2020
Field Research

Monmouth Learning Center

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2020 has certainly been a challenging year for all of us in agriculture. After a promising start to the planting season, delays followed due to prolonged cold, wet conditions in the spring, and hot, dry conditions through much of the summer. Of course, the changes to our normal way of life due to COVID-19 added a new layer of challenges on top of what we normally face.

COVID-19 required us to reimagine much of what we do here at the Learning Center. In-person visits, tours, and trainings were largely eliminated– replaced by more virtual content. Regardless of the method, our goal here at the Monmouth Learning Center has remained the same: to provide you with up-to-date, relevant agronomic information that will benefit you and your operation. With that goal in mind, this booklet contains summaries from several of our key trials and demonstrations around corn and soybean management systems.

For 2021, we will continue to strive to meet that goal with new trials and demonstrations focused on cover crops, nutrient management strategies, insect and weed resistance management, high yield management systems, and many other aspects of crop production research. We also plan to continue showcasing our current and future technologies. We hope you find the information within these pages, as well as the rest of our field trials and demonstrations to be valuable to you and your operation. Please contact us if you have any questions about these summaries, or any of the other projects here at the Monmouth Learning Center. Additionally, you can download digital copies and video versions of these reports by visiting the websites listed below. Be sure to follow us on Facebook, Twitter, and YouTube for seasonal agronomic and tour updates all year long.

Your feedback is always appreciated. Please send us a message or complete the survey below that will pop-up from the following QR code.

Thank you once again, and we look forward (with fingers crossed) to hosting you at the Monmouth Learning Center again in 2021!

Sincerely,

Troy Coziahr | Monmouth Learning Center Manager

Facebook Twitter YouTube bayer.com Survey

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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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

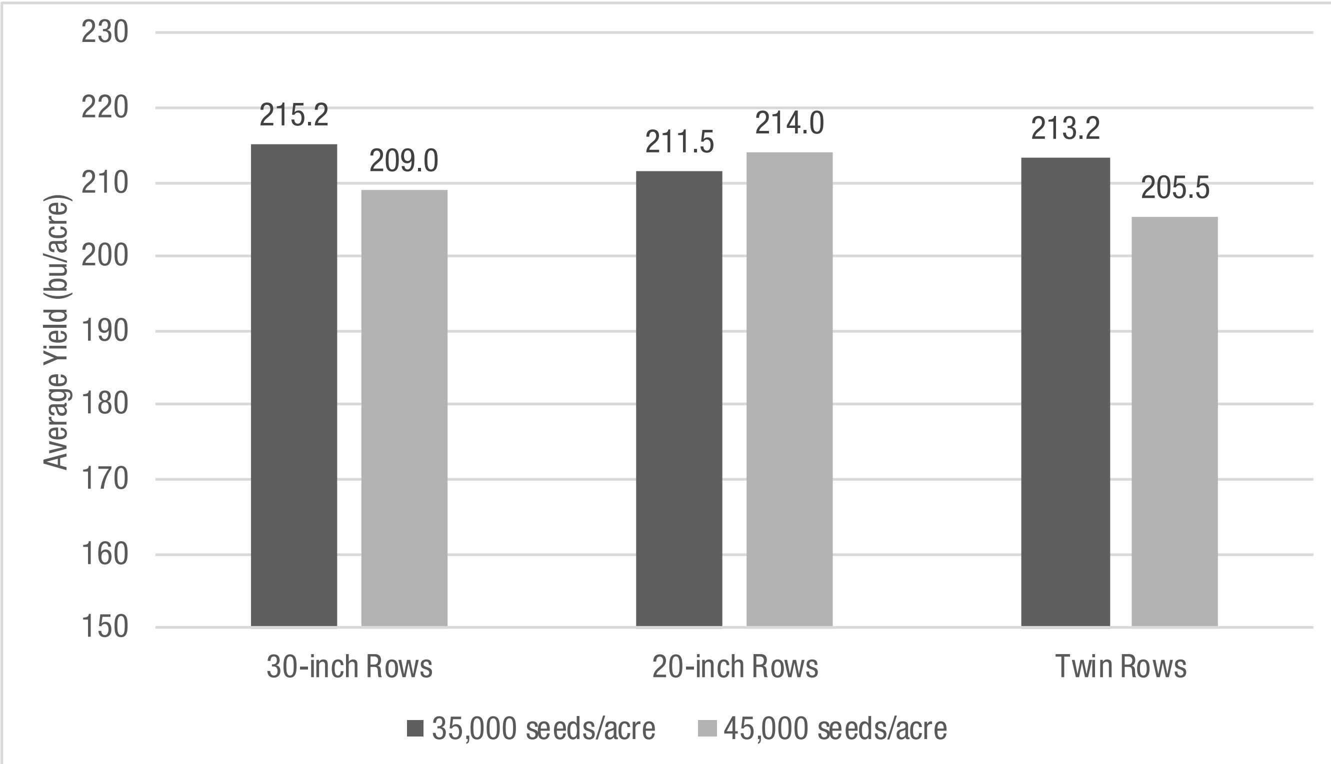

Figure 1. Average corn yield response to seeding rate and row spacing.

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.

Legal Statements

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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.

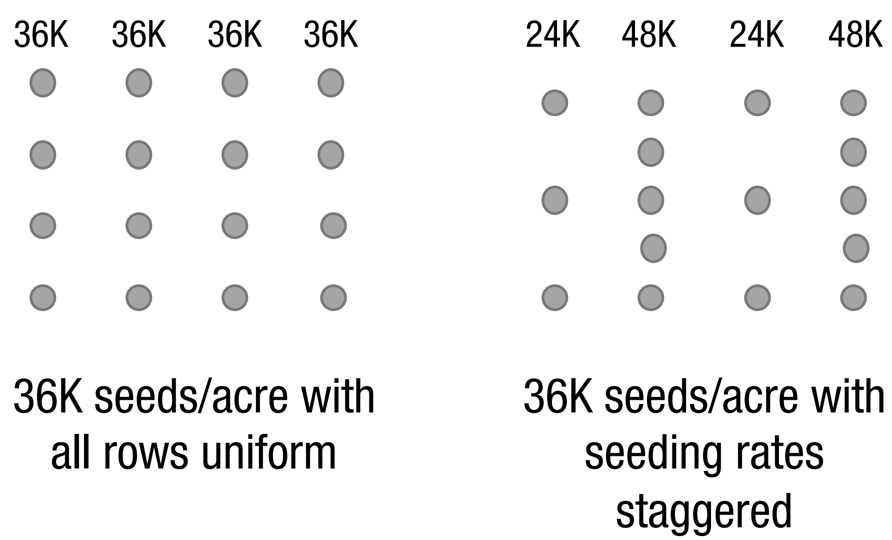

Figure 1. Graphic representation of seeding rate pattern for each treatment.

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

ENVIRONMENT

Single Row Seeding Rate Differences in Corn

Understanding the Results

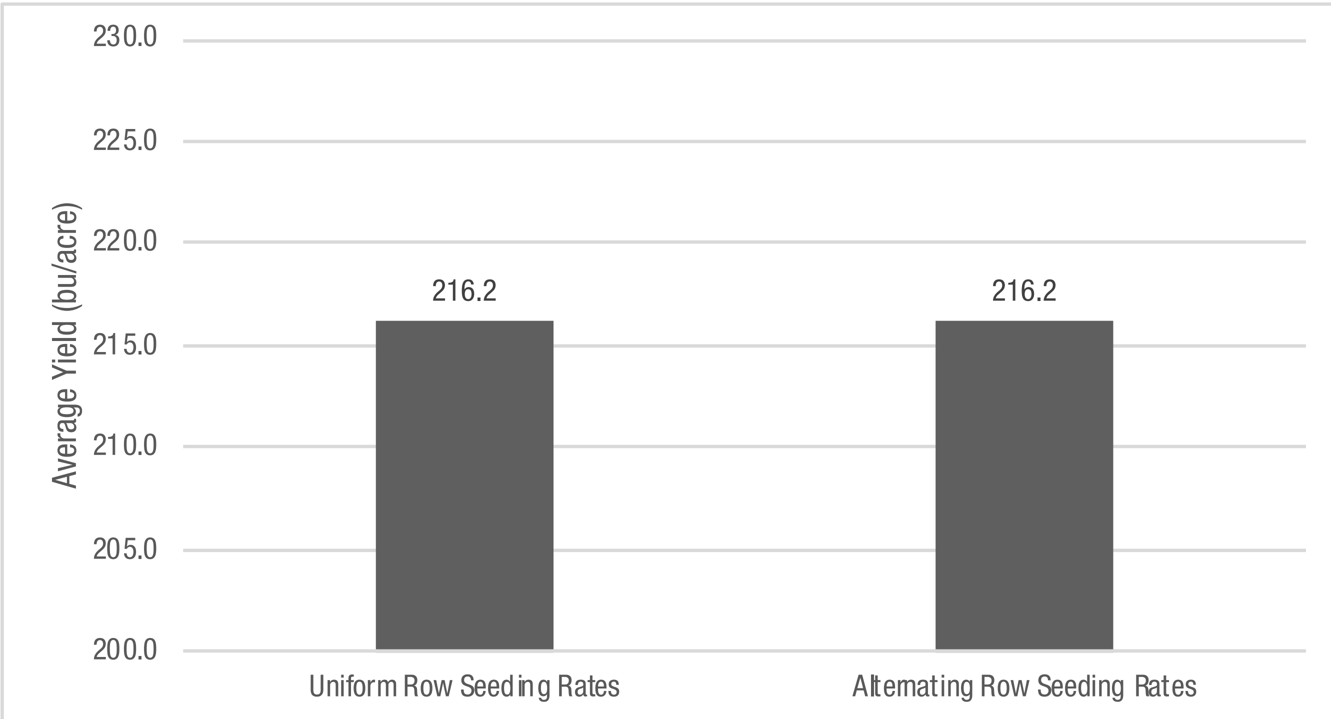

Figure 2. Average yield (bu/acre) comparison of uniform row seeding rates (36,000 seeds/acre) and alternating row seeding rates (24,000 and 48,000 seeds/acre, for an average of 36,000 seeds/acre).

- 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.

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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

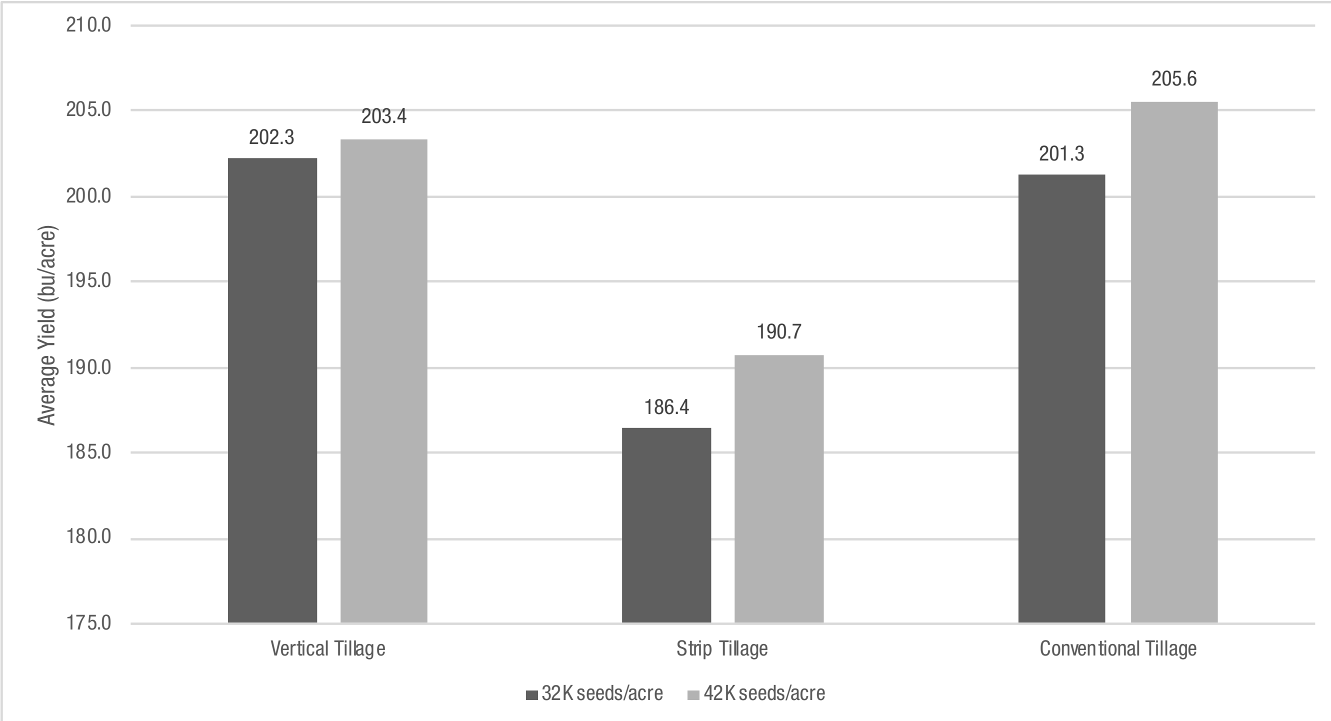

Figure 1. Average corn yields comparing three tillage systems and two seeding rates averaged across two corn products.

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.

Legal Statements

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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. ©2020 Bayer Group. 1017_R8_20

ENVIRONMENT

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

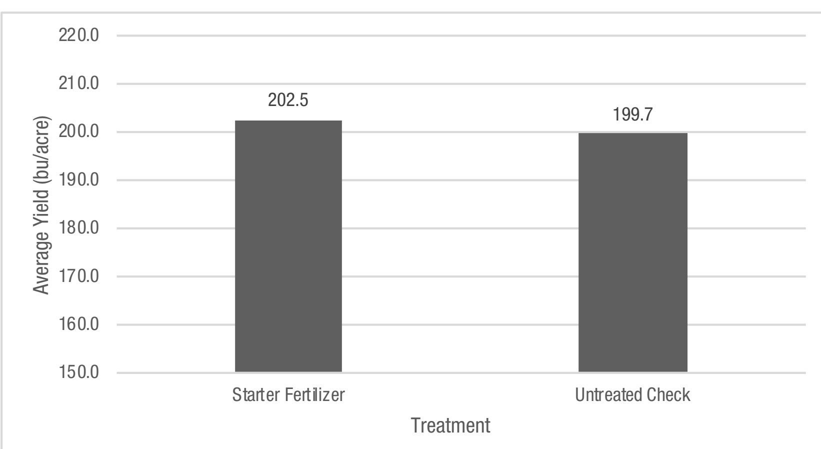

Figure 1. Effect of starter fertilizer on corn yield compared to untreated check in 2020.

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

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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.

FERTILITY

Corn Product Response to Nitrogen Rate

Understanding the Results

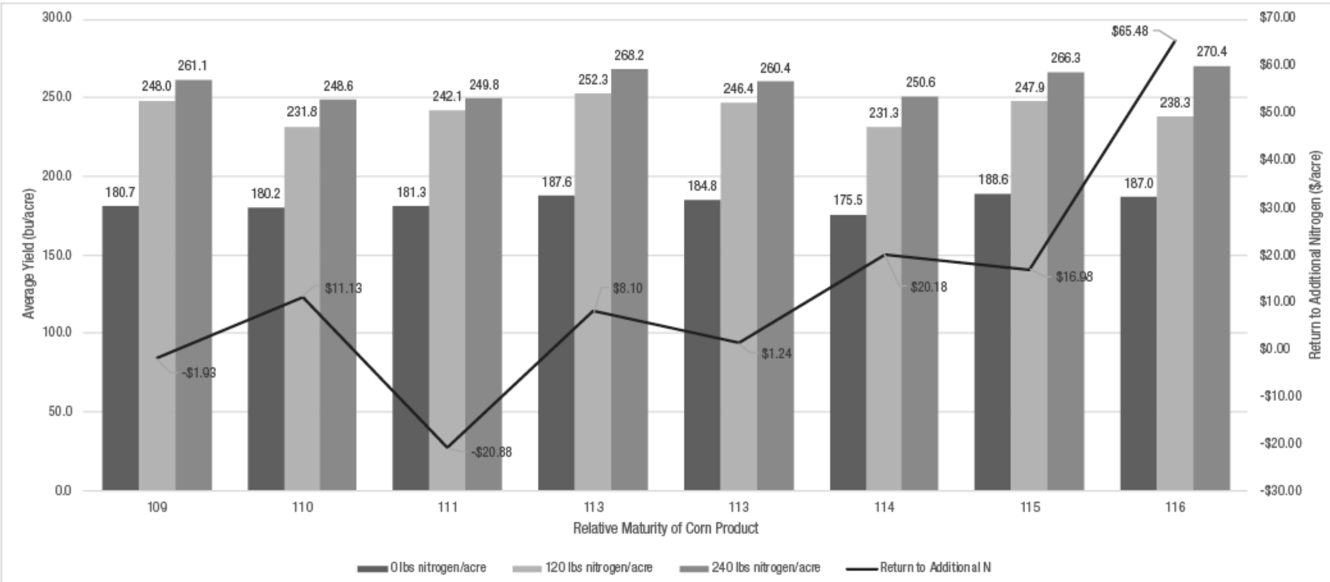

Table 1. Average yield response and return of additional nitrogen ($/acre) by corn product and nitrogen treatment (120 lbs N/acre and 240 lbs N/acre). Calculation assumes a $3.53/bu corn market price and $.40/lb for N.

— 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.

FERTILITY

Corn Product Response to Nitrogen Rate and Timing

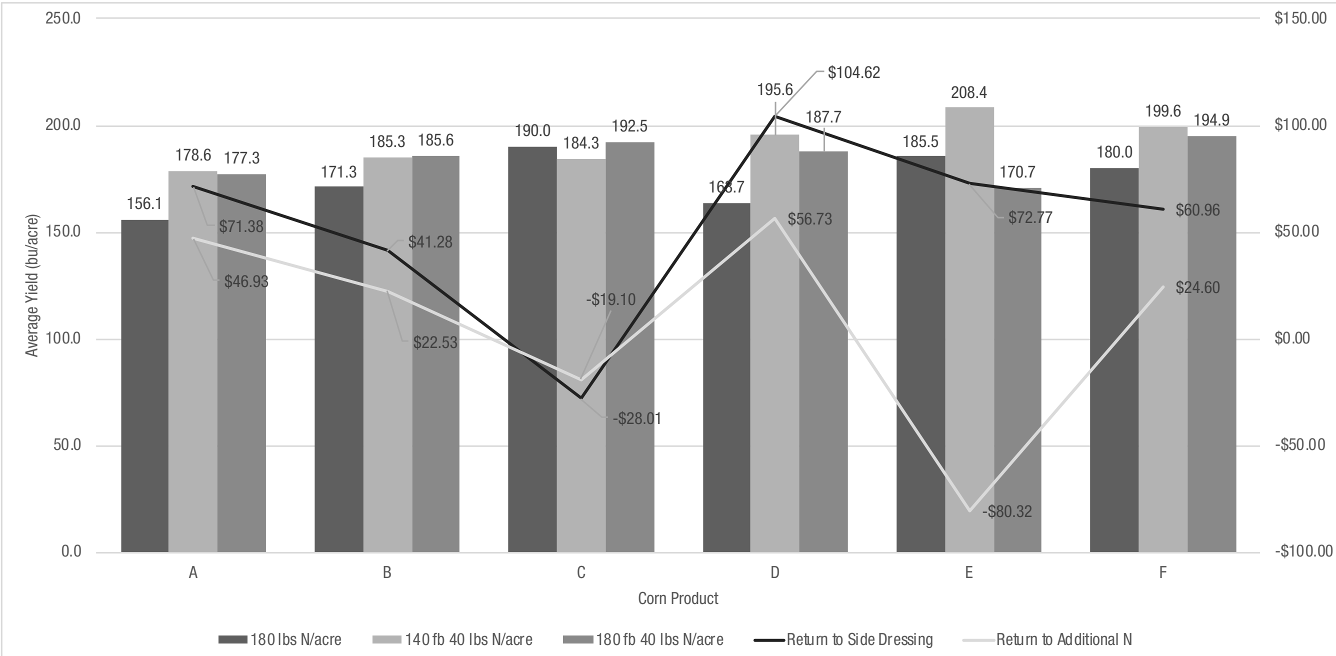

Figure 1. Average yields (bu/acre) of six different corn products at three different nitrogen rates and timings and return over nitrogen cost.

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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FERTILITY

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

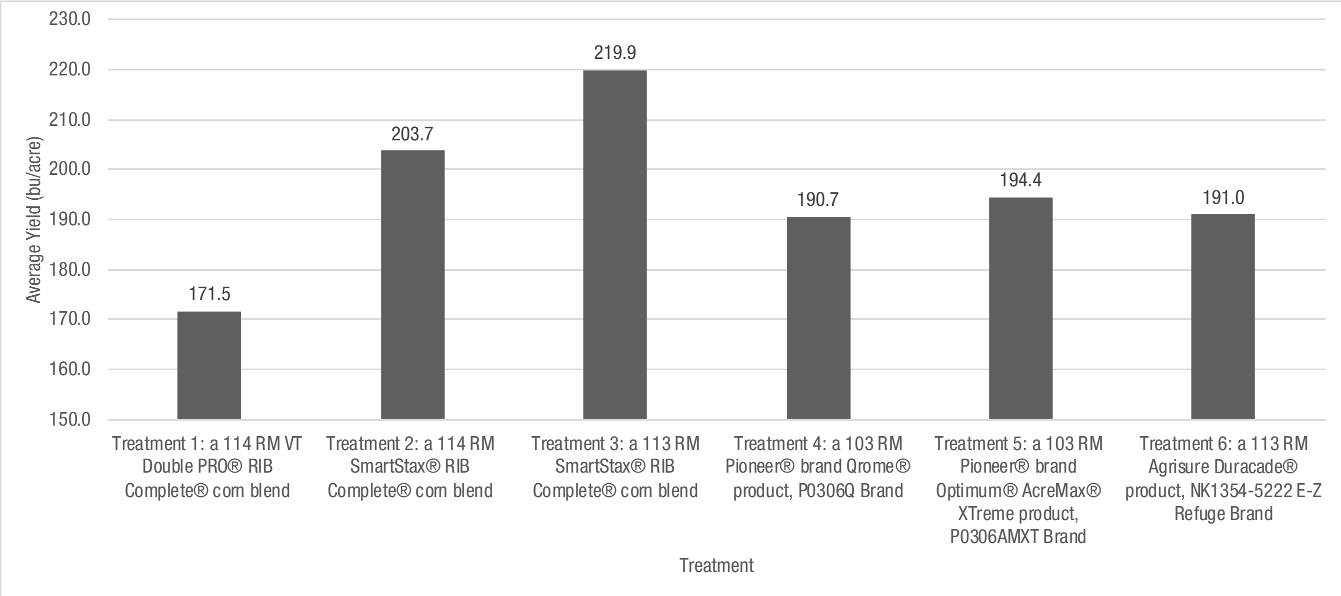

Figure 1. Average yield (bu/acre) per treatment.

- 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.

INSECT CONTROL

Comparing Corn Rootworm Trait Platforms

Legal Statements

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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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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

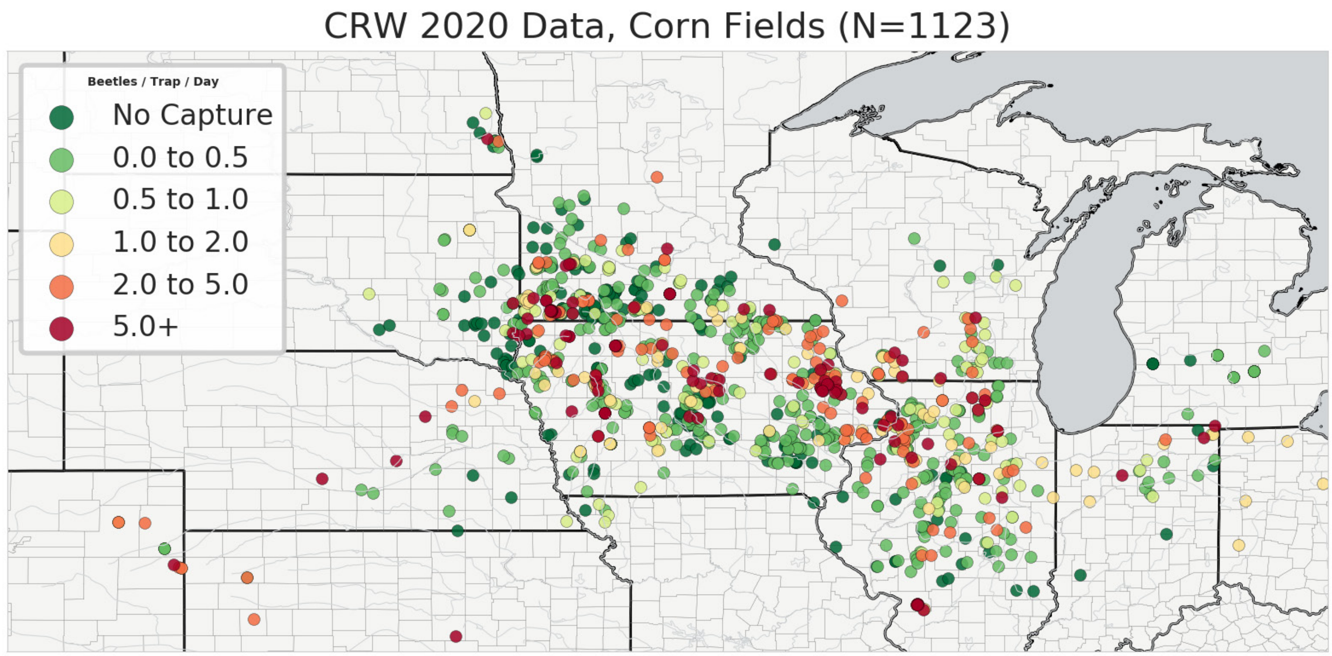


Figure 1a. Corn field locations for corn rootworm trapping in 2020.

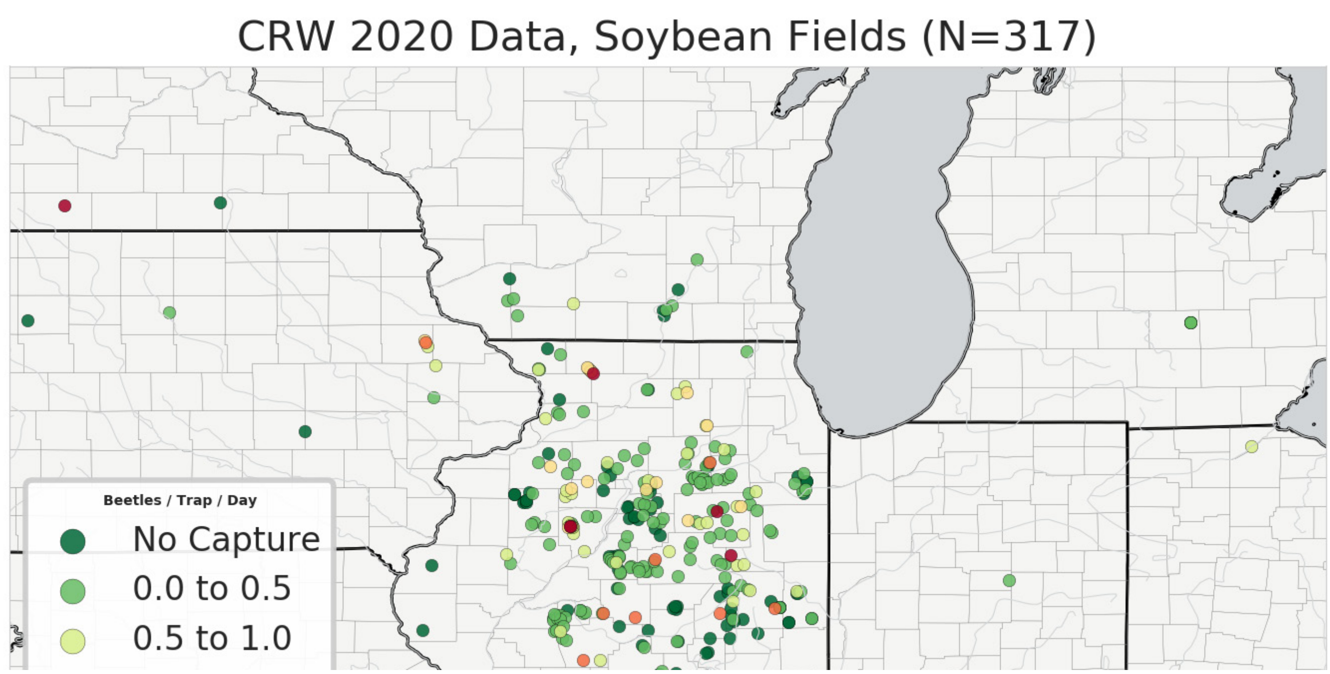
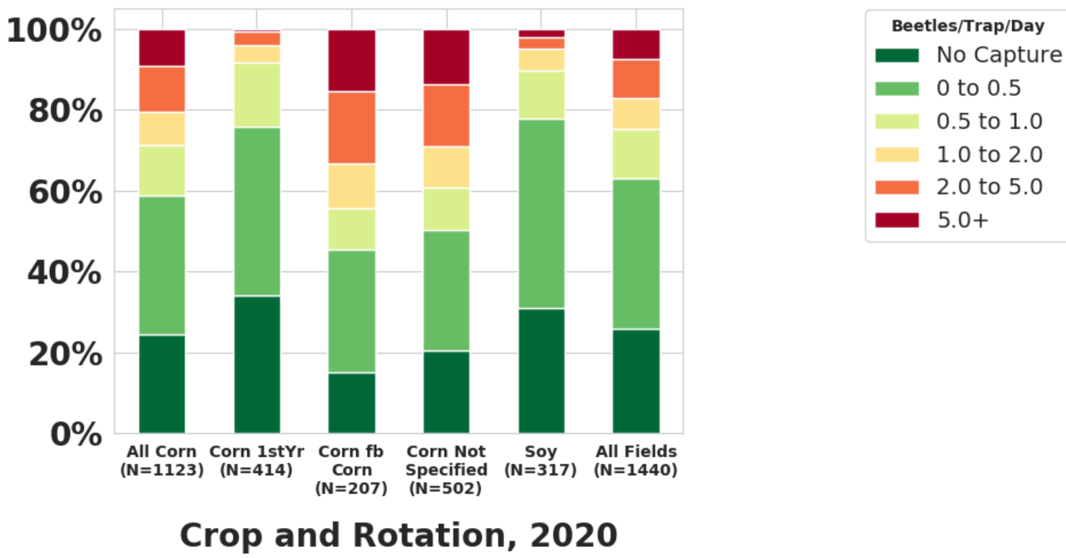


Figure 1b. Soybean field locations for corn rootworm trapping in 2020.

INSECT CONTROL

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.

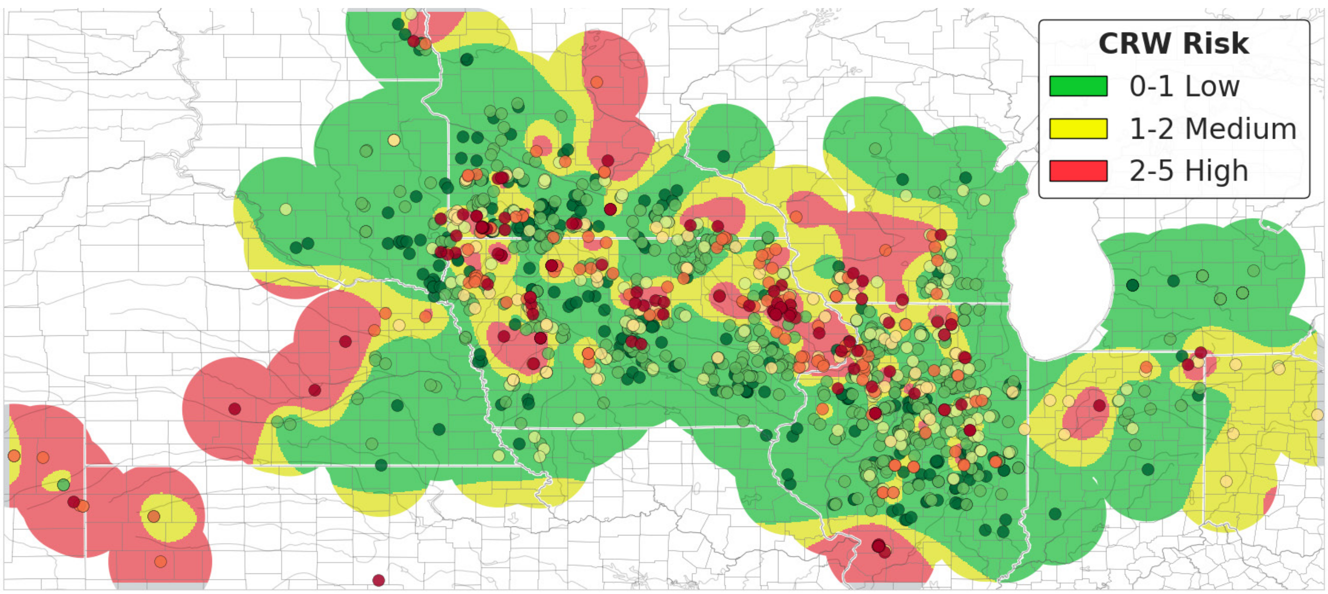


Figure 3. Estimated corn rootworm risk in 2021 using interpolated 2020 corn rootworm data from all fields sampled.

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

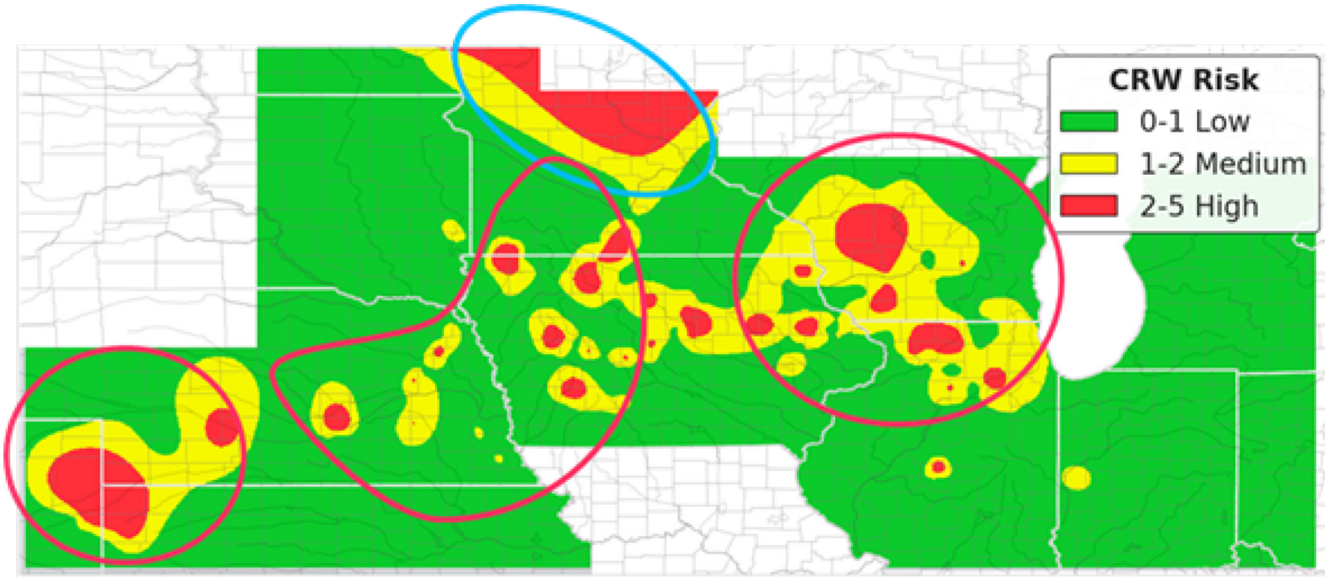


Figure 4a. Estimated corn rootworm risk in 2020 using interpolated 2019 corn rootworm counts from corn fields sampled (based on 1123 fields).

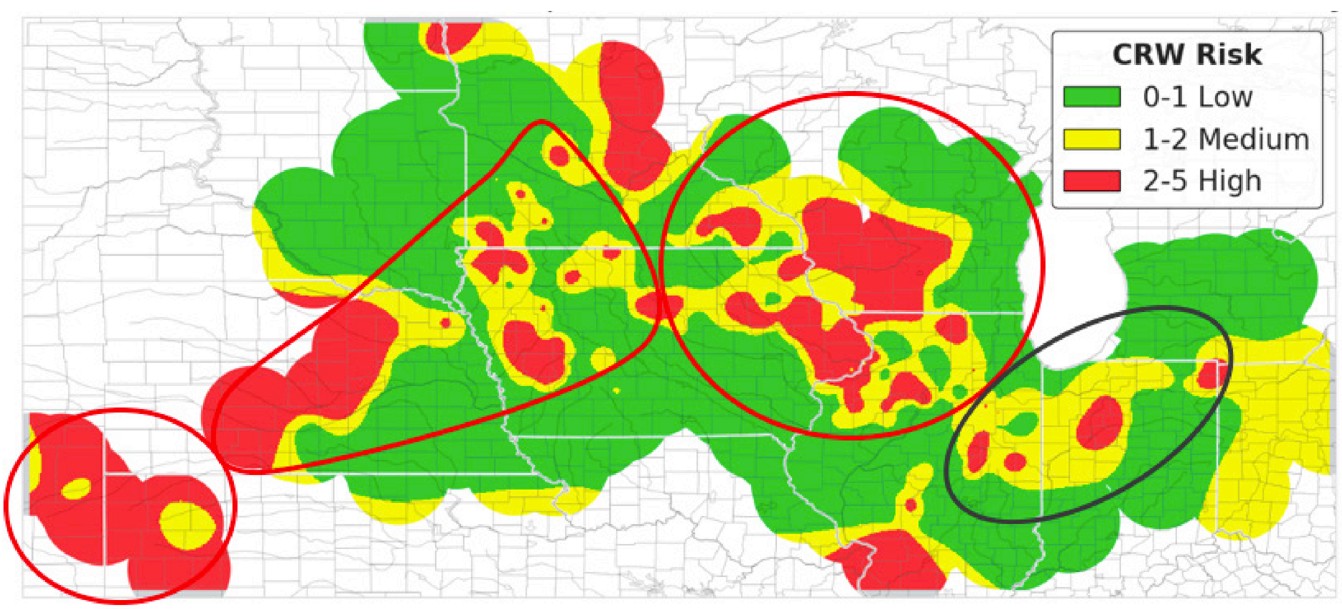


Figure 4b. Estimated corn rootworm risk in 2021 using interpolated 2020 corn rootworm counts from corn fields sampled (based on 1123 fields).

INSECT CONTROL

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

The information discussed in this report is from a multiple 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.

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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

ENVIRONMENT

Influence of Seeding Rate and Planting Date on Soybean Yield

Understanding the Results

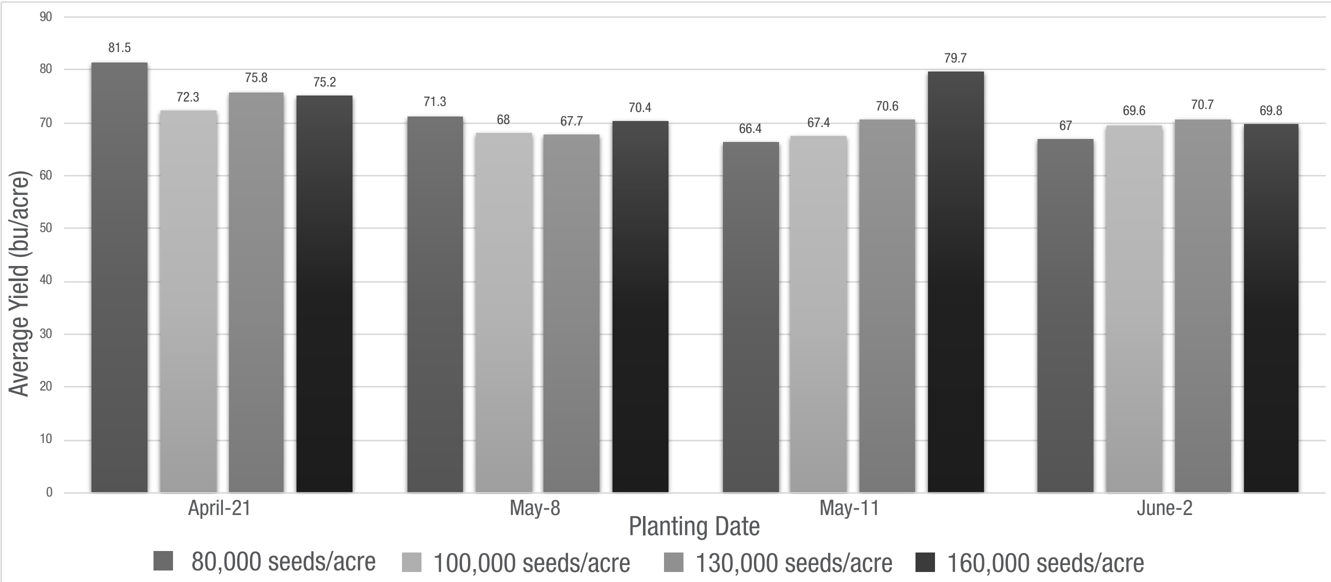

Figure 1. Effect of planting date and seeding rate on average soybean yield.

- 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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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.

FERTILITY

Soybean Response to Foliar Feeding

Understanding the Results

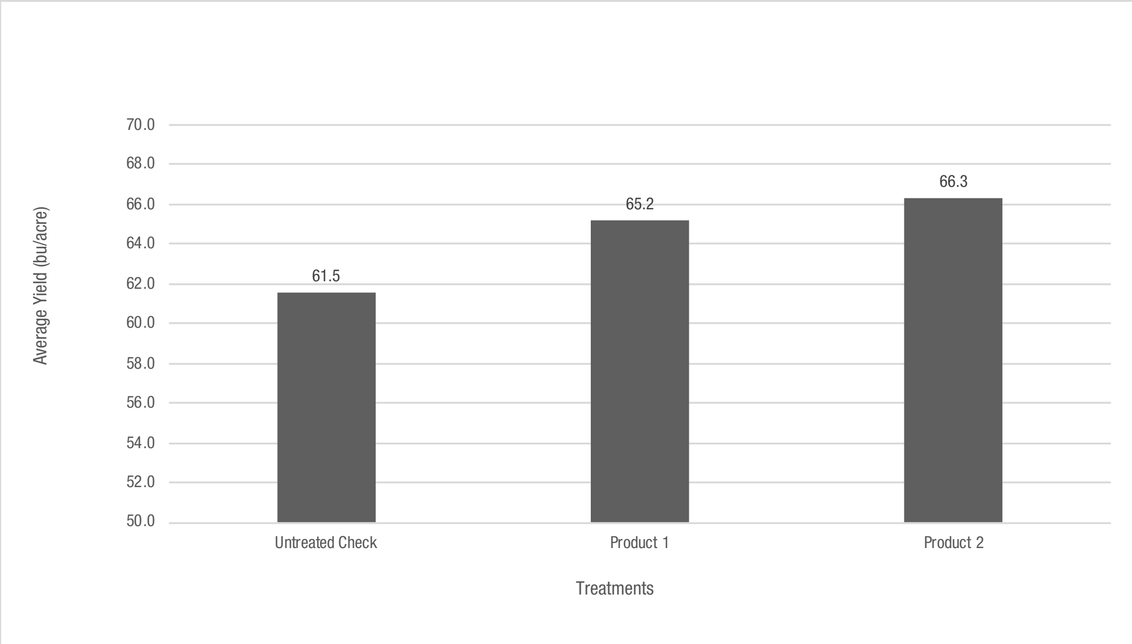

Figure 1. Yield comparison of two foliar applied fertilizer products to an untreated check. Product 1 was a solution containing 5% urea-triazone nitrogen, 20% potassium, and 13% sulfur in the potassium thiosulfate (KTS) form applied at 2 qt/acre. Product 2 was a solution containing 12% slow-release nitrogen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

Determining Corn Growth Stages

Corn has two distinct phases of growth: vegetative and reproductive.

Vegetative Growth Stages in Corn

Vegetative stages are identified by the number of collars present on the plant. The leaf collar method is generally used for staging vegetative (V) development of corn. When corn seedlings emerge from the soil and no leaf collars have formed, plants are in the VE stage. When the plant has one visible leaf collar, it is in the V1 stage. The leaf collar is a light-colored band located at the base of an exposed leaf blade, near the spot where the leaf blade meets the stem of the plant. Leaves within the whorl, not fully expanded and with no visible leaf collar, are not included in the staging. For example, a plant with three collars would be called a V3 plant; however, there may be five to six leaves showing on the plant (Figure 1). Corn plants generally develop up to the V18 stage before reaching maximum height at tassel emergence (VT) and transitioning into the reproductive (R) stages of growth.

Beginning at about V6, the lowest leaves may fall from the plant and dissection of the lower stalk may be necessary to accurately stage the plant. To stage older plants, dig up the plant and split the stalk down into the root ball. Find the triangular "woody" base of the stalk and locate the first internode above the base. The woody, horizontal node is the point of attachment for the fifth leaf or collar. For example, if you can count five visible leaf collars above this point, the corn plant is in the V10 growth stage.

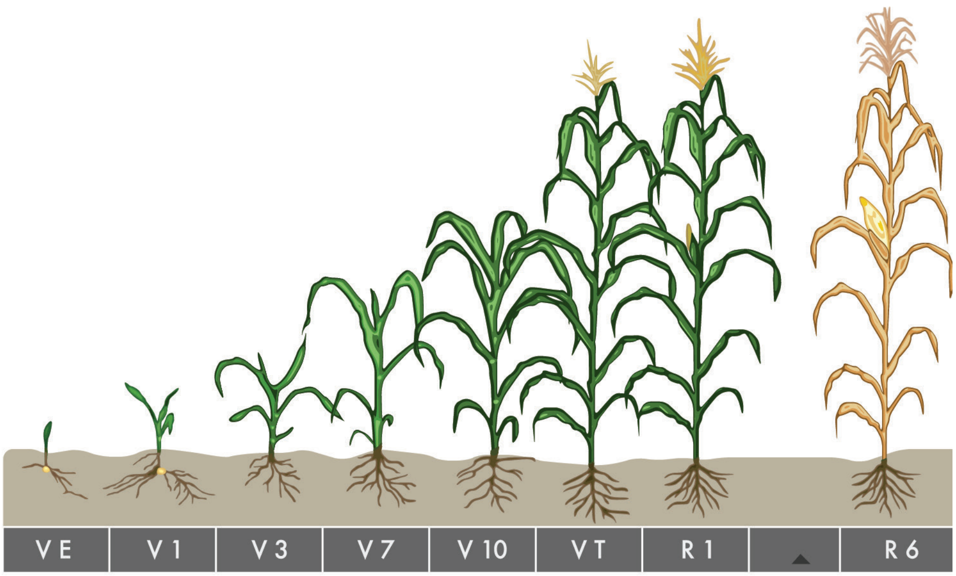

Figure 1. Corn growth stages from emergence to maturity.

Determining Corn Growth Stages

VE Can occur 4 to 5 days after planting under ideal conditions, but up to 2 weeks or longer under cool or dry conditions.

V1-V5 At V1, round-tipped leaf on first collar appears, nodal roots elongate. By V2, plant is 2 to 4 inches tall and relies on the energy in the seed. V3 begins 2 to 4 weeks after VE, and plant switches from kernel reserves to photosynthesis and nodal roots begin to take over. Around V4, broadleaf weeds should be controlled to avoid loss. By V5, the number of potential leaf and ear shoots are determined. Plant is 8 to 12 inches tall and growing point remains below soil surface.

V6-V8 Beginning 4 to 6 weeks after VE, the growing point grows above the soil surface, increasing susceptibility to hail, frost or wind damage. The nodal root system is dominant. At V7, rapid growth phase and stem elongation begin. Number of kernel rows is determined and potential kernels per row begins and continues through V15/16. By V8, the plant reaches 24 inches tall.

V9-V11 Around 6 to 8 weeks after VE, corn begins steady and rapid period of growth and dry matter accumulation. At V9, tassel is developing rapidly, but is not yet visible. New leaves appear every 2 to 3 days and ear shoots are developing

V12-Vnth By V12, the plant is about 4 feet tall or more. Nutrients and water are in high demand to meet growth needs. All leaves are full size and roughly half are exposed to sunlight. Brace roots are developing and the potential number of kernels per ear and size of the ear are still being determined. Insect and hail injury can reduce the number of kernels that develop. The plant is about two weeks away from silking at V15. The tassel is near full size, but not visible. Moisture and nutrient deficiencies at this time can reduce the number of potential kernels per row resulting in shorter ears and lower yield potential.

VT Beginning around 9 to 10 weeks after emergence, corn enters a critical period where successful pollination is required to convert potential kernels into viable, developing kernels. The plant has reached full size. Tassels are fully visible, and silks will emerge in 2 to 3 days. Pollen shed begins and continues for 1 to 2 weeks. Hail can be very damaging at this stage.

Reproductive Growth Stages in Corn

Corn plants enter reproductive growth after completing tassel emergence. Reproductive growth stages are determined by kernel development and not plant collars.

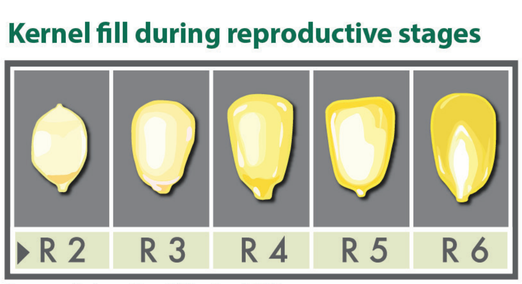

Figure 2. Corn kernel fill during reproductive stages.

Source: University of Illinois, 1999

Determining Corn Growth Stages

Corn Growth Stages

R1 Silking Silking is one of the most critical stages in determining yield potential. For an individual plant it is when the silks are visible. For a field to be in the R1 stage, the average silking date is used. The average silking date is when 50% of the plants have started to silk. Pollination begins at the base and proceeds toward the tip. Potassium uptake is complete, and nitrogen and phosphorus uptake is occurring rapidly. Physiological maturity can be estimated by adding 50 to 55 days to the silking date.

R2 Blister About 12 days after silking, silks darken and dry out. Kernels are white and form a small blister containing clear fluid. Each kernel develops an embryo. Kernels contain 85% moisture. Stress (especially drought) at this stage can reduce yield potential by causing kernel abortion.

R3 Milk About 20 days after silking, kernels are yellow and clear fluid turns milky white as starch accumulates. Kernels contain 80% moisture. The effects of stress are not as severe after this stage, but can still result in shallow kernels, stalk cannibalization, or lodging.

R4 Dough About 26 days after silking, the starchy liquid inside the kernels has a dough-like consistency. Kernels contain about 70% moisture, begin to dent at the top, and have accumulated close to 50% of their maximum dry weight. Stress can produce unfilled or shallow kernels and “chaffy” ears.

R5 Dent About 38 days after silking, nearly all kernels are dented and contain about 55% moisture. Cob has distinct color: white, pink or red. Silage harvest begins sometime during this stage, depending on desired whole plant moisture.

R6 Black Layer About 60 days after silking, physiological maturity is reached, and kernels have attained maximum dry weight at 30 to 35% moisture. Total yield is determined, and frost has no impact on yield.

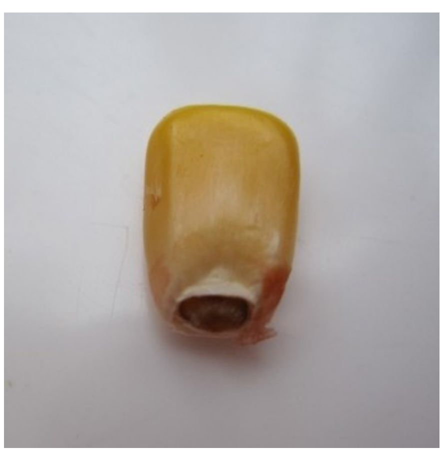

Figure 3. Kernel at black layer, note the darkened tip indicating that full kernel maturity has been reached.

Determining Corn Growth Stages

Estimating Corn Growth Stage with Growing Degree Days[1,2]

Corn growth stages can be estimated using corn growing degree days (GDD) accumulated daily from the date of planting. Corn GDD are calculated by taking the maximum daily temperature plus the minimum daily temperature to determine the average temperature in a 24-hour period. The average temperature is subtracted from the base temperature of 50°F to obtain the corn GDD for the 24-hour period. Corn development slows drastically when the temperature is above 86°F, so when the high temperature exceeds 86°F, it is used as the default high temperature for the day.

$$\text{GDD} = \left[\frac{(\text{Max Temp} + \text{Min Temp})}{2} \right] - \text{Base Temp}$$

Figure 3. Formula to calculate growing degree days (GDD).

Corn generally requires about 82 to 85 GDD from to complete a leaf collar emergence, up to growth stage V10, later vegetative stages only require about 50 GDD for collar emergence. It usually takes 115 to 120 GDD for corn to emerge after planting. Therefore, if a field has accumulated 380 GDD from date of planting, subtracting 115 GDD from 380 GDD equals 265 GDD, so the growth stage estimate for the field would be early V3.

While corn GDD can be used to estimate growth stage, keep in mind that stress factors (especially drought) can influence growth and relying on degree days may not provide an accurate estimation of growth stage.

A corn GDD tool is available at High Plains Research Climate Center, https://hprcc.unl.edu/agroclimate/gdd.php, that can help track GDD and estimate corn maturity based on historical temperature data.

Sources

[1] Nielsen, R.L. 2019. Predict leaf stage development in corn using thermal time. Purdue University Extension. https://www.agry.purdue.edu/ext/corn/news/timeless/VStagePrediction.html.

[2] Nielsen, R.L. 2020. Heat unit concepts related to corn development. Purdue University Extension. https://www.agry.purdue.edu/ext/corn/news/timeless/HeatUnits.html.

Web sources verified 9/24/20.

Legal Information

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Corn Diseases Calendar

Scouting for Corn Diseases

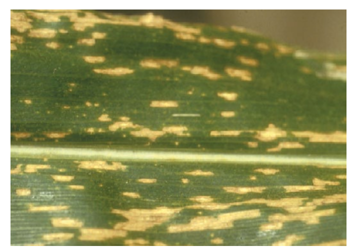
Early Season Emergence to knee-high	Mid Season Knee-high to tasseling	Late Season Tasseling to maturity
Seedling Blights		
Anthracnose Leaf Blight, Bacterial Wilt and Bacterial Leaf Blight (Stewart's Wilt, Stewart's Disease), Goss's Wilt, Physoderma Brown Spot, Common Smut, High Plains Virus		
	Northern Leaf Blight, Southern Leaf Blight, Common Rust, Southern Rust, Crazy Top, Sorghum Downy Mildew, Anthracnose Top Dieback & Stalk Rot, Bacterial Stalk Rot, Pythium Stalk Rot, Maize Chlorotic Dwarf Virus, Maize Dwarf Mosaic Virus, Corn Lethal Necrosis	
		All Ear & Kernel Rots
		Gray Leaf Spot, Head Smut, Charcoal Rot, Diplodia Stalk Rot, Fusarium Stalk Rot, Gibberella Stalk Rot, Red Root Rot]

Leaf Diseases

Anthracnose Leaf Blight

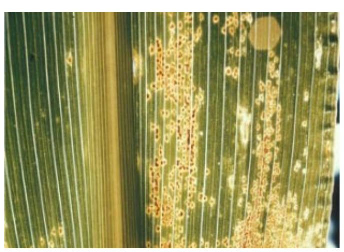
Stewart's Bacterial Leaf Blight

Gray Leaf Spot



Southern Corn Leaf Blight

Northern Corn Leaf Blight

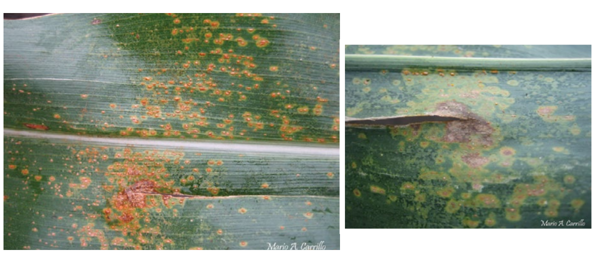


Physoderma Brown Spot

Eyespot

Goss's Wilt

Common Rust



Southern Rust (front and back surface)

Tar Spot

Ear Rots

Diplodia Ear Rot

Fusarium Ear Rot

Gibberella Ear Rot

Aspergillus Ear Rot

Smut/Virus /Fungal Systemic Diseases

Common Corn Smut

High Plains Virus

Corn Lethal Necrosis

Maize Chlorotic Dwarf Virus

Maize Dwarf Mosaic Virus

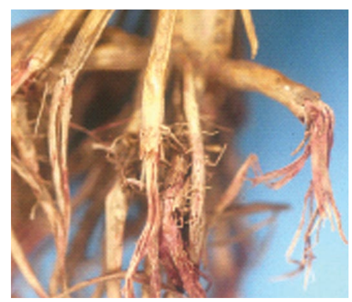
Crazy Top

Stalk & Root Rots

Anthracnose Stalk Rot

Charcoal Rot

Gibberella Stalk Rot



Red Root Rot

Diplodia Stalk Rot

Fusarium Stalk Rot

Fall Residue Retention or Tillage for Disease Management

Considerations for Residue Management

Crop residue retention improves the biological, physical, and chemical properties of soil. Additionally, nutrient recycling is a reason to conserve residue through no-till or minimal tillage field management. Conservation tillage acreage increased for these benefits while also increasing the inoculum sources for certain corn diseases. Crop residue has long been known as an inoculum source to spread disease.

Figure 1. Baled corn residue reduces disease inoculum.

Epidemics of soil-borne diseases tend to occur when susceptible crops are grown for several consecutive years. Crop residues and the soil contain disease pathogens in their dormant state until conditions favor the disease cycle. The density of disease pathogens or inoculum, the primary infection source, is directly and closely related to the occurrence of soil-borne disease. This is in contrast to air-borne diseases, such as common and southern rust, that initiate infection when blown into regions on air currents.

Surface Residue Management

Surface residue has been reported to result in earlier and more severe infections of northern corn leaf blight, southern leaf blight, and yellow blight.[1] Where these diseases have been a problem, crop residue can be buried, burned, baled, or grazed in the fall to reduce the amount on the soil surface post-harvest. Consider also removing alternate hosts for diseases that may remain as weeds and shrubbery in treelines. By reducing the initial plant disease inoculum, early onset of the disease is avoided. Oftentimes, early-onset infections cause more yield loss compared to infections that begin in the later stages of grain fill.

Disease-Dependent Tillage Recommendations

Increased Disease Incidence. Tillage would seem to be the likely management solution for soil-borne fungal infections; however, the occurrence of fusarium and anthracnose infections are not clearly reduced by tillage. An increase in fusarium stalk rot infections have been reported with tillage compared to no-tillage.[2] Chisel-plowing can increase the incidence of anthracnose stalk rot. This is thought to be possible when buried residue causes a systemic infection initiated through the roots.[2]

Decreased Disease Incidence. Moldboard plowing lowers the survival of the northern corn leaf blight pathogen by putting plant debris into greater contact with soil. Buried plant debris becomes a source of energy to fuel soil microorganisms as it decomposes. According to one study, even reduced tillage, which minimizes residue burial, lowers the level of gray leaf spot disease compared with no-tillage.[1]

Fall Residue Retention or Tillage for Disease Management

The bacterium which causes anthracnose, *Colletotrichum graminicola*, is also a poor competitor with soil microorganisms. This bacterium is undetectable after three months of being buried. However, it remains in surface residue for 10 months as an aggressive pathogen.[2]

Some Tillage Leaves Some Residue

Minimal and conventional tillage reduce the amount of *Gibberella zeae* inoculum. However, small amounts of corn residue can affect the spread of this particular disease.[3] Small amounts of disease inoculum in combination with favorable conditions for the disease cycle can increase disease pressure even for well-managed crops. Therefore, an integrated management approach should be used to control diseases.

Research on northern corn leaf blight evaluated the effect of (1) ridge-tillage: planting on a tillage ridge from the previous crop, (2) mulch-tillage: fall and spring cultivation – no moldboard plow, and (3) no-tillage management on the disease. Higher yields in the ridge and mulch-tillage plots were attributed to lower levels of northern corn leaf blight.[1] Although ridge-tillage keeps similar amounts of residue on the soil surface over winter, the use of furrow-openers on the planter were believed to reduce initial inoculum and early-onset of plant infections.

Figure 2. Preparing strips of soil may reduce initial northern corn leaf blight inoculum in early-onset of plant infections.

Figure 3. Corn residue management is a cultural practice to manage some foliar diseases.

Summary

Burial and tillage of surface residue are ways to reduce disease inoculum and decrease the risk for some corn diseases: gray leaf spot, northern corn leaf blight, southern leaf blight, and yellow leaf blight. Other corn diseases including fusarium and anthracnose are not necessarily managed with residue burial and tillage. Additional key factors in corn disease pressure have been noted by researchers: weather, corn product resistance, crop rotation, and location. Consider disease history of the field before tillage preparation and corn seed orders this fall.

Sources

[1] Pedersen, W.L. and Oldham, M.G. 1992. Effect of three tillage practices on development of northern corn leaf blight (*Exserohilum turcicum*) under continuous corn. Plant Disease vol. 76: 1161-1164.

[2] Jirak-Peterson, J.C. and Esker, P.D. 2011. Tillage, crop rotation, and hybrid effects on residue and corn anthracnose occurrence in Wisconsin. Plant Disease vol. 95: 601-610.

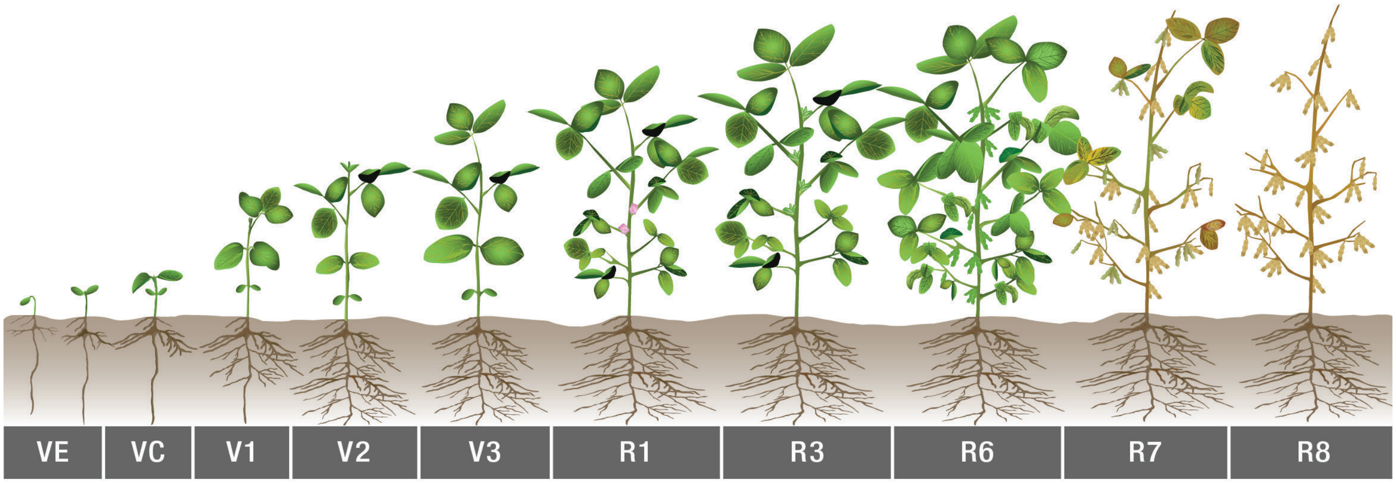
[3] Keller, M.D., Thomason, W.E., and Schmale, D.G. III. 2001. The spread of a release clone of *Gibberella zeae* from different amounts of infested corn residue. Plant Disease vol. 95: 1458-1464.

Legal Statements

Soybean Growth and Development

Soybean growth stages begin with the emergence of cotyledons from the soil surface (VE). When the unifoliate leaves unfold, the plant has reached the VC stage. When the first trifoliate leaves are fully expanded, numbers are used to signify each vegetative (V) and reproductive (R) stage of growth. When the plant begins to set flowers, the growth stages become reproductive and the plant progresses through pod development, seed development, and plant maturity. Vegetative growth stages begin to overlap reproductive stages at about R1. A new growth stage is established when 50% or more of the plants meet the requirements of the growth stage.

Determining Growth Stages in Soybeans



Source: University of Illinois, 1999

Figure 1. Soybeans are largely either indeterminate or determinate in growth habit. For indeterminate products, vegetative growth continues after flowering, and the rate of development is directly related to temperature. Determinate products generally complete vertical growth by the time flowering is completed.

Figure 2. Reproductive growth stages. With growing conditions in the Corn Belt, up to 75 percent of soybean flowers abort and never contribute to yield.[2]

Soybean Growth and Development

Emergence (VE) Through First Trifoliate (V1)

After absorbing adequate moisture and depending on temperature, product, and planting depth, the primary root or radical emerges from a soybean seed and pulls the cotyledons with it to the soil surface (VE). Cotyledons supply the plant's nutrient needs for 7 to 10 days after emergence. Loss of one cotyledon during this time has a limited effect on plant growth; however, loss of both cotyledons at or soon after VE may reduce yield potential 5 to 10%.[1,2] Soon after the cotyledons are fully exposed, unifoliate leaves emerge at the second node and begin creating energy through photosynthesis (the VC stage). Development and full extension of the first trifoliate leaflets (node 3) establishes the V1 stage of growth, and with each fully developed trifoliate on the main stem, another V stage is established.

Second Trifoliate (V2)

During the V2 stage, the second trifoliate leaf is established, and root nodules begin to develop. Nitrogen (N) fixation by the plant begins to occur when plants reach 6 to 8 inches in height. As plants switch from soil-available N to fixed N, the plants may become yellowish. Lateral roots are developing rapidly in the top 6 inches of soil.

Third to Fifth Trifoliate (V3 to V5)

Axillary buds develop into flower clusters (racemes) in the top of the stem. Determinate varieties stop producing nodes on the main stem soon after the onset of flowering.[3] For indeterminate varieties, the total number of nodes the plant can produce on the main stem is established at V5. Axillary buds that develop on an indeterminate soybean plant can help plants recover from damage. This is typically the time that iron chlorosis deficiency symptoms become visible in impacted fields.

Sixth Trifoliate (V6)

Plants develop new growth stages about every 3 days, depending on environmental conditions. At this stage, lateral roots should overlap in 30-inch rows or less. A 50% loss of leaves at this stage may reduce yield potential by about 3%.[2]

Beginning Bloom (R1)

Flowering begins on the third to sixth node, continues up and down the main stem, and eventually moves to the branches. Nodes on the main stem usually have at least one flower. Vertical roots as well as secondary roots and root hairs continue to grow rapidly until R4 or R5.

Full Bloom (R2)

An open flower develops at one of the top two nodes of the main stem. The plant has accumulated about 25% of its total dry weight and nutrients and about 50% of its mature height.[2] Nitrogen fixation by root nodules is increasing rapidly. Loss of up to 50% of plant leaves from hail, insects, or disease at this stage may reduce yield potential by 6%.[2]

Beginning Pod (R3)

A pod on at least one of the upper-most four nodes is $^{3}/_{16}$-inch long or longer. Heat or moisture stress at this stage can reduce pod numbers, seed number per pod, or seed size, which may reduce yield potential. The ability for soybean plants to recover from temporary stress decreases from R1 to R5.5. Favorable growing conditions during this period may result in greater pod number and increased yield potential.

Full Pod (R4)

Pods are growing rapidly, and seeds are developing. At least one ¾-inch long pod has developed on at least one of the four upper-most nodes. Stress during this period (and through R6) can cause more reduction in yield potential than at any other growth stage. Timely rainfall or irrigation may help reduce the potential for yield loss.

Soybean Growth and Development

Beginning Seed (R5)

At least one $^{1}/_{8}$-inch long seed is present in a pod at one of the four upper-most nodes. About half of the nutrients required for seed filling come from the plant's vegetative parts and about half from N fixation and nutrient uptake by the roots. Nitrogen fixation peaks. Stress at this stage can reduce pod numbers, the number of seeds per pod, seed size, and yield potential. Plants attain maximum height, node number, and leaf area at this stage.

Full Seed (R6)

This "green bean" stage marks the beginning of the full seed stage. At least one of the four upper-most nodes should have a pod with a green seed filling the pod cavity. Total pod weight peaks and leaves begin to yellow.

Beginning Maturity (R7)

At least one normal pod on the main stem reaches its brown or tan mature color. Seed dry matter begins to peak. Seeds and pods begin to lose green color. Plants are safe from a killing frost. Yield potential may be reduced if pods are knocked from plants or seeds are shattered from pods.

Full Maturity (R8)

When at least 95% of the pods on a plant have reached their mature color, the plant is fully mature. Typically, 5 to 10 days of good drying weather after the R8 stage has been reached are needed to obtain a harvest seed moisture content of less than 15%.

Sources

[1] Rees, J., Specht, J., Elmore, R., Nygren, A., and Mueller, N. 2019. Considerations after crusted soybean. University of Nebraska-Lincoln.

[2] 2015. Soybean growth and development. University of Wisconsin-Madison. http://corn.agronomy.wisc.edu/Crops/Soybean/L004.aspx

[3] Purcell, L.C., Montserrat, S., and Ashlock, L. 2014. Soybean growth and development. Arkansas Soybean Production Handbook, Chapter 2.

Kandel, H. and Endres, G. 2019. Soybean production field guide for North Dakota. North Dakota State University. A1172.

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Time to Check Stored Soybean Quality

Soybean grain quality is highest at harvest. The goal for producers is to manage grain storage conditions to help preserve that quality. Soybeans that are stored under cool and dry conditions are relatively safe from fungi and insects– the primary causes of grain damage.

Poor management of stored grain can result in spoilage and loss of market grade. Storing grain at the proper moisture content, making routine grain observations during storage, and managing grain temperature are important to prevent grain storage problems. Monitoring stored soybean is particularly important during the late winter months as mild temperatures begin to warm grain masses.

Moisture

Grain spoilage is influenced by the length of storage period (Table 1). In general, the longer the storage period, the lower the moisture content should be for safe storage.

Table 1. Approximate allowable storage time for soybean.

Moisture Content (%)	Grain Temperature (F)					
	30	40	50	60	70	80
	Approximate Allowable Storage Time (Days)					
11	*	*	*	*	200	140
12	*	*	*	240	125	70
13	*	*	230	120	70	40
14	*	280	130	75	45	20
15	*	200	90	50	30	15
16	*	140	70	35	20	10
17	*	90	50	25	14	7
19	190	60	30	15	8	3

*denotes storage time grater than 300 days.

- Airflow through the grain maintains the grain temperature but does not extend the allowable storage time beyond that listed.
- Allowable storage time is cumulative. If 16% moisture soybeans were stored for 35 days at 50°F, one-half of the storage life has been used. If these soybeans were cooled to 40°F, the allowable storage time at 40°F is only 70 days.

Source: Hellevang, K. Enhancing soybean storage starts with harvest moisture. Extension Alert. North Dakota State University Extension. http://ag.ndsu.edu.

Soybean moisture level is critical for maintaining storage quality. Soybean grain should be stored at moisture levels of approximately 12% or less. An accurate moisture meter is needed to check moisture levels accurately. Grain temperature can have a large effect on moisture readings. Cold grain generally causes low readings unless moisture has condensed on the surface. All moisture testers show some variability resulting in different readings when the same sample is tested more than once. To limit this effect, test each sample at least three times and average the readings. Seed soybeans should be kept at lower moisture levels. Moisture levels of 11 to 12% are recommended for long-term storage to help mitigate mold growth.

Temperature

Storage temperature plays an important role in the interaction of moisture content and grain quality in storage. Warmer temperatures require drier soybeans to maintain the same quality and allowable storage time. Controlling soybean temperature during storage is critical. Free fatty acid percentages, a negative characteristic that affects soybean oil quality, tend to increase with seed moisture, storage temperature, and time. Therefore, keeping soybean as cool as possible in the spring and summer can help maintain oil quality.

- Fall - Aerate continuously at any time when the equilibrium moisture content is acceptable and air temperature is 10°F to 15°F cooler than grain temperature until grain is cooled to 40°F.
- Winter - Aerate about every two weeks when air temperature is within 10°F of grain temperature. Store soybeans during the winter near 30°F in northern states and 40°F or lower in southern states.
- Spring and Summer - When mean daily temperatures show steady increase, aerate continuously whenever air temperature is 10°F to 15°F warmer than grain temperature until grain temperature reaches 60°F to 65°F. These temperatures enhance the storage life of soybeans and reduce mold and insect activity.

Improved technology can help manage stored grain, but it should continue to be inspected visually. Temperature cables allow for easy monitoring of the stored grain temperature at several locations, and fan controllers can operate fans according to desired air conditions. However, monitor and verify that fans are operating as desired.

Aeration

Aerate stored soybeans to maintain grain temperature between 35° to 40°F in the winter and 40° to 60°F in the summer. These temperatures reduce mold and insect activity and moisture movement within the bin.

Accumulated moisture can be easily managed if the grain is aerated every couple of weeks. Probe the bin periodically to check for insect infestation and grain temperature increase. Grain temperature increase usually means moisture migration. Aerate to try to control heating or other early storage problems. If that fails, move, re-dry, or sell the beans.

Fungi and Insects

Fungi and insects are fueled by high moisture levels and are more apt to occur in grain with many damaged kernels or trash. High temperatures and high humidity set up an excellent scenario for fungi to grow. Once grain is cooled down to 40°F, the likelihood of fungi growth is much less. Fungi are the most important cause of soybean damage in storage. Insects are more likely to attack damaged beans – either from handling damage or being damaged by some other source, such as fungi.

Soybean Storage Recommendations

- Cool the grain off as soon as possible in the fall. Target temperatures should be initially around 60°F.
- Continue to aerate and uniformly cool grain to between 30°F to 40°F if possible. This will help avoid internal moisture migration and insect activity.
- Monitor soybeans at least once every two weeks during winter storage and weekly during the fall until the grain has been cooled to winter storage temperatures.
- Keep the grain cool for as long as possible into the early spring.
- Monitor the soybeans weekly during the spring and summer. Measure the grain temperature and watch for indications of problems such as condensation, insect activity and increasing grain temperatures. Record temperature values and grain conditions to help track any changes.

Time to Check Stored Soybean Quality

- Cover fans and openings when not in use to help avoid air, moisture and potential insect movement. Ventilate the top of the bin to reduce solar heat affecting the beans at the top of the bin.
- Monitor carefully and fumigate if needed.
- Inspect soybean surface at least every week throughout the storage period.

Sources

Hellevang, K. Enhancing soybean storage starts with harvest moisture. Extension Alert. North Dakota State University Extension. http://ag.ndsu.edu.

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Sadaka, S. March 2014. On-farm drying and storage of soybeans. Arkansas Soybean Production Handbook, Chapter 15. University of Arkansas Extension. http://uaex.edu.

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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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