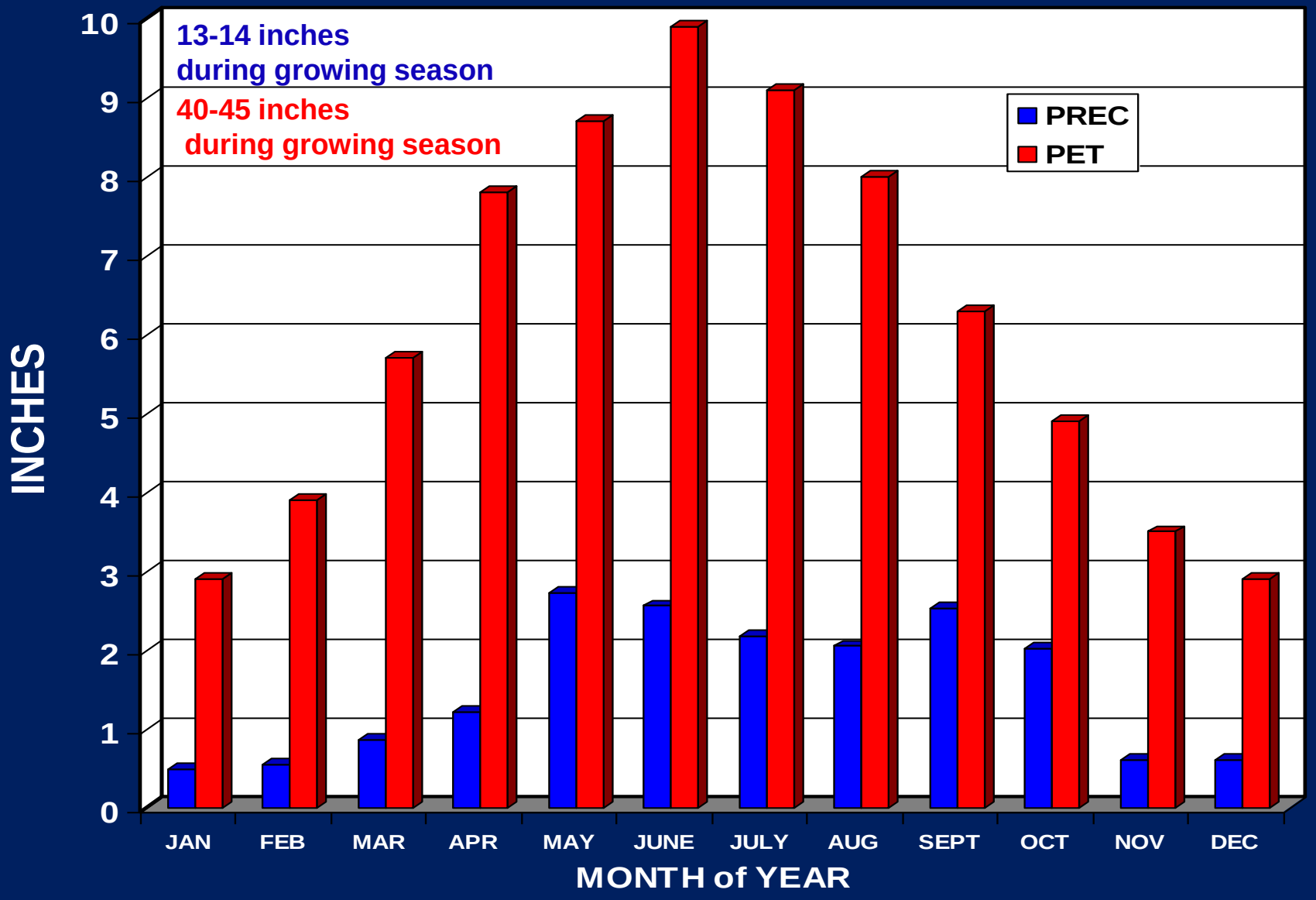
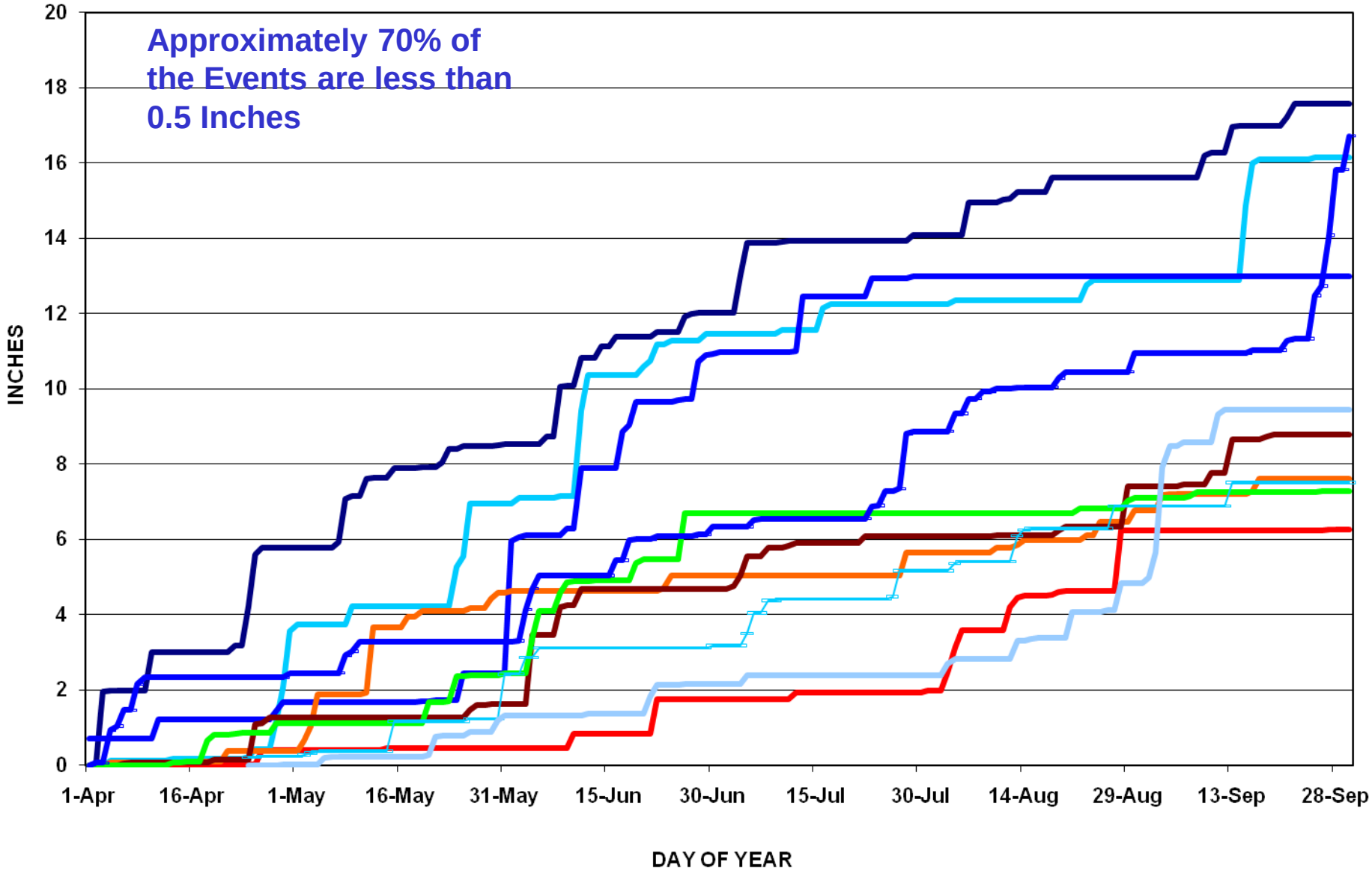
WATER SUPPLY & DEMAND

DAN KRIEG

CROP PHYSIOLOGIST

SOUTHERN HIGH PLAINS




GROWING SEASON RAIN
LUBBOCK TEXAS
Approximately 70% of
the Events are less than
0.5 Inches
INCHES
20
18
16
14
12
10
8
6
4
2
0
1-Apr
16-Apr
1-May
16-May
31-May
15-Jun
30-Jun
15-Jul
30-Jul
14-Aug
29-Aug
13-Sep
28-Sep
DAY OF YEAR

IRRIGATION WATER SUPPLY

- ONE CUBIC FOOT OF WATER= 7.48 GALLONS
- ONE ACRE=43560 SQUARE FEET
- ONE ACRE FOOT OF WATER = 325,829 GALLONS
- ONE ACRE INCH= 27,152 GALLONS
- 1 GPMA= 1440GPAD/27152GPACIN = 0.053 AC IN DAY^{-1}

IRRIGATION WATER SUPPLY

27,225 gallons/acre inch

Gallons/Min/Acre	Acre Inches/Day
1.0	0.053
2.0	0.107
3.0	0.160
4.0	0.214
5.0	0.267
6.0	0.320
7.0	0.373

IRRIGATION APPLICATION RATES
125 acre pivot

VOLUME GPMA	0.5in	1.0 in	1.5 in	Acre Inches/hour
3	80 hrs	160 hrs	240 hrs	0.78
4	57 hrs	113 hrs	170 hrs	1.10
5	45 hrs	90 hrs	136 hrs	1.39
6	38 hrs	75 hrs	113 hrs	1.65

SOIL WATER DATA

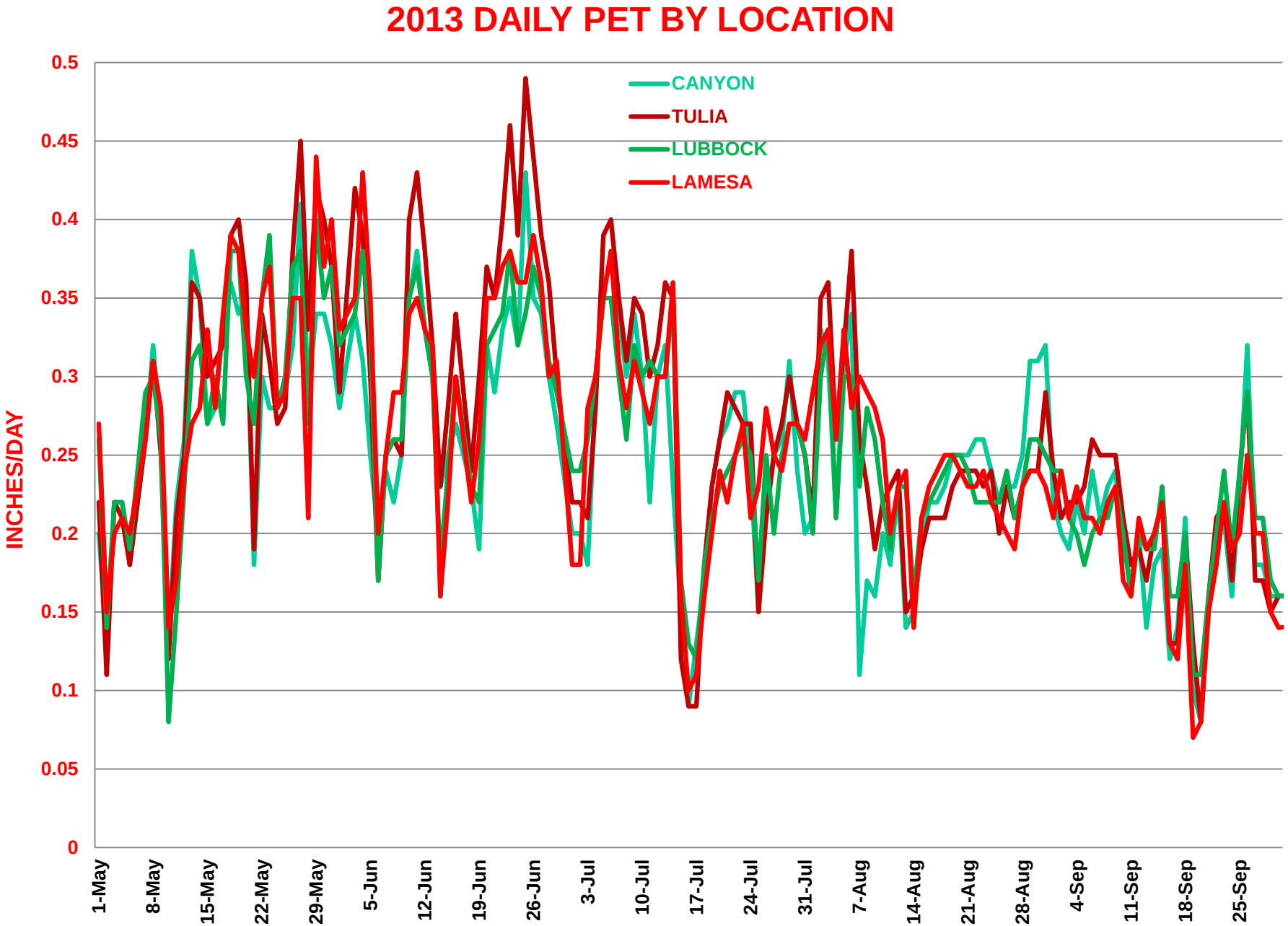
TEXTURE	FIELD CAPACITY Inches/foot	PERMANENT WILTING POINT Inches/foot	PLANT AVAILABLE WATER Inches/foot	INITIATION OF STRESS 60% depletion of PAW	INFILTRATION RATE Inches/hour
PULLMAN CLAY LOAM	4.38	3.05	1.33	0.80	0.21
OLTON LOAM	3.86	2.36	1.50	0.90	0.77
ACUFF LOAM	3.25	2.03	1.22	0.73	1.28
AMARILLO FINE SANDY LOAM	2.88	1.90	0.98	0.59	1.84
PATRICIA & AMARILLOL OAMY FINE SAND	2.60	1.62	0.98	0.59	5.79

POTENTIAL EVAPOTRANSPIRATION

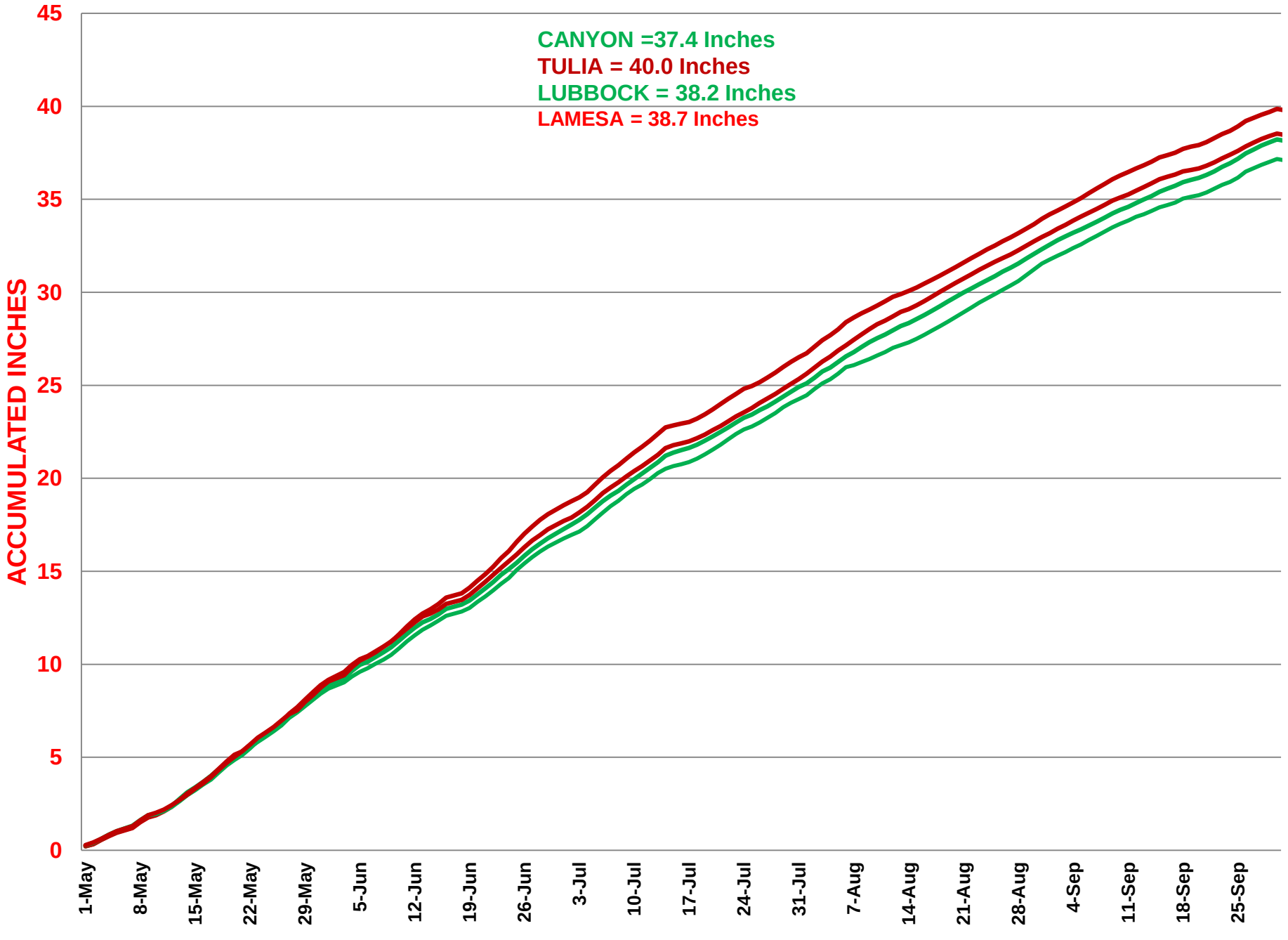
MODIFIED PENMAN EQUATION

$$ET_o = c[W\text{-}R_n + (1\text{-}w) - f(u) - (e_a\text{-}e_d)]$$

ET_o = potential crop evapotranspiration (mm/day)
W = temperature-related weighting factor
R_n = net radiation in equivalent evaporation (mm/day)
f(u) = wind related function
$(e_a\text{-}e_d)$ = vapor pressure deficit of the air at mean air temperature
c = adjustment factor to compensate for the effect of day and night weather conditions.


2013 DAILY PET BY LOCATION
CANYON
TULIA
LUBBOCK
LAMESA
INCHES/DAY
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
1-May
8-May
15-May
22-May
29-May
5-Jun
12-Jun
19-Jun
26-Jun
3-Jul
10-Jul
17-Jul
24-Jul
31-Jul
7-Aug
14-Aug
21-Aug
28-Aug
4-Sep
11-Sep
18-Sep
25-Sep

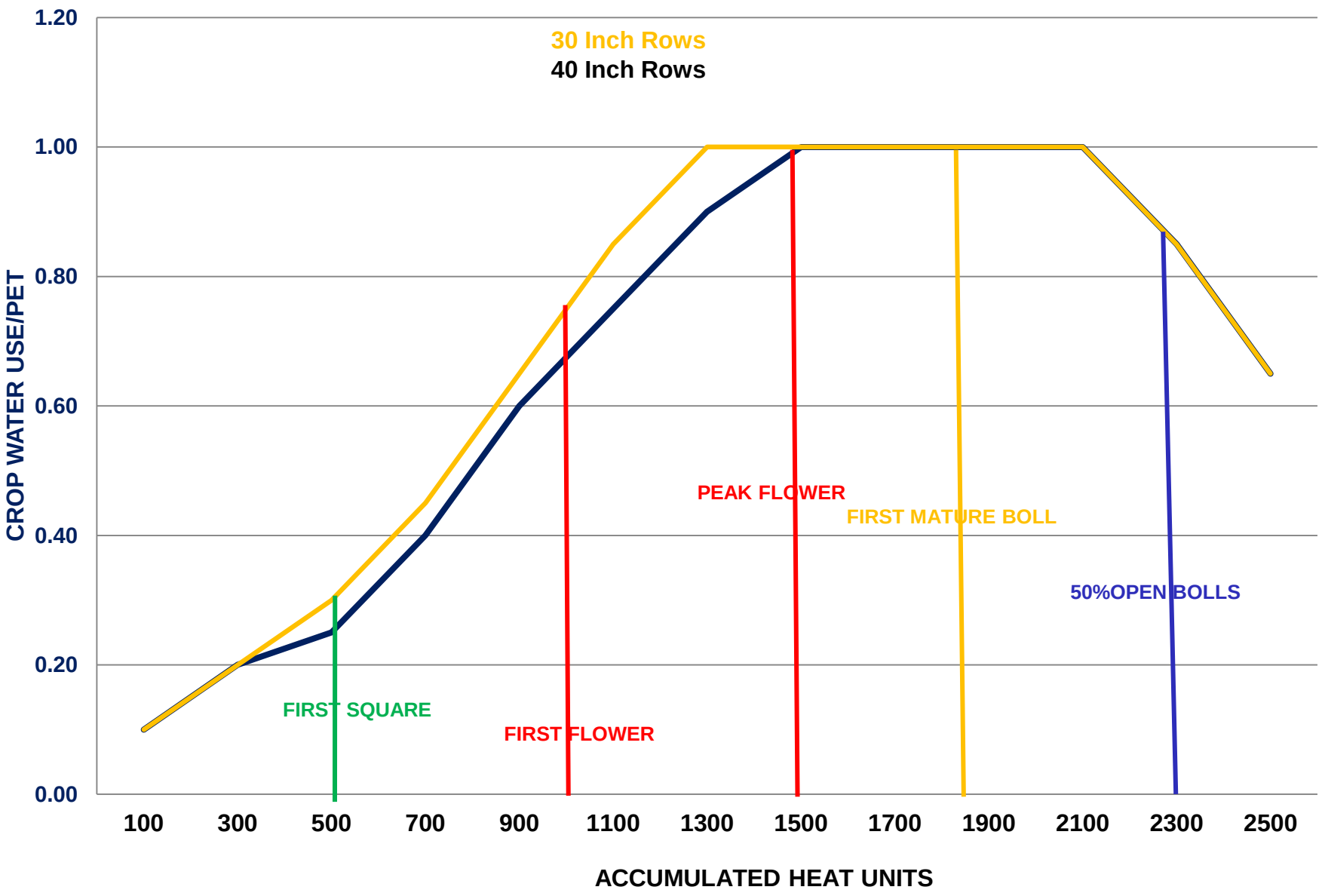
2013 SEASONAL PET BY LOCATION

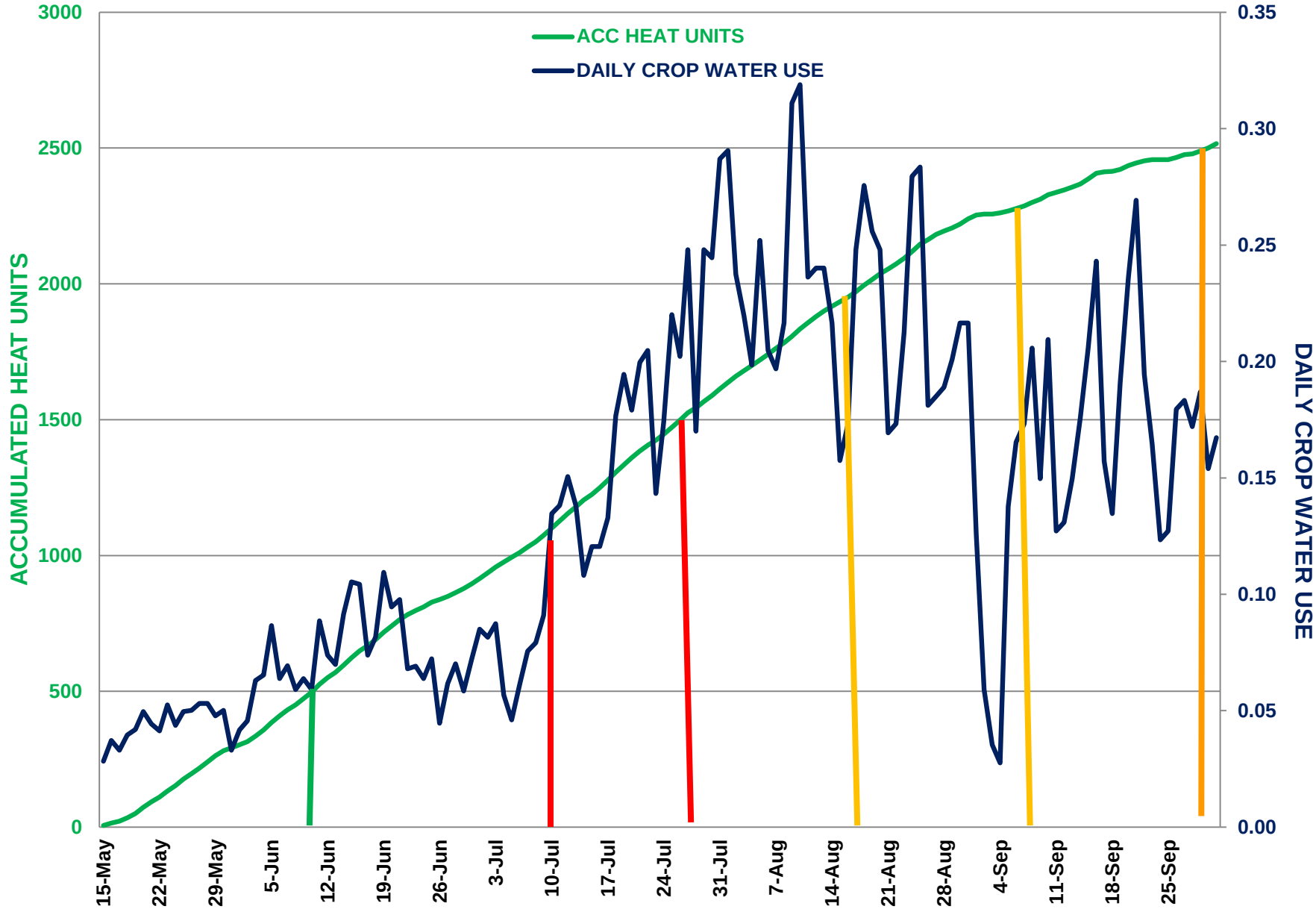


CROP COEFFICIENTS

$$Kc = ET_c / ET_p$$

Kc = **crop specific,**
varies with stage of development
amount of ground cover, and
soil water availability

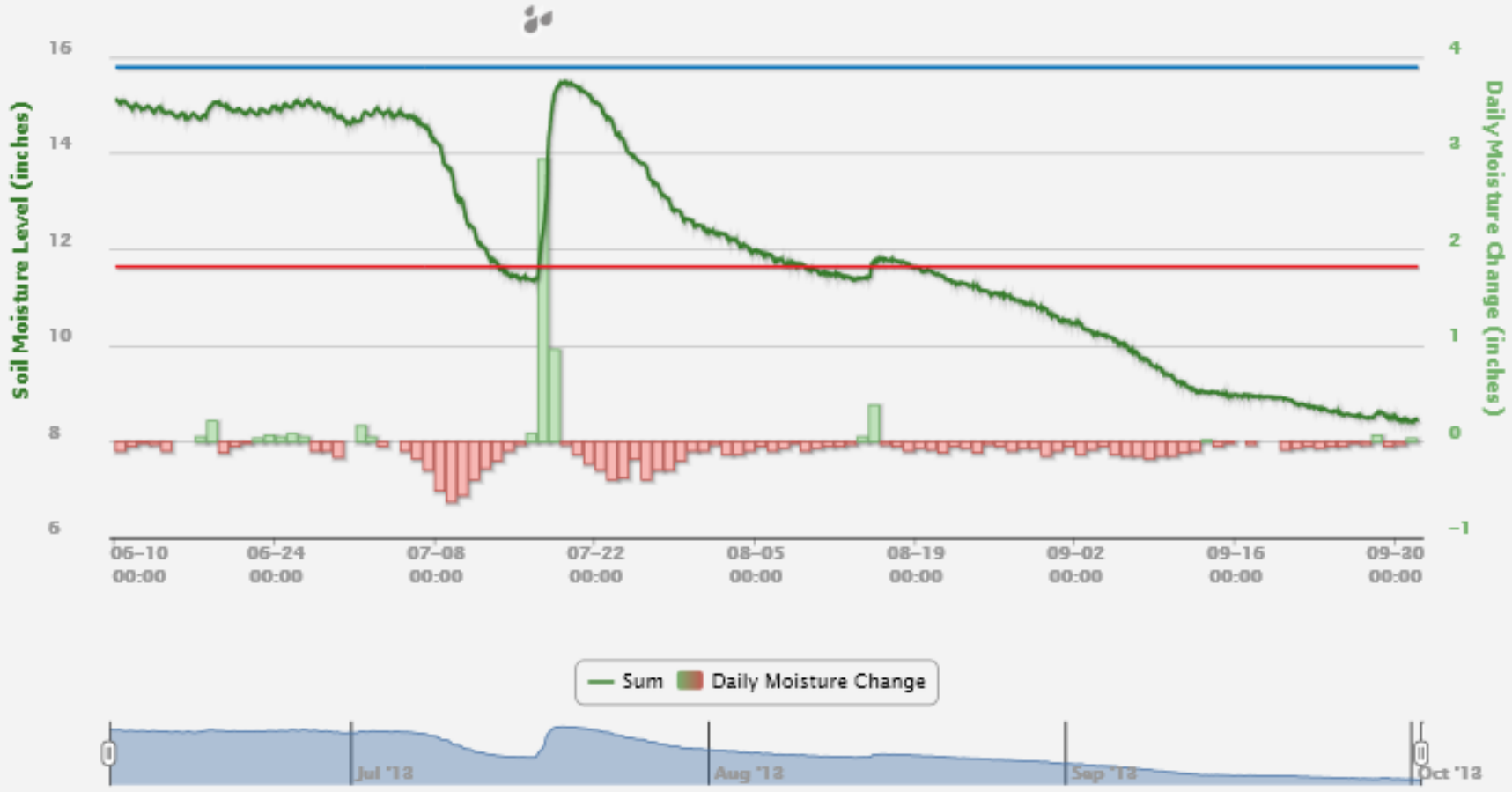

CROP COEFFICIENTS-COTTON
30 Inch Rows
40 Inch Rows
1.20
1.00
0.80
0.60
0.40
0.20
0.00
CROP WATER USE/PET
FIRST SQUARE
FIRST FLOWER
PEAK FLOWER
FIRST MATURE BOLL
50%OPEN BOLLS
100
300
500
700
900
1100
1300
1500
1700
1900
2100
2300
2500
ACCUMULATED HEAT UNITS


2013 COTTON WATER USE
ACC HEAT UNITS
DAILY CROP WATER USE
ACCUMULATED HEAT UNITS
DAILY CROP WATER USE
3000
2500
2000
1500
1000
500
0
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
15-May
22-May
29-May
5-Jun
12-Jun
19-Jun
26-Jun
3-Jul
10-Jul
17-Jul
24-Jul
31-Jul
7-Aug
14-Aug
21-Aug
28-Aug
4-Sep
11-Sep
18-Sep
25-Sep

Joe Hurst 2013 | Drip | PCPB02B300066

06-10-2013 (0:00 AM) to 10-01-2013 (11:59 PM) - America/Chicago

Sensors: All, Use Interpolation: Yes, Show Zeros: No



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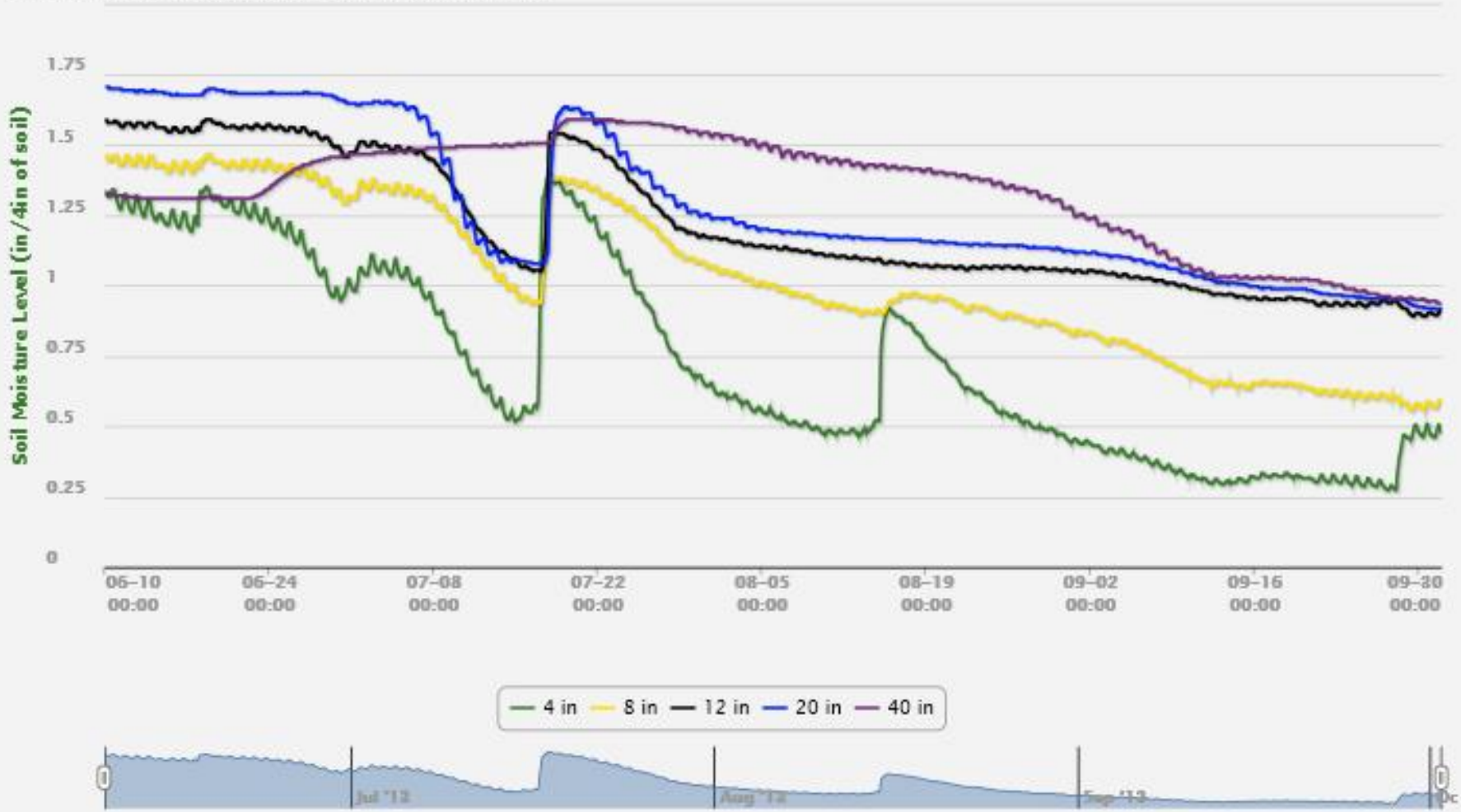


JOE HURST DRIP COTTON

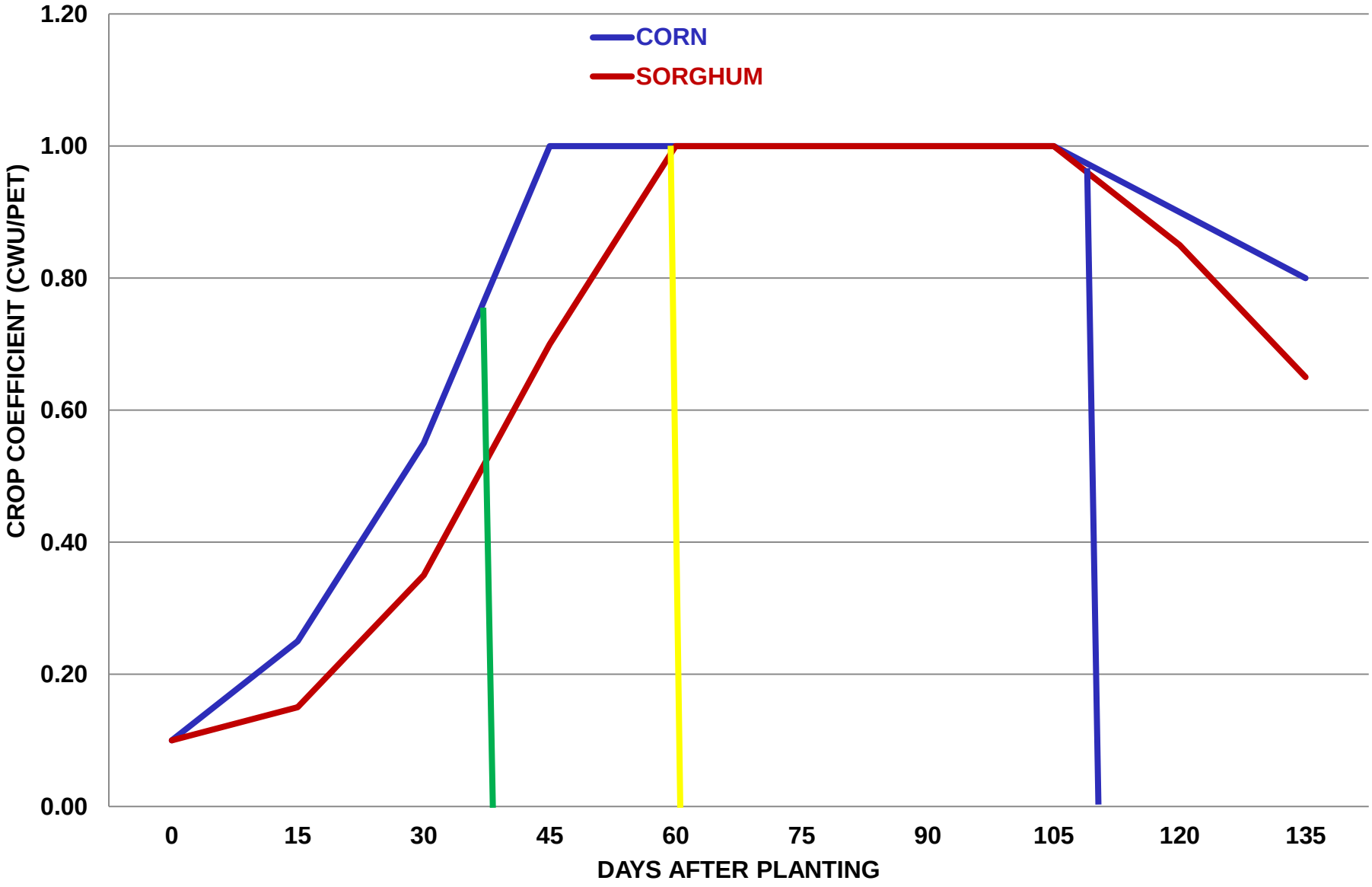
2012

- COTTON YIELD = 1850 POUNDS/ACRE
- RAIN=5.6 INCHES
- IRRIGATION = 18.5 INCHES
- @ 4 GPM
- TOTAL WATER USE EFFICIENCY = 76.8 POUNDS/ACRE INCH

2013

- COTTON YIELD = 1920 POUNDS/ACRE
- RAIN = 8.75 INCHES
- IRRIGATION = 14.8 INCHES
- @ 4 GPM
- TOTAL WATER USE EFFICIENCY = 81.4 POUNDS/ACRE INCH

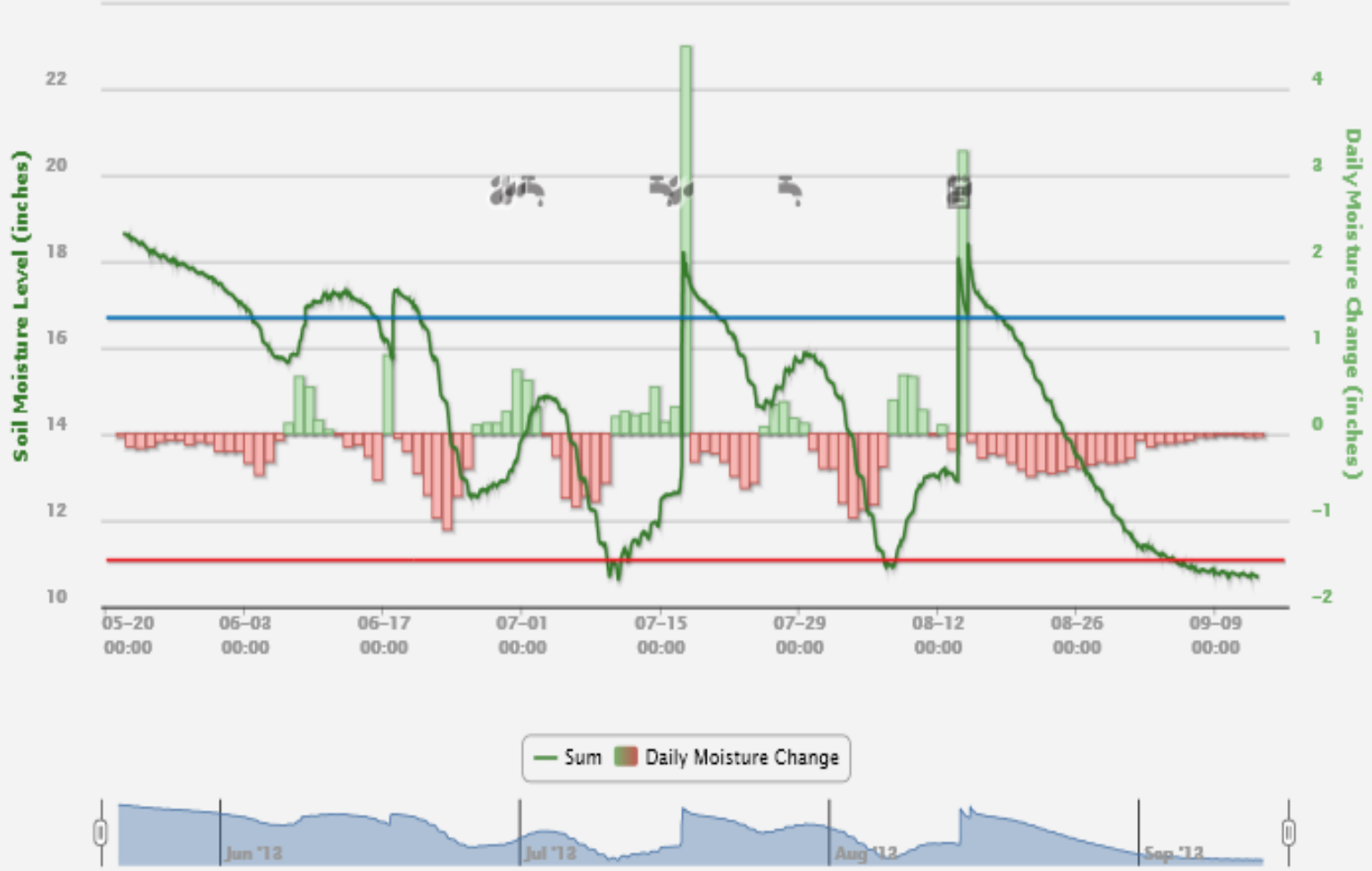
CORN & SORGHUM CROP WATER USE



TTU - Eddie Teeter 2013 | Drip | PCPB02B301545

05-20-2013 (0:00 AM) to 09-15-2013 (11:59 PM) - America/Chicago

Sensors: All, Use Interpolation: Yes, Show Zeros: No



TTU - Eddie Teeter 2013 | Drip | PCPB02B301545

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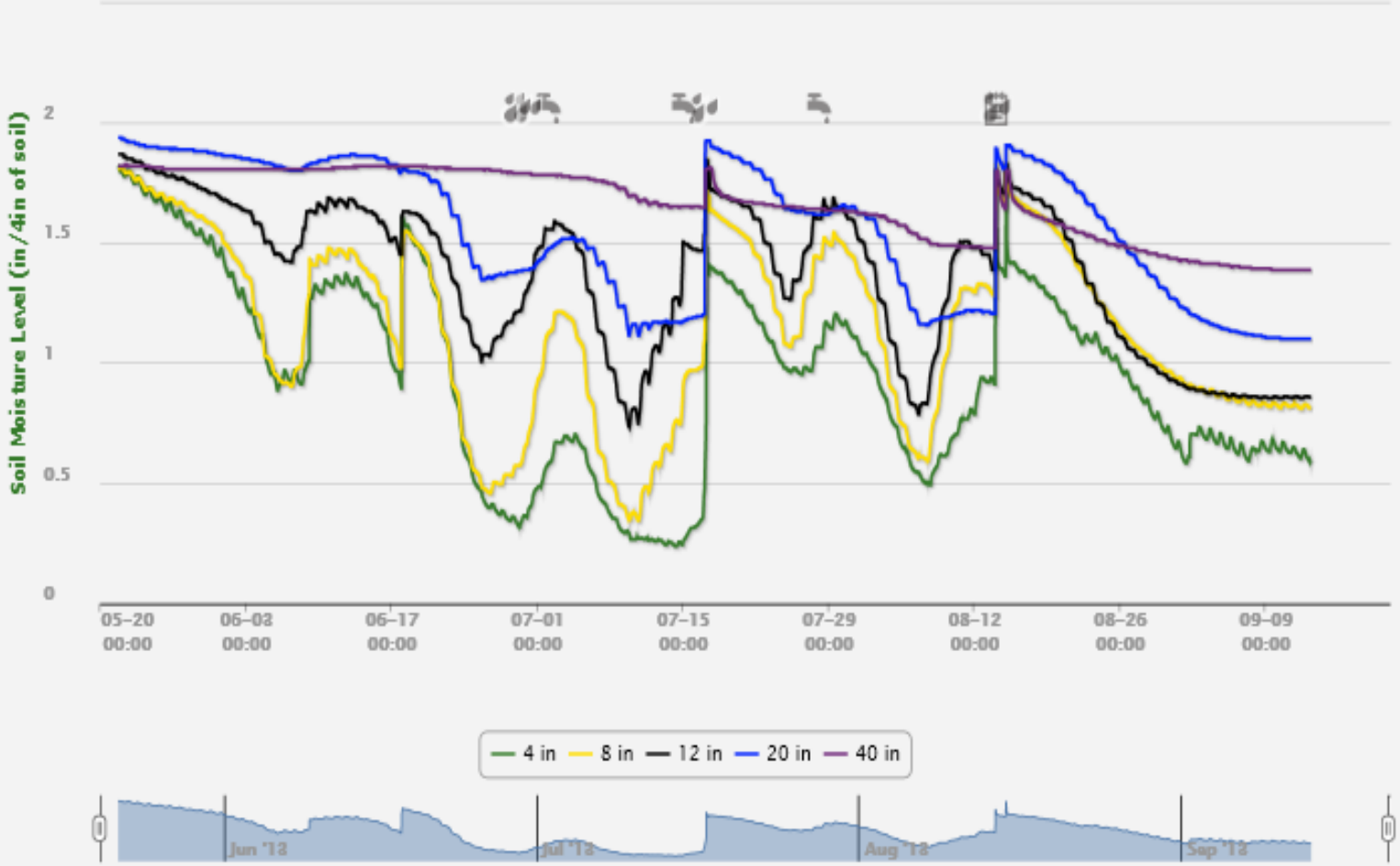
Sensors: All, Use Interpolation: No, Show Zeros: No



EDDIE TEETER CORN-2013

DRIP IRRIGATED	PIVOT IRRIGATED
RAIN = 13 INCHES	RAIN = 12.5 INCHES
IRRIGATION = 16.9 INCHES	IRRIGATION = 16.0 INCHES
TOTAL WATER = 29.9 INCHES	TOTAL WATER = 28.5 INCHES
GRAIN YIELD = 240.5 BU/ACRE	GRAIN YIELD = 239.5 BU/AC
WATER USE EFF = 8.04 BU/AC IN	WATER USE EFF = 8.4 BU/AC IN

DAILY & SEASONAL CROP WATER USE

CROP	MAXIMUM DAILY WATER USE (Inches)	VOLUME REQUIREMENT (GPMA)	DURATION (Days)	SEASONAL WATER USE (Inches)
COTTON	0.25	5	40	22-24
CORN	0.35	7	60	32-35
SORGHUM	0.30	6	40	28-30
WHEAT	0.25	5	75	20-22
PEANUTS	0.30	6	70	30-32

Critical Developmental Stages

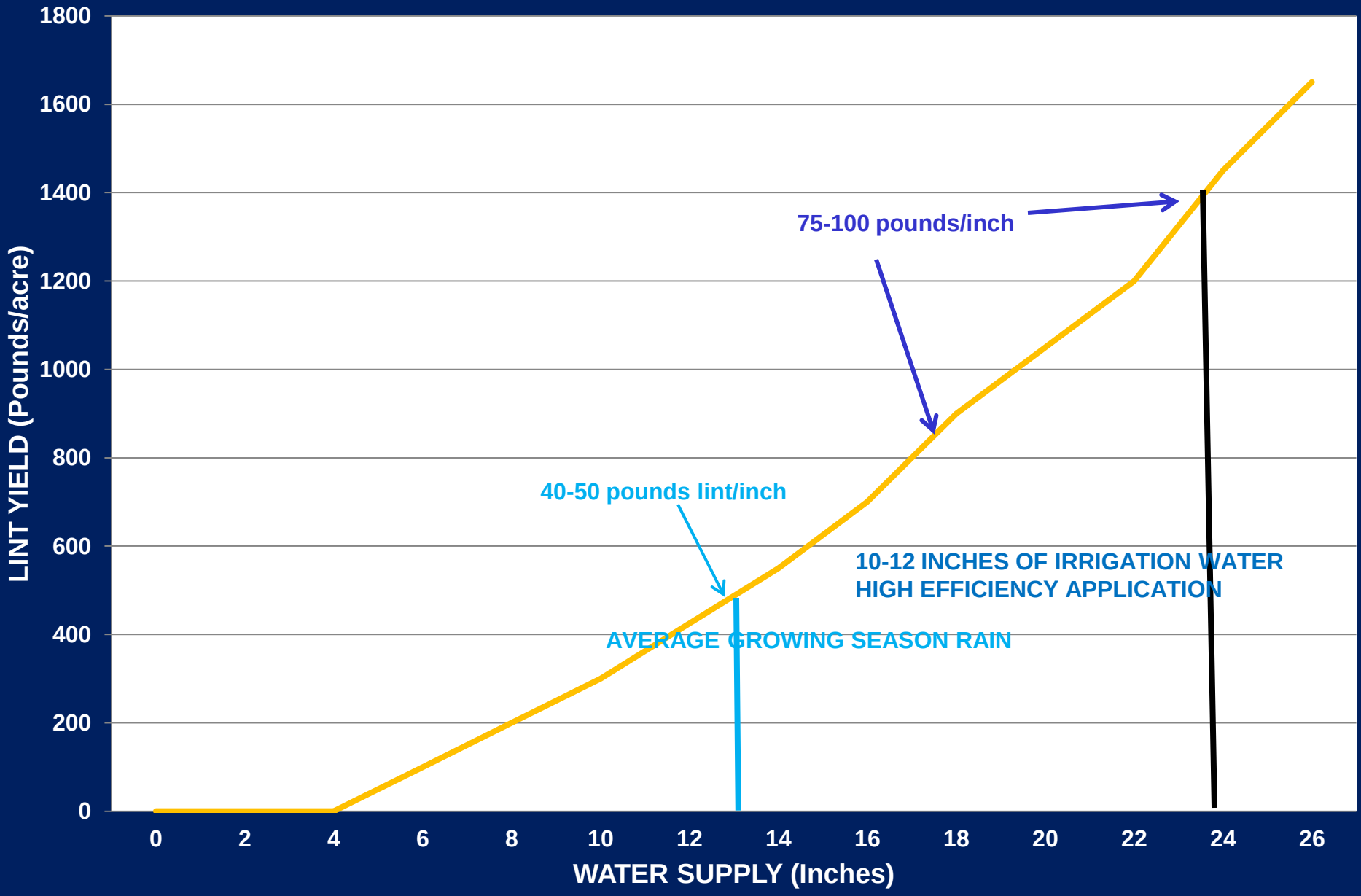
- **Corn:** Two weeks prior to tasseling is the most critical period when establishing number of rows and kernels/row Tasseling & Silking, Water Stress and High Temperature desynchronize pollen shed and silk receptivity Early seed fill, Reduced supply of photosynthate results in kernel abortion
- **Cotton:** First square to first flower establishes number of harvestable fruit. First flower through fourth week of flowering establishes harvestable boll number Bolls less than 5 days old are sensitive to water and nutrient stress causing abortion
- **Sorghum:** Panicle initiation through boot and heading affects seed/head, Water Stress during early grain fill through dough stage affects seed size
- **Peanuts:** Dry surface soil at pegging affects pod number, Water Stress during Pod Fill affects kernel number and size

Regression Coefficients For Yield Components and Water Supply at Various Developmental Stages

Stage of Development	Boll Number/Acre	Lint/Boll	Lint Yield/Acre
TWS	0.34	0.35	0.12
SI-FF	0.58	0.65	0.73
FF-PB	0.55	0.04	0.52
PB-M	-0.45	-0,56	-0.43

TWS= Total Water Supply; SI=Square Initiation; FF=First Flower; PB= Peak Bloom; M=Maturity

COTTON WATER USE EFFICIENCY
TEXAS HIGH PLAINS



BIOLOGICAL-ECONOMIC
WATER USE EFFICIENCY

CROP	INTERCEPT	SLOPE	$ /INCH
COTTON	4	160 SEED COTTON (65-70 Lint)	~50
CORN	10	600	~50
SORGHUM	6	480	~35
WHEAT	4	200	~27
PEANUTS	6	250	~50

Water – Nutrient Interactions FERTIGATION

- Nitrogen-Quantity and Source
- NO_3^- Losses to leaching
- Increase Supply as Yield Potential Increases
- NH_4^+Prefered Source by Crops

NiTROGEN REQUIREMENTS/INCH OF IRRIGATION WATER

CORN=10bu/in at 1.0-1.25 #N/bu =10-12#N/Inch

SORGHUM= 8 bu/in at 0.81#N/bu =6-7#N/Inch

COTTON = 65-75# Lint/in at 3-4 #N/100#

=5-7 #N/Inch

PEANUTS = 250 #/in at 3-4#N/100# = 7-10#N/Inch

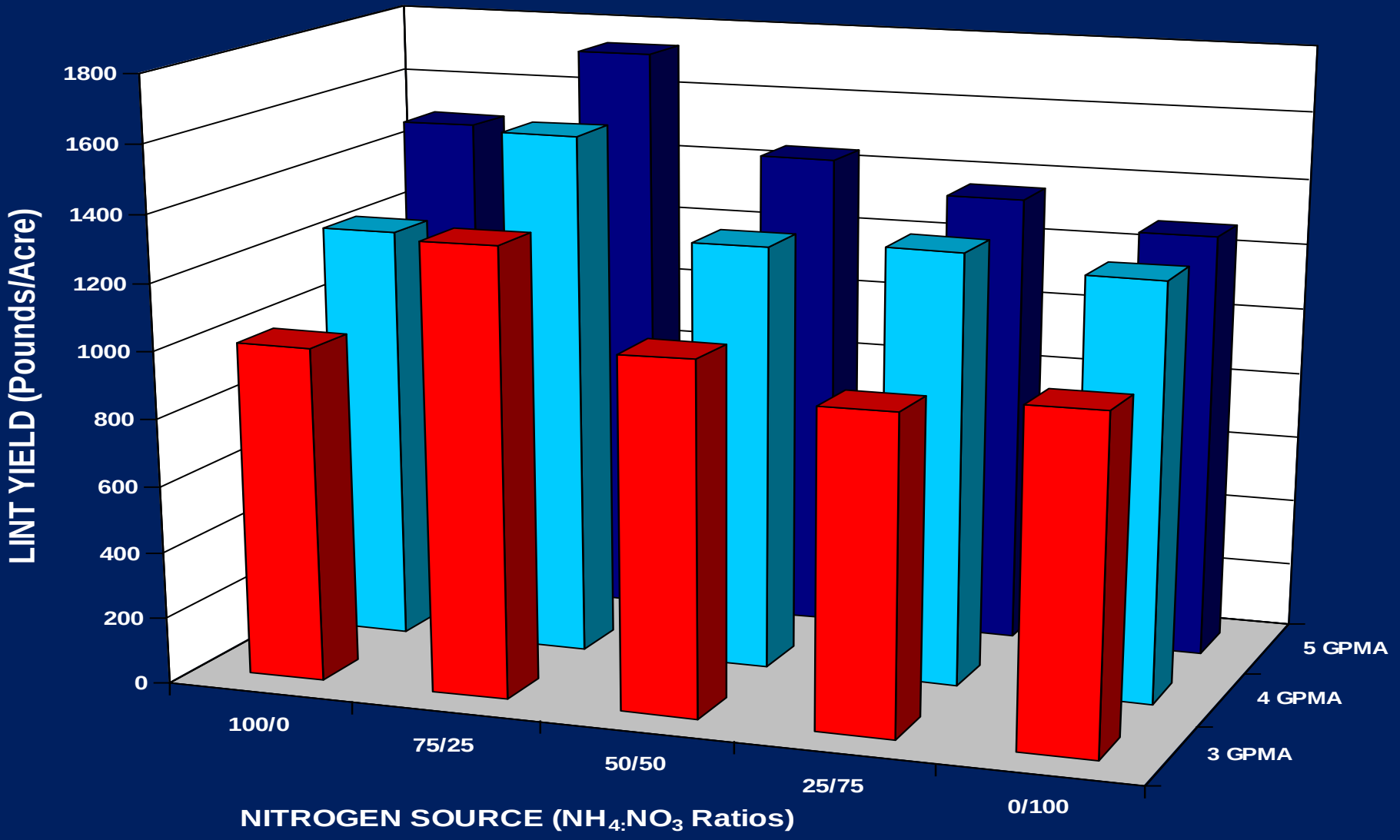
WHEAT = 3 bu/in at 1.25#N/bu = 3-4#N/Inch

CROP PREFERENCE
N SOURCE

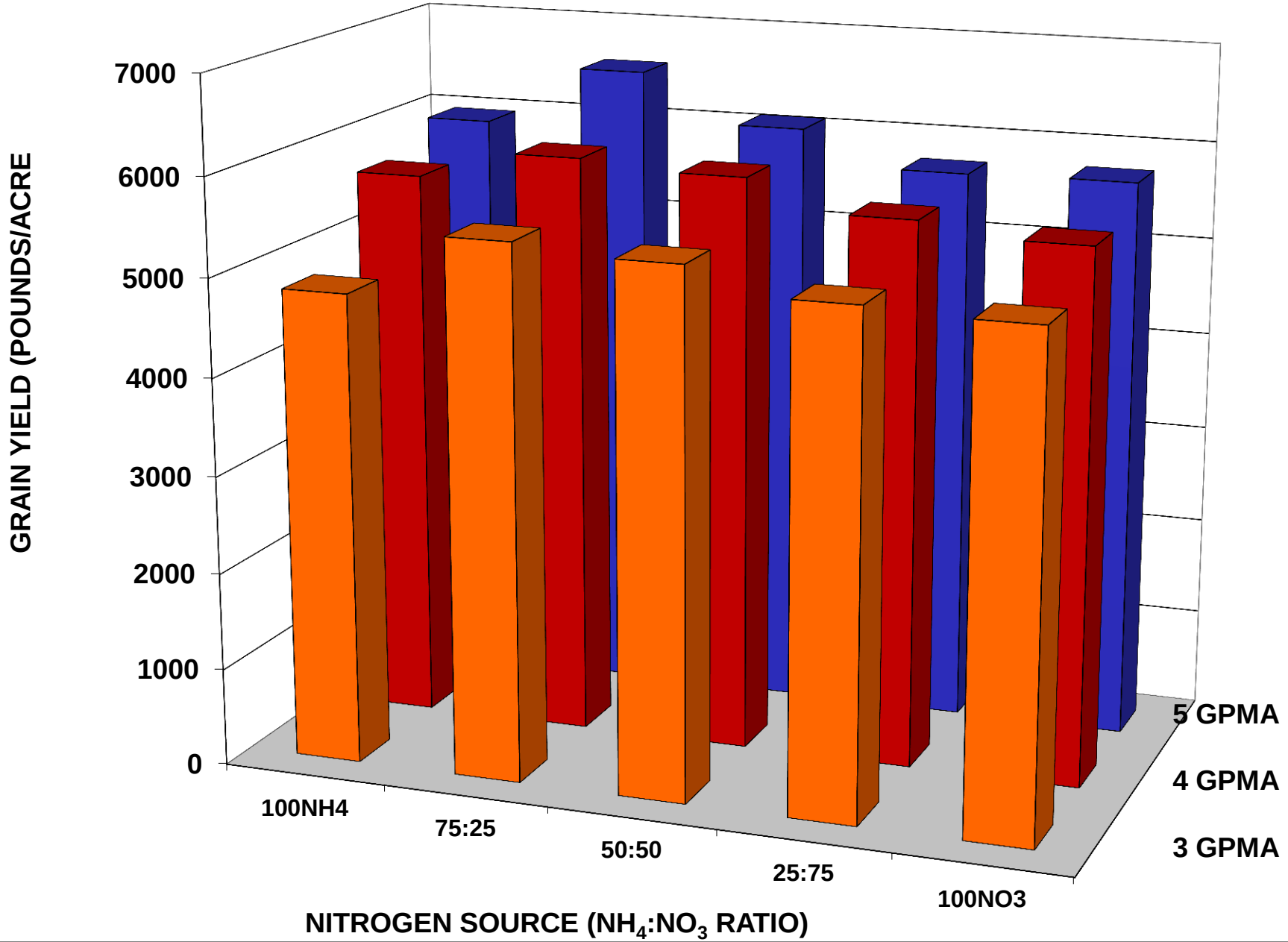
- **Nitrate –NO_3**
- **Predominant form of plant available Nitrogen within relatively short time after application**
- **Movement of NO_3 into plant tissues requires metabolic energy**
- **Reduction of NO_3 to NH_4 requires 8 electrons of reducing power; This is equivalent to ½ mole of glucose**

- **Ammoniacal Nitrogen – NH_4**
- **Rapidly moves into plant tissue**
- **No cost to reduce prior to incorporation into amino acid**

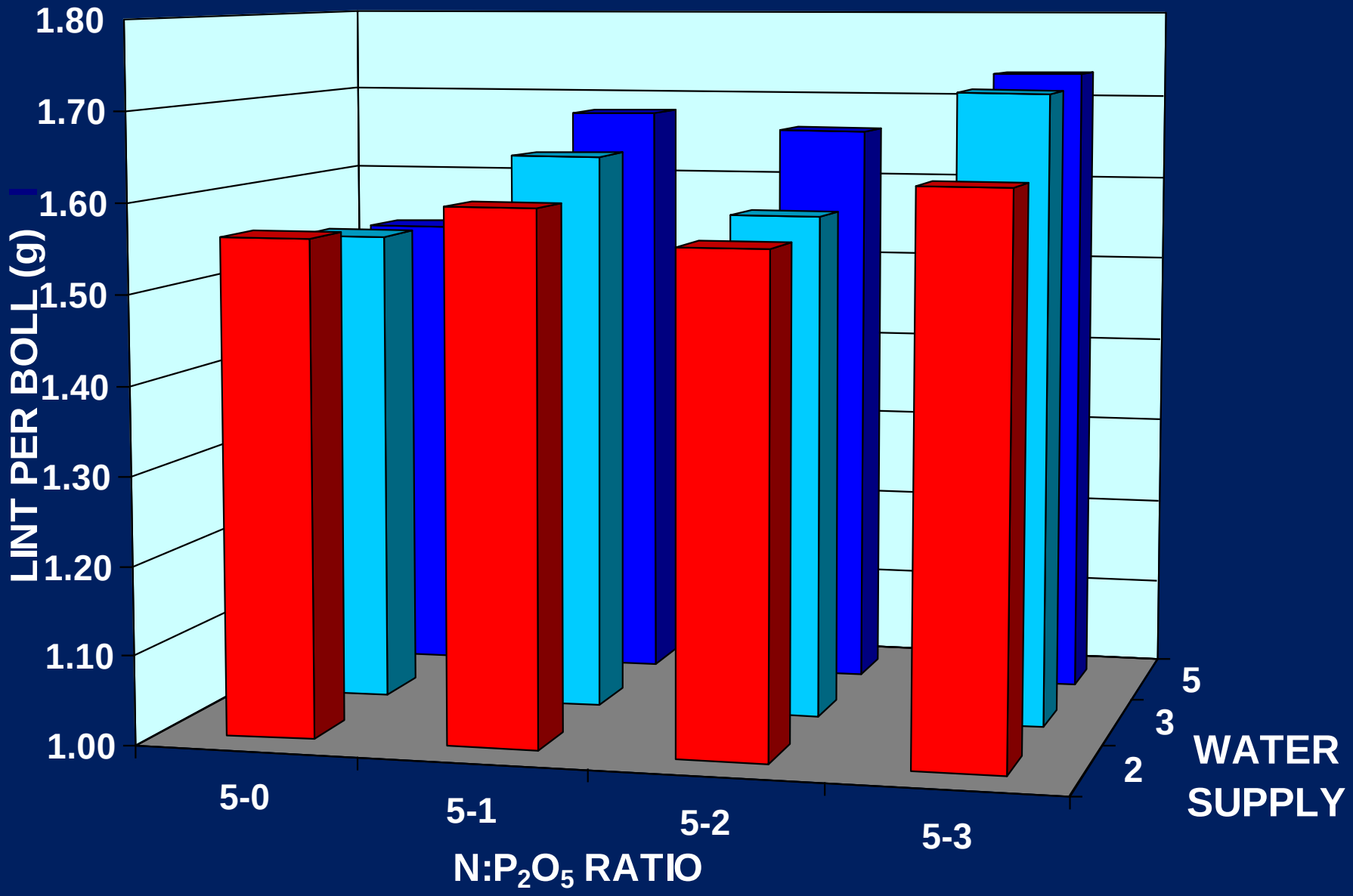
Cotton Response to Nitrogen Source



GRAIN SORGHUM RESPONSE NITROGEN SOURCE



NITROGEN:P_2O_5 RATIO



COTTON RESPONSE TO ZINC APPLICATIONS

TREATMENT	Fine Sandy Loam 0.28 PPM Zn	Clay Loam 0.65 PPM Zn
Control	1120	1240
Soil Applied - Zinc Sulfate (1.0# Zn/ac) Preplant with N & P Application	1190	1270
Foliar Applied-NZn (0.5 pint/acre) Two Applications	1250	1350

Tests conducted for 3 years (1985,1986, & 1987) at Brownfield and New Deal Texas

SUMMARY

- Lack of an adequate water supply throughout the life of most crop plants is the primary cause of yields being only a fraction of the genetic yield potential
- When the water supply is adequate, the availability of adequate essential nutrients is responsible for less than optimum growth rates and development of reproductive organs
- Understanding the needs and management of rate limiting nutrient supplies will greatly increase yield and quality of product within the limits of the water supply