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An Ultra-Early Wheat Seeding System

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Scott Field Day – July 11, 2018

Outline

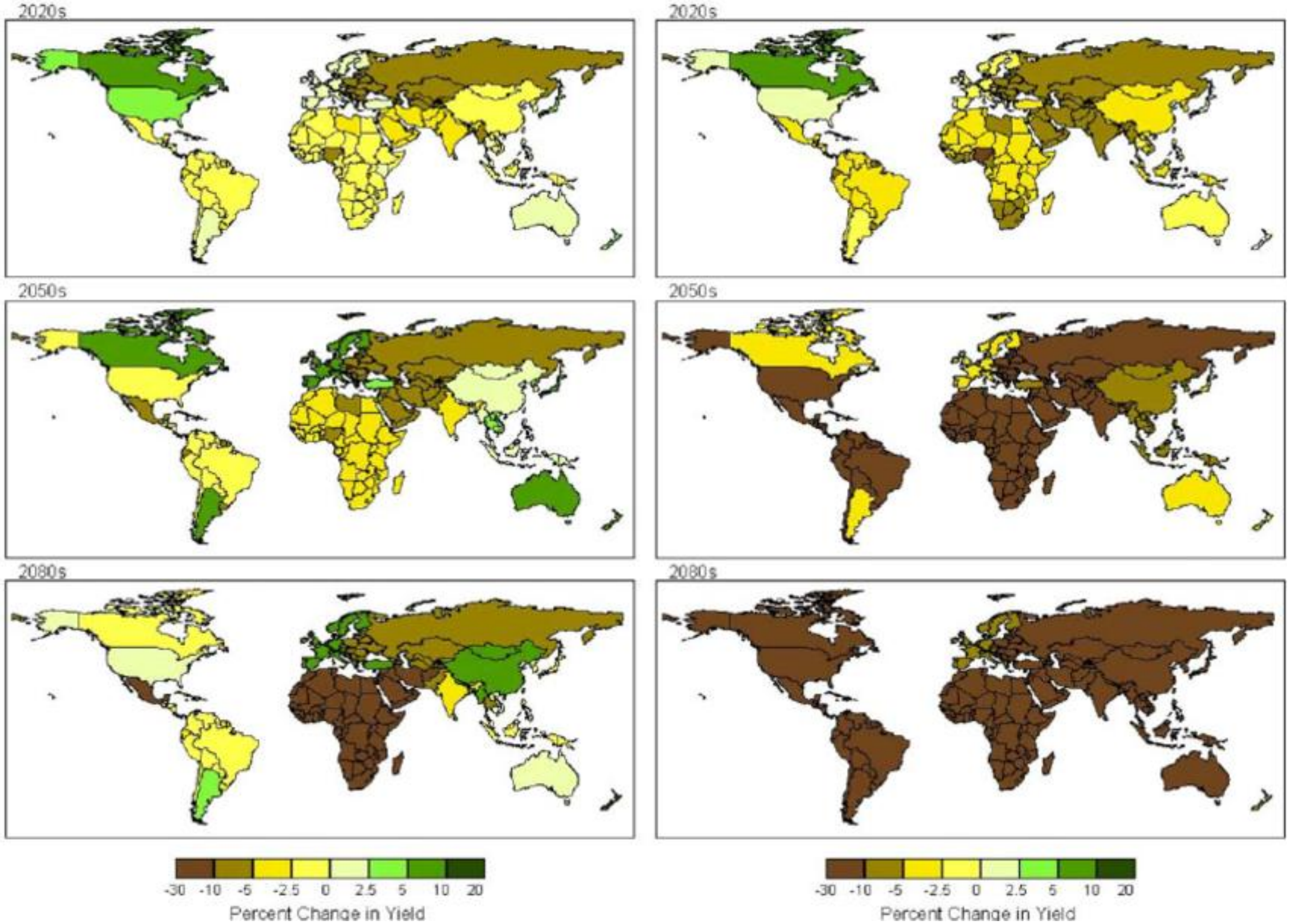
- Background – Why an Ultra-early wheat seeding system?
- Project description
  - Experiments completed and currently underway
- Preliminary results
- Future directions
  - Experiments being initiated in 2017

Background

- What is the optimum soil temperature?
  - Alberta Agriculture and Forestry indicates 20^{o} C (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

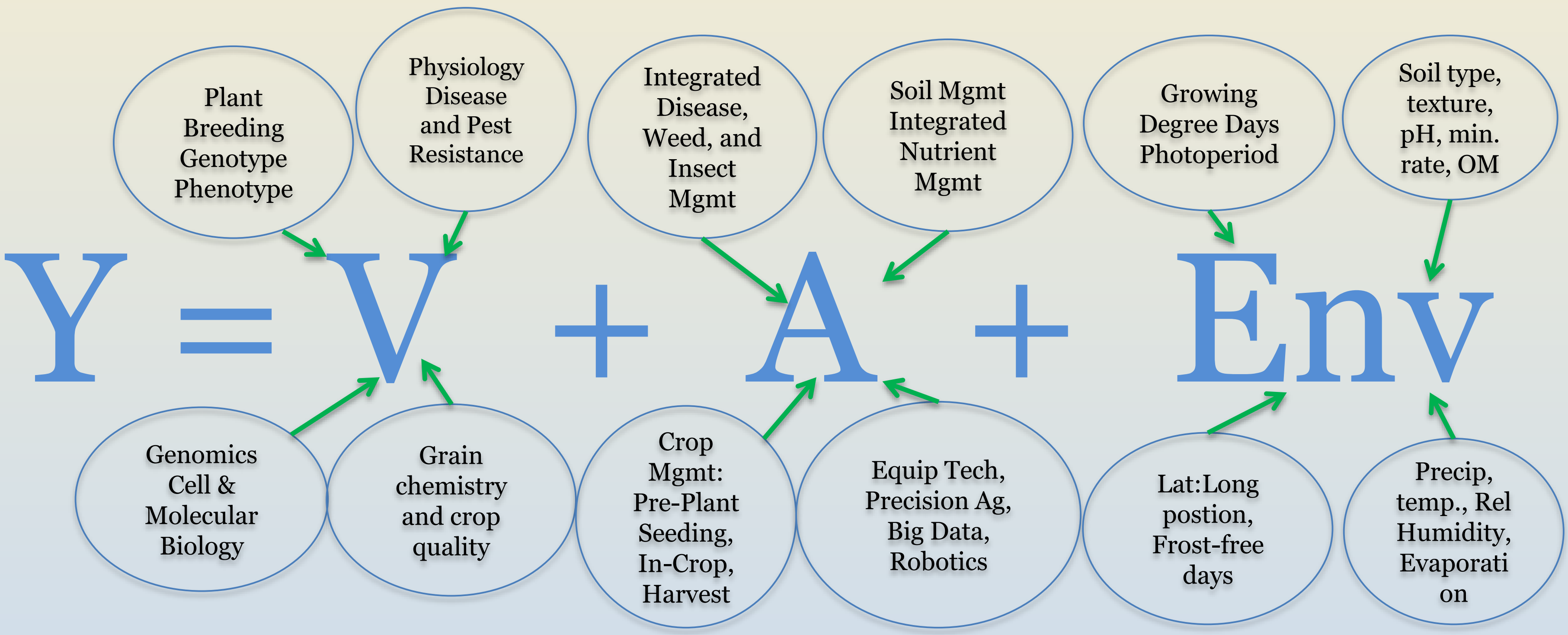


Potential changes (%) in national cereal yields to 2080 compared to 1990, under the HadCM3 SRES A1F1 with and without CO2. Source: (Parry et al. 2004)

Background

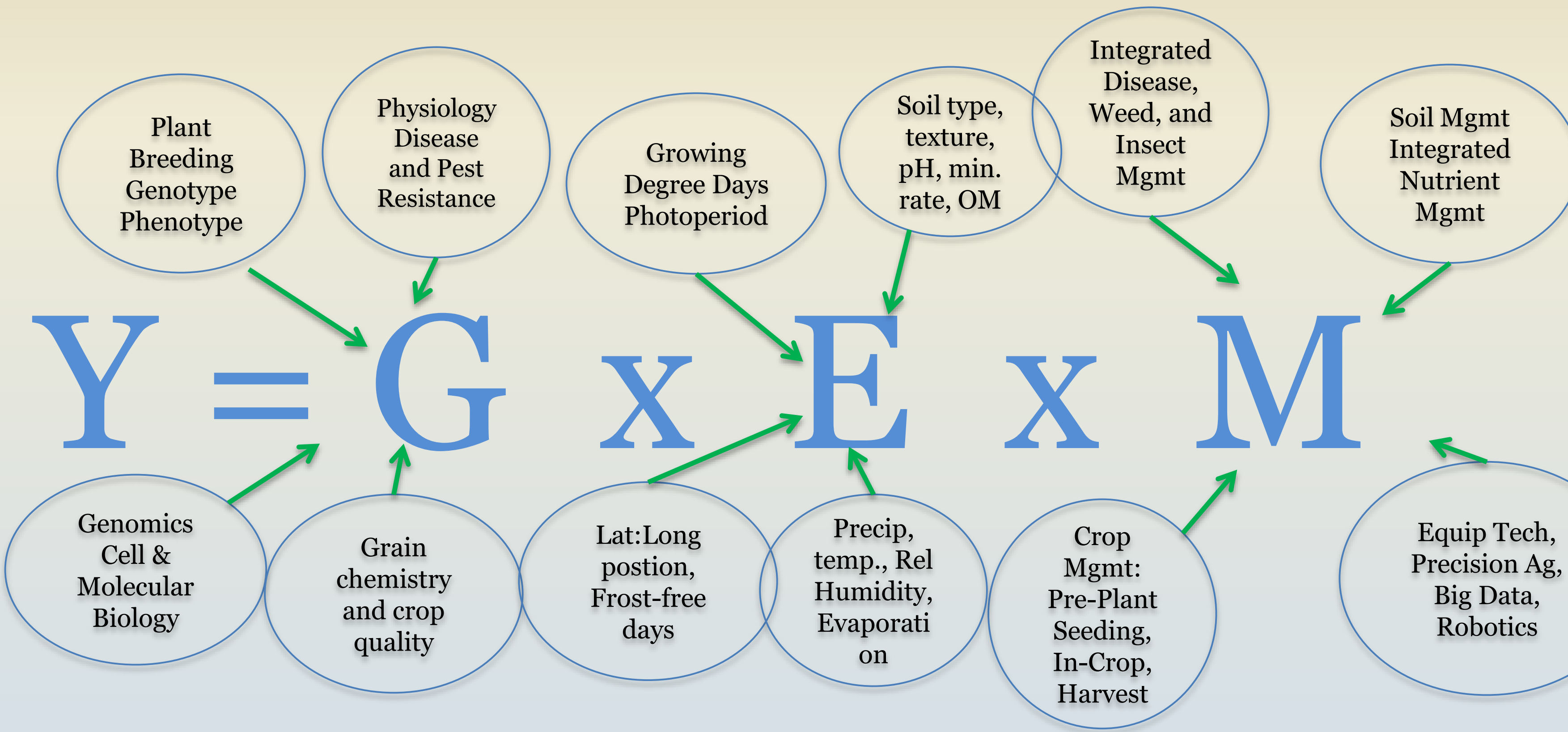
- Increase in atmospheric $C0_2$.
  - Increases plant efficiency.
- Temperature increase.
  - Earlier planting windows
  - Warmer, drier summers
  - Effects on grain filling period
- New Genetics (hybrid wheat?) will need to be coupled with progressive agronomy mgmt

Contributions to
Yield = Variety + Agronomy + Environment



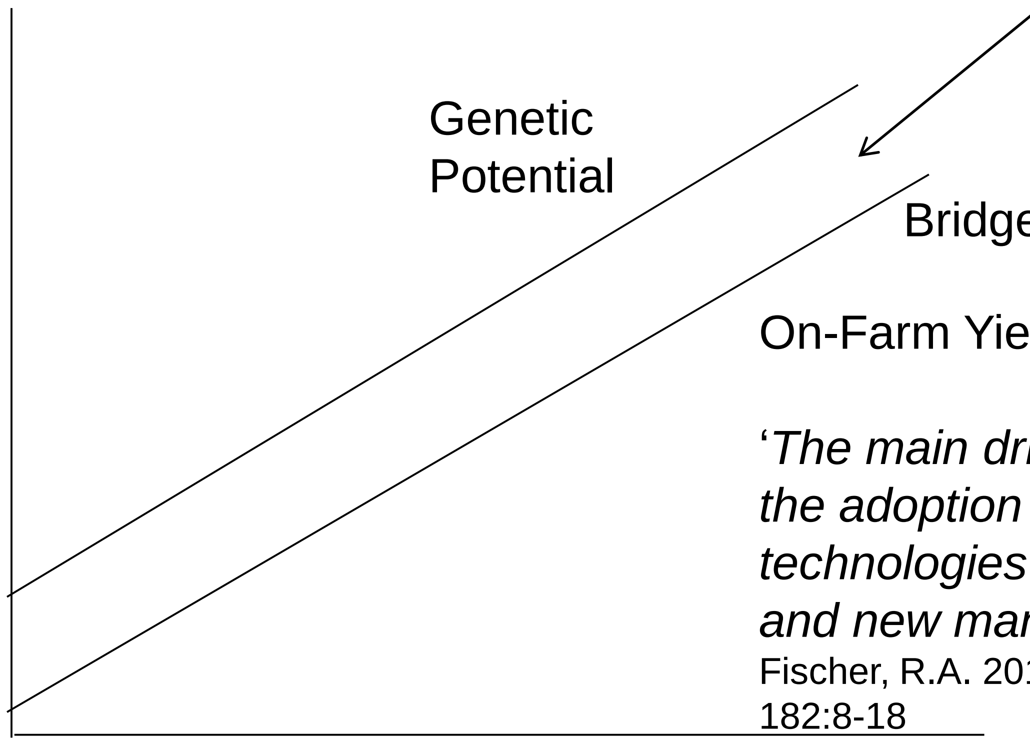
Beres et al. 2016. Integrated Crop Management of Wheat Chapter 28. Pages 112-119 In Langridge, P, . (ed). Achieving Sustainable Wheat Production. Burleigh Dodds, Oxfordshire, UK.

The Synergy of GxExM



The Yield Gap

How Big is the Exploitable and Attainable Yield Gap?



'*The main drivers of FY progress is the adoption of steadily improving technologies such as new varieties, and new management methods.*'
Fischer, R.A. 2015. Field Crops Research. 182:8-18

The gap that exists between genetic potential and grain yield achieved at the farm gate. (Beres et al. 2016. Integrated Crop Management of Wheat Chapter 28. Pages 112-119 In Langridge, P, . (ed). Achieving Sustainable Wheat Production. Burleigh Dodds, Oxfordshire, UK.)

Global Trends - Wheat

- 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

Project Description - Methodology

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

Objective 1 Treatments:

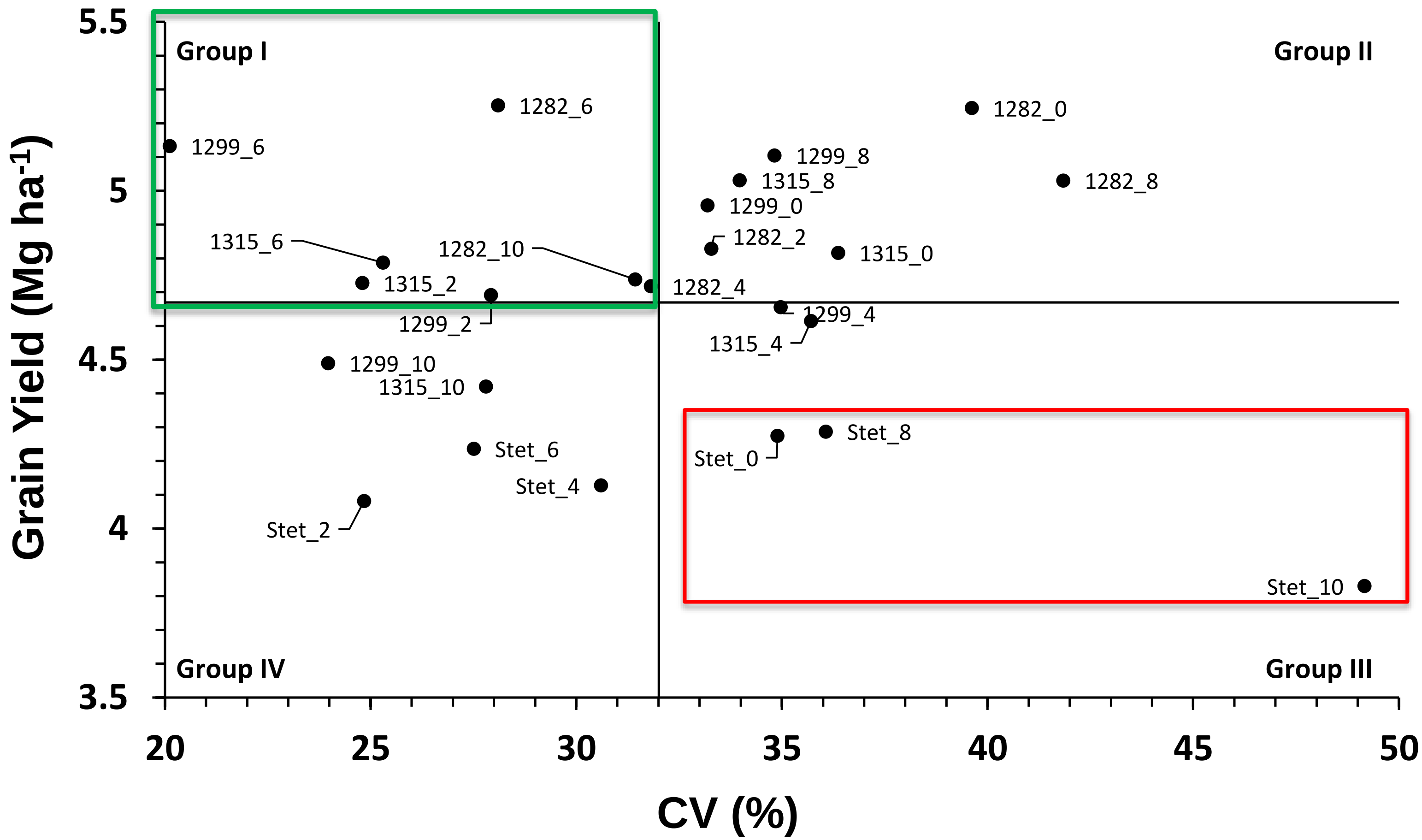
- **Factor 1: Cultivars (4):**

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



Label:
cultivar_soil temp
Stet: Stettler
Numbered line = cold tolerant trait

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

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

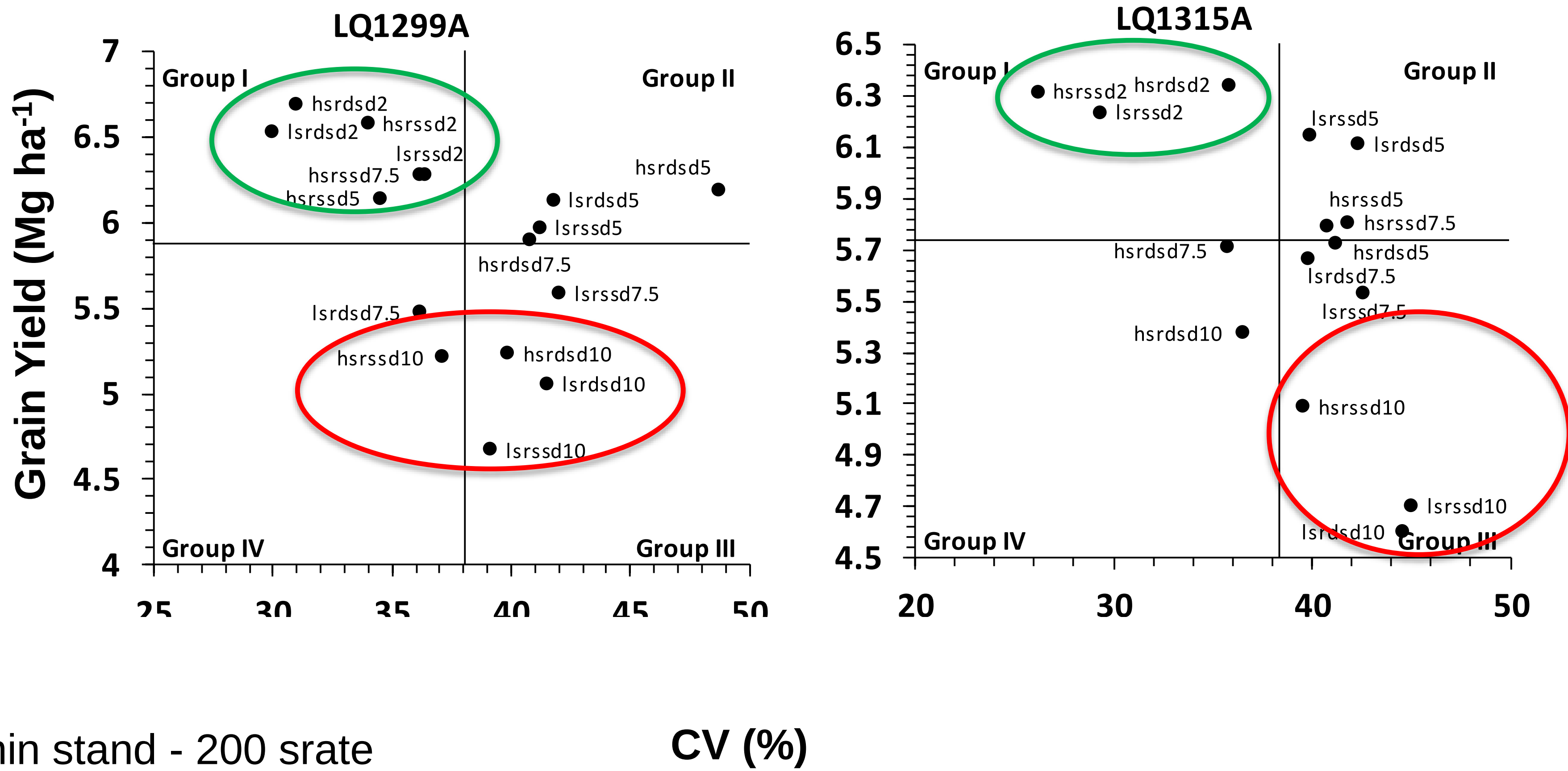
G = Cold tolerant spring wheat lines

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

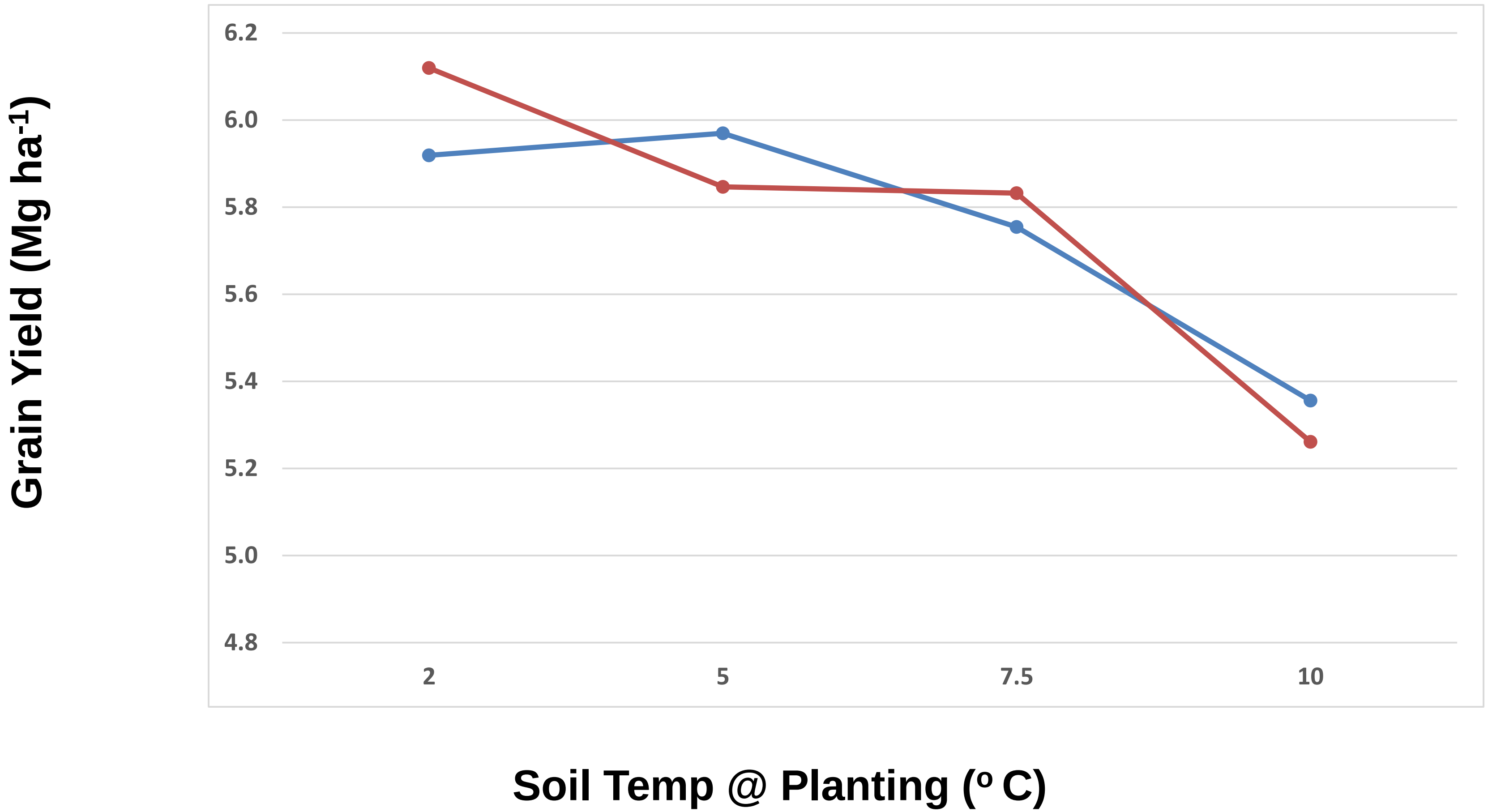
Preliminary Results – Cold Tolerant Trait Only – Soil Temperature



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 = 5cm 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^{o}C.
  - No penalty for seeding at 2^{o}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).

Agronomy Plots. AAFC-Lethbridge, AB CANADA

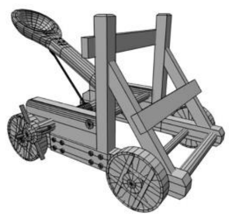
Call For Agronomy EWG ‘Experts’

- **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....

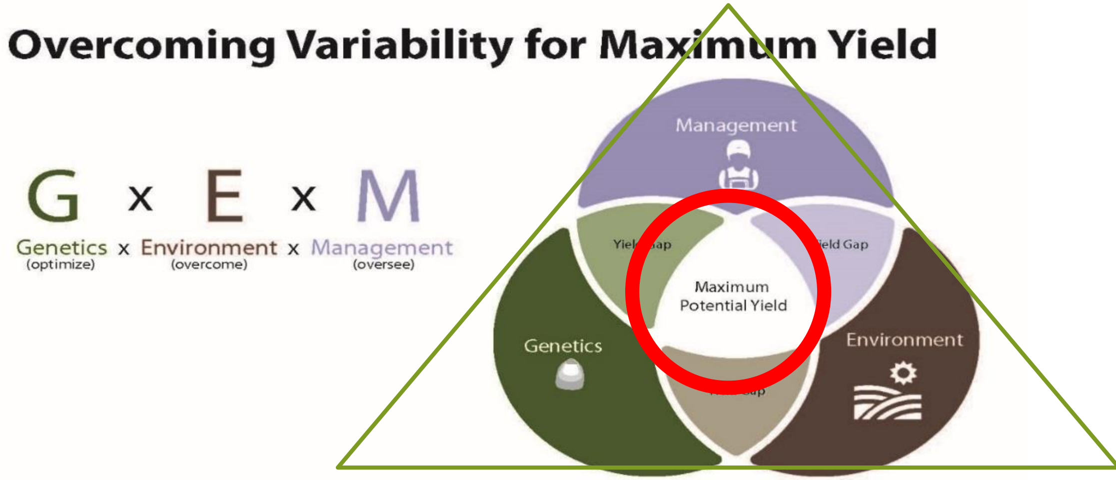
G x E x M

Molecular biology
Plant cell biology
Crop physiology

Farmers
Consultants
Input resellers

- *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’ ⇧ Sweet Spot in Yield Triangle



Source: Dr. Jerry Hatfield- USDA

Thank-you, Funding Partners!
AWC, WGRF and Ab Innovates

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