

## 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 (Scheppers 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).

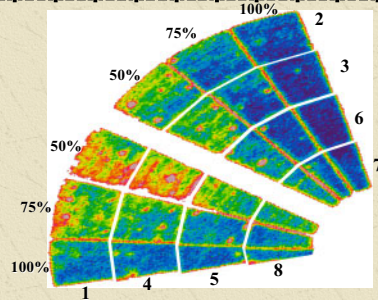
## OBJECTIVES

- ✦ 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



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- ✧ Mikron 7200 LWIR camera.
- ✧ Data analysis was conducted with Mikrosan 2.6.



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- ✧ 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.

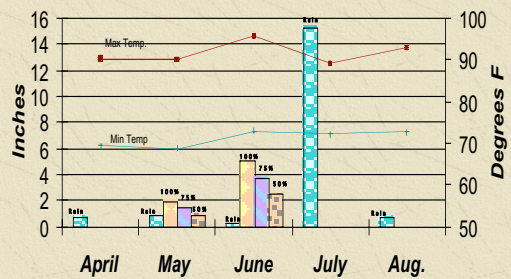


## Materials and Methods



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

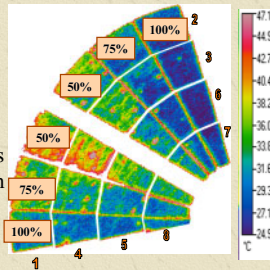
## 2002 Weather and Irrigation



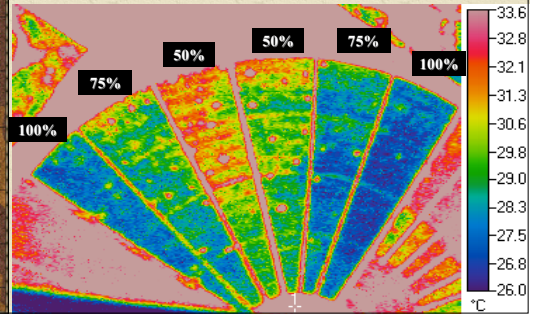
## RESULTS

✧ IR camera was able to detect temperature differences in the irrigation regimes.

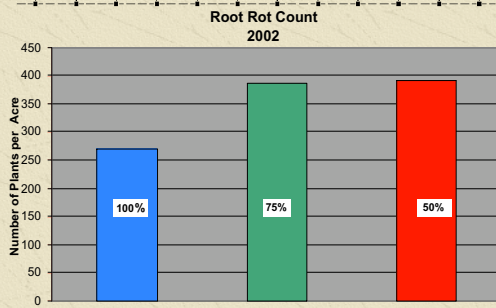
✧ Different temperatures were detected between diseased and healthy plants.



## IR picture showing biotic and abiotic stress.



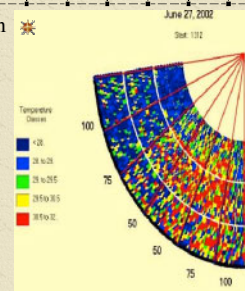
## RESULTS



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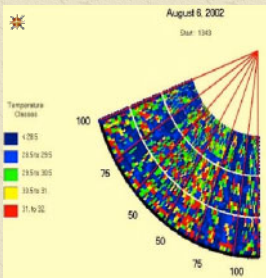
✧ Pivot mounted IRTs can detect temperature differences among the irrigation regimes.

✧ Early season cotton canopy temperatures showed significant differences among all 3 irrigation regimes.

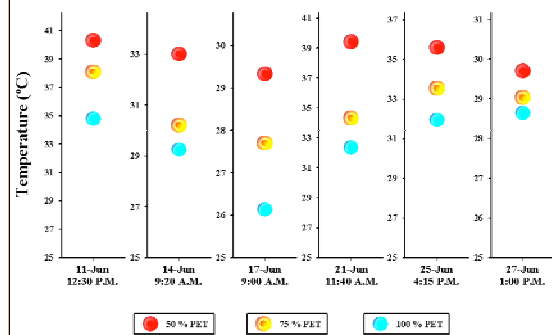


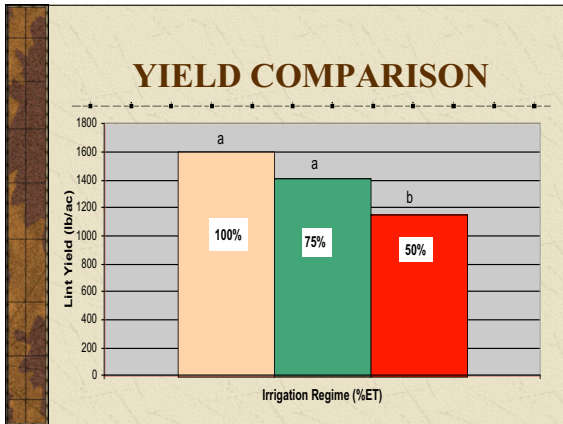
## RESULTS

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



## Bi-weekly cotton canopy temperatures.





### RESULTS

#### Percent Spray Coverage at Canopy Level

Spray Method		Top of Canopy	Mid-Canopy	Bottom
2001	AccuPulse	65%	37%	20%
	Spra Coupe	33%	6.25%	15%
2002	AccuPulse	42%	27%	9.5%
	Spra Coupe	12.8%	2.65%	0.75%

- ### 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.

- ### ACKNOWLEDGEMENTS
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