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

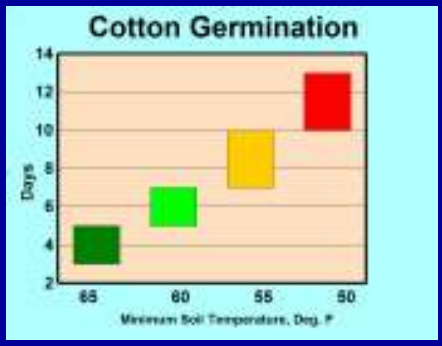
- Soil Temperature
- Weather Forecast
- Summer Heat Stress
- Variety

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

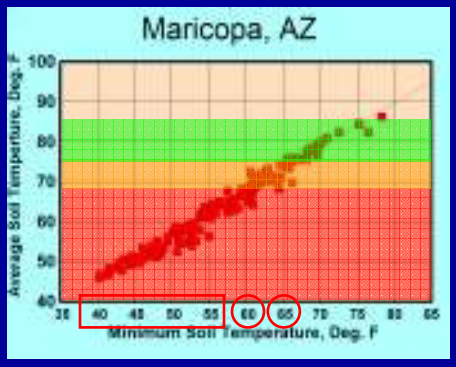
Often Used In West To Guide Planting



Source: Model of Wanjura

- 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

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 58F
  - Delays Subsequent Growth

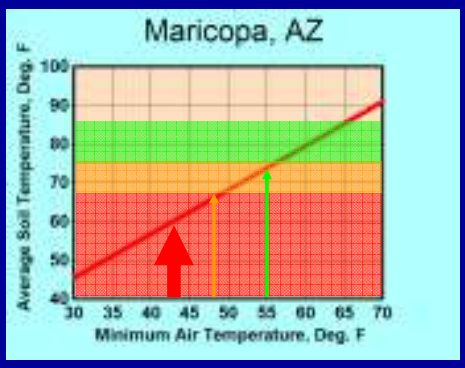
Source: Cotton Physiology Today, March 1990

IMPACT OF COLD (50F) 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

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: 48F & Above**
  - **Minimum Soil Temps: Approach 60F**
- **Highs: 80F & Above**
  - **Warm Daytime Soils Accelerate Germination**
- **Heat Units**
  - **10 HU/Day or 70 HU/Wk**
  - **528 HU After January 1**
  - **April 3rd**

AZMET

www.ag.arizona.edu/azmet

AZMET Hourly Weather Data : MARICOPA : Feb 23 2009

HR	AT	TD	RH	VPD	SR	PPT	ST4	ST20	WS	WSX	WVM	WVD
1	58.3	37.8	46.5	0.9	0.0	0.00	59.2	57.7	2.0	4.7	0.9	23
2	56.8	40.1	53.8	0.7	0.0	0.00	58.8	57.9	2.5	4.0	2.2	176
3	55.6	41.5	59.2	0.6	0.0	0.00	58.3	57.9	1.3	3.1	0.9	174
4	53.2	42.1	65.9	0.5	0.0	0.00	57.7	58.1	1.1	3.4	0.9	138
5	54.5	41.2	60.5	0.6	0.0	0.00	57.4	58.1	2.2	4.3	1.8	168
6	52.0	41.7	67.9	0.4	0.0	0.00	57.0	58.1	1.1	2.7	0.4	134
7	51.8	41.4	67.6	0.4	0.0	0.00	56.5	58.1	1.6	2.9	1.3	13
8	50.7	41.7	71.2	0.4	3.8	0.00	56.1	58.1	1.6	3.4	0.4	93
9	55.4	43.5	64.3	0.5	9.1	0.00	56.1	58.3	2.0	6.0	0.2	260
10	58.3	44.1	59.4	0.7	19.1	0.00	56.5	58.1	2.0	4.3	1.3	328
11	65.5	41.7	42.8	1.3	36.8	0.00	57.9	58.3	1.3	4.5	0.7	352
12	72.9	36.0	26.1	2.0	55.7	0.00	60.4	58.1	3.8	9.4	3.4	333
13	77.7	36.0	22.2	2.5	49.5	0.00	63.0	58.1	1.6	5.6	1.1	2
14	80.4	34.3	19.0	2.9	49.7	0.00	65.5	58.1	3.1	9.4	2.5	271
15	82.2	31.6	16.0	3.2	38.7	0.00	67.1	58.1	3.6	7.8	3.1	287
16	82.9	31.1	15.3	3.3	27.2	0.00	67.3	64.8	3.1	6.7	2.5	252
17	82.0	32.4	16.6	3.1	20.8	0.00	67.1	66.6	5.1	8.9	4.9	277
18	80.1	33.8	18.7	2.8	9.3	0.00	66.9	66.7	5.4	10.1	5.4	283
19	74.7	34.5	23.2	2.3	0.2	0.00	66.2	65.7	2.2	4.0	2.0	283
20	70.7	32.7	24.6	1.9	0.0	0.00	65.1	63.9	3.6	6.7	3.6	316
21	68.0	33.6	27.9	1.7	0.0	0.00	63.9	62.2	1.6	4.3	0.7	219
22	65.3	37.6	35.8	1.4	0.0	0.00	62.6	60.8	2.7	4.0	2.5	189
23	61.7	39.6	44.1	1.0	0.0	0.00	61.5	59.0	3.6	5.4	3.6	149
24	61.3	37.9	41.7	1.1	0.0	0.00	60.1	57.0	4.3	8.3	4.3	160

4" Soil Temperature

20" Soil Temperature (Should Be 60+F)

AZMET

www.ag.arizona.edu/azmet

AZMET Daily Weather Data : MARICOPA : Feb 23 2009

	MAX.	MIN.	MEAN	TOTAL	UNITS
TEMPERATURE	84.0	49.6	65.5		DegF
RELATIVE HUMIDITY	74.8	13.3	41.3		%
DEWPOINT			37.8		DegF
ACTUAL VAPOR PRESS.			0.8		KPas
VAPOR PRESS. DEF.			1.5		KPas
SOIL TEMP. 4 in	67.8	55.9	61.2		DegF
SOIL TEMP. 20 in	67.1	57.0	59.9		DegF
WIND SPEED	10.1		2.7		MPH
WIND VECTOR MAG.			0.9		MPH
WIND VECTOR DIR.			262		Degrees
SOLAR RADIATION				320.1	Langleys
PRECIPITATION				0.00	Inches
AZMET REF. EVAPOTRANSPIRATION				0.13	Inches
STD. REF. EVAPOTRANSPIRATION				0.13	Inches

HEAT UNITS	86/55F		86/50F		86/45F	
----------	DAY	CUM	DAY	CUM	DAY	CUM
SINE CURVE	12.6	265	16.9	409	21.8	583

Daily Summary Provides Minimum Air & Soil Temperature and Heat Units.

WHY NOT JUST PLANT LATER?

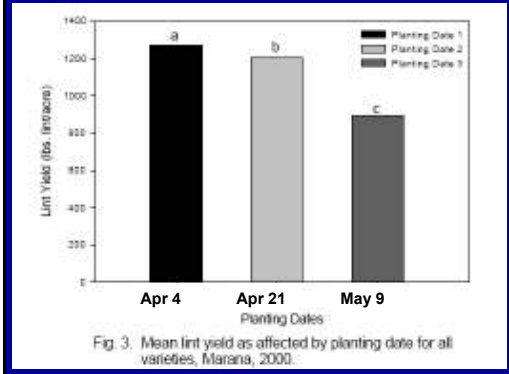


Fig. 3. Mean lint yield as affected by planting date for all varieties, Marana, 2000.

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

Source: Silvertooth et al., 2001

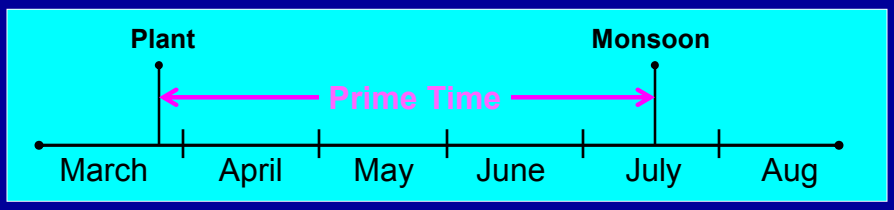
OPTIMAL PLANTING DATES

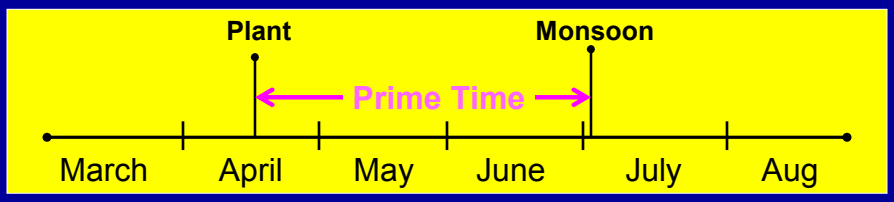
Compromise Between Two Competing Factors

- Proper Soil Thermal Conditions & Weather Forecast
- Minimize Exposure To Heat Stress

PLANTING DATE vs. MONSOON ARRIVAL

Prime Production Time Varies ~5 Weeks



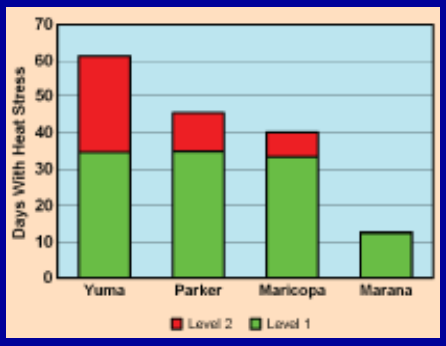


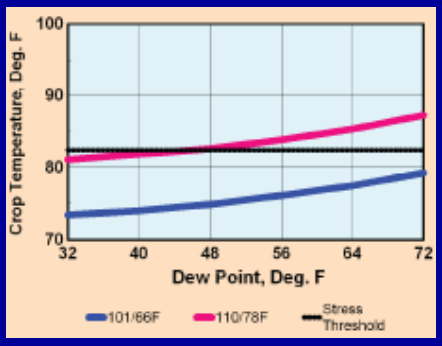
COTTON HEAT STRESS

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





Elevation (Air Temperature)

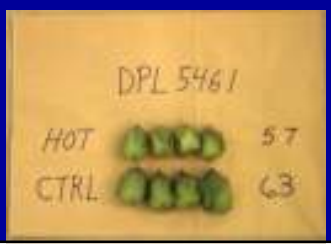
Humidity (Dew Point

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

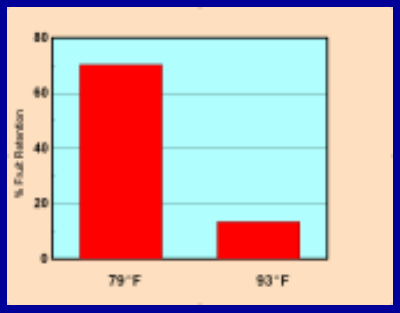
- **Reduced Fruit Retention**
  - **Losses: Low – Moderate**
    - **Young Bolls**
    - **3-5 Days After Bloom**
- **Smaller Boll Size**
  - **Fewer Seeds/Boll**
  - **Increased Number of Motes**
  - **Shorter Boll Fill Period**



LEVEL 2 STRESS

Crop/Flower Temperatures: > 86ºF

- **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

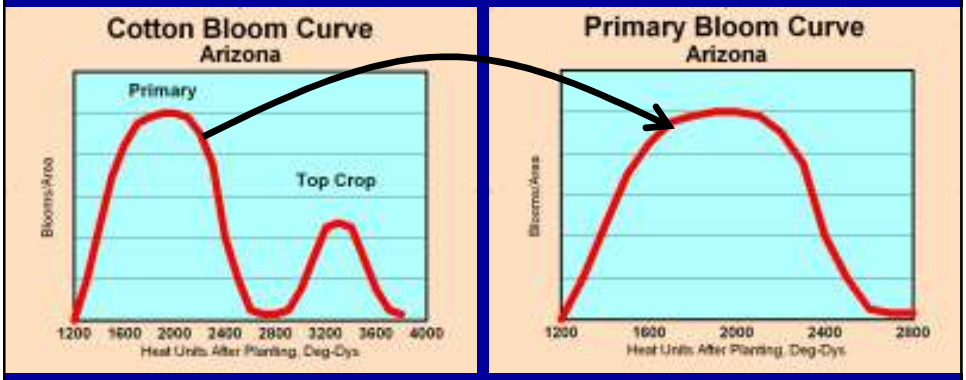
HEAT DAMAGED FLOWER

"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

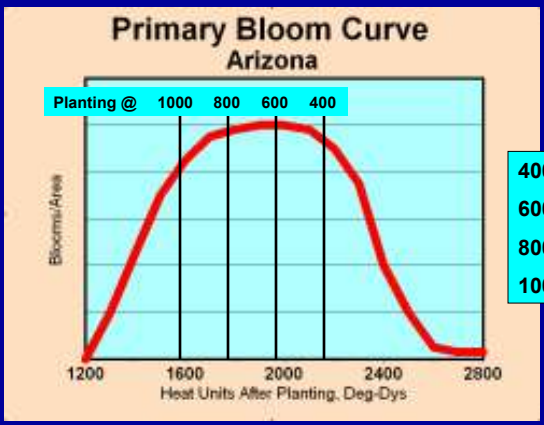
HEAT STRESS IS RELATED TO MONSOON INTENSITY

Location	First Level 1 Stress Median Date	First Level 2 Stress Median Date
Yuma Valley	2 July	10 July
Parker Valley	2 July	15 July
Mohave Valley	28 June	12 July
Maricopa	1 July	13 July
Paloma	5 July	11 July
Queen Creek	27 June	13 July
Marana	5 July	N/A

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

PINAL COUNTY

Arrival of Level 2 Heat Stress vs. Planting Date



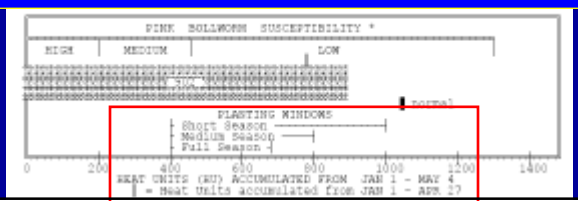
400 HUs = Mar 21
600 HUs = Apr 10
800 HUs = Apr 24
1000 HUs = May 7

Later Planting Exposes More of the Primary Bloom Period To Damaging Heat Stress

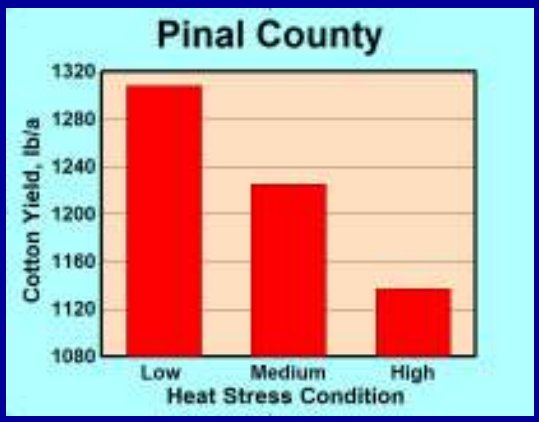
PLANTING WINDOWS

- FULL SEASON: 400-600 / 700 HU*
  - 19 March – 9 April / 17April
- 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

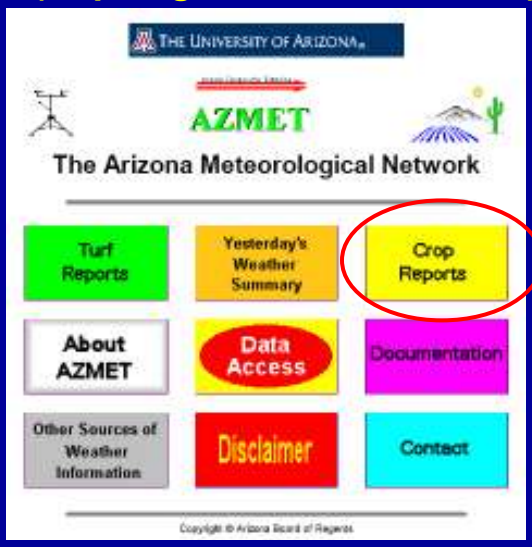


170 lb/a Difference Between Low & High Heat Stress Years

HEAT ISLAND HEAT STRESS

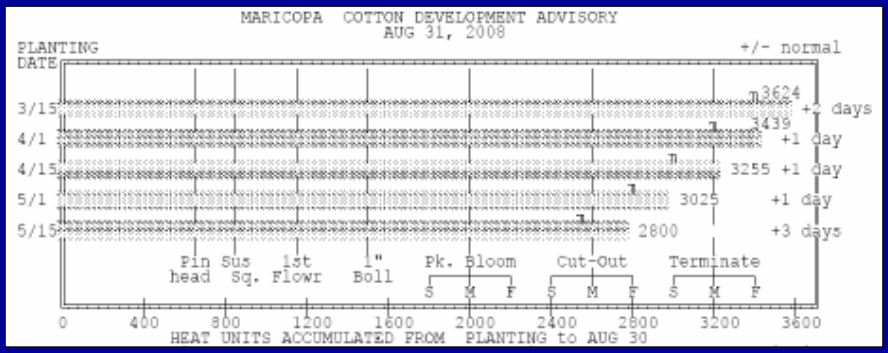
AZMET WEB PAGE

(http://ag.arizona.edu/azmet)



Click

WEEKLY COTTON ADVISORIES



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

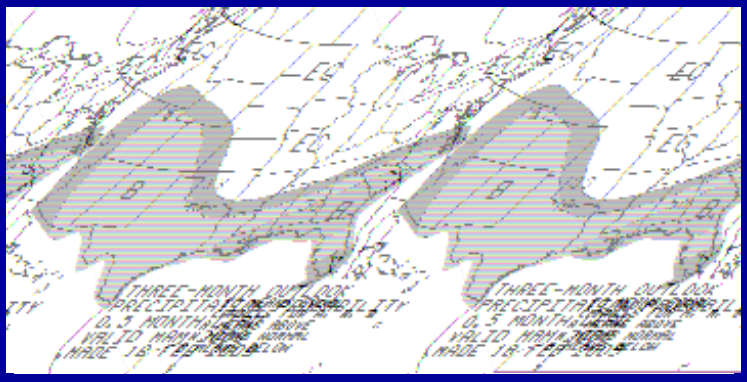
HEAT STRESS ADVISORIES

Maricopa, Arizona
Cotton Heat Stress for 2008

DOY	Date	Stress	
181	Jun 29	84.6	L1
182	Jun 30	84.1	L1
183	Jul 1	84.5	L1
184	Jul 2	84.4	L1
185	Jul 3	86.7	L2
186	Jul 4	85.2	L1
187	Jul 5	84.3	L1
188	Jul 6	85.5	L1
189	Jul 7	83.7	L1
190	Jul 8	83.1	L1
191	Jul 9	83.6	L1
192	Jul 10	81.4	ns
193	Jul 11	78.5	ns
194	Jul 12	79.7	ns

PLANTING SEASON FORECAST

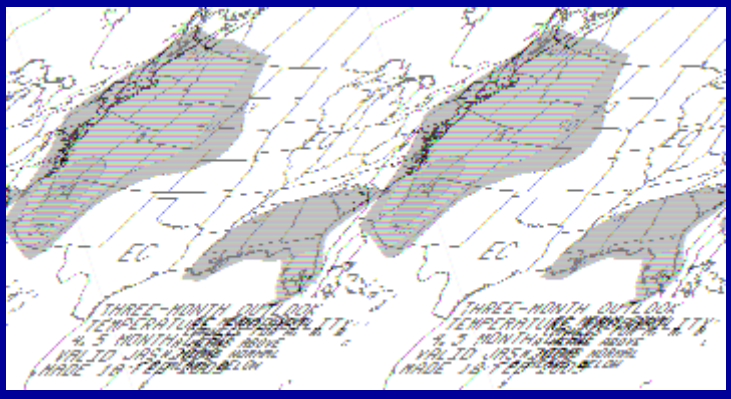
March, April & May



Bias Toward Below Normal Precipitation

MONSOON SEASON FORECAST

July, August & September



Bias Toward Above Normal Temperatures

THE END

THANK YOU!