Water Conservation in Irrigated Row Crop Production

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WATER-SAVING STRATEGIES

Pivot Irrigation
- Deficit Irrigation
- Primed Acclimation
- Conservation Tillage
- PA + CT
- Irrigation Scheduling

Drip Irrigation
- Tape Spacing
- Tape Depth
- Partial Root-Zone Drying (PRD)
- Irrigation Scheduling

How do you improve drought tolerance and/or water-use efficiency in a crop??

New viewpoint: develop MANAGEMENT TOOLS that manipulate physiology under typical field conditions

What do we want to improve?: RUNNERS ANALOGY

Long term (seasonal):
1. Seasonal physiological CONDITIONING – seasonal performance curve TRANSLATES INTO YIELD

Short term (daily/weekly):
2. Daily physiological ENDURANCE – how many days after irrigation/rain do plants "hit the wall"
3. Stress RECOVERY - physiological ability to return to pre-stress levels of performance

Two promising management techniques that improve crop

CONSERVATION TILLAGE
(Strip Till = ST)
Increases soil moisture, increases root growth, changes crop water-use patterns

PRIMED ACCLIMATION (PA)
Exposing crop to moderate drought stress during early development to increase drought tolerance later on

Greatest benefit may be by combining the two techniques
2009 Center Pivot, Uvalde, TX

- 50 acre center pivot
- Quarter sections of COTTON, CORN, SUNFLOWER
- Winter 2008/2009 planted to ryegrass
- Grazed until one month before planting for EACH crop
- Cattle removed and ryegrass terminated one month before planting
- Conventional till – deep tilled, disked
- Strip till – KMC strip till unit – approx. 12” across bed
- 3 irrigation treatments: 100%, 70%, 70% early/100% rest of the season (Primed Acclimation – 70E)
- SIMILAR SYSTEM IN LUBBOCK – USDA/ARS
Total water applied and received - 2009

<table>
<thead>
<tr>
<th>Crop</th>
<th>Irrigation (inches)</th>
<th>Irrigation + Rain</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>70%</td>
<td>70E</td>
</tr>
<tr>
<td>Cotton</td>
<td>11.8</td>
<td>14.5</td>
</tr>
<tr>
<td>Corn</td>
<td>11.7</td>
<td>13.8</td>
</tr>
<tr>
<td>Sunflower</td>
<td>10.3</td>
<td>11.8</td>
</tr>
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70E (Primed Acclimation) applied 1.2 – 1.5 inches less than 100%

Cotton Lint Yield, Uvalde - 2009

Cotton Lint Yield, Lubbock - 2009

Increased CONDITIONING

Increased CONDITIONING
Corn Yield, Uvalde - 2009

So why are conservation tillage and planted acclimation working? 70% irrigation 10 cm depth

Daily Water Use = Sap Flow
Lowered use of water resources increases ENDURANCE in conservation tillage.

PA + ST mechanisms for drought tolerance: CONDITIONING, ENDURANCE, and RECOVERY.

Next question: how do we schedule irrigation for the PA treatment?
Need to sense stress level...

Recovering from a dry condition – mid-season

Improved RECOVERY

Current Irrigation Decision Support Program – Uvalde, TX

Nutrient stress directly...
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**Drip Irrigation Methodology – 2009**
- **OH**
- **SDIR**
  - Tape @ 12” depth
- **SDIF**
  - 4” bed with tape @ 4”
- **SURF**
  - Tape @ 4” depth

- = crop row
- = irrigation source

**PARTIAL ROOT-ZONE DRYING**

A technique developed for production in Australia

- Water is applied to one side of the root system at a time – switched every two weeks.
- PRD avoids drought stressing the plant but elicits hormone signals from roots; results in less canopy production, same yield for less water.
Every Row

Partial Rootzone Drying (PRD)
Sorghum Soil Moisture 2009 – Overhead vs. PRD

Sorghum Yield 2009 – Overhead vs. PRD

**Plant Canopy Temperature – crop stress**

*PRD appears to have same level of crop stress as OH even though less water is being applied*

**CY 2011 Goals:**
- Continued collection of the best “tools” for water savings and drought management
- Biofuel Options – developing oilseed crops for ON-FARM fuel production
- Cropping Systems approach utilizing legumes (decrease fertilizer needs) and grazing (increase economic returns) under conservation tillage
- Alternative irrigation methods – increase WUE