Science Societies

Soil testing is key to yield and economic performance in grain corn

By Laura M. Brenner

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Researchers at Mississippi State University (MSU) conducted preliminary research on grain corn to determine the most beneficial practices for increasing yield and improving grain composition in No. 2 yellow corn. Their research suggests there's more than one way to improve yield and grain composition, including managing uncontrollable environmental factors. However, when it comes to maximizing the economics of corn production, there is one clear pathway that begins with a thoughtfully read soil test. Earn 0.5 CEUs in Crop Management by reading this article and taking the quiz.

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"Initially, we just wanted to look at yield," explains Jagman Dhillon, Assistant Professor of Agronomy and researcher on this trial. "But we also thought [the production practices] should affect the quality of the grain. When we looked at the literature, there wasn't much research on [corn] grain quality."

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Testing the grower-standard for yield

The researchers team recently published two articles on the impact of various "cultural" practices in corn production on grain yield and composition. The trial, which ran from 2020 until 2022, was set at two locations in Mississippi: Verona and Stoneville.

Researchers tested three main production variables that are common practices among Delta farmers. Plant populations were tested at 32,000 and 40,000 seeds/ac in single or twin rows. Six nutrient treatments, plus fungicide, were evaluated. Researchers used the then-popular DeKalb 70-27 corn hybrid seed. Two completely different experimental trials were configured in a randomized complete block design to manage the addition and deletion trials.

When Michael Pisciotta, a CCA with the 4R Nutrient Management Specialty certification, reviewed the papers, he valued the information presented but worried some wouldn't see the biggest takeaway of the importance of setting application rates and protocols based on soil tests. "These omission and addition setups are good; they tap into different factors that are standard parts of production," says Pisciotta, who serves as a director of agronomy covering Mississippi for a specialty fertilizer manufacturer. "But it may not have told the whole story."

Dhillon recognizes the limits of this initial trial and aims to return to the field for follow-up research. According to Dhillon, the researchers' intent for this trial was to test the

grower-standard protocols, regardless of what the soil test called for. The researchers intentionally did not adapt their protocols in response to the soil tests.

“Everything we did was to emulate what producers do,” Dhillon says. “[I saw] more responses on nitrogen, but I didn’t see a response from other nutrients. We knew that [might be the case] from soil testing but went ahead anyway.”

Trial variables

Addition and deletion trials allowed researchers to test nutrition management strategies, row configurations, and planting populations to determine their production value. Researchers added and deleted nutrients stepwise: N, N2 (higher nitrogen rate), N2PK, N2PKS, N2PKSZn, N2PKSZnY (where Y indicates a fungicide treatment).

In addition to testing grower cultural practices, the sites offered differences in moisture management: the Verona site was rainfed while Stoneville was irrigated.

One departure from the grower-standard protocol being tested was the timing of fertilizer in the spring. “Most phosphorus and potassium fertilizer applications are pre-plant,” Pisciotta explains. “This is appropriate because for DAP and MAP, time and temperature are needed for those nutrients to become plant available. We also don’t want to miss windows when specific nutrient demands are high such as phosphate that is available during early vegetative growth.”

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solo

James Dew, lead author of the grain yield paper and co-author of the grain composition paper, broadcasting fertilizer.

Dhillon agrees and chalks up the late fertilizer application to trial logistics and environment-related field delays. According to Cory Vineyard, a CCA who works in Mississippi with a background in agriculture retail, this factor reflects the challenges farmers see during the season.

"I noticed that in one year, they couldn't get a second nutrient application, likely because of the weather," Vineyard said. But that's the real world—we try to do the best we can every year, but it doesn't always happen that way."

Similarly, and back to Pisciotta's point about not reading enough into the research data, the 2020 Stoneville addition trial saw a yield bump from higher nitrogen rates when phosphorus and potassium were applied compared with only nitrogen applications. But there was no yield increase from applications of sulfur, zinc, and fungicide. Pisciotta and Vineyard agree that the takeaway is a factor of the hybrid seed chosen for the trial and the existing soil nutrient load rather than a lack of benefit from those inputs.

"Hybrid selection has so much impact on everything else we work with growers on," said Vineyard. "DeKalb 70-27 is a disease-shield hybrid. Researchers said no diseases were present, which should be expected because of the seed genetics. [Using DeKalb 70-27] means there is potential not to see an ROI from this type of fungicide application. It's also considered a flex ear-hybrid, so [it is less likely to see a] yield bump when increasing population compared with a fixed ear-hybrid."

Pisciotta and Vineyard pointed out the nuance of each factor as it applies to farms and fields across the state. "Being an agronomist does not come with catch-all, blanket

recommendations. You have to literally look at every field, every farm, and work with that grower to create a plan for *that* field," Vineyard says.

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Yield-boosting factors

Despite cloudy feedback in some areas of this trial, researchers did find certain practices prove beneficial to yield increases.

At the irrigated Stoneville site in 2020–2022, twin-row configurations and the higher 40,000/ac seed population improved yield over the single-row and lower-seed-rate configurations. Interestingly, at the rainfed Verona site in 2020 and 2021, twin-row configurations and a 32,000-per-acre seed population showed more promise than the single-row and higher-seed-rate counterparts.



Picture of twin-row configuration (left) and single-row configuration (right). Plant-to-plant spacing between twin-rows was 7.09 inches (18 cm) and beds were 38.2 inches (97 cm) apart in both single- and twin-row configurations.

“Ideally, irrigated sites tend to respond positively to higher plant populations, whereas dryland conditions do not offer similar returns,” Dhillon says. “And we found that twin rows perform better, something producers can adopt if they have the right equipment.”

But he agrees with Picsiotta and Vineyard’s analysis. “Do soil testing. Do it before making any fertility decisions,” Dhillon insists.

Management practices and grain composition

Readers browsing the grain composition article will find that the biggest factor affecting nearly every tested piece of composition was the trial year. This is likely a

by-product of the role environmental factors play in both rainfed and irrigated fields.

Researchers from MSU added a grain composition component to their yield research by testing the grain for protein, starch, oil, and moisture content. They hope to reveal insights into how management practices intended to improve yield may also play a role in grain composition.

This research was conducted on regular commodity field corn where Vineyard doesn't believe grain composition is a major consideration by growers or commodity grain-buying outfits but could become relevant in the future. "Right now, growers are paid on bushels and moisture," he explained. "We see certain markets, such as the distilling market in the U.S., that have a concept of nutrient density related to quality and potentially higher alcohol production, but normal commodity markets do not pay as much attention."

Researchers at MSU are still delving into the market for grain composition research in corn. Dhillon agrees that more grain composition work in other areas of corn production is needed. "It's something to earmark for the future," he says. "Some grain goes for ethanol production, others for feed. We need to collaborate with researchers from those fields to find out what they prefer [from their grains]."

Protein levels

According to the research, protein content increased with increased nitrogen rate in all site years. However, the lack of influence of other nutrients may be due to the higher residual levels in the soil prior to planting. Researchers noted in their article that increased nitrogen without supporting levels of other nutrients can lead to imbalances in plant nutrient uptake and negatively affect protein content.

Another protein content factor was row configurations. Twin-row plantings with a higher seed rate at the rainfed Verona site showed a higher protein content. Interestingly, the irrigated Stoneville site showed higher protein from single-row plantings. Other research suggests higher planting densities negatively impact protein content.

Pisciotta believes factors beyond the researchers' control affect grain composition in this study. "When we go into the twin- vs. single-row pattern, we get into a scenario where there are two factors to take advantage of—light and water," he explains. Then you're trying to manage natural circumstances, and we can't control the weather."

Other essential components

When testing starch levels, researchers found that the interaction between nitrogen and other nutrients—phosphorus, potassium, sulfur, and zinc—harmed starch content. On the contrary, fertilizer treatments positively impacted moisture levels. Researchers suggest an adequate supply of nutrients can extend the grain-filling period, leading to higher moisture content at harvest. Planting density, especially in twin-row configurations, also positively impacted grain moisture content.



Planting density, especially in twin-row configurations as shown above, positively impacted grain moisture content.

Nutrient fertilizer treatments did not significantly impact oil content, regardless of trial location or year.

Lessons to take home

The final findings suggest little yield benefit to what would otherwise be considered essential nutrient and fungicide protocols. When combined with the cost, the return on investment seems bleak. However, this research requires readers to dig deeper into their agronomic toolkit to find the lesson.

“Soil testing is essential to making accurate predictions for soil additions that pay. There could be readers who review this study and say, ‘these things don't pay,’ before thinking about soil levels on the front end,” Pisciotta says.

Mississippi researchers agree. Aside from the findings of their trials, a main takeaway is that soil testing is essential. Moreover, Dhillon wants farmers to take the next step and reconsider the current yield goal method used for nitrogen rate recommendation.

“Our other research has shown that yield goal methods over-recommend nitrogen rates and do not consider environmental variations; moreover, producers tend to apply more than is needed as insurance fertilization,” Dhillon says.

Applying nitrogen at its optimum required rate is a quick way to turn pennies into dollars at the end of the season. Overall, Dhillon hopes this research trial is just scratching the surface of what he hopes to understand about Mississippi corn's production styles and grain composition needs.

“This research is just an initial study. Some grain is used for ethanol production, and others for feed. We need to collaborate with researchers from those fields to ask what they prefer [in grain composition],” Dhillon says. I hope to pursue it, and then we can ask those questions and tweak the future studies.”

Dig deeper

Read the original research reports from the journal *Crop, Forage & Turfgrass Management*:

Dew, J., Li, X., Oglesby, C., Fox, A. A. A., Sharma, R. K., Singh, G., McCoy, J., Kaur, G., Gajula, P., & Dhillon, J. (2024). Assessing the effect of cultural practices on

Mississippi corn.

production: 1. *Grain yield. Crop, Forage & Turfgrass Management, 10,* e20267. https://doi.org/10.1002/cft2.20267

Gajula, P., Dew, J., Sharma, R. K., Kaur, G., Singh, G., Bheemanahalli, R., Reed, V., & Dhillon, J. (2024). Assessing the effect of cultural practices on Mississippi corn production: 2. Grain composition. *Crop, Forage & Turfgrass Management, 10,* e20266. https://doi.org/10.1002/cft2.20266

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1. **In a study of grain quality in No. 2 yellow corn, researchers evaluated how many nutrient treatments?**
   a. 4.
   b. 12.
   c. 8.
   d. 6.

2. **In the study's 2020 addition trial in Stoneville, a yield bump was observed with higher nitrogen rates when**
    a. only nitrogen was applied.
    b. sulfur and zinc were applied.
    c. phosphorus and potassium were applied.
    d. fungicide was applied.

3. **At the irrigated Stoneville site in 2020–2022, which conditions improved yield?**
    a. Single-row and 32,000/ac seed population.
    b. Twin-row and 32,000/ac seed population.
    c. Twin-row and 40,000/ac seed population.
    d. Single-row and 30,000/ac seed population.

4. **The researchers found higher protein content with twin-row plantings.**
    a. True.
    b. False.

5. **Interaction between nitrogen and other nutrients harmed**
    a. starch content.
    b. moisture levels.
    c. oil content.
    d. none of the above.

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