

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

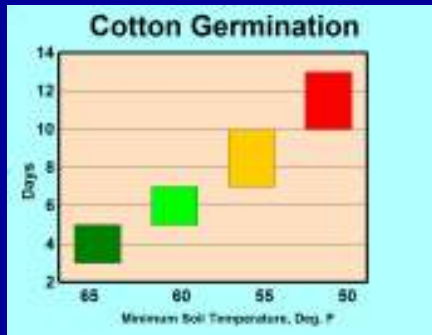
- Soil Temperature
- Weather Forecast
- Summer Heat Stress
- Variety

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

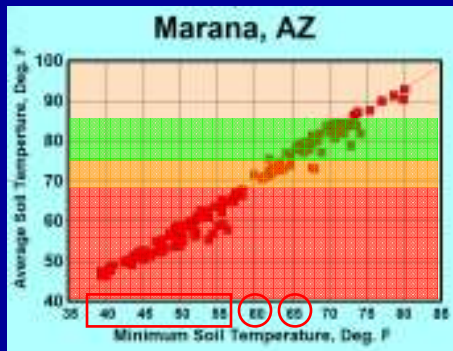
Often Used In West To Guide Planting



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



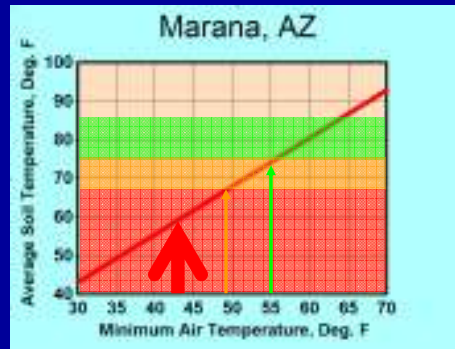
Source: Cotton Physiology Today, March 1990

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
 - 547 HU After January 1
 - April 4th

AZMET

www.ag.arizona.edu/azmet

AZMET Hourly Weather Data: MARANA: Feb 22, 2009

HR	AT	TD	RH	VPD	SR	PPT	ST4	ST20	WS	WSX	WVM	WVD
1	48.7	33.6	55.8	0.5	0.0	0.00	58.3	58.3	4.3	7.2	4.3	101
2	49.3	32.5	52.6	0.6	0.0	0.00	57.2	58.5	5.4	8.3	5.1	108
3	47.5	33.6	58.5	0.5	0.0	0.00	56.3	58.5	6.0	9.2	6.0	90
4	48.4	32.2	53.2	0.6	0.0	0.00	55.6	58.6	6.9	12.1	6.7	108
5	48.9	30.6	48.9	0.6	0.0	0.00	54.9	58.6	7.2	11.6	6.7	118
6	50.4	27.0	40.0	0.8	0.0	0.00	54.3	58.6	6.5	16.3	5.8	147
7	49.1	27.3	42.4	0.7	0.0	0.00	54.0	58.8	8.5	12.1	8.3	112
8	48.6	27.7	43.9	0.7	6.4	0.00	53.4	58.8	5.4	9.2	4.9	124
9	56.1	24.4	29.3	1.1	18.6	0.00	53.8	58.8	6.5	11.0	6.3	128
10	61.5	20.5	20.4	1.5	29.4	0.00	55.0	58.6	9.4	16.1	9.2	118
11	66.9	19.2	15.9	1.9	53.3	0.00	57.4	58.6	7.8	13.0	7.4	128
12	72.7	18.7	12.8	2.4	49.7	0.00	60.6	58.6	6.9	12.1	6.5	137
13	77.2	20.3	11.9	2.8	46.3	0.00	63.5	58.6	2.2	7.4	0.9	180
14	79.0	21.2	11.6	3.0	47.3	0.00	66.0	58.6	2.9	8.9	2.5	328
15	79.9	23.7	12.6	3.0	35.8	0.00	68.2	58.5	4.0	7.8	4.0	318
16	79.2	25.2	13.6	2.9	25.1	0.00	69.1	58.5	4.9	8.7	4.7	321
17	78.6	25.7	14.2	2.9	16.0	0.00	69.4	58.5	5.8	9.4	5.8	316
18	75.2	28.8	18.0	2.5	4.5	0.00	68.9	58.5	4.7	8.1	4.5	308
19	69.3	32.2	25.1	1.8	0.2	0.00	67.8	58.6	2.0	4.3	1.3	286
20	66.7	32.7	28.1	1.6	0.0	0.00	66.6	58.6	1.1	2.7	0.9	175
21	64.4	34.3	32.5	1.4	0.0	0.00	65.5	58.8	2.2	5.6	2.2	105
22	62.6	35.8	36.8	1.2	0.0	0.00	64.4	58.8	3.6	5.6	3.6	86
23	59.9	35.8	40.6	1.0	0.0	0.00	63.3	59.0	4.3	7.4	4.0	97
24	59.5	33.8	37.9	1.1	0.0	0.00	62.4	59.2	4.7	7.4	4.5	100

4" Soil Temperature

20" Soil Temperature
(Should Be 60+F)

AZMET

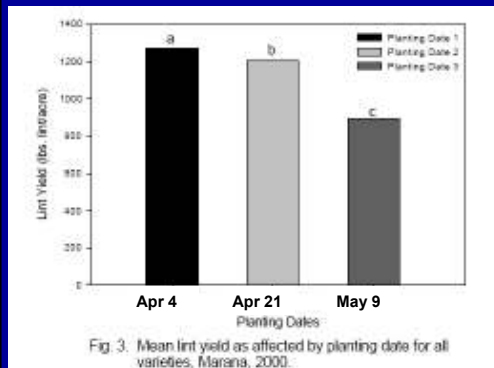
www.ag.arizona.edu/azmet

AZMET Daily Weather Data : MARANA : Feb 22 2009

	MAX.	MIN.	MEAN	TOTAL	UNITS
TEMPERATURE	82.4	46.4	62.4		DegF
RELATIVE HUMIDITY	60.9	10.2	31.5		%
DEWPOINT			28.2		DegF
ACTUAL VAPOR PRESS.			0.5		KPas
VAPOR PRESS. DEF.			1.5		KPas
SOIL TEMP. 4 in	69.4	53.4	61.0		DegF
SOIL TEMP. 20 in	59.2	58.1	58.6		DegF
WIND SPEED	16.3		5.1		MPH
WIND VECTOR MAG.			2.9		MPH
WIND VECTOR DIR.			110		Degrees
SOLAR RADIATION				332.5	Langleys
PRECIPITATION				0.00	Inches
AZMET REF. EVAPOTRANSPIRATION				0.15	Inches
STD. REF. EVAPOTRANSPIRATION				0.18	Inches
HEAT UNITS	86/55F		86/50F	86/45F	
-----	DAY	CUM	DAY	CUM	DAY
SINE CURVE	11.2	289	14.9	435	19.4

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

WHY NOT JUST PLANT LATER?



Source: Silvertooth et al., 2001

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

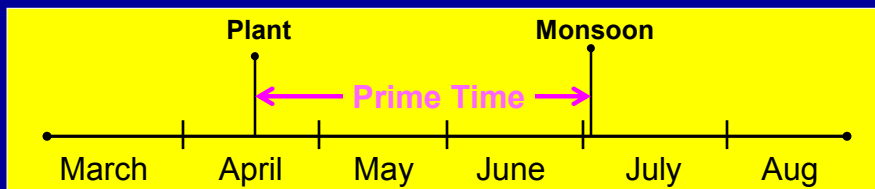
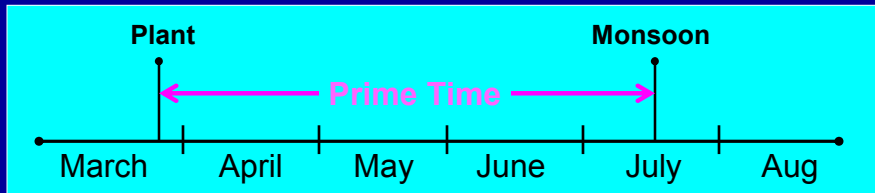
OPTIMAL PLANTING DATES

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

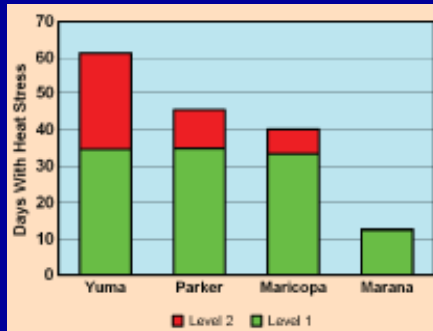


COTTON HEAT STRESS

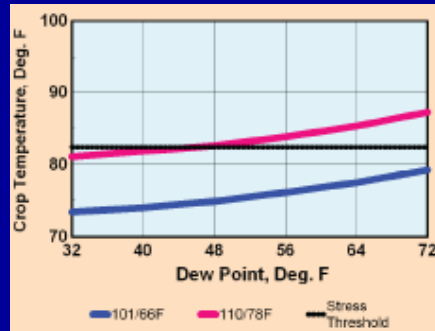
Develops When Mean Crop Temperatures Rise Above Stress Thresholds

- **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)



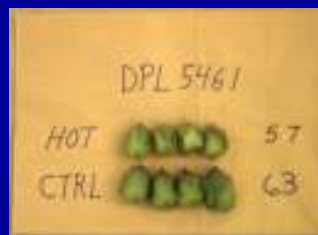
Humidity (Dew Point)

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: 82.5° - 86°F

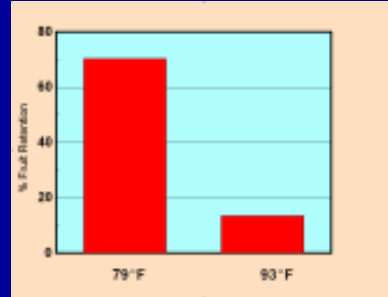
- **Reduced Fruit Retention**
 - **Losses: Low – Moderate**
 - Young Bolls
 - 3-5 Days After Bloom
- **Smaller Boll Size**
 - **Fewer Seeds/Boll**
 - **Increased Number of Motes**
 - **Shorter Boll Fill Period**



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



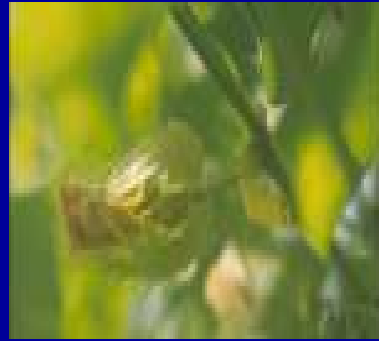
Stressed

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

HEAT DAMAGED FLOWER



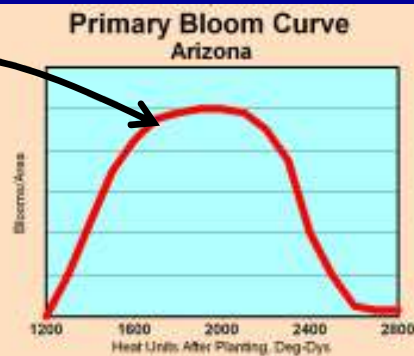
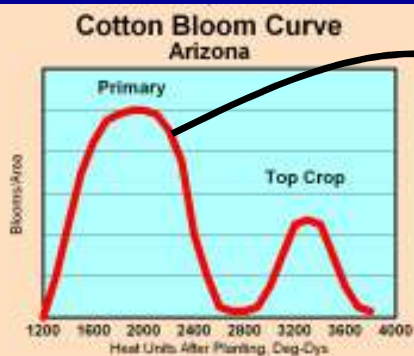
"Elongated Stigma" Caused By Short Filaments



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

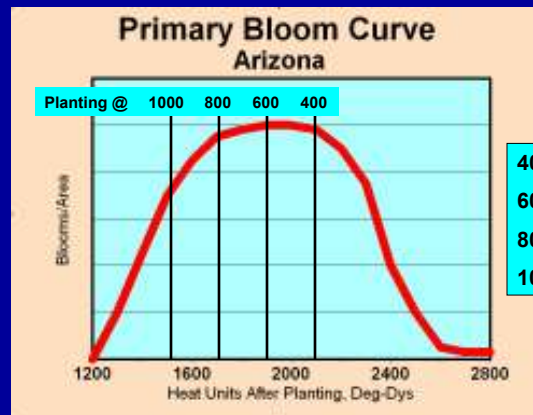
HEAT STRESS IS RELATED TO MONSOON INTENSITY

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.

MARANA AREA

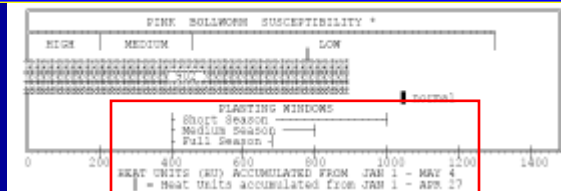
Heat Stress vs. Planting Date



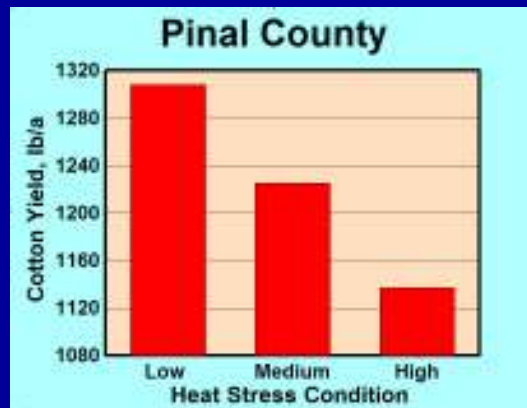
PLANTING WINDOWS

- **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

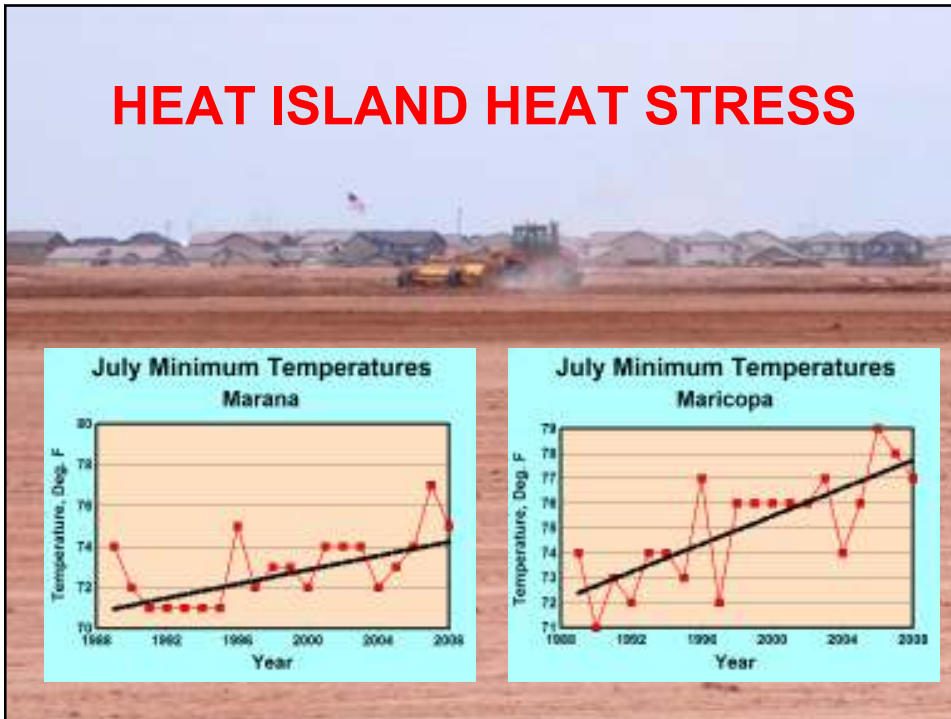


HEAT STRESS & YIELDS



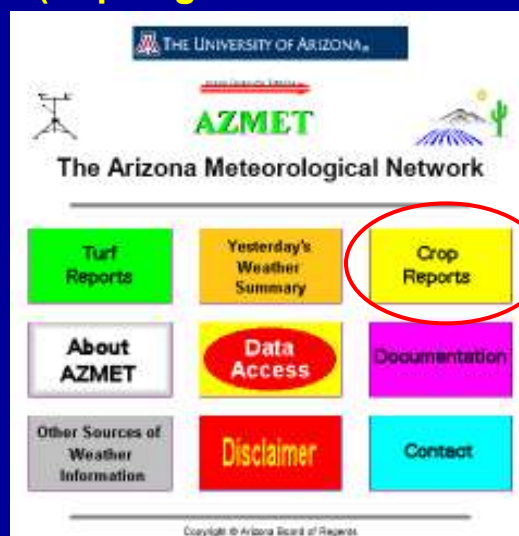
170 lb/a Difference Between Low & High Heat Stress Years

HEAT ISLAND HEAT STRESS



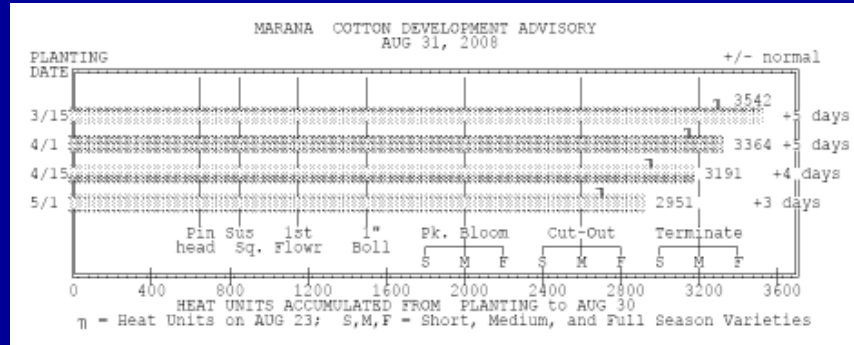
AZMET WEB PAGE

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



Click

WEEKLY COTTON ADVISORIES



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

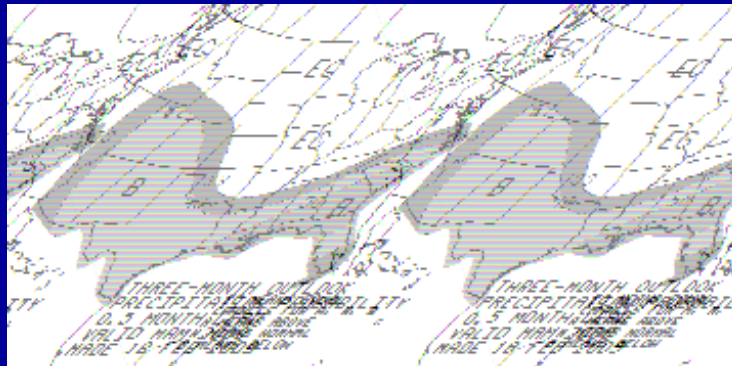
HEAT STRESS ADVISORIES

Marana, Arizona
Cotton Heat Stress for 2008

DOY	Date	Stress
188	Jul 6	82.2 ns
189	Jul 7	80.6 ns
190	Jul 8	81.4 ns
191	Jul 9	80.5 ns
192	Jul 10	78.9 ns
193	Jul 11	76.8 ns
194	Jul 12	78.1 ns
195	Jul 13	78.4 ns
196	Jul 14	79.9 ns
197	Jul 15	81.9 ns
198	Jul 16	83.7 L1
199	Jul 17	84.2 L1
200	Jul 18	84.1 L1
201	Jul 19	80.3 ns
202	Jul 20	77.6 ns
203	Jul 21	81.7 ns
204	Jul 22	81.4 ns
205	Jul 23	80.3 ns
206	Jul 24	82.4 L1

PLANTING SEASON FORECAST

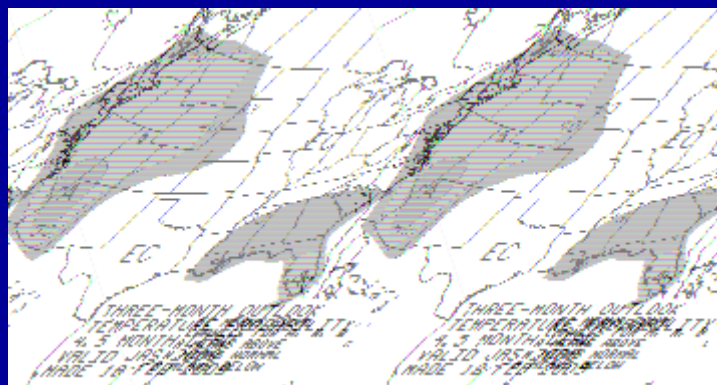
March, April & May



Bias Toward Below Normal Precipitation

MONSOON SEASON FORECAST

July, August & September



Bias Toward Above Normal Temperatures

THE END

THANK YOU!