Sorghum and Soybean Rotation Influence on Cotton Yields as Affected by Tillage and Nitrogen Fertilization

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Introduction

Interest and use of conservation tillage (reduced till) has increased in the South and Southwest. Factors influencing this change include economics and conservation of soil and moisture. Reduced tillage allows more crop residue to remain on the surface, thereby reducing evaporative losses and, in some cases, increasing crop yield (1).

Crop rotations can be instrumental in improving weed control, nutrient utilization and crop yields (2,3). Cropping systems which utilize biological nitrogen (N) fixation are important in maximizing fertilizer N use efficiency (5). Previous research from our region evaluating crop rotations including legumes under conservation tillage is limiting. The objectives of our research were: 1) develop crop rotation/tillage systems and fertility levels for profitable production of major crops, grain sorghum and cotton, and 2) investigate the contribution of a legume to the N fertility need of cotton grown under minimum till (MT) and conventional tillage (CVT) systems.

Materials and Methods

This experiment was conducted at the Texas A&M University Agricultural Research & Extension Center at Corpus Christi for four years. Grain sorghum (*Sorghum bicolor,* (L.) Moench, variety DK 37) and cotton (*Gossypium hirsutum,* variety CAB-CS) and soybean (*Glycine max,* variety NK 452) were grown on a Victoria clay soil (*Udic Pellusterts*). Seeding rates were 85,000, 55,000 and 96,000 seed/acre for grain sorghum, cotton, and soybean, respectively. Three fertilizer N rates were used in each cropping and tillage system. The three N levels were no fertilization, 0-0-0, 0.5X rate (30-20-0 lb/acre^{-1}) and the 1.0X recommended soil test rate (60-20-0 lb/acre) for the sorg:cotton system. For the soybean:cotton cropping system, N rates were one half of those for the sorghum:cotton. All fertilizer was preplant banded in a 4 x 4 inch placement. The experiment was conducted in a randomized block design and replicated four times. Crop rotation systems were compared as main plots. Reduced tillage (total 5 tillage operations) was compared with CVT tillage (10 tillage operations) in a split-plot design. Fertilizer rates were evaluated in a split-split plot design.

Results and Discussion

Yields for the first year were drastically reduced due to drought and are not presented. In the second year, with rainfall well distributed during the growing season above average lint yields for the region were measured. Significant differences in lint yield among rotation systems were measured only in the CT systems and at the medium N rate (Fig. 1). Cotton following sorghum responded to the 30 and 60 lb N/acre when grown with CVT tillage with yields of 961 and 999 lb lint/acre respectively. In the soybean:cotton rotation, yield response peaked at the medium N rate (15 lb N/acre) and decreased with additional N when cotton was grown in the CVT system.

In this system, lint yields peaked at 1040 lb/acre which was 80 lb/acre additional yield over the sorghum:cotton system. A substantial yield increase (205 lb lint/acre) from 15 lb N/acre was measured in the legume rotation with CVT tillage but much lesser response was observed in the MT system. In general, cotton grown with MT following soybean showed only a slight response to N. In contrast, a near curvilinear relationship between lint yields and N fertilizer rate was apparent in the sorghum:cotton rotation in both tillage systems. Yield data averaged over N rates and crop rotations, show that cotton grown under MT was as productive (933 lb/acre) as that produced in the CVT system (940 lb/acre) during this second year of the study.

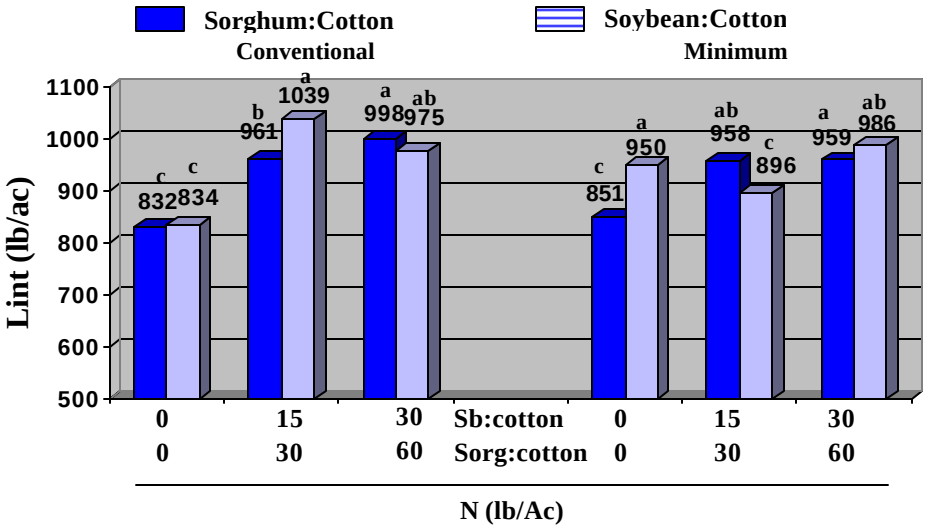

Fig. 1. Effect of soybean grown in alternate years with cotton and tillage on lint yields at three N fertilizer rates.

The scheduled sequence of crop rotations for the third year did not provide an evaluation of rotation effects on cotton. However, data for the fourth year of the experiment are summarized in Figures 2. The contribution of soybean grown in alternate years with cotton in a zero N fertilizer system was strongly reflected in 116% and 92% yield increases for CVT and MT systems, respectively, over the sorghum:cotton rotation (Fig. 2). These percentages represent substantial lint yield increases of 325 and 280 lbs/acre solely due to the legume used in the rotation. When N rate was applied at 30 lb N/acre to sorghum:cotton and 15 lb N/acre to soybean:cotton, 14% and 33% increases in lint yields were measured which equaled 80 and 185 lb/acre additional lint, respectively, for the CVT and MT systems. Increasing N rates 15 and 30 lb N/acre in the CVT system increased yields in the Sb:cotton rotation. However, yields were not increased at the higher rate of N in the MT system.

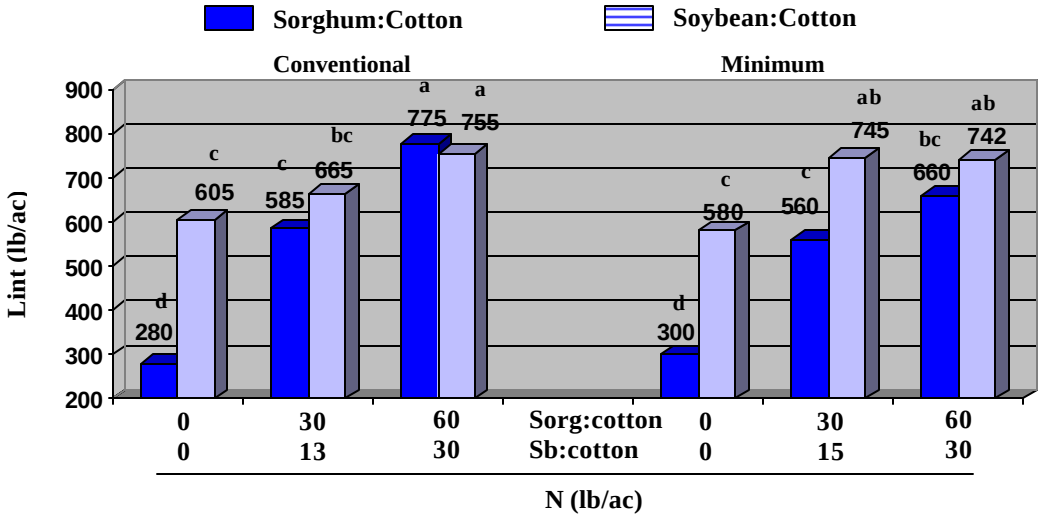

Fig. 2. Effect of soybean in crop rotation and tillage on lint yields at three N fertilizer rates. Bars topped by the same letter across all treatments are not significantly different at the P=0.05 level (Duncan's MR test).

The soybean crop grown in alternate years is harvested as a cash crop. Although the approximate 20 bu/acre yields from the beans does not appear to add much to the cash flow, the contribution from biologically fixed N and other benefits from the legume reflected in the 280 lb/acre additional lint are quite substantial. Results of this study show that 1.5-2.0 bale per acre cotton can be produced with a meager 15 lb N/acre when soybeans are grown in alternate years.

Summary

- A 1-year soybean:1-year cotton rotation system became highly productive in the fourth season requiring minimal fertilizer N input.
- Lint yields increased up to 92% from soybean as compared to sorghum rotations.
- Net contribution from the legume in the rotation increased substantially with time.
- Benefits from legume rotation were greatest in the MT tillage system.
- With the current substantial increases in fertilizer N costs the research results from this study can provide some useful guidelines in producer maximization of fertilizer N utilization. The legume:cotton cropping system is proving to perform best in a MT system. At 15 lb/acre of N fertilizer (less than ¼ of soil test recommended rate and about 1/5 of current rates used by many producers) the soybean:cotton system produced 185 lb/acre additional lint over the traditional sorghum:cotton rotation in the MT system as compared to 80 lb/acre with CVT system. In addition to increased yields, savings in fuel and labor costs with reduced tillage can add to increased profits in cotton production.

Literature Cited

Matocha, J.E. 2007. Invited Paper. Adoption of Reduced Tillage Practices in the Coastal Bend Area of South Texas. Proceedings of National Conservation Tillage Cotton and Rice Conference. Houston, TX.

Matocha, J.E. 2006. Trace. Impact of Crop Rotations and Tillage Frequencies at Varying Nitrogen Fertility on Corn Yields. Proceedings of Southern Conservation Systems Conference. Amarillo, TX.

Wright, A.L., Frank M. Hons and John E. Matocha. 2005. Tillage Impacts on Microbial Biomass and Carbon and Nitrogen Dynamics of Corn and Cotton Rotations. Applied Soil Ecology 29 (2005) 85-92.