’
Fischer, Byerlee, and Edmeades evaluated world-wide trends in yield to conclude:

- Rate of farm yield increased on the average of 0.3% per year
- Potential yield increased at 0.6% per year (no difference between dry vs humid climates or spring vs winter wheat)
- Average yield gap was 48%
- Yield gaps appear to be closing slowly
- Increase potential yield by increasing grain number, harvest index, increased grain weight, and total dry matter

Source: Dr. Jerry Hatfield- USDA
The Yield Gap

• What can we adjust in our wheat system to shrink the yield gap?
  – Potential benefits of early seeding:
    • Capturing early moisture
    • Avoiding excessive heat during grain fill
    • Increased accumulation of GDD → increased yield and increased yield stability.
    • Resource & labour management
    • Earlier maturity
  – Risks:
    • Poor stand establishment/Crop loss to freezing
Project Description

• Hypothesis:
  – Early plantings of a cold tolerant variety + optimum agronomics = extended growing season to improve attainable spring wheat yield & system stability.
Project Description - Objectives

1) Determine feasibility & risks associated with early planting & cold soils

2) Understand differential responses between cold tolerance trait vs. conv genetics + cultural practices

3) Develop a breeding tool that improves the rapid deployment of qualitative genes in to winter wheat.
Project Description – Timelines

1) Proposal submitted to Ag Funding Consortium in 2013 – Approved in 2014

2) 2014: Development of CT lines and development of winter wheat breeding tool.
   Status: completed

3) 2015: Initiation of Objectives 1 and 2 field studies
   Status: Ongoing through 2017 field season to 31 March 2018
Development of Cold Tolerant Lines

CT #1                  CT #2             CT #3              AC Stettler

Seeded in Edmonton March 29, 2016
Photo: July 26, 2016
Project Description - Methodology

Locations: Dawson Creek, BC; Edmonton, Lethbridge, AB; Scott, SK

Objective 1 Treatments:

• **Factor 1: Cultivars (4):**
  1. LQ1282A
  2. LQ1299A
  3. LQ1315A
  4. Check cultivar – Stettler
  5. Check cultivar – Conquer VB – **Only at Lethbridge**

• **Factor 2: Soil Temp (6):**
  1. March 1 (or when soil temp in top 5 cm = 0°C)
  2. March 15 (or when soil temp in top 5 cm = 2°C)
  3. March 29 (or when soil temp in top 5 cm = 4°C)
  4. April 11 (or when soil temp in top 5 cm = 6°C)
  5. April 25 (or when soil temp in top 5 cm = 8°C)
  6. May 10 (or when soil temp in top 5 cm = 10°C)
Preliminary Results

Group I: High mean, low variability
Group II: High mean, high variability
Group III: Low mean, high variability
Group IV: Low mean, low variability

Label:
cultivar_soil temp
Stet: Stettler
Numbered line = cold tolerant trait
Project Description - Methodology

- **Objective 2 Treatments:**
- **Factor 1: Seeding Rate (2):**
  1. 200 seeds m\(^{-2}\)
  2. 400 seeds m\(^{-2}\)
- **Factor 2: Cultivar (2):**
  1. LQ1315A
  2. LQ1299A
- **Factor 3: Seed Depth (2):**
  1. 2.5cm depth
  2. 5cm depth
- **Factor 4: Soil Temp (4):**
  1. March 15 (or when soil temp in top 5 cm = 0 – 3° C)
  2. April 7 (or when soil temp in top 5 cm = 5° C)
  3. April 28 (or when soil temp in top 5 cm = 7.5° C)
  4. May 10 (or when soil temp in top 5 cm = 10° C)
Feb 16th 2016 – Planting Cold Tolerant Wheat Study

G = Cold tolerant spring wheat lines
E = Plantings in cold soils starting with 0°C, replicated in 3 soil zones over 3 Calendar years
M = Sowing density x seed placement depth effects

Soil Temp in top 5cm = 0.3°C
Preliminary Results – Cold Tolerant Trait Only – Soil Temperature

Grain Yield (Mg ha\textsuperscript{-1})

LQ1299A

LQ1315A

Grain Yield (Mg ha\textsuperscript{-1})

CV (%)

lsr = thin stand - 200 srate
hsr = optimal stand - 400 srate
ssd = shallow - 2.5 sdepth
dsd = deep - 5 sdepth

Group I: High mean, low variability
Group II: High mean, high variability
Group III: Low mean, high variability
Group IV: Low mean, low variability
Preliminary Results

Spring wheat grain yield response to soil temperature at planting, averaged over cold tolerance & conventional trait lines.

Blue line = 2.5 cm sowing depth; red line = 5 cm sowing depth.
Preliminary Summary

- Cold tolerant lines and check cultivars have performed well relatively.
  - No penalty for early seeding of CT or check varieties
- Greatest yield observed seeding at soil temps of 2-6°C.
  - No penalty for seeding at 2°C.
- Higher seeding rates have increased yield potential and stability.
- Seeding ultra-early has potential...
- Training of Graduate Students
Future Directions

• Development of best management practices for implementation of an ultra-early wheat seeding system.

Seeded March 29, Edmonton, AB – Photo April 19
Future Directions

• Future Projects to be initiated in 2017:
  – Evaluate the use of fall applied residual herbicides in an ultra-early wheat seeding system.
    • Crop tolerance
    • Increased competitive ability
    • Reduced in-crop herbicide requirement
    • Resistance management tool
Future Directions

• Future Projects to be initiated in 2017:
  – Evaluate the use of nitrogen stabilizers in an ultra-early wheat seeding system.
  – Evaluate CT lines in conjunction with common commercial varieties to determine currently available varieties genetically predisposed to ultra-early seeding.
    • (Combinations of VRN and PPD genes conducive to cold tolerance and acclimation).
Time For A Made In Canada Agronomy Expert Working Group
#AgronomyInstituteofCanada
Call For Agronomy EWG ‘Experts’

- **Who should join the Agronomy EWG?**
  - Agronomists, soil & crop scientists
  - **Cross-disciplines:** IPM scientists (weed, pathology, entomology); Physiologists; crop modellers/remote sensing/digital agriculture (big data) scientists; wheat breeders; economists; statisticians
  - **Others:** social scientists, policy analysts, stakeholders
The bad old days....

G x E

Molecular biology
Plant cell biology
Crop physiology

Genetics
Plant breeding
Seed developers

E x M

Farmers
Consultants
Input resellers

Agronomy
Farming systems

Slide courtesy of Dr. John Kirkegaard
A better way....

- Not which has delivered more, but how to identify best synergies
- What traits will suit the systems of the future (not just the climate)?
- What systems are needed to capitalise on new traits?
Exhibit C: Linkage of ‘G’ x ‘M’ to Overcome ‘E’

Source: Dr. Jerry Hatfield- USDA
Thank-you, Funding Partners!
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