Agronomic Maximization of Soybean Yield and Quality: Row Spacing x Management Interaction

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Introduction

Numerous studies have looked at the effect of soybean row spacing on yield. Most findings suggest that narrow row spacings (less than 76 cm) tend to yield more than wide row spacings, indicating increased light interception (Andrade et al., 2002) and decreased weed densities as some of the reasons. Other studies have looked at the interaction of row spacing with production practices, such as plant population. However, few have looked at the interaction of row spacing with different management systems. Management systems that include multiple yield-enhancing inputs have become increasingly popular in recent years due to higher commodity prices. Little research has been done looking at combinations of these products with different row spacings to understand each one's unique contribution to increasing soybean yield. Narrow row spacing combined with yield-enhancing inputs may be an effective system for maximizing soybean yield.

Objective

Evaluate the interaction of aggressive and standard soybean management practices with row spacing to better understand how they interact influence soybean growth and yield.

Materials and Methods

- Ten field experiments were conducted in Kansas and Minnesota during 2012 and 2013 (2013 data in Minnesota not shown).
- Four management practices were used across three row spacings.
- Analysis of variance was conducted using PROC MIXED in SAS 9.3.

Experimental Design:

- Randomized complete block with split-plot having row spacing as the whole plot factor and management as the subplot factor.

Managements:

1. Untreated control
2. ST + Foliar Fung at R3 (Fungicide & insecticide seed treatment plus foliar fungicide at R3)
3. SOYA Complete (Fungicide, insecticide, biologicals & LCO seed treatment plus BioForge, foliar LCO, foliar fertilizer, foliar insecticide, foliar fungicide, and nitrogen)
4. SOYA minus foliar fungicide (Management 3 without foliar fungicide)

Row Spacing:

- 25 cm, 51 cm, and 76 cm (2012) (Figure 1)
- 19 cm, 38 cm, and 76 cm (2013)

Figure 1. Row spacing used in 2012: 25 cm (left), 51 cm (middle) and 76 cm (right).

Data collected:

- Stand counts at V2/V3 and R8
- Disease and insect assessment before (R3) and after (R5) fungicide and insecticide application
- Lodging ratings, pod counts, and plant heights at R8
- Yield, moisture, test weight, and protein & oil content

Data collected (cont.):

- Normalized difference vegetation index (NDVI) values obtained weekly using a GreenSeeker (Trimble Navigation Ltd. Sunnyvale, CA) sensor.
- Light interception (Purcell, 2000) obtained weekly using a digital camera positioned horizontally 1.6m above the soil surface.
  - Photos were analyzed by SigmaScan Pro (v 5.0, SPSS, Inc., Chicago, IL.) by converting green leaves into red pixels and counting red pixels (Figure 2).
  - Number of red pixels was divided by total number of pixels in photo to give fractional canopy coverage.

Figure 2. Digital photo (left) and same photo after pixel conversion in SigmaScan Pro (right).

Results

Row Spacing x Management

- Soybean yield response due to management did not depend on row spacing (α=0.05) (Figure 3).

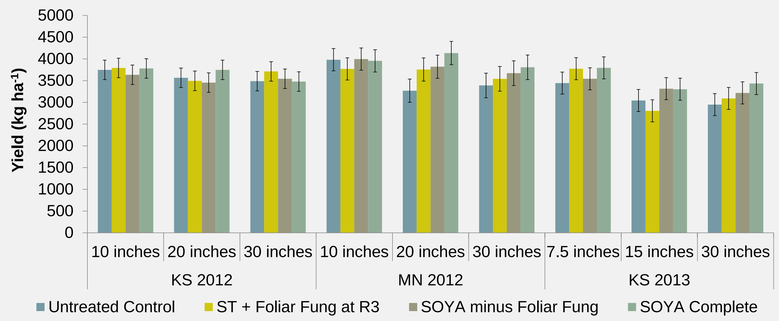

Figure 3. Average yields for management by row spacing across all locations within KS and MN.

- Narrow-row soybeans with minimal inputs often yielded as well as wider row spacings with the complete package of yield enhancing products (Figure 3).

Row Spacing

- Narrow Row spacing affected yield in two of eight experiments (α=0.05). The narrowest row spacing out yielded the widest row spacing by 460 kg ha^{-1} in St. Paul, MN in 2012 and 737 kg ha^{-1} in Rossville, KS in 2013 (Figure 4).

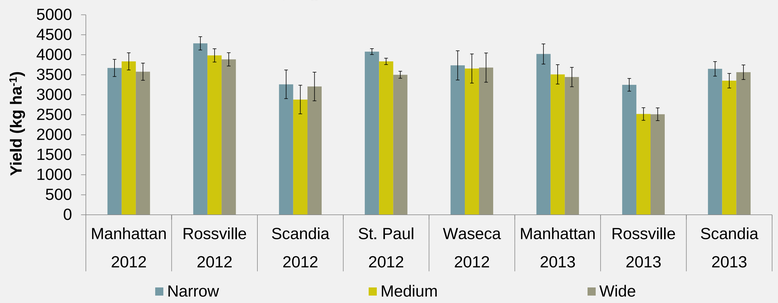

Figure 4. Average yields for each row spacing at all locations. Row spacing of 25, 51, and 76 cm and 19, 38, and 76 cm were used in 2012 and 2013 respectively.

- In 2013 stand counts at all three locations in Kansas averaged 74,000 plants ha^{-1} greater in 19 and 38 cm row spacings than 76 cm row spacing (α=0.05).
- Plant height averaged 4 cm taller in 25 and 51 cm rows than in the 76 cm row spacing in Minnesota in 2012 (α=0.05).

Management

- Management system effected yield only at Scandia in 2012, however, both SOYA treatments yielded less than the untreated control (α=0.05).
- The untreated control and ST + Foliar Fung at R3 managements consistently had greater stands than the two SOYA managements at Manhattan and Rossville, KS in 2012 and 2013 and at Waseca, MN in 2012 (data not shown).

- **Light Interception and NDVI**
- The 76-cm row spacing intercepted more light early in the growing season but quickly fell behind the narrower row spacings as the season progressed (Figure 5).
- All three row spacings had similar ground cover by 80 days after emergence when soybeans were at the R6 growth stage (Fig. 5)

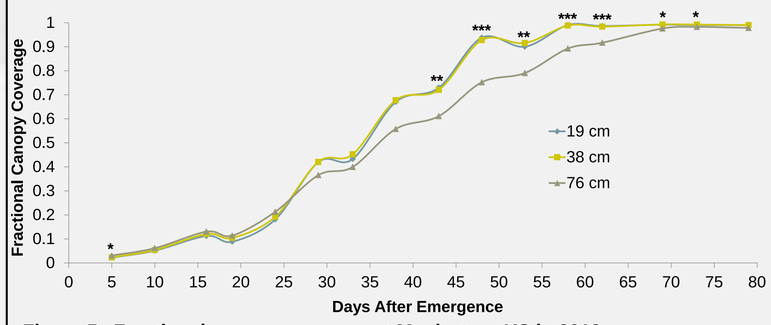

Figure 5. Fractional canopy coverage at Manhattan, KS in 2013.
* Significant at α = 0.05, ** Significant at α = 0.01, *** Significant at α = 0.001

- All four managements had similar NDVI readings until senescence late in the growing season when the two SOYA management systems had greater values than the untreated control and ST + Foliar Fung at R3 managements (Figure 6).

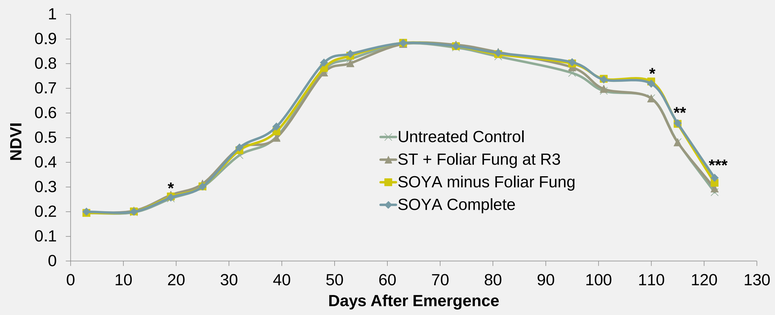

Figure 6. NDVI at Rossville, KS in 2013.
* Significant at α = 0.05, ** Significant at α = 0.01, *** Significant at α = 0.001

Conclusions

- Soybean yield response due to narrow row spacing was equal to or greater than wide row spacing regardless of the management system.
- Aggressive management systems were inconsistent at increasing soybean yields and did not depend on row spacing.

References

- Andrade, F.H., P. Calvino, A. Cirilo, and P. Barbieri. 2002. Yield responses to narrow rows depend on increased radiation interception. Agron. J. 94:975-980
- Purcell, L.C. 2000. Soybean canopy coverage and light interception measurements using digital imagery. Crop Sci. 40:834–837.