tance developing within a fungal population subsequent to fungicide application is quite high. More research regarding fungicide timing and specific product placement in situations where strobilurin-resistant fungi have been detected is necessary.

Program 11SB-2

Optimizing Row Spacing And Plant Population In Soybean

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Introduction

Selection of row spacing and target plant population for optimal economic benefit are two of the most important decisions a soybean farmer makes. Research data has not provided a consistent picture of whether or not narrow- compared with wide-row spacing results in yield increase. For example, in a study conducted by Bowers et al. (2000) (Agronomy Journal 92:524-531), soybean planted in the early soybean production system (ESPS) showed positive yield responses to narrow-row spacing at only 5 out of 10 locations across Texas, Arkansas, and Louisiana. Research also has not shown consistent responses to plant population. What farmers need to know is the minimal target plant population they need for optimizing yield (minimal optimal plant population). Unfortunately, previous research has shown this figure can vary from as little as 12,145 plant/A to as many as 202,430 plant/A. The objectives for this presentation are:

1). Identify conditions under which growers can expect yield increases in narrow vs. wide rows.

2). Determine how much of a yield increase can be expected from narrow-row spacing.

3.) Determine if recommended target plant populations can be reduced without affecting yield.

ROW SPACING BACKGROUND INFORMATION

When soybean was first introduced to the US about 125 years ago, it was grown on a wide-row spacing of 40”. This was required at that time because row spacing had to be at least 40” wide to allow passage of mules used for farm work. Currently, soybeans are grown on a wide range of row spacings, varying from the traditional 40” rows to spacings as narrow as 7”. Generally, wide-row spacing is defined as 30” or wider, whereas narrow-row spacing is anything less than 30”. Acceptance of narrow-row spacing is widespread across the Midwest and Southeast US growing regions. Acceptance has resulted from the following advantages shown for narrow-row culture: 1) potential yield increases; 2) weed suppression; and 3) greater ground cover to limit erosion. However, there are also disadvantages: 1) equipment incompatibility; 2) inability to cultivate for herbicide-resistant weeds; 3) greater difficulty in walking through the field to sweep for insects or check trouble spots; 4) yield responses are sometimes small or nonexistent.

PLANT POPULATION BACKGROUND INFORMATION

Because of the high seed costs for GMO soybean, growers are increasingly concerned about minimizing their seed costs without affecting yield. In essence, farmers want a target plant population that will give optimal yield with the fewest possible plants (minimal optimal plant population). Soybean yield responds to plant population in a plateau manner as described in Figure 1 below. At very low plant populations (10,000 to 30,000 plant/A), yield increases

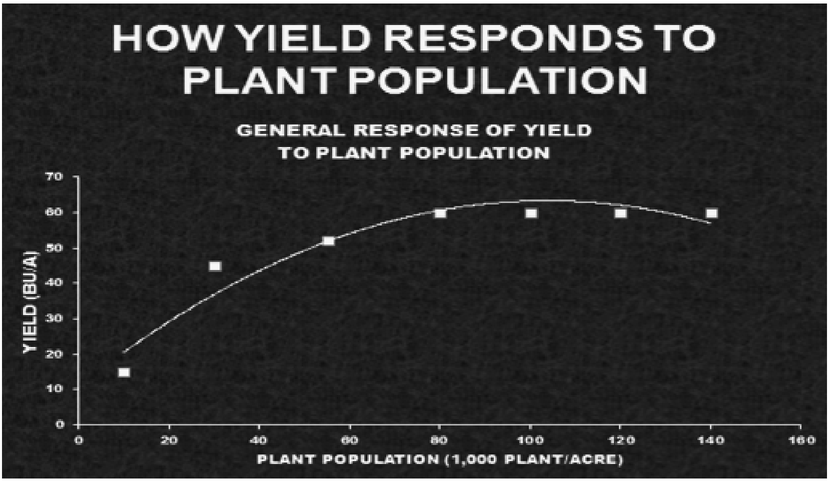

Figure 1. The general response of soybean yield to increasing plant population.

in a linear 1:1 fashion with increased plant population. As plant population rises above 30,000 plant/A, interplant competition for light and other resources begins, resulting in lower yield increases with each increment of plant population. Thus, between 30,000 and 80,000 plant/A, yield responds to increasing plant population in a curvilinear manner rather than a straight line. Finally, optimal yield is achieved at 80,000 plant/A (minimal optimal plant population), and no further yield increases occur at greater plant populations. The minimal optimal plant population varies with environmental and genotypic differences. What farmers want to know is the minimal optimal plant population for their specific environmental/genotypic situation.

Current recommended target plant populations vary across the Southeast US. While North Carolina recommends only 75,000 plant/A, Arkansas advises its growers to aim for 120,000-130,000 plant/A. Louisiana and Mississippi suggest intermediate levels of 80,000-120,000 and 96,000-112,000, respectively. When soybean is planted within the optimal planting period, yield responses to increasing plant population are generally consistent across row spacings. However, at late planting dates where greater plant populations are required to optimize yield (because of reduced plant size), minimal optimal plant population may be greater at narrow- vs. wide-row spacings.

HOW DO YIELD INCREASES OCCUR IN NARROW VS. WIDE ROWS?

Narrow- vs. wide-row spacing creates greater yield by increasing dry matter levels at the R5 developmental stage (start of seed filling) within the range of 0-600 g/m2. This relationship is shown in Figure 2 below. Because of greater light interception, narrow-row spacing often increases dry matter (R5). The magnitude of the yield increase depends upon how great the dry matter increase is, as well as at where the increase occurs on the yield response line shown in Figure 2. Achievement of optimal yield depends on the crop accumulating sufficient dry matter by R5 in order to optimize pod and seed numbers. During the emergence to R5 period the crop produces all vegetative dry matter (stems, leaves, and petioles), and completes most of its flowering and pod set. When narrow-row spacing creates yield increases, it does so by

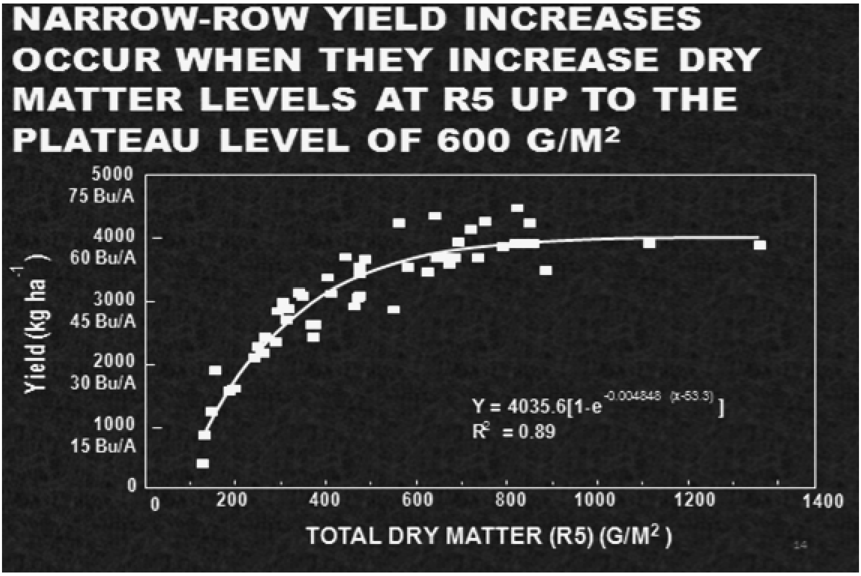

Figure 2. Response of soybean yield to increasing levels of total dry matter accumulation at the R5 developmental stage (start of seed filling).

increasing node number associated with greater dry matter (R5), which then produces increased numbers of pods and seeds. Other yield-contributing factors such as pod per node, seed per pod, and seed weight do not play a role in narrow-row yield increases. An example of this principle is shown below in Figure 3 where yield increases for Centennial and Forrest soybeans were caused by increases in seed number (mainly on branches) with very little effect on seed weight.

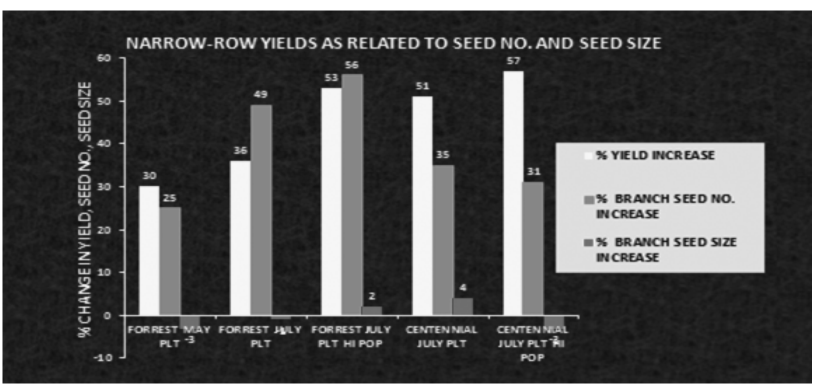

Figure 3. Yield, seed number, and seed size (i.e. weight per seed) as related to narrow-row yield increases for Forrest and Centennial soybean.

Research discussed above indicates how narrow-row yield increases occur through greater dry matter accumulation by the start of seed filling (R5). The question then becomes how do narrow rows create this greater dry matter accumulation. The answer lies in the increased light interception that occurs in narrow compared with wide rows, starting a few weeks after emergence. Once the plants emerge, increased light interception per unit of leaf area in narrow vs. wide rows gives the narrow rows a greater crop growth rate, which in turn generates higher levels of leaf area and light interception as the season progresses. By the time of first flower (R1), light interception levels in narrow rows can be almost twice as great as those in wide rows. An example is shown in Figure 4 below.

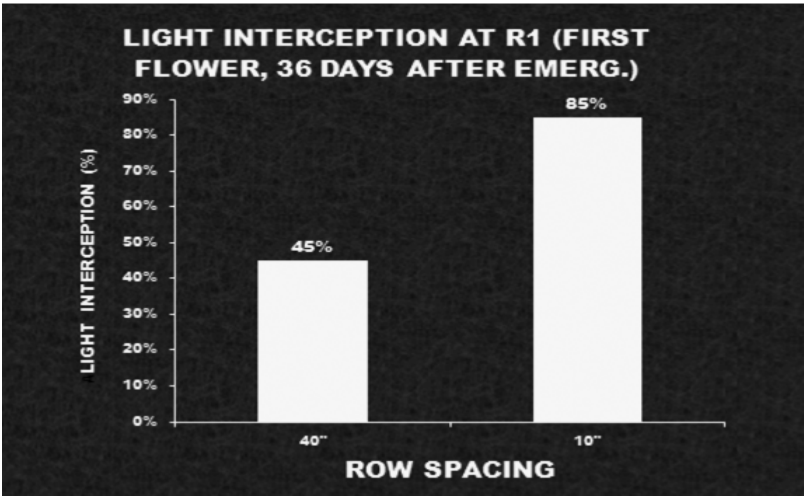

Figure 4. Light interception of narrow and wide rows at 36 days after emergence (R1, first flower) for Centennial soybean planted at a late planting date near Baton Rouge, LA.

This early-season light interception advantage for narrow-row spacing stimulated crop growth rate, dry matter levels at R5, and eventually resulted in a 39% yield increase as shown in Figures 5-7 below.

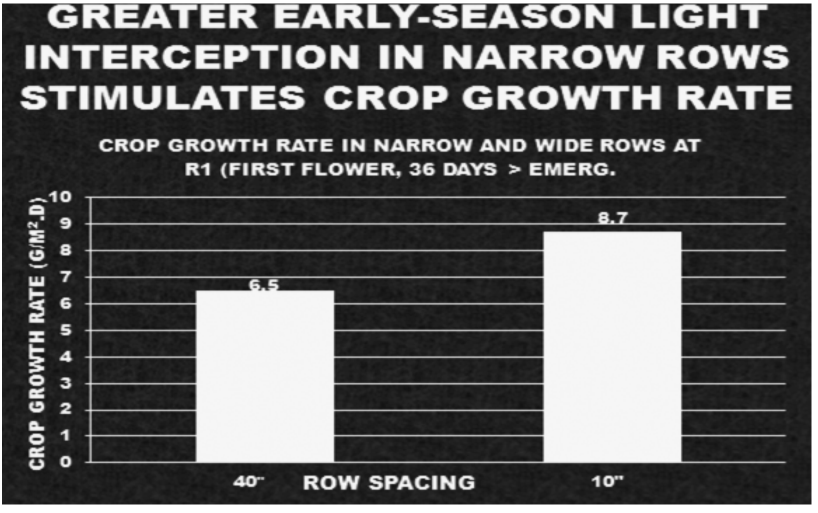

Figure 5. Increased crop growth rate in narrow vs. wide rows occurs from the early-season light interception advantage of the narrow rows.

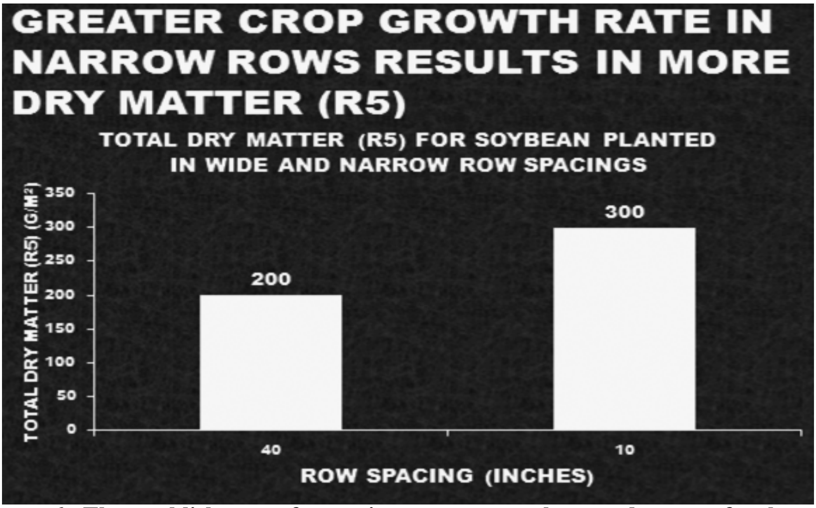

Figure 6. The establishment of a consistent crop growth rate advantage for the narrow rows results in a 50% increase in dry matter (R5).

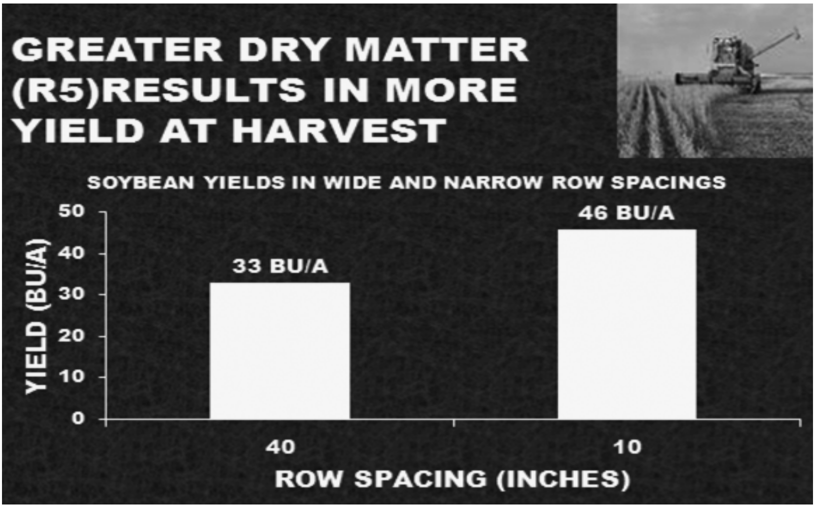

FIGURE 7. With greater seed number resulting from increased dry matter (R5), yield is 39% greater in narrow vs. wide rows.

WHEN DO NARROW-ROW YIELD INCREASES OCCUR?

Now that we have an understanding of how yield increases occur in narrow vs. wide rows, we can predict when reduced row spacing will give us a yield advantage. In cases where a soybean crop achieves a dry matter level of at least 600 g/m2 by R5, no yield benefit occurs from narrow rows. With the advent of the early soybean production system (ESPS) in the Mid South US, growing time between emergence and R5 has been substantially reduced. This means that current Maturity Group III and IV varieties grown in this region are less likely to achieve adequate vegetative dry matter accumulation relative to traditional cropping systems that used later maturing varieties. Thus, narrow-row spacing may have a greater advantage in the ESPS compared with the traditional cropping system.

Because narrow-row yield increases depend on increased light interception and crop growth rate during the emergence-R5 period, any long-term stress occurring during this period can inhibit the yield advantage of narrow rows. The most common stress causing such an inhibition would be drought stress. Drought stress inhibits leaf expansion, thus restricting the light interception advantage for narrow vs. wide rows. Drought stress can also close the stomata (pores in the leaf surface that allow carbon dioxide to enter the plant and water to leave it), restricting the crop growth rate advantage for narrow rows. Other long-term stresses that potentially inhibit the beneficial effects of narrow rows on yield are mineral deficiencies/toxicities, low pH soils, hard pans that restrict root growth, waterlogging, soybean cyst nematode, weed pressure, insects, and diseases. In summary, if a farmer wishes to obtain greater yield in narrow vs. wide rows, long-term stresses during the emergence to R5 period must be avoided.

HOW TO GET OPTIMAL YIELD WITH LOWER PLANT POPULATIONS

Although typical target plant populations recommended for the Mid South US are about 100,000 plant/A, optimal yields can be obtained at lower plant populations by avoiding stresses that slow crop growth rate during the emergence-R5 period. An example is shown below for variety DP 3606 (MG VI) grown in high, normal, and subnormal plant populations near Baton Rouge (Figure 8). Because of ideal growing conditions, crop growth rate for the subnormal plant population was able to equilibrate with that for the normal and high plant populations. Consequently, the subnormal plant population achieved a dry matter level at R5 greater than 600 g/m2 and did not suffer a yield loss. Thus, the story for achieving a minimal optimal plant population is the same for achieving greater yield in narrow- vs. wide rows: stress during the emergence to R5 period must be avoided.

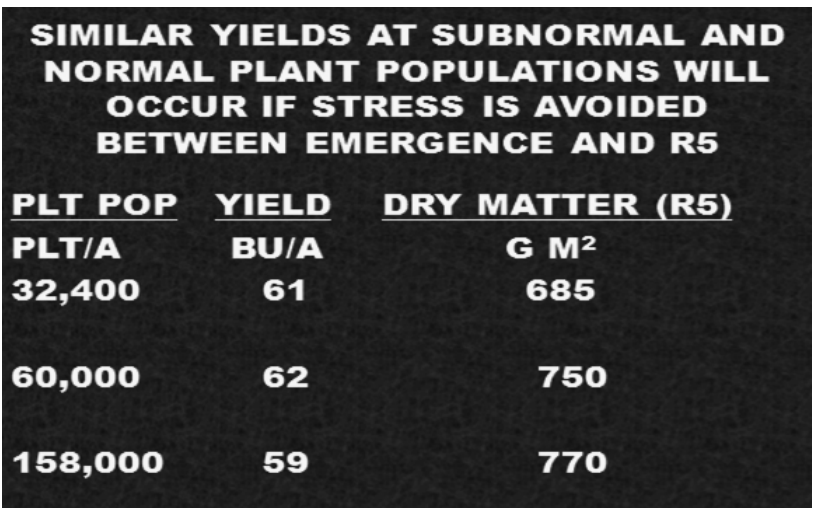

Figure 8. Dry matter and yield relationships for variety DP3606 (MG VI) grown near Baton Rouge, LA at high, normal, and subnormal plant populations.

CONCLUSIONS

1. Yield increases in narrow vs. wide rows can be expected when dry matter (R5) for wide rows falls below 600 g/m2 .
2. Yield increases in narrow vs. wide rows are more likely for current cultivars grown in the early soybean production system (ESPS) compared with later maturing cultivars planted at conventional planting dates.
3. Increased yield in narrow vs. wide rows is unlikely when a long-term stress (such as drought) occurs during the emergence to R5 period.
4. Increased yield in narrow rows is possible when the stress is intermittent rather than continuous.
5. Farmers can obtain optimal yields with subnormal target plant populations by avoiding stresses during the emergence to R5 period.