Evaluating the effects of plant growth regulators and biostimulants in corn to improve germination and yield

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Creative Component

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Overview

- Acknowledgements
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- Introduction
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- Conclusions

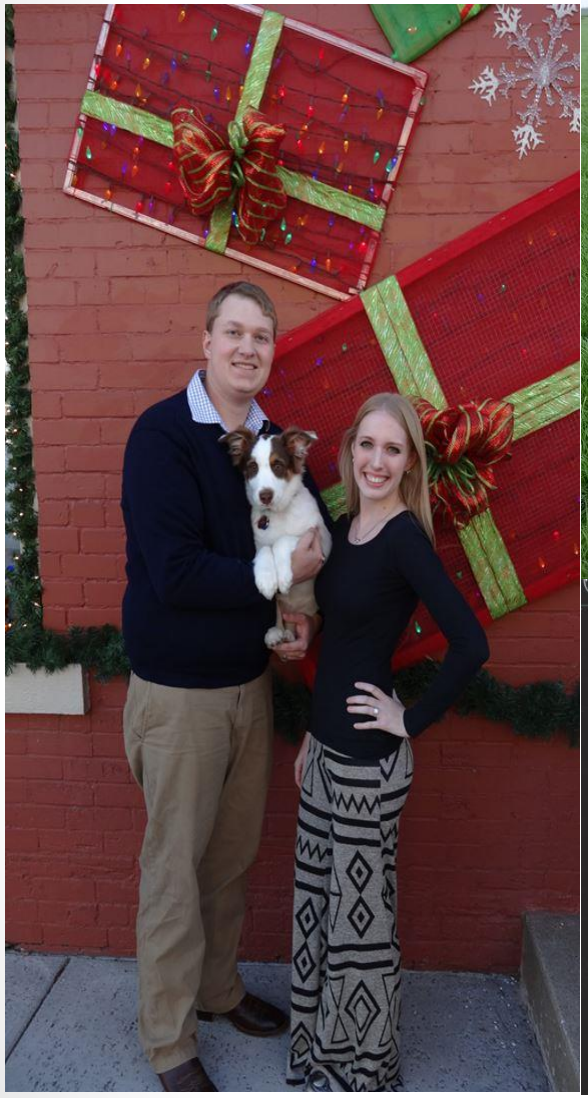
Acknowledgements

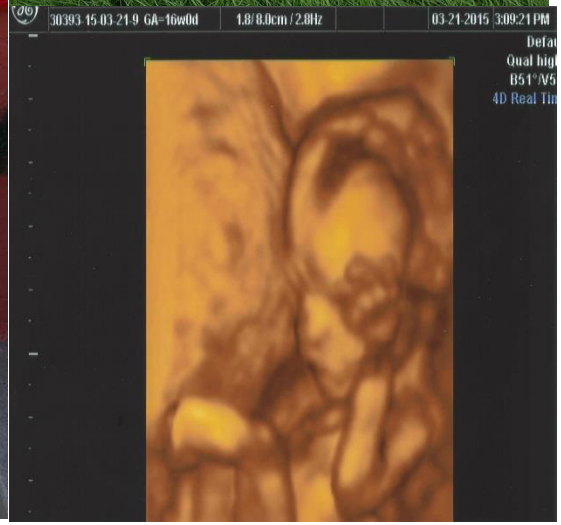
- Family
- Major Professor: Dr. Andrew Lenssen
- Program of Study Committee
  - Dr. Ken Moore
  - Dr. Tom Loynachan
- Dawn Miller
- Colleagues at WinField Solutions
  - Steve Anthofer
  - John Kinnard
  - Laura Henneman
  - Coworkers
- MS Agronomy faculty and staff

Background

- Born in Amarillo, TX
- Raised in Plainview, TX
- Graduate of Texas Tech University – Lubbock, TX
  - B.S. Environmental Crop and Soil Sciences – December 2011
- Started MS Agronomy Program at ISU in Fall 2012
- Live in Hurst, TX

Family

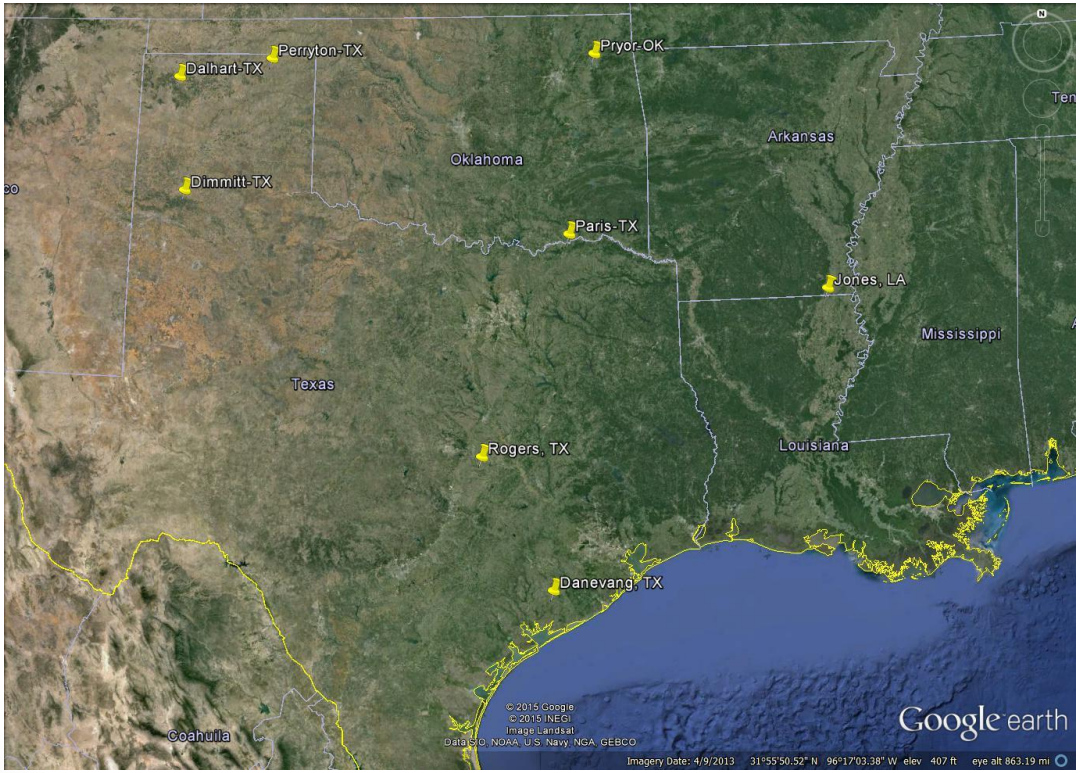




- My wife, Hailey Owens
  - Married July 2011
- Abbie – Mini Australian Shepherd
- 1st baby due Sept 5th

Career

- 2012-Present: Answer Plot Research Manager – WinField Solutions, LLC, a Land O' Lakes Company
  - Responsible for 8 corn and soybean research locations throughout TX, OK, and LA



Project Introduction

- Today's farmers are on a quest for higher yields
- Farmers are planting earlier each year
  - Average corn planting date in Iowa
    - 1975-1979: May 10
    - 2006: April 25th
- Planting early is not always best as conditions may be too wet, too dry or too cool for optimal emergence

Project Introduction

- Consequences of planting in poor conditions reduce emergence and create poor stands
- When gaps or clumps are present increase spacing variability which decreases yields
- Non-uniform stands result in lower yields

Project Introduction

- Seed costs are increasing every year
  - Average Seed Cost in 2014: $120/acre (Bt, RR) [1]
  - Average Seed Cost in 2005: $39/acre[1]
- Seed is such a large investment for growers in today's agriculture that it is extremely important to protect the seed investment

[1]TAMU Extension Corn Budgets

Introduction

- Biologicals or Yield Enhancers
  - Used to enhance yields and plant growth by improving overall plant health and productivity.
  - Products in this category:
    - Plant Growth Regulators (PGRs)
    - Biostimulants
    - Inoculants
    - Biopesticides

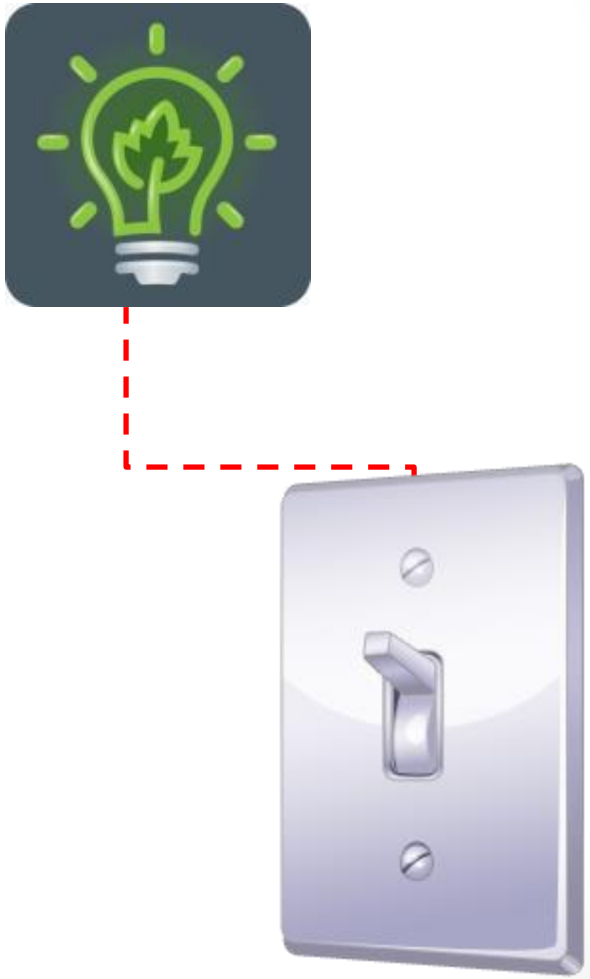
Introduction

- Many agricultural companies are making investments
  - Acquisitions of companies by Bayer CropScience and BASF
  - In 2012, Monsanto invested $29-million in biologicals
  - Products in this space are expected to grow 15-20% in market share over the next 5 years
- Follow the money….
  - Sales of just PGRs in 1987 were $430 million
  - 2012 PGR sales $3,360 million
  - 2019 expected PGR sales $5,936.2 million

(Transparency Market Research, 2014)

Introduction

- What are plant growth regulators?
  - Plant growth regulators (PGRs) are synthetic plant hormones.
  - Hormones are used within the plant for communication between cells to coordinate growth and development.
  - Turns the lights on in the plant.



Introduction

- 5 Main Categories of PGRs
  - Senescence down-regulated genes – stimulate germination and growth of seeds
    - Auxins – indoleacetic acid (IAA), indolebutanoic acid (IBA)
    - Gibberellins – gibberellic acid (GA)
    - Cytokinins – kinetin
  - Senescence associated genes
    - Ethylene/Ethylene releasers – ethylene, ethephon
    - Inhibitors/Retardants – abscisic acid (ABA)

Introduction

- Auxins
- Effects
  - Promote cell enlargement and division
  - Differentiation of vascular tissue, i.e. forming xylem and phloem
  - Apical Dominance
  - Delays leaf senescence
  - Assimilate Partitioning
  - Root Initiation
    - Secondary Root Formation
  - Development of Buds, Flowers and Fruit
  - Legumes
    - Increased Nodulation
    - Increased Leghemoglobin Content (Protein that causes the red color)
    - Increased Nodule Nitrogen Content
    - Increased the Enzymes of Nitrogen Assimilation

Introduction

- Gibberellins
  - Over 120 types of GA identified.
- Effects
  - Stimulate cell elongation and division
  - Stimulation of shoot elongation
  - Critical for seed germination
    - Convert the stored starches in the seed into food for the embryo. Turns on the RNA and DNA
  - Overrides stress proteins.
  - Delays leaf and fruit senescence's

Introduction

- Cytokinins (Kinetins)
- Effects
  - Necessary for cell division
  - Promotes primary root growth
  - Stimulate growth of the main plant stem
  - Promotes primary root growth
  - Help plants withstand water stress
  - Leaf expansion

Introduction

- Biostimulants
  - Enhance a plant's physiological or biochemical processes
- Categories
  - Seaweed extracts
  - Microbial inoculants
  - Humic substances
  - Fulvic acids
  - Amino acids

Introduction

- Humic Substances
  - Naturally occurring in most soils
  - Largest component of soil organic matter
  - Organic compounds formed by decomposition of residues.
  - Have auxin-like properties
- Effects
  - Root hair formation
  - Lateral root development
  - Respiration
  - Protein synthesis
  - Enzyme activity

Introduction

- Complex Polymeric Polyhydroxy Acids (CPPA)
  - Type of PGR that contains highly plant-active compounds from natural soil organic matter
- Effects
  - Enhance plant growth
    - Increasing root and shoot growth
  - Aid plants in moderating moisture and salt stress
  - Hormone-like activity that affects gene expression
  - Helps plants combat against abiotic stresses

Introduction

- With all these different types of products on the market, will any of them help meet farmers pursue higher yields?
  - This project is an opportunity to evaluate the use and combination of PGRs
    - Evaluate stand recruitment
    - Stand uniformity
    - Root:Shoot ratios
    - Total plant biomass
    - Corn grain yield

Materials and Methods

- 4 potentially yield enhancing PGR treatments were evaluated.

Treatment Entry Number	Description
1	Ascend SL
2	Ascend SL + Zurance
3	AGM 14008
4	AGM 14007
5	Untreated control

Materials and Methods

- Explanation of treatments
  - Ascend SL – an EPA registered PGR that contains Gibberellins, Auxins and Cytokinins
  - AGM 14007 – contains Ascend SL + the amino acid proline
  - AGM 14008 – contains Ascend SL + proline and glycine betaine (GB)
  - Zurance – a CPPA product

Materials and Methods

- Explanation of treatments (cont.)
- AGM 14007 (Proline):
  - Proline – beneficial to plants under osmotic stresses
    - Accumulates in plants under dehydration to improve water retention and prevent dehydration.
    - Yield enhancement product that doesn’t necessarily improve root or shoot growth.
- AGM 14008 (Proline + GB)
  - GB also accumulates in plants in response to environmental stress.
    - Helps mediate osmotic adjustment of plants under stressful conditions.

Experimental Design

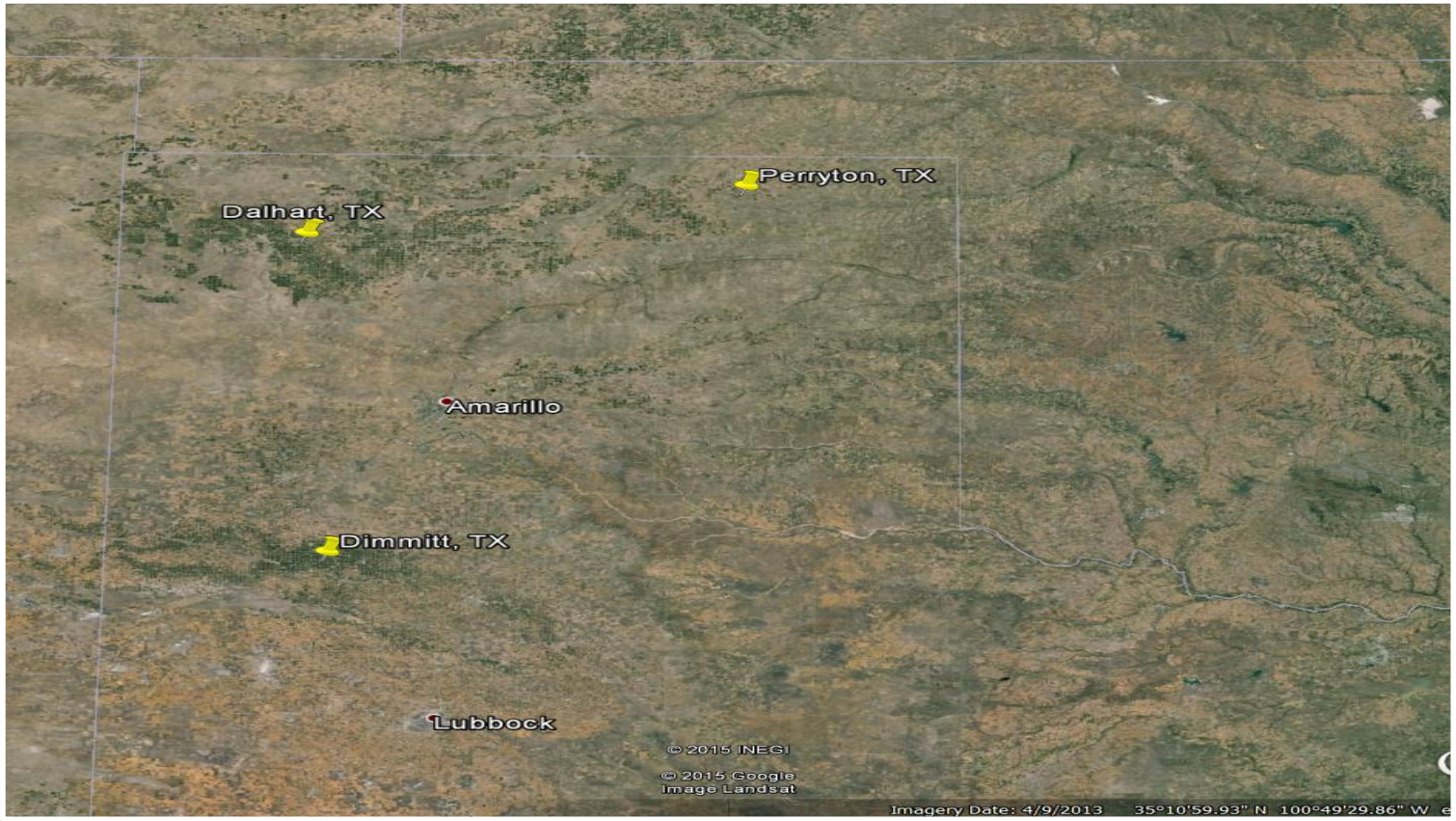
- Randomized complete block design with 4 replications of the four experimental PGR treatments and an untreated check
- Each location used a separate randomization
- Plot parameters
  - Individual plots were 4 rows that were 10 ft. × 27.5 ft.
  - Yield data collected on center two rows at Dalhart and Perryton
  - Yield data collected on rows 1 and 2 at Dimmitt
  - Root:Shoot data was taken on non-yield data rows

Planting

- Planted with a 2007 Dynamic Disk Wintersteiger Planter
- 38,000 planting population
- 30” row spacing
- Croplan ® 6640VT3P was used across all treatments and locations as the hybrid

Materials and Methods

- Experiment conducted in 2014 at 3 WinField Answer Plot research locations



Location Summary

Location	Tillage	Soil Type	Fertilizer Program	Texture and Drainage	Soil pH
Dalhart	Strip-till	Gruver loam 0-1% slope	February Strip-till of 160N-105P_2O_5 -50-K_2O – 34S June - 100N	Fine, well drained	8.1
Dimmitt	Tandem Disk	Olton Clay Loam 0-3%	Fall 150N-100P_2O_5 -50-K_2O – 5S- 15 Zn June – 150N	Fine, well drained	8.1
Perryton	Strip-Till	Sherm Clay Loam 0-1%	February Strip-till of 156N-90P_2O_5 -30-K_2O – 20S June - 153N	Fine, well drained	8.0

Data Collection

- Stand Data
  - Count every plant that is in the 2 harvest rows at the V4 time frame
- Root:Shoot ratios and plant biomass were collected at V4
  - Obtained 2 plants from the non-harvest rows of each plot
  - Removed plants from soil and washed off any loose soil with water
  - Blotted plants with paper towel to remove free surface moisture
  - Separated the root from the shoot by cutting at soil line
  - Weigh and record the root and shoot for each plant
  - Calculate the root to shoot as fresh wt. (g)/shoot fresh wt. (g)

Harvest Data Collection

- Collected with a Wintersteiger Split Grain Combine equipped with Harvest Master ™ Grain Gauge
- Harvested when grain had dried down to 18% moisture
- Combine collected
  - Moisture
  - Test weight
  - Raw yield

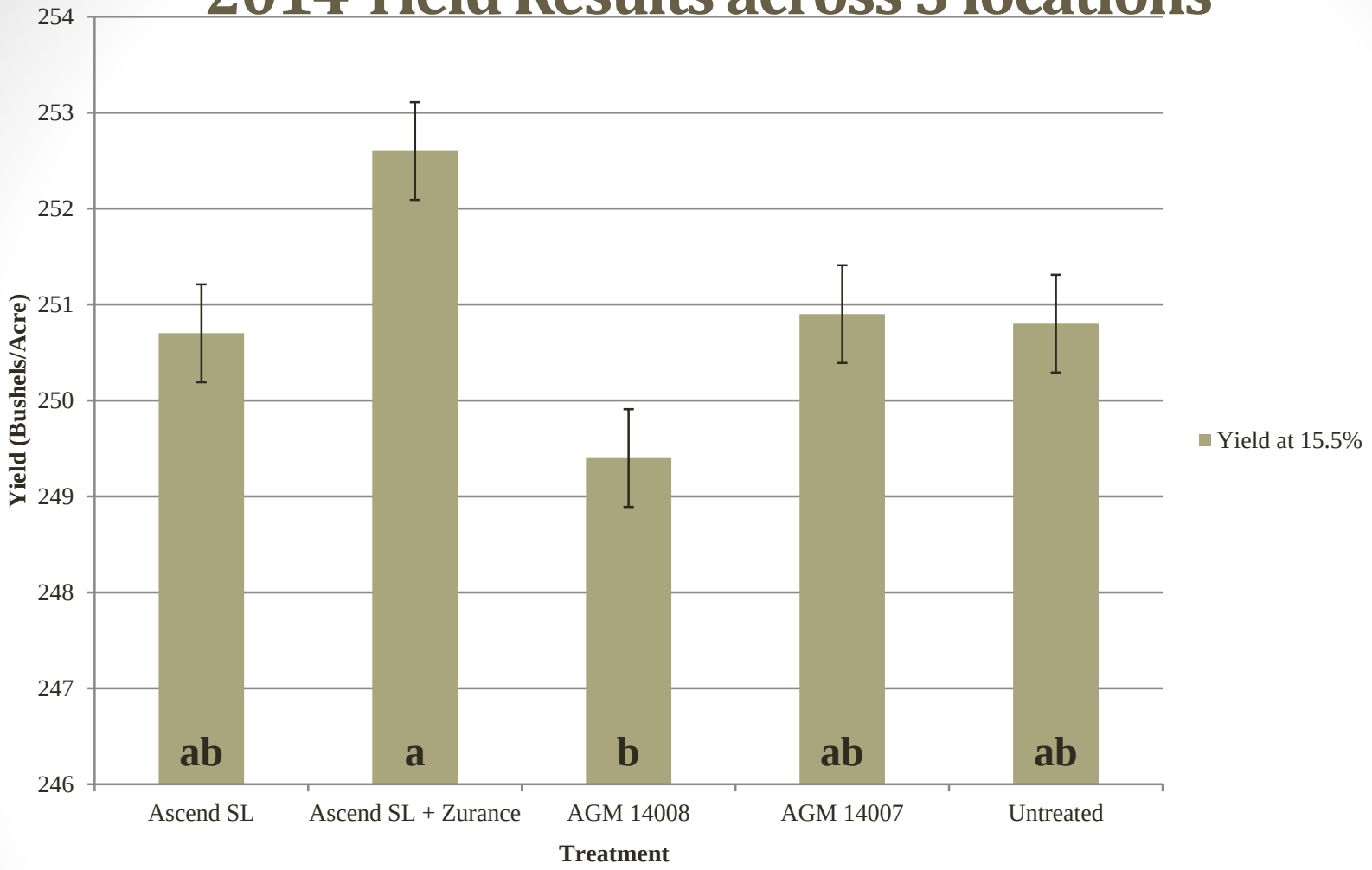
Data Analysis

- All data were analyzed and interpreted using PRISM 2012
  - Used standard ANOVA principles
  - Analyzed as a RCBD experimental design
- Yield was adjusted to 15.5% grain moisture content
- Root:Shoot ratio and total biomass were natural log transformed prior to analysis to normalize variance components

Results and Discussion

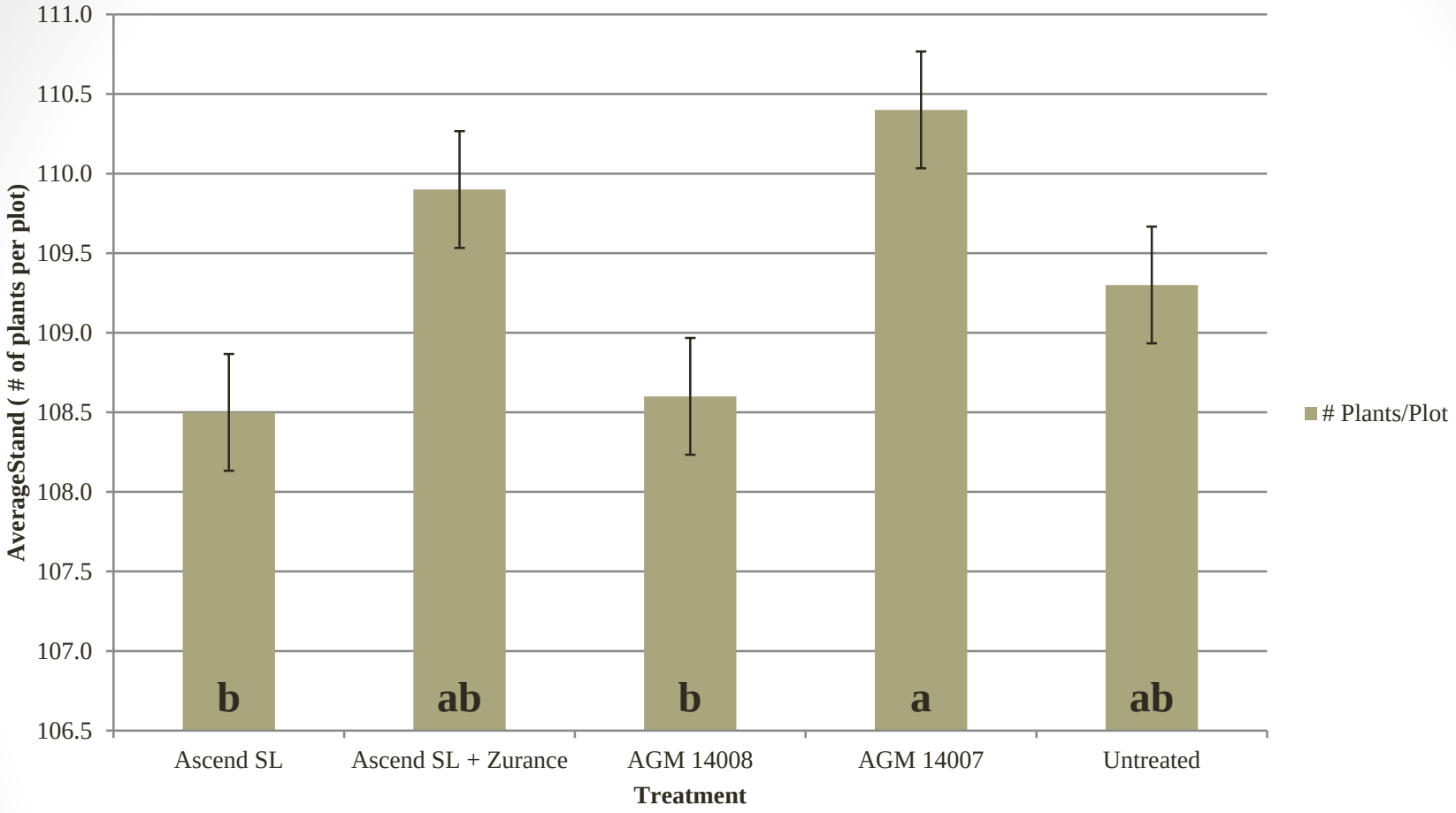
- Root:Shoot ratios, root weight, shoot weight and biomass were not collected at the Perryton location
  - Irrigation wasn’t applied until 10 DAP so stands and emergence were very uneven
- AGM 14008 showed inconsistencies at all 3 locations when stand counts were being taken
  - This correlates with yield and root:shoot data

2014 Yield Results across 3 locations



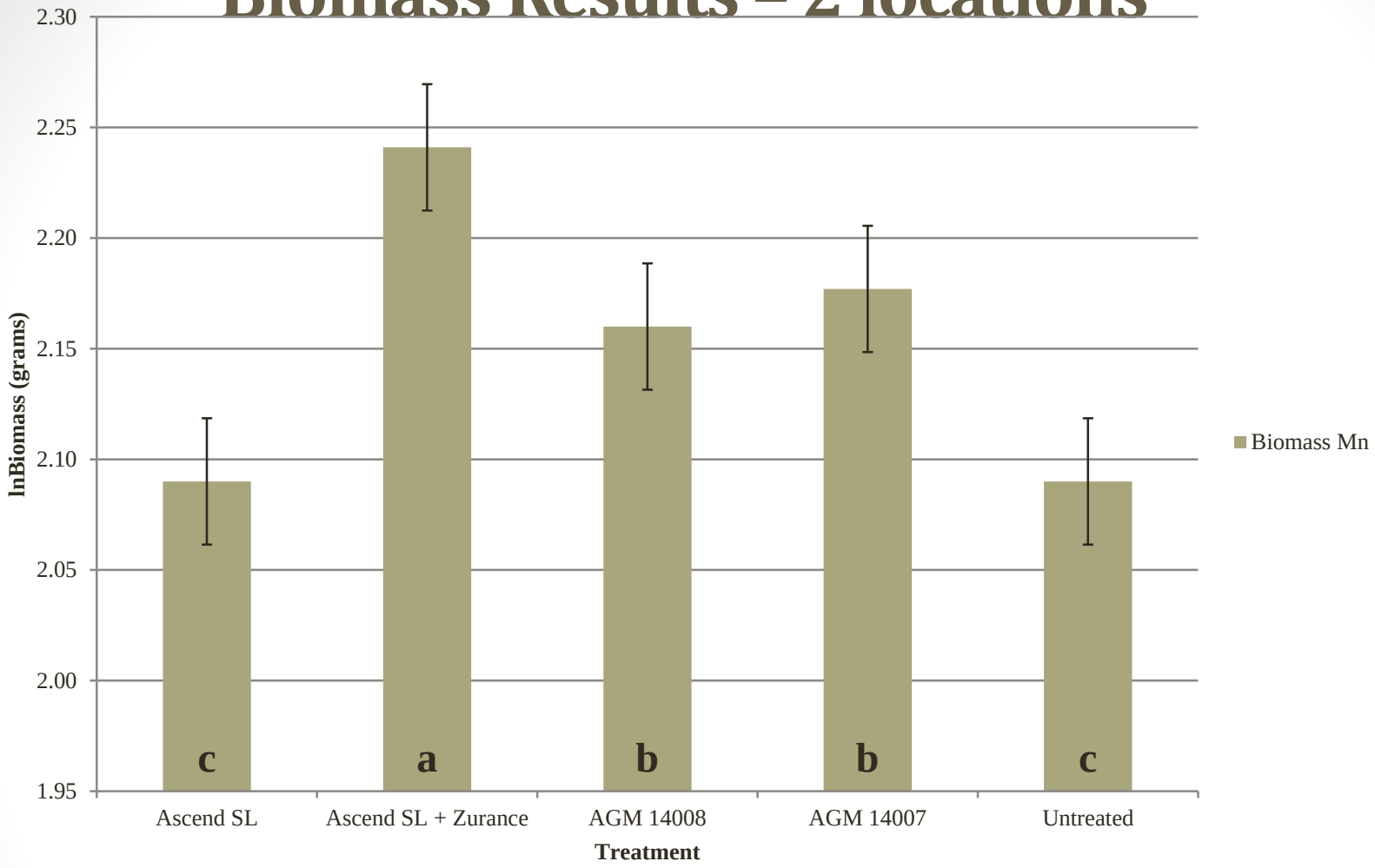
- LSD (.1) = 2.3 bu/A
- Poor performance of AGM 14008
- Ascend SL + Zurance statistically different from all other treatments

V4 Stand Count Results – 3 locations



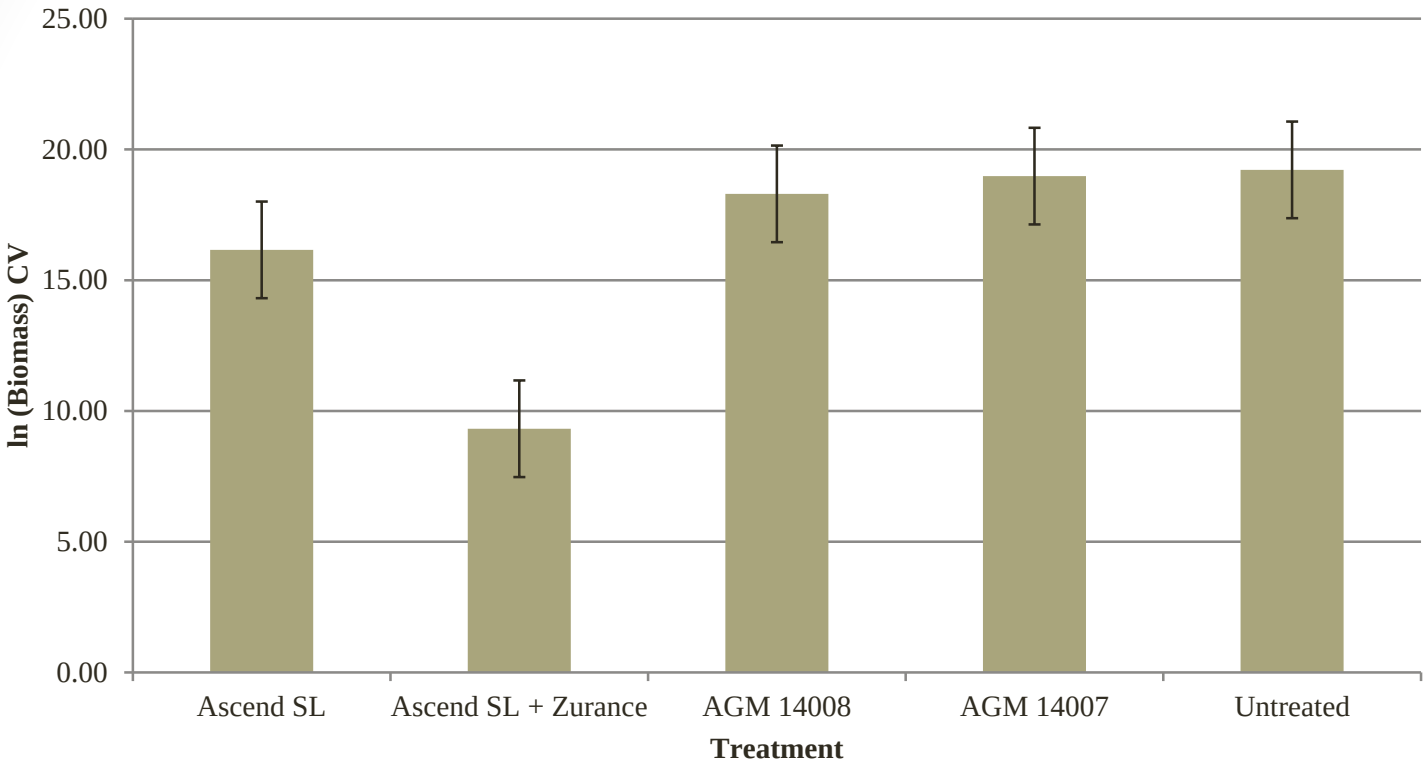
- AGM 14007 had highest stand densities followed by Ascend SL + Zurance, then the UNT
- Addition of proline helped with emergence
- AGM 14008 and Ascend SL place at the bottom

Biomass Results – 2 locations



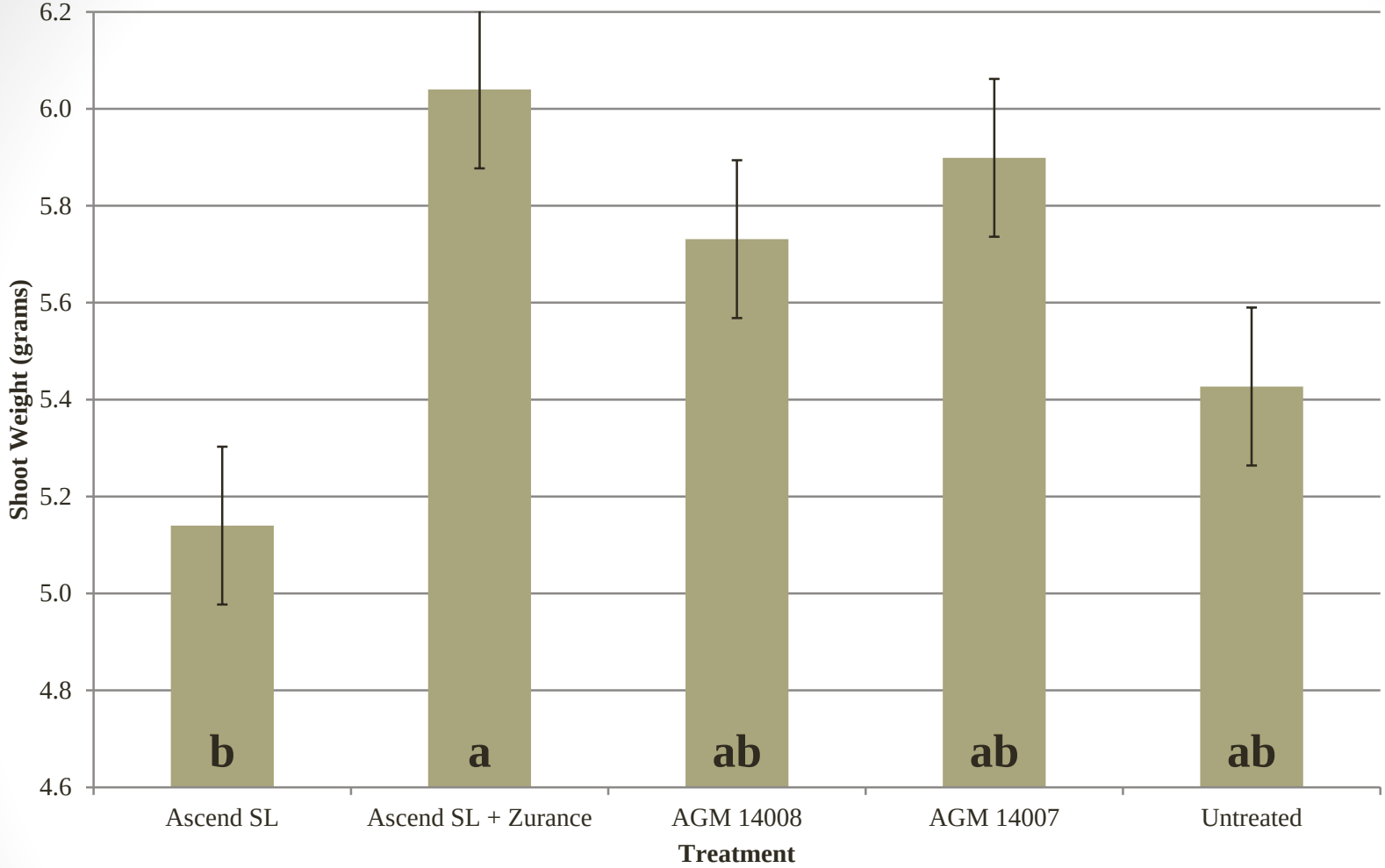
- Natural log of biomass of individual V4 corn plants
- 3 distinct data classes

Biomass CV's – 2 locations



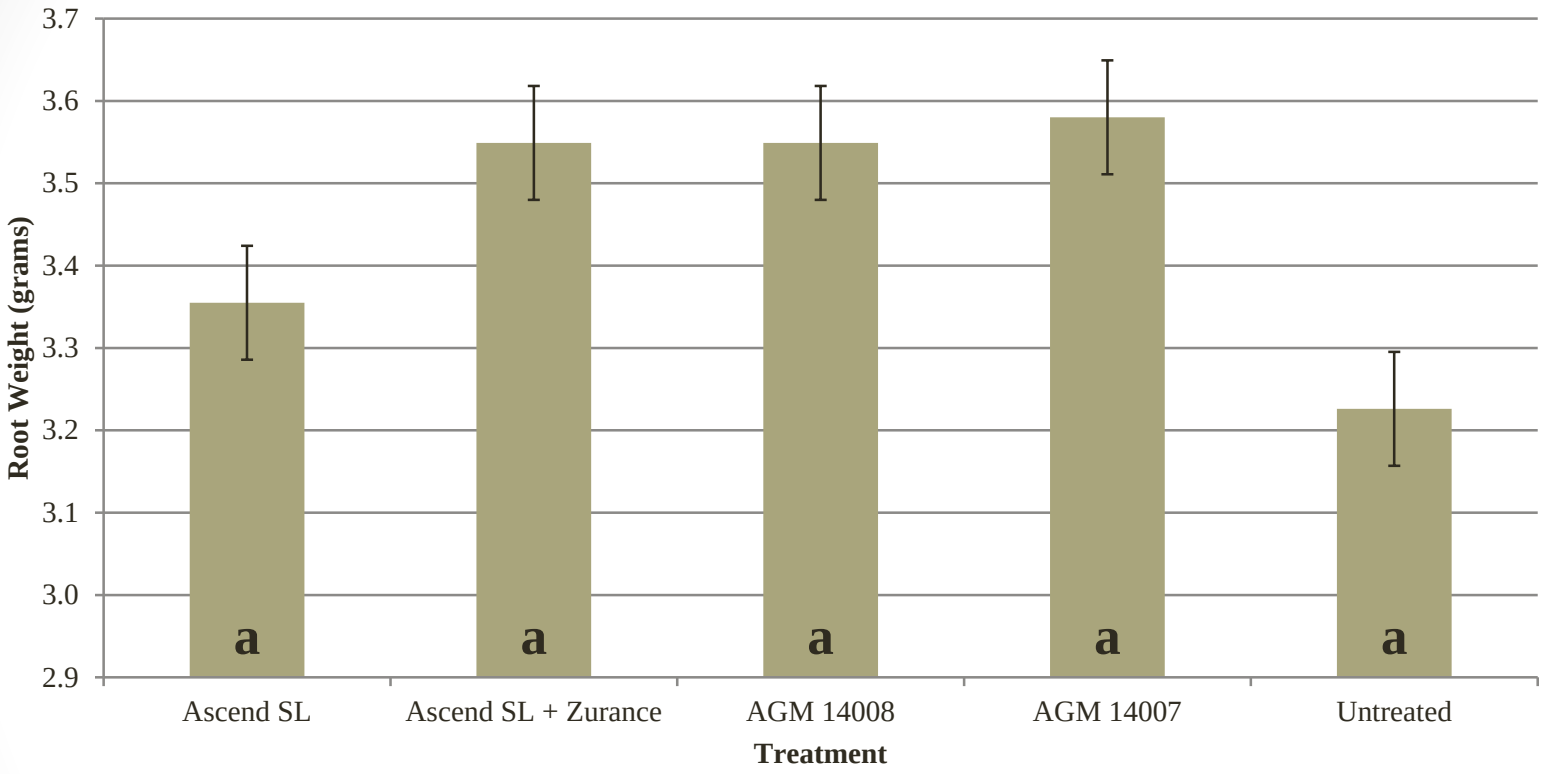
- CV of the natural log of biomass for individual V4 corn plants
- Ascend SL + Zurance had less variation in individual plant weight meaning more uniform across locations.

Average Fresh Shoot Weight of V4 Corn Plants – 2 locations



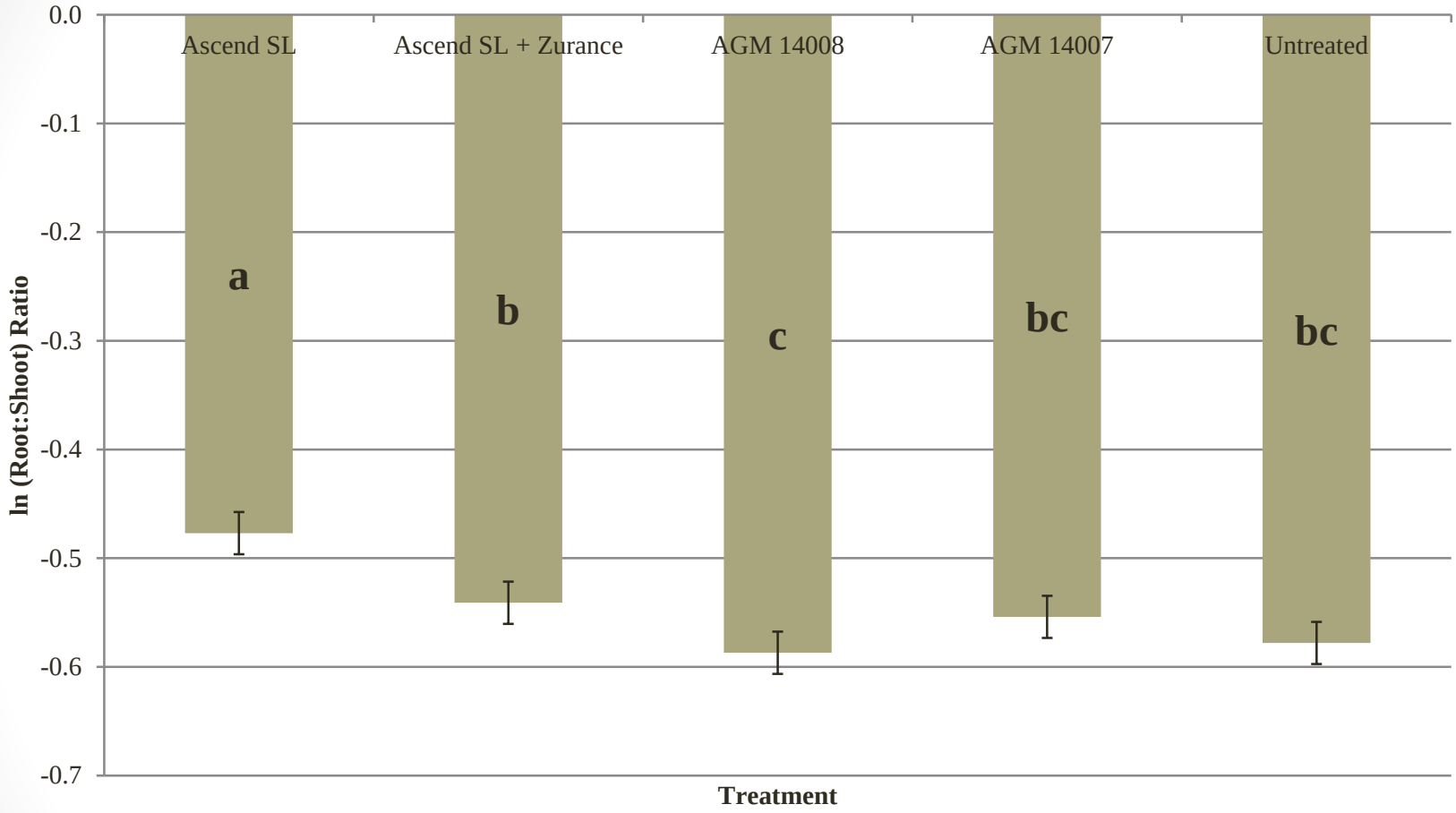
- Ascend SL + Zurance had the highest fresh shoot weight

Average Root Fresh Weight of V4 Corn Plants – 2 Locations



- No significant differences among treatments
  - Little variance among treatments
  - Lots of variation in the data

Natural log of Root:Shoot ratio for V4 corn – 2 locations



As the natural log of the root:shoot ratio approaches 0, yield performance is higher

Conclusions

- Use of a PGR combined with a biostimulant had positive effects on stands recruitment, root:shoot ratios, and total plant biomass of corn
- AGM 14007 (Proline) provided better stand establishment
- Ascend SL + Zurance
  - Highest yielding product in this study
  - Greater biomass with less variation
  - Placed second, behind Ascend SL for Root:Shoot ratio
  - Greatest shoot weight

Future Research

- A multi-year, multiple location study would help support these findings
- This study should include more samplings throughout the season of biomass and Root:Shoot ratios

Questions?