Optimizing Potassium Fertility Levels for No-Till Soybean Production

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INTRODUCTION

Potassium (K) is considered the second most absorbed nutrient by soybean [Glycine Max (L) Merr] (Borkert and Yamada, 2000). It is the most abundant cation in plants and is associated with many of the physiological processes supporting plant growth and development. Adequate K nutrition has a considerable beneficial effect on the water balance of plants (Pettigrew, 2008). Research has shown that addition of K fertilizer on K-deficient soils increased the number of pods of soybean as well as exerted a beneficial influence on retaining pods until harvest (Coale and Grove, 1990). It has also been demonstrated that adequate K markedly improved seed quality by reducing the number of shriveled, shrunken, moldy and off-color beans (Bharati et al. 1986) as well as increased the content of the seed oils (Yin and Vyn, 2003). Another study reported that the health beneficial phytochemicals of isoflavones in soybean seed was increased by K fertilization (Yin and Vyn 2004). Overall, optimum levels of K fertilization are needed for maximum yield levels particularly when cognizance is given to the soil type. Based on this, the current K recommendations for soybean made by The University of Tennessee are 80 lb/acre of K_2O for low testing soils and 40 lb/acre of K_2O for medium testing soils; no K fertilizer is recommended for high and very high testing soils. Because of continuous yield increases resultant from new soybean cultivars and better management practices, the current K recommendations may need to be updated.

OBJECTIVE

To evaluate the effectiveness of the current K fertilizer recommendations for soybean made by the major soil testing laboratories in the State of Tennessee.

MATERIALS AND METHODS

Site Experiment;

This study was conducted in 2008 and 2009 at the Jackson and Milan Research and Education Centers of The University of Tennessee in West Tennessee and was performed on low to medium testing soils following the results of the soil test done in 2007 before the initiation of the study (Table 1).

The following six treatments were evaluated for each year at each location with the first five common to both locations while the last site-specific based on the soil testing laboratory's recommendations:

0, 40, 80, 120, 160 lb a^{-1} K_2O

90 lb a^{-1} K_2O (2008) + 0 lb a^{-1} K_2O (2009) [Jackson, recommended by a commercial soil testing lab (CL)]

80 lb a^{-1} K_2O (2008) + 0 lb a^{-1} K_2O (2009) [Milan, recommended by UT soil testing lab (UT)]

arranged in a randomized complete block design with four replicates, on plot sizes of 10' by 30' for Jackson and 15' by 30' for Milan.

All muriate of potash fertilizer was applied at about the time of planting by surface broadcasting.

Soybean variety 'Pioneer 94M80' was planted in a 30-inch row each year at both locations under no-tillage.

Measurements;

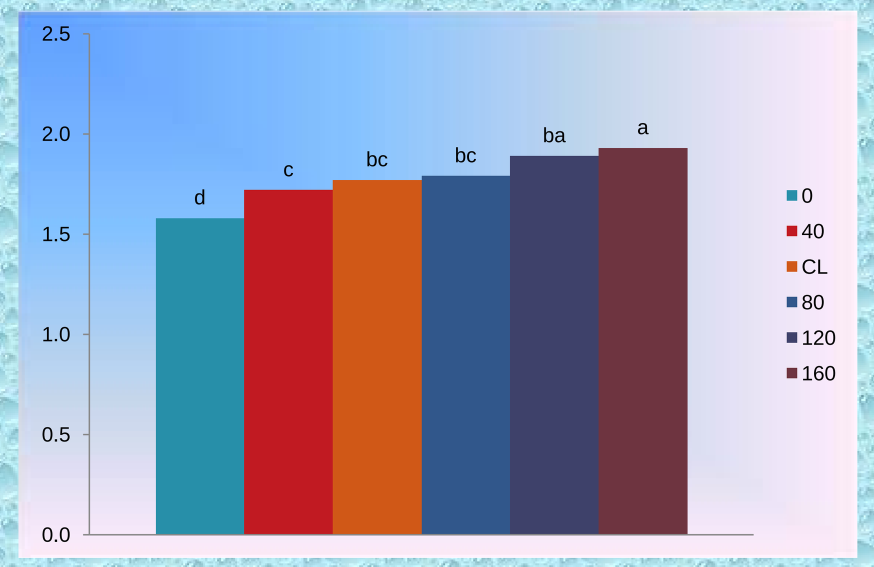
- Soil–test K before treatment implementation and after soybean harvest, leaf K concentration, and seed K concentration
- Plant population, plant height, and canopy Normalized Difference Vegetative Index (NDVI) at different key growing stages such as V5, R1 and R3
- Yield, and disease rating (charcoal rot)

Statistical Analysis;

The required measurements were statistically analyzed for each year and location as well as averages for the years and locations. The non- linear regression of yields with K treatments 1 to 5 was evaluated for optimal K application rate.

Table 1: Initial Soil Properties (0-6 Inches) in 2007

Property	Jackson	Milan
pH	6.4	6.7
Organic Matter (%)	1.4	
Available K (lb/ac)	178 (Medium)	78 (Low)
Available P (lb/ac)	62	20
Available Mg (lb/ac)	144	20



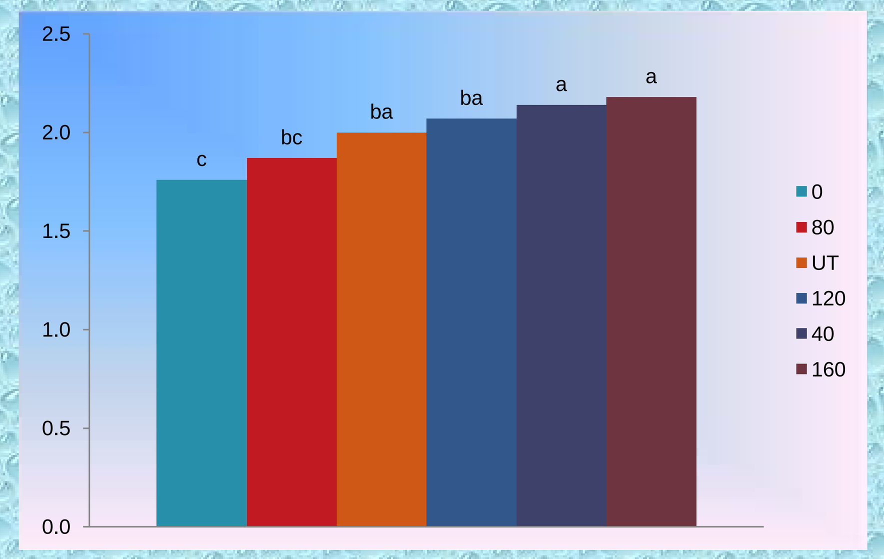
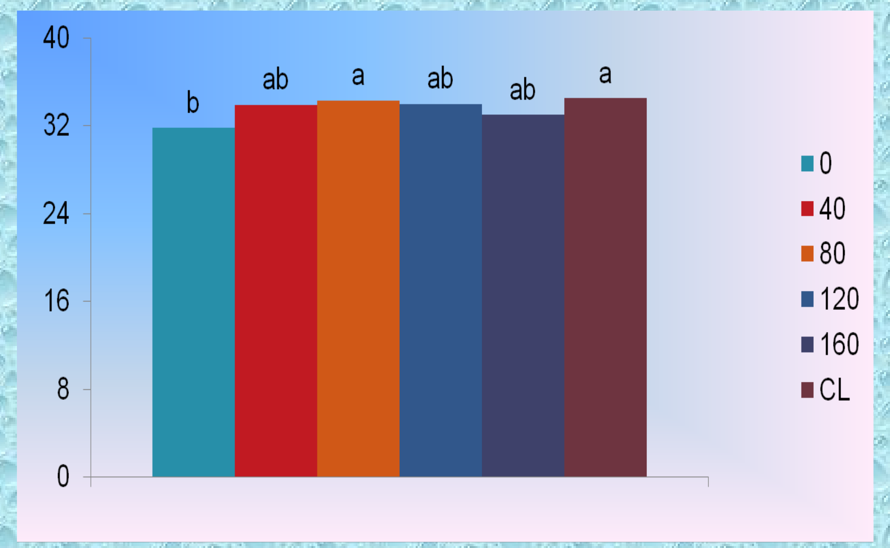


Figure 1 & 2; Leaf K Concentration Averaged over 2008 & 2009 (Jackson & Milan)



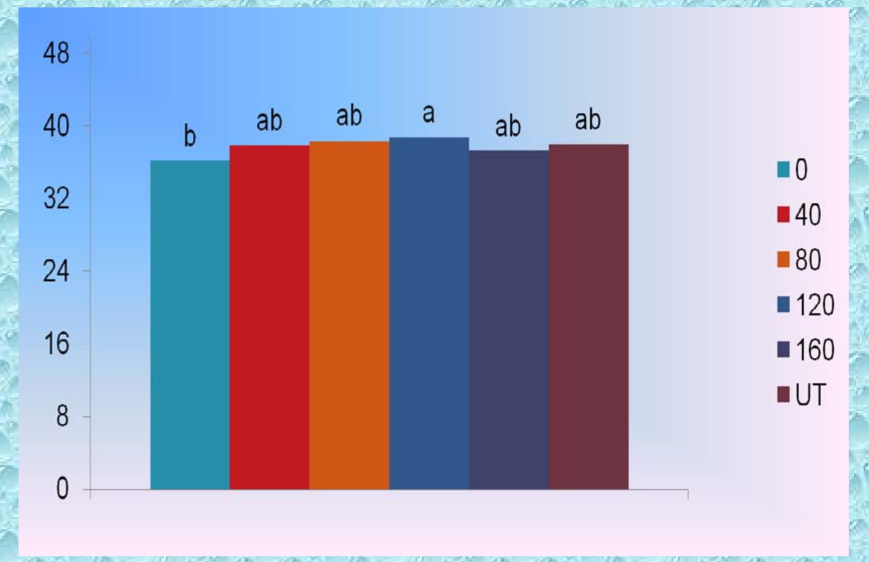
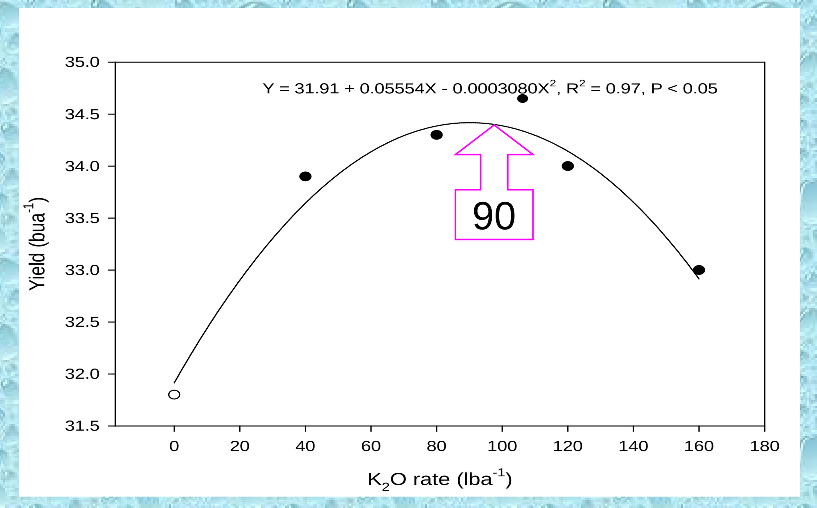


Figure 3 & 4; Yield Response to K Rates Averaged over 2008 & 2009 (Jackson & Milan)



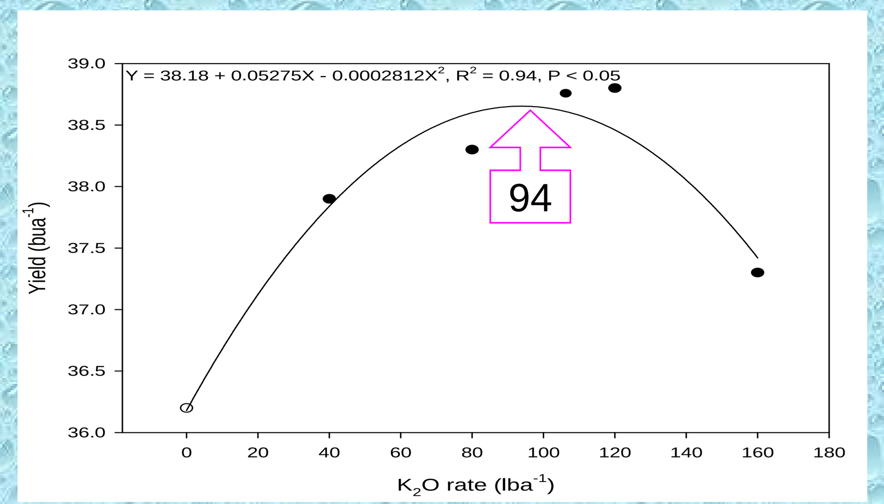


Figure 5 & 6; Yield Response Curve to K Averaged over 2008 & 2009 (Jackson & Milan)

RESULTS AND DISCUSSION

Leaf K Nutrition;

- Leaf K concentration showed a significant response to the K treatments with a general trend of increase in leaf K with increase in K application rates about 12 weeks after planting at both locations and years (Figures 1 and 2).

Yield Response;

- At both Jackson and Milan, the yield responses to K application rates were generally greater in 2008 than 2009, but the responsive trends were similar for both years (data not shown).
- At Jackson, the two-year average results showed that application of 80 lb a^{-1} of K_2O at planting by surface broadcasting significantly increased yield by 7.9%, compared with the zero K control (Figure 3).
- There was a significant yield increment of 8.5% with treatment six which was recommended by a commercial soil-testing laboratory and only received one K application during the two years with an average application rate of 45 lb a^{-1} of K_2O per year (Figure 3).
- Numerical but insignificant yield increases were observed with the other K treatments (Figure 3).
- At Milan, applying 120 lb a^{-1} of K_2O at Milan significantly increased yield by 7.2%, relative to the zero K treatment (Figure 4).
- There was no significant yield differences among the application rates of 40, 80, and 120 lb a^{-1} of K_2O (Figure 4).
- The quadratic regression of yields with K treatments one to five indicated that 90 lb a^{-1} K_2O was the optimal K application rate at Jackson (Figure 5) while 94 lb a^{-1} K_2O was optimal at Milan (Figure 6) for maximum yield based on the two-year averages.
- Since the weather was dry late in the season of 2008, and some sudden death syndrome occurred in 2009 at both locations, soybean yields suffered a bit from the adverse weather conditions and disease problems. This may have some negative effects on the yield responses to K applications.
- Yield increases of approximately 3 to 4 bu a^{-1} with the application of 80 lb a^{-1} K_2O per year at both locations in this study seemed not to be profitable based on the current prices for soybean grain and muriate of potash fertilizer.

CONCLUSIONS

- The yield responses to K application rates varied with years, but the responsive tendencies were similar for both years at Jackson and Milan.
- Applying about 90 lb a^{-1} of K_2O seems to be the best rate for both locations with a maximum yield increase ranging from 7% to 8%.
- So far the K management practice which was based on the recommendations from the soil-testing laboratories works well in term of soybean yields.

ACKNOWLEDGMENTS

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