2021

FIELD RESEARCH BOOK

FEATURING 2020 RESEARCH & RESULTS

Stewart™

LOCAL SOLUTIONS. PROMISES DELIVERED.

Welcome to the Third Edition of the Bayer Crop Science Field Research Book.

On behalf of the entire Market Development Team at Crop Science, thank you for staying safe and raising the vital crops needed for a safe and sustainable food supply in 2020.

At Crop Science, our single focus is on your success and that of your operation. In Market Development, we are committed to helping our farmer customers learn more about our full product portfolio and how it can best meet the unique needs of their individual farming operations.

To that end, this year's Field Research Book takes the results from field trials across the United States – in both large and small plot formats – to give you the best data to make informed decisions about what may work best for your specific needs.

Just like you, we have a strong focus on winning genetics, integrated weed and pest management, efficiency, and effectiveness. In short, we try to anticipate everything you can experience on your farm to help you navigate each and every year as successfully, sustainably and profitably as possible.

The team and I hope you will find this research summary valuable. As always, we'd welcome any feedback you have and thoughts on what you'd like to see in the next edition.

Thank you again for your business and here's to a successful 2021.

John Chambers
Head of North America Market Development
Bayer Crop Science

CATEGORY:

The reports in this book are arranged by crop. Each report is also tagged with one of these icons to quickly show you what it's about.

DISEASES

ENVIRONMENT

FERTILITY

INSECT CONTROL

WEED CONTROL

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CONTENTS

National Systems Protocol Disease Management

Trial Objective

Corn is confronted with several serious disease threats during the season. Managing these diseases with the use of seed and foliar fungicide treatments is essential to maintain yield potential. The objectives of these trials include:

- Evaluate the efficacy of seed treatments and foliar fungicides on reducing yield loss due to Fusarium Crown Rot, stalk health issues and other corn diseases.
- Communicate the value that native disease tolerance, seed applied solutions, and foliar fungicides bring to disease risk management systems.

Research Site Details

Experiment Description	# Locations Planned	# Locations Harvested	Tillage Type
2020-01-76-34	40	35	34

- A total of 58 corn products were included from national and regional brands.
- The experimental design was a single replication with large strips.
- Two seed treatments were evaluated (Acceleron® Seed Applied Solutions ELITE and Acceleron® Seed Applied Solutions BASIC); known as Elite and Basic for the remainder of the report.
- Four blocked fungicide treatments were evaluated at different plant growth stages - Untreated (UNT), V5 stage only (V5), both V5 and R1 stages (V5R1) and R1 stage only (R1).

Understanding the Results

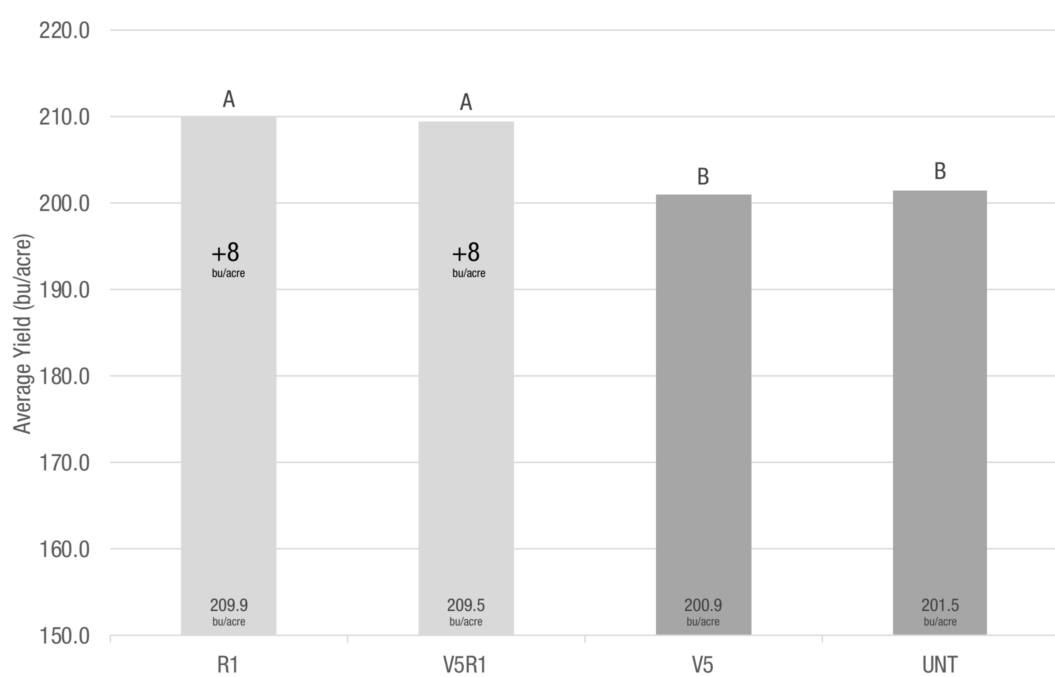

Figure 1. Average yield response to different fungicide application timings across all regions, seed treatments and corn products.

National Systems Protocol Disease Management

Broad Acre Yield Across Locations

- Across all locations, V5 was the only application that does not seem to contribute to yield potential.

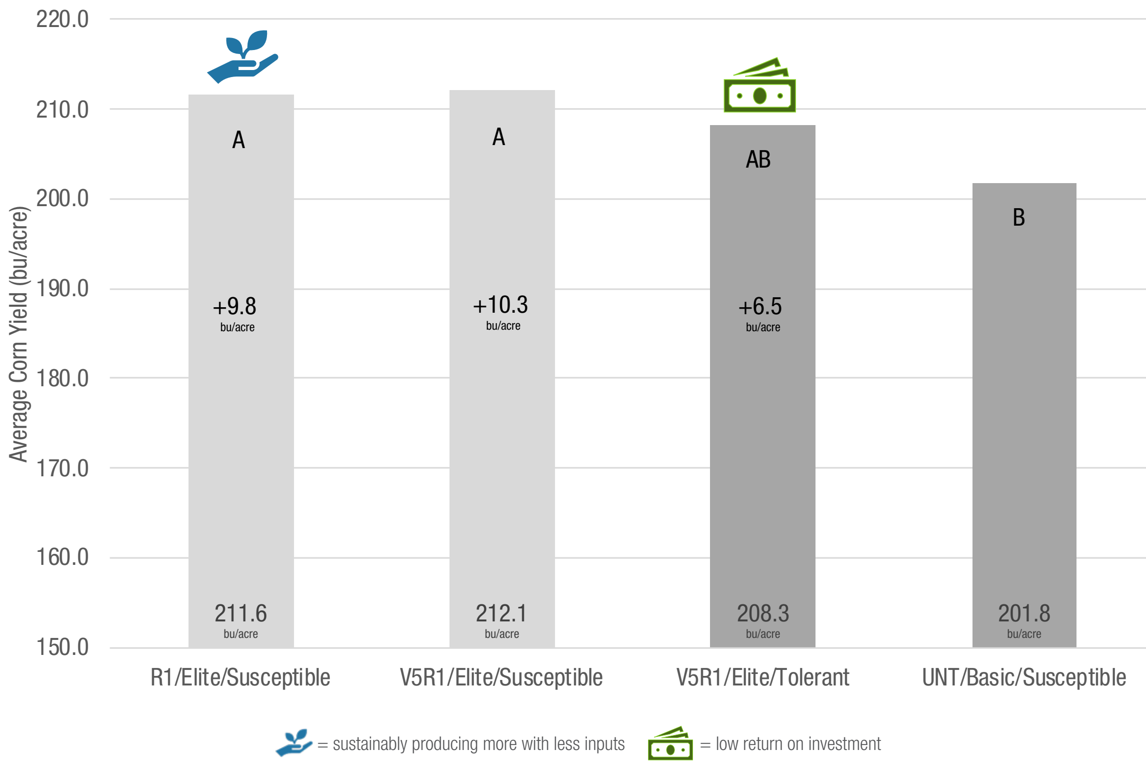

Figure 2. Comparison of different fungicide application systems across all regions.

Systems Comparison

- R1/Elite/Susceptible yielded 10 bu/acre better versus Untreated/Basic/Susceptible (Low input system).

Regional Results

Eastern Corn Belt: 4 locations

- R1 only block yielded 8 bu/acre higher than Untreated.
- R1/Elite Susceptible package yielded 21 bu/acre higher than Untreated/Basic Susceptible (Low inputs system).

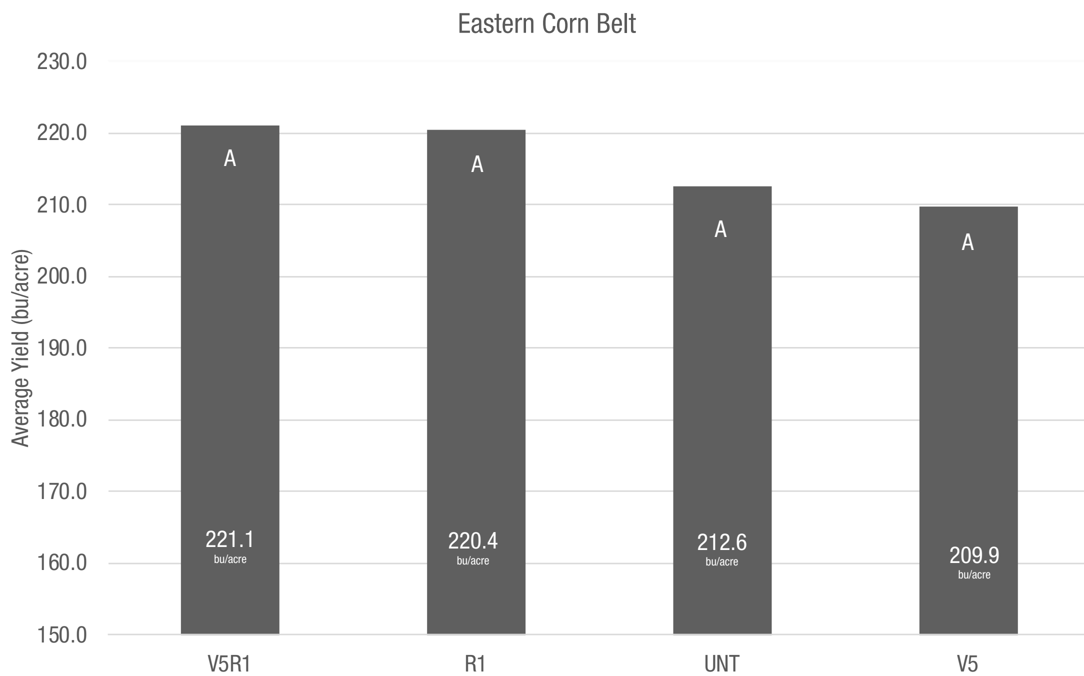

Figure 3 A. Comparison of corn yield responses to timing of fungicide applications evaluated on a regional basis across the Eastern Corn Belt.

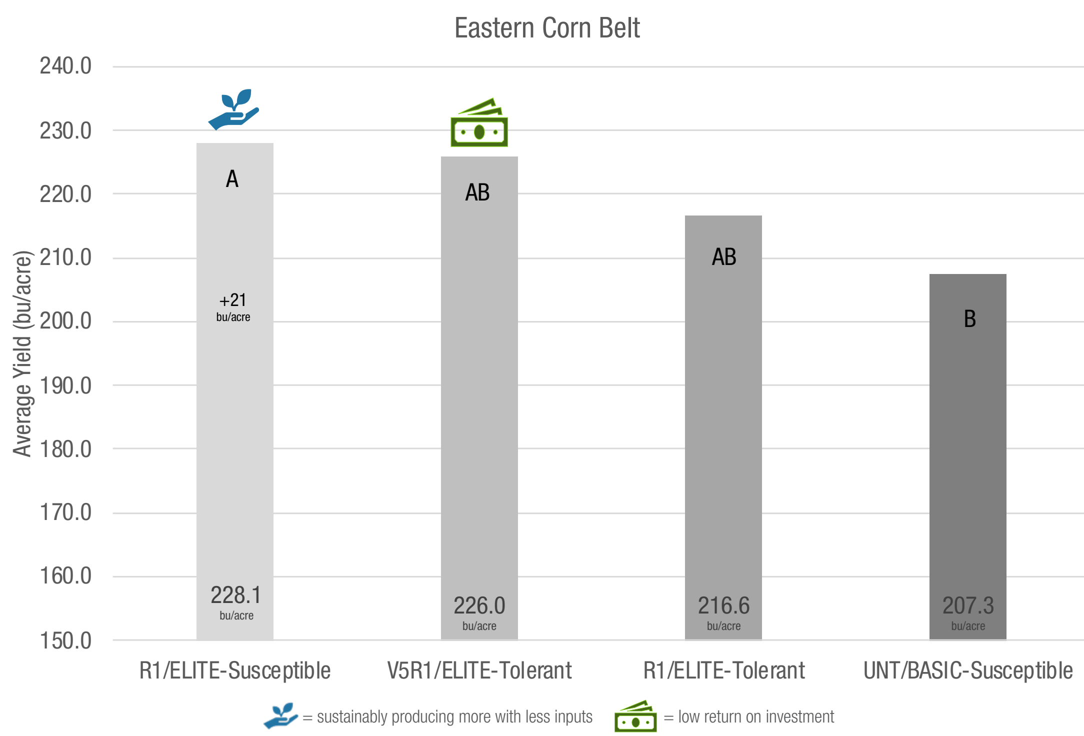

Figure 3 B. Comparison of fungicide systems trials (including seed treatments, germplasm and foliar fungicide applications) evaluated on a regional basis across the Eastern Corn Belt.

South/East Coast: 5 locations

- No significant difference between application timings vs Untreated block but V5R1 application showed 10 bu/acre advantage over Untreated.
- V5R1/Elite Tolerant package (High Inputs) yielded 10 bu/acre higher than Untreated /Basic Susceptible (Low inputs system).

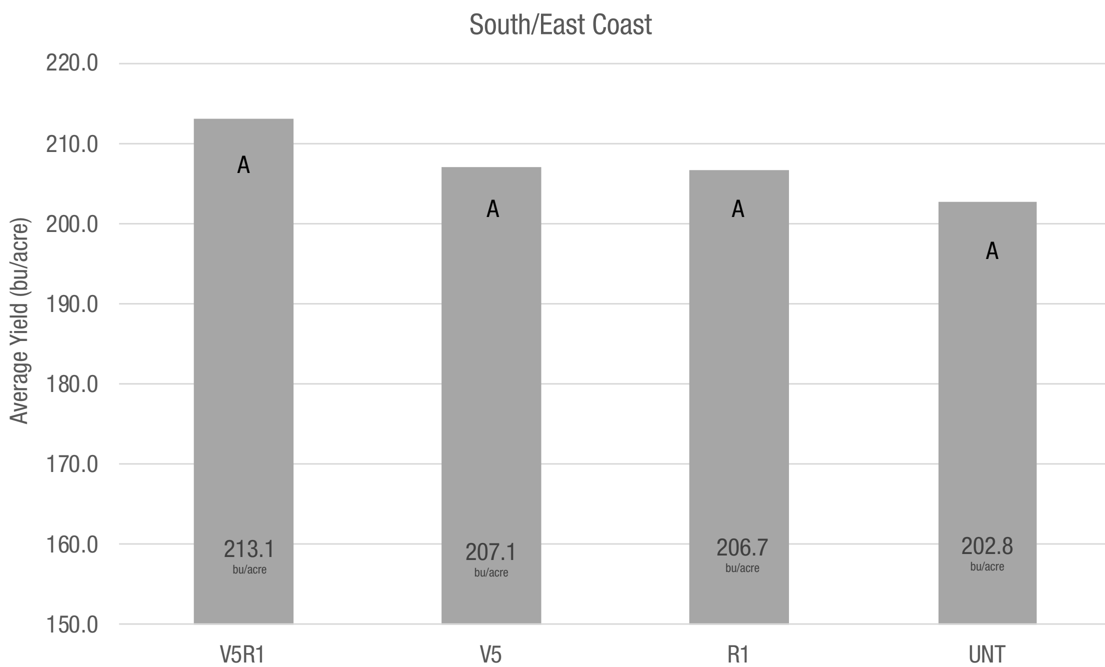

Figure 3 C. Comparison of corn yield responses to timing of fungicide applications evaluated on a regional basis across the South/East Coast.

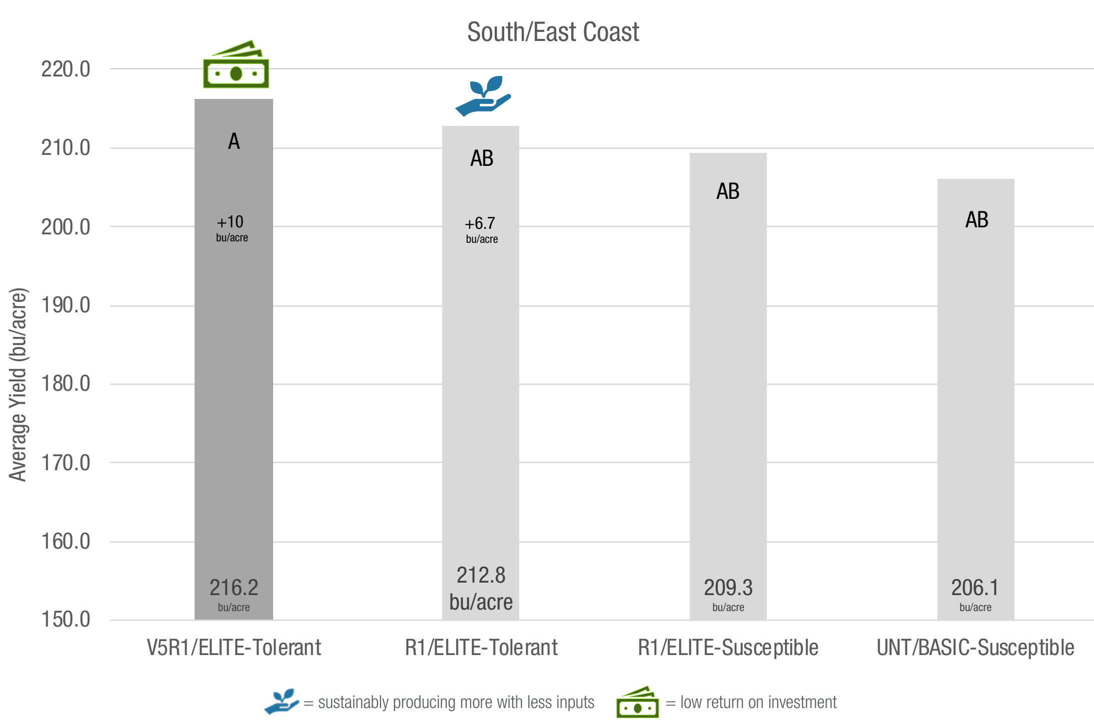

Figure 3 D. Comparison of fungicide systems trials (including seed treatments, germplasm and foliar fungicide applications) evaluated on a regional basis across South/East Coast.

Central Plains: 7 locations

- R1 and V5R1 showed significant yield advantage over V5 only block.
- R1/Elite Susceptible package yielded 6 bu/acre higher than Untreated/Basic Susceptible (Low inputs system).

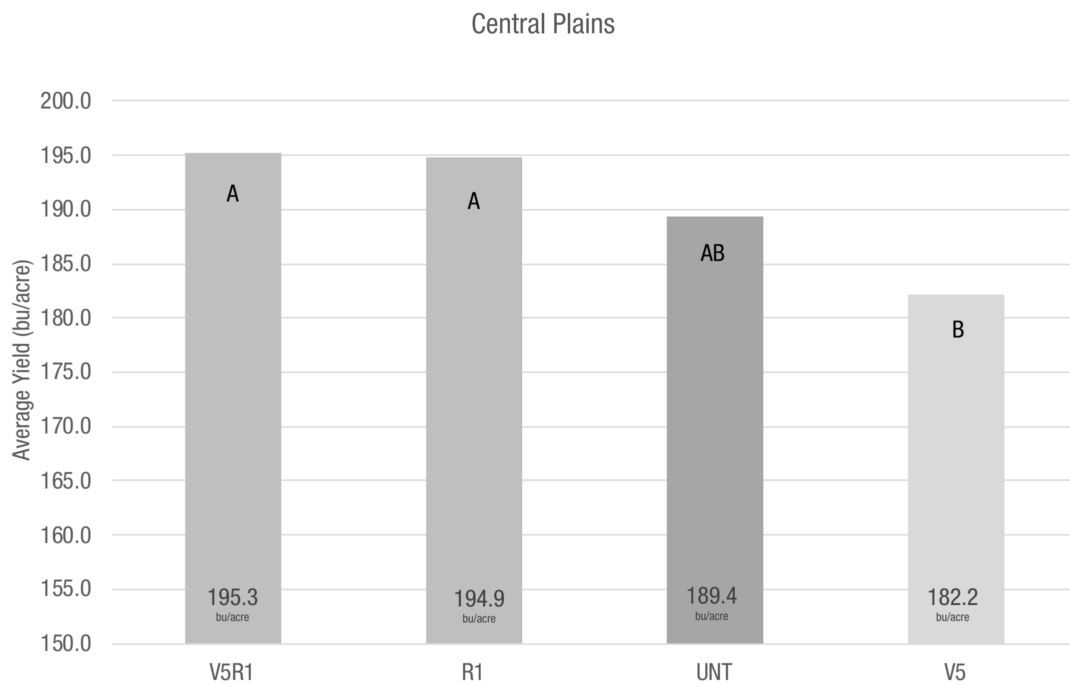

Figure 3 E. Comparison of corn yield responses to timing of fungicide applications evaluated on a regional basis across the Central Plains.

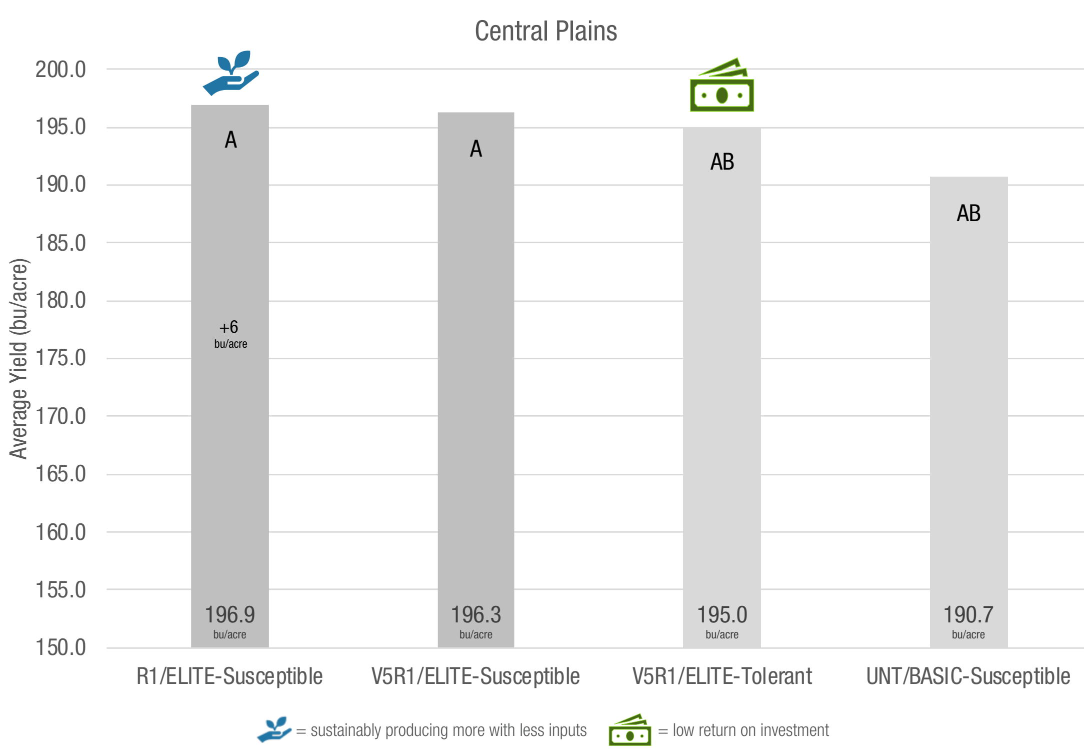

Figure 3 F. Comparison of fungicide systems trials (including seed treatments, germplasm and foliar fungicide applications) evaluated on a regional basis across the Central Plains.

Illinois: 5 locations

- *R1 only and V5R1 yielded 19-20 bu/acre higher than Untreated block.
- *R1/Elite Tolerant package yielded 30 bu/acre higher than Untreated/Basic Susceptible (Low inputs system).

*Statistically non-significant differences

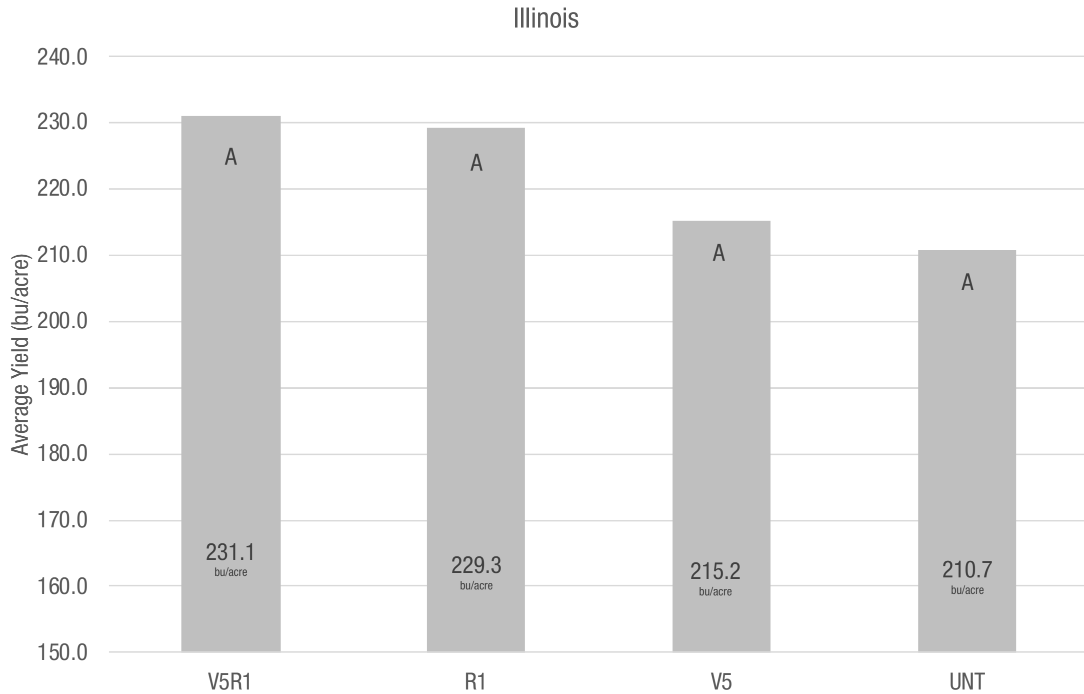

Figure 3 G. Comparison of corn yield responses to timing of fungicide applications evaluated on a regional basis across Illinois.

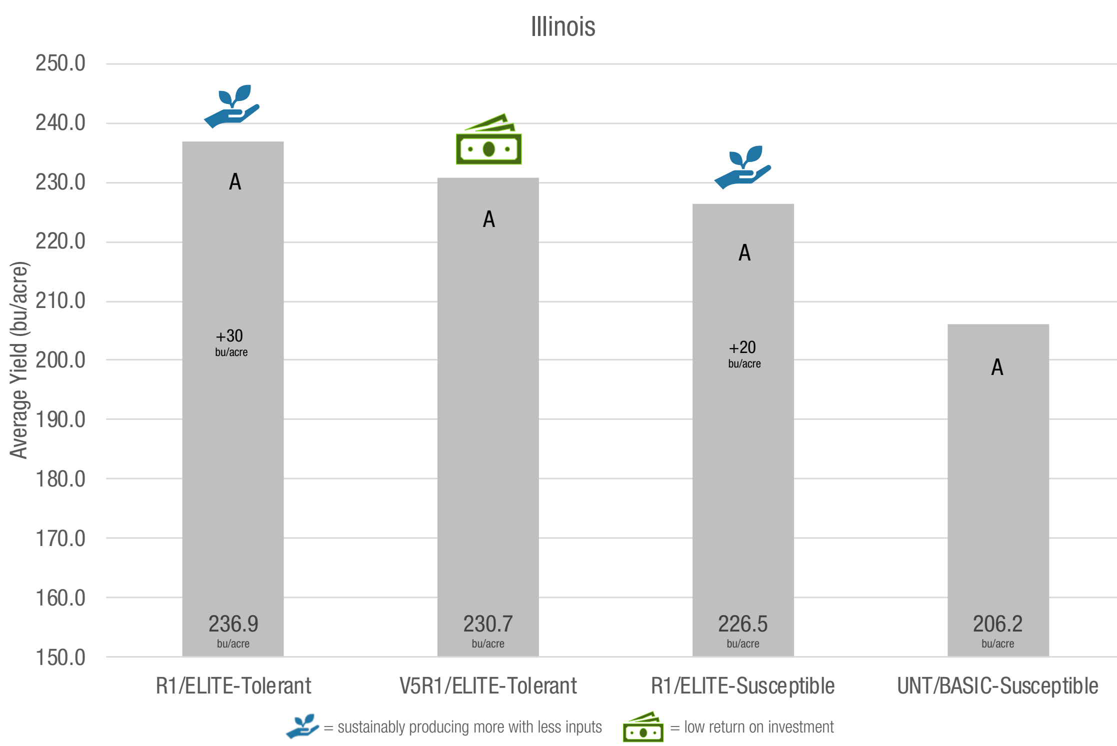

Figure 3 H. Comparison of fungicide systems trials (including seed treatments, germplasm and foliar fungicide applications) evaluated on a regional basis across Illinois.

Midwest: 4 locations

- *R1 only and V5R1 application showed 9-10 bu/acre advantage over Untreated.
- *Both R1/Elite Susceptible and V5R1/Elite Susceptible packages yielded 17 bu/acre higher than Untreated/Basic Susceptible (Low inputs system).

*Statistically non-significant differences

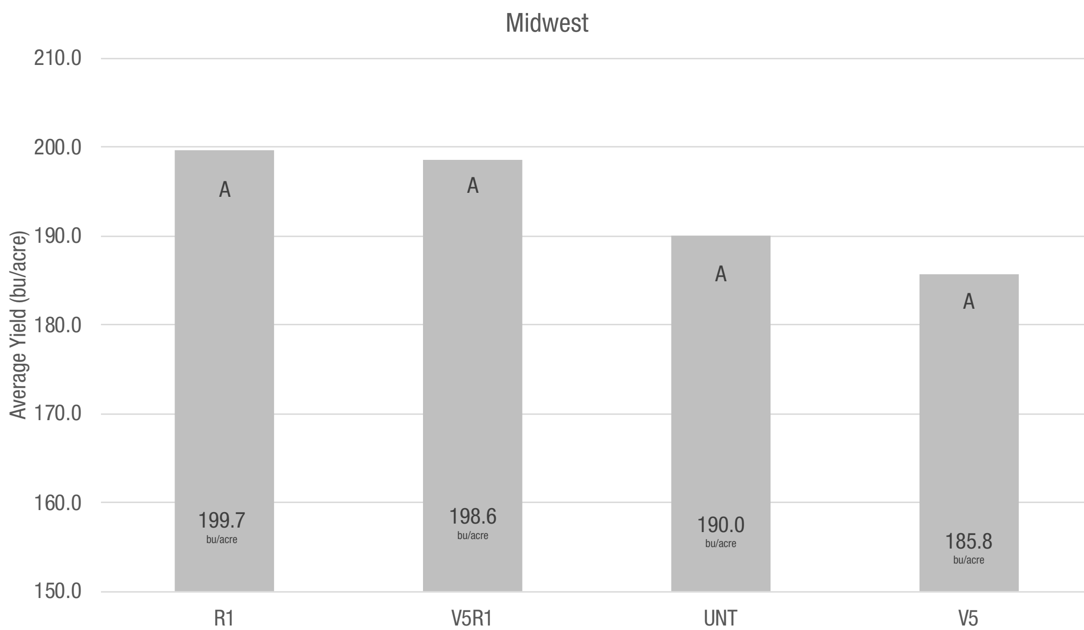

Figure 3 I. Comparison of corn yield responses to timing of fungicide applications evaluated on a regional basis across the Midwest.

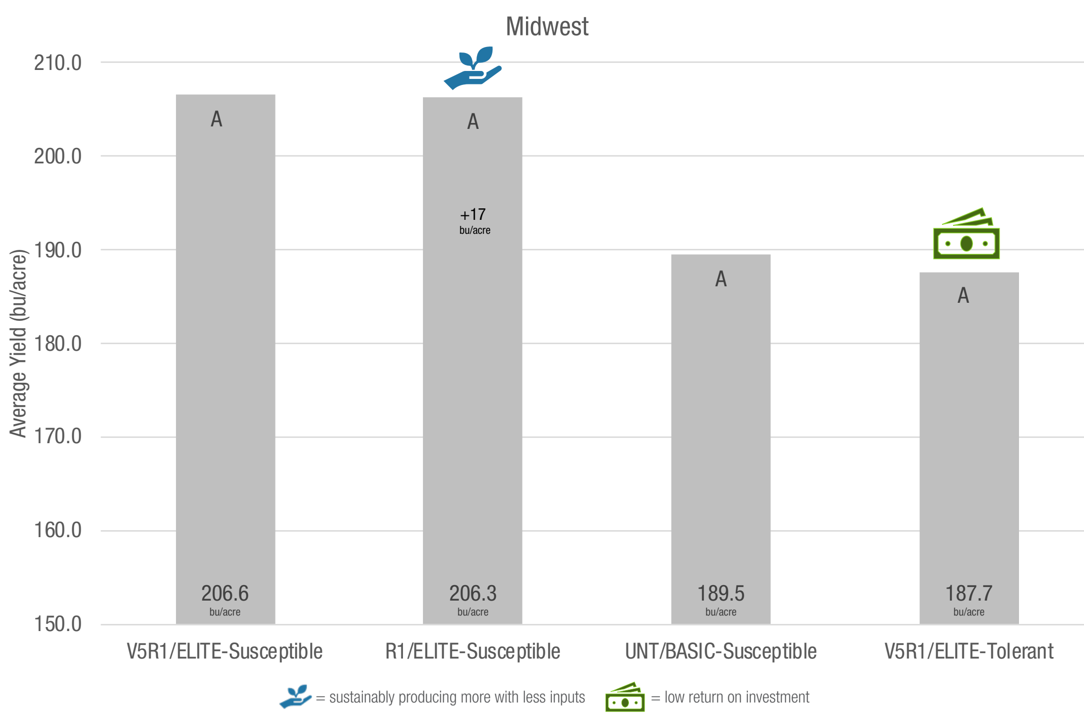

Figure 3 J. Comparison of fungicide systems trials (including seed treatments, germplasm and foliar fungicide applications) evaluated on a regional basis across the Midwest.

Northern Plains: 3 locations

- *R1 and V5R1 blocks yielded 4-5 bu/acre better than Untreated.
- *R1/Elite Tolerant yielded 9 bu/acre higher than Untreated/Basic Susceptible (Low inputs system).

*Statistically non-significant differences

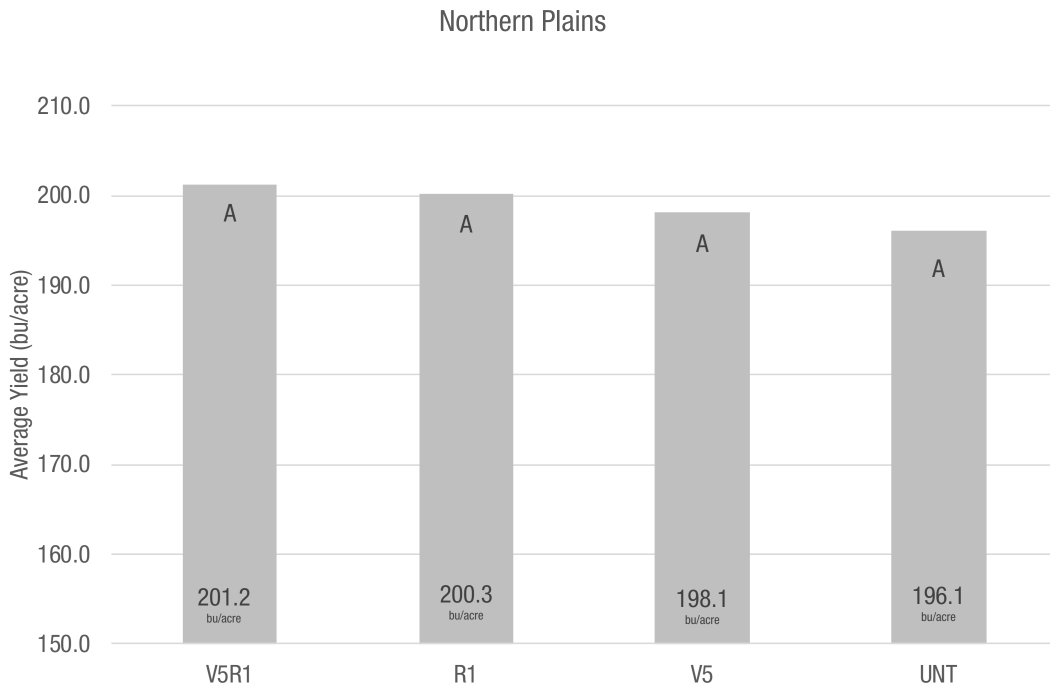

Figure 3 K. Comparison of corn yield responses to timing of fungicide applications evaluated on a regional basis across the Northern Plains.

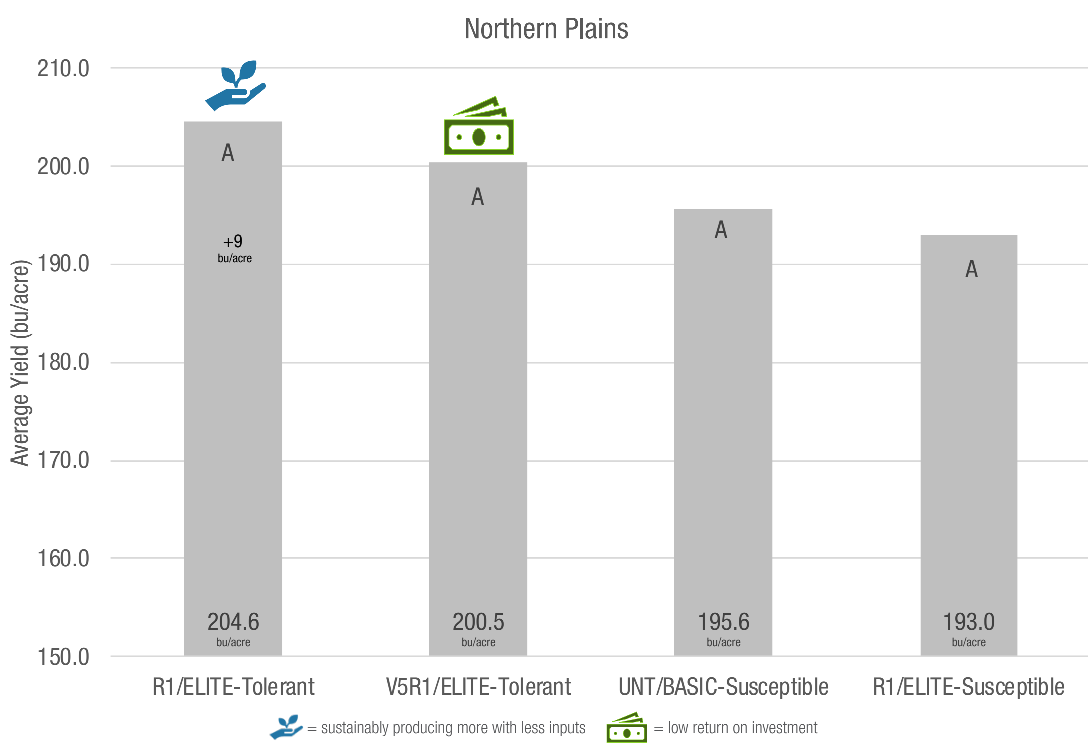

Figure 3 L. Comparison of fungicide systems trials (including seed treatments, germplasm and foliar fungicide applications) evaluated on a regional basis across the Northern Plains.

National Systems Protocol Disease Management

Key Learnings

- In this trial, both R1 and V5R1 blocks had lower foliar disease severity ratings and better staygreen when comparted to the Untreated block.
- Corn products with higher susceptibility to foliar and stalk diseases showed better yield response to R1 applications.
- Overall, across all locations yield data supports very little to no value from additional V5 applications.
- V5 only applications showed mixed results compared to Untreated block with three regions showing 2-5 bu/acre yield increases and four regions showing a 3-7 bu/acre yield decreases. These results suggest that there might be a regional fit for V5 applications.

Legals

ALWAYS READ AND FOLLOW PESTICIDE LABEL DIRECTIONS. FOR CORN, EACH ACCELERON® SEED APPLIED SOLUTIONS OFFERING is a combination of separate individually registered products containing the active ingredients: BASIC plus Poncho®/VOTiVO® Offering for corn: metalaxyl, prothioconazole, fluoxastrobin, clothianidin, Bacillus firmus I-1582. ELITE plus Poncho®/VOTiVO® Offering for corn: metalaxyl, clothianidin, and Bacillus firmus I-1582; prothioconazole and fluoxastrobin at rates that suppress additional diseases. BASIC Offering for corn: metalaxyl, prothioconazole, fluoxastrobin, and clothianidin. ELITE Offering for corn: metalaxyl, and clothianidin; and prothioconazole and fluoxastrobin at rates that suppress additional diseases. BioRise® Corn Offering is the on-seed application of BioRise® 360 ST. BioRise® Corn Offering is included seamlessly across offerings on all class of 2016 and newer products.

The distribution, sale, or use of an unregistered pesticide is a violation of federal and/or state law and is strictly prohibited. Not all products are approved in all states.

Performance may vary, from location to location and from year to year, as local growing, soil and weather conditions may vary. Growers should evaluate data from multiple locations and years whenever possible and should consider the impacts of these conditions on the grower's fields.

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Dryland Corn Production Systems in a Tough Environment

Trial Objective

- Successfully managing dryland corn requires a well-planned system to achieve the best results with limited moisture.
- This research trial compares a Bayer system of corn and herbicide products to a competitive system of corn and herbicide products in a dryland environment.

Research Site Details

Location	Soil Type	Previous Crop	Tillage Type	Planting Date	Harvest Date	Potential Yield (bu/acre)
Gothenburg, NE	Cozad silt loam	Sorghum	No tillage	5/8/2020	11/2/2020	200

- The study design was a randomized complete block with 12 treatments and four replications.
- Four Bayer corn products and two competitive corn products were planted at 16,000 and 22,000 seeds/acre, to simulate the lower and upper range of dryland seeding rates in the area. From Gothenburg, seeding rates trend lower as you move west and higher as you move east.
- The previous crop was grain sorghum to provide a drier environment to stress the dryland corn systems.
- Treatments 1 through 8 were planted to Bayer corn products and received a pre-emergence herbicide application of Balance® Flexx herbicide (0.125 qt/acre), Harness® Xtra 5.6L herbicide (2 qt/acre), Roundup PowerMAX® herbicide (1 qt/acre) and AMS (17 lb/100 gal), and a V6 application of DiFlexx® herbicide (0.25 qt/acre), AAtrex® 4L herbicide (0.5 qt/acre), Roundup PowerMAX herbicide (1 qt/acre) and AMS (17 lb/100 gal).
- Treatments 9 through 12 were planted to competitive brand corn products and received a pre-emergence herbicide application of Cinch® ATZ herbicide (2.25 qt/acre), Sterling Blue® herbicide (0.125 qt/acre), Durango® DMA® herbicide (1.1 qt/acre) and AMS (17 lb/100 gal), and a V6 application of Sterling Blue herbicide (0.25 qt/acre), AAtrex 4L herbicide (0.5 qt/acre), Durango DMA herbicide (1.1 qt/acre) and AMS (17 lb/100 gal).
- The pre-emergence herbicide application occurred on 5/9/2020, and the V6 application occurred on 6/30/2020.
- Fertility applied with a Chafer Streambar included 20 lb nitrogen/acre, 50 lb phosphorus/acre, 11 lb sulfur/acre on 4/14/2020 and 150 lb nitrogen/acre applied 4/27/20.
- No other pesticides were used in this trial.
- 2020 was a dry year with below average precipitation during the growing season particularly during grain fill. Precipitation was 5.18 inches in May, 1.56 inches in June, 4.19 inches in July, 0.51 inches in August, and 0.5 inch in September.
- At harvest, yield was collected as a measure of system performance.

Dryland Corn Production Systems in a Tough Environment

Bayer @ 16,000 seeds/acre

Competitive @ 16,000 seeds/acre

Bayer @ 22,000 seeds/acre

Competitive @ 22,000 seeds/acre

Figure 1. Ear comparison from 8.7 feet of row. Ears close together are from same plant. Bayer Crop Science, Gothenburg Water Utilization Learning Center, Gothenburg, NE in 2020.

Dryland Corn Production Systems in a Tough Environment

Understanding the Results

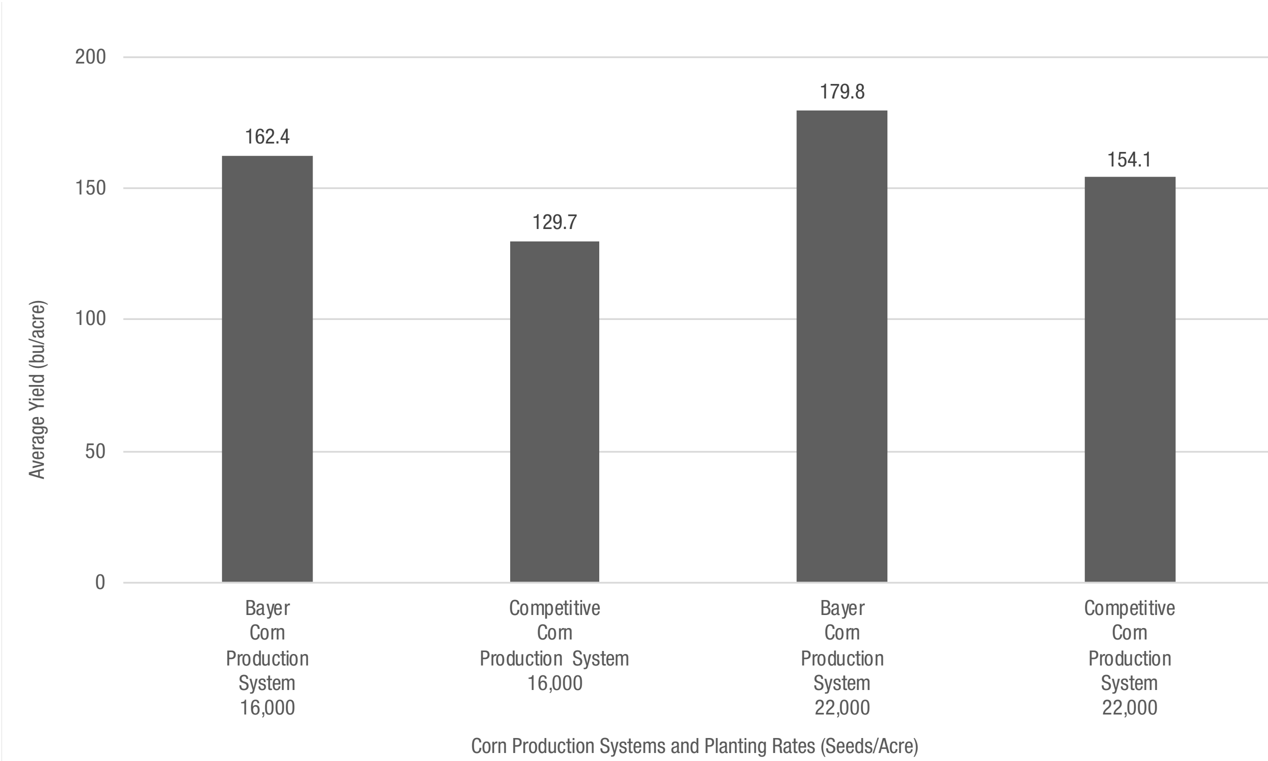

Figure 2. Average yield comparison between Bayer and competitive dryland corn production systems at the Bayer Crop Science, Gothenburg Water Utilization Learning Center, Gothenburg, NE in 2020.

- For this trial, the Bayer corn production system had an average yield advantage of over 30 bu/acre at a planting rate of 16,000 seeds/acre and over 25 bu/acre at 22,000 seeds/acre (Figure 2).
- Returns, based on the yield advantage, a seed cost of $250/80K unit, and $3.80/bu for commodity corn showed a Bayer corn production system advantage of $143/acre for 16,000 seeds/acre and $116/acre for 22,000 seeds/acre over the Competitive corn production system.
- Increasing the seeding rate by 6,000 seeds/acre improved the yield for both systems.
- The increase in seeding rate also improved the return/acre for both systems when the seed cost was set at $250/80K unit of seed and a corn price of $3.80/bu.
- For every dollar spent on seed, moving from 16,000 seeds/acre to 22,000 seeds/acre returned $3.53 in the Bayer production system.

Dryland Corn Production Systems in a Tough Environment

Key Learnings

- Improving profitability potential on dryland acres is a key revenue driver on many farms. It is also an uncertain one because precipitation plays a much larger part in yield potential than it does for fully irrigated acre.
- 2020 was a below average season in terms of precipitation with very low rainfall totals during the grain fill period in August and September.
- In the tough environment, the Bayer dryland corn production system outperformed the competitive corn production system at both seeding rates.
- For this trial, increasing the seeding rate from 16,000 seeds/acre to 22,000 seeds/acre provided better average yields and returns in a year when precipitation was limited.
- Corn product selection is a critical component of a tailored solution, please consult your seed representative to help you select the best corn products for your farm.

Legal Statements

The information discussed in this report is from a single site, replicated demonstration. This informational piece is designed to report the results of this demonstration and is not intended to infer any confirmed trends. Please use this information accordingly.

ALWAYS READ AND FOLLOW PESTICIDE LABEL DIRECTIONS. Performance may vary, from location to location and from year to year, as local growing, soil and weather conditions may vary. Growers should evaluate data from multiple locations and years whenever possible and should consider the impacts of these conditions on the grower's fields.

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Corn Product Characterization Response to Different Planting Populations - 2020

Trial Objective

For over a decade, Bayer has been using an innovative planter technology, the Genotype by Environment Narrative planter (GEN), to help understand and characterize corn product performance in response to plant population and location. This internally-developed tool provides the technical field teams the ability to simultaneously plant multiple corn products at different seeding rates across a field. These unique planting capabilities generate over 100,000 detailed yield observations each season across diverse growing conditions. This program provides data for our agronomy experts to optimize product performance and recommendations for all corn-growing regions in the United States. The objectives of this research were to:

- Evaluate all new Bayer corn products using seeding rates ranging from 18,000 to 50,000 seeds/acre across multiple locations in the United States.
- Provide growers with product-specific planting recommendations.
- Assess new products in as many yield environments as possible over a two-year period.
- Provide growers with insight for their specific situation and the product they selected.

Research Site Details

- This research included 123 testing locations across the United States.
- The products tested were selected by the regional field teams as important in that geography.
- Testing locations targeted diverse environments (yield environment, crop rotation, tillage practice, etc.).
- Agronomic management practices used in this study mimicked local best management practices.
- Products tested were both first-year commercial and pre-commercial corn products.
- The experimental design was a split-plot randomized complete block (RCB) with 2 replications. Corn product was the main plot and seeding rate was the sub plot.
- Small plots were used: four 35-foot rows per plot with a row width of 30 inches.
- Seeding rates were as follows:
  - Low-yielding acres: 18,000, 24,000, 28,000, 32,000, 38,000, and 44,000 seeds/acre
  - High-yielding acres: 24,000, 32,000, 36,000, 40,000, 44,000, and 50,000 seeds/acre

Corn Product Characterization Response to Different Planting Populations - 2020

Understanding the Results

- Product-specific data on the response to plant population allows for customized recommendations for new corn products specific for a grower's geography.
- Multiple years of data allow agronomists to determine the influence of weather on corn product performance. This adds to the robustness of the recommendations generated in this system.
- The relative responsiveness of a product to plant population can change depending on the yield environment and management.

Key Learnings

The information generated in this program drives innovation within Bayer while it provides data to the farmers who rely on our premium genetics to deliver top yields. The data that these trials generate help growers optimize product placement and seeding rates of Bayer corn products to maximize the return on their investment in our corn products.

- Consult with your Technical Agronomist, who has access to this data, early in the year for information on the performance of all our newest products.
- Visit Climate FieldView™ seed scripts at https://climate.com/2020-seed-scripts to see how this data is being used to develop specific corn product recommendations. Pairing the product-level seeding rate characterization with the specific agronomic environment of your operation can optimize your system.

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Corn Response to Tillage and Seeding Rate

Trial Objective

- Previous research conducted at the Bayer Learning Center at Monmouth, IL yielded mixed results when comparing different tillage systems.
- This trial was conducted to compare the yield response of corn under three different tillage types and two different seeding rates.

Research Site Details

Location	Soil Type	Previous Crop	Tillage Type	Planting Date	Harvest Date	Potential Yield (bu/acre)	Seeding Rate (seeds/acre)
Monmouth, Illinois	Silt loam	Corn	Vertical, strip, conventional	5/2/20	10/8/20	250	32K, 42K

- Treatments consisted of three tillage systems and two seeding rates for a total of six treatments.
  - Tillage system:
    - Vertical tillage
    - Strip tillage
    - Conventional tillage (fall chisel plow followed by one pass with a soil finisher prior to planting)
  - Seeding rates:
    - 32,000 seeds/acre
    - 42,000 seeds/acre
- This study had two replications of each of the six treatments.
- Two different corn products were planted in this trial, but there were no meaningful differences observed between the corn products. Therefore, results presented are an average of both corn products.

Understanding the Results

- Although statistically insignificant, small yield increases were observed at the higher planting population in all three tillage systems.
- Vertical and conventional tillage resulted in similar yields whereas strip tillage yielded lower. This may have been the result of faster drying and warming of the soil with vertical and conventional tillage during the prolonged cool and wet conditions experienced in the spring of 2020.

Corn Response to Tillage and Seeding Rate

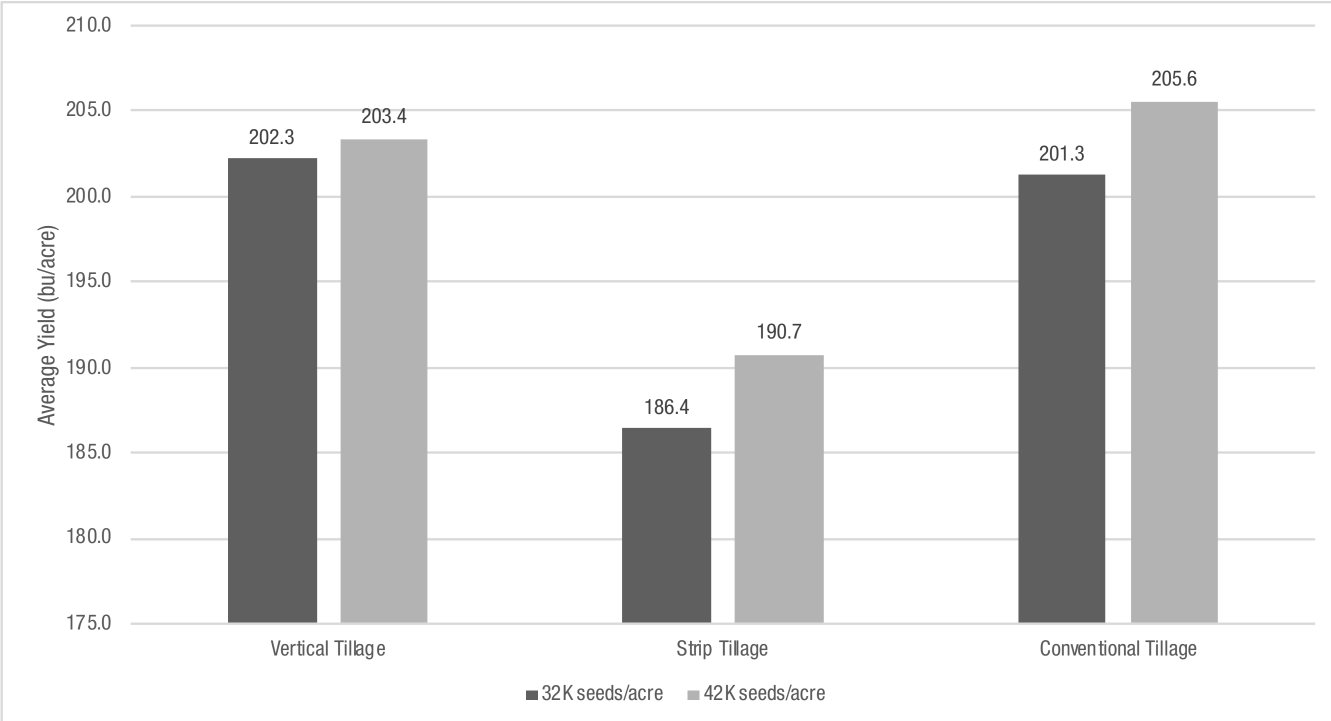

Figure 1. Average corn yields comparing three tillage systems and two seeding rates averaged across two corn products.

Key Learnings

- The interaction of soil type and environmental conditions can vary from year to year and have an effect on soil conditions at planting time.
- Some level of tillage may help to facilitate faster drying and warming of the soil in the spring.
- Consult your local Field Sales Representative or Technical Agronomist for tailored recommendations on your farm.

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Corn Yield Response to Seeding Rate and Row Spacing

Trial Objective

- As corn products are developed to have higher yield potential and better stress tolerance, the optimum seeding rate has steadily increased.
- Previous work at the Bayer Learning Center at Monmouth, IL suggests the optimum seeding rate for most corn products is around 38,000 seeds per acre in our yield environment.
- Previous work at the Learning Center suggests row configurations narrower than 30 inches may increase stress reducing potential yield benefits at seeding rates greater than 38,000 seeds per acre.
- This demonstration was conducted to evaluate the yield response to seeding rate and row spacing.

Research Site Details

Location	Soil Type	Previous Crop	Tillage Type	Planting Date	Harvest Date	Potential Yield (bu/acre)	Seeding Rate (seeds/acre)
Monmouth, Il	Silt loam	Soybean	Conventional	6/5/20	10/27/20	250	35K, 45K

- Treatments consisted of two seeding rates and three row configurations for a total of six treatments.
  - Seeding rates:
    - 35,000 seeds/acre
    - 45,000 seeds/acre
  - Row configurations:
    - 30-inch
    - 20-inch
    - Twin rows on 30-inch centers
- Each treatment was replicated twice.

Corn Yield Response to Seeding Rate and Row Spacing

Understanding the Results

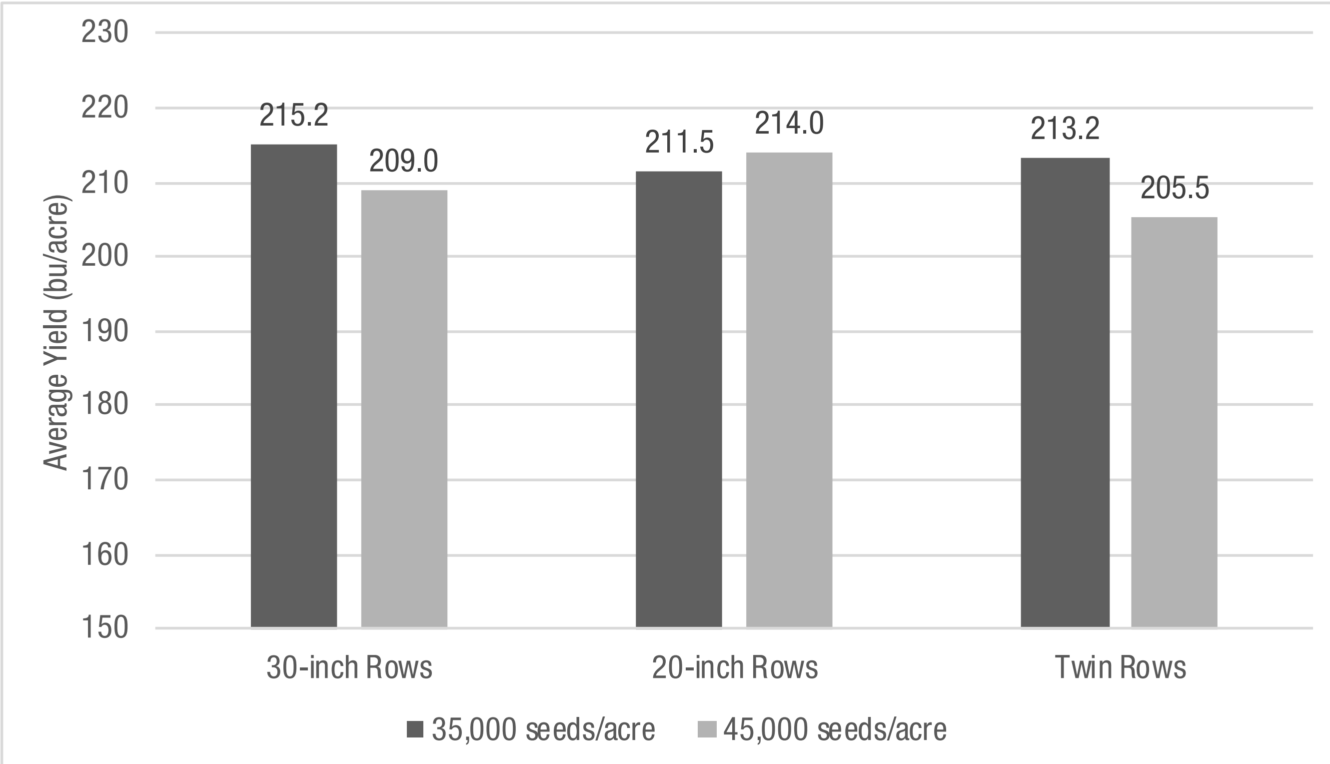

Figure 1. Average corn yield response to seeding rate and row spacing.

Key Learnings

- The results from this demonstration were contradicting to similar work at the Bayer Learning Center over the past several years:
  - Response to either seeding rate or narrower row configuration was not consistent.
  - The very late planting date and other factors may have created more plant growth limitations compared to stresses from plant density.
- The Bayer Learning Centers have generated robust data around optimum plant density for corn. Consult your local Field Sales Representative or Technical Agronomist on tailored recommendations for your specific farm.

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Single Row Seeding Rate Differences in Corn

Trial Objective

- Previous research at the Bayer Crop Science Learning Center at Monmouth, IL would suggest the optimum seeding rate for corn is approximately 36,000 to 38,000 seeds per acre, depending on soil type and genetics.
- A study was conducted to determine if there is any advantage or disadvantage to planting different seeding rates in alternating rows compared to planting a uniform seeding rate in all rows.

Research Site Details

Location	Soil Type	Previous Crop	Tillage Type	Planting Date	Harvest Date	Potential Yield (bu/acre)	Seeding Rate (seeds/acre)
Monmouth, Il	Silt loam	Soybean	Conventional tillage	5/2/20	10/8/20	250	36K

- In this study, all plots were planted at a rate of 36,000 seeds/acre. However, there were two different seeding rate treatments:
  - All rows evenly spaced at 36,000 seeds/acre.
  - Seeding rate for each row alternated at 24,000 and 48,000 seeds/acre, for an average of 36,000 seeds/acre.

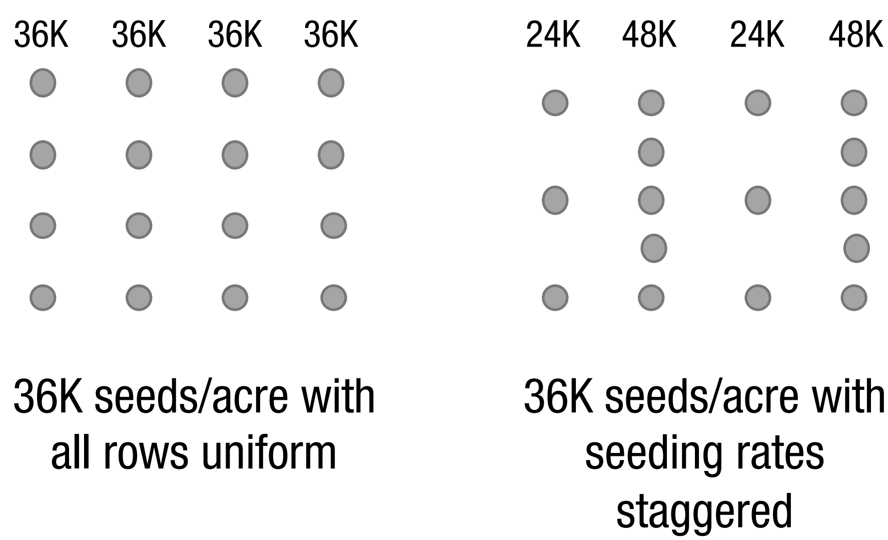

Figure 1. Graphic representation of seeding rate pattern for each treatment.

- Treatments were planted with a commercial planter equipped with individual row control precision technology.
- Each treatment had four replications.

Single Row Seeding Rate Differences in Corn

Understanding the Results

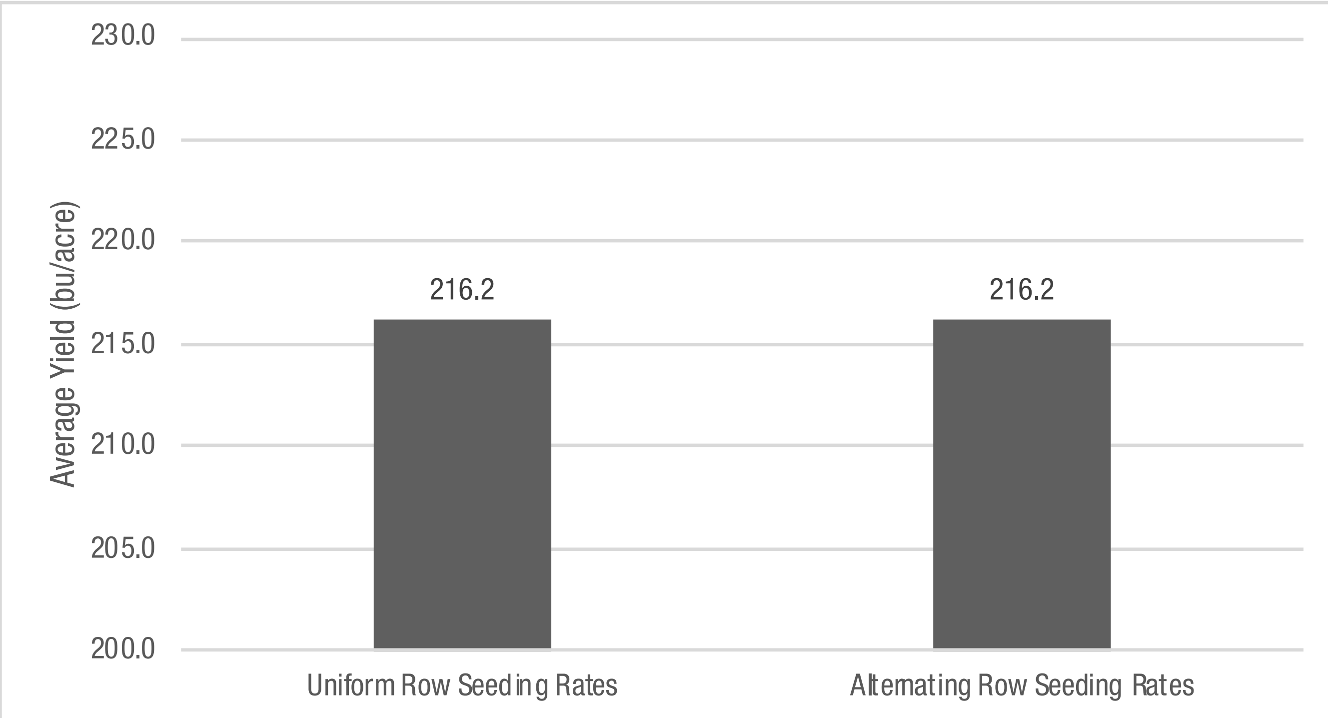

Figure 2. Average yield (bu/acre) comparison of uniform row seeding rates (36,000 seeds/acre) and alternating row seeding rates (24,000 and 48,000 seeds/acre, for an average of 36,000 seeds/acre).

- For this study, no average yield differences were observed between the two different row arrangements, as well as no differences in test weight and grain moisture.

Key Learnings

- Interestingly, it was observed that the uniform seeding rate treatment had more ears, but they were smaller. The alternating row seeding rate had fewer, larger ears. Thus, the overall average grain yield was the same.
- Soil type, fertility levels, growing conditions, and genetics may impact the results when alternating seeding rates in individual rows.
- Consult your local Field Sales Representative or Technical Agronomist for tailored recommendations to fit your farm.

Legal Statements

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Using Starter Fertilizer in Corn

Trial Objective

- Previous research at the Bayer Learning Center at Monmouth, IL has not shown benefit in the ability of in-furrow starter fertilizer to result in grain yield increases in soils with adequate fertility.
- There are many different starter fertilizer products available, with varying claims of efficacy.
- The objective of this research was to evaluate a newer starter fertilizer product for corn.

Research Site Details

Location	Soil Type	Previous Crop	Tillage Type	Planting Date	Harvest Date	Potential Yield (bu/acre)	Seeding Rate (seeds/acre)
Monmouth, Il	Silt loam	Corn	Conventional	6/4/20	10/27/20	250	36K

- This trial consisted of two treatments:
  - An untreated check (UTC).
  - A starter fertilizer treatment applied in-furrow at 2.5 gal per acre with an analysis of 7-17-3 plus the following micronutrients in chelated form:
    - .07% Cu
    - .20% Fe
    - .06% Mn
    - .95% Zn
- All other conditions were the same between the two treatments.
- Soil testing at the site indicated high fertility levels.
- There were six replications in this trial.

Understanding the Results

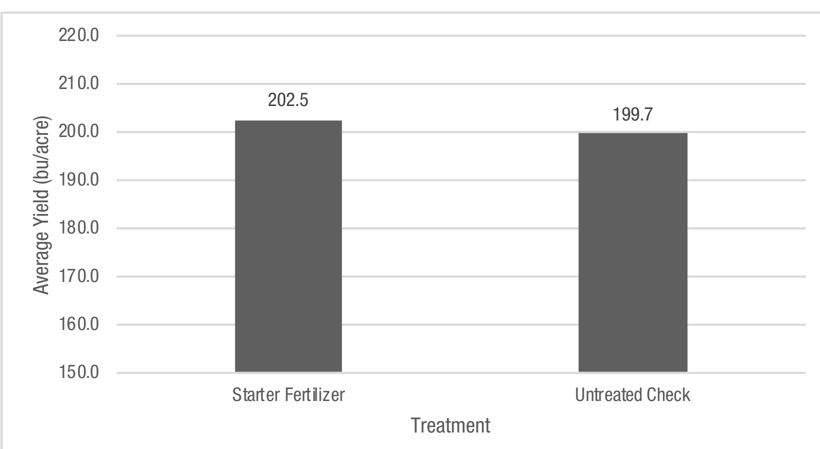

Figure 1. Effect of starter fertilizer on corn yield compared to untreated check in 2020.

Using Starter Fertilizer in Corn

- There was no significant yield difference between plots that received starter fertilizer and the untreated checks in this demonstration trial (Figure 1). This agrees with previous testing at the Bayer Learning Center at Monmouth, IL.
- The late planting date may have led to other factors being more limiting than early season nutrient availability, but these results agree with previous Learning Center results at more typical planting dates.

Key Learnings

- Results suggest that there may be little benefit to starter fertilizer applications in-furrow under the conditions of this testing. It is important to understand the conditions at planting to help with decisions on starter fertilizer in-furrow applications.
- There is some evidence in university data that starter fertilizers may provide a benefit in prolonged cool, wet soil conditions early in the season.1
- Consult your local Field Sales Representative or Technical Agronomist for tailored recommendations for your farm operation.

Source

[1] Hoeft, R. 2000. Will starter fertilizer increase yield? University of Illinois. http://bulletin.ipm.illinois.edu.

Legal Statements

Corn Product Response to Nitrogen Rate

Trial Objective

- Nitrogen (N) is an expensive yet necessary input in corn systems.
- Proper N application rates can help maximize corn yield potential and efficiency while minimizing environmental losses.
- Corn products may have different responses to additional N.
- This trial evaluated corn product yield response to N application rate.

Research Site Details

Location	Soil Type	Previous Crop	Tillage Type	Planting Date	Harvest Date	Potential Yield (bu/acre)	Seeding Rate (seeds/acre)
Monmouth, Il	Silt loam	Soybean	Conventional	5/13/20	10/9/20	250	36K

- Treatments consisted of eight corn products planted at 36,000 seeds/acre with three different N rates applied:
  - 0 lbs/acre
  - 120 lbs/acre
  - 240 lbs/acre
- Nitrogen in the form of 32% urea and ammonium nitrate (UAN) (32-0-0) was applied preplant and incorporated.
- Plots were harvested and adjusted to 15% moisture
- There were three replications of each treatment.

Corn Product Response to Nitrogen Rate

Understanding the Results

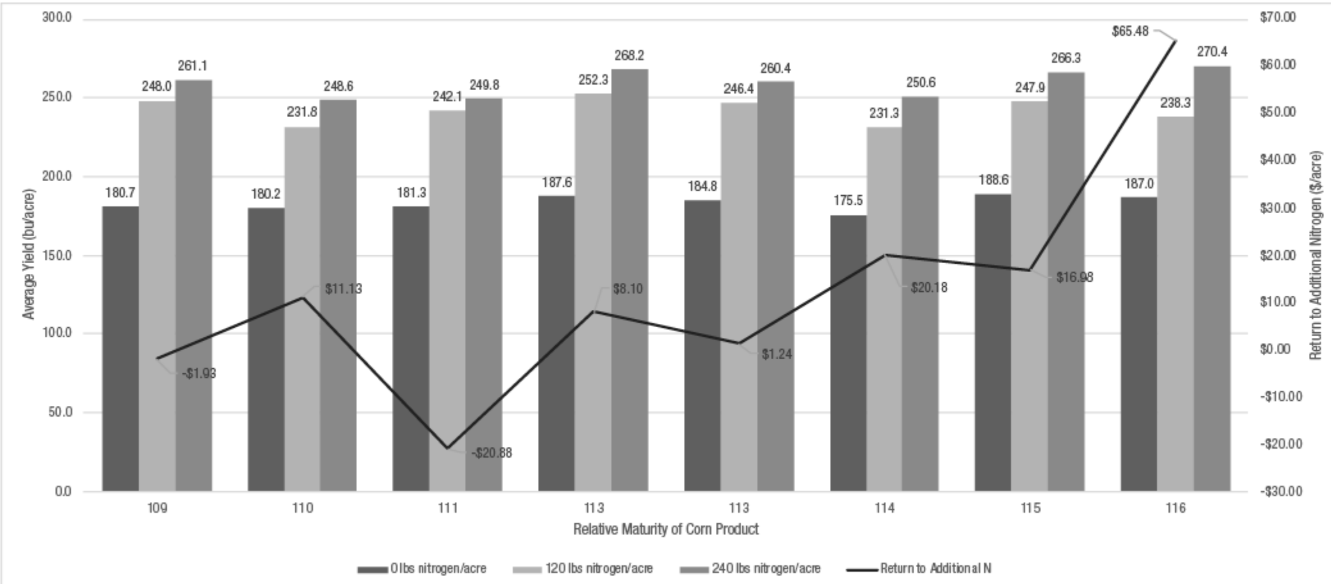

Table 1. Average yield response and return of additional nitrogen ($/acre) by corn product and nitrogen treatment (120 lbs N/acre and 240 lbs N/acre). Calculation assumes a $3.53/bu corn market price and $.40/lb for N.

- Response to N rate treatments varied by corn product.
- When factoring in N cost, increasing N rate was not always profitable.

Key Learnings

- Many factors, including product genetic background, soil type, weather, previous crop, tillage, etc., can influence the yield response and profitability potential of a N application.
- It is important to consider yield goals and N cost when making management decisions.
- Response to N can vary from year to year. Consult your local Field Sales Representative or Technical Agronomist for recommendations for your farm.

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Corn Product Response to Nitrogen Rate and Timing

Trial Objective

- Nitrogen (N) is a key input in corn production and is essential for a successful and profitable corn crop. It is also expensive and can be difficult to manage.
- Genetics may be an important factor in the optimum nitrogen rate and timing of application.
- This trial was conducted to evaluate the response of several corn products to different nitrogen management strategies.

Research Site Details

Location	Soil Type	Previous Crop	Tillage Type	Planting Date	Harvest Date	Potential Yield (bu/acre)	Seeding Rate (seeds/acre)
Monmouth, IL	Silt loam	Corn	Conventional	5/12/20	10/8/20	250	36K

- Treatments consisted of six corn products planted at 36,000 seeds/acre and three nitrogen management strategies, for a total of 18 treatments.
  - Nitrogen (N) rates and timings:
    - 180 lbs N/acre applied preplant incorporated (PPI)
    - 140 lbs N/acre PPI followed by 40 lbs N/acre side-dressed at V6
    - 180 lbs N/acre PPI followed by 40 lbs N/acre side-dressed at V6
- All nitrogen was applied as 32% UAN solution. A urease inhibitor was added to the side-dress applications.
- Plots were harvested and adjusted to 15% moisture.

Understanding the Results

- This demonstration assumes $3.53 per bushel, $.50 per pound of N, and $8.00 per acre for side dress application costs (Figure 1).
- These results would suggest that 180 lbs of N was close to the optimum nitrogen rate.
- There was a range in average yield response to nitrogen rate and side-dressing.
- With one exception, the products tested responded more positively to splitting the nitrogen application (140 lbs N/acre PPI followed by 40 lbs N/acre side-dressed at V6) compared to adding additional nitrogen beyond 180 lbs N/acre (180 lbs N/acre PPI followed by 40 lbs N/acre side-dressed at V6).
- Return over nitrogen cost generally followed the yield trend, although in some cases an increase in yield did not result in an increase in net return.

Corn Product Response to Nitrogen Rate and Timing

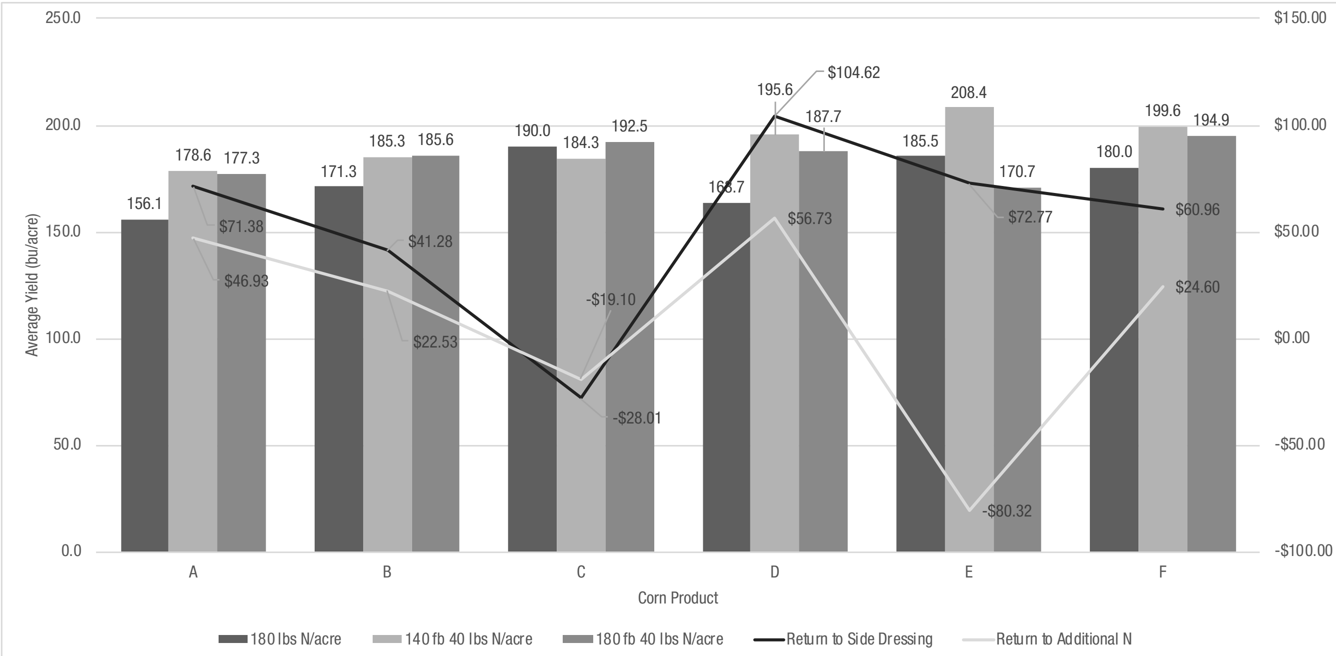

Figure 1. Average yields (bu/acre) of six different corn products at three different nitrogen rates and timings and return over nitrogen cost.

Key Learnings

- Many factors, including product genetics, soil type, weather, previous crop, tillage, can influence the yield response and profitability of a nitrogen application.
- It is important to consider yield goals and nitrogen cost when making management decisions.
- Response to nitrogen can vary from year to year. Consult your local Field Sales Representative (FSR) or Technical Agronomist for recommendations for your farm.

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Comparing Corn Rootworm Trait Platforms

Trial Objective

- The corn rootworm complex, (Western corn rootworm, Northern corn rootworm, and Mexican corn rootworm) is commonly referred to as the 'billion-dollar pest complex' due to it's potential to adversely affect yield.
- Various companies offer several choices of corn products that contain *Bacillus thuringiensis* (Bt) proteins to control corn rootworm.
- With this is mind, the Bayer Learning Center at Monmouth, Il conducted a demonstration to compare the effectiveness of several competing pyramided corn products containing more than one Bt protein active against corn rootworm.

Research Site Details

Location	Soil Type	Previous Crop	Tillage Type	Planting Date	Harvest Date	Potential Yield (bu/acre)	Seeding Rate (seeds/acre)
Monmouth, Il	Silt loam	Corn	Conventional tillage	6/4/20	10/27/20	250	36K

- This demonstration consisted of six total treatments including three different competitive trait platforms, each containing a 5% refuge blend of a non-Bt corn product:
  - Treatment 1: a 114 RM VT Double PRO® RIB Complete® corn blend
  - Treatment 2: a 114 RM SmartStax® RIB Complete® corn blend (same genetic background as Treatment 1)
  - Treatment 3: a 113 RM SmartStax® RIB Complete® corn blend
  - Treatment 4: a 103 RM Pioneer® brand Qrome® product, P0306Q Brand
  - Treatment 5: a 103 RM Pioneer® brand Optimum® AcreMax® XTreme product, P0306AMXT Brand (same genetic background as Treatment 4)
  - Treatment 6: a 113 RM Agrisure Duracade® product, NK1354-5222 E-Z Refuge Brand
- Each treatment had two replications.
- This trial was conducted in a field area that was in its third year of corn with a prior history of rootworm feeding.

Comparing Corn Rootworm Trait Platforms

Understanding the Results

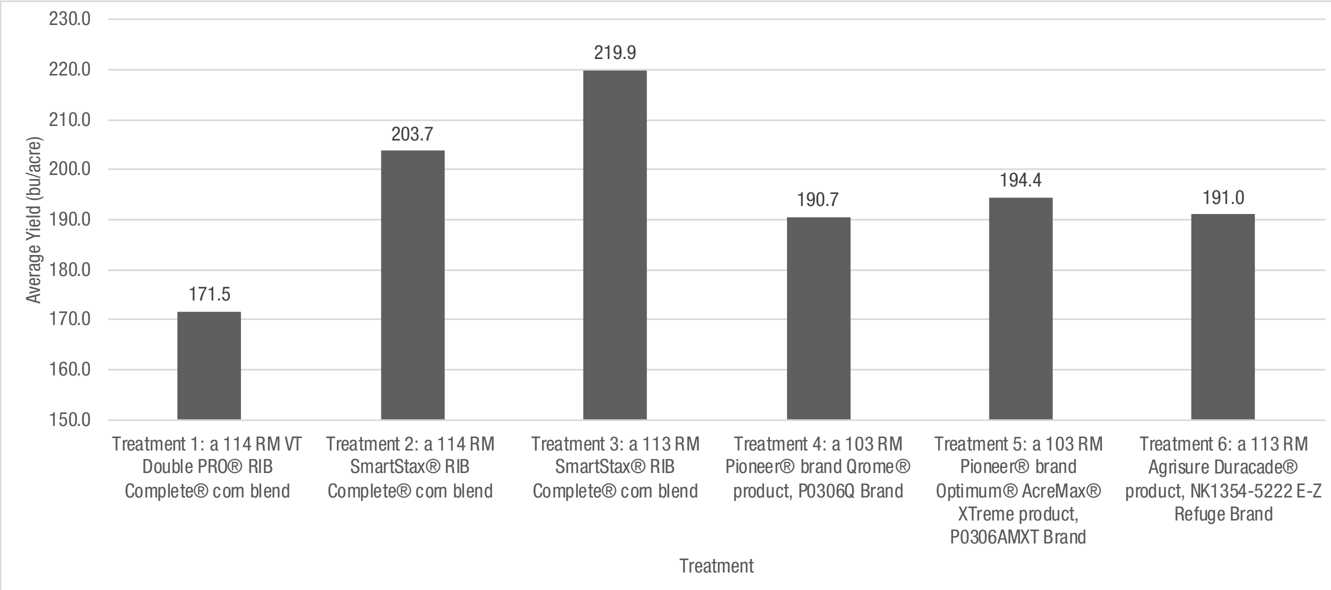

Figure 1. Average yield (bu/acre) per treatment.

- All products with CRW trait protection yielded higher than Treatment 1, which contained no trait protection for CRW.
- There are many variables affecting yield, such as genetics and RM, but in this trial both SmartStax® RIB Complete® corn blend products (Treatment 2 and Treatment 3) yielded higher than the competitive trait platforms (Treatments 4, 5, and 6).

Key Learnings

- SmartStax® RIB Complete® corn blend products contain two proteins for corn rootworm control to help maximize yield potential.
- An effective corn rootworm management program should consist of multiple best management practices. This could include an effective pyramided trait corn product such as SmartStax® Technology.
- Consult with your local Field Sales Representative or Technical Agronomist for custom tailored recommendations to fit your specific needs.

Comparing Corn Rootworm Trait Platforms

Legal Statements

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ALWAYS READ AND FOLLOW PESTICIDE LABEL DIRECTIONS. SmartStax® PRO RIB Complete® corn blend is not currently available for commercial sale or commercial planting. Commercialization is dependent on multiple factors, including successful conclusion of the regulatory process. The information presented herein is provided for educational purposes only, and is not and shall not be construed as an offer to sell.

B.t. products may not yet be registered in all states. Check with your seed brand representative for the registration status in your state.

IMPORTANT IRM INFORMATION: RIB Complete® corn blend products do not require the planting of a structured refuge except in the Cotton-Growing Area where corn earworm is a significant pest. See the IRM/Grower Guide for additional information. Always read and follow IRM requirements.

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Insect Resistance Management
Planting Refuges, Preserving Technology

Before opening a bag of seed, be sure to read, understand and accept the stewardship requirements, **including applicable refuge requirements for insect resistance management,** for the biotechnology traits expressed in the seed as set forth in the Monsanto Technology/Stewardship Agreement that you sign. By opening and using a bag of seed, you are reaffirming your obligation to comply with the most recent stewardship requirements.

Using 2020 Corn Rootworm Beetle Counts to Assess the Risk of Economic Injury in 2021

Trial Objective

- Monitoring of corn rootworm (CRW) beetle numbers in current corn and soybean fields can be used to help assess the potential risk of a CRW larval infestation reaching economic damage levels in corn fields during the next growing season.
- This information may help guide decisions regarding management strategies including corn product selection.
- The objective of this study was to measure adult CRW populations in corn and soybean fields in 2020 to assist in risk evaluation for 2021.

Research Site Details

Location	Soil Type	Previous Crop	Tillage Type	Planting Date	Harvest Date	Potential Yield (bu/acre)	Seeding Rate (seeds/acre)
1440 fields	Drained or well-drained	Various	Various	Various	Various	110-250	Various

- One to four Pherocon® AM non-baited trapping sites were established at 1440 field locations across the corn-growing areas of IA, IL, IN, OH, MI, WI, MN, ND, SD, NE, KS, CO, and MO (Figure 1).
- The trapping sites were installed in the interiors of corn and soybean fields that encompassed a variety of crop and management histories. Soybean fields were sampled in parts of the corn-growing area to assess the potential risk associated with the variant western CRW, which is known to lay eggs in soybean fields.
- The Pherocon® AM traps were changed at 5- to 10-day intervals for 2-8 consecutive weeks through CRW adult emergence, mating, and egg laying phases (late July through late September).
- Following each sampling interval, the counts of adult northern and western CRW beetles were recorded and used to calculate the average number of CRW beetles/trap/day by field.
- At the end of the collective sampling period, the average capture value for each field was determined and the data were used in further analysis.

Understanding the Results

Categories for CRW beetle counts are based on action thresholds (beetles/trap/day) suggested by Extension entomologists at the University of Illinois (UI) and Iowa State University (ISU) and provide the economic injury potential for the following season.[1,2]

- Less than 2 beetles/trap/day indicate a relatively low risk of economic injury.
- Greater than 1 beetle/trap/day suggests a low risk for economic injury but could indicate populations are increasing.
- Greater than 2 beetles/trap/day indicate the probability for economic injury is likely if control measures are not used.
- Greater than 5 beetles/trap/day indicate that economic injury is very likely, and populations are expected to be very high the following year.

Using 2020 Corn Rootworm Beetle Counts to Assess the Risk of Economic Injury in 2021

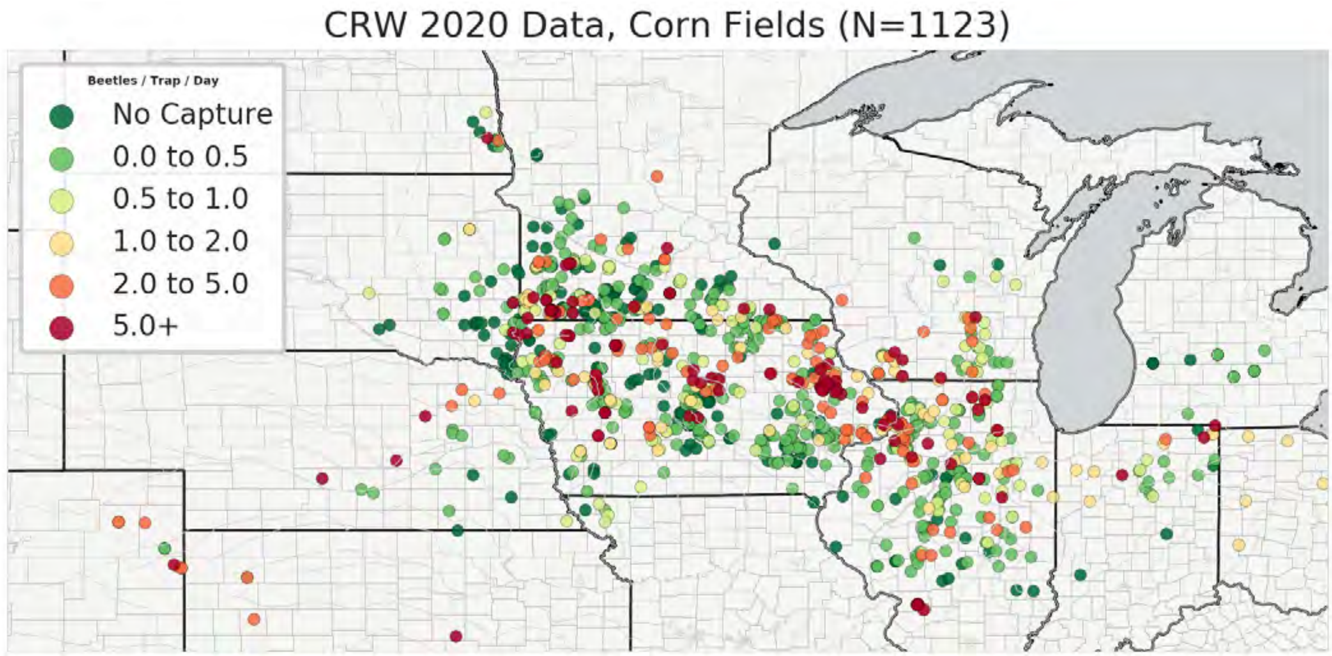


Figure 1a. Corn field locations for corn rootworm trapping in 2020.

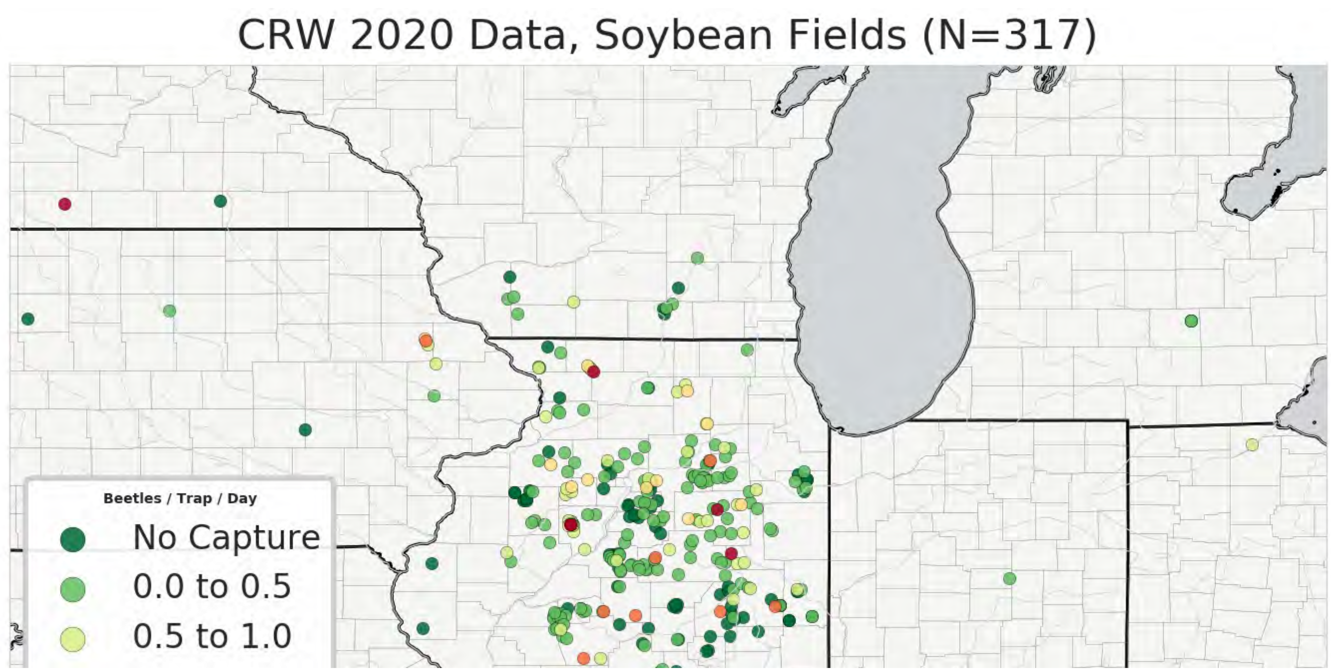
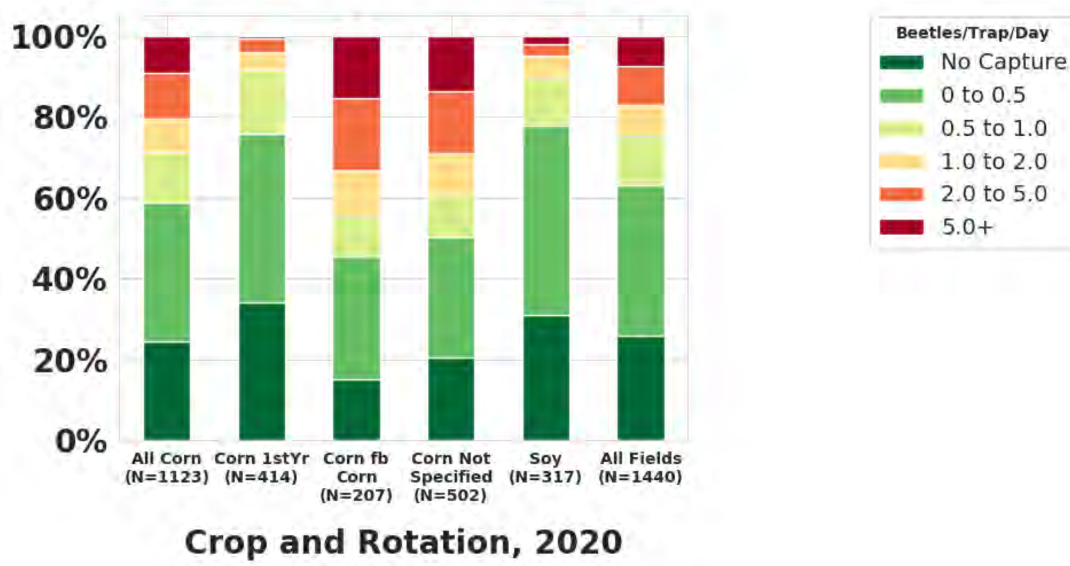


Figure 1b. Soybean field locations for corn rootworm trapping in 2020.

Using 2020 Corn Rootworm Beetle Counts to Assess the Risk of Economic Injury in 2021



(Data in this graph are the result of field trials conducted on 1440 field plots in 13 different states in 2020).

Figure 2. Overall summary of average corn rootworm beetles captured per trap per day.[1,2]

Table 1. Summary of field sampling and adult corn rootworm captures in 2020.

2020 Crop	2019 Crop	Number of Sampled Fields	Average Peak Number of Corn Rootworm Beetles/Trap/Day
Total Corn	All Rotations	1123	1.73
Corn	Soybean	414	0.42
Corn	Corn	207	2.79
Corn	Not Specified	502	2.36
Soybean	Corn	317	0.5
Corn and Soybean	All Rotations	1440	1.46

2020 CRW Beetle Survey Data

- CRW populations were variable across the corn-growing area, which suggests that environment and management affect CRW pressure.
- 22% of corn fields had counts exceeding the economic threshold of 2 beetles/trap/day.
- 8% of the corn fields were approaching threshold levels.
- Corn followed by (fb) corn had higher average maximum daily counts than first-year corn (2.79 vs. 0.42 beetles/trap/day) (Table 1).
- Of the corn fb corn fields, 33% exceeded the economic threshold while less than 3.9% of first-year corn fields exceeded the threshold (Figure 2).
- Counts from soybean fields were low, with no adults being captured in 29% of the fields and fewer than 4.7% of the fields exceeding the threshold.
- Counts of 0 were recorded in 21% of corn fields sampled.

Using 2020 Corn Rootworm Beetle Counts to Assess the Risk of Economic Injury in 2021

2020 Data Interpolation

- Point data were interpolated to estimate populations and relative risk at the landscape level.
- To account for variations in sampling density and distribution, interpolations were based on average maximum values calculated within a systematic grid applied to the estimation area.
- On a broad scale, CRW populations, and consequently 2021 risk potential, are possibly elevated in corn fields in central and southwest NE, northeast CO, northwestern KS, west, central, and east central IA, southwest WI, northern IL, central and southern MN, and southeastern ND (Figure 3).
- Corn rootworm populations are estimated to be relatively low in many parts of ND, SD, MN, IN, and central IL; however, localized hot spots can be found every year.
- CRW beetle presence in soybean fields was found to be low in most of the areas that were sampled.

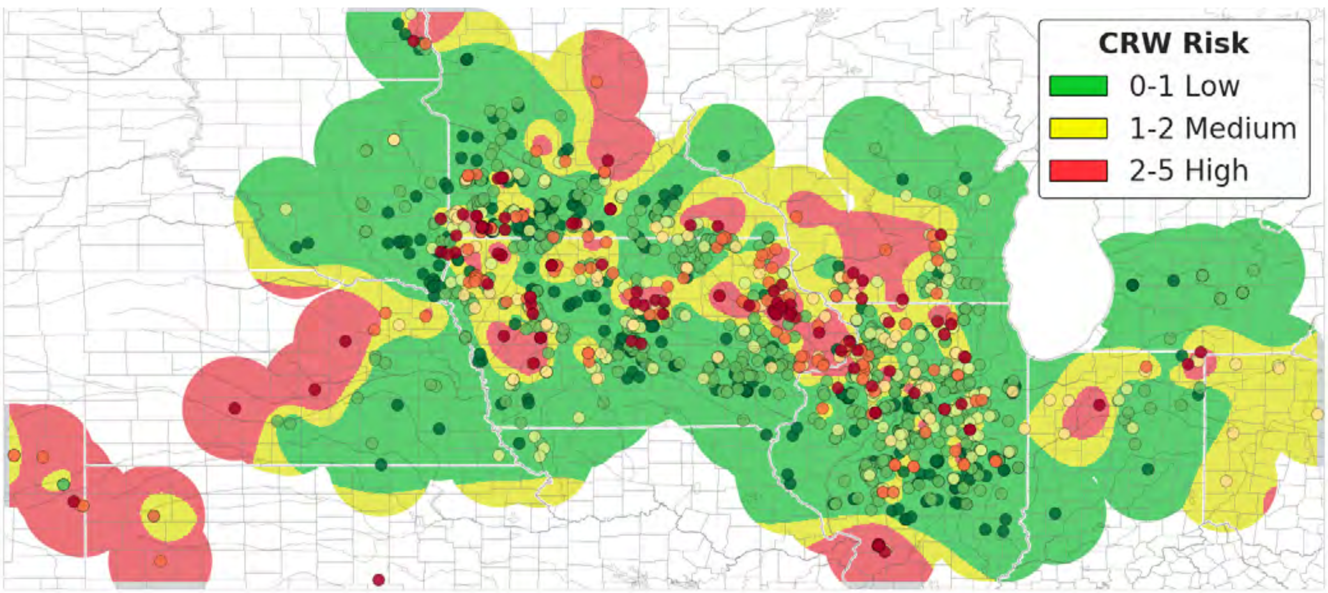


Figure 3. Estimated corn rootworm risk in 2021 using interpolated 2020 corn rootworm data from all fields sampled.

Comparison of 2019 vs. 2020 CRW Beetle Data (Figures 4a and 4b).

- Absolute comparisons between 2019 and 2020 populations should be made with limited confidence due to differences in sampling intensity and distribution. However, trends may still be reliably identified.
- Areas with large populations (i.e. “hot spots”) are generally consistent from year to year.

Using 2020 Corn Rootworm Beetle Counts to Assess the Risk of Economic Injury in 2021

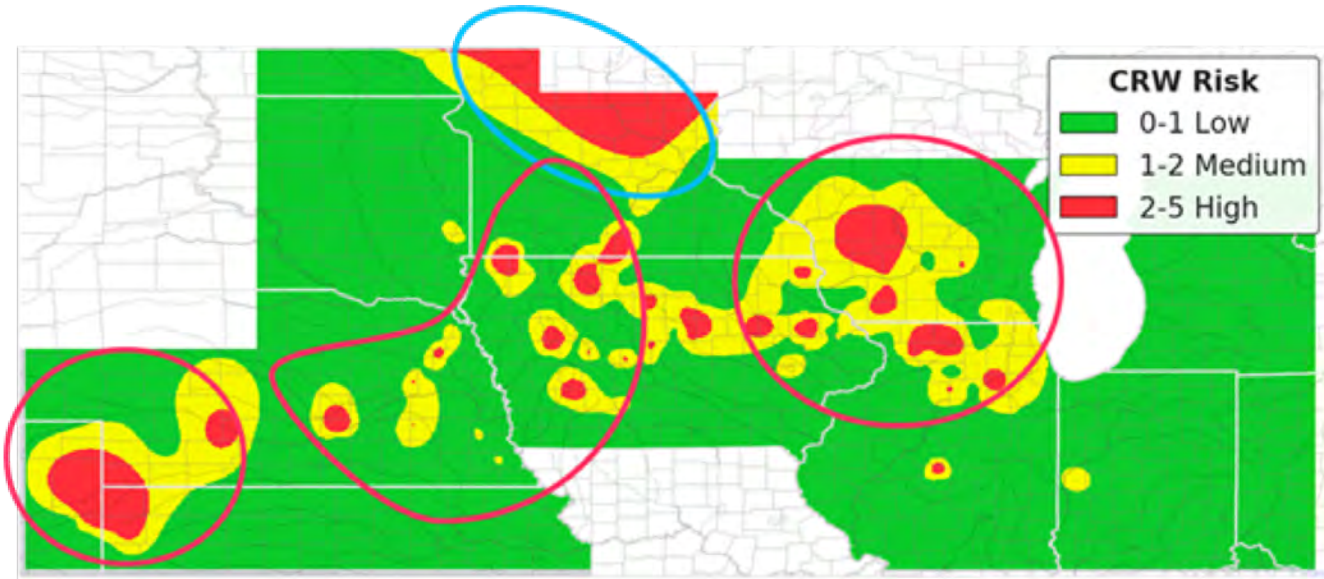


Figure 4a. Estimated corn rootworm risk in 2020 using interpolated 2019 corn rootworm counts from corn fields sampled (based on 1123 fields).

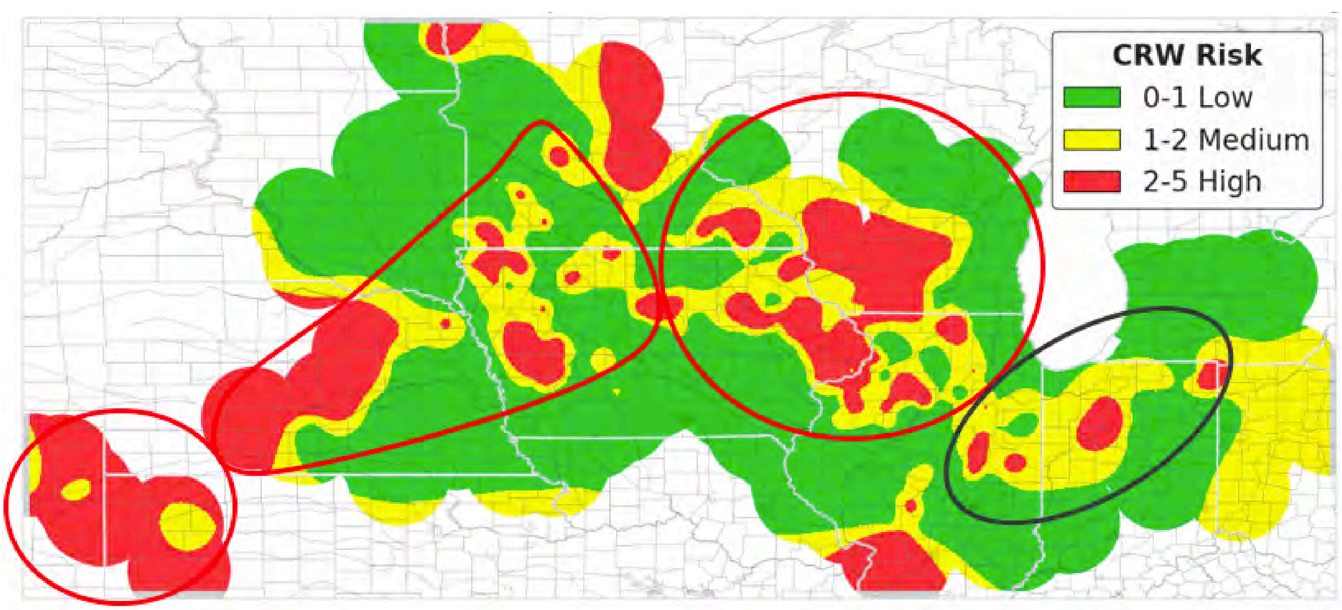


Figure 4b. Estimated corn rootworm risk in 2021 using interpolated 2020 corn rootworm counts from corn fields sampled (based on 1123 fields).

Using 2020 Corn Rootworm Beetle Counts to Assess the Risk of Economic Injury in 2021

Key Learnings

- Corn rootworm is a persistent and annual threat to yield and profit potential, making it a pest that cannot be ignored. University research has demonstrated that even a moderate level of CRW feeding can cause yield losses averaging 15% with losses of 45% or more being possible.[3]
- In the absence of site-specific data, local/regional surveys may provide insight at the landscape level and can be used to make informed decisions regarding management and product selection decisions.
- Beetle numbers and infestation geographies change. Continue to monitor present and historical data to gain information regarding CRW infestation potential. This information can be used to help prepare for the 2021 season and the selection of CRW Bacillus thuringiensis (B.t.)-protected corn products or soil-applied insecticides to protect your crop against the risk of CRW larvae damaging roots and reducing your yield potential.

Sources

[1] Western corn rootworm. Diabrotica virgifera virgifera LeConte. Extension & Outreach. Department of Crop Sciences. University of Illinois. http://extension.cropsciences.illinois.edu/fieldcrops/insects/western_corn_rootworm.

[2] Hodgson, E. and Gassmann, A. 2016. Guidelines for using sticky traps to assess corn rootworm activity. Integrated Crop Management. Iowa State University. https://crops.extension.iastate.edu/cropnews/2016/06/guidelines-usingsticky-traps-assess-corn-rootworm-activity.

[3] Tinsley, N.A., Estes, R.E., and Gray, M.E. 2012. Validation of a nested error component model to estimate damage caused by corn rootworm larvae. Journal of Applied Entomology.

Legal Statements

Dicamba Formulation Impact on Corn

Trial Objective

- Dicamba, a growth regulator, is an effective herbicide for early weed control in corn. However, using a dicamba formulation that doesn't contain a safener can cause brace root abnormalities (fusing) and increased stalk brittleness.[1] These injuries can lead to an increase in greensnap, root lodging, and a subsequent decrease in corn yield.
- The objective of this study was to determine the effect of safened versus unsafened dicamba products on plant health and yield of corn.

Research Site Details

Location	Soil Type	Previous Crop	Tillage Type	Planting Date	Harvest Date	Potential Yield (bu/acre)	Seeding Rate (seeds/acre)
Gothenburg, NE	Hord silt loam	Corn	Strip till	4/30/20	10/31/20	250	36,000

- The study was setup as a split-plot design with herbicide treatments as the whole plot and corn products as the sub-plot with four replications.
- The three herbicide treatments were a non-dicamba treated check, an unsafened dicamba product application, and a safened dicamba product application.
  - » The unsafened dicamba formulation was Sterling Blue® herbicide at a rate of 0.5 qt/acre.
  - » The safened dicamba formulation was DiFlexx® herbicide at a rate of 0.5 qt/acre.
- All dicamba treatments, including the non-dicamba check, were applied on 6/24/20 in combination with Delaro® 325 SC fungicide (0.125 qt/acre), Roundup PowerMAX® herbicide (1 qt/acre), and AMS (17 lb/100 gallon) at the V6 growth stage of corn.
- Five corn products were used in this study.
  - » 104 relative maturity (RM) and 107-RM corn products with growth regulator herbicide injury ratings of CAUTION.
  - » 105-RM, 109-RM and 113-RM corn products with growth regulator herbicide injury ratings of ACCEPTABLE.
- All treatments received herbicide applications of Roundup PowerMAX herbicide (32 oz/acre), Harness® herbicide (2 pt/acre), Balance® Flexx herbicide (3 pt/acre), and Atrazine 4L herbicide (32 oz/acre) on 5/1/20.
- Corn was sprinkler irrigated and fertilized with 70 lb phosphorus/acre, 15 lb sulfur (S)/acre, and 27.5 lb nitrogen (N)/acre via strip till on 4/26/20; 100 lb N/acre applied 4/28/20 using Stream Bars; and 15 lb S/acre and 90 lb N/acre applied sidedress on 6/26/20 with 360 Y-DROP® applicators.
- Shelled corn weight, moisture, and test weight were collected to calculate average yield. Corn greensnap counts were taken to determine the percent greensnap.

Figure 1. Corn product on August 17, 2020 with the safened dicamba formulation treatment of DiFlexx® herbicide.

Dicamba Formulation Impact on Corn

Understanding the Results

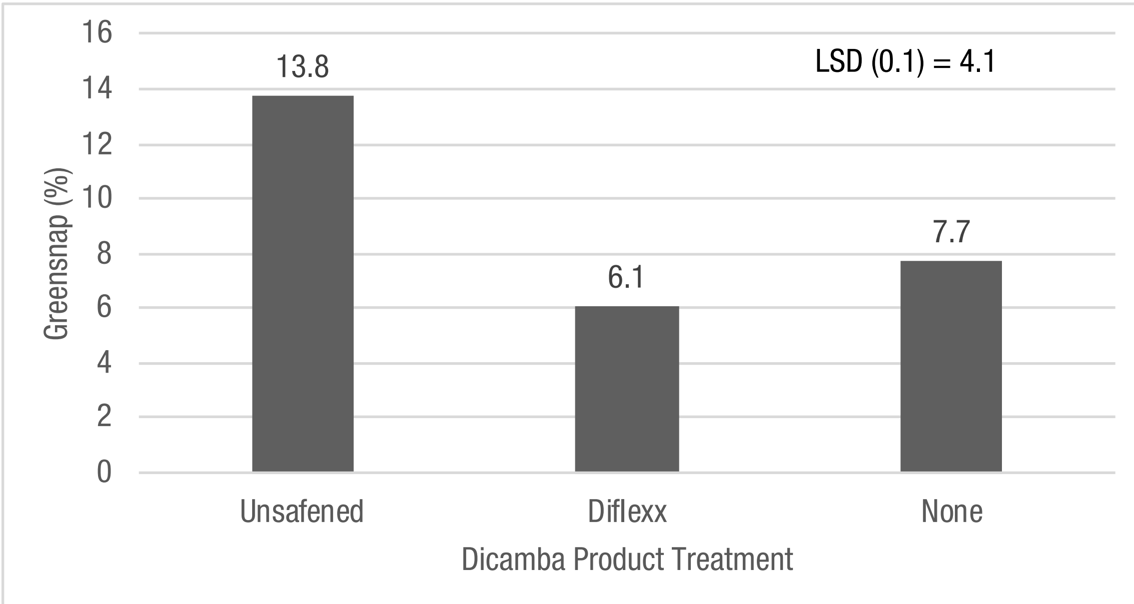


Figure 2. Average corn yield with unsafened and safened dicamba herbicide products.

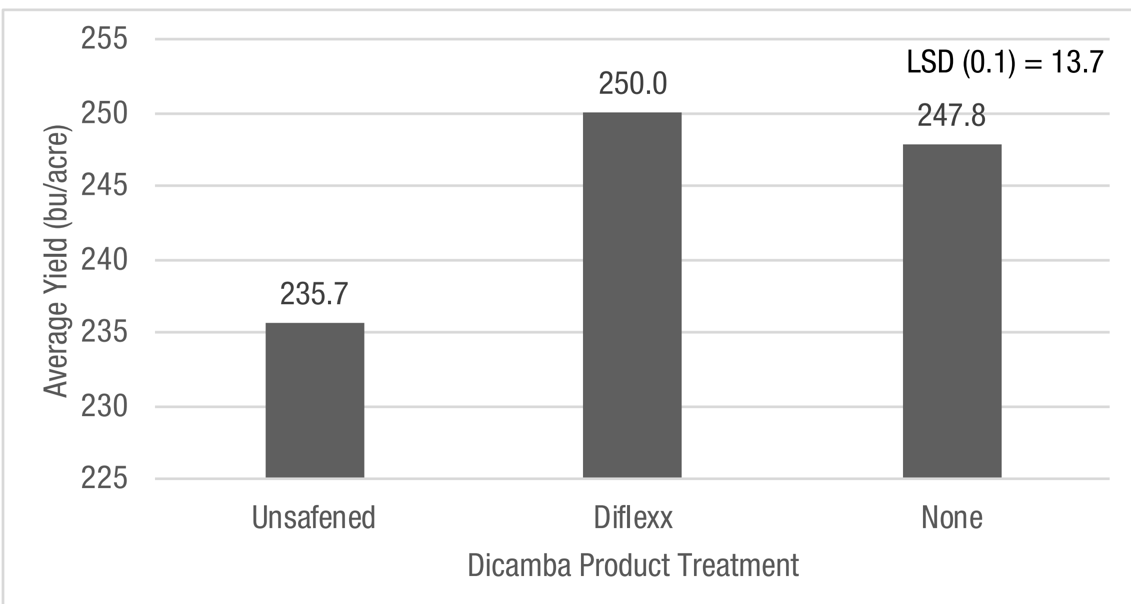


Figure 3. Greensnap percentage impact from unsafened and safened dicamba herbicide products averaged across corn products.

Dicamba Formulation Impact on Corn

Table 1. Average greensnap percentage and yield for each corn product under different dicamba herbicide formulation treatments.						
	Non-treated		DiFlexx® Herbicide (Safened)		Unsafened Dicamba	
Corn Product	Greensnap (%)	Average Yield (bu/acre)	Greensnap (%)	Average Yield (bu/acre)	Greensnap (%)	Average Yield (bu/acre)
104-RM	16.1	235.6	7.4	243.2	22.4	217.9
105-RM	12.0	243.4	12.4	243.1	18.3	224.5
107-RM	1.3	253.2	2.4	246.9	2.4	239.6
109-RM	6.2	255.2	4.3	256.8	11.1	241.0
113-RM	2.9	251.4	4.2	254.2	11.1	244.3

- For this trial, the safened dicamba formulation treatment of DiFlexx® herbicide produced an average corn yield that was significantly greater than the unsafened dicamba formulation herbicide treatment (Figure 2).
- Corn greensnap percentage was significantly higher for the unsafened dicamba formulation treatment compared to the safened DiFlexx herbicide treatment and the non-treated check (Figure 3).
- The greater percentage of greensnap in the unsafened dicamba formulation treatment was likely a result of stalk brittleness that directly reduced corn yield.
- There was little difference in percent greensnap between corn products with CAUTION and ACCEPTABLE growth regulator herbicide injury ratings (Table 1).

Key Learnings

- Unsafened dicamba formulation products can have the potential to cause corn to greensnap at a higher rate than corn treated with safened dicamba formulation products.
- Farmers are encouraged to use safened dicamba formulation products like DiFlexx® herbicide as an option for early weed control in corn to help lower the risk of crop damage and decreased yield potential that can be observed when using unsafened dicamba herbicide products.

Reference

[1] Clay, S. 2016. Chapter 42: Herbicide injury to corn. In Clay, D., Carlson, C., Clay, S., and Byamukama, E. (eds). iGrow Corn: Best Management Practices. South Dakota State University. https://extension.sdstate.edu.

Legal Statements

Evaluation of Disease Management Systems in Soybean – White Mold

Trial Objective

- White mold (WM, also called Sclerotinia stem rot) is a substantial problem in the U.S. North Central soybean production region and in Canada. Caused by the fungus *Sclerotinia sclerotiorum* that overwinters in the soil, WM is often recognized by fluffy, white growth on soybean stems. WM development is favored by cool, cloudy, wet, and humid weather at first flowering. The disease is more problematic in soybeans in high-yield environments where high plant populations, narrow row spacing, and an early-closing canopy are commonly used.
- The objective of this study was to evaluate a system-based approach for WM disease management supported by genetic resistance of germplasm and foliar fungicide.
- Soybean products with varying levels of resistance to WM were evaluated under different fungicide management options.

Research Site Details

- Fields with a history of WM were selected for this study.
- Plots were planted in a split-plot design with fungicide treatment as the main plot and soybean product as the sub-plot.
- Fungicide treatments included:
  - Untreated
  - Application of Delaro® 325 SC fungicide (Group 3 + Group 11) at 8 oz/acre tank-mixed with Luna® Privilege (Group 7) fungicide at 2 oz/acre at R1
  - Application of Delaro 325 SC fungicide at 8 oz/acre tank-mixed with Luna Privilege fungicide at 2 oz/acre at R1 and R3
- Soybean products used were classified as susceptible (S), moderately susceptible (MS), moderately resistant/ moderately susceptible (MR/MS), moderately resistant (MR), or resistant (R) to WM.
  - Resistant varieties were left out of most data analyses because they were unavailable or missing from 5 out of the 13 locations.
- Plots were randomized within the trial.
- WM disease ratings were taken at the R6 growth stage.
- 50 trial locations from 2019 and 2020 were planted for this study, and the data shown below is the average of the 13 locations (26%) kept for this analysis because they had moderate to high white mold pressure.

Evaluation of Disease Management Systems in Soybean – White Mold

Understanding the Results

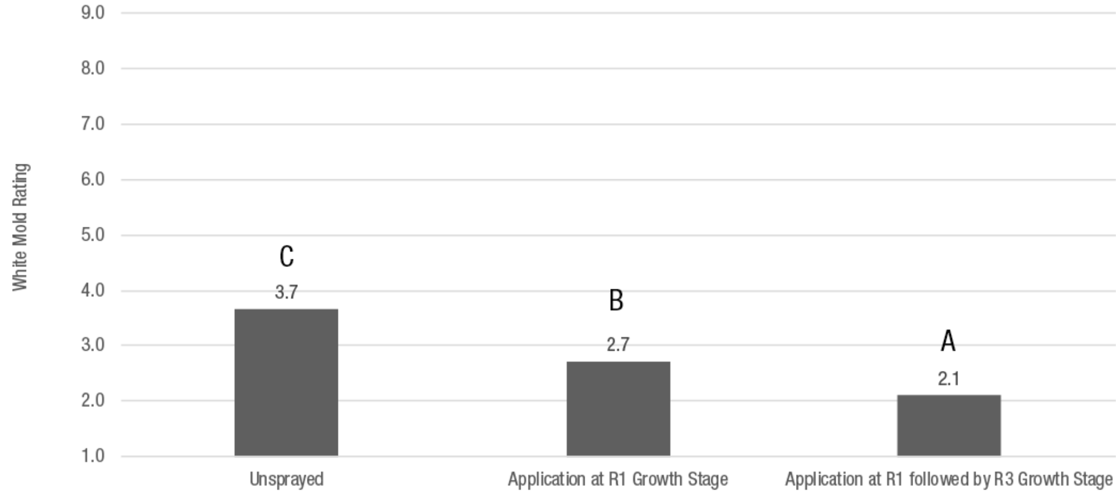


Figure 1. Average WM disease index rating for each fungicide treatment of Delaro® 325 SC fungicide tank-mixed with Luna® Privilege fungicide. WM disease index: 1 = no disease, 9 = severe disease. Mean separation letters (a, b, c) denote statistically significant differences at an alpha = 0.1.

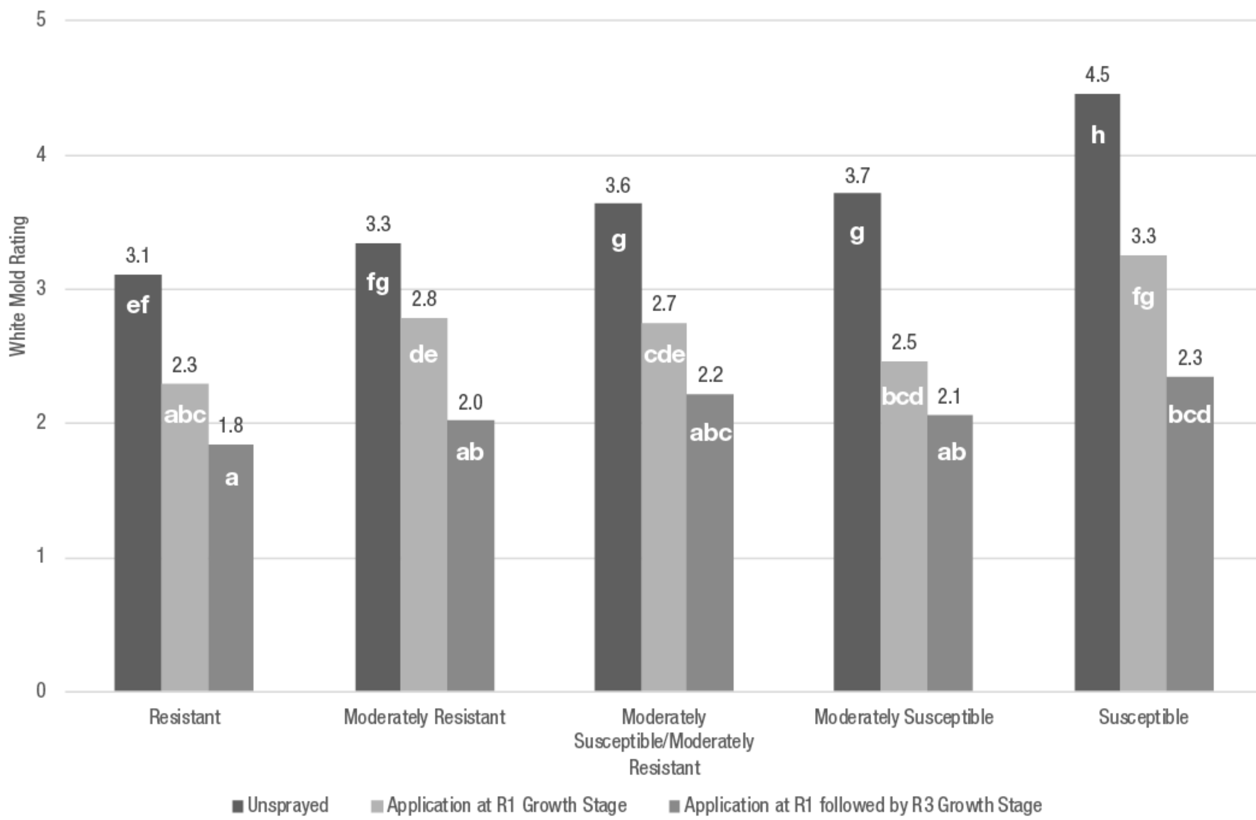


Figure 2. Average WM disease index rating by fungicide spray treatment and WM disease classification of soybean products. Fungicides: Delaro® 325 SC fungicide tank-mixed with Luna® Privilege fungicide. WM disease index: 1 = no disease, 9 = severe disease. Mean separation letters (a through h) denote statistically significant differences at an alpha = 0.1.

Evaluation of Disease Management Systems in Soybean – White Mold

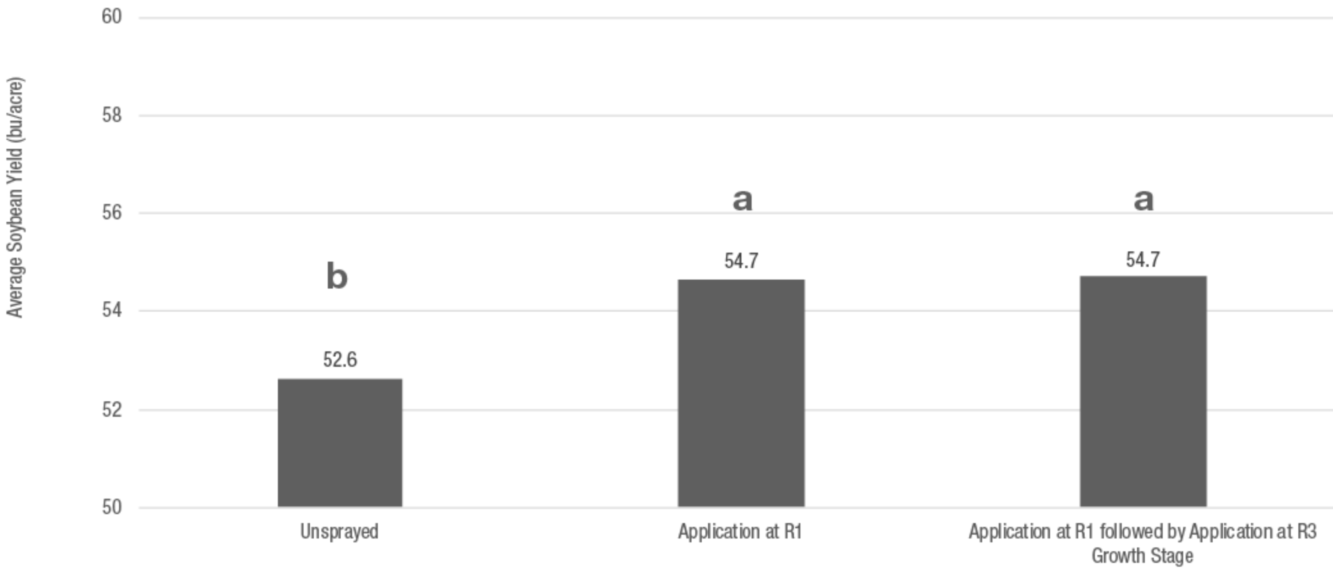


Figure 3. Average yield for each fungicide treatment across all soybean products and locations. Fungicides: Delaro® 325 SC fungicide tank-mixed with Luna® Privilege fungicide. Mean separation letters (a, b) denote statistically significant differences at an alpha = 0.1.

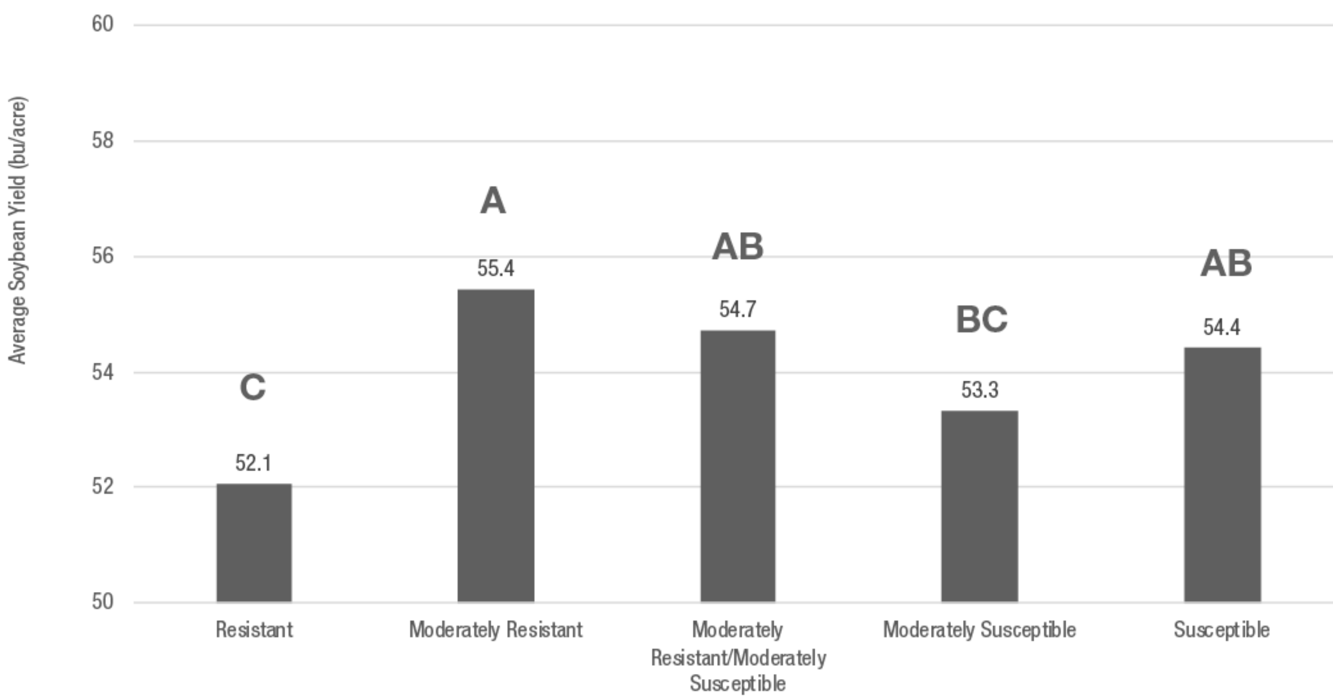


Figure 4. Average yield of treatments for each WM disease classification of soybean products. Mean separation letters (a) denote statistically significant differences at an alpha = 0.1.

Evaluation of Disease Management Systems in Soybean – White Mold

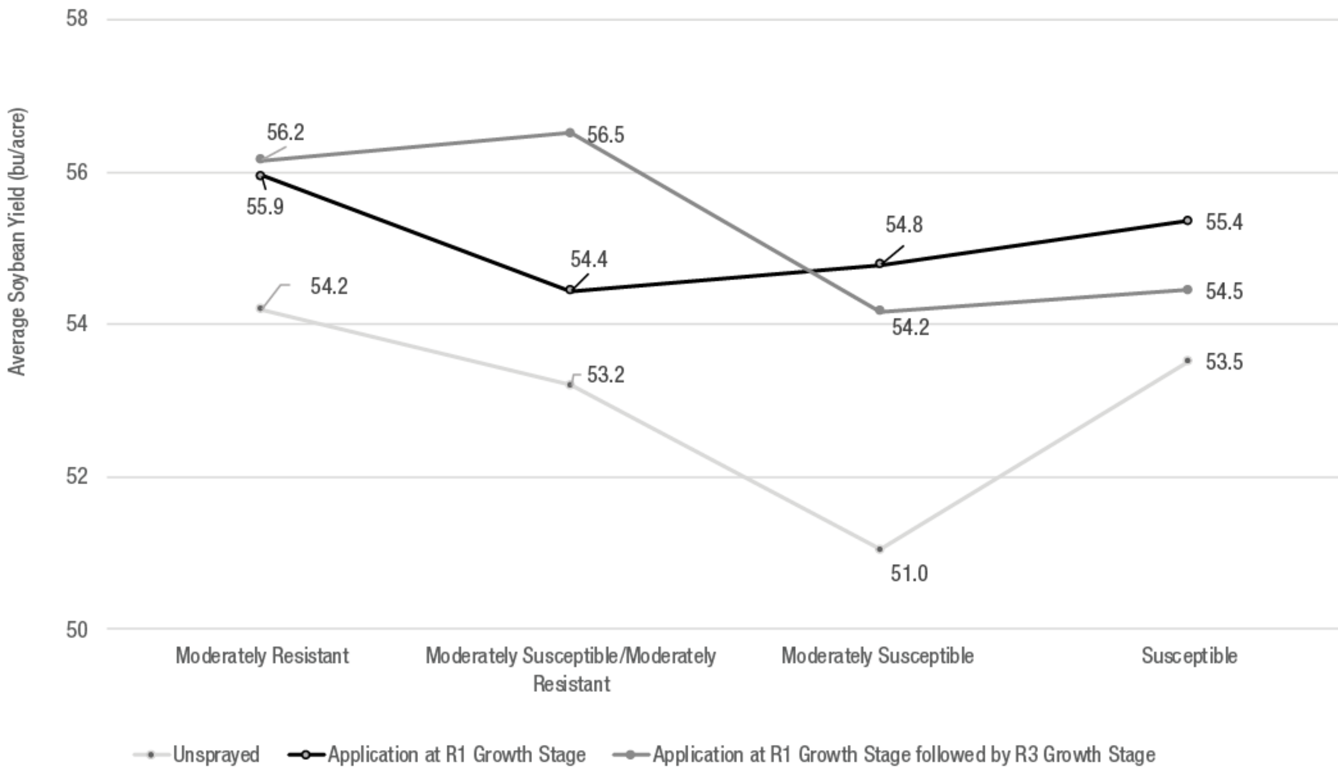


Figure 5. Average yield by fungicide treatment and WM disease classification of soybean products. Fungicides: Delaro® 325 SC fungicide tank-mixed with Luna® Privilege fungicide.

Evaluation of Disease Management Systems in Soybean – White Mold

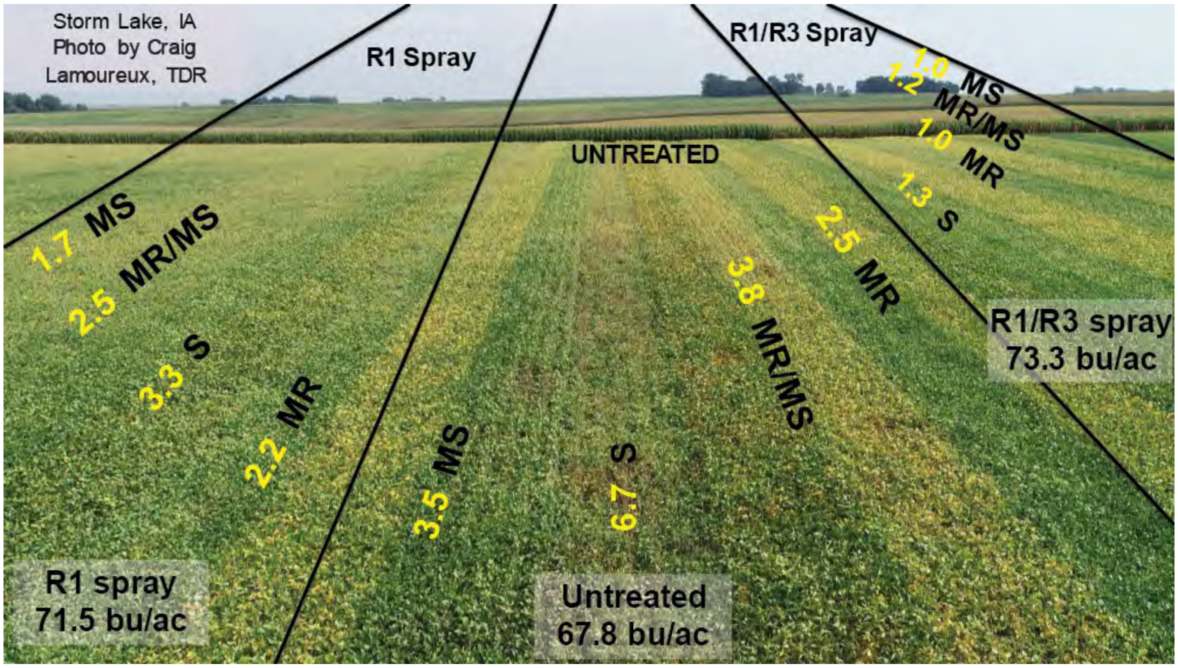


Figure 6. Aerial imagery showing visual differences of WM disease severity for each of the fungicide spray treatments and WM disease classification of products. Soybean products sprayed at R1 then followed by an R3 application yielded the highest and had the lowest WM disease index recorded in a location with relatively high WM incidence and severity (WM index numbers in yellow. WM disease index: 1 = no disease, 9 = severe disease). Fungicides: Delaro® 325 SC fungicide tank-mixed with Luna® Privilege fungicide.

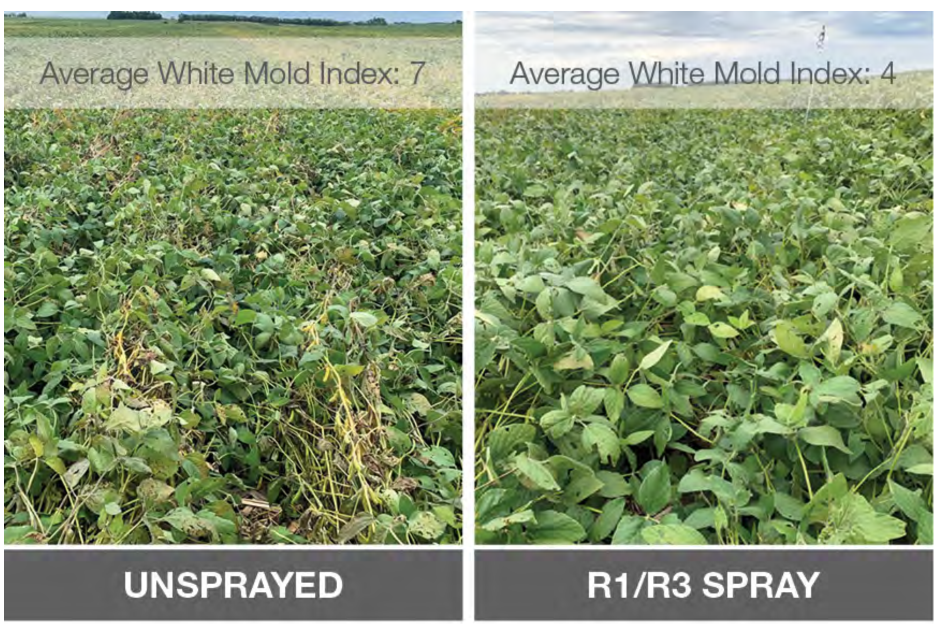


Figure 7. Side-by-side comparison of a soybean product susceptible to WM showcasing the effect of fungicide applications (R1 and R3) on WM disease control and plant health. Fungicides: Delaro® 325 SC fungicide tank-mixed with Luna® Privilege fungicide. WM disease index: 1 = no disease, 9 = severe disease.

Evaluation of Disease Management Systems in Soybean – White Mold

Key Learnings

- Within the data set, there was strong WM disease suppression in response to fungicide application, resulting in a significant advantage of more than 2 bu/acre over the unsprayed treatment.
- Within the data set, these interactions between disease classification and fungicide application at R1 growth stage were found -
  - Moderately Resistant soybean products and Moderately Resistant/Moderately Susceptible soybean products had a 1.45 bu/acre advantage with fungicide applied at the R1 growth stage compared to untreated check.
  - Moderately Susceptible soybean products and Susceptible soybean products had a 2.85 bu/acre advantage when fungicide was applied at R1 growth stage compared to untreated check.
- Yield of Moderately Resistant soybean products with fungicide applied at R1 growth stage was not statistically different than yield from other disease classes with fungicide applied at R1 growth stage.
- However, yield of Moderately Resistant soybean products with fungicide applied at R1 growth stage was numerically highest of all management systems that were untreated or had a fungicide applied at R1 growth stage.

Legal Statements

Influence of Seeding Rate and Planting Date on Soybean Yield

Trial Objective

- Previous work at the Bayer Learning Center at Monmouth, IL demonstrated planting date as an important factor influencing soybean yield potential.
- Depending on the year, earlier soybean planting dates may be a management practice with low-risk and high-return.
- Generally, soybean seeding rate should increase when planting occurs later in the season.
- In 2020, the Learning Center at Monmouth, IL conducted a trial to determine if seeding rate influences the average yield of soybeans across multiple planting dates.

Research Site Details

Location	Soil Type	Previous Crop	Tillage Type	Planting Date	Harvest Date	Potential Yield (bu/acre)	Seeding Rate (seeds/acre)
Monmouth, IL	Silt Loam	Corn	Conventional	4/21/20, 5/8/20, 5/11/20, 6/2/20	10/20/20	80	80K, 100K, 130K, 160K

- Treatments consisted of a 3.6 maturity group soybean product planted at four planting dates and four seeding rates for a total of 16 treatments.
- Planting dates:
  - April 21, 2020
  - May 8, 2020
  - May 11, 2020
  - June 2, 2020
- Seeding rates:
  - 80,000 seeds/acre
  - 100,000 seeds/acre
  - 130,000 seeds/acre
  - 160,000 seeds/acre

Influence of Seeding Rate and Planting Date on Soybean Yield

Understanding the Results

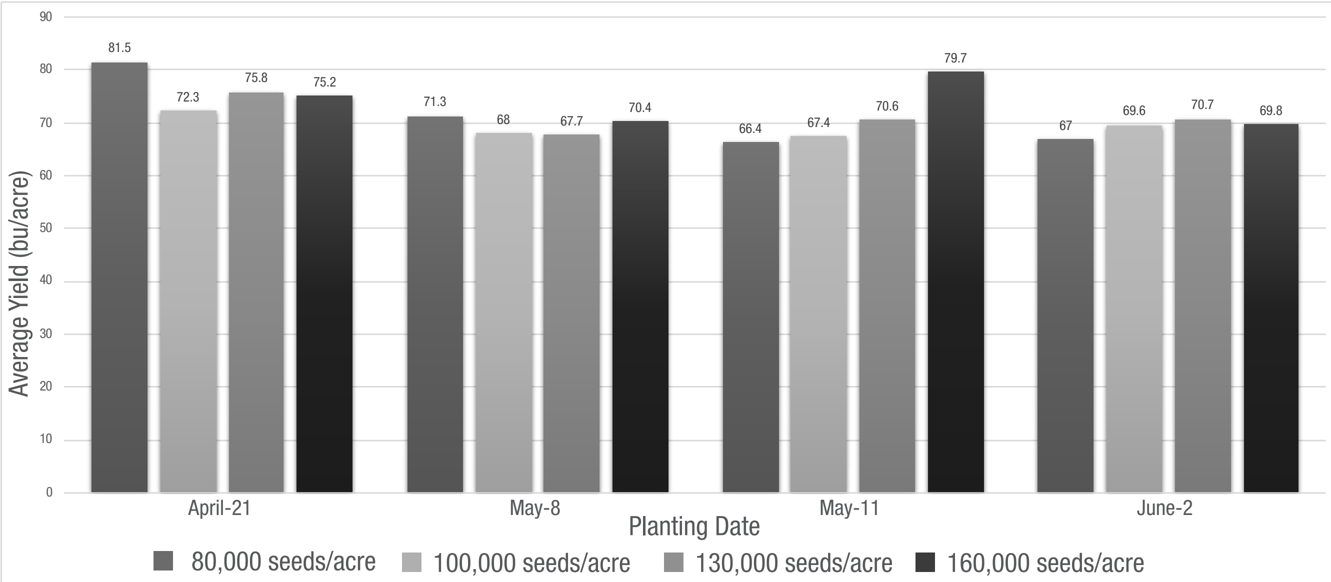


Figure 1. Effect of planting date and seeding rate on average soybean yield.

- The soybean plant is rather versatile in its growth and development. As plant population decreases, soybean plants develop additional branches and nodes to compensate for lost yield components.
- In this trial, earlier planting dates typically had greater average yields compared to later planting dates, which is in line with university recommendations as well as previous Learning Center results.
- In addition, later planting dates responded more positively to increased seeding rates. This finding is also supported by university recommendations and previous research at the Learning Center.

Key Learnings

- These results suggest:
  - Planting soybean early may help maximize profit potential.
  - Planting soybean late may require increased seeding rates to optimize yield and profit potential.
- Optimum seeding rate for soybean is highly variable from year to year. Contact your local Field Sales Representative or Technical Agronomist and discuss planting recommendations for the current situation and year.

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Potential Inputs for Soybean Production

Trial Objective

- Every year farmers evaluate which inputs they may want to use in their soybean production system to increase yield and return on investment. To help farmers with this decision, different inputs such as seeding rate, planting date, fungicide use, and fertilizer applications were evaluated for their potential impact on soybean yield.

Research Site Details

Location	Soil Type	Previous Crop	Tillage Type	Planting Date	Harvest Date	Potential Yield (bu/acre)	Seeding Rates (seeds/acre)
Gothenburg, NE	Hord silt loam	Corn	Strip tillage	5/1/2020, 5/28/2020	10/02/2020	90	160K, 220K

- The study consisted of ten treatments with five categorized as base management (BM) and five categorized as high management (HM) (Table 1). Treatments 1 and 6 were considered the base for BM and HM inputs, respectively.

Table 1. Base management (BM) and high management (HM) treatments.

				Fertilizer (Strip-Till Applied 4/22/2020)		
Treatment	Seeding Rate (seeds/acre)	2020 Planting Date	Delaro® 325 SC Fungicide (Applied 8/5/2020 at R3) (fl oz/acre)	Phosphorus (lbs/acre)	Sulfur (lbs/acre)	Nitrogen (lbs/acre)
1 BM	**160,000**	**5/28**				
2 BM	220,000	5/28				
3 BM	160,000	5/1				
4 BM	160,000	5/28	8			
5 BM	160,000	5/28		40	8.75	15.8
6 HM	**220,000**	**5/1**	**8**	**40**	**8.75**	**15.8**
7 HM	160,000	5/1	8	40	8.75	15.8
8 HM	220,000	5/28	8	40	8.75	15.8
9 HM	220,000	5/1		40	8.75	15.8
10 HM	220,000	5/1	8			

- This study was designed as a randomized complete block with four replications.
- A 2.6 maturity group soybean product was planted.
- The plots were sprinkler irrigated and weeds were controlled as needed.
- No insecticides were applied, and fungicides were applied as described in Table 1.
- Plots were combine-harvested, and a subsample of grain from each replication was taken to determine moisture content percent, test weight, and total weight.
- Statistical analysis for Fisher's LSD was performed.
- Input costs:
  - » Seed at $50/140,000 seed unit.
  - » Fungicide and application at $23/acre.
  - » Phosphorus/nitrogen mix at $445/ton and sulfur at $275/ton.
  - » These costs do not account for additional savings farmers can realize when using Bayer PLUS Rewards.*

*See program terms & conditions for full details.

Understanding the Results

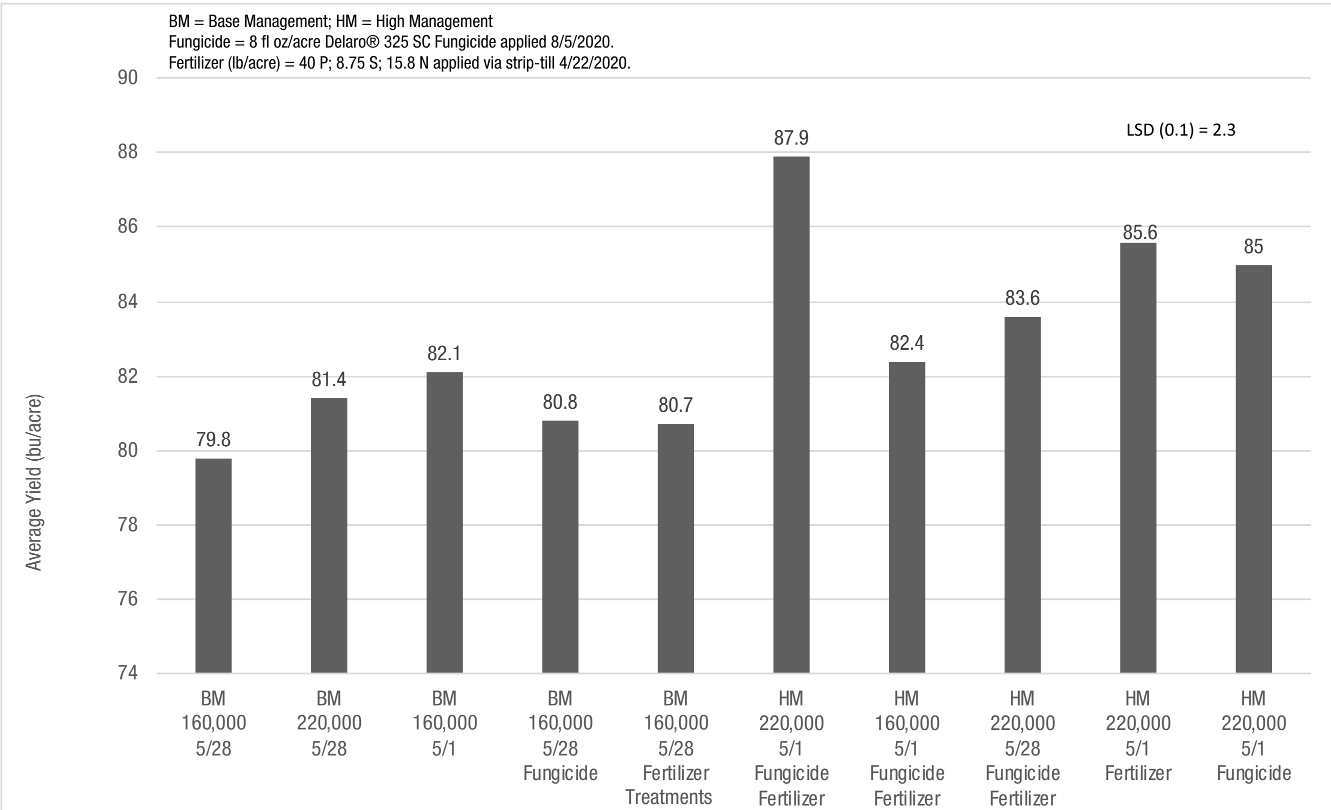

Figure 1. Average soybean yield (bu/acre) comparisons for base (BM) and high management (HM) inputs at the Gothenburg Water Utilization Learning Center in Gothenburg, Nebraska.

- The highest average yield (87.9 bu/acre) occurred with the high management treatment that had a fertilizer application via strip-till on April 22, an early planting date of May 1, and a Delaro® 325 SC Fungicide application on August 5. In this study, the higher seeding rate of 220K seeds/acre appeared to have a positive influence on yield. In previous studies at the Bayer Crop Science, Gothenburg Water Utilization Learning Center, there has been minimal yield difference between a 220K and 160K seeds/acre seeding rate as seen in an irrigated study in 20171 and a dryland study in 2018.[2]
- For the base management treatments in this study, an earlier planting date of May 1 had a significant positive impact on yield of a few bushels per acre although the positive impact on yield can be higher as seen in 2017.[1] The May 1 planted soybeans matured earlier (Figure 2).

Figure 2. Planting date impact on soybean maturity. May 28 planting on the left is just starting to turn yellow while May 1 planting on the right is about 50% mature pod.

Potential Inputs for Soybean Production

Table 2. Return of extra inputs over costs compared across different soybean commodity prices.

Treatment	Treatment Inputs	Total Extra Cost*	$8/bu	$10/bu	$12/bu
1 BM	160K, 5/28	$0.00	$638.40	$798.00	$957.60
2 BM	220K, 5/28	$21.43	$629.77	$792.57	$955.37
3 BM	**160K, 5/1**	**$0.00**	**$656.80**	**$821.00**	**$985.20**
4 BM	160K, 5/28, Fungicide**	$23.00	$623.40	$785.00	$946.60
5 BM	160K, 5/28, Fertilizer***	$30.80	$614.80	$776.20	$937.60
6 HM	**220K, 5/1, Fungicide, Fertilizer**	**$75.23**	**$627.97**	**$803.77**	**$979.57**
7 HM	160K, 5/1, Fungicide, Fertilizer	$53.80	$605.40	$770.20	$935.00
8 HM	220K, 5/28, Fungicide, Fertilizer	$75.23	$593.57	$760.77	$927.97
9 HM	220K, 5/1, Fertilizer	$52.23	$632.57	$803.77	$974.97
10 HM	220K, 5/1, Fungicide	$44.43	$635.57	$805.57	$975.57

*These costs do not account for additional savings farmers can realize when using Bayer PLUS Rewards.
**Fungicide = Delaro® 325 SC Fungicide, ***Fertilizer (lb/acre) = 40 P; 8.75 S; 15.8 N applied via strip-till 4/22/2020.

- Economic observations for this study (Table 2):
  - » Planting a soybean crop earlier doesn't have traditional input costs such as fertilizer or pesticide applications. However, depending on the growing season, there may be a cost to the entire operation associated with moving to an earlier planting because some corn may be planted later than optimum. For this scenario, there are no associated costs for the May 1 planting date as it is an easy way to potentially increase soybean yield.
  - » The high management treatment in this study had high yields, but also had the highest cost except for the HM – Early Planting treatment which had similar costs. The HM treatment becomes more profitable as the value of soybeans increase from $8 to $12/bu.

Key Learnings

- Moving the planting date from the end of May to the end of April through the first week in May is an easy no cost input that typically increases soybean yield.
- When evaluating crop inputs for high management systems, the whole system should be considered. At the Learning Center, there has been a consistent trend of putting multiple crop inputs together providing increased yield potential. This was observed this year with the high management treatment. However, determining the value of each individual input can be difficult. Year to year variations occur but understanding that inputs build on each other in the system is an important point as farmers build-out their future soybean production plans.

Sources

[1] Gothenburg Learning Center. 2017. Interaction of soybean planting date on seeding rate. Field Research Book.

[2] Gothenburg Learning Center. 2018. Influence of row width on soybean yield. Field Research Book.

Legal Statements

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Trial Objective

- Soybean producers have many decisions to make regarding their inputs and agronomic system. However, benefits from different inputs are not always mutually exclusive.
- The objective of this trial is to determine the effect of high-input management systems and their individual components on soybean yield.
- Bayesian economic analysis is used to predict break-even probabilities of these high input soybean systems.

Research Site Details

	Treatment Number	FACTORS				
		Treatment	Foliar Fungicide	Foliar Insecticide	Seed Treatment	Variety Type
	1	HIGH INPUT	Delaro® Complete fungicide* @ R3	Leverage® 360 insecticide @ R3	FI***+ILeVO®**	Non-Defensive
Remove Input	2	Foliar Fungicide	None	Leverage® 360 insecticide @ R3	FI+ILeVO®**	Non-Defensive
Remove Input	3	Foliar Insecticide	Delaro® Complete fungicide* @ R3	None	FI+ILeVO®**	Non-Defensive
Remove Input	4	Seed Treatment	Delaro® Complete fungicide* @ R3	Leverage® 360 insecticide @ R3	FI	Non-Defensive
Remove Input	5	Variety Type	Delaro® Complete fungicide* @ R3	Leverage® 360 insecticide @ R3	FI+ILeVO®**	Defensive
	6	Low Input	None	None	FI	Defensive
Add Input	7	Foliar Fungicide	Delaro® Complete fungicide* @ R3	None	FI	Defensive
Add Input	8	Foliar Insecticide	None	Leverage® 360 insecticide @ R3	FI	Defensive
Add Input	9	Seed Treatment	None	None	FI+ILeVO®**	Defensive
Add Input	10	Variety Type	None	None	FI	Non-Defensive

*Delaro® Complete fungicide = Tank mix of Delaro® 325 SC fungicide (8 fl oz/acre) and Luna® Privilege fungicide (2 fl oz/acre)
**ILeVO® seed treatment rate = 0.15 mg active ingredient/seed
*** FI = Fungicide and Insecticide

Predicting Soybean Input Profitability

- Variety Type:
  - **Non-Defensive**: These products had lower disease tolerance ratings for disease(s) of concern in the trial location.
  - **Defensive**: Products identified as "Defensive" were selected for their relatively high disease tolerance ratings for disease(s) of concern in the trial location.
- Small plot dimensions approximately 10x30 ft.
- Three replications per location, and means were separated using Fisher's LSD ($\alpha = 0.10$)
- 31 internal sites in 2021 in Iowa, Illinois, Indiana, Missouri, Kentucky, Michigan, Minnesota, Kansas, Tennessee, Arkansas, North Dakota, Nebraska, Ohio, South Dakota, and Wisconsin.
- Disease pressure, in general, was overall very low at the 31 U.S. locations in 2020.
- On a 1-9 disease intensity scale (with a value of 1 signifying no disease) the overall average from all plots were:
  - Sudden Death Syndrome = 1.1
  - White Mold = 1.0
  - Frogeye Leaf Spot = 1.1

Understanding the Results

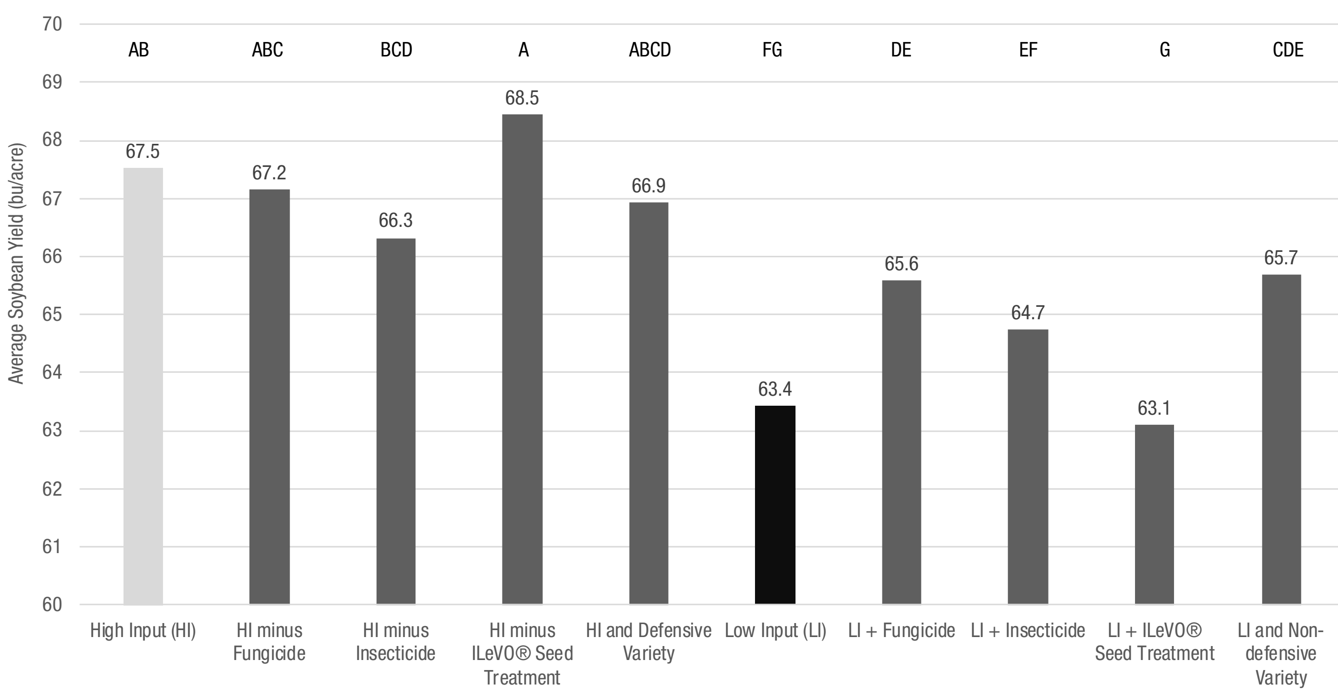

Figure 1. Average soybean yield from high and low input soybean systems.

Predicting Soybean Input Profitability

Table 1. Break-even probabilities for input systems compared to base treatment (Treatment 6) at multiple yield levels and soybean sale prices.*

Input	Yield Level (bu/acre)					
	- - - 50 - - -		- - - 60 - - -		- - - 70 - - -	
	Soybean sale price ($/bu)					
	12	14	12	14	12	14
	---------------% probability of break-even ---------------					
High Input	81	93	94	98	98	99
High minus Fungicide	99	100	100	100	100	100
High minus Insecticide	50	69	72	85	85	92
High minus ILeVO® Seed Treatment	100	100	100	100	100	100
High (Defensive Variety)	54	76	79	90	90	96
Low + Fungicide	74	83	84	90	90	93
Low + Insecticide	91	92	92	93	93	94
Low + ILeVO® Seed Treatment	11	15	16	20	20	24
Low (Non-defensive Variety)	100	100	100	100	100	100

*Using Bayesian economic analysis to compute posterior probabilities given the means and variance from 2020 data and assumed marginal costs for inputs.

Figure 2. Side-by-side comparison of High-Input System.

Predicting Soybean Input Profitability

Key Learnings

- In these trials, the high input system (Treatment 1) had greater average yield compared to the low input system (Treatment 6) of 4.1 bu/acre.
  - Additionally, all the high input systems (Treatments 1 through 5) out yielded the base low input system (Treatment 6).
- Adding foliar fungicide (Treatment 7) increased average yield compared to low input system (Treatment 6).
- Input systems in this analysis generally have a high probability of breaking even with the soybean price and yield levels displayed in Table 1 except for the "Low + ILeVO® seed treatment" system (Treatment 9).
- More site-years are desired for this study to help make region-specific recommendations with a more robust data set. This trial will be conducted again in 2021.

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Soybean Response to Foliar Feeding

Trial Objective

- Previous work at the Bayer Crop Science Learning Center at Monmouth, Illinois has shown little or no benefit from applying in-season foliar feed to soybean in fields without underlying fertility deficits.
- After receiving multiple requests to review newer products, a trial was developed to evaluate two foliar feed products in 2020.

Research Site Details

Location	Soil Type	Previous Crop	Tillage Type	Planting Date	Harvest Date	Potential Yield (bu/acre)	Seeding Rate (seeds/acre)
Monmouth, Il	Silt loam	Corn	Conventional	5/11/20	10/13/20	70	130K

- Treatments consisted of one untreated check and two foliar feed products applied at the R3 growth stage:
  - An untreated check was included for comparison.
  - Product 1: A solution containing 5% urea-triazone nitrogen, 20% potassium, and 13% sulfur in the potassium thiosulfate (KTS) form applied at 2 qt/acre.
  - Product 2: A solution containing 12% slow-release nitrogen and 12% potassium applied at 1 gal/acre.
- The foliar feed applications included a surfactant at 2 fl oz/acre.
- Plots were planted in fields with adequate nutrients, as determined by soil test results.
- There were two replications of each treatment.
- Plots were harvested and adjusted to 13% moisture content.

Soybean Response to Foliar Feeding

Understanding the Results

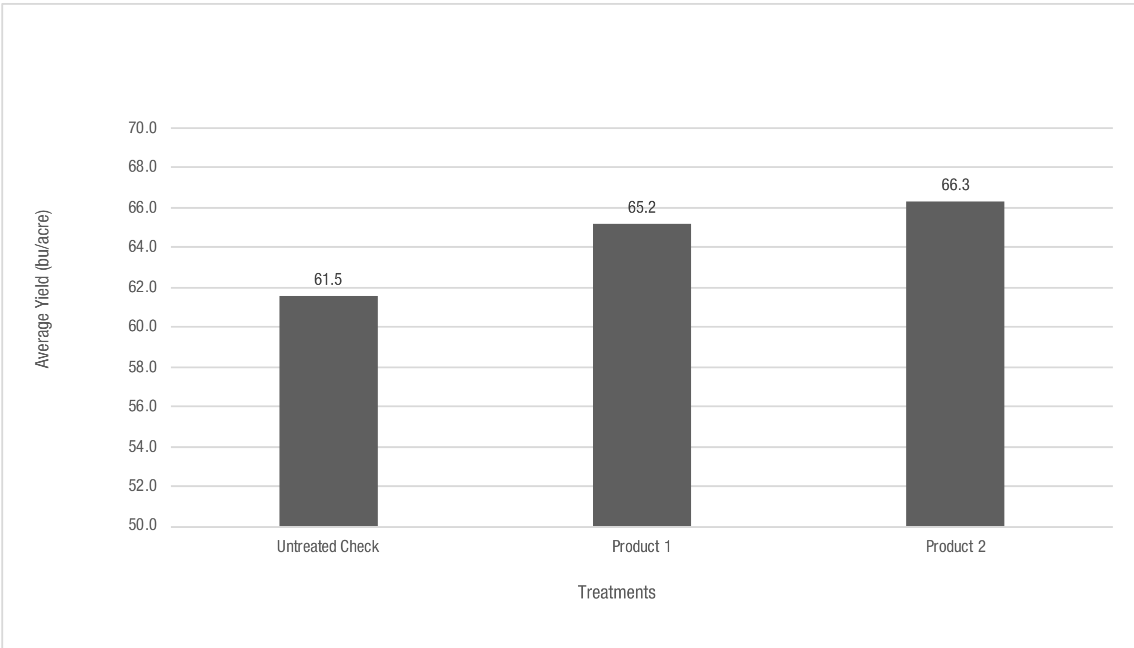

Figure 1. Yield comparison of two foliar applied fertilizer products to an untreated check. Product 1 was a solution containing 5% urea-triazone nitrogen, 20% potassium, and 13% sulfur in the potassium thiosulfate (KTS) form applied at 2 qt/acre. Product 2 was a solution containing 12% slow-release nitrogen and 12% potassium applied at 1 gal/acre.

- While yields were not dramatically different in this trial, higher yields were observed with both foliar feed products compared to the untreated check.
- No visual differences were observed in the plots.

Key Learnings

- These results are inconsistent with previous foliar feed trials conducted at the Learning Center. However, the differences in yield observed warrant further study to see if these products can benefit a soybean management system.
- Balanced soil fertility is important in any crop production system. It is important to conduct soil tests on a regular interval to evaluate any underlying fertility issues that need to be addressed.
- Consult your local Field Sales Representative or Technical Agronomist for tailored recommendations for your farm.

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