Corn Yields Benefit in Rotations with Cotton

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Abstract
Continuous cotton (Gossypium hirsutum L.) was the primary crop for the Mississippi Delta until recently. Corn (Zea mays L.) is now grown on about 1 million acres in Arkansas, Mississippi, and Louisiana, usually in rotation with cotton. This research evaluated corn’s performance in a four-year furrow irrigated rotation with cotton at Stoneville, MS. The experimental design was a randomized complete block with a split-plot arrangement of treatments replicated eight times. Whole plots were cropping sequences assigned at random. Cropping sequences were continuous cotton, continuous corn, corn-cotton-corn-cotton, or cotton-corn-corn-cotton. Four adapted corn hybrids and cotton cultivars were grown as sub-plots beginning in 2000 to 2003. Corn grain yields were greater following cotton than continuous corn in 2001 (169 bu/acre vs. 160 bu/acre) and 2002 (126 bu/acre vs. 117 bu/acre). Grain yields from continuous corn differed among years but with no consistency. Hybrids differed in yield among all years but no consistency in these data was noted. Test weights for continuous corn differed among years but were not below the requirement for US No. 2 yellow corn. Weights of 100 kernels did not differ among years or treatments. Economics dictate cropping sequences but corn can benefit from following cotton in rotation.

History of Crop Rotations
Crop rotations have long been advocated for their benefits to all species grown in the sequence (5). In the north-central USA corn-soybean (Glycine max L. Merr.) rotations are common, with small grains species occasionally being included in the sequence (9). In this same region, farms with both crop and livestock enterprises often include forage legumes in rotations to provide hay, pasture, and nitrogen for subsequent grain crops.

Cotton has been the dominant crop in the Mid-South, especially the Mississippi Delta, since the region was settled. For most of the Delta’s history, rotation of cotton with other crops did not occur due to labor and infrastructure factors associated with the crop’s production. The introduction of soybeans in the 1930s and rice (Oryza sativa L.) in the late 1940s to the Mid-South, however, took some of the heavier clay soils of the Delta out of cotton production and converted them to growing these two crops, usually in some form of rotation sequence (2). Continuous cotton remained the primary crop on the loams and sandy loams of the Delta (14). Monoculture cotton, like many other crops, can experience several production problems. Research over several decades has demonstrated that crop rotations can reduce diseases, nematodes, and weeds and improve cotton yields (1,4,13).

Cotton remains the primary cultivated cash crop in the Mid-South, but corn production has increased extensively in the area during the past 10 years. In the lower Mississippi River Valley states of Arkansas, Louisiana, and Mississippi, corn production has increased from nearly 600,000 acres in 1995 to about 1 million acres in 2005 (10). A large portion of this corn production occurs in rotation with cotton and is sold as cash grain. Past research on corn-cotton rotations has dealt primarily with the effects the rotation has upon the cotton crop. The objective of this experiment was to determine the effects different corn-cotton rotation sequences have on corn grain production in the Mississippi Delta.
**Rotation Sequences and Methods**

This research was part of a corn-cotton rotation experiment conducted at Stoneville, MS from 2000 to 2003. The research was conducted on a Beulah fine sandy loam (coarse-loamy, mixed, thermic Typic Dystrochrept) that had been planted to cotton for at least 50 years prior to the experiment. The experimental design employed was a randomized complete block, with a split plot arrangement of treatments, replicated eight times. Whole plots were four crop rotation sequences: (i) continuous cotton, (ii) continuous corn, (iii) corn-cotton-corn-cotton, or (iv) cotton-corn-corn-cotton. These were randomly assigned at the initiation of the experiment and remained in place for its duration. Each phase of these four sequences did not occur every year but across years according to the rotation sequence. Sub-plots were four corn hybrids [cvs. Pioneer 3223, Funks 4653, Syngentia N79-L3Bt, or Garst/AgriPro 9701 (in 2000) and 9909 (in 2001 to 2003)] and four commercial cotton cultivars. Garst/AgriPro 9701 was no longer available after 2000. Sub-plots were six rows spaced 40 inches apart, 25 ft long and assigned at random within each whole plot each year of the study. Data were analyzed in accordance to procedures outlined by Gomez and Gomez (7) using PROC MIXED of the SAS 9.1 of the Statistical Analysis System (SAS Institute Inc., Cary, NC).

The experimental site was prepared for planting each year by sub-soiling, diskimg, and forming ridges 20 inches high spaced 40 inches apart. Each year the entire experiment received a pre-plant application of liquid NH$_4$NO$_3$:urea at a rate of 100 lb of N per acre and murate potash at a rate of 60 lb K$_2$O/acre. Corn plots received an additional 100 lb of N per acre at growth stage V6 as defined by Ritchie et al. (12) and as recommended by Larson and Oldham (8) for a yield goal of 160 bu/acre. Cotton plots received no additional fertilizer post-emergence. Weed control for both corn and cotton was achieved by a pre-plant incorporation of pendimethalin over the experiment at 1 lb a.i./acre followed by a pre-emergence application of metolachlor at 1 lb a.i./acre. The experiment also was cultivated at growth stage V6 of the corn just prior to the second application of N fertilizer. No insecticides were applied to the corn plots in this experiment.

Planting of all plots occurred 19 April 2000, 10 April 2001, 15 April 2002, and 14 April 2003. Corn was seeded at a rate of 115% of a final population goal of 24 500 plants/acre. One furrow irrigation at a rate of approximately 1.0 inch/acre was applied to the experiment at growth stage R2 to minimize moisture stress on both crop species but not interfere with reproductive growth of the cotton. A 17-ft section in the center of each of the four middle rows of each experimental unit of corn was marked with flagging tape prior to harvests. These areas were then picked by hand and shelled using an Almaco (Nevada, IA) gasoline powered corn sheller. The grain was weighed and approximately a 2.5-lb sample acquired for moisture and test weight determinations. Yields were adjusted to 15.5% moisture.

**Corn Yields and Test Weights**

Corn grain yields on plots following cotton were greater ($P \leq 0.01$ in 2001 and $P \leq 0.10$ in 2002) in this experiment than corn following corn (Table 1). These findings are comparable to previous research with other crops preceding corn (11). Plots were virtually weed free during the duration of this experiment and insects or diseases on the corn were never determined to be at economic thresholds. Carryover N in both corn and cotton plots are unlikely as both crops received the recommended levels on N and it is widely accepted that virtually no N fertilizer carryover occurs from season to season in the Mid-South due to frequent rainfall during the winter and the soil rarely freezing. In the continuous corn sequence, grain yields in 2002 and 2003 were less ($P \leq 0.01$) than 2000 and 2001 but the yield in 2003 was greater than 2002. The low yields that occurred in 2002 compared to 2003 may be attributed in part to less natural rainfall and higher ambient temperatures, as recorded within ¼ mile of the experimental site, during kernel development in 2002 (5.8 inches and 12 days $\geq 95{^\circ}F$) than in 2003 (7.5 inches and 5 days $\geq 95{^\circ}F$) (3,6).
Table 1. Corn grain yields among three different crop sequences in an irrigated corn-cotton rotation experiment at Stoneville, MS\textsuperscript{v}.

<table>
<thead>
<tr>
<th>Rotation</th>
<th>Yield \textsuperscript{bu/acre}</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2000</td>
</tr>
<tr>
<td>Continuous corn\textsuperscript{y}</td>
<td>155 a</td>
</tr>
<tr>
<td>Corn-cotton-corn-cotton\textsuperscript{z}</td>
<td>154</td>
</tr>
<tr>
<td>Cotton-corn-corn-cotton\textsuperscript{z}</td>
<td>—</td>
</tr>
</tbody>
</table>

\textsuperscript{v} Means of 4 Hybrids (Garst/AgriPro 9701 (in 2000), 9909 (in 2001-2003), Pioneer 3223, UAP Funk’s 4653, and Syngentia NK N72-L3Bt) and 8 replications.

\textsuperscript{w} Means within the column are significantly different at \( P \leq 0.01 \).

\textsuperscript{x} LSD at \( P \leq 0.10 = 8 \).

\textsuperscript{y} Means within the row followed by the same letter are not significantly different by LSMeans at \( P \leq 0.01 \).

\textsuperscript{z} Means within a row are significantly different at \( P \leq 0.01 \).

The hybrid \times year interaction for the grain yields of the continuous corn sequence was statistically \( P \leq 0.10 \) significant (Table 2). No one hybrid though was consistently higher yielding than any other during the duration of this experiment. Again grain yields in 2002 did tend to be lower than the other three years for the likely reasons previously described.

Data on 100 kernel weights for the experiment were determined from 2000 to 2002 but yielded no statistically significant differences among treatments, hybrids, or years. Throughout all the data collected, mean 100 kernel weights only ranged from 1.09 oz to 1.11 oz among cropping sequences and years.

Table 2. Corn grain yields of four corn hybrids grown as continuous corn treatments in an irrigated corn-cotton rotation experiment at Stoneville, MS\textsuperscript{x}.

<table>
<thead>
<tr>
<th>Hybrid</th>
<th>Yield \textsuperscript{bu/acre}</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2000</td>
</tr>
<tr>
<td>Garst/AgriPro\textsuperscript{y}</td>
<td>149</td>
</tr>
<tr>
<td>4653</td>
<td>156</td>
</tr>
<tr>
<td>N79-L3Bt</td>
<td>152</td>
</tr>
<tr>
<td>3223</td>
<td>161</td>
</tr>
</tbody>
</table>

LSD at \( P \leq 0.10 \) for a row or a column = 15.

\textsuperscript{x} Means of 8 replications.

\textsuperscript{y} Hybrid 9701 was used in 2000 and 9909 in 2001-2003.

Grain test weights were found to differ among years within a cropping sequence but were not affected by cropping sequences within a year (Table 3). In the continuous corn treatment, grain test weights were greater \( P \leq 0.01 \) in 2000 than the subsequent years. In the corn-cotton-corn-cotton sequence grain test weight was greater in 2000 than 2002 and in the cotton-corn-corn-cotton sequence grain produced in 2002 had a greater test weight than that grown in 2001. However, none of the observed grain test weights were below the minimum of 54.0 lb/bu required to grade US No. 2 Yellow Corn, the most common grade traded on the market and needed for milling (15).
Table 3. Corn grain test weights among three different crop sequences in an irrigated corn-cotton rotation experiment at Stoneville, MS\textsuperscript{x}.

<table>
<thead>
<tr>
<th>Rotation</th>
<th>Test weight (lb/bu)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2000</td>
</tr>
<tr>
<td>Continuous corn\textsuperscript{y}</td>
<td>59.7 a</td>
</tr>
<tr>
<td>Corn-cotton-corn-cotton</td>
<td>59.7</td>
</tr>
<tr>
<td>Cotton-corn-cotton-corn</td>
<td>—</td>
</tr>
</tbody>
</table>

\textsuperscript{x} Means of 4 Hybrids (Garst/AgriPro 9701 in 2000 and 9909 in 2001-2003, Pioneer 3223, Funk's 4653, and Syngentia NK N72-L3Bt) and 8 replications. Means within a column are not significantly different.

\textsuperscript{y} Means within the row that are followed by the same letter are not significantly different by Ismeans at \( P \leq 0.01 \).

**Conclusions**

In this experiment, corn following cotton appears to produce greater grain yields than when following a previous corn crop in the Mississippi Delta. Further research to determine if such a trend would continue and the cause of these differences would be useful. Kernel weights and grain test weights though seemed unaffected by the cropping sequences. Benefits to crop rotations, in general, are well established ecologically. However, the net economic return per unit of land area for any crop species must be considered when selecting a cropping sequence. Short-term financial demands and projected commodity prices are always a consideration in constructing cropping plans as well as previous cropping successes or failures.

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**Literature Cited**
