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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Acknowledgements

• Family
• Major Professor: Dr. Andrew Lenssen
• Program of Study Committee
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  • 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.

<table>
<thead>
<tr>
<th>Treatment Entry Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ascend SL</td>
</tr>
<tr>
<td>2</td>
<td>Ascend SL + Zurance</td>
</tr>
<tr>
<td>3</td>
<td>AGM 14008</td>
</tr>
<tr>
<td>4</td>
<td>AGM 14007</td>
</tr>
<tr>
<td>5</td>
<td>Untreated control</td>
</tr>
</tbody>
</table>
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

<table>
<thead>
<tr>
<th>Location</th>
<th>Tillage</th>
<th>Soil Type</th>
<th>Fertilizer Program</th>
<th>Texture and Drainage</th>
<th>Soil pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dalhart</td>
<td>Strip-till</td>
<td>Gruver loam 0-1%</td>
<td>February Strip-till of 160N-105P₂O₅ -50-K₂O – 34S June - 100N</td>
<td>Fine, well drained</td>
<td>8.1</td>
</tr>
<tr>
<td>Dimmitt</td>
<td>Tandem Disk</td>
<td>Olton Clay Loam 0-3%</td>
<td>Fall 150N-100P₂O₅ - 50-K₂O – 5S- 15 Zn June – 150N</td>
<td>Fine, well drained</td>
<td>8.1</td>
</tr>
<tr>
<td>Perryton</td>
<td>Strip-Till</td>
<td>Sherm Clay Loam 0-1%</td>
<td>February Strip-till of 156N-90P₂O₅ -30-K₂O – 20S June - 153N</td>
<td>Fine, well drained</td>
<td>8.0</td>
</tr>
</tbody>
</table>
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
• 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
• 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.**
- 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
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?