PLANTING DATE:
A Means of Limiting Exposure To Heat Stress

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UA RECOMMENDATION:
• Early Optimal Planting Dates
  • Spring Soil & Weather Conditions
  • Minimize Exposure To Heat Stress
  • Earlier Termination & Harvest
PLANTING DECISIONS

- Soil Temperature
- Weather Forecast
- Summer Heat Stress
- Variety

SOIL TEMPERATURE ISSUES

- Cool Soils
  - Slow Germination
  - Increased Susceptibility To Disease

- Cold Soils
  - Chill Injury
  - Root Damage/Seedling Death
  - Season Long Reduction In Performance
MINIMUM SOIL TEMPERATURES
Often Used In West To Guide Planting

- **65F+**: Optimal
  - 3-5 Days
- **60F**: Acceptable
  - 5-7 Days
- **55F**: Marginal
  - 7-10 Days
  - Reduced Stands
- **50F**: Danger
  - 10+ Days
  - Poor Stands
  - Root Damage

Source: Model of Wanjura

WHY MINIMUM SOIL TEMPERATURE??

- Research Uses Average
  - Optimal: 75-85F
  - Acceptable: 68-75F
  - Danger: <65F
- Minimum & Average
  - Are Closely Related
- Minimum
  - Easier To Measure

8 am Soil Temperatures
FIRST DAY IS CRITICAL!!
As Soils Cool To 50°F…

- Cold Imbibition (First 6 Hrs)
  - Abortion Of Radical Tip
  - ? Afternoon Planting ?
- Cold Germination (18-30 Hrs)
  - Damage of Root Cortex
  - Premature Lateral Root Development
- Chill Below 58°F
  - Delays Subsequent Growth

IMPACT OF COLD (50°F) SOIL

- Prior To Emergence
  - Poor Germination
  - Root Malformation
    - Loss of Tap Root
    - Cell Damage & Disease
- Post Emergence
  - Surface Rooting
    - Tap Root May Not Develop Properly
    - Poor Water Uptake
  - Water Stress

Source: Cotton Physiology Today, March 1990
GOOD WEATHER FORECAST

Minimum Air & Soil Temperatures Are Closely Related

- Soils Reach...
  - Optimal Range
    - Lows in mid-50s
  - Acceptable Range
    - Lows in Upper 40s
  - Danger Range
    - Lows in Lower 40s

We Can Use Forecasted Minimum Air Temperatures As A Guide for Planting

GOOD PLANTING FORECAST

Soils Should Approach/Exceed Acceptable Thermal Range

- Clear Weather
  - Sun Helps Heat Soil
- Lows: 48°F & Above
  - Minimum Soil Temps: Approach 60°F
- Highs: 80°F & Above
  - Warm Daytime Soils Accelerate Germination
- Heat Units
  - 10 HU/Day or 70 HU/Wk
  - 547 HU After January 1
  - April 4th
AZMET Hourly Weather Data: MARANA  Feb 22, 2009

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4" Soil Temperature

20" Soil Temperature (Should Be 60+F)

AZMET Daily Weather Data: MARANA : Feb 22 2009

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WHY NOT JUST PLANT LATER?

- Yields Usually Suffer
  - Planting Date Studies
    - Work of Silvertooth
  - Heat Stress
    - Monsoon
    - Poor Fruit Retention

Source: Silvertooth et al., 2001

OPTIMAL PLANTING DATES

Compromise Between Two Competing Factors

- Proper Soil Thermal Conditions & Weather Forecast
- Minimize Exposure To Heat Stress
PLANTING DATE vs. MONSOON ARRIVAL

Prime Production Time Varies ~5 Weeks

COTTON HEAT STRESS

Develops When Mean Crop Temperatures Rise Above Stress Thresholds

- No Stress
  - Crop Temperature Below 82.4°F (28°C)
- Level 1
  - Crop Temperature: 82.4°F - 86°F (28°C - 30°C)
- Level 2
  - Crop Temperature: Greater Than 86°F (30°C)
FACTORS IMPACTING HEAT STRESS IN ARIZONA

Evaporation from plant leaves helps cool cotton canopies. This cooling effect is reduced during the monsoon, causing canopy temperatures to rise – often to stressful levels.

LEVEL 1 STRESS

Crop/Flower Temperatures: 82.5º - 86ºF

• Reduced Fruit Retention
  – Losses: Low – Moderate
    • Young Bolls
    • 3-5 Days After Bloom

• Smaller Boll Size
  – Fewer Seeds/Boll
  – Increased Number of Motes
  – Shorter Boll Fill Period
LEVEL 2 STRESS

Crop/Flower Temperatures: > 86°F

- Heavy Fruit Loss
  - Starts Within 1-3 Days

- Damaged Squares
  - Malformed Flowers
  - 15 Days Later

- Reduced Boll Size
  - Hooked Beak Bolls

Fruit Retention of DPL 5415 Grown At Indicated Temperatures Through Primary Bloom Period

DISRUPTS NORMAL DEVELOPMENT OF REPRODUCTIVE STRUCTURES

Non-Stressed
Stamens Extend Above Stigma
Anthers Produce Pollen
Pollen Transfers to Stigma Easily

Stressed
“Stigmatic Exertion”
Caused By Short Filaments
Anthers Produce No Pollen
Ovules Often Not Receptive
HEAT DAMAGED FLOWER

“Elongated Stigma” Caused By Short Filaments

Results in Boll Abortion 3-5 Days Post Bloom

FOCUS ON PRIMARY BLOOM CYCLE

Generates Bulk of Yield in Most Years

Objective: Minimize Exposure to L2 Stress Before Peak Bloom
HEAT STRESS IS RELATED TO MONSOON INTENSITY

The median data of occurrence for the more damaging Level 2 Stress is July 13th in central Arizona.

MARANA AREA
Heat Stress vs. Planting Date

400 HUs = Mar 18
600 HUs = Apr 9
800 HUs = Apr 25
1000 HUs = May 8
PLANTING WINDOWS

- **FULL SEASON: 400-600 / 700 HU***
  - 19 March – 9 April / 17 April
- **MEDIUM MATURITY: 400-800 HU***
  - 19 March – 25 April
- **SHORT SEASON: 400-1000 HU***
  - 19 March – 8 May

* Heat Units After January 1st

HEAT STRESS & YIELDS

170 lb/a Difference Between Low & High Heat Stress Years
HEAT ISLAND HEAT STRESS

AZMET WEB PAGE
(http://ag.arizona.edu/azmet)
WEEKLY COTTON ADVISORIES

Soil Temperatures, Planting Conditions, Heat Units, Water Use, Heat Stress, Normals & Weather Forecasts

HEAT STRESS ADVISORIES

Marana, Arizona

Cotton Heat Stress for 2008

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PLANTING SEASON FORECAST
March, April & May

Bias Toward Below Normal Precipitation

MONSOON SEASON FORECAST
July, August & September

Bias Toward Above Normal Temperatures
THE END

THANK YOU!