Cotton Variety Testing: Additional Information on Variety X Environment Interactions

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MILLER et al.1 presented data on the magnitudes of variety × environment interactions observed in cotton variety tests conducted over a 3-year period at 9 locations in North Carolina. A substantial variety × location × year second-order interaction for lint yield was observed in these tests, indicating that the varieties showed differential responses when grown under different environments. The variety × year and variety × location first-order interactions, however, were small and nonsignificant for yield. Apparently neither location nor years had any consistent effect on these differential varietal responses. Furthermore, the lack of a sizeable variety × location interaction in the North Carolina area suggested that it would not be necessary to divide the state into subareas for variety-evaluation purposes.

The above data were obtained from a rather limited number of locations and years, in one specific area, and the question arises as to the general applicability of such observations. During 1935 to 1937, a group of cotton varieties were tested at a series of locations in the cotton belt, from North Carolina to Texas. Analyses of these data should provide additional information, with more general applicability, on the nature and magnitudes of variety × environment interactions in cotton. The objective of the present paper is to report the results of these analyses and to discuss their implications on variety-testing procedures.

MATERIALS AND METHODS

Complete data were available for 16 cotton varieties tested in 8 replicates at the same 11 locations for the 3-year period, 1935–1937. The 11 test locations were Statesville, N. C.; Florence, S. C.; Knoxville, Tenn.; Jackson, Tenn.; Marianna, Ark. (delta location); Marrianna, Ark. (upland location); Stoneville, Miss.; Baton Rouge, La.; College Station, Texas; Greenville, Texas; and Lubbock, Texas. Plantings at each of these locations were made on the same block of land for the 3-year period. Additional tests had also been conducted in Alabama and Georgia, but since the test location within each of these states was not the same for all 3 years, these data were omitted from the present analyses.

Field data were obtained from each location according to a uniform set of instructions. Gin data were obtained at a central location, and the same gin was used for processing the samples sent from the different test areas. Fiber-length evaluations were likewise made in a central laboratory.

Variance analyses of the combined data and estimation of the variance components were straightforward, following the procedures outlined in detail by Miller et al.2

1 Joint contribution from Departments of Field Crops and Experimental Statistics, North Carolina Agr. Exp. Sta., Raleigh, and Crops Research Division, ARS, USDA. Journal Paper 1046, North Carolina Agr. Exp. Sta. Original data collected under direction of O. A. Pope in cooperation with personnel at the state experiment stations and Federal field stations at which the tests were conducted.
2 Professor of Field Crops and Collaborator, Crops Research Division, ARS, USDA; previously Professor of Experimental Statistics, now Head, Department of Genetics, North Carolina State College; and formerly Agronomist, Division of Cotton and Other Fiber Crops and Diseases, BPPEA, ARS, USDA, now deceased.

EXPERIMENTAL RESULTS

Estimation of Variance Components

Estimates of the pertinent variance components are presented in Table 1. The relative magnitudes of these components indicate the relative importance of the corresponding sources of variation.

Considering lint yield, it is noted that the variety × year interaction was relatively large and statistically significant; this source of variation being slightly larger than the variety component. The first-order interaction of varieties × locations was considerably smaller than that for the second-order interaction, although still statistically significant. The variety × year source of variation was very small and nonsignificant. The large second-order interaction indicates that the varieties showed differential responses when grown in different environments. The presence of a variety × location interaction indicates further that there was at least some consistent location effect on these differential responses. That is, certain varieties tended to rank consistently different in yield at certain locations, in all 3 years of testing, than they did at other locations.

The fact that this source of variation was relatively small in magnitude, however, indicates that a rather large portion of the differential varietal responses could not be accounted for by consistent differences in the cotton-growing environments of the different locations. The very small and nonsignificant variety × year interaction indicated that the varieties ranked essentially the same in yield performance in each of the 3 years of testing. Apparently the reactions of the varieties to different types of environments encountered over the 11 locations in any 1 year were similar to those encountered in the other 2 years.

Three of the 11 locations were in Texas, at the very western edge of the testing region. It is generally considered that the cotton-growing environments of this Texas area are rather different from those encountered in the remainder of the region under study. Consequently the yield data were reanalyzed, with these 3 locations omitted. The resulting variance components are presented in column 3 of Table 1. Comparing these components with those from the analysis of the 11 locations, it is noted that the variety × location interaction source of variation was decreased in size, and was no longer statistically significant. This suggests that a major portion of the original variety × location interaction may have been due to the effects of the Texas locations. The second-order interaction, however, was large and highly significant indicating that the varieties were still showing substantial differential responses to the

Table 1—Variance component estimates from combined analysis of 16 varieties grown at 11 locations for 3 years.

<table>
<thead>
<tr>
<th>Variance source</th>
<th>Lint yield, lb./plot</th>
<th>Lint percent</th>
<th>Wt. of 100 bolls, lb.</th>
<th>Fiber length, 1/32 in.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variety</td>
<td>1,416</td>
<td>1.328</td>
<td>25.83</td>
<td>0.0487</td>
</tr>
<tr>
<td>Variety × year</td>
<td>0.010</td>
<td>0.013</td>
<td>0.05</td>
<td>0.0022</td>
</tr>
<tr>
<td>Variety × locs.</td>
<td>0.018**</td>
<td>0.029</td>
<td>0.37**</td>
<td>0.0014**</td>
</tr>
<tr>
<td>Variety × year × locs.</td>
<td>1.373**</td>
<td>1.075**</td>
<td>0.64**</td>
<td>0.0026**</td>
</tr>
<tr>
<td>Plot error</td>
<td>5.258</td>
<td>4.139</td>
<td>8.43</td>
<td>0.8986</td>
</tr>
</tbody>
</table>

*Interaction mean square significant at 5% level of probability. **Interaction mean square significant at 1% level of probability. 1 From analyses omitting 3 Texas locations (see text).