2012

Demonstration Reports

MONSANTO LEARNING CENTER

at Scott, Mississippi

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THANK YOU FOR VISITING THE LEARNING CENTER AT SCOTT, MS

We would like to thank you once again for visiting the Monsanto Learning Center in Scott, Mississippi! We had a successful year in 2012 with visitors from all over the U.S., and the world. For 2013, we plan to continue showcasing our current technologies and pipeline technologies, and will continue to look at new ways to improve our agronomic systems trials in order to enhance your experience while visiting Scott.

As always, our mission is to provide valuable agronomic and technical information that will help keep you on the forefront of yield, efficiency and profitability. With this in mind, we have once again compiled summary results from some of our key trials and demonstrations that were in the field during 2012. Included in this data are results from corn, cotton, soybean, and new technology demonstrations. Along with this, you will find preliminary evaluations of advanced agronomic systems which span the range from water use efficiency and tillage to the very exciting IFS systems currently in development at Monsanto.

We hope you find the information contained in the reports to be valuable to your farming operation. If you would like more details about the information contained here please feel free to contact me, or your local Monsanto representative. We look forward to hosting you again in 2013!

Please remember, we always welcome your opinion and welcome you to visit in person anytime that is convenient.

Visit us online at: www.monsanto.com or email us at learning.center-scott@monsanto.com.

Best wishes and see you in field,

Jay Mahaffey and the staff of the Monsanto Learning Center

WEATHER FOR THE 2012 SEASON

Environmental conditions at the Monsanto Learning Center at Scott, MS during the 2012 growing season contributed to above average yields for all crops. Temperatures were fairly moderate for the region with few extreme heat indexes recorded. Precipitation for the season was slightly above average. Heat units for crop growth and development accumulated at a rate similar to the 2011 season.

Temperature, Humidity, and Rainfall

Temperatures during the 2012 season were similar to the long-term average at the Learning Center. May was slightly warmer than usual, but the months of June, July, August, and September followed the normal temperatures. There were only a few days in late July when the daytime high temperature was at or above 100º F, and only one night when the recorded low was above 80º F (Figure 1). The lack of extended periods of extreme heat during the season contributed to the high yields for all crops at the Learning Center.

The humidity was abnormally low during late June and early July, which helped to reduce the potential for extreme heat during this period. The heat index dipped even lower through mid-July, along with almost 5.5 inches of rainfall received from July 8th through July 16th (Figures 1 and 2). The only extended period of high to extreme heat occurred from mid- to late July.

Rainfall was periodic and timely during the season (Figure 2). Monthly total rainfall was as follows: May 1.8 inches, June 4.8 inches, July 5.5 inches, August 6.2 inches, and September 4.6 inches for a total of nearly 23 inches of rainfall. May rainfall was below average, but June, July, August, and September were all above average. The longest period of no rain was 25 days from mid-June through the first week in July.

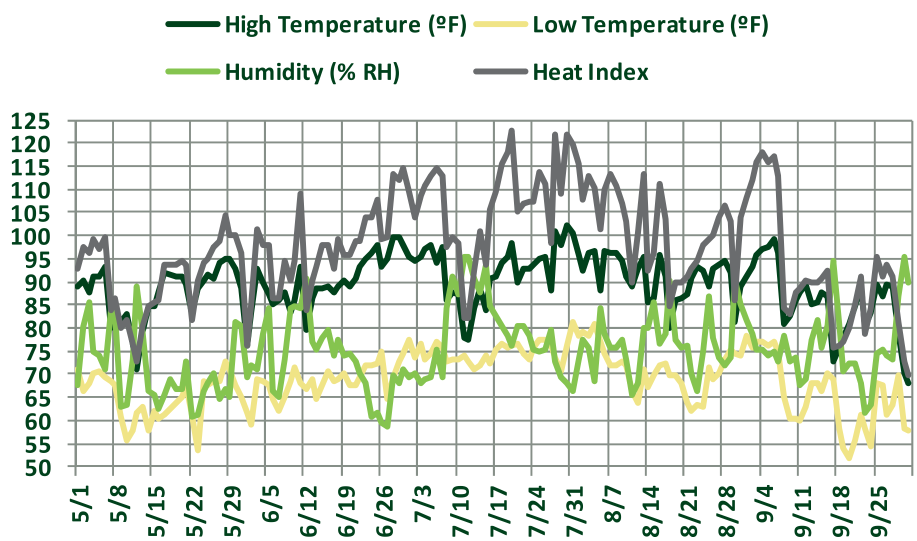


Figure 1. High and low temperatures, relative humidity, and heat index for Scott, MS from May 1 to October 1, 2012.

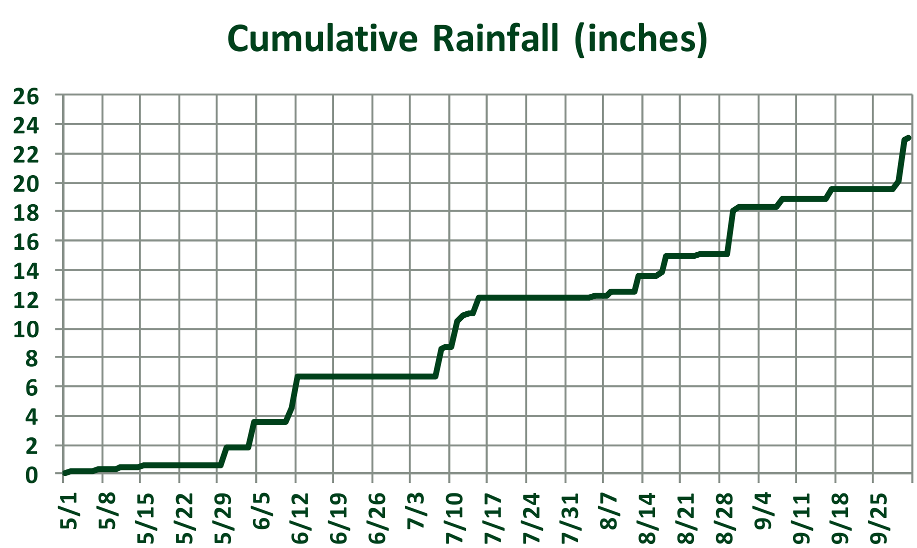


Figure 2. Accumulated rainfall for Scott, MS from May 1 to October 1, 2012.

WEATHER FOR THE 2012 SEASON

Rainfall events of more than one inch occurred once in May, twice in June, three times in July, twice in August, and once in September. The rainfall helped to produce above average yields in dryland crop production systems. The lack of flooding rains combined with adequate drainage helped provide an advantage to 30-inch row production systems in both corn and soybeans. Adequate rainfall combined with periods of low humidity, cool nights, and minimal periods of high to extreme heat helped contribute to above average yields observed for all crops in 2012.

Heat Index and Worker Safety

Extreme heat can severely impact crops, as well as individuals working on the farm. The heat index is the temperature felt by the human body due to the combined effects of temperature and humidity, and can be used to help determine the risk of heat-related illness for outdoor workers. A combination of high heat and high humidity can mean trouble to workers in the field. A very high to extreme risk level occurs when the heat index is greater than 115º F. Risk level is high when the heat index is 103º F to 115º F. A moderate risk level occurs when the heat index is 91º F to 103º F, and one should exercise caution when the heat index is less than 91º F. Over 70% of the working days during May through September in 2012 had a heat index of 91º F or greater (Figure 1).

Everyone should be careful while conducting field work in the heat. When heat advisories are issued, anyone working outdoors should take extra precaution. Workers should conduct strenuous outdoor activities in the early morning or evening, wear light-weight materials, drink plenty of water, and take frequent breaks in shade or air conditioning.

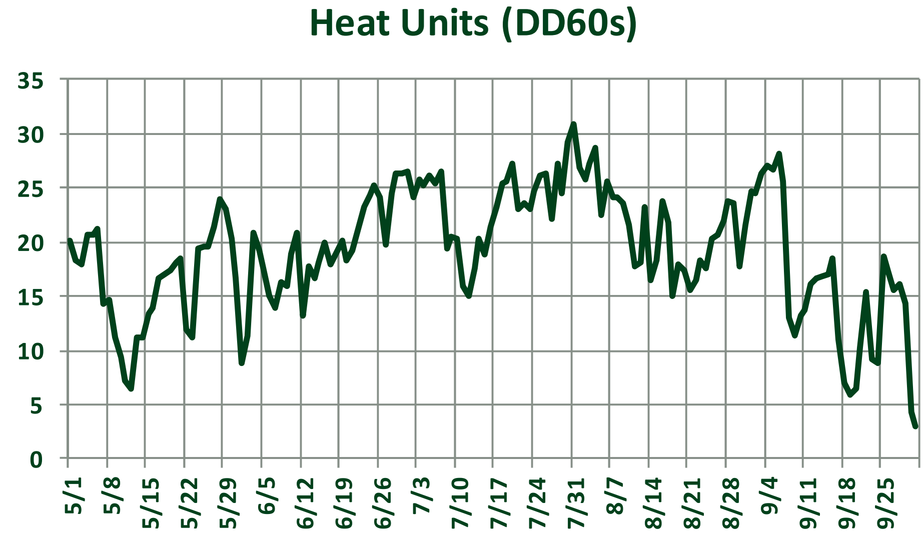
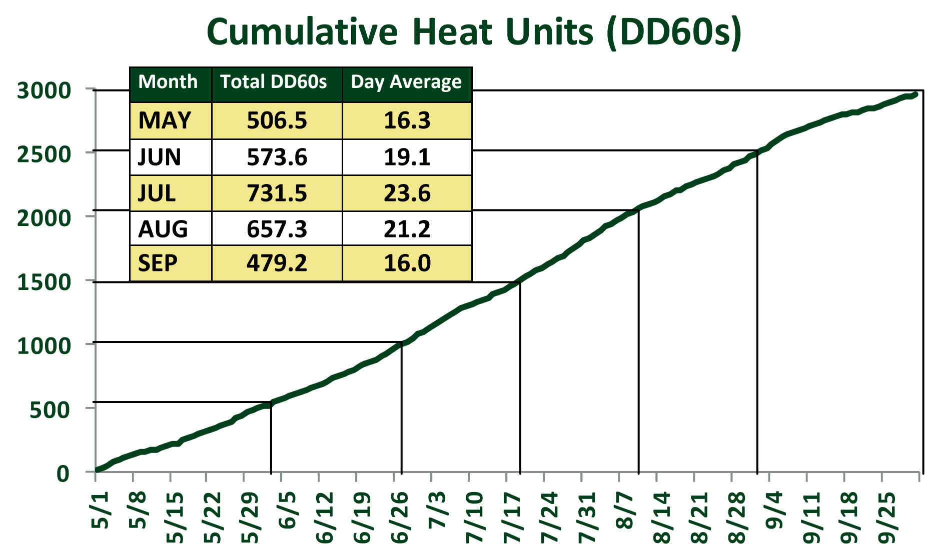


Figure 3. Heat units during the season for Scott, MS from May 1 to October 1, 2012.



Month	Total DD60s	Day Average
MAY	506.5	16.3
JUN	573.6	19.1
JUL	731.5	23.6
AUG	657.3	21.2
SEP	479.2	16.0

Figure 4. Heat unit accumulation for Scott, MS from May 1 to October 1, 2012.

Heat Units (DD60)

Plant growth and development is related to heat unit accumulation. Heat units are equal to the average temperatures for a day minus some minimum growing temperature. DD60 heat units are used as an aid in managing cotton, providing information about when to plant, when to expect first bloom and when bolls might be maturing.

WEATHER FOR THE 2012 SEASON

Heat unit accumulation varied throughout the 2012 growing season, but DD60s were accumulated at a rate similar to previous seasons (Figures 3 and 4). The accumulated heat units per day ranged from around 10 to 20 DD60s during May and September, peaking around 25 to 30 DD60s during July. The average heat unit accumulation was 19.2 DD60s per day from May 1 to October 1, 2012.

Comparison of 2011 and 2012 Weather

Environmental conditions were good for crop production during both 2011 and 2012 at the Learning Center. Heat unit accumulation for crop growth and development was similar in both years (Figure 5).

Temperatures were fairly moderate in both years. However, heat indexes were generally not as high in 2012 (Figure 5). There were more extended periods of heat indexes over 115, and more days where the daytime high was over 100º F in 2011. Rainfall received from mid-June to late September was nearly equivalent in both years. Multi-week periods of no rainfall also occurred in both years that caused some production problems.

The period of mid-June through mid-July was an important contrast in crop growing conditions between 2011 and 2012. The humidity was abnormally low during this period in 2012, resulting in lower heat indexes and reduced crop stress. Favorable humidity conditions were a major reason for above average yields for all crops across the south in 2012.

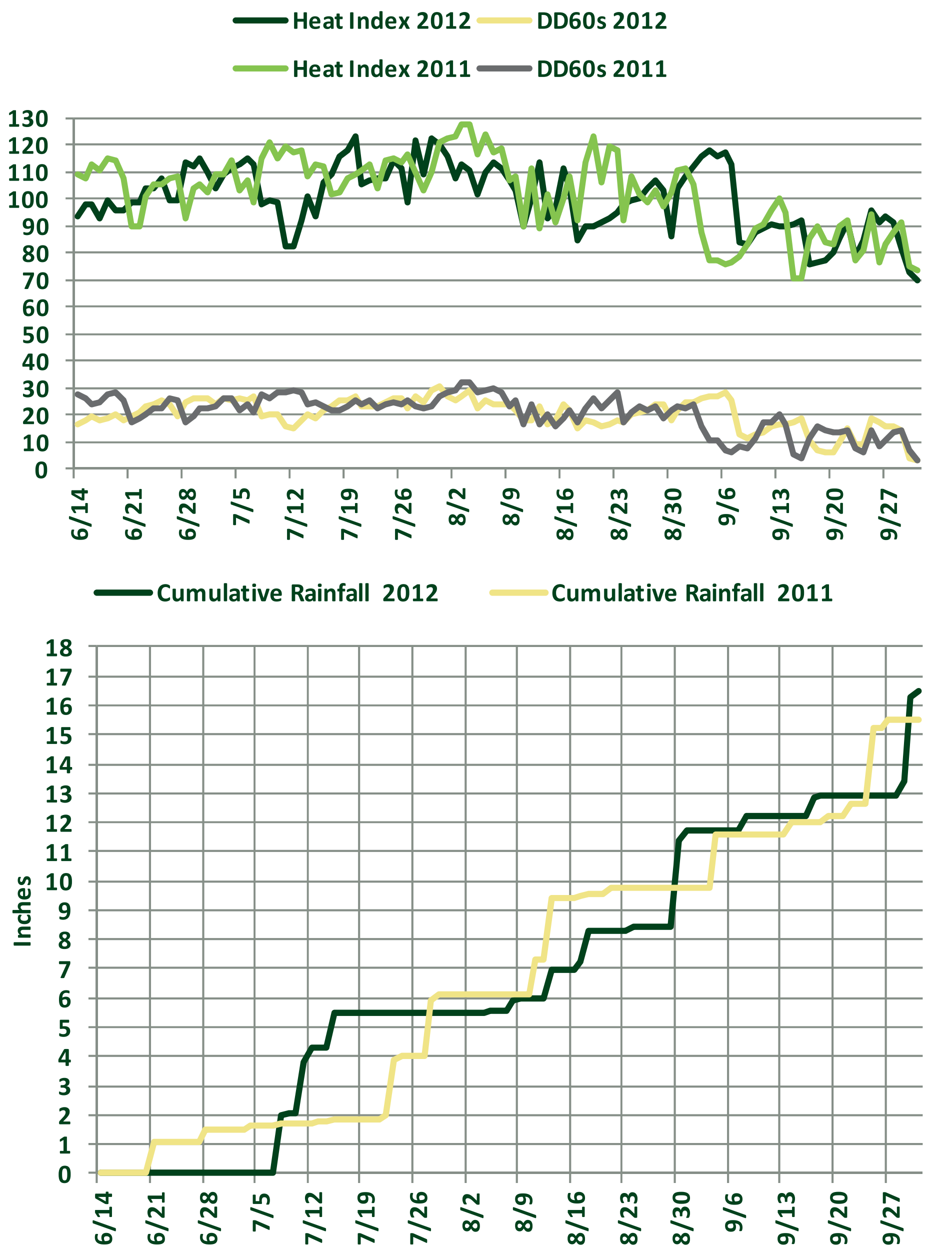


Figure 5. Heat index, heat unit (DD60s), and accumulated rainfall comparisons of the 2011 and 2012 seasons over the time period from June 14 to October 1.

The information discussed in this report is from a single site, non-replicated, one-year 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.

EFFICIENT USE OF IRRIGATION RESOURCES

Water use has become a hot issue in the Delta region of the Mississippi River basin. The total annual rainfall in the Mississippi Delta region is more than required for optimum plant growth; however, rainfall distribution during the summer months can be scarce[1]. Periodic summer droughts make irrigation necessary to avoid crop failure. Two approaches to help increase the supply of available water for crop use are to 1) maximize infiltration and storage of moisture in the soil; and 2) increase supplemental irrigation capacity. Because irrigation applications are costly and time consuming, the efficient use of irrigation is a main objective for crop production in the region.

Materials and Methods

In 2012, the Monsanto Learning Center in Scott, MS began investigating ways to utilize irrigation more efficiently. Conversation with local university and agricultural engineers, pointed to the fact that silt loam soils commonly found throughout the region, are known to become compacted and sealed. Consequently, movement of irrigation water into the root zone is limited. In some fields, much of the rainfall and supplemental irrigation being applied may merely run over the ground and flow directly into the ditches. Deep tillage in the fall can be used to help store rainfall for the following season.

The question becomes, are there benefits to in-season deep tillage? Discussions with a local agricultural engineer revealed an in-season tillage system that was utilized in the early 1990's which provided effective water utilization and reduced the number of pivot irrigation applications needed. The innovative engineer designed and constructed a deep tillage parabolic subsoiler for use in crop. The equipment was used to break the compaction layer of the silt loam soil, allowing the irrigation water to penetrate to the root zone and eliminate irrigation frequencies.

For the initial study, many possible tillage systems were explored. The following parameters were used:

- Tillage to run 10 to 12 inches deep
- Tillage to provide minimal soil displacement
- System must be adaptable to commonly used implements
- The system could be used in conjunction with other operations

A subsoiler was constructed for this trial with the use of M1 Winged Anhydrous Knives manufactured by Nichols Tillage Tools® mounted on an Orthman® toolbar directly behind the buster (Figure 1 - 3). The subsoiler was adjusted to run 10 inches deep and could be used in conjunction with the buster to allow for furrow irrigation. An on-farm trial was initiated in 2012 with a portion of the pivot irrigated field left untreated as a check. In-season deep tillage was run just prior to cotton layby herbicide application with the constructed parabolic subsoiler.

The Learning Center was assisted by Jason Krutz, Associate Research/Extension Professor specializing in irrigation at the Mississippi State Delta Research and Extension Center. Irrigation sensors were installed to measure infiltration rates in the treated and untreated areas of the field. Unfortunately a sensor failed during the trial, eliminating data collection. This study will again be conducted in 2013.

Figure 1. A subsoiler was constructed with the use of M1 Winged Anhydrous Knives manufactured by Nichols Tillage Tools® mounted on an Orthman® toolbar.

EFFICIENT USE OF IRRIGATION RESOURCES

Summary Comments

Even though irrigation sensor data was not collected, the following observation and evaluations were made.

- The infiltration rate appeared to be much higher in the tillage portion of the trial. Water did not pool as much in the tillage portion of the demonstration, versus the areas of the field that did not receive in-season tillage.
- In the areas of the field that did not receive in-season tillage, excessive pooling occurred where compaction was made by the tires of the high-clearance sprayer during the layby application.

Figures 2 (left) and 3 (above). A subsoiler was constructed with the use of M1 Winged Anhydrous Knives manufactured by Nichols Tillage Tools® mounted on an Orthman® toolbar.

References

[1]The Yearbook of Agriculture 1957: Soil. The Mississippi Delta Region. United States Department of Agriculture. 524-527.

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INTEGRATED FARMING SYSTEMS℠ PLATFORM PRECISION AGRICULTURE DEMONSTRATION

Monsanto's Integrated Farming Systems℠ (IFS) will pilot the company's first product, FieldScripts℠, during the 2013 planting season in Monsanto's Ground Breakers® trials. FieldScripts℠ products combine two ideas: more yield through genetics and machinery by matching the best hybrid with a variable rate planting recommendation for each individual field. FieldScripts℠ products are a convergence of equipment, computer technology, and Monsanto science that can help growers maximize yield potential and provide a potential reduction in risk. This is accomplished by matching hybrids with variable rate populations appropriate for yield environments in each field. In anticipation of the FieldScripts℠ products launch, a demonstration trial was conducted at the Monsanto Learning Center at Scott, MS to showcase the advancements in precision agriculture technology.

FieldScripts℠ Products and Technology

The IFS Certified Seed Dealer will work with customers to select desired fields to enroll in FieldScripts℠. To develop a unique FieldScripts℠ product to work with a grower's variable rate planter technology, the grower will need to provide information, such as: field boundaries, two years of geo-spatially referenced yield data, and soil test results to their IFS Certified Seed Dealer. Using Monsanto's extensive seed-by-environment databases, the company will deliver a best hybrid match for each field, along with a variable rate seeding prescription by FieldScripts℠ Management Zone for that hybrid, specific to that single field. The prescription will be provided through Precision Planting's FieldView™ app for the iPad® handheld device to the farmer's tractor cab. The prescription will then be automatically executed as the field is planted.

Ground Breakers® Trials

Monsanto uses the Ground Breakers® program to gain feedback from growers on product introductions ahead of commercialization. Next year FieldScripts℠ products will be piloted in Ground Breakers® trials. Monsanto anticipates FieldScripts℠ will be launched in 2014.

Scott Demonstration Trial

In anticipation of the FieldScripts℠ products, the Monsanto Learning Center at Scott, MS wanted to demonstrate the advances in precision farming technology to growers. After much

Figure 1. Aerial photo of soybean and sunflower precision agriculture demonstration plot.

INTEGRATED FARMING SYSTEMS℠ PLATFORM PRECISION AGRICULTURE DEMONSTRATION

discussion and planning, a demonstration of the capabilities of the Monsanto Learning Center planting systems was implemented. This demonstration focused on educating growers on the process of obtaining a field prescription and implementing a variable rate precision planting as well as the accuracy of today's precision technology.

SST Software, an Oklahoma company, assisted in formulating a prescription for the application of the demonstration inputs. Two crops were chosen: one that required a nitrogen (N) application (sunflowers) and one that did not (soybeans). Upon receiving the prescription, the software was downloaded into the applicator/planter control system on each tractor utilized in the demo. The first application was a 28% N solution applied only in the areas of the demo where the sunflowers were to be planted. Following the application of N, the crops were planted at the appropriate planting rates. The sunflowers were planted at 28,000 seeds per acre with a single row 38-inch planting system. The last application consisted of twin row 38-inch soybeans planted at 140,000 seeds per acre. The result is shown in Figure 1.

The agronomists at the Monsanto Learning Center at Scott, MS have demonstrated the ability to precisely prescribe inputs and apply them in a designated management zone. With the anticipated launch of FieldScripts℠ in 2014, the agronomists at Monsanto Learning Center at Scott, MS will continue to work on innovative ways to demonstrate the practicality of precision technology.

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CORN YIELD RESPONSE COMPARING TWO ROW CONFIGURATIONS

Twin-row corn production has gained popularity in the Mississippi Delta especially on wide-row, raised-bed systems. Common questions about twin-row corn are "whether yields can be increased by planting at higher populations, and whether certain products are more suited to the system than others"? This demonstration was conducted to help answer these questions, and to assist growers when making decisions on corn seed selection and planting populations.

Study Guidelines

A corn demonstration trial was conducted at the Monsanto Learning Center at Scott, MS comparing single and twin-row planting configurations on 38-inch wide-row spacing in a raised-bed system. Three DEKALB® brand corn products (DKC64-69 brand, DKC66-97 brand, and DKC69-29 brand) were chosen for this demonstration. Each product was planted in both row configurations at three populations (31,000, 36,000, and 39,000 plants per acre). Twin rows were planted 7.5 inches apart on 38-inch beds with a Monosem® twin-row planter (Figure 1). Field work and preparation was appropriate for the row configuration, with twin rows requiring some extra preparation in making the relatively wide, flat, and stable bed typically needed to optimize the planting performance of the twin-row planter. Corn was planted on April 5 and harvested on September 6, 2012. Standard agronomic practices for the area were implemented with irrigation provided as needed.

Results and Conclusions

When averaged across planting populations, twin rows out-yielded single rows by 2.2% or 5 bu/acre. The yield increase of twin rows over single rows was similar to that obtained in 2011 testing at this location.[1] In other testing, a three-year Mississippi State University study did not find any yield advantage to corn grown in twin rows over single rows on 38-inch centers.[2] Testing often indicates that twin-row corn production will not necessarily result in greater yields compared to single-row plantings at similar populations, but there is also no indication of a reduction in yield with the twin-row configuration.[3] With planting technology (planting speed, E-Set units, hydraulic planter drives, planter adjustments, increasing grower awareness) improving over the years in both systems, yield differences between the two configurations may be diminishing. Precision twin-row planting can offer the potential for corn yield increases by improving plant-to-plant spacing both across and down the rows.

In this demonstration, twin-row corn yields increased with increasing planting populations (Figure 2). Corn yield increased by

Figure 1. Single and twin-row configurations planted on 38-inch centers.

CORN YIELD RESPONSE COMPARING TWO ROW CONFIGURATIONS

3% or 7 bu/acre from the lower planting population of 31,000 plants per acre (ppa) to the higher planting population of 39,000 ppa in the twin-row configuration. With single rows, corn yield increased from a planting population of 31,000 to 36,000 ppa, but there was no further increase in yield when planting at the high population of 39,000 ppa. The results suggest that there may be a greater opportunity for corn yield potential with higher planting populations in a twin-row configuration.

When averaged across row configurations and planting populations, the three DEKALB brands yielded similarly with an overall demonstration plot average of 233 bu/acre. However, the products responded differently to row configuration and planting population (Figure 3). Twin rows out-yielded single rows regardless of the planting population with DKC66-97 and DKC69-29 brands. The twin-row yield advantage ranged from 3 to 6% (6 to 14 bu/acre) with these products. However, twin rows out-yielded single rows only at the lowest planting population of 31,000 ppa with the DKC64-69 brand. Testing in 2011 with DKC64-69 brand showed little interaction of row configuration and population on yield.[1] DKC69-29 brand appeared to benefit the most from higher planting populations in this testing. DKC66-97 and DKC69-29 brands also appeared to respond better to the twin-row configuration.

Summary Comments

Results from this demonstration and previous testing can provide information on average yield response to row configuration and planting population. Additionally, the row configuration and population data become more valuable when considering which product to place on a specific acre.

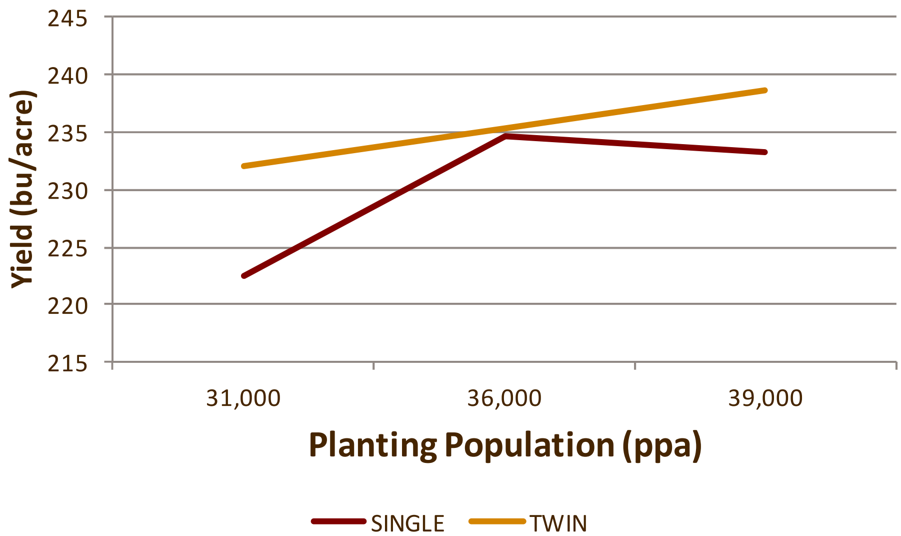

Figure 2. Effect of planting population on corn yield averaged across three DEKALB® brands planted in single and twin-row configurations on 38-inch wide-row spacing in 2012.

DKC64-69 brand has shown consistency over the past two years of testing with little interaction of row configuration and population on yield. In both years, the highest yield for DKC64-69 brand was at 36,000 ppa in both single and twin-row configurations. The results are also consistent with extensive commercial experience, and similar to previous results where optimal yields for DKC64-69 brand have been in the 32,000 to 34,000 ppa range.

In this study, yields of DKC66-97 brand increased with higher planting populations, and yields were higher in the twin-row configuration. In general, the response of DKC66-97 brand to higher populations agrees with previous experience in testing DKC66-96 brand, a similar and related Genuity® VT Triple PRO® product. Yields of DKC69-29 brand also increased with higher planting populations, and higher yields were obtained in the twin-row configuration. Results indicate that yield potential can be greatly influenced by the interaction of product, plant population, and planting configuration.

References

[1] Corn yield response to population and row configurations. Monsanto Learning Centers 2011 Demonstration Reports.

[2] Buehring, N.W. et.al. 2003. Corn response to twin and narrow rows with selected seeding rates. Northeast Branch Experiment Station, North Mississippi Research and Extension Center, Mississippi State University, Verona, MS.

[3] Bruns, H. A. et.al. 2012. Comparing single-row and twin-row corn production in the Mid South. Online. Crop Management doi:10.1094/CM-2012-0404-01-RS.

CORN YIELD RESPONSE COMPARING TWO ROW CONFIGURATIONS

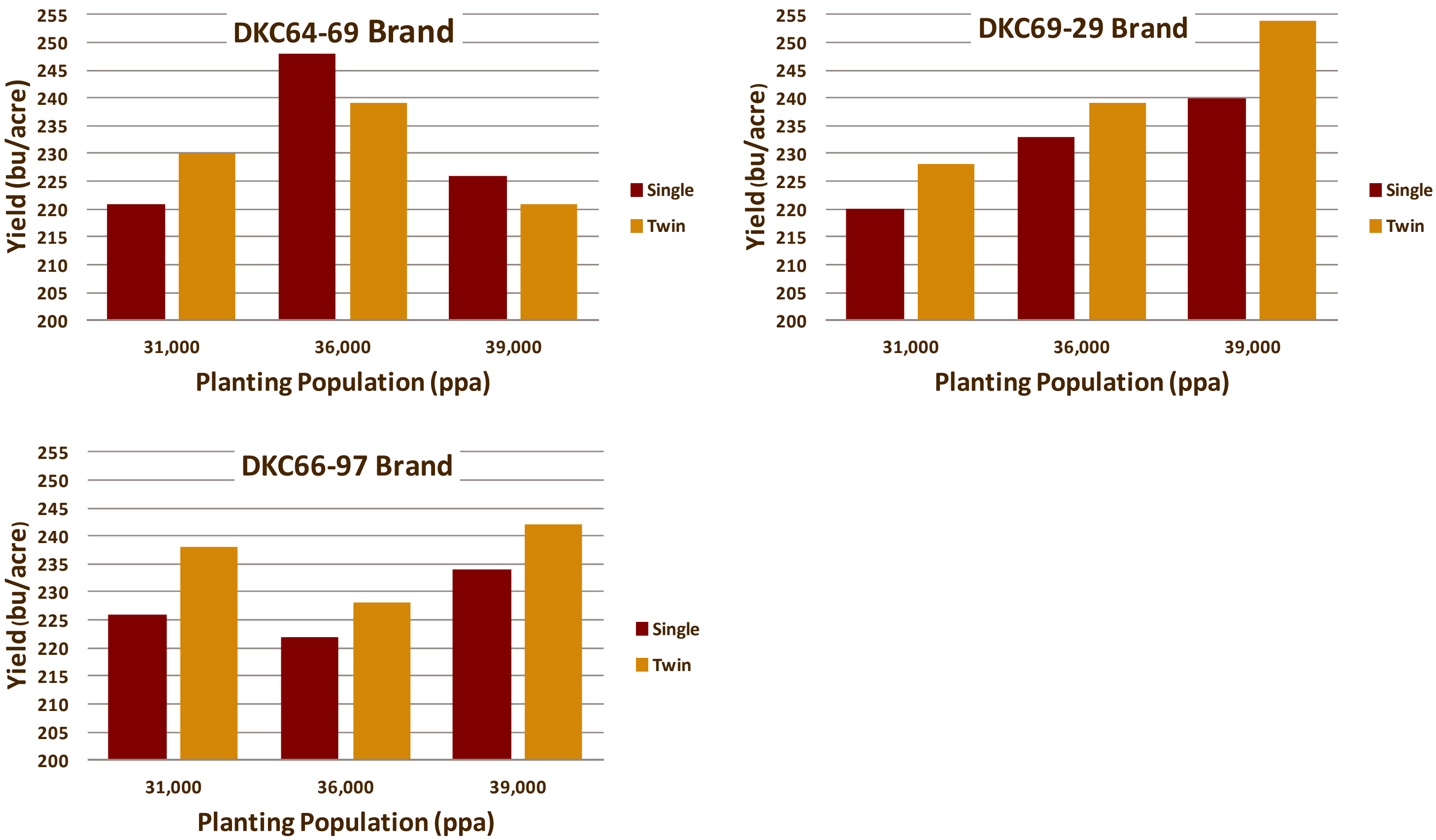

Figure 3. Effect of row configuration and planting population on corn yield of three DEKALB® brands in 2012.

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CORN YIELD RESPONSE TO ROW SPACING AND POPULATION

Corn production has transitioned to narrower (30-inch) row widths in many Southern regions. Twin-row corn has also gained popularity especially on wide-row (38-inch), raised-bed systems. In response to grower requests, modern and/or recently released corn brands were planted to 30-inch single-row and 38-inch twin-row configurations at different planting populations. This demonstration looks at how these row configurations compare, how specific products are adapted to these corn production systems, and what planting populations are most beneficial to the specific product.

Study Guidelines

Testing was conducted in 2012 at the Monsanto Learning Center at Scott, MS to evaluate the effects and interaction of row spacing configuration, plant population, and corn brand on yield potential. Six DEKALB® brand corn products (DKC61-06, DKC61-88, DKC64-69, DKC66-97, DKC67-57, and DKC67-88 brands) ranging from 111 to 117 day relative maturity were selected for this demonstration. Each product was planted in 30-inch single-row (SR) and 38-inch twin-row (TR) configurations at three populations (33,000, 36,000, and 39,000 plants per acre). Twin rows were planted 7.5 inches apart on 38-inch beds, and required extra bed preparation to establish the wide, flat, stable bed needed for uniform TR planting. Corn was planted on March 25 and harvested on September 6, 2012. Standard agronomic practices for the area were implemented with irrigation provided as needed. Regionally appropriate fertility practices for corn were applied with a yield goal of 200 bushels per acre (bu/acre).

Results and Discussion

Averaged across all corn brands and planting populations, the 30-inch SR configuration out-yielded the 38-inch TR configuration by an average of 6.4% or 13.6 bu/acre. Yields for both row configurations were not significantly influenced by planting population when averaged across corn brands (Figure 1). Averaged across the three planting populations, all corn brands yielded more when planted in the 30-inch SR configuration (Figure 2). Of the corn brands evaluated in this demonstration, the yield of DKC61-88 brand was least affected by row configuration and planting population.

Not all corn brands responded the same to planting population (Figures 3,6, and 7). DKC61-06 brand, DKC66-97 brand, and DKC67-57 brand had increased yields when planted at higher populations. DKC64-69 brand and DKC67-88 brand had decreased yields when planted at higher populations. DKC61-88 brand did not have yields that were greatly affected by planting population. In general, both row configurations responded similarly to planting population by corn brand (Figures 4-7).

Testing over years has shown that corn brands can respond differently to row spacing/configuration and planting populations. DKC61-06 brand has responded positively to higher planting populations in both 2011 and 2012 testing, with a more positive response to population increases when planted in 38-inch twin rows (Figure 5).[1] DKC64-69 brand has not shown a positive yield response to higher populations in either year of testing, and should be planted in a population range of 32,000 to 34,000 ppa (Figure 3).[2] The response of DKC66-97 brand to higher populations agrees with previous testing of DKC66-96 brand, a

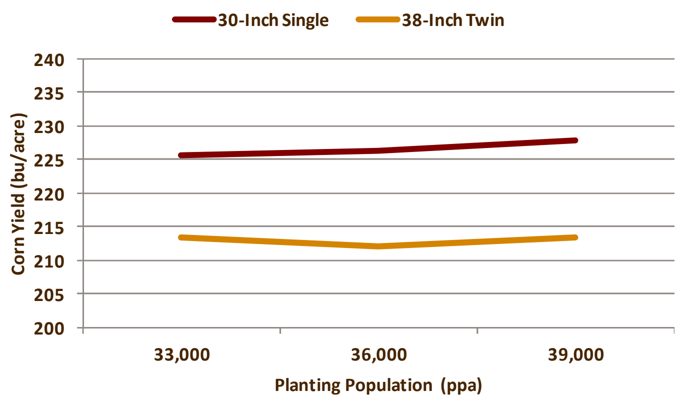

Figure 1. Effect of row configuration and planting population on corn yield averaged across six DEKALB® brands in 2012.

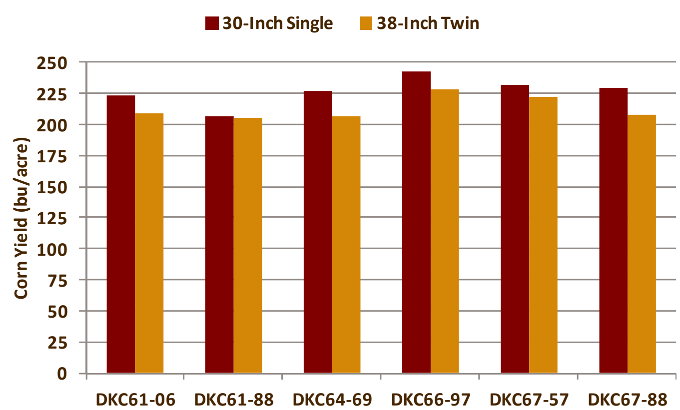

Figure 2. Effect of row configuration and DEKALB® brands on corn yield when averaged across three planting populations in 2012.

CORN YIELD RESPONSE TO ROW SPACING AND POPULATION

brand responded positively to population increases in both 2011 and 2012 testing.[2]

In general, for the products evaluated in this demonstration, DKC61-06 brand, DKC66-97 brand, and DKC67-57 brand have the best opportunity to benefit from higher planting populations. Whereas, DKC61-88 brand, DKC64-69 brand, and DKC67-88 brand should not be planted at higher populations. Both DKC61-88 brand and DKC67-88 brand are taller corn products with higher ear placement, and should not be planted at higher populations due to increased risk of lodging. Corn products with lower ear placement tend to be the better yielding at the higher planting populations.

Summary Comments

Although the 30-inch SR configuration out-yielded the 38-inch TR configuration in this demonstration, testing at this location in 2010 and 2011 showed that 38-inch TR generally yielded more than 30-inch SR.[1,3] Management and environmental factors can alter the yield potential of corn planted in both row configurations. The lack of flooding rains combined with adequate drainage helped provide an advantage to 30-inch SR production systems in 2012. The 30-inch rows were able to intercept more sunlight, nutrients, and water without water logging being an issue.

With proper field preparation and management, both row spacing configurations can work well in Southern corn production systems. Both the 30-inch SR and 38-inch TR configurations can offer many of the advantages of narrower rows, allowing for earlier and better light interception and utilization of water and nutrients through better plant distribution. Both configurations spread plant uniformity across the field, and twin rows can spread uniformity down the corn row as well. Bed integrity and drainage can be a challenge with 30-inch SR, and should be given careful consideration in planning 30-inch production systems. Likewise, bed preparation is critical with 38-inch TR, and planter adjustment is necessary for proper staggering of twin rows. All of these factors should be considered when choosing a row configuration, when choosing products for planting, and when preparing or adjusting equipment for planting.

Overall, these demonstrations illustrate the importance of selecting products that consistently perform in an area. After selection, understanding how the individual products respond to different populations, row spacings and configurations can help maximize corn yield potential.

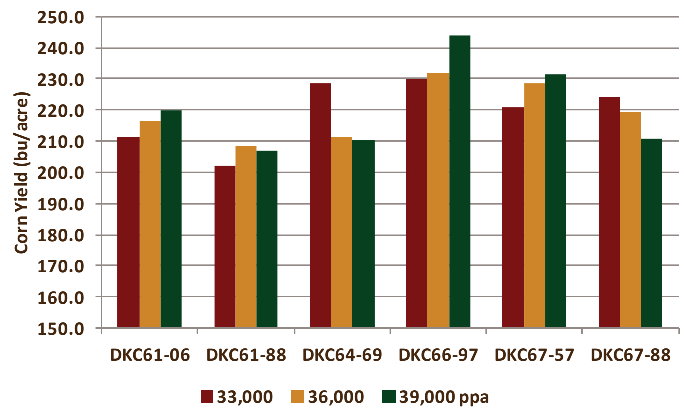

Figure 3. Effect of planting population and DEKALB® brands on corn yield when averaged across both row configurations in 2012.

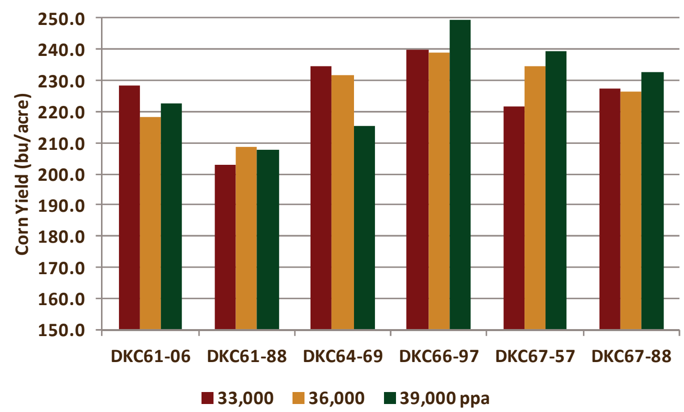

Figure 4. Effect of planting population and DEKALB® brands on corn yield when planted on 30-inch single rows in 2012.

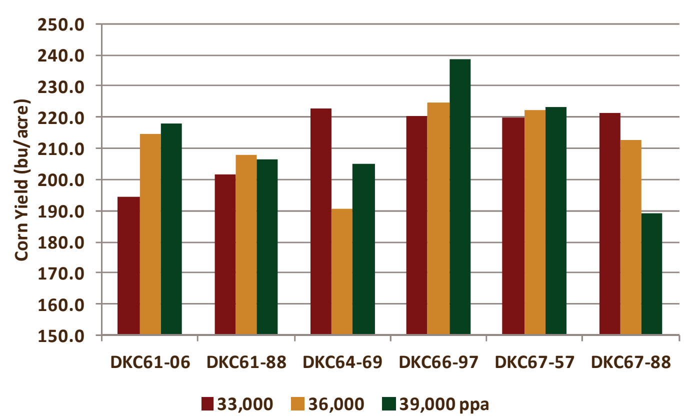

Figure 5. Effect of planting population and DEKALB® brands on corn yield when planted on 38-inch twin rows in 2012.

CORN YIELD RESPONSE TO ROW SPACING AND POPULATION

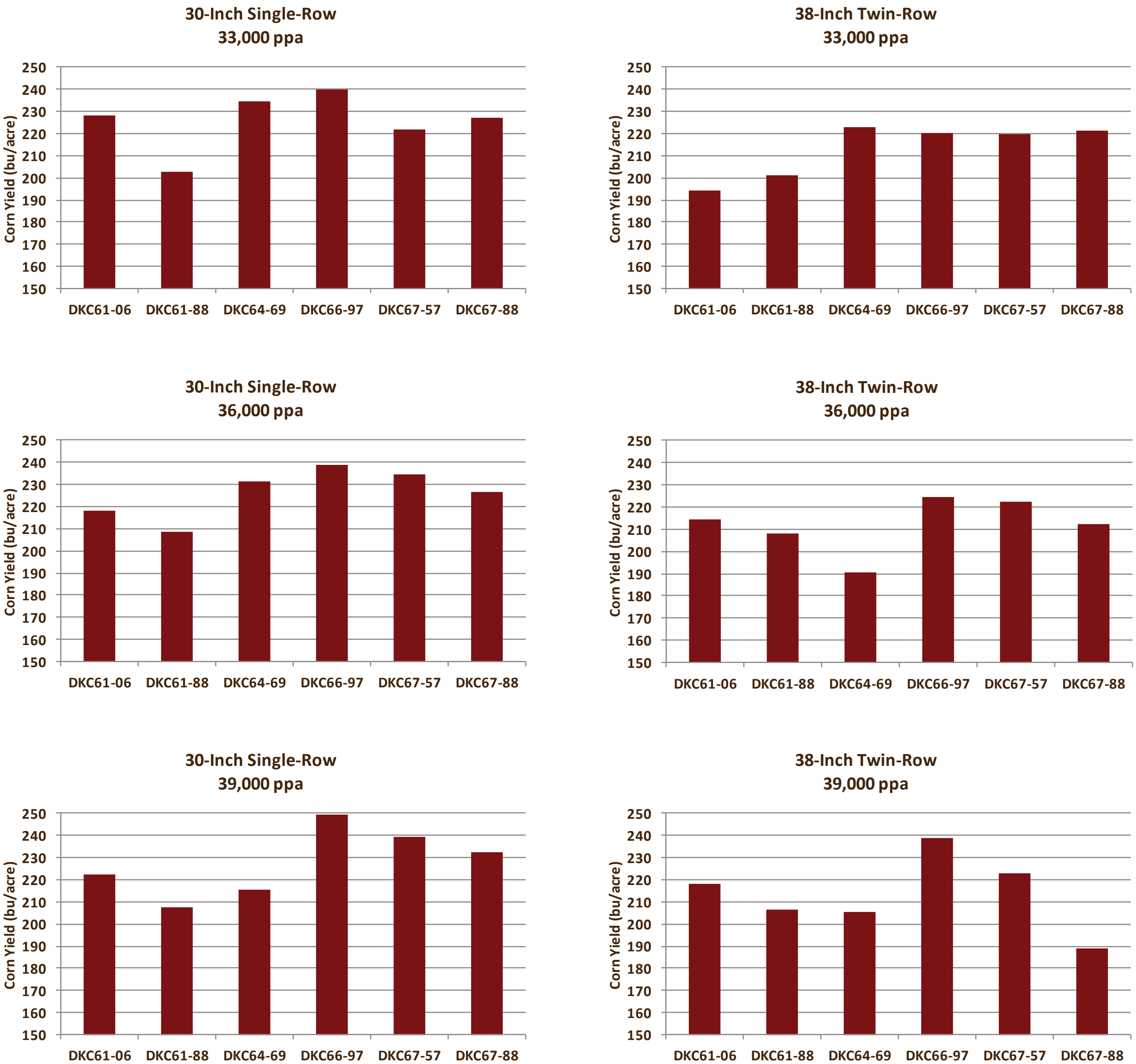

Figure 6. Comparative corn yields of six DEKALB® brands at different row spacing configurations and planting populations in 2012.

CORN YIELD RESPONSE TO ROW SPACING AND POPULATION

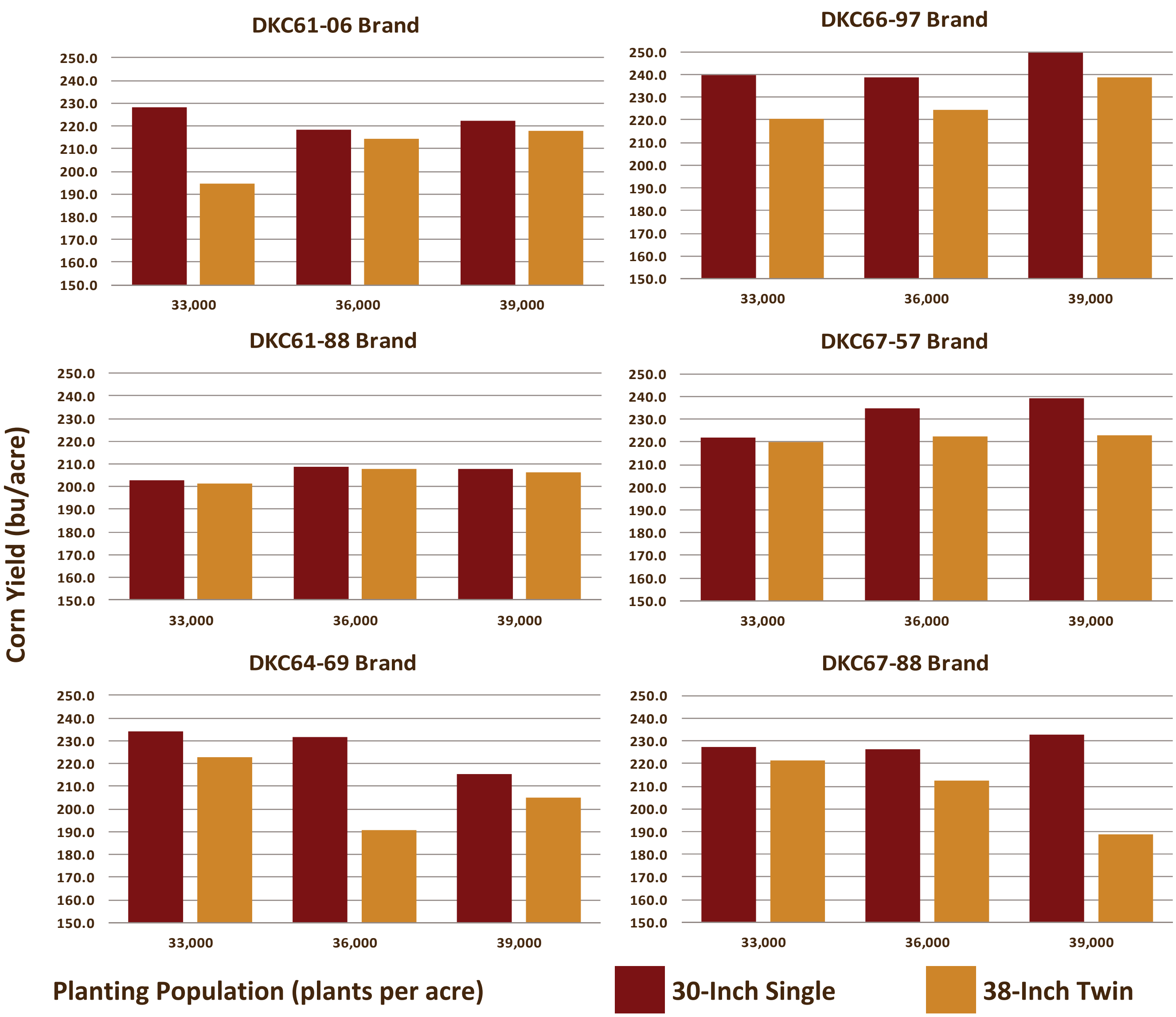

Figure 7. Effect of row configuration and planting population on corn yield of six DEKALB® brands in 2012.

References

1 Corn response to population, row configuration, and soil type. Monsanto Learning Center 2011 Demonstration Report.

2 Evaluation of new corn brands x population. Monsanto Learning Center 2011 Demonstration Report.

3 Cotton, corn and soybean row width and planting configuration comparison. Monsanto Learning Centers 2010 Demonstration Report.

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EVALUATION OF THREE ROW CONFIGURATIONS IN MIDSOUTHERN CORN PRODUCTION

Midsouthern corn growers who have a desire to move to 30-inch or narrower rows to optimize grain yield potential need to know which corn products are best adapted to planting at a range of populations in narrow rows. Research demonstrates that the response of individual corn products to row width and plant population can vary. This 2012 study follows the research of previous years to answer questions on the effects of plant population and row configuration on corn yield potential.

Study Guidelines

Testing was conducted at the Monsanto Learning Center at Scott, Mississippi in 2012 to evaluate the effects and interaction of plant population, row spacing, and germplasm on yield potential. Corn plots were planted in 30-inch single rows, 38-inch single rows, and twin rows planted 7.5 inches apart on a 38-inch bed. To facilitate irrigation and field drainage, all rows were planted on beds. Planted populations were 33,000, 36,000 and 39,000 seeds per acre (seeds/acre). Standard agronomic practices for the area were implemented.

Two corn products were planted in each row configuration and at each plant population. The corn products selected were: DKC64-69 brand, a 114 relative maturity (RM) product with Genuity® VT Triple PRO® technology, and DKC66-97 brand, 116 RM with Genuity® VT Double PRO® technology. DKC64-69 brand has a medium-high plant height and medium-high ear placement and a large ear, while DKC66-97 brand has a shorter plant height and ear placement with a relatively small ear. Both products were harvested for yield and adjusted to 15.5 percent moisture.

Results and Conclusions

Averaged across all row widths and plant populations, DKC66-97 brand produced about 11 bu/acre higher yield than DKC64-69 brand (Figure 1). DKC64-69 brand did not respond to increasing populations while DKC66-97 brand demonstrated a positive yield response to higher populations. DKC66-97 brand in 30-inch single rows produced the highest average yield of 242.69 bu/acre (Figure 2). In most cases better adaptation of a corn product to one row configuration or another was not observed.

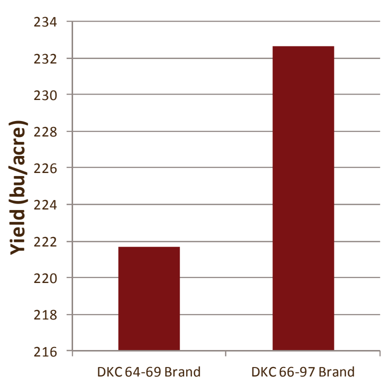

Figure 1. Average Yield Across all Row Widths and Plant Populations

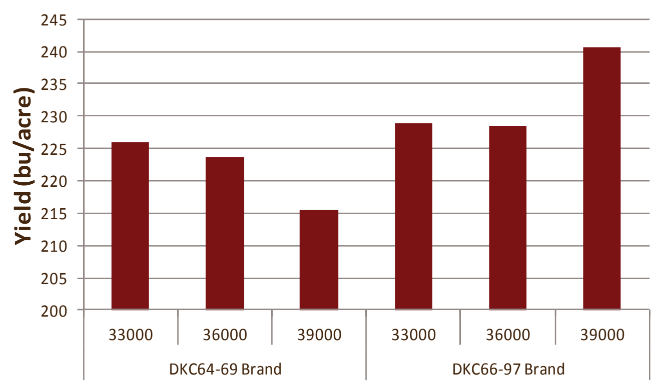

Figure 2. Average Brand and Population Effect on Yield Across all Row Widths

Averaged across all row widths, DKC64-69 brand produced 225 bu/acre when planted at 33,000 seeds/acre; 224 bu/acre when planted at 36,000 seeds/acre; and 215 bu/acre when planted at 39,000 seeds/acre. DKC66-97 brand produced 229 bu/acre when planted at 33,000 seeds/acre; 229 bu/acre when planted at 36,000 seeds/acre; and 241 bu/acre when planted at 39,000 seeds/acre (Figure 2).

Averaged across all plant populations, DKC64-69 brand produced average yields of 227 bu/acre in 30-inch rows; 232 bu/acre in 38-inch single rows; and 206 bu/acre in 38-inch twin rows. DKC66-97 brand produced average yields of 243 bu/acre in 30-inch single rows; 227 bu/acre in 38-inch single rows; and 228 bu/acre in 38-inch twin rows (Figure 3).

The corn product that responds with a higher yield in a specific row configuration generally also responds with a higher yield in another row configuration, as long as the grower does what is necessary to optimize conditions for that row configuration (uniform seed spacing/placement, adequate bed preparation, clear middles to allow irrigation and drainage). This data indicates that growers should carefully consider both plant population and row configuration when making corn seed selections.

EVALUATION OF THREE ROW CONFIGURATIONS IN MIDSOUTHERN CORN PRODUCTION

Plant Population Observations

As noted in Table 1, at 36,000 to 38,000 seeds/acre, the plant-to-plant spacing in 30-inch rows is more than 25 percent greater than in 38-inch single rows. This allows for better light, nutrient, and water interception, with less early plant-to-plant competition, and can increase yield potential if bed and row middle preparation allow for proper drainage. The data from this trial indicated that growers can increase yield potential with narrow rows and higher plant populations if they choose a corn product that is proven to respond to higher plant populations.

Planting Configuration Observations

When 36,000 seeds/acre are properly spaced and planted in 38-inch twin rows, lines drawn between plants on alternating rows form an isosceles triangle (Figure 5). The “triangle” in twin rows becomes equilateral at 38,117 seeds/acre. This is in the population range where maximum yields at the Scott Learning Center generally occur. This serves as a visible endorsement for maximum uniformity in plant spacing, whether seeds are planted in single or twin rows. Keys to achieving maximum uniformity include: properly adjusted twin-row planters, narrow row spacing, e-set units, proper planting speed, talc at planting and other considerations. Uniform plant spacing can be achieved down the row with proper placement and across the field with: single rows, various twin row configurations, and in 30-inch single rows. Each system will have varying levels of inherent non-uniformity. However, growers have the ability to influence the level of uniformity via proper equipment adjustment and operation.

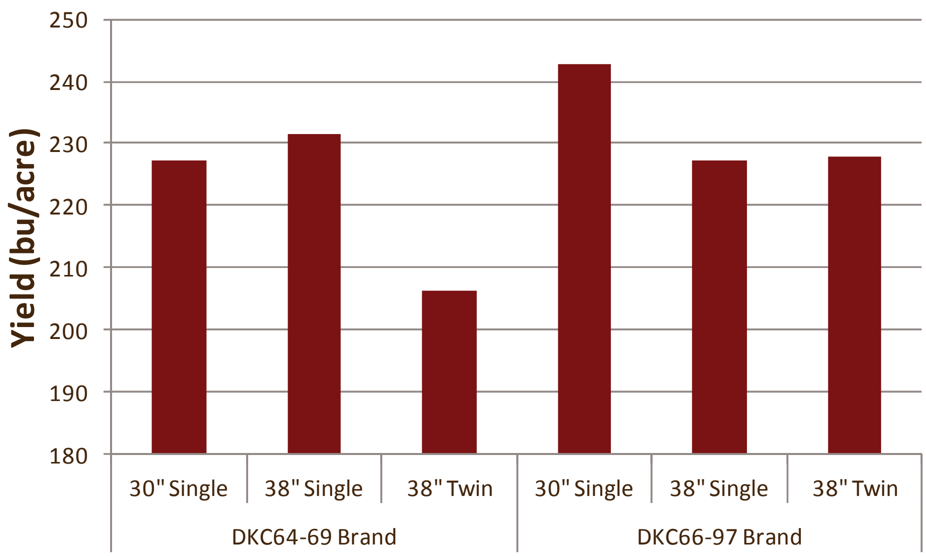

Figure 3. Average Brand and Row Width Effect on Yield Across All Populations

Table 1. Plant to Plant Spacing in Various Row Configurations

Population	Row Spacing 30"	Row Spacing 38" - Single	Row Spacing 38" - Twin
28000	7.5	5.9	11.8
30000	7.0	5.5	11.0
32000	6.5	5.2	10.3
34000	6.1	4.9	9.7
36000	5.8	4.6	9.2
38000	5.5	4.3	8.7
40000	5.2	4.1	8.3

EVALUATION OF THREE ROW CONFIGURATIONS IN MIDSOUTHERN CORN PRODUCTION

Row Configuration Observations

38-inch single rows

Positive

- Compatible with existing planting equipment
- Offers maximum drainage on most soil types
- Compatible with all row crops

Negative

- May not maximize yield potential of grain crops

38-inch twin rows

Positive

- Allows more uniform spacing of plants across the field and within the row
- Offers excellent yield potential in both corn and soybeans
- Allows single-row cotton production with minimal additional equipment issues
- Offers good drainage

Negative

- Requires a wide, flat bed to plant and establish maximum uniformity in corn
- May involve equipment issues such as stagger adjustment and reliability

30-inch single rows

Positive

- With equal drainage, this is probably the highest yielding system
- May help in maximizing yield potential in grains
- Compatible with corn, soybeans and cotton
- Allows use of one set of equipment for all crops

Negative

- Requires dedicated equipment
- Growers must make allowances to maximize drainage or the advantages brought by 30-inch rows will be negated by water issues and irrigation will be difficult
- Growers must establish a high bed and re-plow middles at layby to maximize drainage

Figure 5. Plant spacing for single and twin row plantings at 36,000 seeds/acre. Twin row planting is correctly staggered when lines between plants create an isosceles triangle.

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EVALUATION OF DEKALB® BRAND CORN PRODUCTS TO PLANTING DENSITY

Generally, corn yield potential will become greater with increasing populations[1,2]. However, the optimum plant population density can vary depending on product genetics[3,4,5]. As a hedge against weather related lodging risk and accounting for the plant structure and ear placement of most older, southern adapted products, many Southern producers have traditionally planted corn at lower than optimal plant populations. This is because lodging can occur with increased plant populations and can be magnified when insect or weather damage is introduced[6]. Producers want to know: a) the populations appropriate for each corn product, b) if population and yield can increase without greatly increasing the risk of lodging, and c) the general characteristics of corn products that perform well when planted at higher populations. This demonstration trial was conducted to address those questions and see how DEKALB® brand corn products perform at different plant populations.

Study Guidelines

A corn demonstration trial was conducted at the Monsanto Learning Center at Scott, MS to compare yield response to plant population. Ear characteristics, such as: height, weight, and momentum (height x weight) were measured. Eight DEKALB® corn products (DKC61-88 brand, DKC62-09 brand, DKC64-69 brand, DKC66-86 brand, DKC66-97 brand, DKC67-57 brand, DKC67-88 brand, and DKC69-29 brand) with varying ear placement were chosen for this demonstration. Each product was planted at three populations (33,000, 36,000, and 39,000 seeds per acre) in 38-inch X 7.5-inch twin rows. Each twin-row plot was replicated twice. Corn was planted on April 10 and harvested on August 29, 2012. Standard agronomic practices for the region, as well as field work and extra preparation needed for the twin-row configuration was implemented. The extra work needed to optimize the twin-row system, consists of making the beds wide, flat, and stable. The plots were irrigated as needed.

Results

The measurements taken from each replicated plot were:

- Height to the ear shank from ground, 10 ears per plot
- Weight per ear in grams from 10 ears per plot
- Momentum calculated as height in inches x weight in grams
- Yield in bushels per acre from the 4 rows x 150 ft plot adjusted to 15.5% moisture

Momentum is a measurement of the combined force from ear weight (grams) and ear placement (inches from the ear shank to the ground), where higher placed heavier ears have the potential to contribute to lodging characteristics for a given corn product. In 2012, lodging did not occur in this demonstration trial. Therefore, some of the higher ear placement products did well at high populations. In reality, the risk of planting high populations of corn products with high ear placement, large ears, and/or the associated increase in ear *momentum*, would be unacceptable in a commercial production system. Additional information from the Scott Learning Center Summary titled *Standability Evaluations of DEKALB® Brand Corn Products in the Midsouth* reported that products harvested a month after the optimum harvest date had significant differences in lodging.

Differences among the DEKALB® brand corn products were seen in most measured parameters. Yield response to population showed three of the products (DKC61-88 brand, DKC62-09 brand, and DKC64-69 brand) had the highest yield at 36,000 plants per acre (ppa) and a yield decrease at 39,000 ppa (Figure 1). Four corn products (DKC66-86 brand, DKC66-97 brand, DKC67-57 brand, and DKC69-29 brand) yielded most at the highest population of 39,000 ppa. DKC69-29 brand showed a step-wise increase in yield that corresponded with population. Finally, DKC67-88 brand had a slight increase in yield at 36,000 ppa; however, yield held at around 200 bu/acre at the low and high populations.

Five of the corn products (DKC61-88 brand, DKC64-69 brand, DKC66-97 brand, DKC67-57 brand, and DKC67-88 brand) had increases in plant height as populations increased (Figure 2). The general observation of the ear weight measurements concluded that as population increases, ear weight decreases (Figure 3). The combined height and weight measurement, termed *momentum*, did not follow any trend across products. However, based on the *momentum* ratings DKC67-88 brand has the highest potential to lodge (Figure 4). Plant population also had an influence on ear placement and size as higher and smaller ears were witnessed when higher populations were planted.

Older corn products have typically had high ear placement with an increased risk of lodging, especially as populations increased; while, newer corn products, such as DKC66-97 brand, DKC66-86 brand, and DKC67-57 brand, can allow increases in population without greatly increasing risk.

EVALUATION OF DEKALB® BRAND CORN PRODUCTS TO PLANTING DENSITY

Momentum gives some idea of the lodging potential, but planting configuration and genetically inherent stalk strength are also important in the decision making process. For example, it is not recommended that either DKC67-88 brand or DKC64-69 brand corn products be planted at populations higher than 31,000-33,000 seeds per acre. When these brands are planted at populations that would be appropriate for products such as DKC66-97 brand, there is an increased risk of lodging. Where well adapted, these brands should be planted first, planted at lower (relative to products such as DKC66-97 brand), but appropriate populations (a maximum of 31,000-33,000 ppa), and harvested first to best manage the weather related lodging risk.

On the contrary, DKC69-29 brand, DKC66-97 brand, and DKC67-57 brand corn products offer the ability to push yield by increasing populations without greatly increasing risk. However, this should be done with care and within reason. A separate standability study, mentioned earlier, was conducted to reinforce this concept.

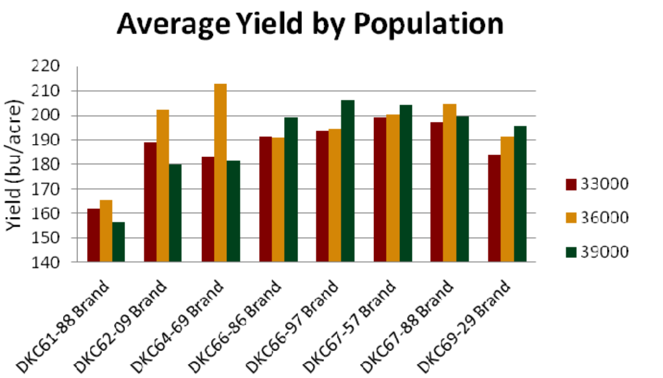

Figure 1. Average yield of different DEKALB® Brand corn products at three different plant populations.

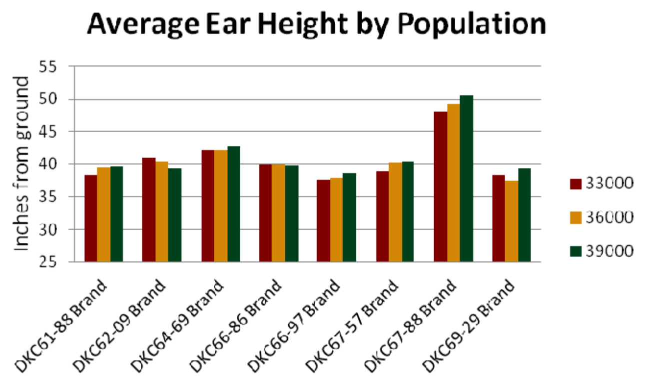

Figure 2. Average ear height of different DEKALB® Brand corn products at three different plant populations.

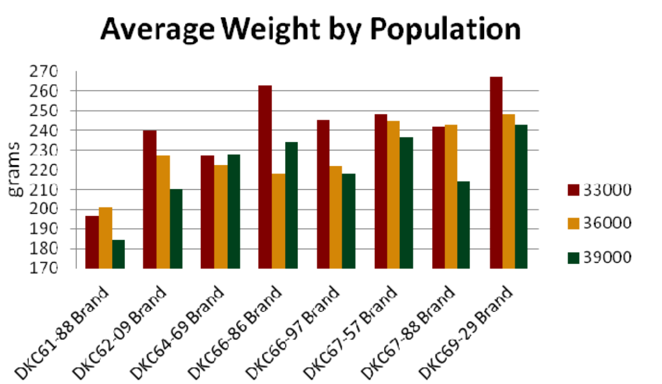

Figure 3. Average ear weight of different DEKALB® Brand corn products at three different plant populations.

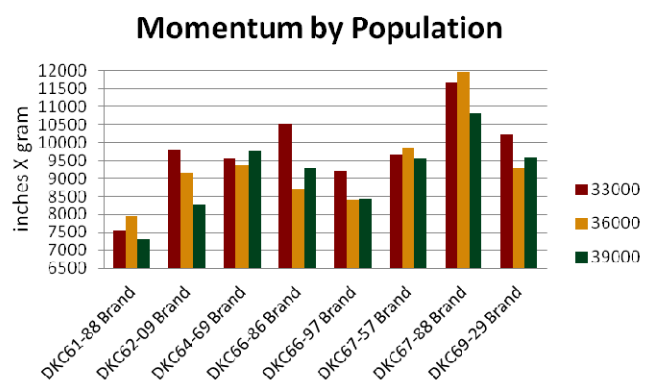

Figure 4. Average momentum measurement (ear height X ear weight) of different DEKALB® Brand corn products at three different plant populations.

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[1]Thomason, W. 2005. Corn plant populations and yield goals. Virginia Tech Cooperative Extension. Crop and Soil Environmental News, March 2005. Available online: www.ext.vt.edu/; [2]Williams, W.A., Loomis, et al. 1968. Canopy architecture at various population densities and the growth and grain yield of corn. Crop Sci. 8:303-308; [3]Collins, W.K., Russell, W.A., Ederhart, S.A. 1965. Performance of two-ear type of Corn Belt maize. Crop Sci. 5:113-116; [4]Cox, W.J. 1996. Whole-plant physiological and yield responses of maize to plant density. Agron. J. 88:489-496; [5]Widdicombe, W.D. and Thelen, K.D. 2002. Row width and plant density effects on corn grain production in the northern Corn Belt. Agron. J. 94:1020-1023; [6]Sorensen, R.B. et al. 2006. Row pattern, plant density, and nitrogen rate effects on corn yield in the Southeastern US. Plant Management Network; Standability evaluations of DEKALB® brand corn products. Scott Learning Center Demonstration Report 2012.

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IMPACT OF MULTIPLE STRESS FACTORS ON CORN YIELD POTENTIAL

Corn plants face multiple stresses throughout the growing season which can reduce yield potential. Some stresses may be avoided by proper planning, equipment adjustments, and timing of inputs.

Study Guidelines

A demonstration was conducted during 2012 at the Monsanto Learning Center at Scott, MS to evaluate the impact of multiple stress factors on corn yield potential in the southern United States. Factors evaluated are shown in Table 1.

Two corn products with different base genetics and relative maturities (RM) of 114 and 116 days were planted on March 17th, which is in the early part of the planting cycle for the latitude of Scott, MS. Each treatment was replicated twice.

Yield comparisons for each factor with and without stress are shown in Table 2. In addition, yield comparisons based on increases in the number of stress factors per plot are shown in Figure 1.

Table 1. Normal and stress factors evaluated in the trial: plant population, planting depth, fertility, and irrigation.

Factor	Management	
Plant Population	Normal	36,000 seeds/acre
	Low	31,000 seeds/acre
Planting Depth	Normal	2 inches
	Improper	1 inch
Fertility (Nitrogen N)	Normal	with 2 splits of 120 units each
	Late	delayed 10 days past normal with 2 splits of 120 units each
Irrigation	Normal	on time, as needed
	Late	10 days late

Results & Conclusions

All stress factors caused a decrease in yield when compared to normal management, with the exception of the late irrigation application. A higher yield was reported for the late irrigation application possibly due to the timing of rainfall events, i.e. the timely irrigation treatments received rainfall shortly after irrigation events which lead to an overwatering condition. Low planting population and late fertility decreased yield potential. The normal planting population out-yielded the low planting population by 22.6 bu/acre, and the normal fertility program out-yielded the late fertility by 18.9 bu/acre. Proper planting depth had the greatest influence on yield potential with a 58.2 bu/acre yield difference between the normal planting depth (2 inches) and the shallow planting depth (1 inch).

Table 2. Average yield (bu/acre) for each factor with and without stress.

Factor	Management	Yield (bu/acre)
Plant Population	Normal	195.7
	Low	173.1
Planting Depth	Normal	213.5
	Improper	155.3
Fertility (Nitrogen N)	Normal	193.8
	Late	174.9
Irrigation	Normal	181.6
	Late	187.1

IMPACT OF MULTIPLE STRESS FACTORS ON CORN YIELD POTENTIAL

As the number of stress factors evaluated increased, the reported yield decreased (Figure 1). The plots with no stress had an average yield of 235.5 bu/acre. The addition of each stress caused incremental decreases in yield ranging from 7.4 bu/acre to 36.4 bu/acre. Plots that had 4 stress factors had the lowest average yield of 162.9 bu/acre.

This study reinforces the fact that multiple crop management decision making processes are essential to establish, maintain and preserve optimal yield potential. First, it is critical to make good, up-front decisions regarding corn product selection and plant population while setting a realistic yield goal. Second, properly adjusted equipment, that achieves the desired planting depth and consistency, along with equipment maintenance is essential to plant and establish correct populations. Third, small alterations in timing, such as late fertility applications, can have a negative impact on yield potential. If these factors do not adequately provide what is needed for optimal plant growth they can contribute to yield loss. This demonstration supports the premise that the additive effect of multiple stresses can have an additive effect on reducing corn yield potential.

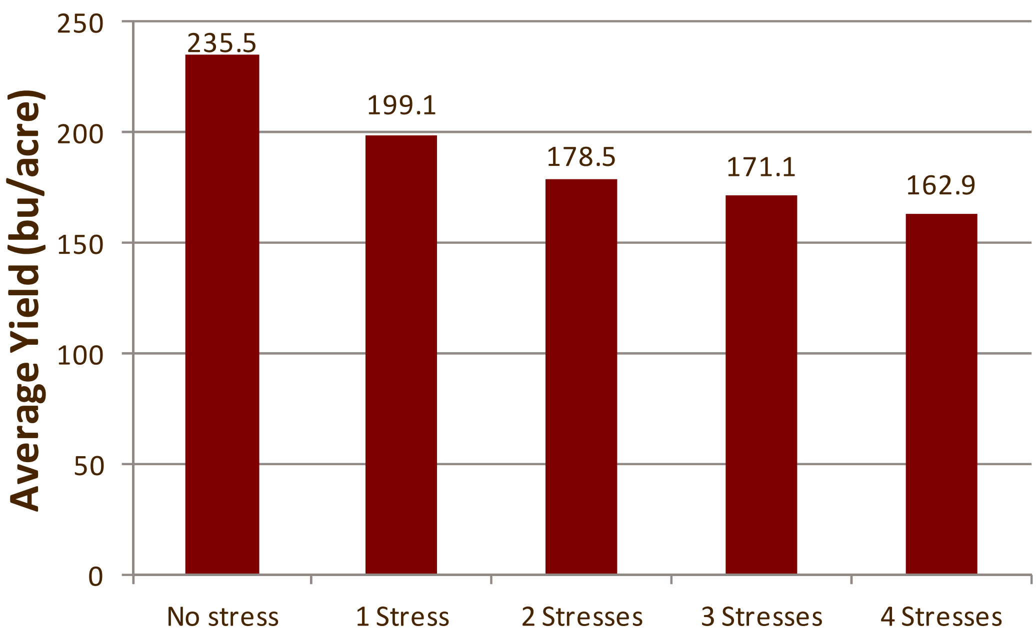

Figure 1. Average yield (bu/acre) based on number of stresses.

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PLANTING POPULATION EFFECT ON YIELD POTENTIAL IN DRYLAND AND IRRIGATED CORN

Planting population is a critical crop planning decision which ultimately helps establish corn yield potential. Optimum corn planting populations may vary greatly depending on whether the field is in a rainfed or irrigated production system. Many producers may look to reduced plant populations as a saving on seeding costs; however, final yield may be reduced with low planting populations, particularly when nutrients and water are not yield-limiting factors.

Planting population recommendations vary in the midsouth, from as low as 16,000 seeds/acre for less productive dryland acres to 38,000 seeds/acre on highly productive irrigated fields with a trend toward increasing populations in highly productive fields[1,2]. Typically seeding rates should exceed the desired planting population by 5 to 10%. Many corn products have recommended planting rates based on "earflex", which is the product's ability to compensate for fewer plants/acre where the ear has the potential to grow both in length and girth[1].

Study Guidelines

Demonstration trials were conducted in 2012 at the Monsanto Learning Center at Scott, MS to determine the effect of five planting populations: 25,000, 28,000, 31,000, 34,000 and 37,000 seeds/acre, with and without irrigation, on the yield potential of corn products. Two corn products, DKC64-69 brand (114-day relative maturity (RM)) and DKC66-96 brand (116-day RM), both with Genuity® VT Triple PRO® traits, were planted on April 4, 2012. Half of the trial was furrow irrigated as needed and the other half was dryland. Standard agronomic practices for the area were implemented. The demonstration trial was harvested on August 16, 2012 for yield and adjusted to 15.5 percent moisture.

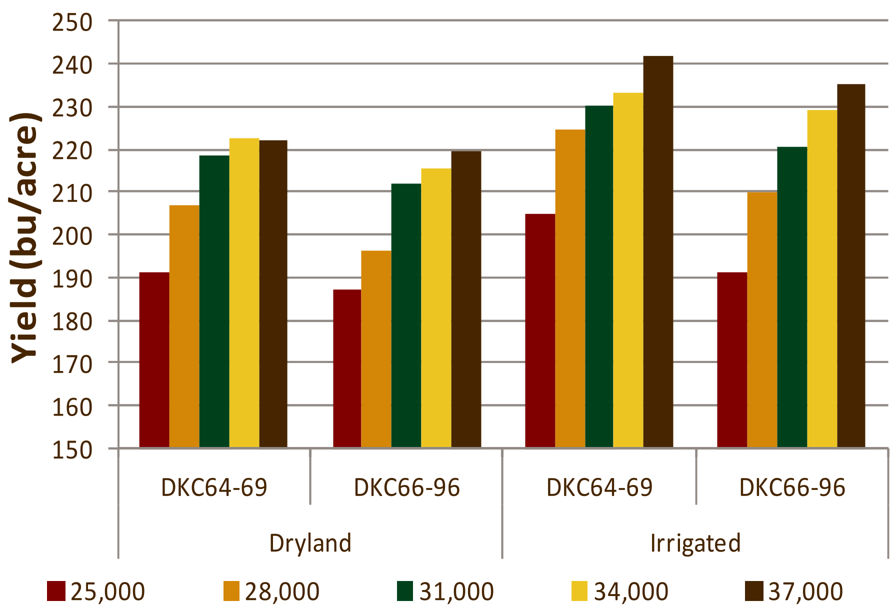

Figure 1. Planting population effect on yield potential for two corn products on irrigated and dryland acres.

Results

Yield results for the dryland demonstration show that DKC64-69 brand had the highest yield when planted at 34,000 seeds/acre and DKC66-96 brand had the highest yield at 37,000 seeds/acre. However, yield did not increase greatly with planting population beyond 31,000 seeds/acre on dryland. For the irrigated demonstration, both products had the highest yield when planted at 37,000 seeds/acre. These results suggest that higher yield potential may be realized in irrigated corn when planted at populations higher than 31,000 seeds/acre. It is important to note that it is not recommended to plant DKC64-69 brand at populations over 34,000 seeds/acre to help manage the potential for late-season lodging.

Conclusions

Under ideal environmental conditions, yield potential on dryland corn fields may increase at planting populations above 31,000 seeds/acre, but a grower assumes additional risk with the additional seed investment and gambles that rainfall will be adequate to utilize the planted populations to increase corn grain yield. Ear barrenness and ear tip kernel abortion may occur when high planting populations cause interplant competition in the presence of environmental stresses. When evaluating a corn product and planting population, monitoring

PLANTING POPULATION EFFECT ON YIELD POTENTIAL IN DRYLAND AND IRRIGATED CORN

barren stalks and ear tip kernel abortion can help in determining a suitable population[2].

It is important to note that yields presented for 2012 for dryland corn were above average for Scott, MS due to the timing of rainfall events (Figure 2). This demonstration will need to be repeated to obtain results more typical for dryland acres in the region.

This demonstration also illustrates how irrigation can help facilitate corn production at higher planting populations, contributing to both yield level and yield stability. Yield results from this trial suggest that planting populations for an irrigated field should be 31,000 seeds/acre or higher (depending on hybrid planted) to maximize yield potential. However, planting populations are a localized decision based on a detailed knowledge of the grower's local climate, product choice, yield history, yield goal, and tolerance for risk. In general, as risk is reduced either with the addition of irrigation and/or proper product selection, properly managed, higher surviving populations have the potential to generate higher yields.

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[2]Larson, E. J. Corn plant population. Mississippi State University Extension Service . IS1548.

[3]Thompson McClure, A. Planting corn for grain in Tennessee. University of Tennessee Extension. W077.

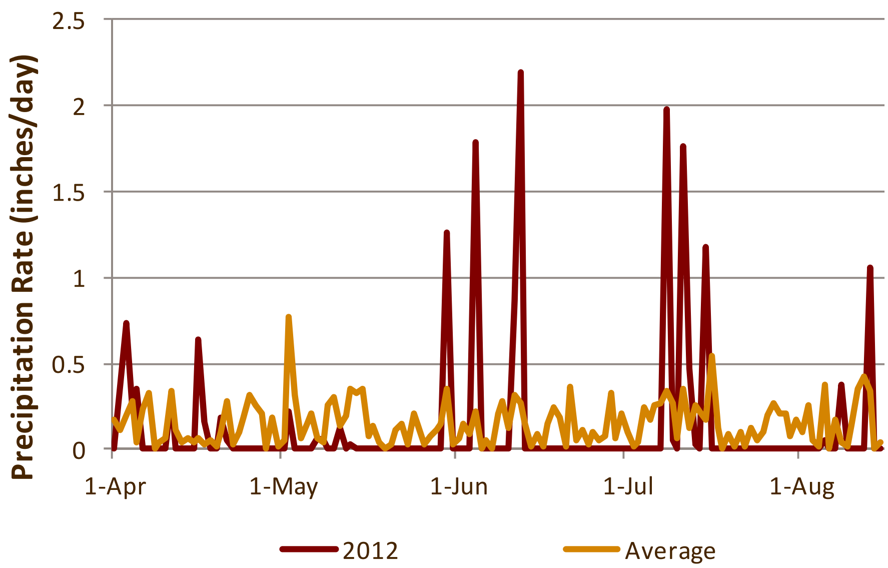

Figure 2. Rainfall in 2012 compared to 10-year average for Scott, MS.

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STANDABILITY EVALUATIONS OF DEKALB® BRAND CORN PRODUCTS IN THE MIDSOUTH

Delays in corn harvest can expose corn crops to an increased level of weather related lodging, depending on the local climate in a given growing season. Weather related lodging can result in significant yield loss and the severity can be influenced by planting population and other product characteristics[1]. This demonstration trial was conducted to evaluate the ability of DEKALB® brand corn products to stand in the field after the normal harvest window, which can aid in product placement and in-season management decisions. This measure of standability also serves as a preliminary indicator of relative standability among this group of corn products.

Study Guidelines

A corn demonstration trial was conducted at the Monsanto Learning Center at Scott, MS to evaluate the ability of DEKALB® Brand corn products to stand in the field, one month after the normal harvest time, in response to weathering. Corn product standability has an influence on population decisions at planting. Nine DEKALB® corn brands (DKC61-88, DKC62-09, DKC64-69, DKC66-86, DKC66-97, DKC67-57, DKC67-88, DKC68-05, and DKC69-29) were chosen for this demonstration. Demonstration treatments consisted of the corn products and harvest timing. The large plots, planted in an area of the farm known as the "Highway Cut" were divided with one larger portion harvested for yield. A smaller portion (150 feet X 8 rows) was used for the standability evaluation and harvested one month after the normal harvest time. Corn was planted on March 29, 2012. The first harvest date was August 26 and the second harvest was September 26, 2012. Standard agronomic practices for the region were implemented and plots were irrigated as needed. At the end of August, Hurricane Issac generously provided the rain (3+ inches over 2 days) and wind (25 mph for sustained periods) needed to properly test the response of the corn brands to weathering.

Results

Four DEKALB® corn brands (DKC62-09, DKC66-97, DKC67-57, and DKC69-29) had little or no yield loss when left in the field a month past the normal harvest time (Figure 1). The other five DEKALB® corn brands (DKC61-88, DKC64-69, DKC66-86, DKC67-88, and DKC68-05) experienced yield losses of 18% or higher when harvested one month late. DEKALB® corn brands DKC67-88 and DKC68-05 showed the highest yield losses of 72.6% and 39.4% from the delayed harvest.

Summary Comments

Table 1 lists the percent yield loss found between the first and the second harvest as well as corn product characteristics from the 2012 Scott Learning Center Demonstration Trial titled, "Evaluation of DEKALB® Brand Corn Products to Planting Density". The data from Table 1 shows that product characteristics influence the standability of

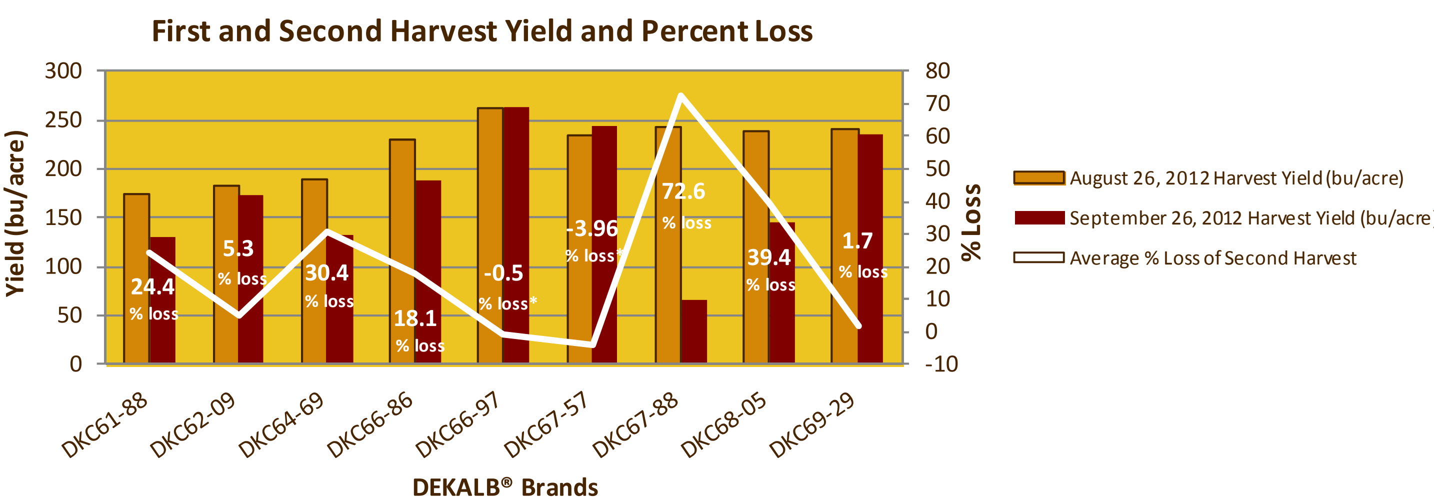

Figure 1. Average first and second yield and % loss of second harvest for nine DEKALB® Brand corn products. *Negative losses are due to differences in yield potential between the ends of the field harvested in the demonstration. The "second harvest" plots came from the higher yielding end of the field.

STANDABILITY EVALUATIONS OF DEKALB® BRAND CORN PRODUCTS IN THE MIDSOUTH

the corn brands. The results indicate that some DEKALB® corn brands (DKC62-09, DKC66-97, DKC67-57, and DKC69-29) offer the opportunity to plant at higher populations (>36,000 kernels per acre) to help maximize yield potential, without greatly increasing the risk of potential yield loss due to lodging.

On the contrary, some DEKALB® corn brands (DKC61-88, DKC64-69, DKC67-88, and DKC68-05) should not be planted at higher populations (>31,000-35,000 kernels per acre) due to their potential risk of lodging at these higher populations. In the event that taller corn brands with high ear placement are planted, the following steps can help manage weather related risks:

- Establish yield goals and provide fertility to help maximize stalk quality and grain yield potential
- Plant low to mid populations (31,000-34,000 kernels per acre)
- Plant these corn brands first
- Manage for earliness
- Harvest these corn brands first

References

[1] Thomison, P.R., et al. 2011. Corn response to harvest date as affected by plant population and hybrid. Agron. J. 103:1765-1772 (2011); [2] Evaluation of DEKALB® Brand corn products to planting density. Scott Learning Center Demonstration Report 2012; Additional sources used to create this Learning Center Summary: Erickson, B. and Valentin, L. September 2008. Evaluating corn harvest timing. Purdue University. Top Farmer Crop Workshop Newsletter.

Table 1. DEKALB® Brand Data from two 2012 Scott Learning Center Demonstration Trials.

Brands	2012 Scott Learning Center Demonstration Trials			
	Standability Evaluations of DEKALB® Brand Corn Products in the Mid South	Evaluation of DEKALB® Brand Corn Products to Planting Density (reported at 36,000 plants per acre[2])		
	Percent Loss Between 1st and 2nd Harvest (%)	Average Ear Height (inches from the ground)	Average Ear Weight (grams)	Average Ear Height by Ear Weight (inches X grams)
DKC61-88	24.4	39.5	201.3	7950.2
DKC62-09	5.3	40.4	227.4	9167.6
DKC64-69	30.4	42.1	222.3	9364.5
DKC66-86	18.1	39.9	218.1	8709.1
DKC66-97	-0.5	37.9	221.9	8404.0
DKC67-57	-3.96	40.2	244.6	9825.0
DKC67-88	72.6	49.3	243.2	11975.9
DKC68-05	39.4	Data Not Taken	Data Not Taken	Data Not Taken
DKC69-29	1.7	37.5	248.1	9292.6

*Negative losses are due to differences in yield potential between the ends of the field harvested in the demonstration. The “second harvest” plots came from the higher yielding end of the field.

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COTTON VARIETY BY POPULATION: RESPONSE IN 2:1 SKIP-ROW PLANTING

Increasing numbers of cotton growers are interested in switching from 38-inch solid row plantings to 30-inch, 2:1 skip-row planting. This planting system would allow them to use the same 30-inch planter in cotton, corn, soybeans, and other row crops. This trial was developed to answer grower questions about proper plant populations and variety selection in skip-row cotton, and whether or not skip-row cotton will produce yields substantially equal to solid row plantings.

Materials and Methods

A demonstration trial was conducted in 2012 at the Monsanto Learning Center at Scott, MS, to show the impacts and interaction of population by variety in 2:1 skip-row cotton plantings. Three cotton products were planted at four different populations. The products were DP 0912 B2RF, DP 1034 B2RF and DP 1219 B2RF. Planting populations were 14,000, 28,000, 41,000 and 55,000 seeds/acre.

Cotton was planted on April 30 and harvested on October 10. Agronomic management was similar to local standards, including conventional tillage, weed management, insect management and irrigation as needed. Plant growth regulator (PGR) applications (4.2% mepiquat chloride; .35 lb. active ingredient per gallon) were significantly lower in the skip-row cotton than would normally be applied in solid-row cotton. The first PGR application of 10.4 fl oz/acre was made on June 22. The second and final PGR application 14.2 fl oz/acre was made on July 6. Delayed and reduced PGR rates allowed plants to produce more vegetative growth and fill the skipped rows. This additional vegetative growth also allowed plants to develop more fruiting positions to compensate for plants missing from the skipped rows.

Results

Some growers believe they may save money on seed and technology fees by planting skip-row cotton. This trial, across all cotton products, showed that plant populations per field acre (not acre of row feet) need to be in the same range as solid planted cotton. The seed that would have been planted in the skipped rows should be planted in the remaining rows to achieve an acceptable plant population for optimum yield potential. This results in the same seed cost per acre, with plants closer together

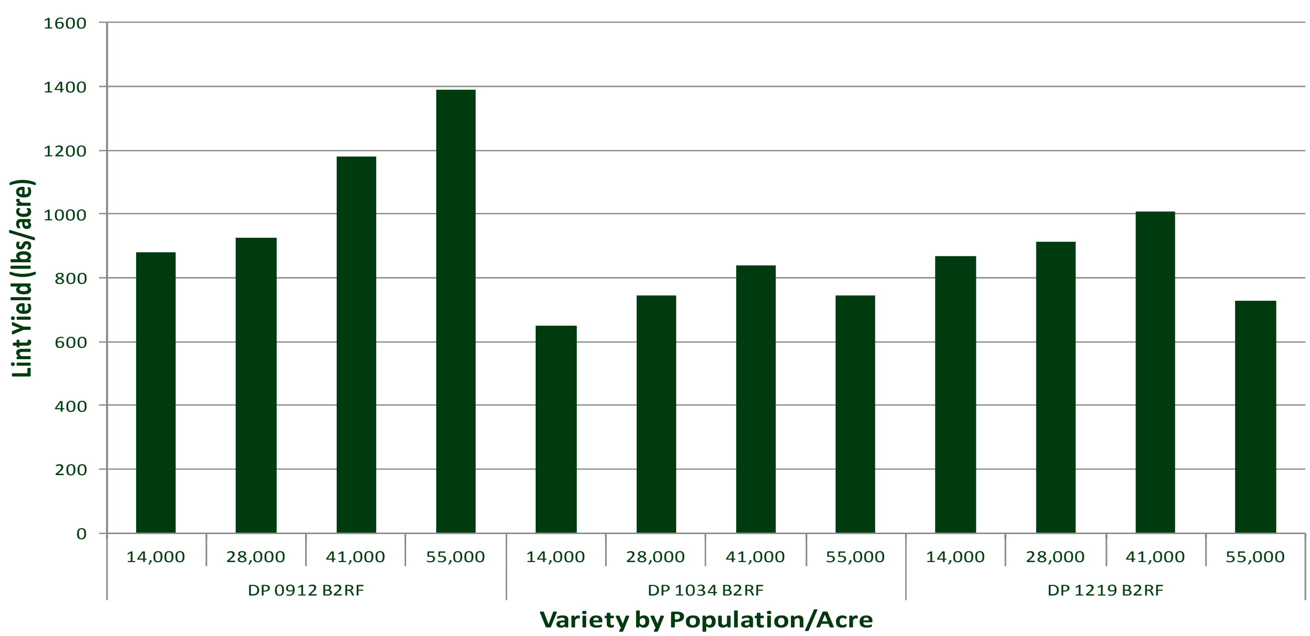

Figure 1. Cotton variety by population response in 2:1 skip-row planting.

COTTON VARIETY BY POPULATION: RESPONSE IN 2:1 SKIP-ROW PLANTING

down each row. DP 0912 B2RF produced the highest yield in the trial (1390 lbs/acre) when planted at 55,000 seeds/acre, and the second highest yield of 1182 lbs/acre when planted at 41,000 seeds per acre. DP 1219 B2RF produced the third highest yield (1009 lbs/acre) when planted at 41,000 seeds/acre. DP 1034 B2RF produced 838 lbs/acre when planted at 41,000 seeds/acre. (Figure 1).

Summary Comments

- Cotton growers can expect similar yields from either 38-inch solid rows or 30-inch, 2:1 skip rows, as long as the grower does what is necessary to optimize conditions for that row configuration: uniform seed spacing/placement, adequate bed preparation, clear middles to allow irrigation and drainage (Based on data from previous years).

- Indeterminate cotton products that produce more vegetative growth and spread and fill in the "skip," perform better than determinate varieties in 30-inch, 2:1 skip-row plantings.

- Generally, less determinate cotton products should be planted at average per-field-acre populations for the variety.

- Skip-row planting allows for better light penetration before canopy closure.

- Skip-row planting may provide some level of a moisture conservation advantage over solid-planted cotton.

- Growers should not expect to save on seed and technology costs by adopting the 2:1, skip-row pattern. Most or all of the seed that would have been planted in the skipped row should be evenly distributed in the planted rows.

- Growers should carefully read planter manuals to determine settings to achieve the desired population per acre of land, not per planted acre.

- In skip-row plantings, PGR rates can be delayed and significantly reduced below levels typically necessary in solid-row cotton.

- Until near canopy closure, growers may reduce costs with banded ground applications of insecticides.

- Since cotton plants will eventually fill the skipped row, all over-the-top applications from mid-to-late-season, should be calculated as if the cotton were planted in solid rows.

- Particular care should be taken to keep the skipped row free of weeds until canopy closure.

- Fruit retention was observed to be exceptionally high in the skip -row cotton.

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EFFECT OF PLANT GROWTH REGULATOR STRATEGIES IN COTTON

A key factor in producing high-yielding cotton is managing the perennial and indeterminate growth habit of the cotton plant with plant growth regulators (PGRs). Proper use of PGRs, such as mepiquat chloride (Pix®), can be critical to help maximize yield potential in any given year, while the mismanagement of PGRs can result in reduced yield potential. When determining the proper application timing of PGRs, several factors such as soil type, soil fertility, irrigation, and field history should be considered.

Environmental factors can also influence PGR strategies and their effectiveness. However, understanding a particular variety's growth habit and response to a PGR application is one of the most important factors in developing sound PGR management strategies. Plant response to PGRs can vary depending on the cotton variety, plant genetics, and the environmental conditions during and after application. This makes blanket PGR recommendations difficult and often impractical.

Materials and Methods

In order to better understand the growth habits and response of the newer Deltapine® cotton varieties and older conventional varieties, a study was conducted at the Monsanto Learning Center at Scott, MS to investigate the effects of passive and aggressive PGR management strategies. Eleven cotton varieties were planted on May 1, 2012 (Table 1). Cotton varieties were planted in 12 row plots with 4 rows receiving the aggressive PGR management strategy, 4 rows receiving the passive PGR management strategy, and 4 rows left as an untreated check (UTC). The passive and aggressive treatments of a 4.2% mepiquat chloride are provided in Table 2. The passive treatment was designed to be optimal for less aggressively growing varieties and below optimal for more aggressively growing varieties. The plots were irrigated as needed and harvested with a commercial cotton picker. An application of Prevathon® insecticide was applied to conventional cotton varieties (DP 20 and DP 50). Seed cotton was ginned and weighed to determine lint yield per acre and plant heights were taken from the aggressive PGR and UTC plots.

Results

Not all varieties respond similarly to PGR applications, so measuring and comparing actual growth can help indicate the agronomic status of a field. Traditionally, producers learn PGR management strategies during the first few years after variety introduction. This demonstration is an attempt to help learn and apply specific management strategies earlier in the life cycle of the cotton product and to compare PGR response of new varieties to old conventional varieties.

Table 1. Deltapine cotton varieties in PGR management strategy demonstration.

Deltapine® Cotton Varieties

Class of 09	Class of 10	Class of 12
DP 0912 B2RF	DP 1048 B2RF	DP 1252 B2RF
	DP 1044 B2RF	DP 1219 B2RF
		DP 1212 B2RF
Class of 13	**Conventional**	
DP 1311 B2RF	DP 20	
DP 1321 B2RF	DP 50	
DP 1359 B2RF		

Table 2. Timing, date, and rate of the passive and aggressive PGR management strategies.

PGR Management Strategies
(4.2% mepiquat chloride)

PGR Strategy	Timing	Date	Rate
Passive	12 nodes	June 22	10.4 oz/acre
	15 nodes	July 6	14.2 oz/acre
	20 nodes	July 23	12 oz/acre
Aggressive	8 nodes	June 22	12 oz/acre
	12 nodes	June 28	16 oz/acre
	20 nodes	July 6	20 oz/acre

EFFECT OF PLANT GROWTH REGULATOR STRATEGIES IN COTTON

Deltapine® cotton varieties differed in response to PGR management strategies (Figure 1). A passive PGR strategy resulted in a higher final yield for seven of the eleven selected varieties, while four cotton varieties produced higher yields with the more aggressive PGR management strategy. The largest yield difference when comparing the same variety across the two PGR regimes was 228 lbs lint/acre for DP 1321 B2RF, which yielded more under the passive PGR strategy. The largest difference in favor of the aggressive PGR strategy was 99 lbs lint/acre for DP 1212 B2RF. For all data collected in this trial it is important to remember this is an unreplicated demonstration.

The different PGR management strategies also affected the height of cotton plants at harvest. All cotton varieties reported the tallest plants in the untreated check (UTC) (Figure 2). Results from this evaluation show that some varieties are more responsive than others to PGR applications. Certain varieties were not as responsive to PGR applications because height control was not needed, these varieties were likely more determinate with the fruit load helping to control vegetative growth of the plant.

Conclusions

As expected, not all cotton varieties responded the same to PGR applications. Both less determinate varieties and varieties which typically have relatively aggressive early-season growth responded favorably to aggressive PGR applications (DP 1252 B2RF, DP 1048 B2RF, and DP 1212 B2RF). When more determinate varieties are planted, yield may be reduced with a more aggressive PGR management strategy as observed in DP 1321 B2RF and DP 1044 B2RF.

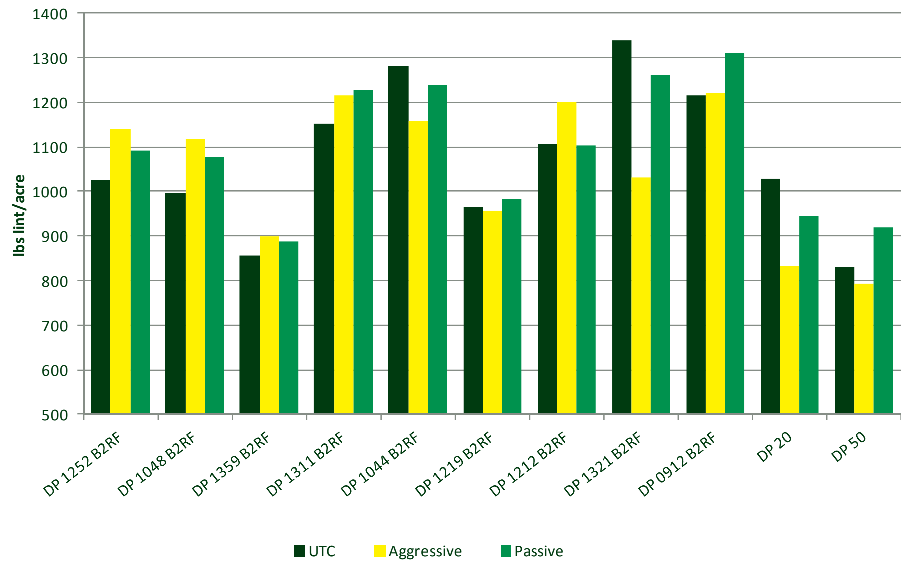

Figure 1. Effect of PGR strategies on yield (lbs lint/acre) of Deltapine® cotton varieties. UTC = untreated check

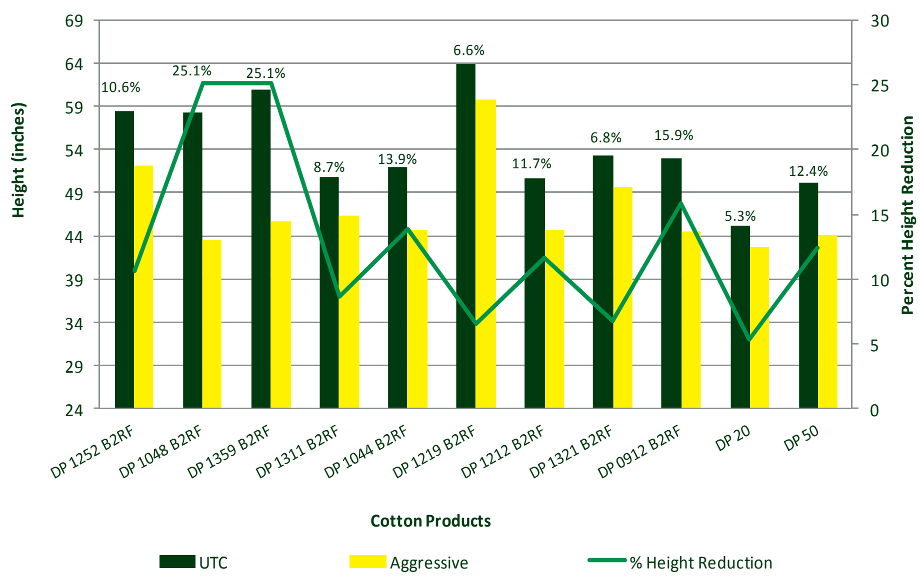

Figure 2. Effect of PGR strategies on harvest height (inches) and percent of height reduction of Deltapine® cotton varieties. UTC = untreated check

EFFECT OF PLANT GROWTH REGULATOR STRATEGIES IN COTTON

When evaluating PGR response of the old Deltapine® cotton varieties, DP 20 and DP 50 were responsive to PGR applications resulting in lower yields for all PGR regimes except the passive management of DP 50. When comparing the height of the older cotton varieties to newer cotton varieties, DP 20 and DP 50 were shorter than all but one new variety in the untreated check, suggesting that the older varieties may not have needed the aggressive PGR management of newer varieties on the market. DP 20 and DP 50 also yielded less than most of the newer cotton varieties which demonstrates progress that has been made to the increase yield potential of cotton varieties in the past 25 years.

Care should be taken to observe all varieties with respect to their growth patterns. When making PGR application decisions for any cotton variety, remember to look at the node elongation of node 4-5 from the top of the plant, soil moisture, agronomic practices and weather patterns. This study gives a snapshot of responses in only one growth environment, location and year, but may provide insight into recommendations of what to look for in growth and development of the Deltapine® Class of 09, 10, 11, 12, and 13 cotton varieties.

Note: These results are not intended to provide you with a blueprint on how to grow any specific variety but merely provide some research with them. Your experience and knowledge will remain an invaluable component to the successful management of any variety. This information is being provided to aid decision making and advice regarding the management of these varieties. The information is not intended to replace your experience and knowledge regarding the proper management of your individual crops.

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VARIETY BY SEEDING RATE BY PLANT GROWTH REGULATORS IN COTTON

Cotton varieties today have a broad range of fruiting characteristics and vegetative growth as compared to many varieties from the past. Current varieties may begin fruiting earlier (at lower nodes), may set a larger crop due to earlier fruiting, and have the ability to extend the fruiting period via indeterminant fruiting patterns. A greater range of indeterminancy and efforts to eradicate the boll weevil have allowed many of these shifts in fruiting pattern to be realized as production tools by cotton producers. As with past varieties, the range of growth habit and indeterminacy allows for customized seeding rates and plant growth regulator (PGR) applications to be used as management tools for the cotton crop. PGR management decisions depend on local climate, production systems, and the specific variety planted. Consequently, management systems ranging from less aggressive PGR applications in more determinate varieties to lower seeding rates in less determinate varieties may be used as tools to optimize growth management and/or yield potential. In 2012, the Monsanto Learning Center at Scott, MS evaluated the interaction of cotton variety, seeding rate, and PGR use on cotton lint yield.

Study Guidelines

A demonstration trial was conducted at the Monsanto Learning Center at Scott, MS to evaluate the effects of cotton variety, seeding rate, and PGR rates and timing on lint yield. Three Deltapine® cotton varieties were planted at seeding rates of 14,000; 27,000; 41,000; and 55,000 seeds/acre (Table 1). These seeding rates represented 1, 2, 3, and 4 seeds/foot. Two PGR regimes were implemented: passive and aggressive (Table 1). In general, the passive treatment starts later, and lower rates of PGR are applied throughout the season as compared to the aggressive treatment.

All varieties were Genuity® Bollgard II® with Roundup Ready® Flex (B2RF) cotton. The plots were planted on May 1 and harvested on October 1, 2012. Conventional tillage and other standard agronomic practices for the region were implemented. Irrigation and insecticides were applied to the plots as needed.

Table 1. Description of the variables evaluated.

Cotton Varieties	Seeding Rate (seeds/acre)	PGR Regimes	
		Passive:	Aggressive:
DP 1321 B2RF	14,000	10.4 oz/acre on June 22	12 oz/acre on June 22
DP 1212 B2RF	27,000	14.2 oz/acre on July 6	16 oz/acre on June 28
DP 1252 B2RF	41,000	12 oz/acre on July 23	20 oz/acre on July 6
	55,000	36.6 oz/acre seasonal total	48 oz/acre seasonal total

Results

Results from the 2012 demonstration trial had trends similar to previous trials from the Monsanto Learning Center at Scott, MS. All cotton management demonstrations and management decisions should be carefully considered in the context of the year that they were conducted. In general several observations can be made from the 2012 trial which include:

- Across all products and both PGR management strategies at seeding rates of 27,000 seeds/acre and above, yields were similar (Figure 1). This reinforces the need for very specific management decisions to optimize the crop. This also points out the fact that populations can be reduced too much and in some cases, there is no need to increase populations beyond the level that ensures a good stand in the range of 30,000-35,000 plants/acre established in the field.

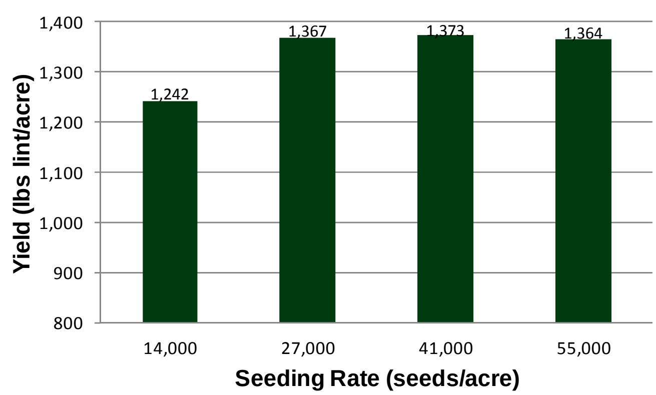

Figure 1. Average cotton yield by seeding rate.

VARIETY BY SEEDING RATE BY PLANT GROWTH REGULATORS IN COTTON

In 2012, the passively managed plots outyielded the aggressively managed plots by almost 200 lbs lint/acre (Figure 2). This can be attributed to a good crop with relatively high retention and fall weather that allowed a strong finish. With good conditions the plants continue to develop and successfully set fruit on more nodes. This ultimately allows for higher numbers of harvested fruiting forms and the associated higher yield. The aggressive PGR regime stops this development and reduces yield in some seasons. An early fall can have the same impact by stopping boll development due to lack of heat units.

- In all three varieties, the aggressively managed plots yielded as much or more at higher seeding rates than at lower seeding rates (Figure 3). This indicates that higher populations could require more aggressive PGR management as plants may have more vegetative growth to compete for light. This competition allows the plants to stay in the vegetative growth phase longer and delays fruiting. PGRs help rebalance the vegetative versus reproductive growth and, in many cases, this can help increase yields at higher populations. However, this is highly moderated in the interaction of environment by variety and only careful, timely scouting can measure the need for PGR intervention.

- The passively managed plots yielded as much or more at lower populations and generally had higher yields than the aggressively managed plots. DP 1252 B2RF was an exception that can likely be accounted for in the relatively later fruiting start and the longer fruiting period the other varieties experienced this season as well as the good fall weather that helped finish a later crop. Typically, DP 1252 B2RF begins to fruit relatively early for a full season variety. However, DP 1252 B2RF has an extended fruiting window due to a different sink (or use of the plant's energy) compared to the larger seeded varieties in this study: DP 1321 B2RF and DP 1212 B2RF. In other words, the full maturity variety, DP 1252 B2RF, may have experienced a shorter fruiting window this season, which likely reduced yield relative to the other varieties at lower populations.

Summary

The 2012 data indicates that variety-specific cotton management decisions are important to optimize cotton yield. In 2012, a passive PGR regime appeared to offer the highest yield potential for the cotton products and populations evaluated. However, it should be noted that 2012 was a season without great potential for excess vegetative growth. This type of season is often characterized by relatively high whole plant fruit retention, moderate/timely rainfall during the season, and good weather to finish the crop. The 2012 data suggests the optimal seeding rates for the cotton products can be safely adjusted in various cropping systems without a yield penalty or causing great complications in growth management.

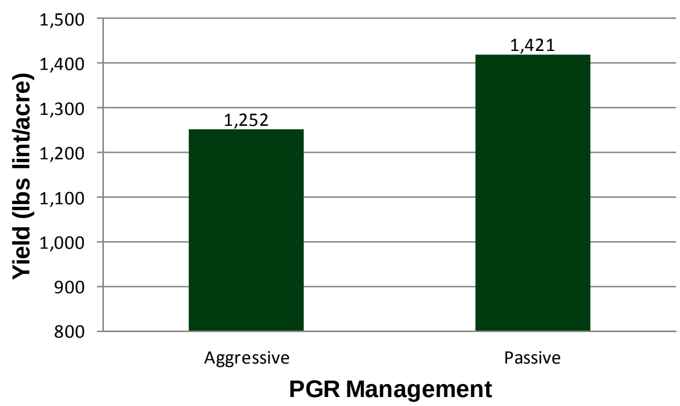

Figure 2. Average cotton yield by PGR management.

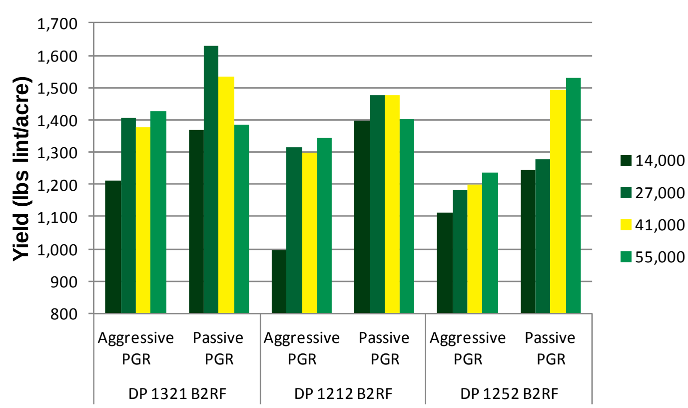

Figure 3. Average cotton yield by variety, seeding rate, and PGR management.

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COMPARISON OF ROW CONFIGURATIONS AND PLANTING POPULATIONS IN SOYBEANS

Both 30-inch single row and 38-inch twin row plantings (7.5-inches apart on top of the bed) have been shown to have several potential benefits. These benefits can include: maximizing light interception, improving drainage versus flat planting systems, and allowing for increased plant root development, which ultimately can increase nutrient and water interception. Because of these potential benefits, a multi-year effort is underway to evaluate row spacings that could improve soybean yield potential. The use of 38-inch twin-row spacing could also allow better compatibility for soybeans in a cotton rotation while preserving yield potential. In 2012, an additional component was added to evaluate the affect of planting population on soybean yield potential with relation to row configuration.

Materials and Methods

From 2010 to 2012 a study was conducted at the Monsanto Learning Center at Scott, MS to evaluate narrow row spacing effects on soybean yield. In 2012, three soybean products with relative maturities (RM) of 4.6, 4.8, and 5.3, were evaluated for yield in 38-inch twin-row and 30-inch single row systems. For both row configurations each product was planted at 90,000, 120,000 and 150,000 seeds/acre. Plots were planted on April 20, 2012 and harvested on September 19, 2012. Agronomic practices were in alignment with local standards and irrigation was applied as needed.

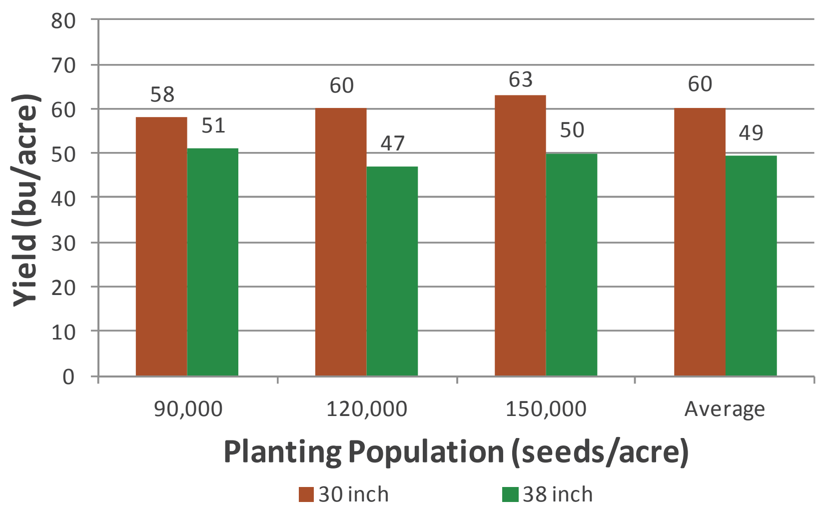

Figure 1. Average yield (bu/acre) of three different planting populations in 30-inch single rows and 38-inch twin-rows when averaged across three soybean products in 2012.

Results

In 2012, the 30-inch single rows yielded an average of 60 bu/acre, while the 38-inch twin-rows averaged 49 bu/acre when averaged across soybean products and planting populations (Figure 1). The 30-inch single rows out-yielded the 38-inch twin-rows for the three planting populations and three different products by an average of 11 bu/acre (Figures 1 and 2). The lowest population (90,000 seeds/acre) yielded similar to the higher planting populations in both 30-inch single rows and 38-inch twin-rows.

In similar research conducted in 2011, 30-inch single rows yielded an average of 5 bu/acre higher than 38-inch twin-rows when

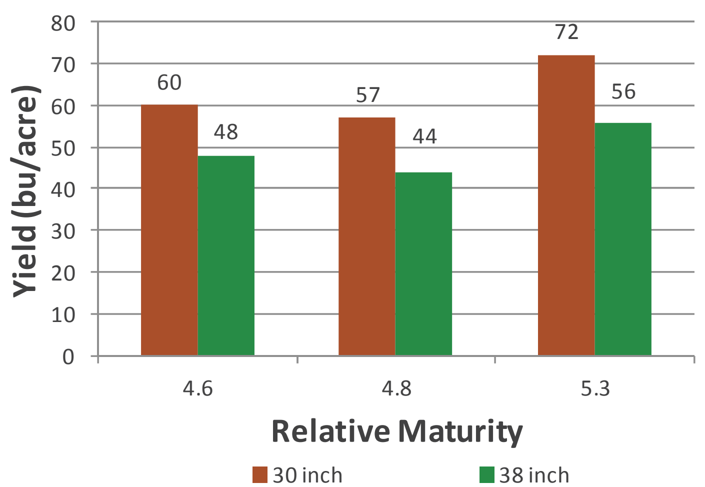

Figure 2. Average yield (bu/acre) of soybean products by relative maturity when planted in 30-inch single rows and 38-inch twin-rows in 2012.

COMPARISON OF ROW CONFIGURATIONS AND PLANTING POPULATIONS IN SOYBEANS

averaged across four different soybean products (Figure 3). However, in 2010 the 38-inch twin-rows out-yielded 30-inch single rows by 7 bu/acre. The differences in yields between the row spacing may be due in part to environmental conditions of the given trial year particularly seasonal rainfall and the associated issues with drainage.

Summary Comments

Twin-row systems appear to be an option for soybean production in the midsouth region and have the added benefit of being compatible with cotton production. In 2011 and 2012, lower rainfall amounts may have contributed to higher overall yields in the 30-inch rows as drainage was not a concern. In years where drainage may become a yield-reducing factor, 38-inch rows may improve drainage, negating the higher yield potential of 30-inch row spacings.

With the addition of the planting population component to the demonstration, one year of data suggests that with favorable in-season conditions, established populations which are lower than expected (on the lower end of the traditionally accepted levels) can have similar yield potential to higher planting/established populations; however, results will likely vary depending on the environmental conditions. In 2012, seedlings had favorable environmental conditions for establishment. In years with less favorable early-season conditions fewer seedlings may survive and reduced stands will negatively affect yield

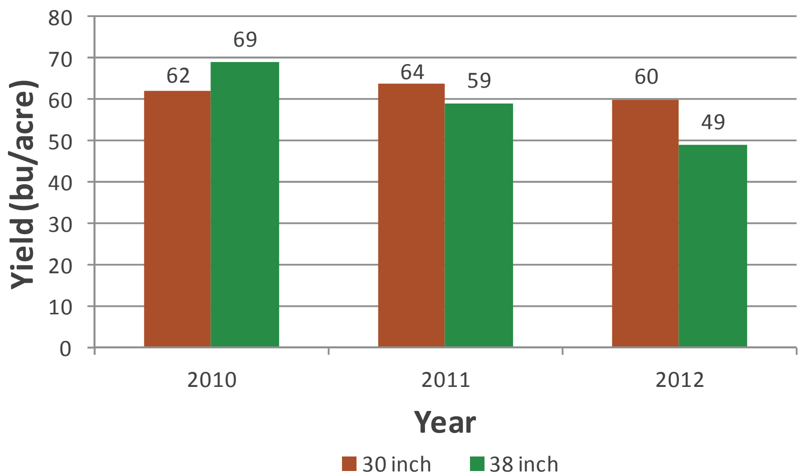

Figure 3. Average yield (bu/acre) of soybean products planted in 30-inch single rows and 38-inch twin-rows for trials conducted in 2010-2012.

potential. When poor early-season environmental conditions occur, higher planting populations could serve to maintain or increase yield potential. It is not recommended to plant at low populations; however, if a soybean stand is reduced after planting, the crop may provide adequate yield potential given favorable environmental conditions for the remainder of the season.

One other influence of population is specifically applicable to southern soybean production. In many cases where soybeans are planted on highly productive, irrigated soils (i.e. traditional cotton soils), planting populations may be reduced to help manage the potential for lodging. This is particularly true when locally-adapted varieties are relatively tall.

Seeding rate decisions should always be made to help guarantee a final stand that can optimize yield potential depending on localized emergence conditions, planting date, seed quality and treatments, and the individual field conditions. Historically these planting rates have been in the range of 140,000 seeds planted, which has generally established around 125,000 surviving plants. In general, higher planting rates are most applicable to less productive soil types, whereas lower populations may be used to help manage lodging potential in highly productive systems without sacrificing yield potential. Reduced populations should not be considered in less productive systems.

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EVALUATION OF SOYBEAN SEED TREATMENT IN THE MIDSOUTH

A high percentage of midsouth growers choose to use soybean seed treatments. Wet, poorly drained soils, common during spring planting and crop emergence, favor the development of the fungal pathogens that cause soybean seedling diseases, which may slow germination and plant growth. Early-season insect pests may also damage soybean seeds and seedlings, causing adverse effects on plant growth. Seed treatments can help protect seed and seedlings from pests, resulting in more uniform plant stands, better yield potential and ultimately increase return on investment.

Study Guidelines

Testing was conducted at the Monsanto Learning Center at Scott, MS to evaluate the effects of soybean seed treatment on soybean yield. Three soybean products (AG4005 brand, AG4632 brand and AG5332 brand) were planted on April 20, 2012. Each product was planted at a rate of 140,000 seeds per acre. Half of each product was treated with an Acceleron® Seed Treatment Products for soybeans, containing both fungicides, an insecticide and a nematode protection agent, PONCHO®/VOTIVO®. The combination included Acceleron DX-309 Fungicide Seed Treatment, Acceleron DX-109 Fungicide Seed Treatment and Acceleron IX-409 Insecticide Seed Treatment. The other half was left untreated. Standard agronomic practices for the area were implemented. Each product was harvested for yield.

Results and Conclusions

The seed treatment was a positive contributor to yield for all products in this trial in 2012, with treated products producing nearly 11 bu/acre higher yield than untreated plots (Figure 1). Acceleron Seed Treatment Products improved stands and plant health in all varieties. AG4005 brand produced an average yield of 81.88 bu/acre in treated plots and 74.84 bu/acre in untreated plots (an increase of 7.04 bu/acre for the treated soybeans). AG4632 brand produced and average yield of 66.15 bu/acre in treated plots and 53.24 bu/acre in untreated plots (an increase of 12.91 bu/acre for the treated soybeans). AG5332 brand produced an average yield of 69.60 bu/acre in treated plots and 57.18 bu/acre in untreated plots (an increase of 12.42 bu/acre for the treated soybeans). Averaged across all three varieties, the treated plots produced yields of 72.54 bu/acre compared to 61.75 bu/acre in untreated plots (an increase of 10.79 bu/acre for the treated soybeans) (Figure 2).

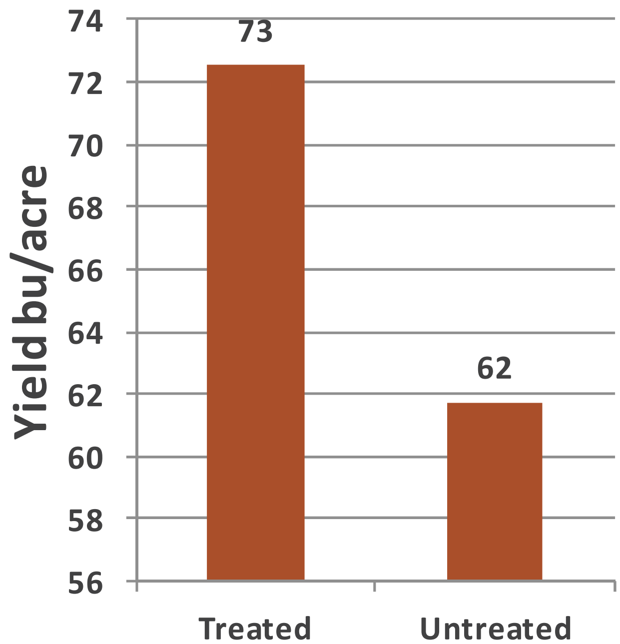

Figure 1. Average yield effect of Acceleron® Seed Treatment Products for soybeans.

Acceleron Seed Treatment Products

Acceleron Seed Treatment Products have been selected to compliment Genuity® Roundup Ready 2 Yield® and Roundup Ready® soybeans by helping to protect soybean seeds and seedlings from disease and insect damage. Acceleron Insecticide/Fungicide Seed Treatment Products for soybeans also improve plant health. In the past, most seed treatments consisted of one or two active ingredients which primarily controlled seedling diseases. Acceleron Seed Treatment Products contain advancements in seed treatment technology, including multiple modes of action, broad spectrum control of insects and diseases with increased length of protection.

EVALUATION OF SOYBEAN SEED TREATMENT IN THE MIDSOUTH

Acceleron Seed Treatment Products offer control of key diseases: Pythium, Phytophthora, Fusarium and Rhizoctonia, and protection from key insects, such as bean leaf beetle, soybean aphid, seedcorn maggot, wireworm and white grub. This broad spectrum control comes from an exclusive fungicide combination of pyraclostrobin and metalaxyl as well as the insecticide imidacloprid, which provides both above- and below-ground insect protection. Protection from Acceleron Seed Treatment Products can last for up to 30 days. For 2013, Acceleron Insecticide/Fungicide Seed Treatment Products for soybeans will contain the fungicides pyraclostrobin for Fusarium and Rhizoctonia control, metalaxys for Pythium and Phytophthora control and fluxapyroxad for control of Fusarium and Rhizoctonia, as well as the insecticide imidacloprid.

History of Performance

A three-year summary (2008-2010) of field data from Monsanto small plot and strip plot trials, with varying levels of disease and insect pressure, indicated soybeans treated with Acceleron Fungicide/Insecticide Seed Treatment Products had an average performance gain wins 73 percent of the time compared to untreated soybeans. In addition, data from the same trials indicated that Acceleron Seed Treatment Products improved soybean stand and vigor.

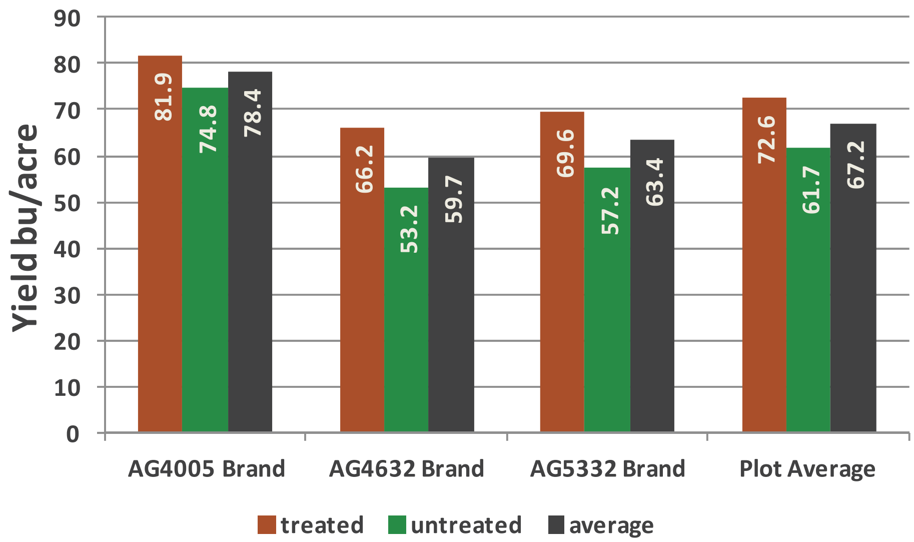

Figure 2. Average soybean yield response to seed treatment.

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NOTES

NOTES

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

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Roundup Technology® includes Monsanto's glyphosate-based herbicide technologies.

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Insect Resistance Management
Planting Refuges, Preserving Technology

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Roundup Ready 2 TECHNOLOGY®

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