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Identification of Yield-Limiting Factors in Southeast Kansas Cropping Systems

G. F. Sassenrath
Kansas State University, gsassenrath@ksu.edu

X. Lin
Kansas State University, xlin@ksu.edu

D. E. Shoup
Kansas State University, dshoup@ksu.edu

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Abstract

Crop performance and yield within production fields varies as a function of growing environment and soil properties within the field. Components contributing to yield in corn, wheat, and soybean production were examined through on-farm measurements of soil properties in southeast Kansas. Additional tests in research plots explored components contributing to yield in greater detail. Environmental variability between the 2013 and 2014 growing seasons contributed to differences in yield. Additional variability in soil parameters influenced crop performance, particularly for soils high in clay content.

Keywords

yield-limiting factors, cropping systems, southeast Kansas, corn, wheat, soybean

Cover Page Footnote

We would like to express our gratitude to the farmers who cooperated with this research and to Lonnie Mengarelli and Garth Blackburn for their efforts.

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Summary

Crop performance and yield within production fields varies as a function of growing environment and soil properties within the field. Components contributing to yield in corn, wheat, and soybean production were examined through on-farm measurements of soil properties in southeast Kansas. Additional tests in research plots explored components contributing to yield in greater detail. Environmental variability between the 2013 and 2014 growing seasons contributed to differences in yield. Additional variability in soil parameters influenced crop performance, particularly for soils high in clay content.

Introduction

The yield potential of crop cultivars is modified by soil productive capacity and growing environment. The difference between the yield potential of a cultivar and the actual harvested yield on-farm represents a loss of return on investment and inefficiency in crop production. Many factors contribute to this loss of yield potential, including environment (temperature, sunlight, and rainfall), soil quality, pests, and inefficiencies in management practices. This research is designed to identify critical components that determine yield through on-farm measurements of crop performance, soil quality, and climate. The results of this research will be used to develop improved production methods to enhance the yield harvested by farmers.

Previous results from on-farm studies indicate a major factor contributing to soybean yield is number of plants per acre. Previous work by Ken Kelley at the Southeast Agricultural Research Center showed soybean yields were optimal at 15-in. row spacing in conventional tillage and 7.5-in. spacing for no-till production. Additional studies were undertaken on research plots to determine optimal planting configuration and plant population for current soybean cultivars.

Experimental Procedures

Plant and soil samples were collected from production fields in collaboration with cooperating farmers in 2013 and 2014. Production fields were selected from three counties in southeast Kansas and for a variety of management practices for corn, wheat, and soybean. Soybean production systems included full-season and double-cropped, and rowed and drilled production methods.

Two-row-wide line-transects were established through the fields, and multiple sampling locations were established along each transect. At each sampling location, plants were hand-harvested from 3 ft^2, dried, and plant parts separated for determination of yield components (plants per area, pods, cobs or heads per plant, seeds per area, average seed size, etc.). Soil samples were taken at each sampling site and analyzed for bulk density, nutrients, pH, organic matter, and classification (percentage clay, silt, and sand content). Potential factors contributing to the yield differences were identified through correlating climatic conditions, soil health, management, and yearly crop yields.

To explore the change in soybean productivity with row spacing and plant population, soybean (48T80RR) were drilled into 7-in., 15-in., and 30-in.-wide rows with a Great Plains no-till drill to four different plant stands (100,000; 137,500; 175,000; and 212,500 seeds/a) at the Southeast Agricultural Research Center station near Columbus, KS. Plots were 10 ft × 50 ft and replicated six times. Standard agronomic practices were followed for optimal crop production. Center rows of each plot were harvested at maturity with a plot combine.

Results and Discussions

Yield Components

2014 was an exceptional year for corn production. Overall yields were substantially higher than in 2013, with average corn yield from production fields over 200 bu/a (Figure 1). The most important yield component of corn was number of kernels per ear, emphasizing the importance of good soil moisture during this critical period of corn growth. Kernel loss was most commonly due to poor pollination or disease. Average kernel weight also contributed to variability in yield. In addition, producer management practices during harvest contributed to harvest inefficiency. Preliminary measurements indicate yield loss during harvest could be as high as 20% of the overall yield. This harvest loss is evident when high densities of volunteer corn emerge after harvest. Corn yield components were much more variable for the 2013 growing season than in 2014.

Soybean yields in 2014 were closer to average for Southeast Kansas and were most dependent on the number of plants per acre with a trend towards lower yields with lower plant densities. This indicates the importance of stand establishment to ensure good soybean yield. The number of pods per plant was also highly variable, which contributed to yield variability. The number of seeds per pod and seed size were fairly consistent.

Results from research plots indicate a trend toward higher soybean yield with greater plant populations at all row spacings (Figure 2); however, the increased seed costs required at the higher planting populations limit the return on investment.

Wheat yield was most dependent on the number of seed heads produced per area. Individual wheat seed weight was fairly consistent. The variability of yield components in wheat was similar to that seen for corn and soybean.

Corn and soybean yields were most sensitive to high temperatures, whereas wheat yield was most sensitive to high rainfall during the spring harvest season. All crop yields were reduced as clay content of the soil increased (Figure 3).

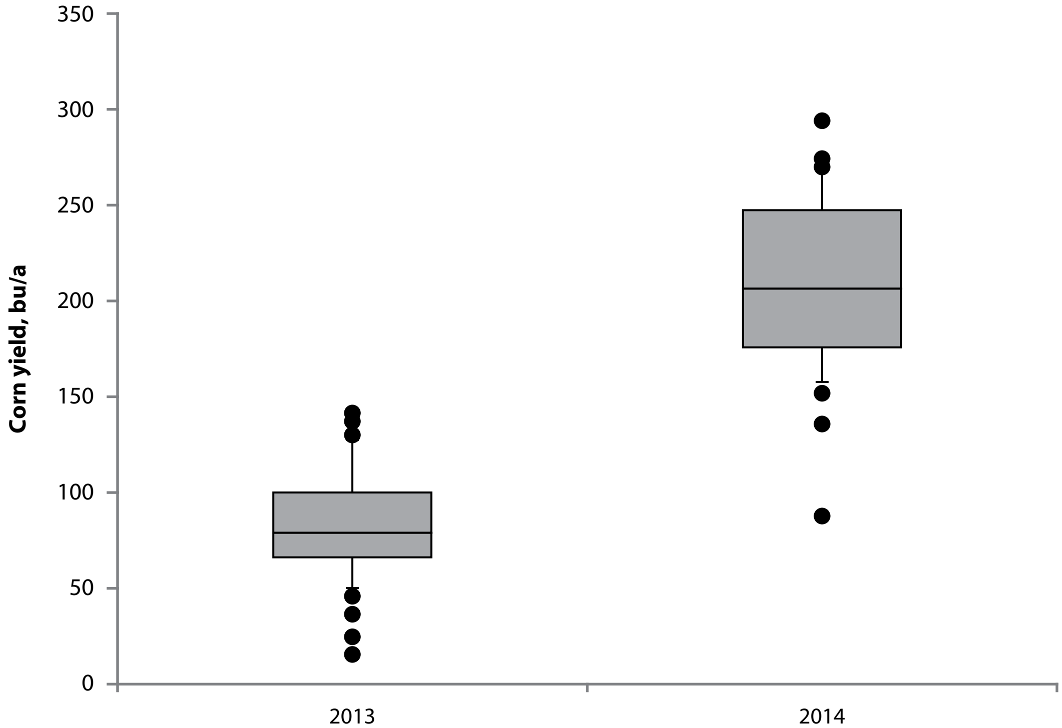

Figure 1. Comparison of corn yield for 2013 and 2014. The box encloses the majority of measured values from the 25th to the 75th percentile, with the line in the middle of the box representing the mean for each year. The whiskers above and below each box indicate the 10th and 90th percentile of values, respectively. Outliers are measured values at the very high or low end of each measurement. Note yield at one location in 2014 was close to 300 bu/a.

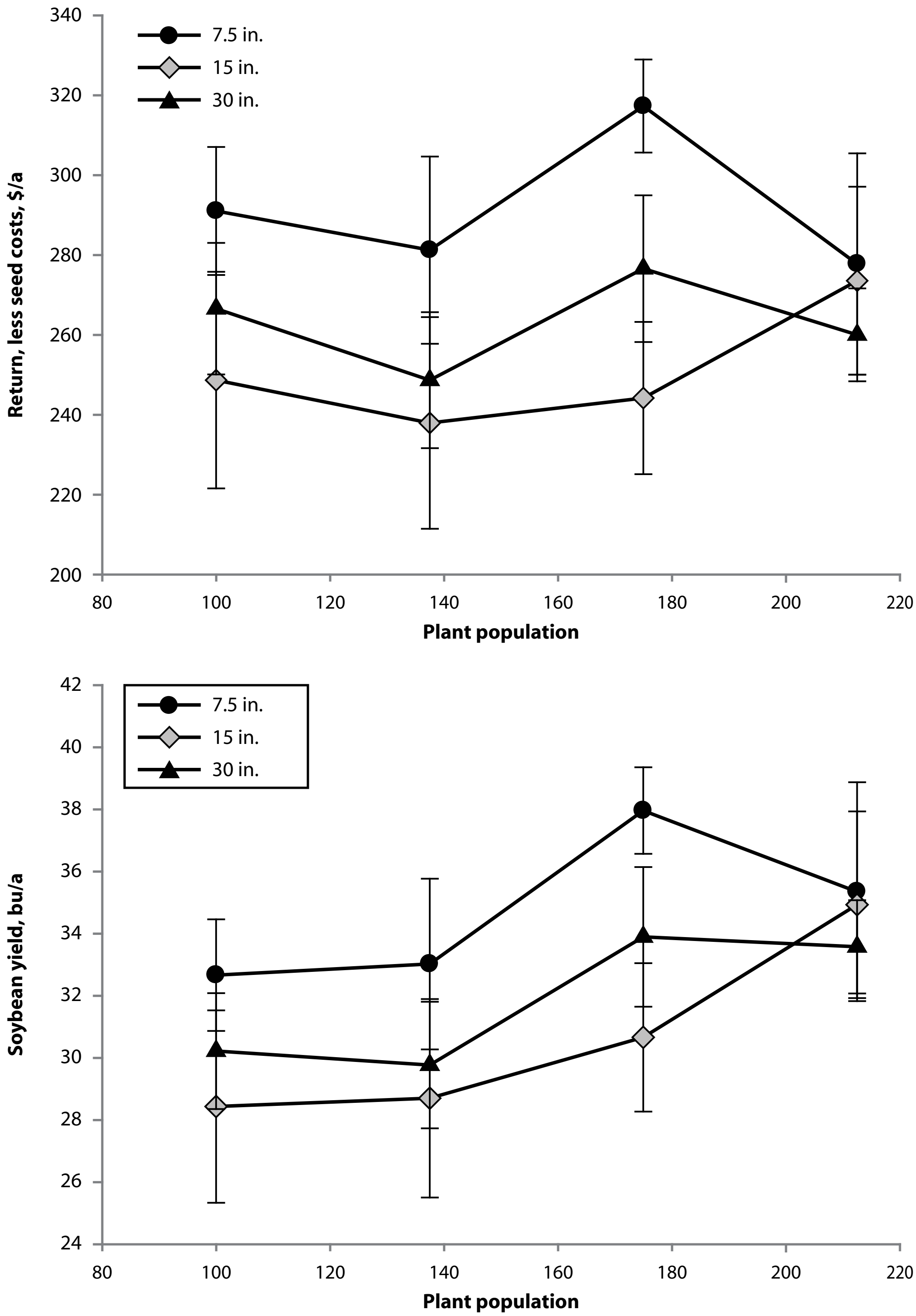

Figure 2. Soybean yield and return with row spacing (7.5 in., 15 in., and 30 in.) and plant population (100,000; 137,500; 175,000; and 212,500 seeds/a). Yield was measured by harvesting center rows with a plot combine. Note the expanded scale of the left axis (24 to 42 bu/a). Return on investment was determined accounting only for additional seed costs needed for higher planting densities. Again, left-axis scale does not begin at zero.

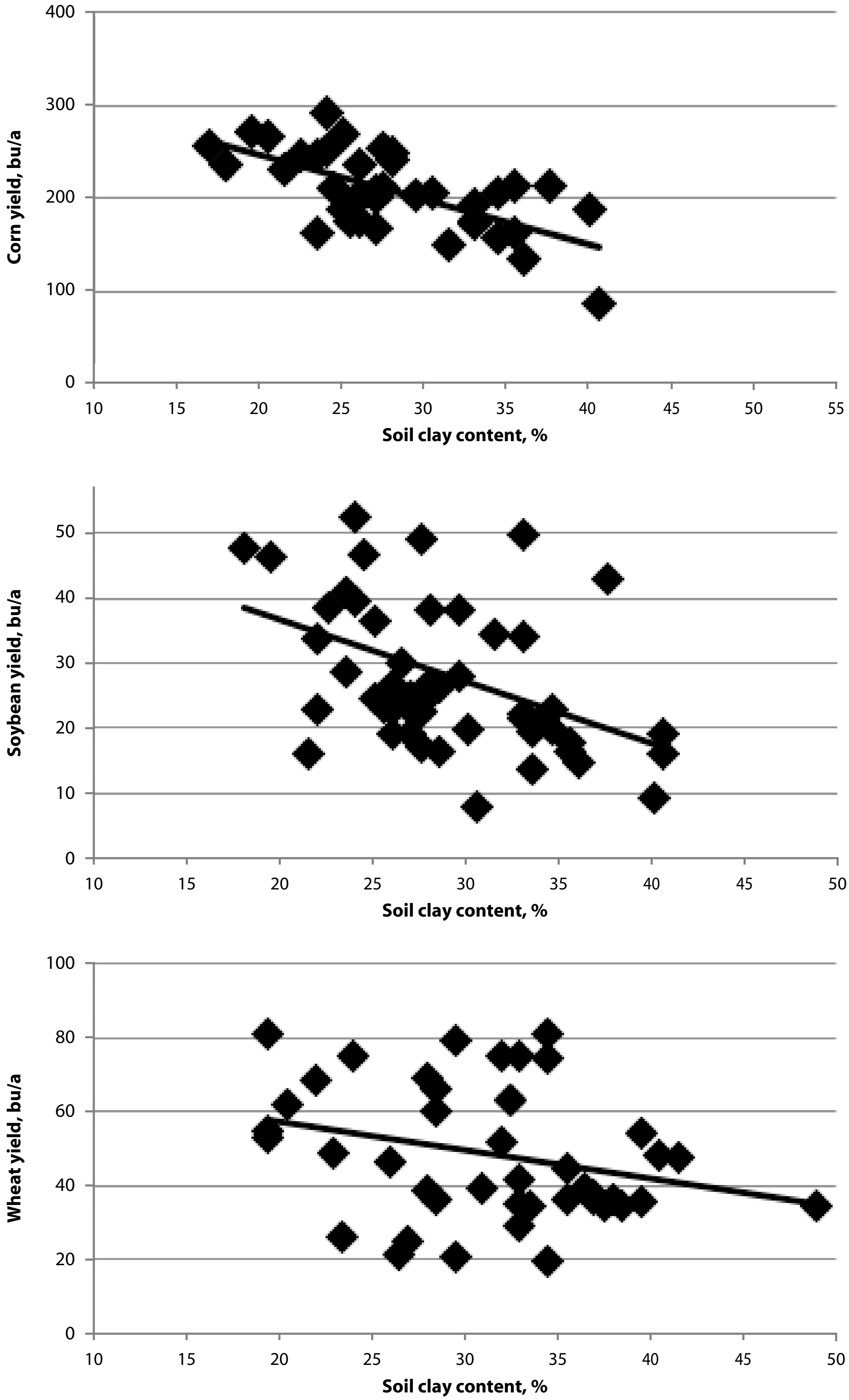

Figure 3. Decline in crop yields from production fields as a function of soil clay content increases.