Agronomic Maximization of Soybean Yield and Quality: Population x Management Interactions

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Introduction

Currently, many commercial products advertised to improve yield are available to soybean [Glycine max L. (Merr.)] growers. The majority of these products have been tested individually; however, their interactions with various management practices including soybean plant population, have not been validated. Our objective was to determine the potential yield gain associated with the interaction of management practice and soybean population.

Materials and Methods

Locations: Research was conducted at two locations in Wisconsin, Iowa, Michigan, Illinois, Indiana, Kentucky, Arkansas, three locations in Kansas, and four locations in Minnesota in 2012 (Fig.1).

Treatments: Two management regimes were employed, an untreated (UTC) and a high input system termed SOYA (Systematic Optimization of Yield-enhancing Applications) on six different target plant populations (123,500; 197,600; 271,700; 345,800; 419,900; and 494,000 seeds ha^{-1}). A detailed description of each treatment is given in Table 1. All other soybean management strategies followed University best management practices.

Cultivars. Cultivars were selected regionally to be adapted for maturity and with appropriate defensive traits. All cultivars were obtained from Asgrow® (Monsanto Company, 2013) and were expected to be modern high-yielding cultivars. The experiment was replicated by environment, defined as location within year.

Data Collection. Stand counts were taken at emergence and harvest to confirm emergence and attrition rates. Growth stage was assessed weekly to ensure proper treatment application timing. Disease and insect pressure was monitored weekly during the growing season. Grain yield was determined by machine harvest and subsamples were taken for grain quality and seed mass determination.

Statistical Analysis. Variables were subjected to a non-linear regression analysis using the PROC NLIN procedure in SAS Version 9.3 (SAS Institute Inc., Cary, NC). Variables were regressed over target population, management regime, and the target population x management regime interaction. Significant interactions were found for growing region and analysis was therefore separated by growing region. Population data were fit using the following equation: $y = \alpha(1 - exp^{-\beta x})$ where **α** is the predicted asymptotic maximum and **β** represents the responsiveness of ***y*** as plant populations increase. This equation has been used and described by Edwards and Purcell (2005).

- Colt, AR
- Newport, AR
- Farley, IA
- Humboldt, IA
- Monmouth, IL
- Urbana, IL
- Wanatah, IN
- West Lafayette, IN
- Manhattan, KS
- Rossville, KS
- Scandia, KS
- Hodgenville, KY
- Lexington, KY
- Breckenridge, MI
- East Lansing, MI
- New Richland, MN
- St. Paul, MN
- Waseca, MN
- Arlington, WI
- Janesville, WI

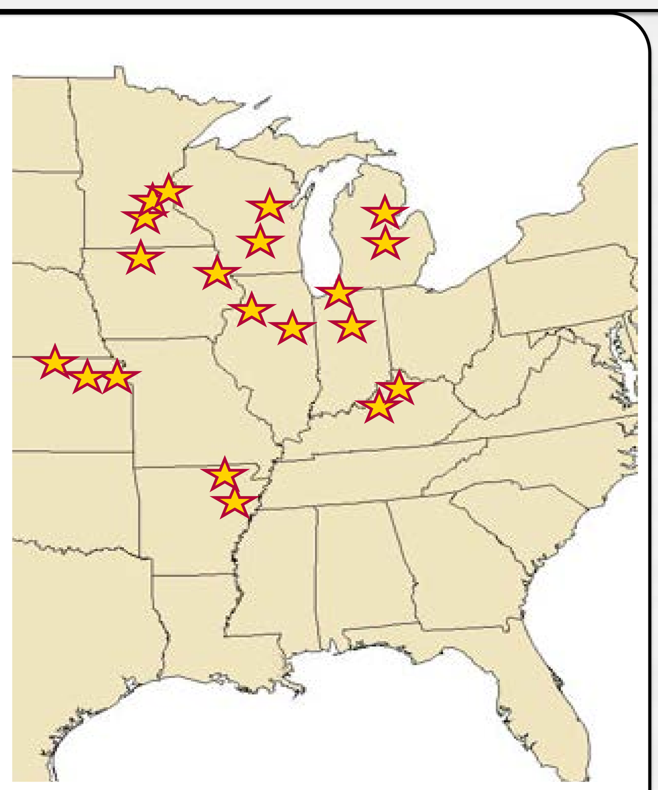

Fig. 1 Map of growing locations

Table 1. Application rates and timings

Application Timing	Management Regime	
	UTC	SOYA
Seed Applied	N/A	Pyraclostrobin (8.2 g ai cwt^{-1}) Metalaxyl (12.6 g ai cwt^{-1}) Imidacloprid (46.1 g ai cwt^{-1}) Clothianidin (0.13 mg ai seed^{-1}) Optimize® (0.02 mg ai cwt^{-1}) (Novozymes, 2010)
V4	N/A	Ratchet® (0.11 mg ai ha^{-1}) (Novozymes, 2010) Urea 46% (84 kg ha^{-1}) ESN® (84 kg ha^{-1}) (Agrium Advanced Tech., 2013)
R1	N/A	Task Force 2® (1.09 kg ai ha^{-1}) (Loveland Products Inc., 2013)
R3	N/A	BioForge® (1.12 kg ha^{-1}) (StollerUSA, 2013) Headline ® (99.0 g ai ha^{-1}) (BASF, 2013) Warrior II® (29.3 g ai ha^{-1}) (Syngenta, 2013)

Conclusions

- ✓ Maximum yield was obtained at populations lower (~40K to 65K) than previous reports (Edwards and Purcell, 2005) and may be a consequence of the widespread drought through most of the growing season in the Southern Plains and Southeast, and in the latter part of the season in the Northern Plains.
- ✓ SOYA treatments increased soybean yield 170 to 300 kg ha^{-1} however; the economics of the SOYA management approach must be considered and has yet to be analyzed.
- ✓ The absence of a significant interaction between population and management indicates there are no greater benefits to the SOYA treatments at higher populations in comparison to lower populations.

Yield Results

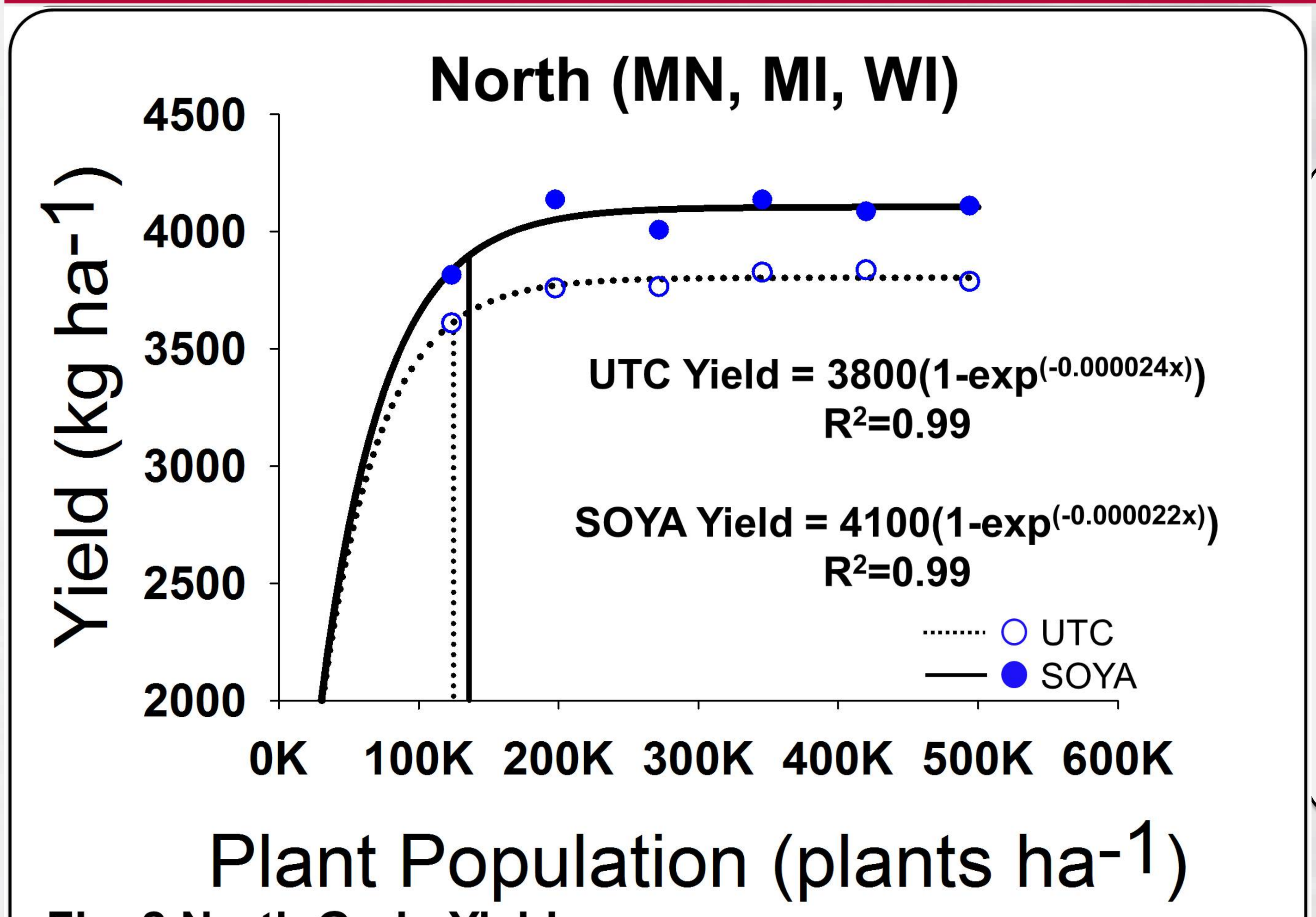

Fig. 2 North Grain Yield

- ✓ 95% of maximum UTC yield (3610 kg ha^{-1}) was obtained at 124,805 plants ha^{-1}
- ✓ 95% of maximum SOYA yield (3900 kg ha^{-1}) was obtained at 136,170 plants ha^{-1}
- ✓ Yield increased with population in both treatments (*P*<0.001)
- ✓ Regression analysis indicated SOYA increased yield ~300 kg ha^{-1} compared to UTC (*P*<0.001)

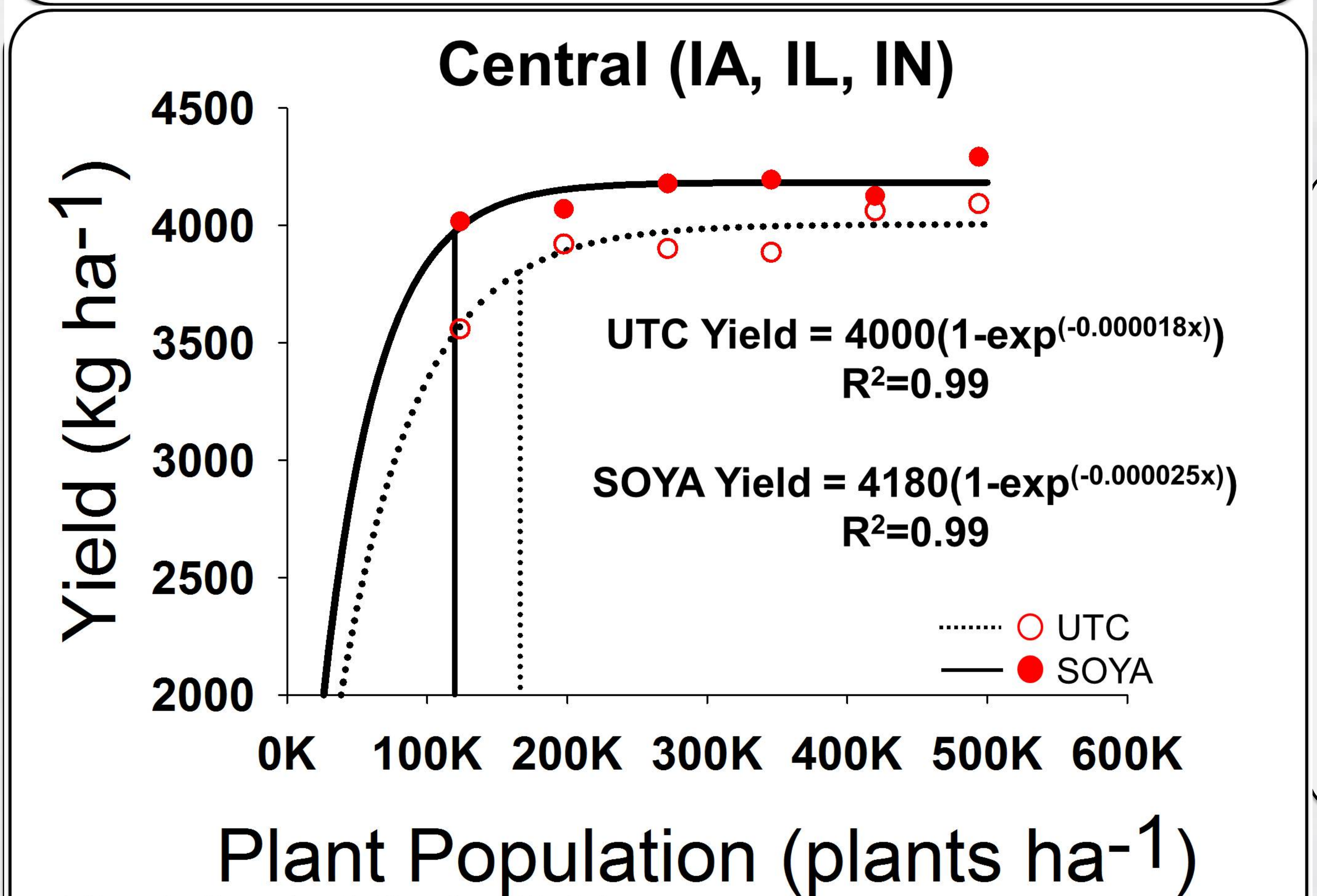

Fig. 3 Central Grain Yield

- ✓ 95% of maximum UTC yield (3800 kg ha^{-1}) was obtained at 166,430 plants ha^{-1}
- ✓ 95% of maximum SOYA yield (3970 kg ha^{-1}) was obtained at 119,829 plants ha^{-1}
- ✓ Yield increased with population in both treatments (*P*<0.001)
- ✓ SOYA increased yield ~178 kg ha^{-1} compared to UTC (*P*<0.001)

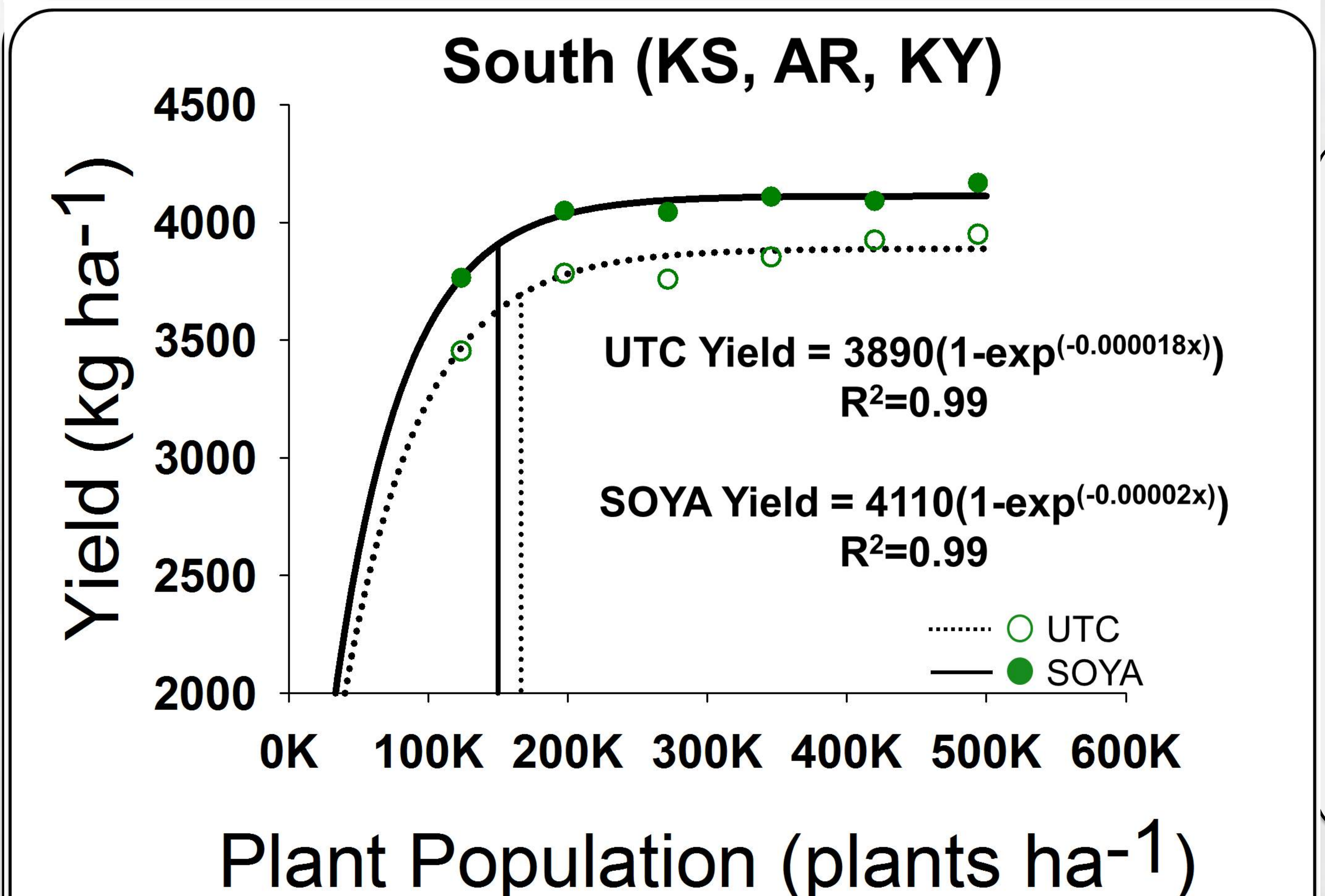

Fig. 4 South Grain Yield

- ✓ 95% of maximum UTC yield (3690 kg ha^{-1}) was obtained at 166,430 plants ha^{-1}
- ✓ 95% of maximum SOYA yield (3910 kg ha^{-1}) was obtained at 149,787 plants ha^{-1}
- ✓ Yield increased with population in both treatments (*P*<0.001)
- ✓ SOYA increased yield ~224 kg ha^{-1} compared to UTC (*P*<0.001)

Literature Cited

- Edwards, J.T. and L. Purcell. 2005. *Soybean yield and biomass responses to increasing plant population among diverse maturity groups: I. agronomic characteristics*. Crop Sci. 45:1770-1777.
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