Increased Water Use Efficiency-Limited Irrigation to Manage Crop Stress: A Remote Sensing Study

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INTRODUCTION

The Texas Legislature placed water restrictions on the farming industry by limiting growers to a maximum use of 2 acre-foot of water per year in the Edwards Aquifer Region.

Maximization of agricultural production efficiency has become a high priority for numerous studies in the Wintergarden Area of Texas.

INTRODUCTION

Investigations have proposed Site-Specific Management (SSM) as an alternative to address this problem (Schepers and Francis, 1998).

SSM involves satellite-based remote sensing technology and mapping systems to detect specific areas suffering from stress within a field (i.e. water, insect, and disease stress).

INTRODUCTION

Infrared thermometers (IRTs) mounted on irrigation systems or operated from aircrafts can detect water stress by recording changes in leaf temperature caused by the alteration of soil-plant water flow continuum (Hatfield and Pinter, 1993; Michels et. al., 1999).

Crop canopy temperature has been found to be an effective indicator of plant water stress (Moran, 1994).

INTRODUCTION

Detection and identification of crop diseases have been evaluated by using remote sensing technology (Nilsson, 1995).

OBJECTIVES

Use remote sensing instruments for locating areas showing biotic and abiotic stress signs and/or symptoms in a cotton field.
Evaluate canopy temperature changes in cotton with the use of IRTs.
Assess yield and yield parameters relative to canopy temperatures.
Evaluate thoroughness of spray coverage and spray efficacy by comparing spray deposition patterns of a site specific pesticide applicator (Accu-Pulse) to that of ground application equipment by using water-sensitive paper and by sampling insect populations.
MATERIALS AND METHODS

- Center-pivot LESA irrigation system
- Stoneville 4892B/Round-up Ready cotton at 50,000 ppa on 40-inch spacing
- Three irrigation regimes: 100% ETc, 75% ETc, and 50% ETc

MATERIALS AND METHODS

- Mikron 7200 LWIR camera.
- Data analysis was conducted with Mikroscan 2.6.
- Exergen Irt/c.01-T 80F/27C infrared thermometers.
- Thirty IRTs mounted on the pivot at 15-foot spacing.
- Pivot mounted with a height to view angle ratio of 1:1.

Materials and Methods

- The Accu-Pulse was compared to a traditional ground-rig applicator.
- Pre- and Post-treatment insect counts were done before and after each application.

2002 Weather and Irrigation

- Graph showing rainfall and temperature data.
RESULTS

- IR camera was able to detect temperature differences in the irrigation regimes.
- Different temperatures were detected between diseased and healthy plants.

IR picture showing biotic and abiotic stress.

RESULTS

- Pivot mounted IRTs can detect temperature differences among the irrigation regimes.
- Early season cotton canopy temperatures showed significant differences among all 3 irrigation regimes.

RESULTS

- Late season cotton canopy temperature readings showed no significant differences between the 75 and 100% ETc regimes.

BI-weekly cotton canopy temperatures.
YIELD COMPARISON

<table>
<thead>
<tr>
<th>Irrigation Regime (%)ET</th>
<th>Lint Yield (lb/ac)</th>
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<tbody>
<tr>
<td>100%</td>
<td>110%</td>
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<tr>
<td>75%</td>
<td>78%</td>
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<tr>
<td>50%</td>
<td>50%</td>
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</table>

RESULTS

<table>
<thead>
<tr>
<th>Percent Spray Coverage at Canopy Level</th>
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<tbody>
<tr>
<td>Spray Method</td>
</tr>
<tr>
<td>-------------</td>
</tr>
<tr>
<td>2001</td>
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<td>2002</td>
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CONCLUSIONS

- Pivot mounted IRTs and IR cameras were able to differentiate water stress between the irrigation regimes.
- However, only the IR cameras were effectively able to distinguish between biotic and abiotic stresses with the assistance of groundtruthing.
- Cooler canopy temperatures were reflected in higher lint yields. Deficit irrigation up to 75% ETc had no impact on yield, indicating that water savings are possible without yield depletion.
- Canopy temperature can be an excellent tool to monitor plant stress.

CONCLUSIONS

- Accu-Pulse cost is a fraction of other application methods at approximately $0.50 per acre.
- The Accu-Pulse can be used when fields are wet and conventional ground application equipment could not be able to travel across the field.
- Applications can be computer controlled so that they may be applied at any time, even when personnel are not present.
- Accu-Pulse system utilizes a separate water source.
- Center pivot is used as a spray boom.

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