Physiological Response of Okra- and Normal-Leaf Cotton Isolines at Two Temperature Regimes

Evangelos D. Gonias, Derrick M. Oosterhuis, and Androniki C. Bibi

RESEARCH PROBLEM

Variations in leaf shape range from highly divided leaves (okra leaf) to normal-leaf shape (Meredith, 1984). Heitholt et al. (1992) described higher yields of okra-leaf isolines for a given amount of intercepted radiation, indicating that the okra-leaf types utilized more efficiently the intercepted radiation than the normal-leaf types. However, information on physiological parameters of the cotton isolines that can explain the differences in radiation utilization is limited.

BACKGROUND INFORMATION

The variation in cotton leaf shape results in differences in canopy architecture and light interception characteristics (Wells and Meredith, 1986). The okra-leaf cotton compared to normal-leaf types has been characterized by smaller leaf-area per leaf (Heitholt et al., 1992), reduced leaf-area index (Kerby et al., 1980), and less but sufficient vegetative growth (Wells and Meredith, 1986). In a three-year experiment, okra-leaf cotton produced more lint yield than the normal-leaf isoline, while normal-leaf type had higher seasonal light interception (Heitholt, 1994). The same author reported that the okra-leaf isoline had greater yields at plant populations above 10 plants/m and lower yields at leaf-area indices below 4.0, while the normal-leaf type had higher yields at 5 plants/m and lower yields at leaf-area indices above 5.0. In addition, higher canopy CO$_2$ uptake (Kerby et al., 1980) and higher single-leaf photosynthesis (Pettigrew et al., 1993) have been reported for okra-leaf type cotton.

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1 Graduate assistant, distinguished professor, and graduate assistant, respectively, Department of Crop, Soil, and Environmental Sciences, Fayetteville.
RESEARCH DESCRIPTION

The study was conducted at the University of Arkansas Agricultural Research and Extension Center, in Fayetteville, Ark., using two large growth chambers (Model P36, Conviron, Winnipeg, Canada). The normal- and okra-leaf isolines of the cotton cultivar FM832 (provided by Dr W.R. Meredith, USDA) were planted in twelve 2-L pots containing Sunshine mix (Sun Gro Horticulture Distribution Inc., Bellevue, Wash.) in each of the two growth chambers. The plants were grown in day/night temperature regimes of 30/20°C and watered with half-strength commercially available Peter’s nutrient solution (Spectrum Group, St. Louis, Mo.) as necessary. At the pinhead square stage of growth the temperature regime of one chamber was changed to 38/20°C. Measurements taken a week later included leaf photosynthesis (PN), chlorophyll fluorescence yield test (FL), membrane leakage (ML), SPAD, and specific leaf weight (SLW). All measurements were recorded close to midday on the uppermost, fully expanded main-stem leaf located four nodes below the terminal of the plant. The study was statistically analyzed as a two factors (temperature and isolines) factorial using JMP 6.0.2.

RESULTS AND DISCUSSION

No statistically significant interaction between temperature and isolines was observed for all the parameters measured (Table 1), indicating that both isolines reacted physiologically the same at the two temperature regimes. Increasing the day temperature from 30°C to 38°C significantly decreased leaf photosynthesis (Fig. 1) and chlorophyll fluorescence, as well as membrane leakage (P=0.057). The decrease in membrane leakage might be explained by potentially higher wax accumulation on the leaf surface due to the prolonged temperature stress. Isolines had a statistically significant effect on SPAD with the okra-leaf isoline having higher value than the normal-leaf. Specific leaf weight did not significantly differ between both temperatures and isolines.

PRACTICAL APPLICATION

The results of this study indicate that the two isolines responded similarly at the two temperature regimes. Although leaf photosynthesis and chlorophyll fluorescence were reduced under temperature stress, the isolines did not significantly differ. The more efficient utilization of intercepted radiation reported for other cotton isolines is possibly due to canopy architecture characteristics and not due to differences in physiological parameters.

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LITERATURE CITED


Table 1. P-values for the main effects and interactions of temperature and isolines for the physiological parameters measured.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>PN</th>
<th>FL</th>
<th>ML</th>
<th>SPAD</th>
<th>SLW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>0.002</td>
<td>0.035</td>
<td>0.057</td>
<td>0.320</td>
<td>0.149</td>
</tr>
<tr>
<td>Isolines</td>
<td>0.277</td>
<td>0.234</td>
<td>0.121</td>
<td>0.001</td>
<td>0.228</td>
</tr>
<tr>
<td>Temperature* isolines</td>
<td>0.963</td>
<td>0.793</td>
<td>0.551</td>
<td>0.522</td>
<td>0.523</td>
</tr>
</tbody>
</table>

PN = leaf photosynthesis; FL = chlorophyll fluorescence; MS = membrane leakage; SPAD = an estimate of chlorophyll; and SLW = specific leaf weight.

Fig. 1. Effect of temperature on leaf photosynthesis of the two cotton isolines.