Abstract
A field study was conducted in 2012 and 2013 at Chillicothe, TX, to investigate the lint yield, water use efficiency (WUE), and spectral reflectance responses of cotton under different irrigation and tillage treatments. A split-split plot design with three replications was used with irrigation as the main plot (dryland, 45% evapotranspiration replacement, 90% evapotranspiration replacement, and irrigation based on a remote sensing method), tillage (conventional and no-till) as the sub-plot, and varieties (PHY499, DP1044, PHY375, and FM9170) as the sub-sub-plot. Lint yield, WUE, and fiber quality were significantly affected by irrigation and irrigation-by-variety interaction. Increasing irrigation level resulted in a linear increase in lint yield and WUE. The irrigation-by-variety interaction showed that the 90% evapotranspiration (ET) replacement treatment involving PHY375 produced the highest lint yield and WUE. Tillage did not significantly affect lint yield, WUE, and fiber quality. Increasing irrigation resulted in a linear increase in fiber length and strength, and a linear decrease in fiber micronaire.

Objectives
The objectives of this study were to 1) compare lint yield, WUE, and fiber quality of four cotton varieties under different irrigation and tillage management practices and 2) investigate the spectral reflectance response of cotton under different irrigation levels in the semi-arid Texas Rolling Plains.

Materials & Methods

Site Description and Experimental Design
- The study was conducted in 2012 and 2013 at the Texas A&M AgriLife Research Station at Chillicothe, TX (34°15’N and 99°30’W; 431 m above mean sea level).
- The experimental design was a split-split design with three replications. Each main plot was 23 m long and 16 rows wide.
- Main plots consisted of four irrigation treatments (dryland, 45% ET, 90% ET, and irrigation based on a remote sensing method), subplots consisted of two tillage systems (No tillage and Conventional tillage), and sub-subplots consisted of 4 cotton varieties (FM9170, DP1044, PHY375, and PHY499). The daily crop water demand was calculated as follows: $ET_c = k_c \times ET_i$.

Data Collection and Statistical Analysis
- Multispectral scene reflectance was recorded using a portable 16 channel spectroradiometer (CropScan, Rochester, MN) at 2 m above the surface.
- Reflectance measurements were taken on cloud-free days within 2 hours around local solar noon time on harvest rows throughout the growing season.
- Two vegetation indices were calculated using the reflectance data. The normalized difference vegetation index (NDVI) as NDVI = (NIR – RED)/(NIR + RED) and the normalized difference water index (NDWI) as NDWI = (NIR – SWIR)/(NIR + SWIR) where NIR is the reflectance at the wavelength of 810 nm, RED is the reflectance at the wavelength of 665 nm, and SWIR is the reflectance of shortwave infrared at the wavelength of 1160 nm.

Results & Discussion

- Replacing 90% ET produced the highest lint yield and WUE (Table 1).
- Tillage did not significantly affect lint yield or WUE (Table 1).
- Among varieties, PHY375 produced higher lint yield. (Table 1).
- Figure 2a-c illustrates fiber length, strength, and micronaire response to total water.
- Increasing total water linearly increased fiber length and strength for all varieties (Fig. 2a and b).
- For fiber micronaire, all varieties showed a linear decrease as total water increased (Fig. 2c).
- Among varieties, FM9170 had the highest fiber length increases while DP1044 had the lowest increases in response to increasing total water application (Fig. 2a).
- FM9170 showed the greatest fiber strength increase as a result of increased water level (Fig. 2b).

<table>
<thead>
<tr>
<th>Irrigation</th>
<th>Lint yield (kg ha$^{-1}$)</th>
<th>WUE (kg ha$^{-1}$ mm$^{-1}$)</th>
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</thead>
<tbody>
<tr>
<td>Dryland</td>
<td>490D§ 1.67B</td>
<td></td>
</tr>
<tr>
<td>45% ET</td>
<td>1189B 2.12</td>
<td></td>
</tr>
<tr>
<td>90% ET</td>
<td>1233A 2.20</td>
<td></td>
</tr>
<tr>
<td>Variety</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PHY499</td>
<td>1179B 2.17</td>
<td></td>
</tr>
<tr>
<td>DP1044</td>
<td>1223A 2.19</td>
<td></td>
</tr>
<tr>
<td>PHY375</td>
<td>1233A 2.20</td>
<td></td>
</tr>
<tr>
<td>FM9170</td>
<td>1229A 2.20</td>
<td></td>
</tr>
</tbody>
</table>

Summary & Conclusions
- Results from this field study showed that lint yield, WUE, and fiber quality were affected by irrigation amounts and variety characteristics in the semi-arid Texas Rolling Plains.
- The highest lint yield (1764 kg ha$^{-1}$) and WUE (2.54 kg lint ha$^{-1}$ mm$^{-1}$) was obtained for the 90% ET irrigation treatment.
- Among varieties, PHY375 performed better at higher irrigation levels while PHY499 performed better at low irrigation levels.
- No significant benefit from the minimum tillage treatment was observed in the current study.
- NDWI performed better compared to NDVI as no saturation problems were observed in NDWI values during the peak growing season.

Acknowledgment
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- We would like to thank all employees at the Chillicothe Research Station for their assistance in field work.