AN EVALUATION OF THREE EARLY MATURING COTTON CULTIVARS FOR PRODUCTION POTENTIAL AND INSECT DAMAGE IN REDUCED- AND CONVENTIONAL-TILLAGE SYSTEMS

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Abstract: The cotton cultivars Coker 304, McNair 220, and Pee Dee 6520 were grown for 3 yr in a conventional- or a reduced-tillage system. Insect damage was not significantly different between the tillage systems. Yields were erratic in the tillage systems, being lower in reduced-till plots the first 2 yr and equal the last year. Some differences were noted in yields between the cotton cultivars in different years. Grass and weeds became more prevalent in the reduced-tillage plots by the third year of the study. Overall cost estimates indicated conventional tillage did not offer any advantage over the reduced-tillage system.

Key Words: Cultivars, insect damage, reduced tillage, conventional tillage, short-season production.

The concept of using early-maturing cotton cultivars to escape or reduce insect damage has been expounded since 1901 when Frederick Mally proposed the use of rapid-fruiting cottons and early stalk destruction to avoid boll weevil damage. Progress in developing suitable early-maturing cotton cultivars has been slow, largely due to the practice of using long-season high-yielding cultivars combined with multiple applications of insecticides. Insecticide resistance and cost have reduced the attractiveness of this type of cotton production, while several studies in Texas (Heilman et al. 1977; Namken and Heilman 1973) and in Missouri (Shepard 1982) have shown short-season cotton production can be a viable alternative.

Reduced-tillage crop production offers potential for conserving topsoil and reducing machinery costs. Several studies have shown cotton can be produced with reduced-tillage systems, but the techniques and herbicide management systems need considerable refinement before reduced-tillage systems become practical over wide areas of the cotton belt (Scott and Ford 1974; Cannon 1970, Porterfield and Davidson 1974; Roach 1981). The present experiments were designed to evaluate three cotton cultivars which mature earlier than most standard varieties and which are adapted to the Southeastern United States for yield and insect damage levels in reduced- and conventional-tillage systems.

MATERIALS AND METHODS

For a 3-yr period (1980 - 1982) three cotton varieties (Coker 304, McNair 220, Pee Dee 6520), which may mature up to 2 wk earlier than other standard varieties

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adapted to the Southeast, were planted on the Pee Dee Experiment Station, Florence, SC (a field station of the South Carolina Agricultural Experiment Station). Five 0.081-ha main plots of each variety were randomized in three blocks and split into 0.04-ha section for tillage treatments. The field soil was a Duplin fine sandy loam and a Varina loamy fine sand with 0 to 2% slope. The 1st year the entire field was prepared in the same manner — disked, 0.34 kg trifluralin per ha applied and disked in, then subsoiled to 35 cm, bedded in 0.96-m wide rows and fertilized with 272 kg of 5-10-10 per ha in one operation. The cotton was planted 15 - 16 April (the first period when the soil temperature was above 15°C for 3 d) with a two-row minimum tillage Cole® planter with double-disk openers, and oversprayed with 2.8 kg fluometuron per ha. All plots were sidedressed with 56 kg of CaNO₃ (a highly soluble form of nitrogen and calcium with a short residue time) per ha on 4 June, with only the conventional-tillage plots being plowed.

The insecticides azinphosmethyl (0.28 kg Al/ha), fenvalerate (0.12 kg Al/ha), and monocrotophos (0.56 kg Al/ha) were applied as single or combination sprays by a high-clearance sprayer as needed based on weekly field scouting. Sampling for insect damage was done one or two times per week by counting fruiting structures on three, 2-m-row sections per plot, and determining the number damaged by boll weevils, Anthonomus grandis Boheman or bollworms [Heliothis zea (Boddie) and H. virescens (Fabricius)]. Spray schedules were begun whenever boll weevil and/or bollworm damaged squares exceeded 5% of the total squares counted. Observations on plant populations, squaring rate, and rate of boll formation and opening were also made. All plots were defoliated with 0.23 kg of tributyl phosphorothioate per ha and machine harvested.

The same land preparation, planting, sampling, insecticide spraying, and harvesting techniques were used the 2nd and 3rd years of the study, except the reduced-tillage plots were not disked or treated with fluometuron. Instead, paraquat (0.06 kg Al/ha) was broadcast-sprayed over the reduced-tillage plots approx. 14 d prior to planting, and sidedress nitrogen was applied with cultivation in all plots.

During all 3 yr of the study, the conventional plots were sweep-cultivated as needed, usually two to three times during the season. Spot treatments of the plots with glyphosate at recommended rates was performed in some plots for control of Bermuda grass. Beneficial insects were sampled by D-Vac® machines each year by vacuuming whole plants in 7.6 m of one row per plot per week until insecticide sprays substantially reduced insect populations. Levels of insect damage, yields, plant populations, and rate of boll formation for the plots and varieties were analyzed by appropriate ANOV techniques and compared by Duncan’s multiple range test at the 0.05 level.

**RESULTS AND DISCUSSION**

Since tillage practices during the 1st year of the study were identical except for cultivation at sidedress, insect damage was not separated by tillage treatments. Boll weevil damage reached 5% in early June and insecticide applications began on 12 June. For the season, 11 spray applications of azinphosmethyl were applied, and during the period of 18 July to 8 August were combined with either fenvalerate (five times) or monocrotophos (5 times) for boll weevil, bollworm, and spider mite control. There were no significant differences between boll weevil and
bollworm damage levels in the cotton plots (Table 1). There were significant differences in yields of seed cotton between varieties and between tillage systems. Coker 304 and McNair 220 yields were not different, nor were Coker 304 and Pee Dee 6520. McNair 220 yields were significantly greater than Pee Dee 6520. Overall yields between the tillage systems were significantly different, with the conventional-tillage plots producing approx. 118 kg/ha more seed cotton than the reduced-tillage plots. This was probably due to the method of sidedress nitrogen application since the CaNO₃ remained on the soil surface in the reduced-tillage plots and was not available to the plants except through rainfall infiltration.

Table 1. Mean overall seasonal boll weevil and Heliothis spp. damage levels in, and seed cotton yields of, three cotton varieties grown under conventional- or reduced-tillage practices at Florence, SC in 1980.

<table>
<thead>
<tr>
<th>Cotton cultivar</th>
<th>Mean % square damage*</th>
<th>Seed cotton yields kg/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Heliothis spp. Boll weevil</td>
<td>Reduced tillage</td>
</tr>
<tr>
<td>Coker 304</td>
<td>1.3</td>
<td>3.3</td>
</tr>
<tr>
<td>McNair 220</td>
<td>1.5</td>
<td>2.6</td>
</tr>
<tr>
<td>PD 6520</td>
<td>1.6</td>
<td>3.7</td>
</tr>
<tr>
<td>X</td>
<td>1.5</td>
<td>3.2</td>
</tr>
</tbody>
</table>

*Mean percentages of square damage by each insect for the period 27 June to 4 August. Means separated by Duncan's multiple range test at 0.05 level; no letters indicate nonsignificance. Damage by tillage plots not separated during 1980.

Total predator numbers of the most common predator groups reported by Roach (1980) (Geocorids, nabids, spiders, minute pirate bugs, coccinellids, lacewings, carabids, and ants) totaled 13,076/ha on 11 June in all plots prior to the first application of azinphosmethyl for boll weevil control. After one spray application on 12 June, the population was ca. 10,932/ha, but was practically eliminated by the third and fourth spray. This pattern of predator elimination was the same as that shown previously by Roach and Hopkins (1981) in North Carolina and South Carolina cotton fields.

Maturity of the cotton varieties was not significantly different during 1980 based on squaring rate, rate of boll formation, or rate of boll opening. The range of open bolls among the three varieties was 19 - 27% on 11 August, 37 - 45% on 19 August, and 71 - 76% on 27 August. The cotton plots were defoliated on 28 August and harvested 11 September, with all plots picking clean (above 95%) with one operation. Dry weather during July, August, and September probably held down yields and hastened plant maturity in all the cultivars. Rainfall for the 3-month period equalled 21.1 cm with 6.6 cm of the total falling the last 2 d of September. For comparison, the long term avg amount of precipitation for this 3-month period was 43.9 cm.

During the 2nd year of the study, the cotton was planted 23 April, a week later than in 1980. Boll weevils again infested the cotton by mid-June and a 3- to 5-d spray schedule with azinphosmethyl was initiated 26 June. Thereafter, 15 azinphosmethyl sprays were applied on a 3- to 5-d schedule, and, during the period 17 July - 2 September, fenvalerate (10 treatments) was added to the
azinphosmethyl for bollworm control. Table 2 shows the mean percent square damage by boll weevils and bollworms for the July - August period in the cotton varieties and tillage systems. No significant differences were found in the amount of damage among varieties or between tillage systems.

Predaceous insect numbers showed a similar pattern of decline, as was observed the previous year. On 14 July, the predaceous insect population after four azinphosmethyl sprays was 8,018/ha, while in an adjacent untreated plot (0.4 ha of McNair 220) the population was 19,029/ha. On 21 and 28 July, the number of predators was 4,757 and 2,310/ha, respectively, while the number in the adjacent untreated plot remained around 10,000/ha. This was after two fenvalerate + azinphosmethyl sprays and the four previous azinphosmethyl sprays.

As in 1980, the cotton varieties showed no difference in time of maturity, and all plots averaged 66% open bolls on 16 September. The cotton was harvested 7 October and again picked above 96% clean with one picking. The seed cotton yields are shown in Table 2. There were significant differences among cultivars with McNair 220 having the highest yields, followed by Pee Dee 6520 and Coker 304. Also, the conventional-tillage plots produced significantly more cotton than the reduced-tillage plots.

In the 3rd year of this study, the cotton was planted 23 April. Boll weevils again required insecticide treatment during the pinhead square stage and bollworms also infested the cotton by mid-June. Azinphosmethyl was applied 9 June and from 18 June to 23 August, 14 sprays of azinphosmethyl + fenvalerate were applied to the plots on a 3- to 5-d schedule. Table 3 shows the mean percent insect damage to squares during the period 1 July to 27 August. There were no significant differences between damage in the tillage systems, but Coker 304 had a higher boll weevil damage level than the other two varieties. Boll weevils were difficult to control during 1981 and 1982, and even with the high number of sprays, the infestation level exceeded 10% damaged squares for the entire season. The regular spray schedule again virtually eliminated the predaceous insect complex. Vacuum sampling indicated a pre-spray population of 9,176/ha (14 June), and levels of 5,032 and 1,972/ha on 23 June and 1 July, respectively. Thereafter, very few predators were found in the plots and sampling was discontinued in mid-July.

Yields of seed cotton from the plots are shown in Table 3. The cotton was harvested late (6 October) due to equipment failure, but open boll counts indicated ca. 50% open on 31 August and 75 - 80% on 14 September. The October harvest date did give better than 95% seed cotton harvest. Statistically, all three varieties yielded the same under both tillage systems, which was different from the first 2 yr of the study. However, yields were almost 100% higher; more favorable weather conditions may have been responsible for the increased yields.

Plant development in the tillage systems was similar except for 1981, which was abnormally dry. In 1981, the plants in reduced-tillage plots appeared to mature earlier and were smaller in areas where grass and weed problems persisted.

For the 3 yr of this study, neither pest nor beneficial insect populations could be related to changes in tillage systems. The necessity of early season boll weevil control obviously reduced populations of beneficial insects as well as the boll weevils. In the 3rd year of the study, bollworm infestation by the F1 generation in June also necessitated earlier spraying. Normally, the F2 generation of moths,
Table 2. Mean % seasonal square damage by *Heliothis* spp. and boll weevils, and seed cotton yields in three cotton cultivars grown under reduced- and conventional-tillage systems at Florence, SC 1981.

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<th>Cotton Cultivar</th>
<th><em>Heliothis</em> spp. Mean % square damage</th>
<th>Boll weevil Mean % square damage</th>
<th>Yields in seed cotton (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coker 304</td>
<td>14.0</td>
<td>10.5</td>
<td>1198</td>
</tr>
<tr>
<td>McNair 220</td>
<td>13.5</td>
<td>11.4</td>
<td>1648</td>
</tr>
<tr>
<td>PD 6520</td>
<td>12.0</td>
<td>11.7</td>
<td>1530</td>
</tr>
<tr>
<td>X</td>
<td>13.2</td>
<td>10.6</td>
<td>1458 a</td>
</tr>
</tbody>
</table>

*Mean damage estimates for the period 2 July to 24 August 1981.

† Means followed by the same letters are not significantly different at the 0.05 level, Duncan's multiple range test. No letters indicate nonsignificance.

Table 3. Mean % seasonal square damage by *Heliothis* spp. and boll weevils, and seed cotton yields in three cotton cultivars grown under reduced- and conventional-tillage systems at Florence, SC 1982.

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</tr>
</thead>
<tbody>
<tr>
<td>Coker 304</td>
<td>3.2</td>
<td>16.4 a</td>
<td>2504</td>
</tr>
<tr>
<td>McNair 220</td>
<td>2.5</td>
<td>11.1 b</td>
<td>2688</td>
</tr>
<tr>
<td>PD 6520</td>
<td>2.4</td>
<td>10.3 b</td>
<td>2158</td>
</tr>
<tr>
<td>X</td>
<td>2.7</td>
<td>12.6</td>
<td>2450</td>
</tr>
</tbody>
</table>

*Mean damage estimates for the period 1 July to 27 August 1982.

† Means followed by the same letters are not significantly different at the 0.05 level, Duncan's multiple range test. No letters indicate nonsignificance.
which emerges in mid- to late-July causes the most damage in cotton in this area.

It is difficult to put exact figures on dollar savings by reducing specific mechanical field operations but some estimates are available (Anon. 1980, Anon. 1983). The cost of heavy disking was estimated between $4.03 and $5.55 per acre ($9.95 - $13.71 per ha); light disking and herbicide application between $2.88 and $4.04 ($7.11 - $9.98 per ha); cultivating row crops between $2.54 and $3.49 per acre ($6.27 - $8.62 per ha); and picking cotton between $39.41 and $62.43 per acre ($97.34 - 154.20 per ha). These figures were based on diesel fuel cost of $1.25 per U.S. gallon. Thus, in our tests a reduction of one heavy and one light disking, two cultivations, and a second picking resulted in minimal cost savings of $51.40 per acre ($126.96 per ha) over a conventional production program. Short-season practices alone reduced the possibility of having to pick the cotton a second time, or a $39.41 per acre ($97.34 per ha) savings. Obviously these cost estimates would be lower than were the 1983 costs or the current 1984 costs.

Cotton yields in 1980 averaged 118 lb (53.5 kg) seed cotton or approximately 45 lb (20.4 kg) lint per acre less in the reduced tillage system; 276 lb (125.2 kg) seed cotton or 105 lb (47.6 kg) lint per acre less in 1981; and 42 lb (19 kg) seed cotton or 16 lb (7.2 kg) lint more in the reduced-tillage plots in 1982. For cotton selling at $0.65 per lb, this translates to $29.25 less per acre ($11.84 per ha) in yield in 1980, $68.25 less per acre ($27.63 per ha) in 1981, and $10.40 more per acre ($4.21 per ha) in yield in the reduced-tillage plots in 1982. Compared to a minimal savings of $51.40 per acre ($126.96 per ha) in production costs by reduced tillage, conventional tillage did not show any economic advantage over the reduced-tillage system for the 3-yr period.

Agronomically, the use of reduced tillage created some grass problems in the experimental area but the three cotton cultivars still produced a good cotton crop even though it was often less than the conventional-tillage system. The experimental design did not permit extensive changes in farming practices each year, but several changes in the reduced-tillage system would probably have been beneficial. For example, directed or over the top applications of selected herbicides such as sethoxydin would have minimized most of the weed and grass problems noted in this paper. Earlier-than-normal planting and crop maturity in our plots did not reduce insect problems nor the amount of insecticide required in this area. However, the earlier maturity of the cotton did allow an early and complete once-over harvest. Thus, savings were realized in land preparation and harvest cost in this system but insecticide and herbicide costs were essentially the same as conventional cotton-production practices. The selection of cotton cultivars for use in reduced-tillage systems is also an important factor, since, in our tests, the cultivar McNair 220 appeared to perform better overall under our climatic conditions than the other two cultivars.

REFERENCES CITED


