Soybean Seeding Rates and Optimal Plant Densities

K·STATE Research and Extension

Department of Agronomy | **MF3460** | **Crop Production**

An optimal seeding rate is one of the most influential factors for increasing soybean profitability. Seed is one of the most expensive inputs. Soybean seeding rate, row spacing, and planting date are all related.

The final number of seeds per linear row foot decreases as row spacing narrows. For example, at a target population of 105,000 plants per acre and 85 percent germination, 30-inch rows need twice the number of seeds per linear foot as 15-inch rows (six versus three seeds per linear foot).

Seeding rates for high-yielding soybeans

Information gathered from the Kansas Soybean Yield Contest shows maximum yield (more than 90 bushels per acre) could be achieved with seeding rates ranging from 120,000 to 180,000 seeds per acre (Figure 1). Contest yields mostly ranged from 60 to 90 bushels per acre.

Consider yield potential for each environment when deciding soybean seeding rates. Yield potential is primarily defined by weather conditions (before and after planting), genetic potential, soil type, fertility program, and use of crop production best management practices (proper weed, insect, and disease control from planting until harvest).

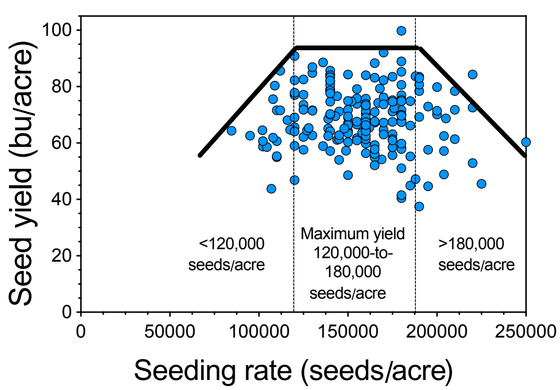

Figure 1. *Yield versus seeding rate from Kansas Soybean Yield Contest data.*

Optimal plant densities in soybeans

The agronomic-optimal plant density is defined as the minimum number of plants (in a per-unit-area basis) required to maximize yield. Soybean plant density levels above the optimal density increase the risk of lodging and disease development without adding a yield benefit, reinforcing the need for defining the agronomic-optimal plant density.

To achieve the proper plant density required for each yield environment, when deciding the seeding rates, consider potential soil and weather conditions that could affect the success of the final stand establishment.

A recent study by Carciochi, Ciampitti and collaborators from Corteva Agriscience presented a new insight about the optimal plant density by yield environment. For that study, a soybean database evaluating seeding rates ranging from 69,000 to 271,000 seeds per acre was created, including final number of plants and seed yield.

The data were classified in yield environments: low (LYE, <59.6 bushels per acre), medium (MYE, 59.6-64.1 bushels per acre), and high (HYE, >64.1 bushels per acre).

The main outcomes for this study were:

- Optimal plant density decreased by 24% from low (127,000 plants per acre) to high (97,000 plants per acre) yield environments (Figure 2).
- The optimal density (50% interquantile) ranged between 109,000 to 144,000 plants per acre for the low, from 77,000 to 114,000 plants per acre for the medium, and 76,000 to 117,000 plants per acre for the high-yield environment (Figure 3).
- Greater optimal density for the low yield was not related to a low plant survival rate.

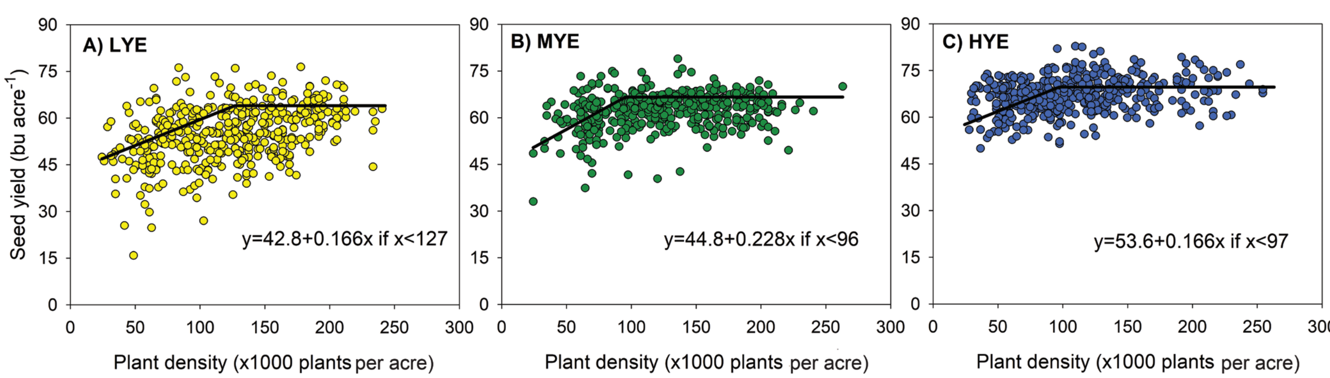

Figure 2. *Relationship between seed yield and plant density for low (LYE, less than 59.6 bushels per acre, A), medium (MYE, 59.6–64.1 bushels per acre, B), and high yield environments (HYE, more than 64.1 bushels per acre, C). Models were fitted using hierarchical Bayesian models.*

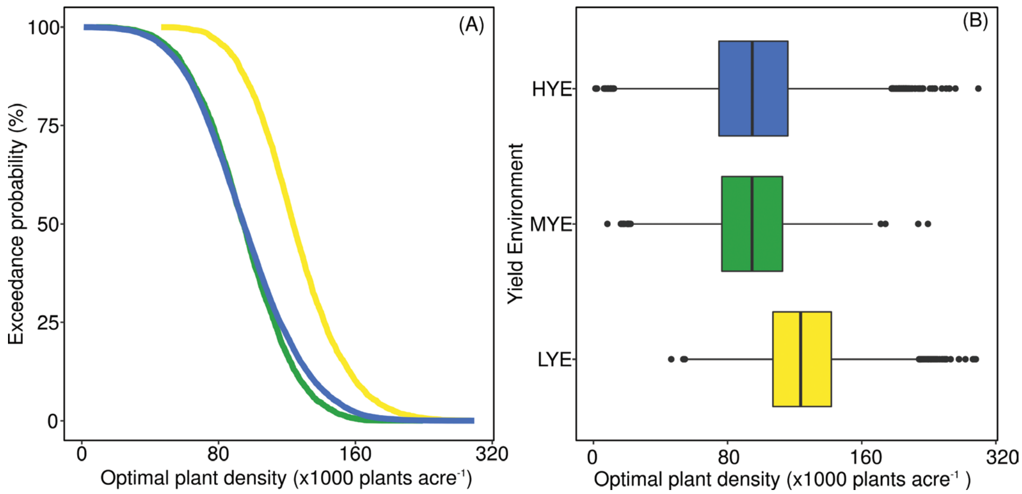

Figure 3. *Panel A shows exceedance probabilities (%) of agronomic optimal plant density and panel B shows the agronomic optimal plant density range to achieve the plateau-level for the seed yield-to-plant density relationship for the low (LYE, in yellow), medium (MYE, in green), and high yield environment (HYE, in blue). Panel B, box plots portray the 25th (bottom edge of the box) and the 75th (top edge of the box). The solid line within the box represents the median and the circles refer to outliers.*

- Less precipitation during the reproductive period was one of the main causes for the need to increase the plant density in low-yield environments to overcome a possible reduction in the crop's reproductive ability.

This information allows for site-specific management strategies, such as variable seeding rate. Within a field, yield variation could be better related to the adjustment of seeding rate for soybeans, improving both the productivity and net return for farmers.

The exceedance probability of the agronomic optimal plant density at each yield environment (Figure 3) showed a greater difference for the LYE compared with both MYE and HYE.

For example, the maximum probability for reaching the agronomic optimal plant density with fewer than 100,000 plants per acre was 58% for both the MYE and HYE but it was reduced to 17% for the LYE.

A simple analysis of the average weather conditions for the three yield environments showed that the cumulative precipitation during the late-season soybean growth period (reproductive) was 39% lower in LYE compared with MYE and HYE. Previous studies reported that drought stress during early reproductive growth stages reduced per-plant leaf area and number and length of branches, and consequently seed yield was also reduced. Average daily mean temperature for the reproductive period was 8% higher in LYE compared to MYE and HYE, which could exacerbate the effect generated by the lower precipitation in the LYE.

Environmental conditions (e.g., water availability, temperature, and radiation), as well as other factors such as fertility or pests, could affect soybean leaf area and branching, reducing crop growth rate, and negatively affecting the soybean's reproductive ability. Variation in environmental conditions producing different yield potential affects the final agronomic-optimal plant density for soybeans.

Summary

Results of this study showed the agronomic optimal plant density depends on the yield environment, so plant density could be reduced by 24% in both MYE and HYE relative to the LYE.

This is valuable information for site-specific management strategies, such as varying the seeding rate. Thus, within a field, yield variation could be better related to the adjustment of seeding rate for soybeans, improving both productivity and net return.

Adjusting seeding rates reduces risks of yield losses due to suboptimal densities in a low-yield environment, while limiting higher seed costs due to supra-optimal densities, especially for medium- and high-yield environments.

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