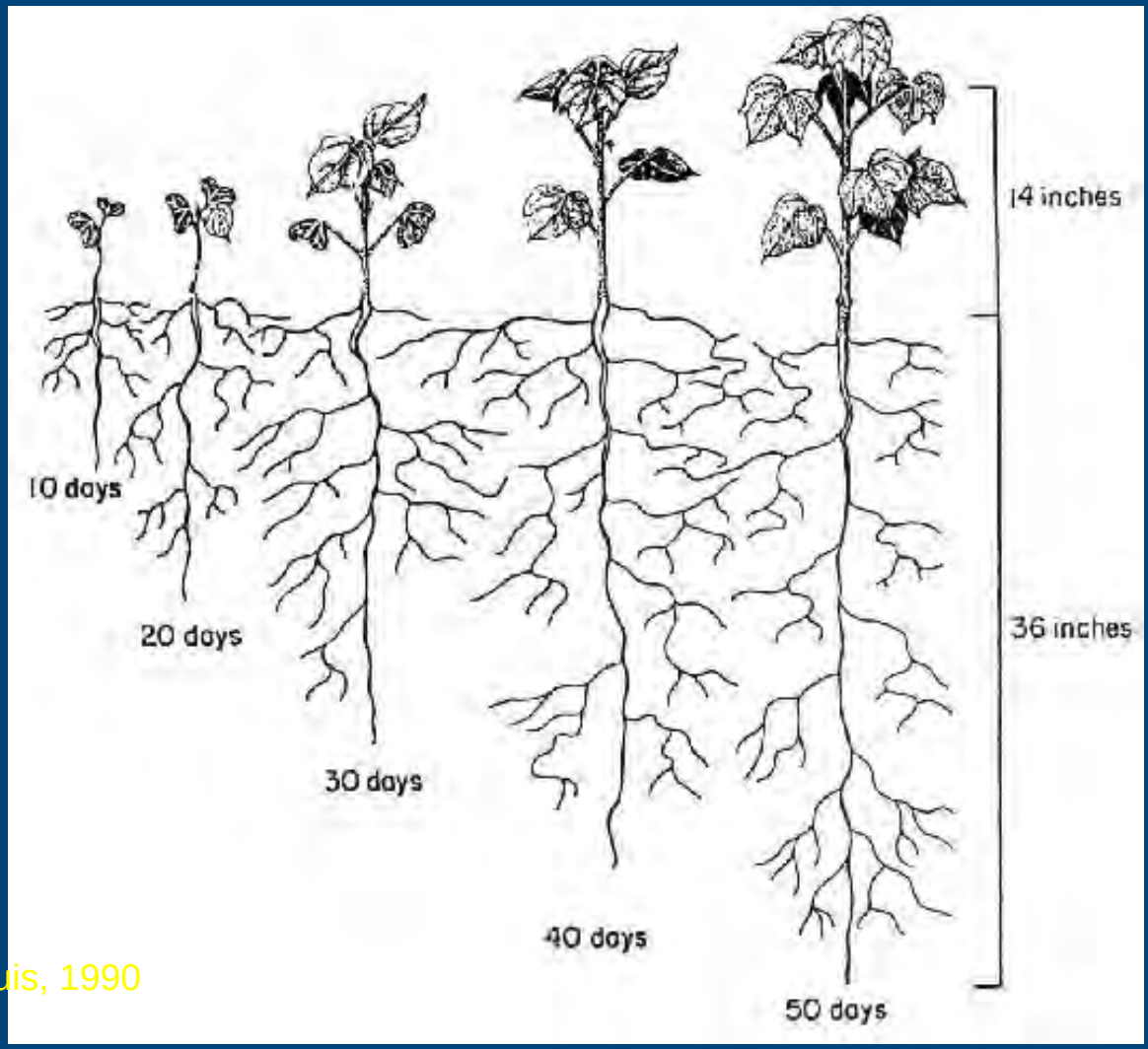
Fertilizer Placement Strategies for Row Crop Production

Larry Oldham, Ph.D.

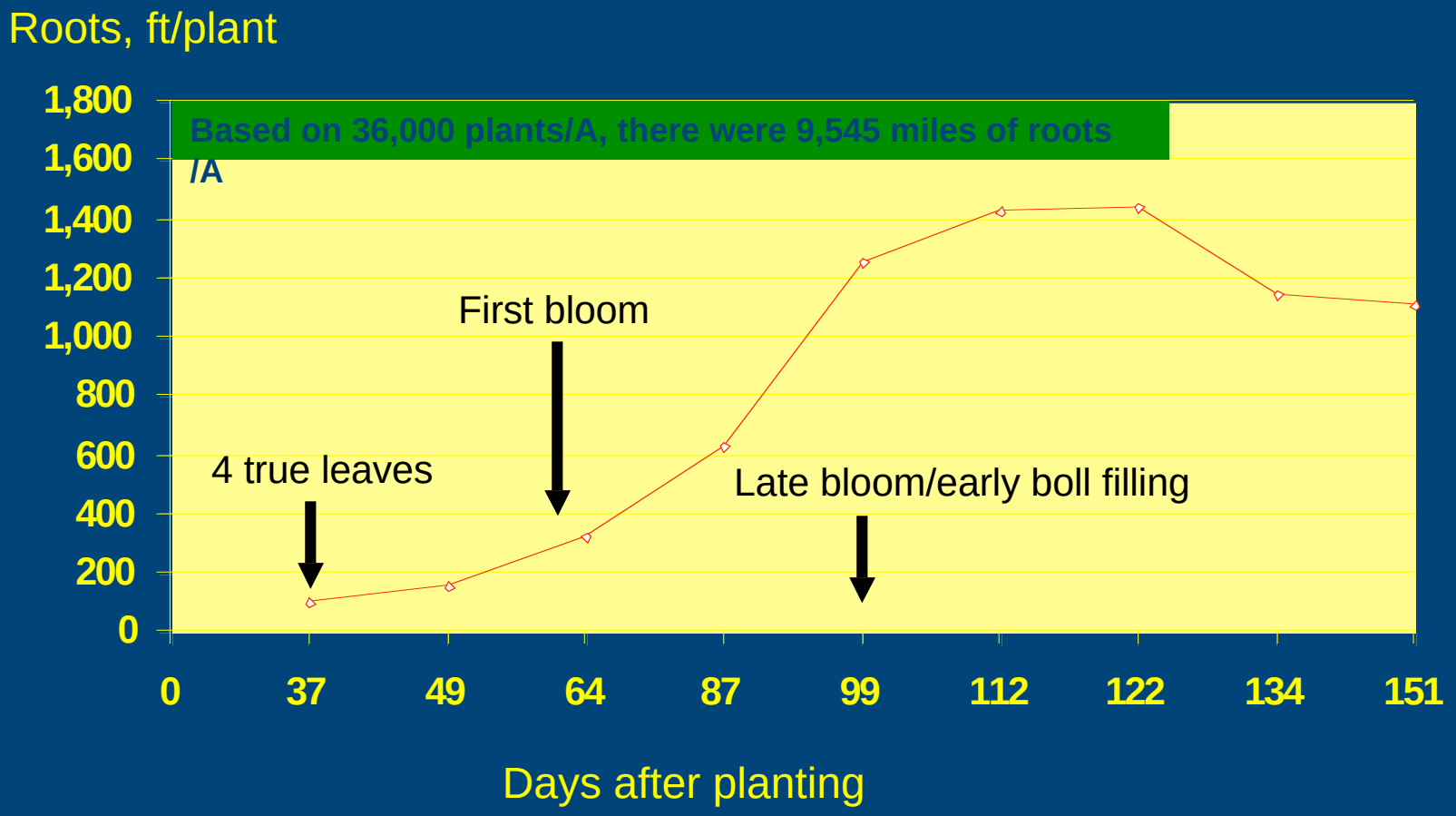
Extension Professor - Soils

Early Season Root Development of the Cotton Plant



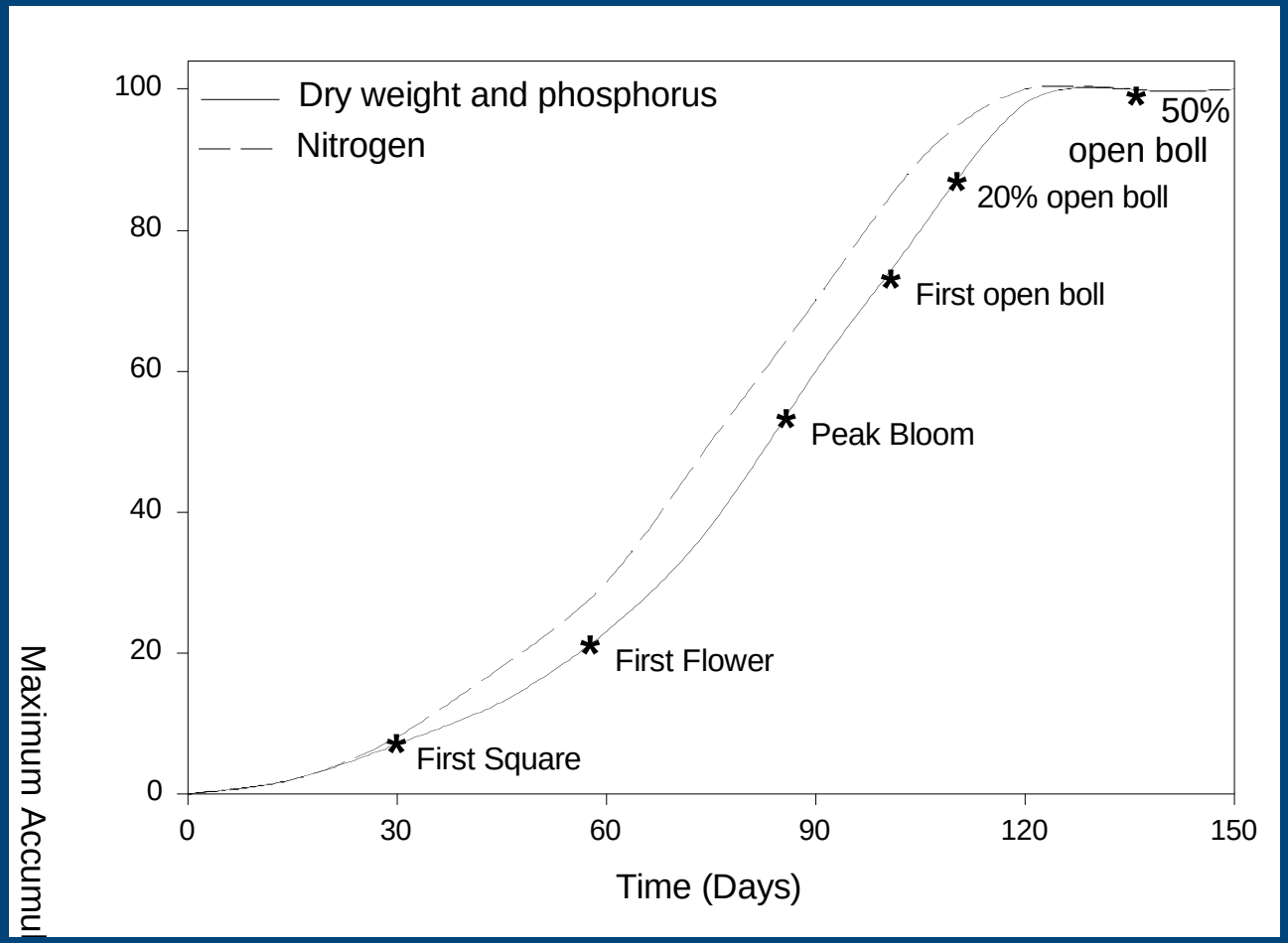
Source: Oosterhuis, 1990

Cotton Root Length as Affected by Days After Planting (Field Study)



Source: Schwab, Mullins & Burmester, 2000

Dry Matter Accumulation, and Nitrogen and Phosphorus Uptake of Cotton



Source: D. Krieg

Cotton Nutrient Uptake Compared to Yield

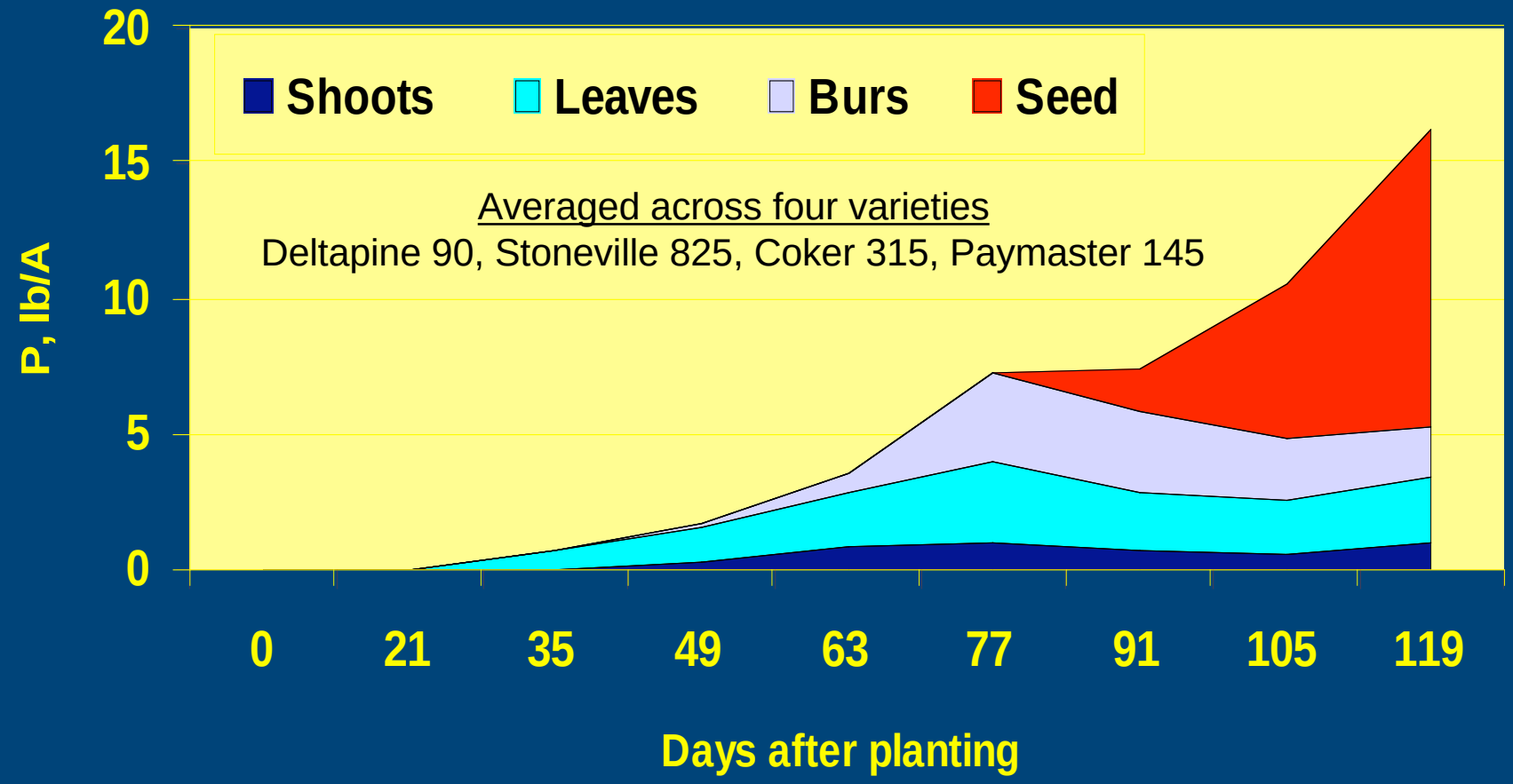
Where - Who	Year	Cotton type	Lint yield	N	P_2O_5	K_2O
			(lb/A)	-- lb per 100 lb of lint --		
GA-Olson	1942	Upland	760	18	8	18
CA - Bassett*	1970	Acala	1,450	10	3	11
Israel - Halevy*	1976	Acala	1,580	14	6	12
AL - Mullins	1990	Upland	880	20	6	18
LA - Breitenbeck	1993	Upland	1,230	14	6	13
AZ – Unruh*	1996	Upland	1,186	15	5	23
	1996	Pima	965	21	7	25
Removal in harvested crop						
PPI	2002	All		6.7	2.9	4.0

* Irrigated tests

Functions of Phosphorus in Cotton Production

- Essential for vigorous root and shoot growth
- Promotes early boll development and hastens maturity
- Helps overcome the effects of compaction
- Increases water use efficiency
- Necessary for energy storage and transfer in plants
- A two-bale crop can take up more than 50 lb P_2O_5/A

P Uptake by Modern Cotton Varieties
Lint Yield, 880 lb/A



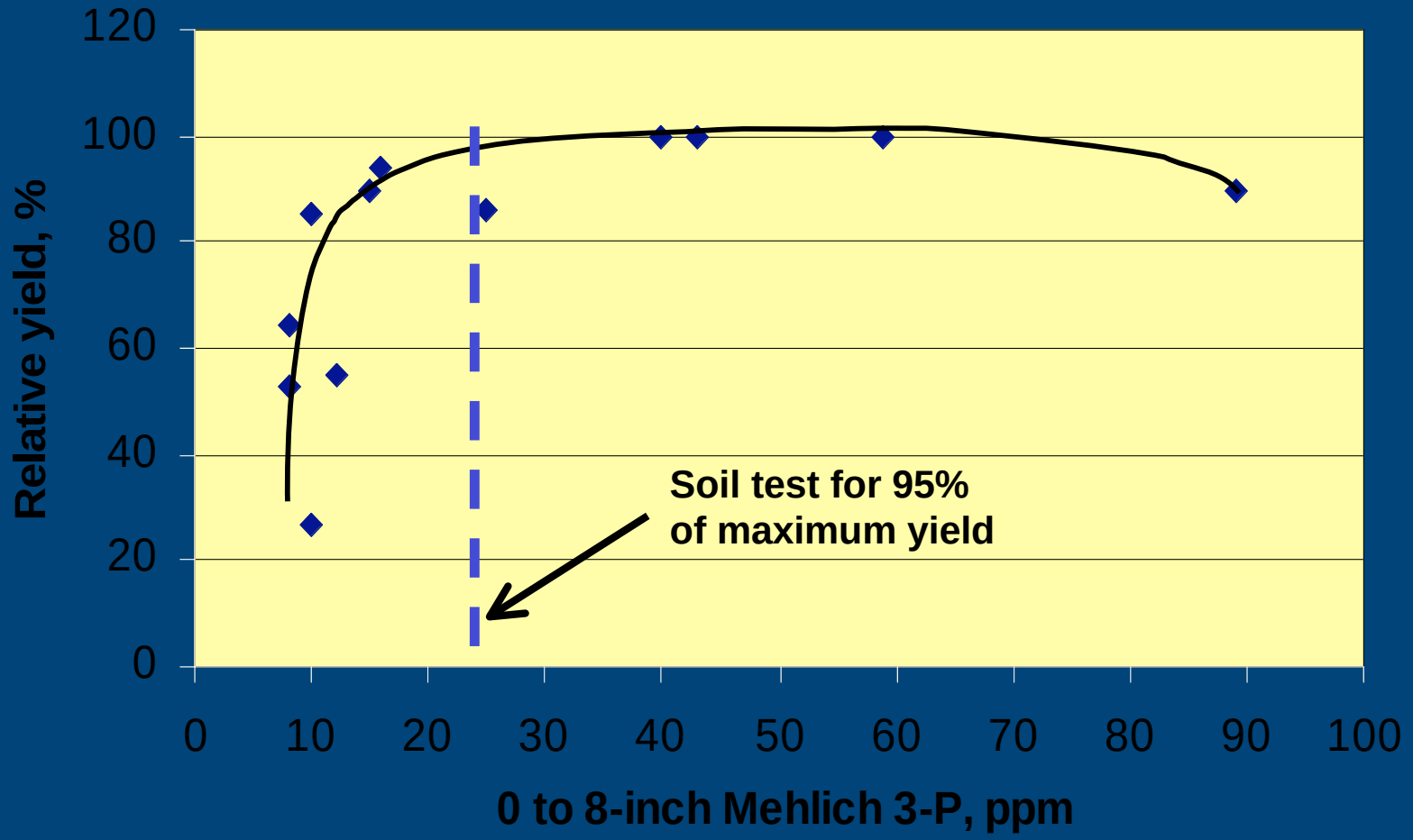
Source: Mullins & Burmester, 1990

Probability of a Phosphorus Response . . . An Example

Soil test P, category	Probability of response
Very low	> 80%
Low	60-80%
Medium	40-60%
High	20-40%
Very high	< 20%

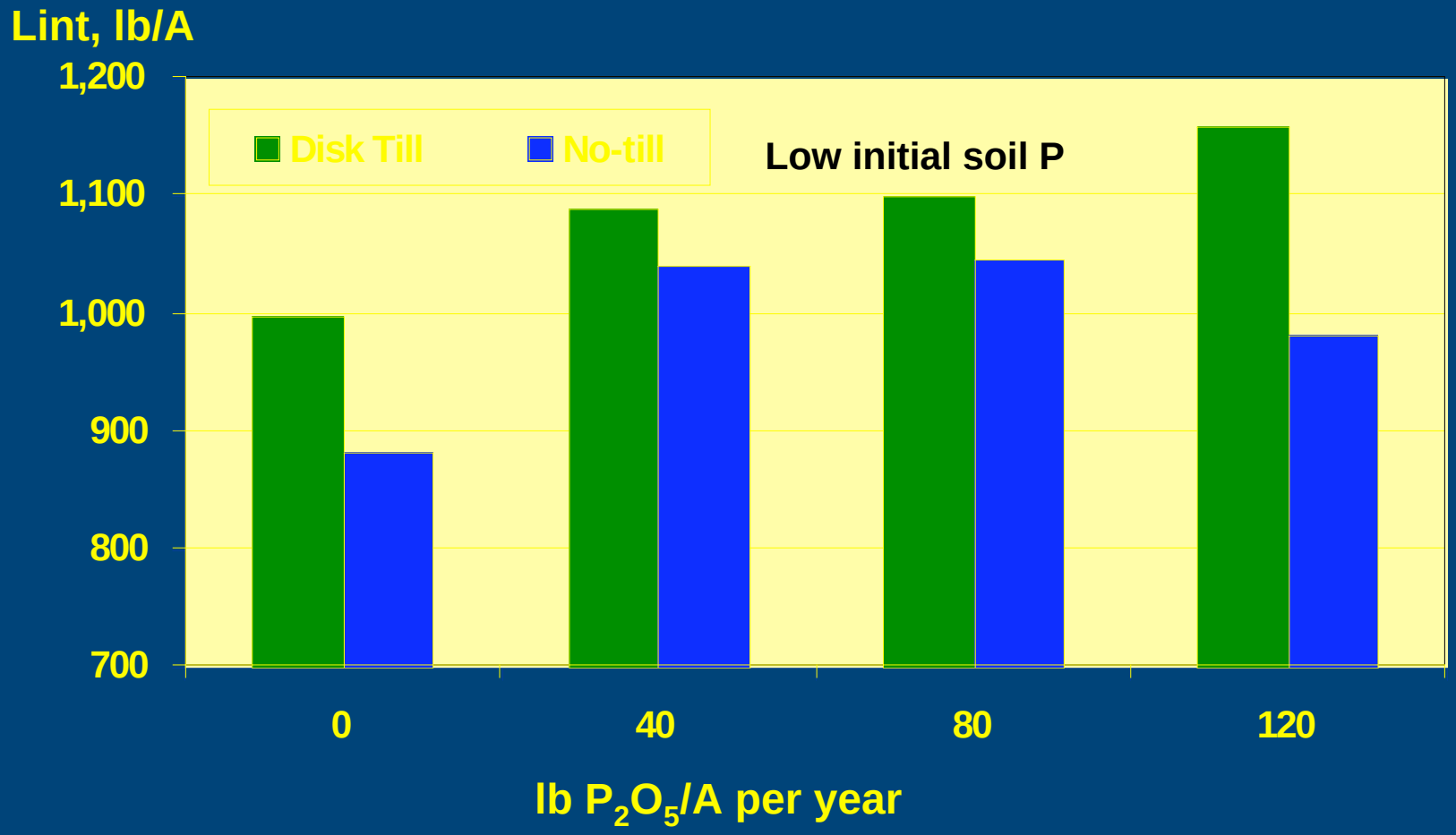
Category definitions vary among laboratories

Cotton Relative Yield Response to Mehlich 3 Soil Test P in North Carolina



Source: Cox, F.R. and J.S. Barnes, 2002

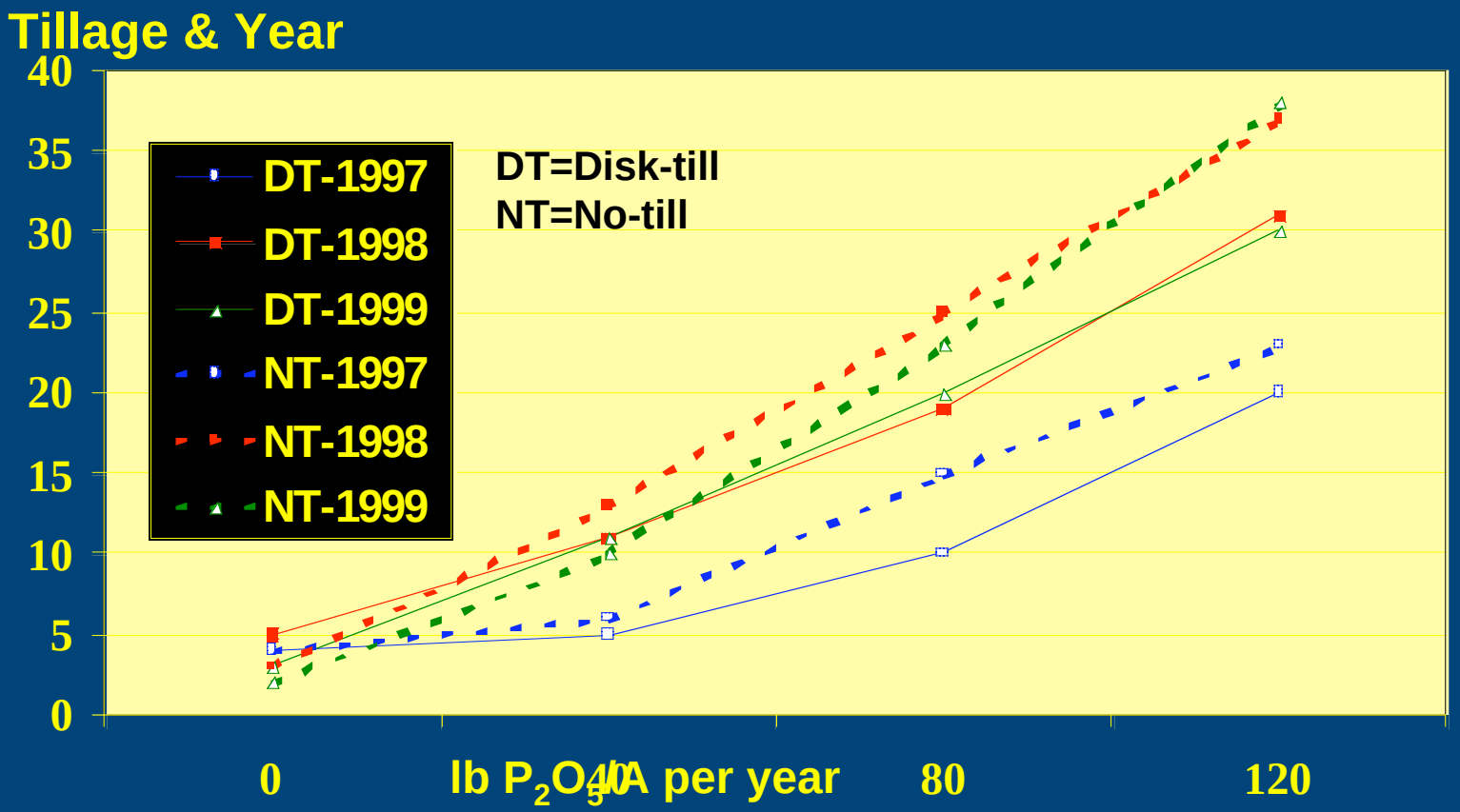
Six-Year Average Cotton Response to Phosphorus Rate and Tillage in Tennessee



Source: Howard & others, 2001

Mehlich 1 Soil P Levels After Three Years of P Fertilization on a Loessial Silt Loam Soil in TN

Mehlich 1 P, ppm at 0 to 6 in. depth



Source: Howard & others, 2001

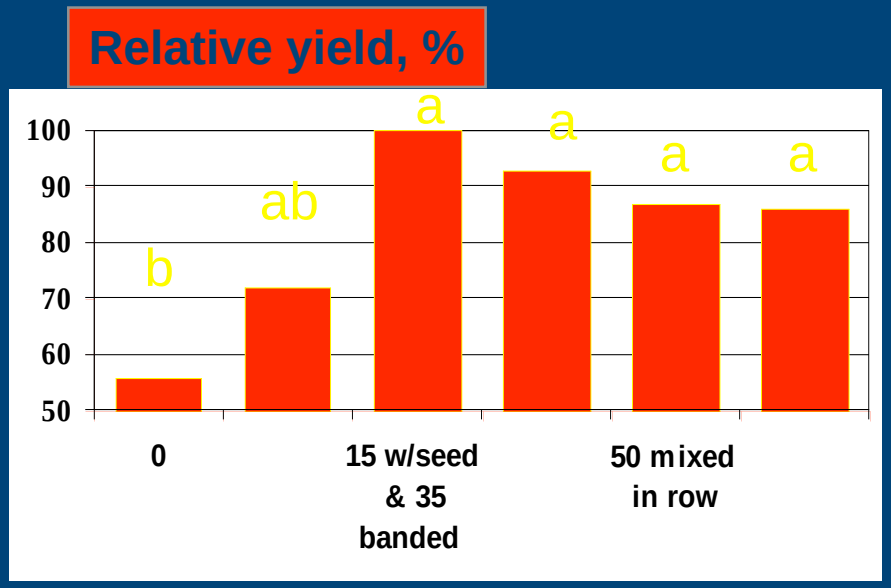
Phosphorus Placement Options

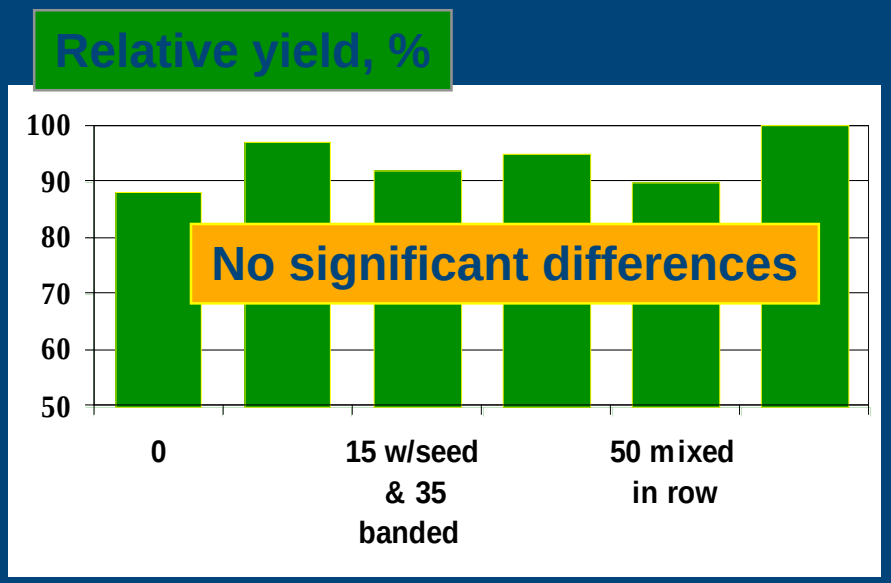
- Broadcast
- Banded 2 x 2 (2 in. to the side and 2 in. below seed)
- Surface banded
- Deep banded
- In-furrow with the seed (rates are limited due to possible seedling damage and toxicity)
  - Rates of 11-37-0 greater than 2.5 to 2.8 gal/A have been shown to reduce cotton stands and yield, and rates greater than 1.5 gal/A are not recommended (Burris et. al., 1992)

Effects of P Placement on Relative Cotton Yield

Low P soil
(29 lb/A extractable P)

High P soil
(126 lb/A extractable P)





lb P_2O_5/A applied and placement method

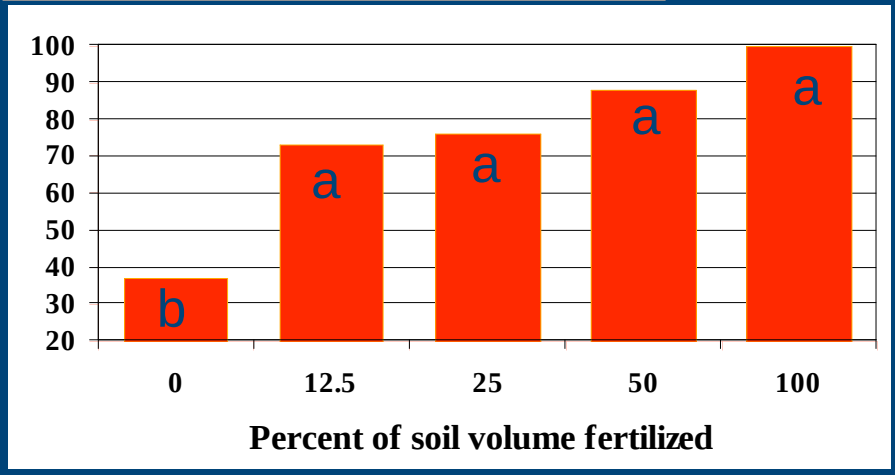
Source: Nelson & others, 1949. See notes for application methods

Effects of P Placement on Relative Cotton Root Length (Laboratory study)

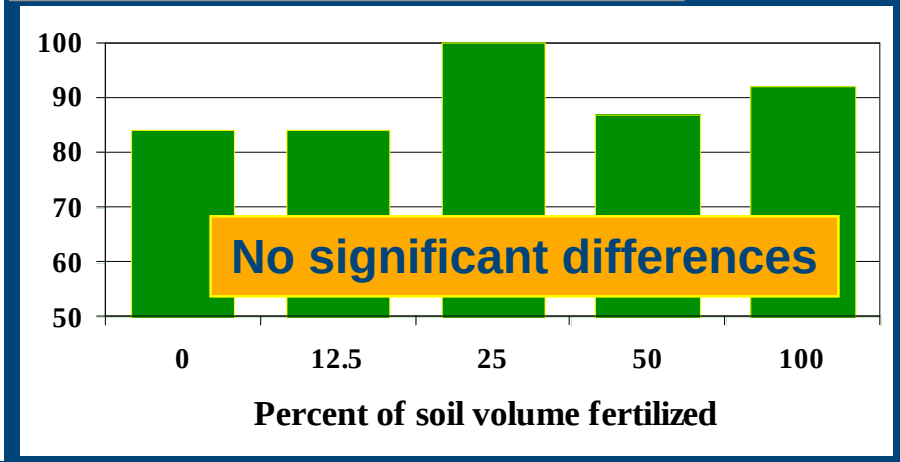
Low P Dewey soil (CEC=10)
14 lb/A (7 ppm) Mehlich 1-P

High P Marvyn soil (CEC=5)
88 lb/A (44 ppm) Mehlich 1-P

Relative total root length %



Relative total root length, %



Applied P per pot was identical within a soil

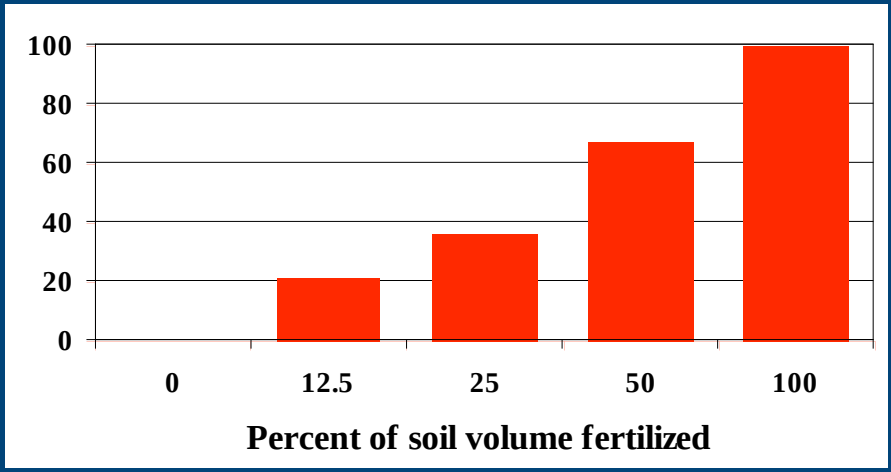
Source: Mullins, 1993

Effects of P Placement on Percent of Roots in Fertilized Soil (Laboratory study)

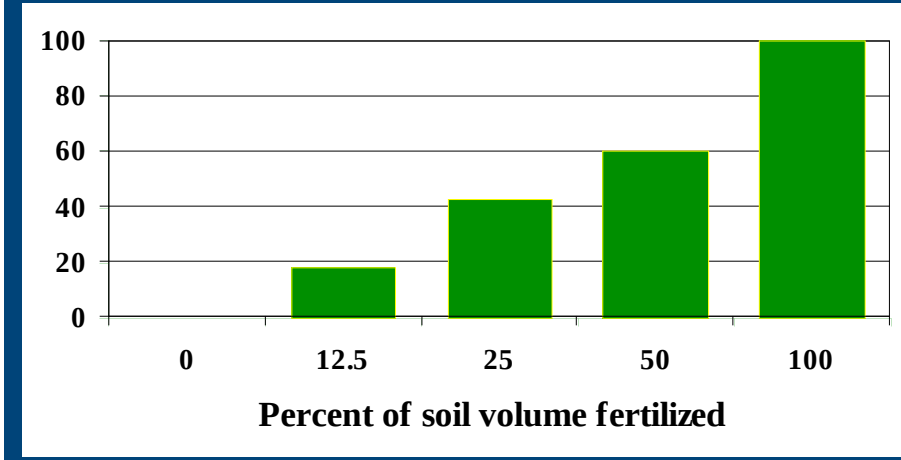
Low P Dewey soil (CEC=10)
(14 lb/A Mehlich 1-P)

High P Marvyn soil (CEC=5)
(88 lb/A Mehlich 1-P)

% of roots in P-treated volume



% of roots in P-treated volume



Applied P per pot was identical within a soil

Source: Mullins, 1993

Effect of In-furrow Starter Fertilizer on Cotton Yield (LA)

Year	Soil texture	Check	In-furrow Starter	Difference
		lint yield, lb/A		
1990	Silt loam	1255	1400	145*
1991	Silt loam	1184	1191	7
1991	Silt loam	1503	1586	83*
1992	Silt loam	878	889	11
1992	Silt loam	922	911	-11
1992	Silt loam	999	1040	41
1992	Clay	515	697	182*
1992	Silt loam	734	837	103*
1993	Silt loam	941	1174	233*
Average		992	1081	88

* Differences were significant a the 0.05 level of probability.
11-37-0 starter was applied at the rate of 1.5 gal/A.
All soils tested high to very high in P.

Source: Kovar et. al., 1993.

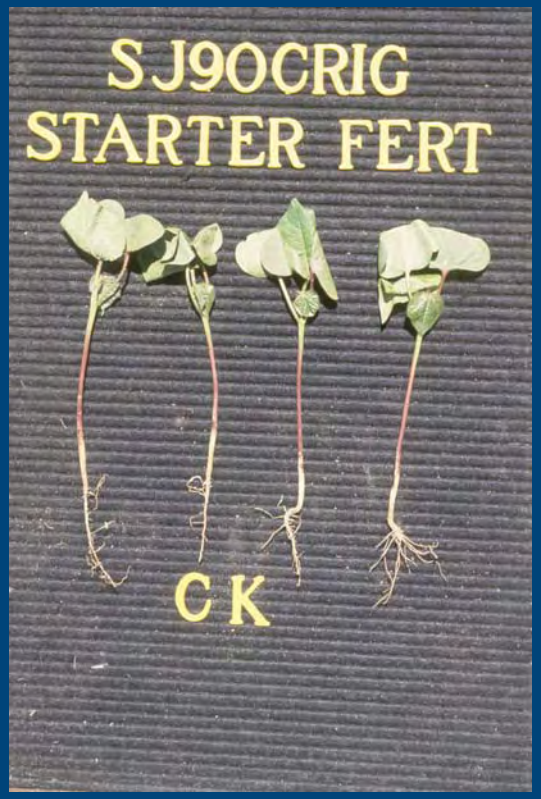
Effect of Surface Banded Starter Fertilizer on Cotton Yield (LA)

Year	Soil texture	Check	Surface banded	Difference
		lint yield, lb/A		
1990	Silt loam	1,255	1,443	188*
1990	Silt loam	823	895	72
1990	Silt loam	1,045	1,032	-13
1991	Silt loam	1,184	1,331	147*
1991	Silt loam	949	1,073	124*
1992	Silt loam	999	1,144	145
1992	Silt loam	878	957	79*
1993	Silt loam	860	969	109*
Average		999	1,106	106

* Differences were significant a the 0.05 level of probability.
11-37-0 starter was applied in a 3 inch surface band at the rate of 12 gal/A.
All soils tested high to very high in P.

Source: Kovar et. al., 1993.

Effects of Fertilizer Placement on Cotton Seedling Growth (LA)



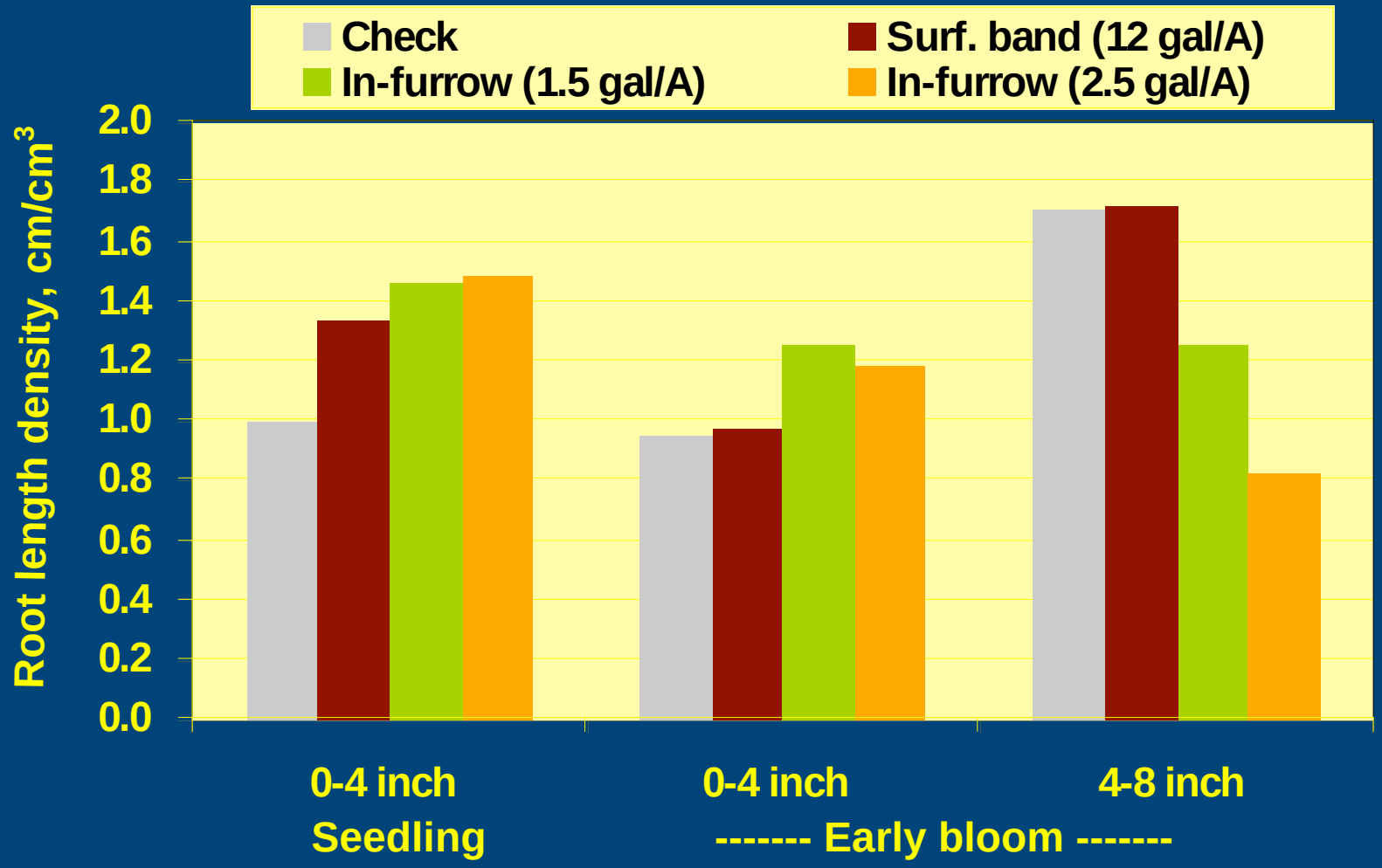
Check

12 gal/A 11-37-0 surface banded

1.5 gal/A 11-37-0 in-furrow

Source: Kovar et. al., 1993. High soil test P level

Effect of Starter Fertilizer (11-37-0) on Cotton Root Length Density (LA)



Source: Kovar et. al., 1993. High soil test P level

Conclusions

- Adequate P nutrition is critical in optimizing yield, quality, and profit in cotton production.
- While placement of P fertilizer is not as important as in the production of many other crops, banding P can increase yields in some situations (e.g., reduced or no-till, compacted soil conditions).
- Soil test levels should be maintained in the medium to high range to assure consistent production, and that P does not limit cotton yield and quality.

Starter Fertilizer for Cotton

Eddie Funderburg Version

Beginnings with Starter Fertilizer on Cotton

- Want simple, cheap technique
- Question regarding soils where P would not be recommended broadcast
- Profitability

Brief Early History

- 1 location in Yazoo Co in 1985
- Applied 12 gallons/A of 10-34-0 in a 4 inch band over the top of the row
- Achieved good response
- 3 locations (Yazoo, Carroll and Tallahatchie) in 1986
- Significant responses in 2 of 3 locations

Mississippi Summary

- Approximate, reconstructed data
- In 18 on-farm sites, there were significant yield responses in 13 sites
- Average yield increase was ~ 85 lbs lint/A across all locations
- Average yield increase where a significant response was observed was ~ 100 lbs lint/A
- All involved 12 gallons/A of 10-34-0 or 11-37-0 per acre in a 3-4 inch surface band or a dribble surface band 2 inches to the side of the row

Results from Other States

- Abundant studies conducted across the cotton belt
- Contradictory findings

No-Till Cotton Response to Starter Fertilizer in AL

Yields are only for years with significant yield response

(data from Touchton et al., 1986, and unpublished data)

Location	Seed Cotton Yield, lb/A		
	No starter	Starter	Increase
Tenn. Valley (2 of 3 years)	2415	2795	380
Wiregrass (2 of 3 years)	3500	4040	540
Monroeville (1 year)	1600	2160	560
Brewton (1 year)	1935	2003	68

Source: C. C. Mitchell Auburn Univ.
Courtesy Cliff Snyder, PPI

Alabama Data

- **In 1988-89, surface-banding N-P starter significantly increased yield at only one of 16 field locations over a two-year period – *Mitchell and Burmester, AU Farm Demonstration Reports February 1989 and December 1989***

Georgia Data
Hodges and Baker
1990 Prod Beltwide Cotton Conf

- *"Starters did result in significant yield increases on a Tifton soil testing high in P. Responses included increased height at first square and lint yield. Although 2X2 placement methods have been more consistent in providing yield increases, the differences are usually not significantly greater than 3 inch sprayed bands".*

Tifton, Georgia 1996-98
Gascho, et al

Proc 22nd Ann Southern Cons Till Conf for Sust Ag

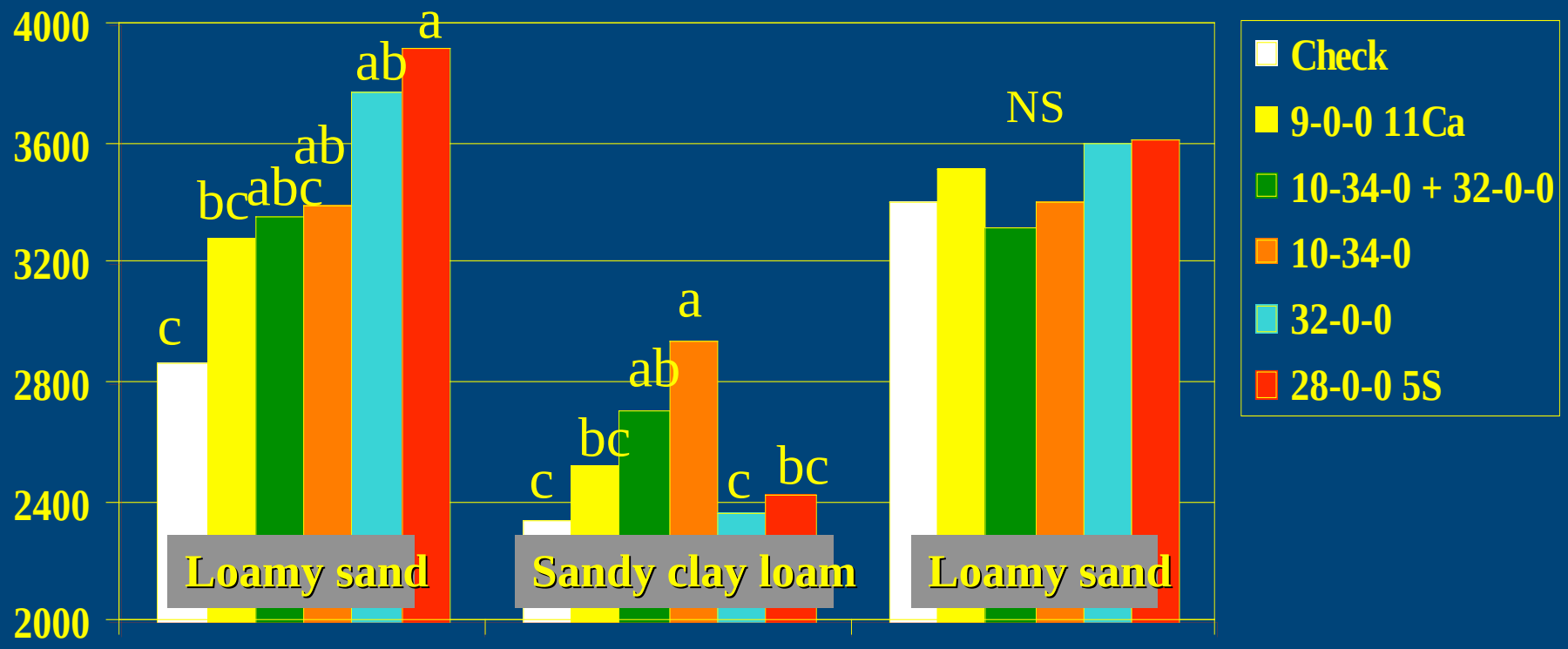
	1996	1997	1998	Average
Check	1114 b	1120 b	982 a	1072
10-34-0 2X2	1192 a	1228 a	962 a	1127

Starter fertilizer main effects averaged across poultry litter rates.

Seedcotton Yield Response to Starters in Georgia, 1997 Bednarz, Harrris, & Shurley. 2000. Agron. J. 92:766-771

Seedcotton yield, lb/A

Note: Recommended preplant fertilizer was applied at each site



	Midville	Plains	Tifton
Mehlich 1 P (lb/A)	36	34	61

pH was 6.1 to 6.2

Starter placed 2 inches below and 2 inches to side of seed

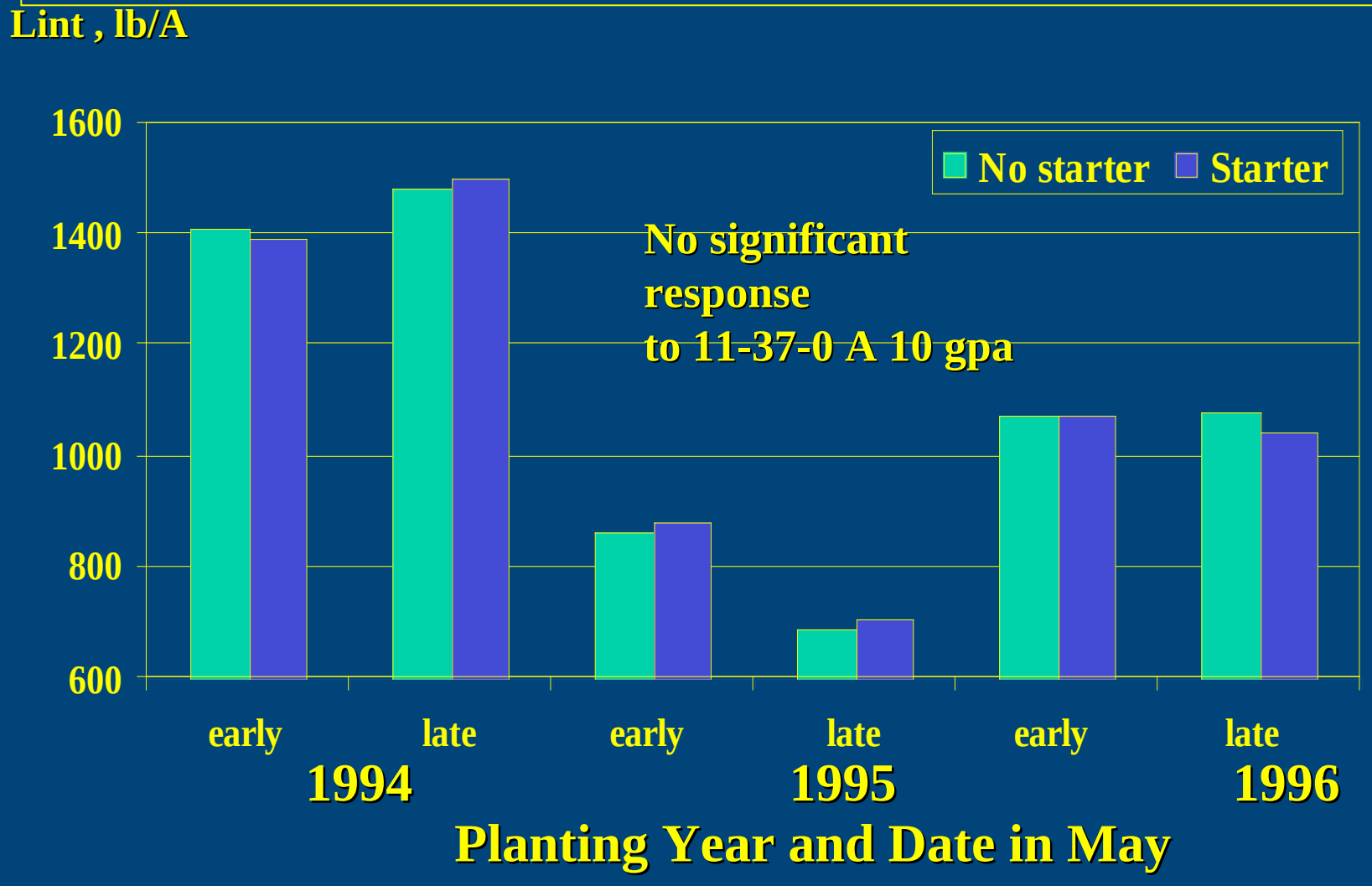
Total of 90 lb N/A applied to all treatments during the growing season

North Carolina Data
David Guthrie
1988 Proc Beltwide Cotton Conf

- **In North Carolina, 2x2-inch band application of starter significantly increased yield at four locations during a two-year period**

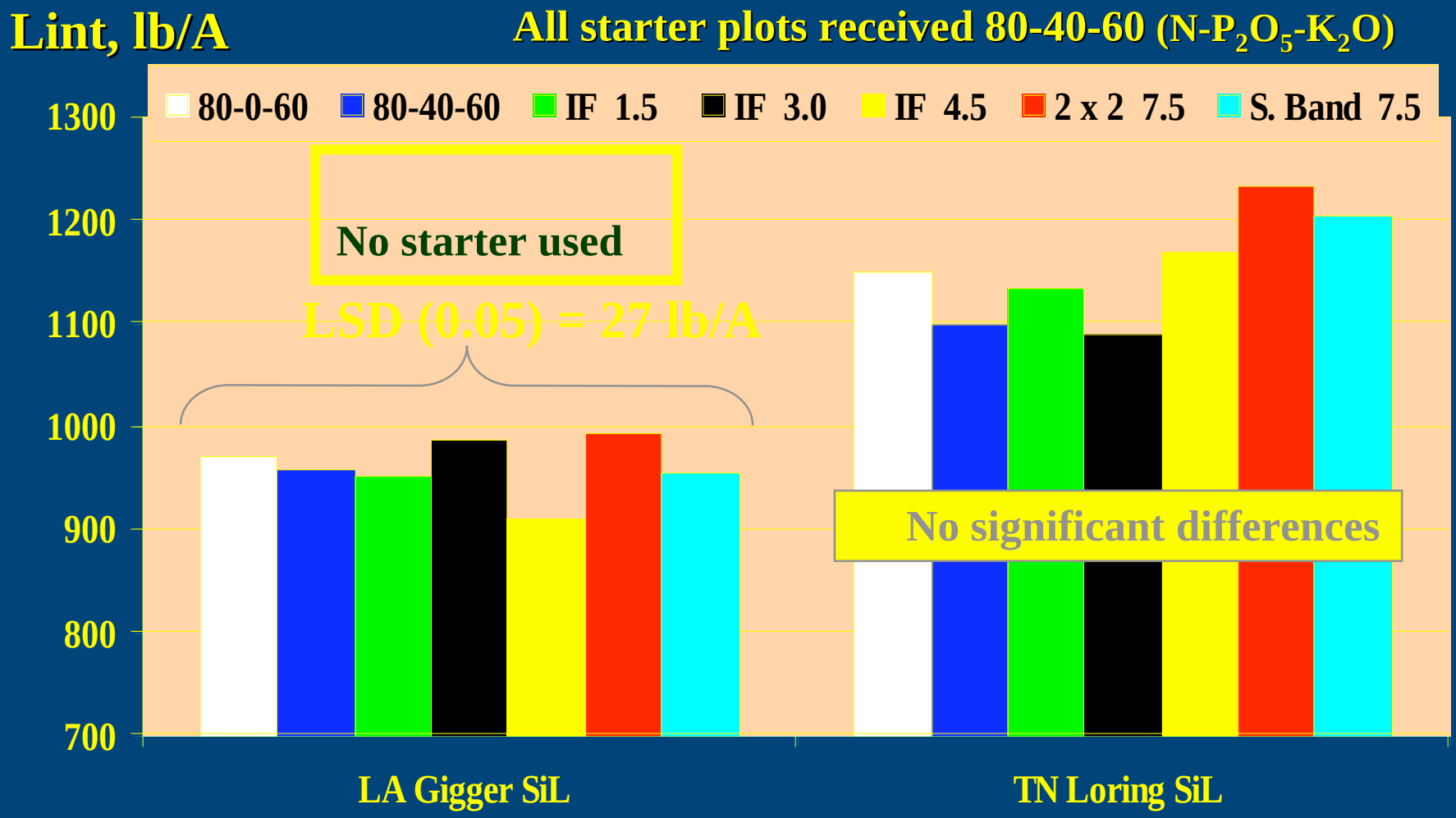
Influence of In-Furrow Starter Fertilizer on Cotton Yield in Portageville, Missouri

Phipps et al. 1997. Proc. Beltwide Cotton Conference 2:1476-1479



3-Year Average Starter Response by Conventional Till Cotton in Louisiana and Tennessee

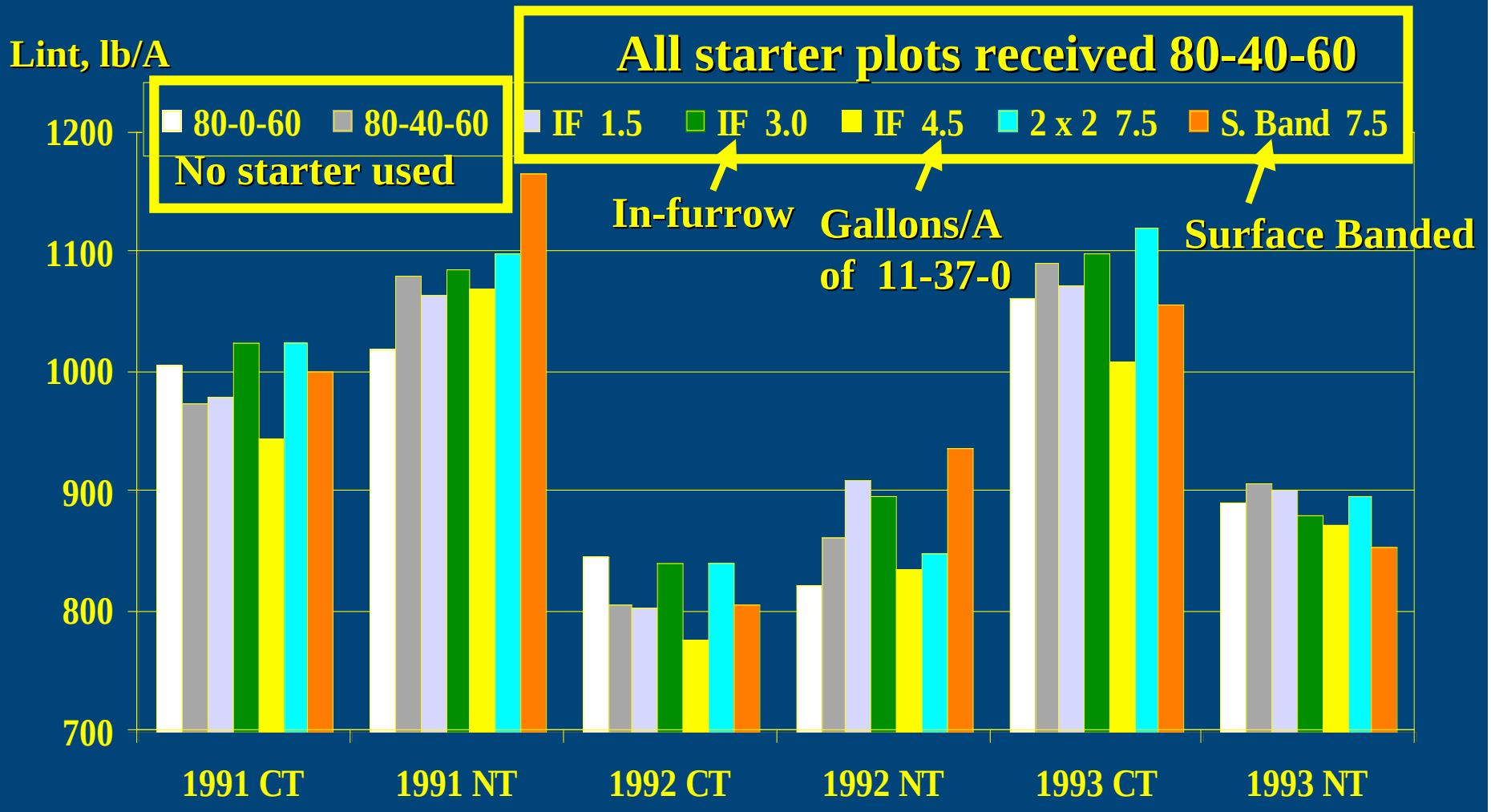
Hutchinson and Howard. 1997. J. Plant Nutrition 20(7&8):975-986.



Soil test P level rated high at both sites

Starter Fertilizer Response by Conventional and No-Till Cotton on a Gigger Silt Loam in Louisiana

Kovar, Funderburg and Hutchinson. 1993/94. Better Crops 78(1):9-11



CT= conventional till; NT=No-till

Cotton Response to Starter Fertilizer in Farmer Fields -LA

Kovar, Funderburg and Hutchinson. 1993/94. Better Crops 78(1):9-11

		Cotton lint yield, lb/A		
Year	Soil	Check	Starter	Difference
1990	Commerce SiL	1255	1400	145*
1991	Commerce SiL	1184	1191	7
1991	Necessity SiL	1503	1586	83*
1992	Loring SiL	878	889	11
1992	Caspiana SiL	922	911	(11)
1992	Commerce SiL	999	1040	41
1992	Sharkey C	515	697	182*
1992	Norwood SiL	734	837	103**
1993	Rilla SiL	941	1174	233**
MEAN		992	1081	89

Starter = 1.5 gpa 11-37-0 in-furrow @ planting

Response to Starter in Farmer Fields - LA

Kovar, Funderburg and Hutchinson. 1993/94. Better Crops 78(1):9-11

		Cotton lint yield, lb/A		
Year	Soil	Check	Starter	Difference
1990	Commerce SiL	1255	1443	188**
1990	Norwood SiL	823	895	72
1990	Loring SiL	1045	1032	(13)
1991	Commerce SiL	949	1073	124**
1992	Commerce SiL	999	1144	145*
1992	Loring SiL	878	957	79*
1993	Loring SiL	860	969	109*
MEAN		999	1106	107

Starter = 3-inch surface band 11-37-0 @ 12 gpa @ planting

Summary

- Starters do not work for all the people all the time
- When they do work, results are profitable
- Encourage farmers to try system on limited acreage before making decision

North Carolina State 2005 - 2006

Deanna Osmond et al.

Question?

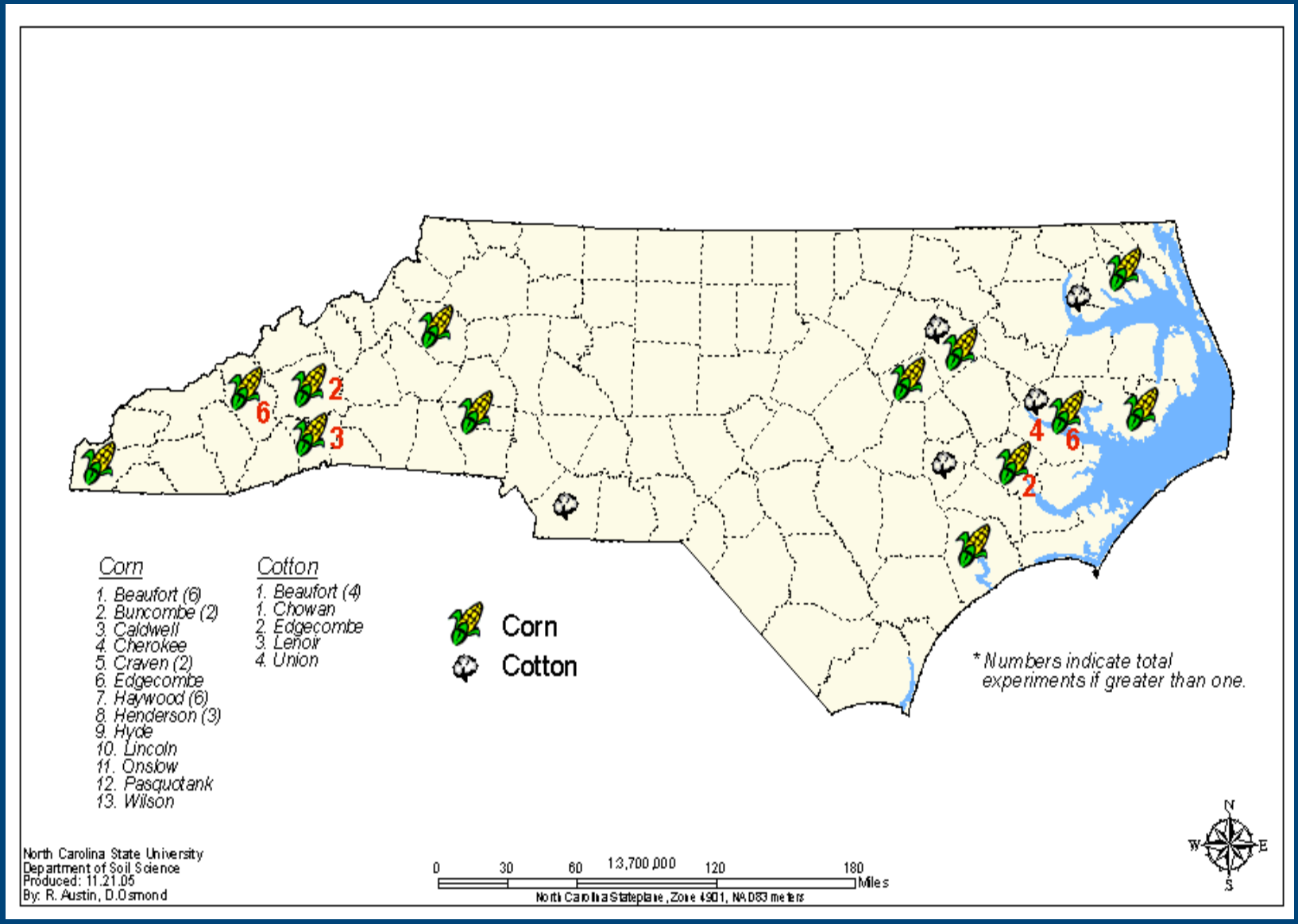
When Soil Test Levels Are Very High

(>100 P-Index)

Do Producers Still Need Starter Phosphorus Fertilizer?

Methodology

P Starter Trial Locations



Experimental Design: Corn and Cotton

Starter N
+
Layby N

Starter N + P
+
Layby N

Data Collected: Soil, Fertilizer & Agronomic

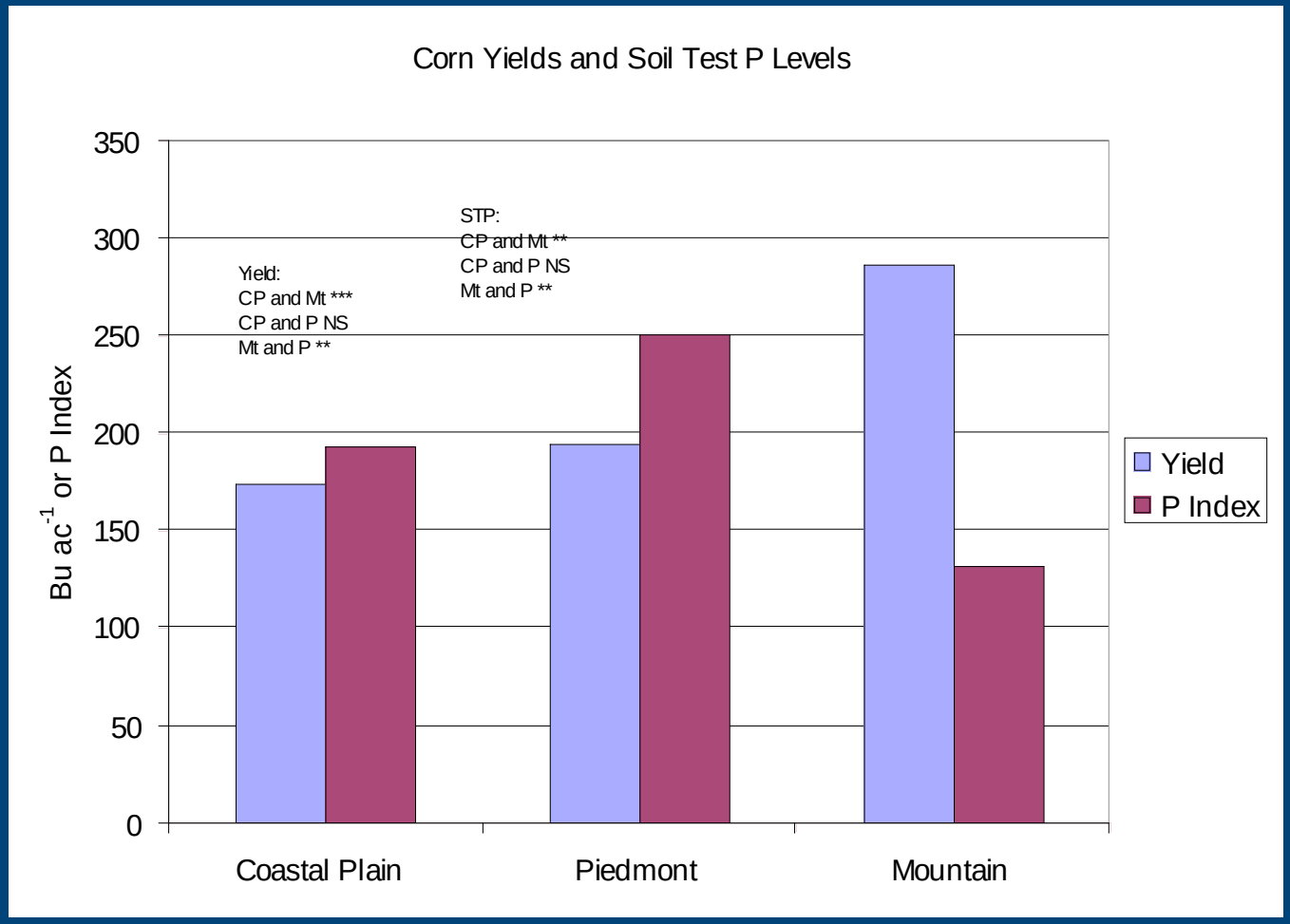
- Soils Information
  - Soil mapping unit
  - Realistic yield expectation
  - Soil test P – before
  - Soil test P – after
- Fertilizer Information
  - Total N rate
  - Application date(s)
  - Fertilizer source(s)
  - Application type
- Agronomic Information
  - Seed treatment
  - Herbicide (name & quantity)
  - Insecticide program (name & quantity)
  - Variety
  - Row spacing

Data Collected: Plant Growth Characteristics

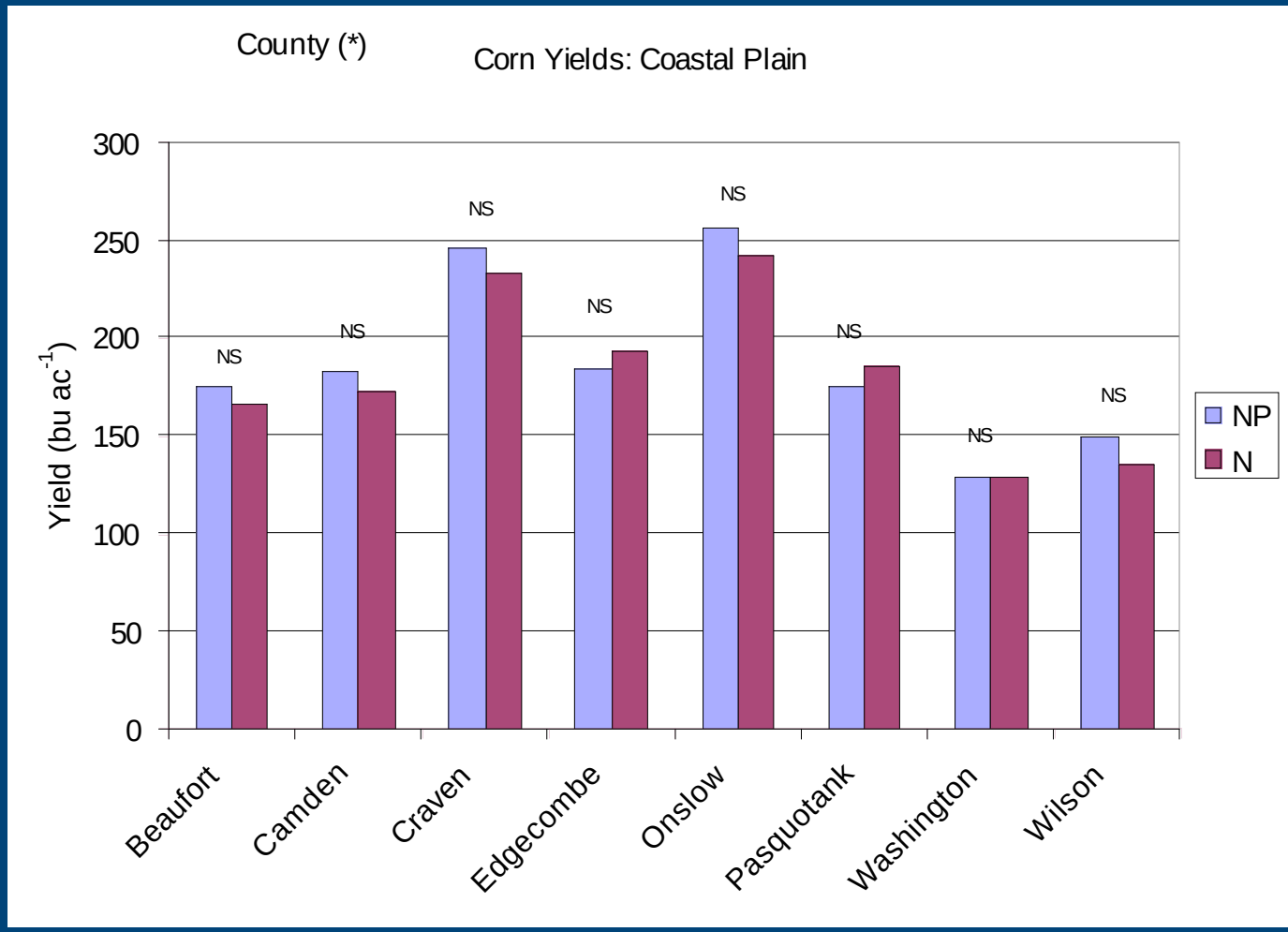
Corn	Cotton
Plant Height (3 wks ger)	Plant Height (3 wks ger)
Plant Tissue (10-12”)	Plant Tissue (8 leaf stage – most dev. Leaf)
Days to Silking	Date of Early Bloom
	Nodes Above White Flower
Final Plant Population	Final Plant Population
Yield	Yield


2005 & 2006

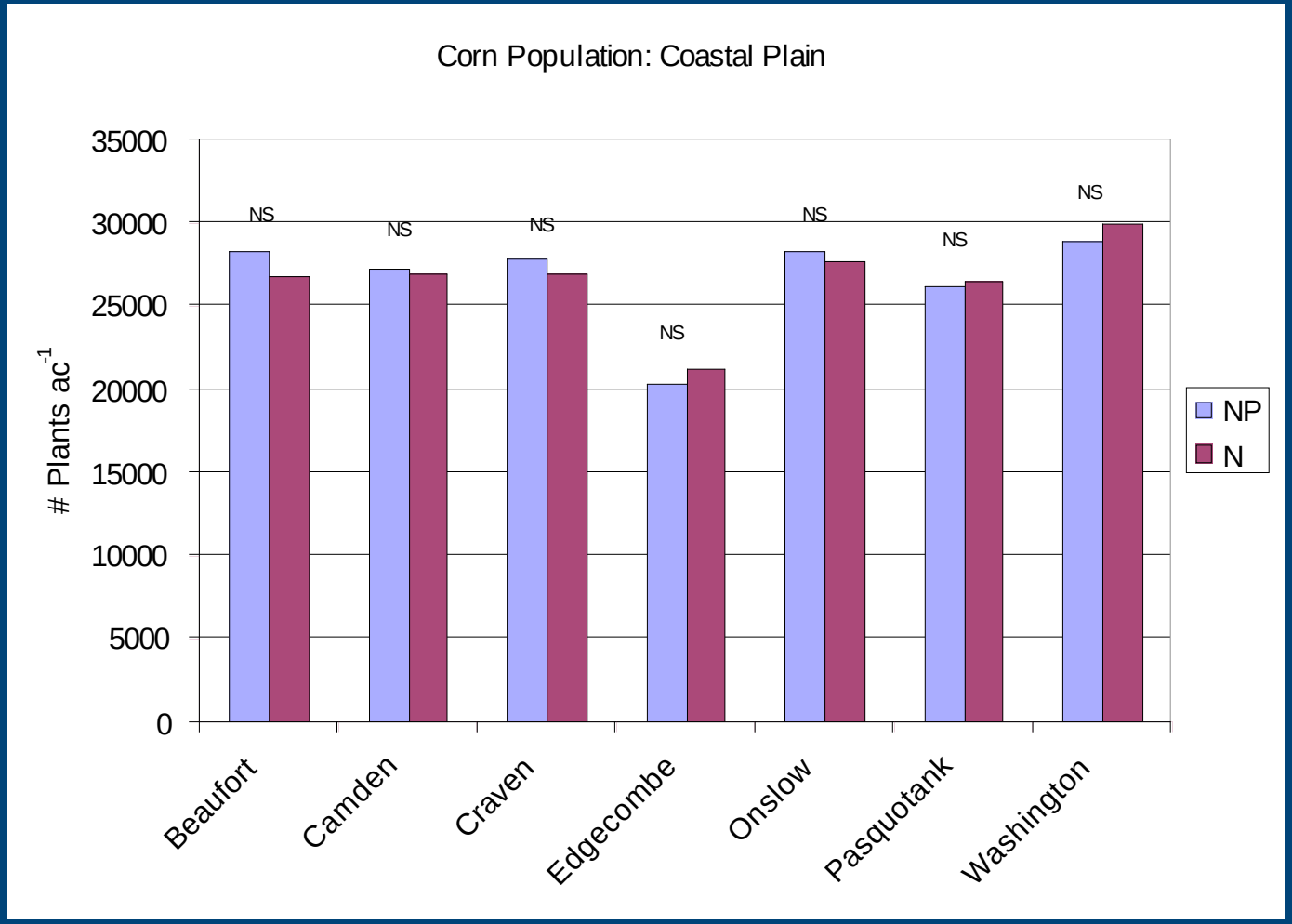
Corn Yields and Soil Test P Levels



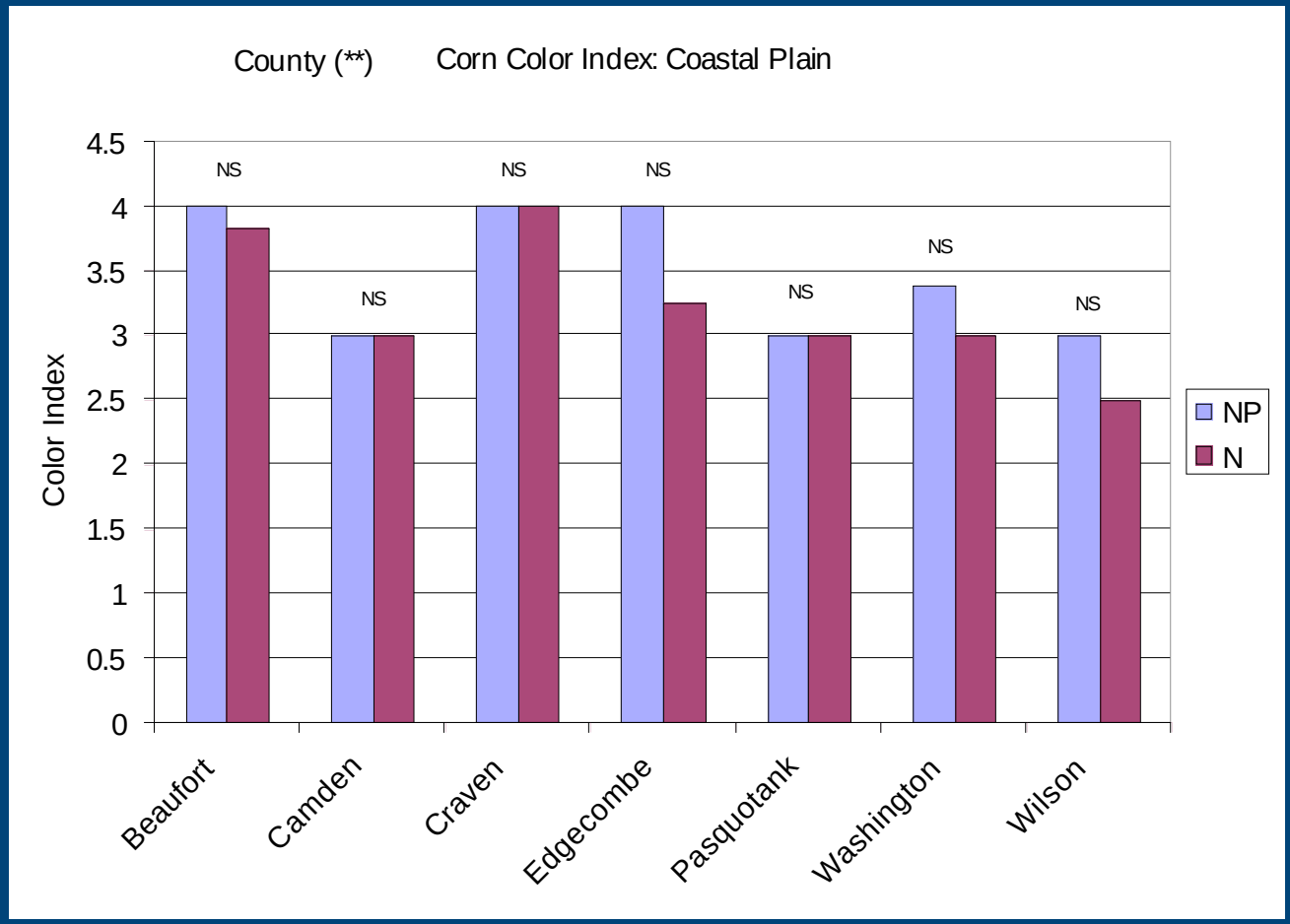
Corn Yields: Coastal Plain



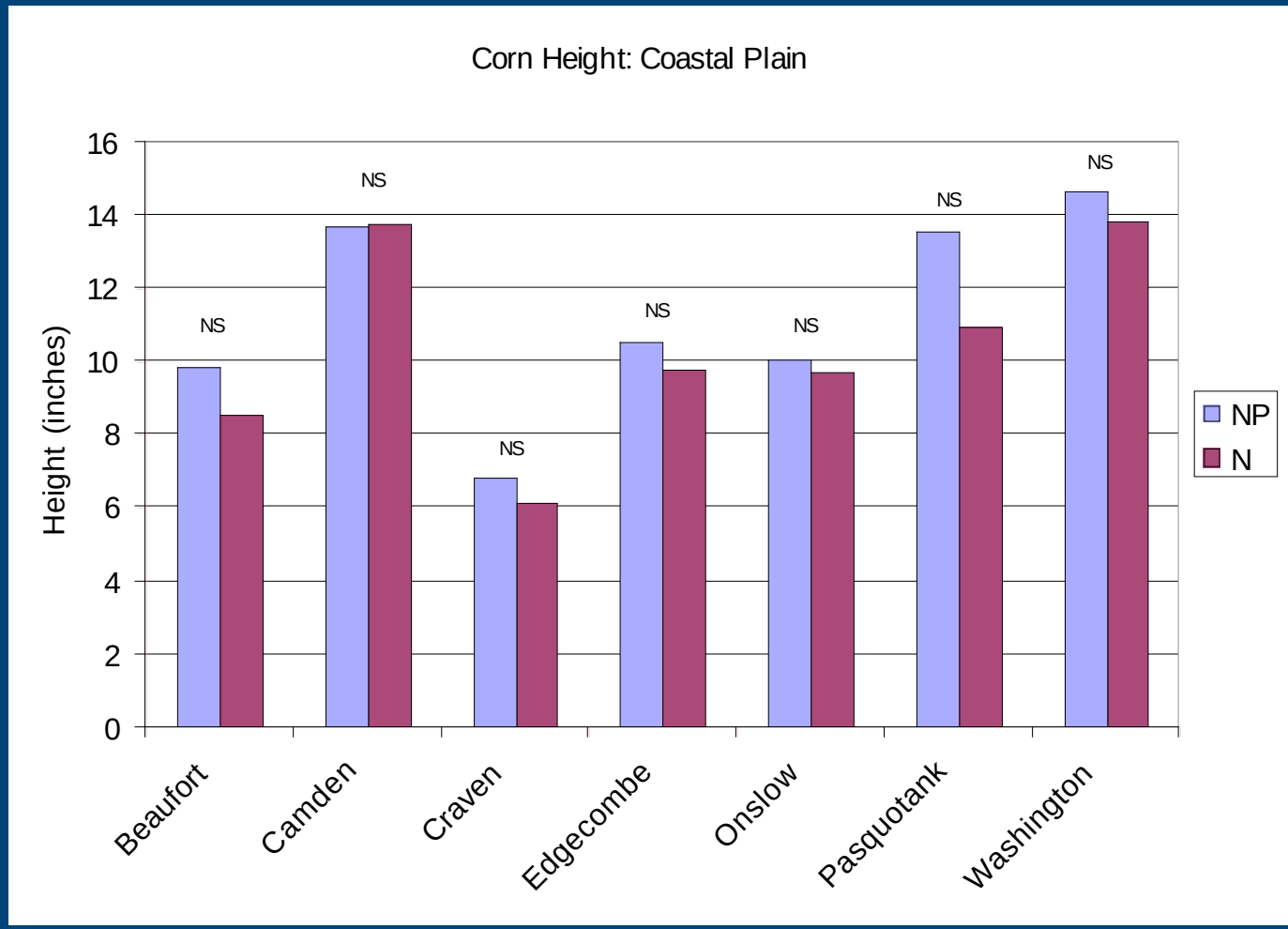
Corn Population: Coastal Plain



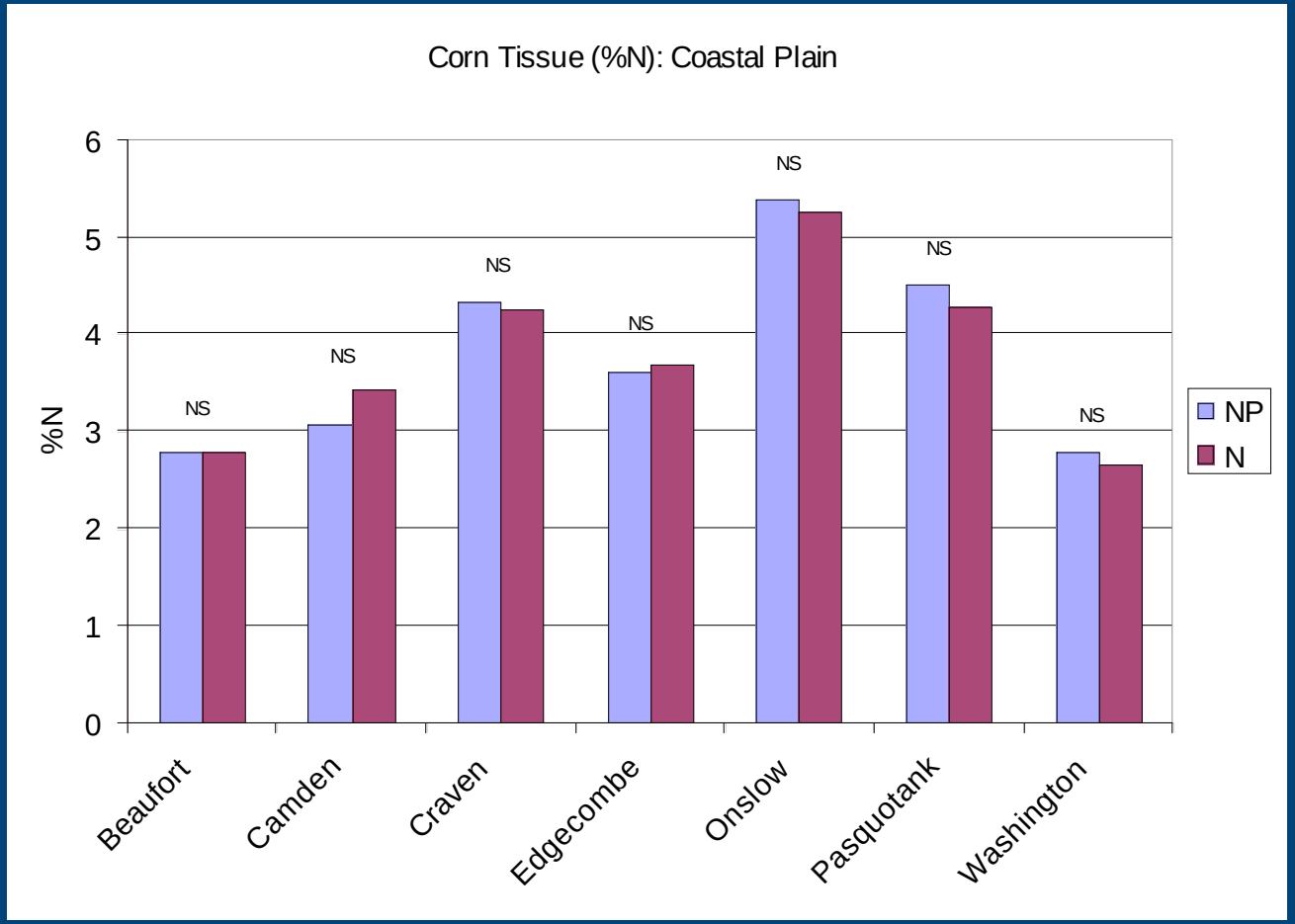
Corn Color Index: Coastal Plain



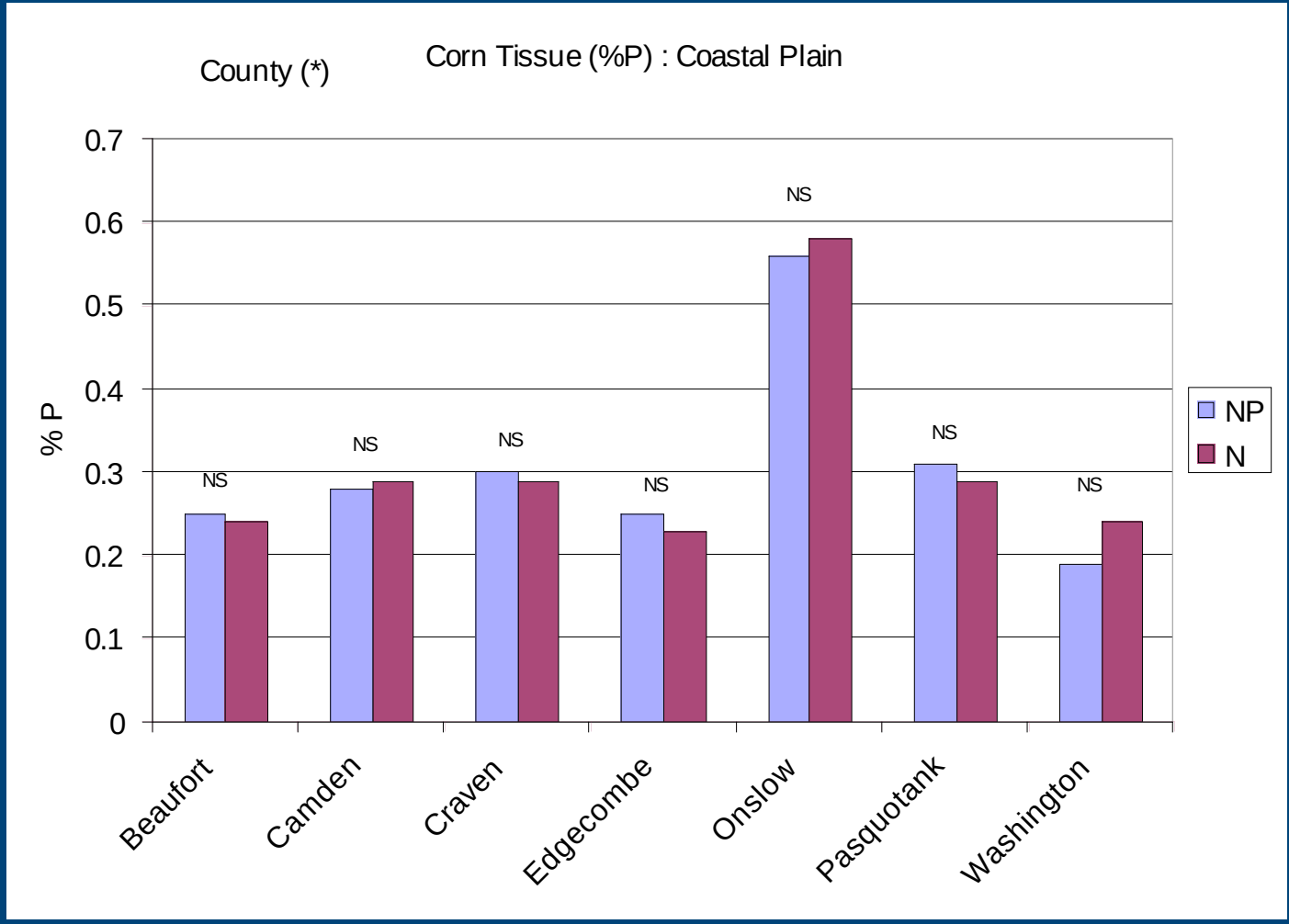
Corn Height: Coastal Plain



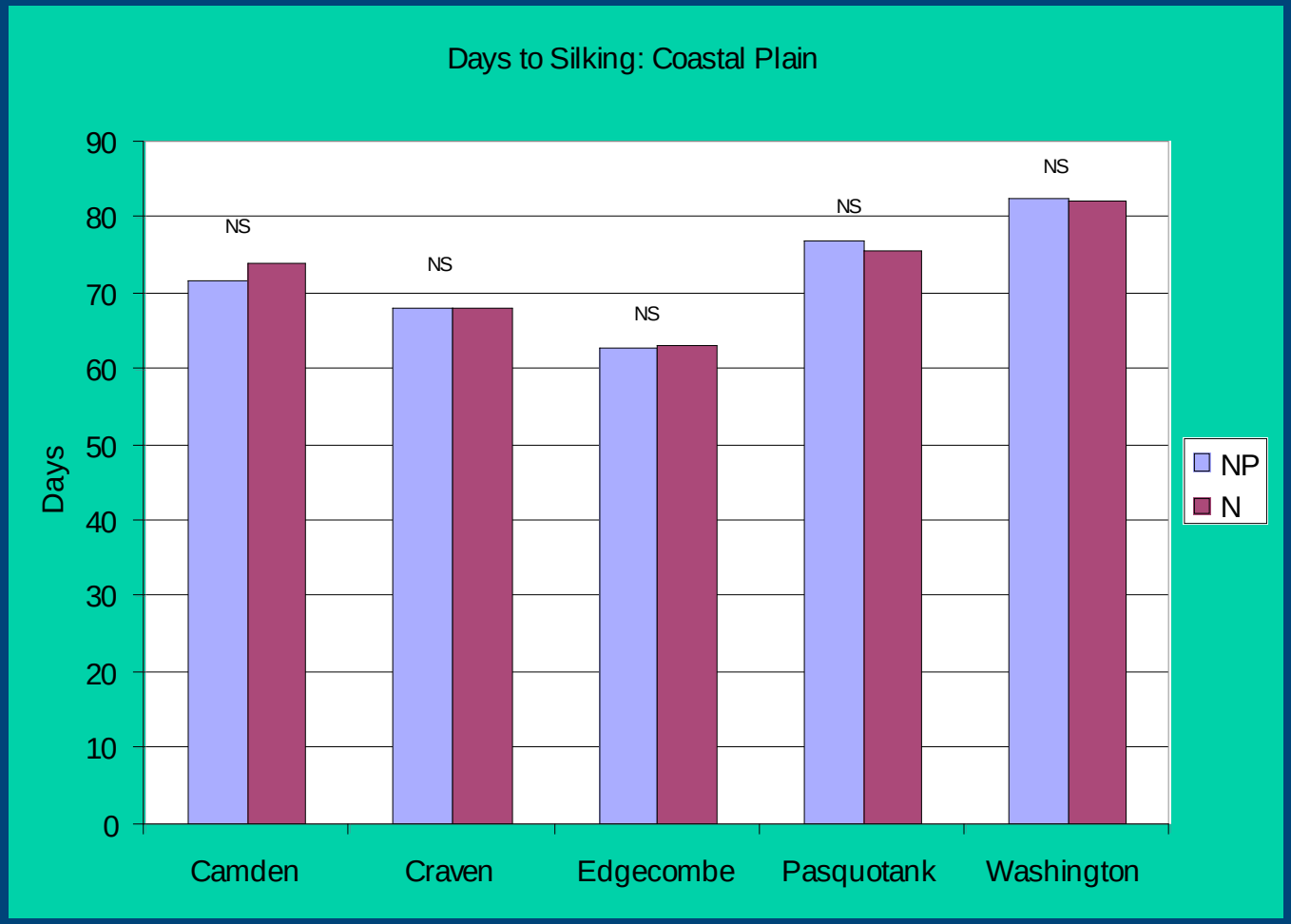
Corn Tissue - % N: Coastal Plain



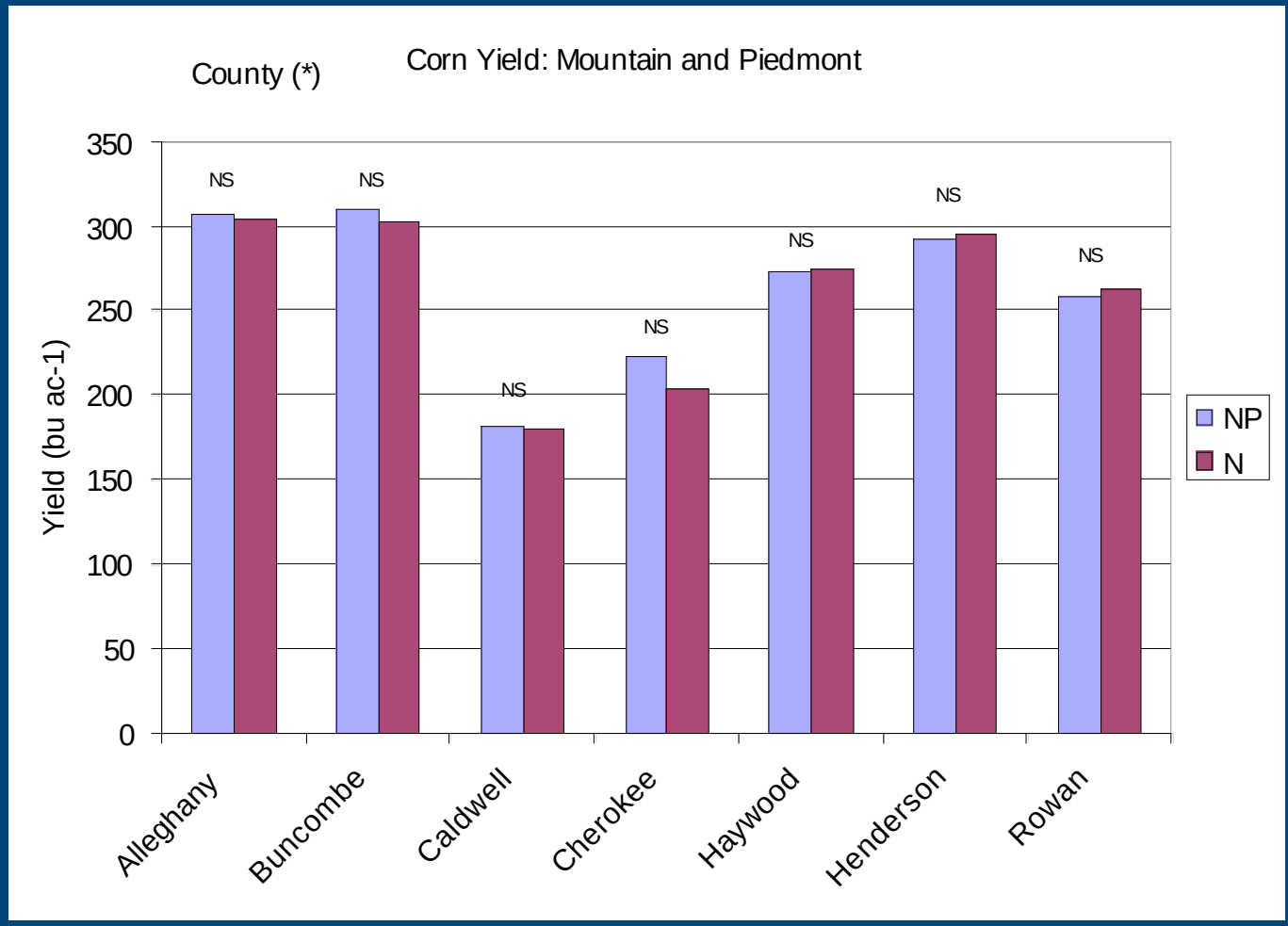
Corn Tissue - %P: Coastal Plain



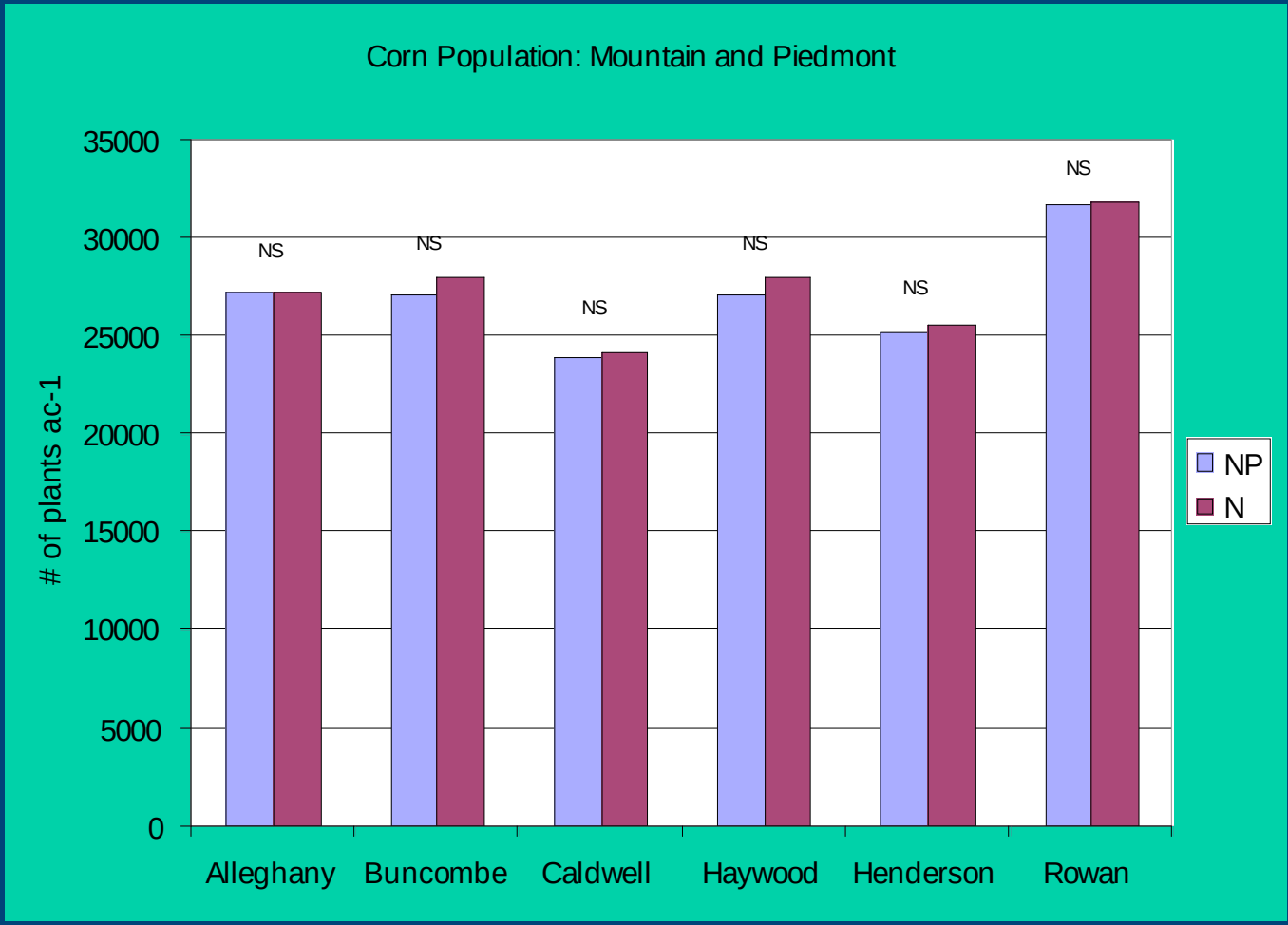
Days to Silking: Coastal Plain



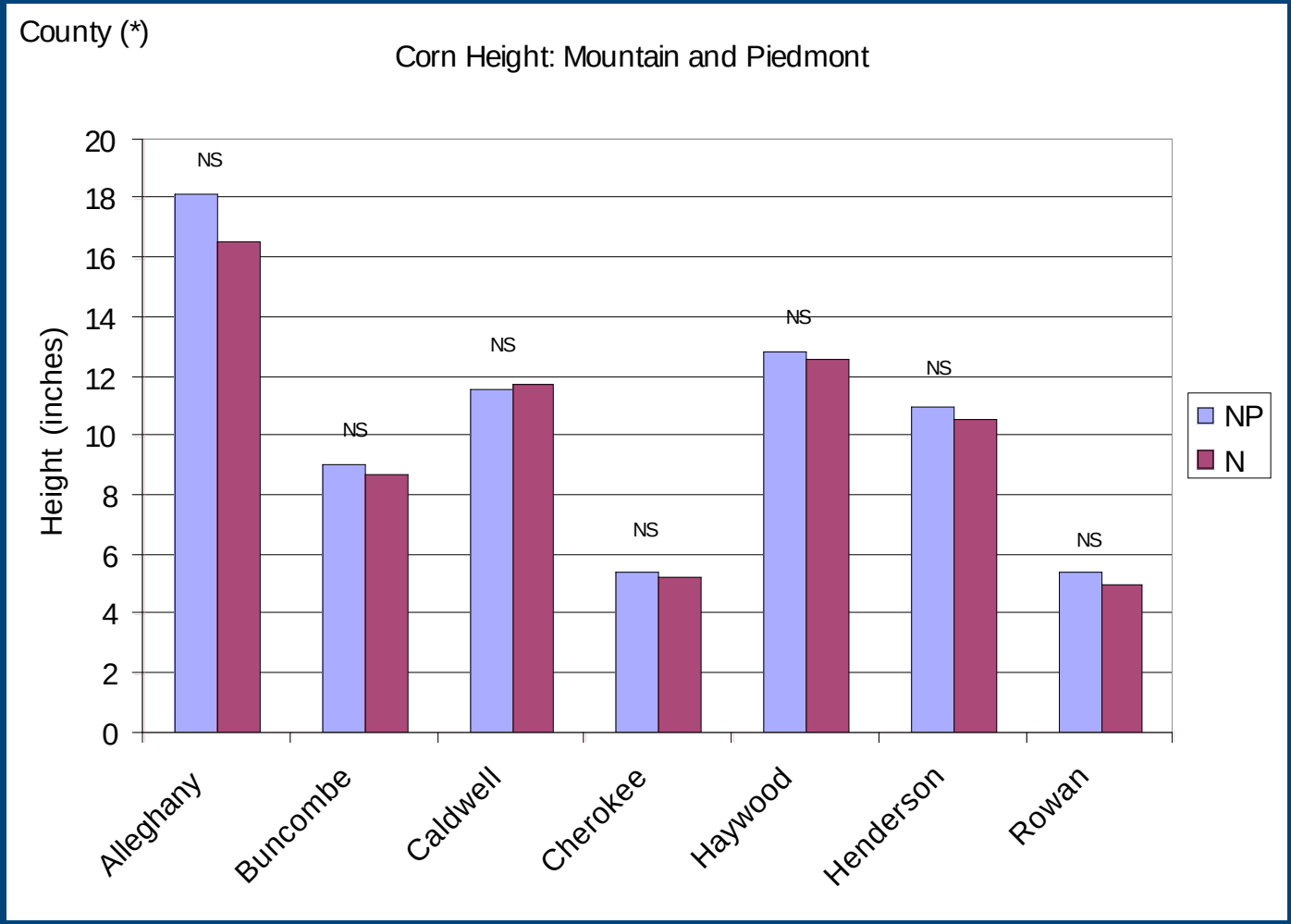
Corn Yield: Mountain and Piedmont



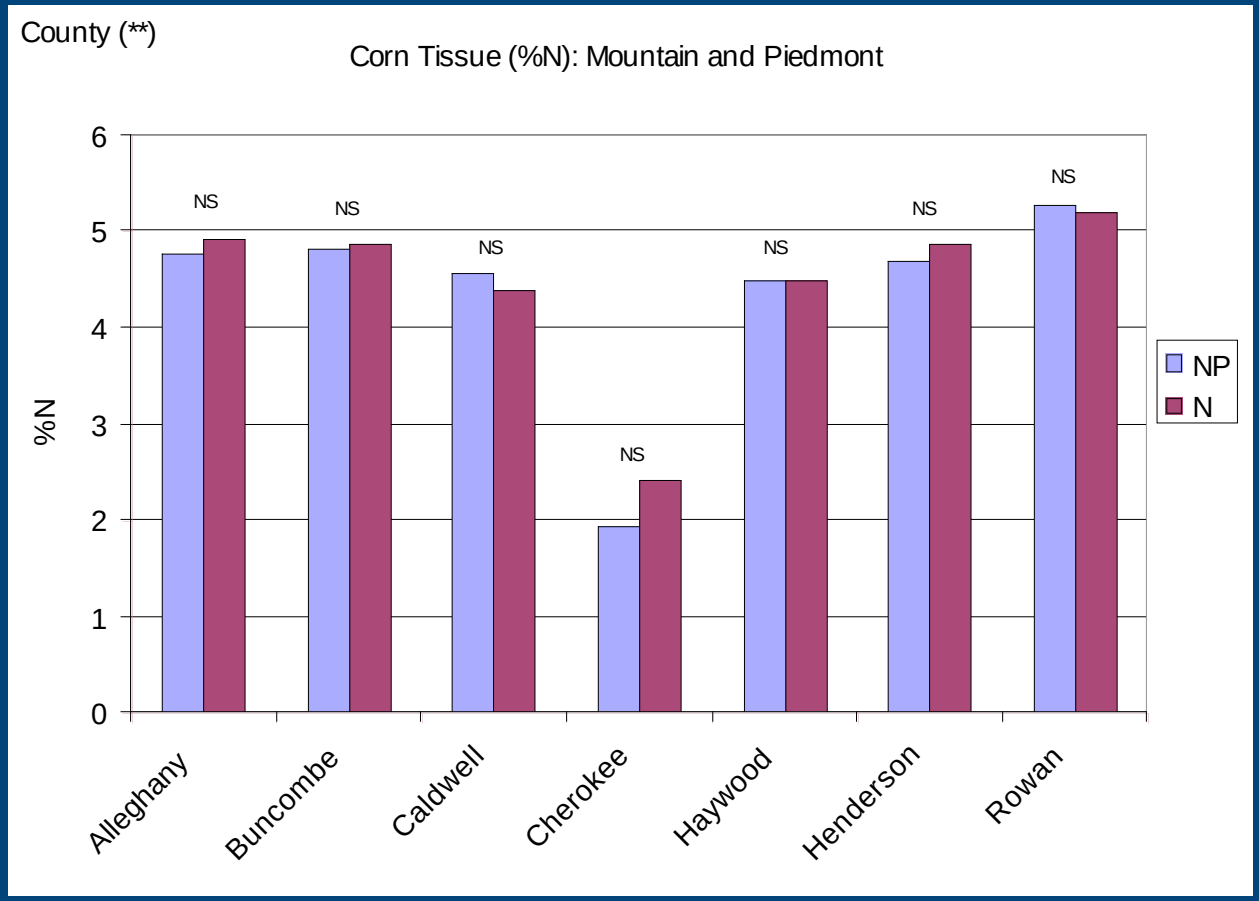
Corn Population:Mountain and Piedmont



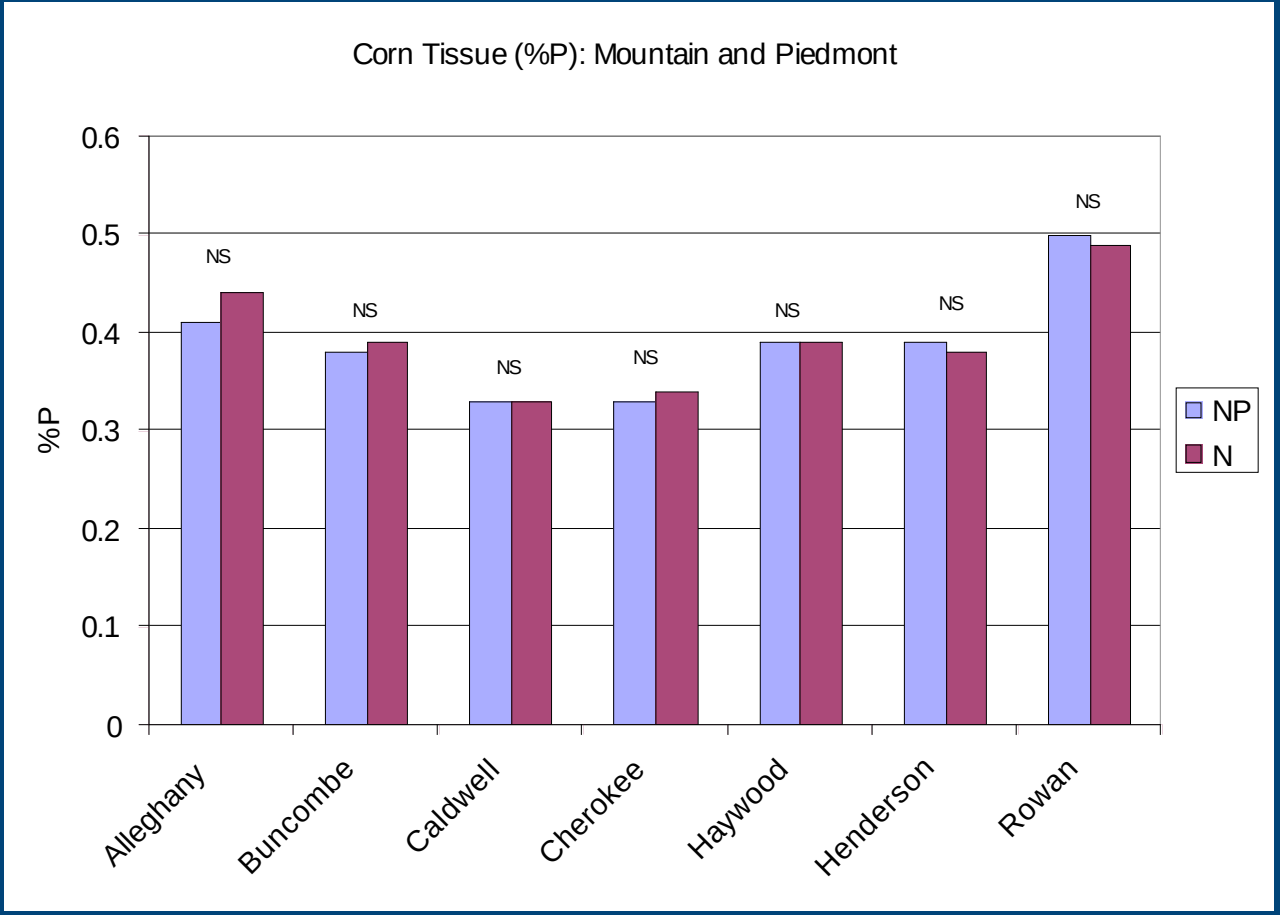
Corn Height: Mountain and Piedmont



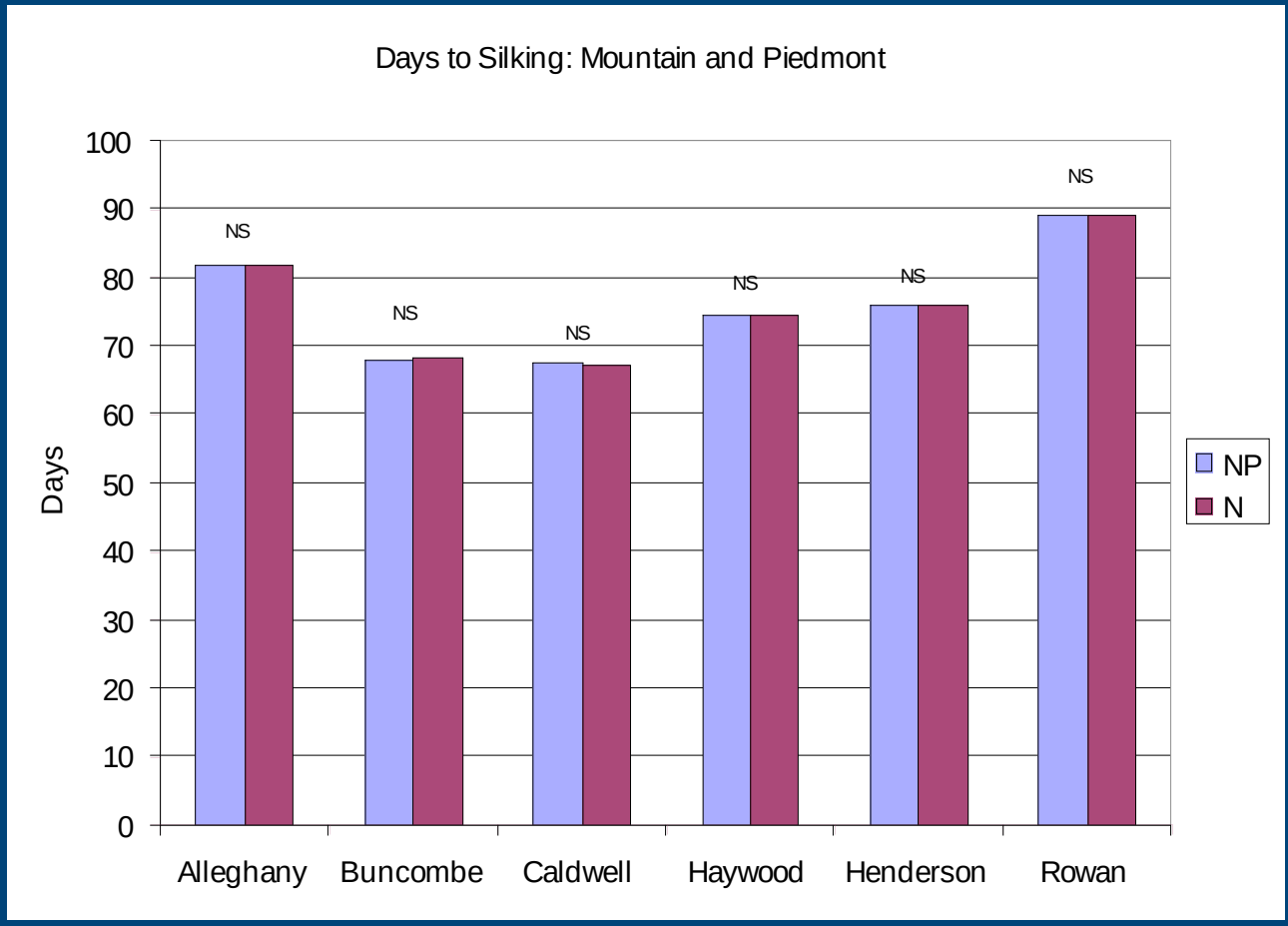
Corn Tissue %N: Mountain and Piedmont



Corn Tissue %P: Mountain and Piedmont

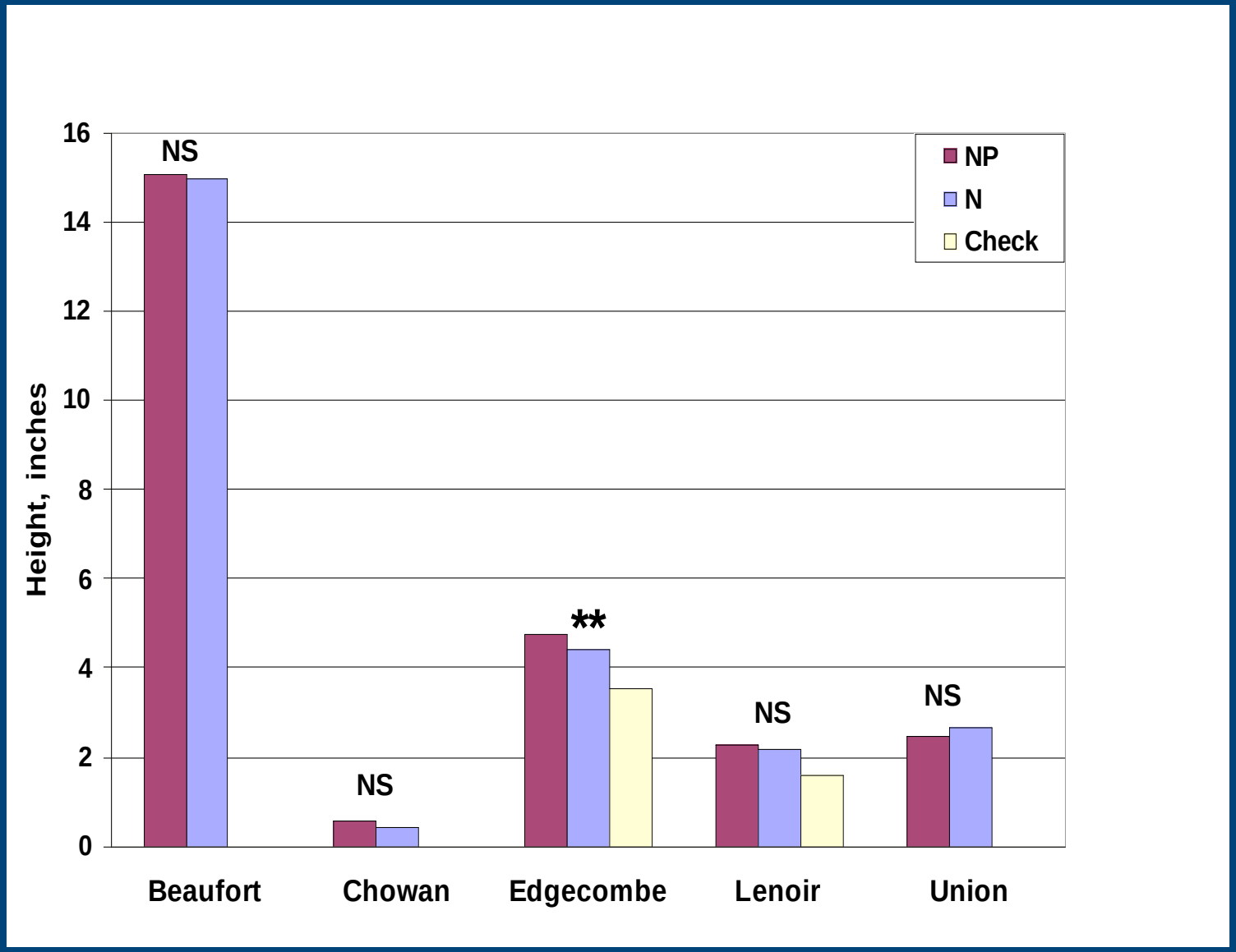


Corn Color Index: Mountain and Piedmont

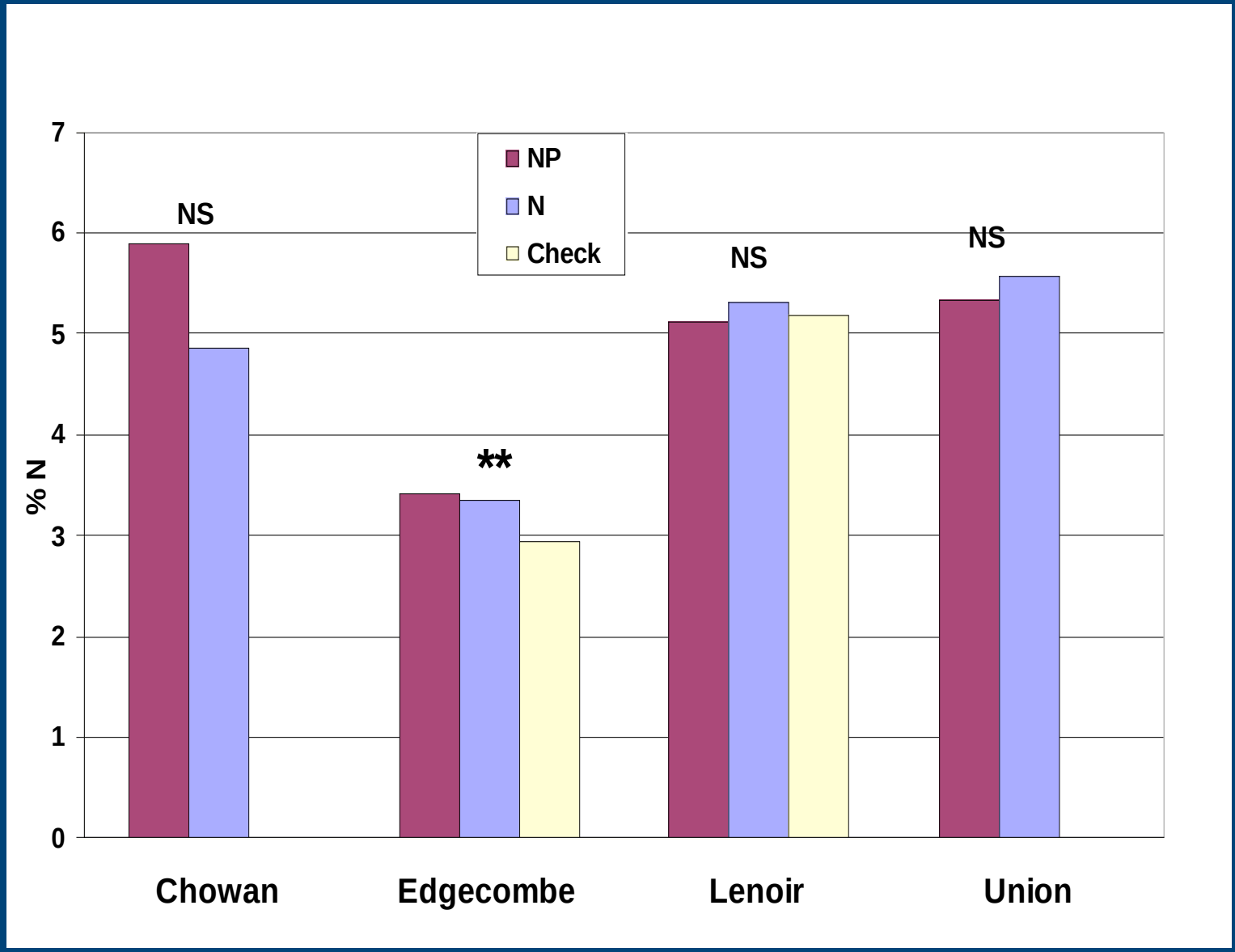



2005

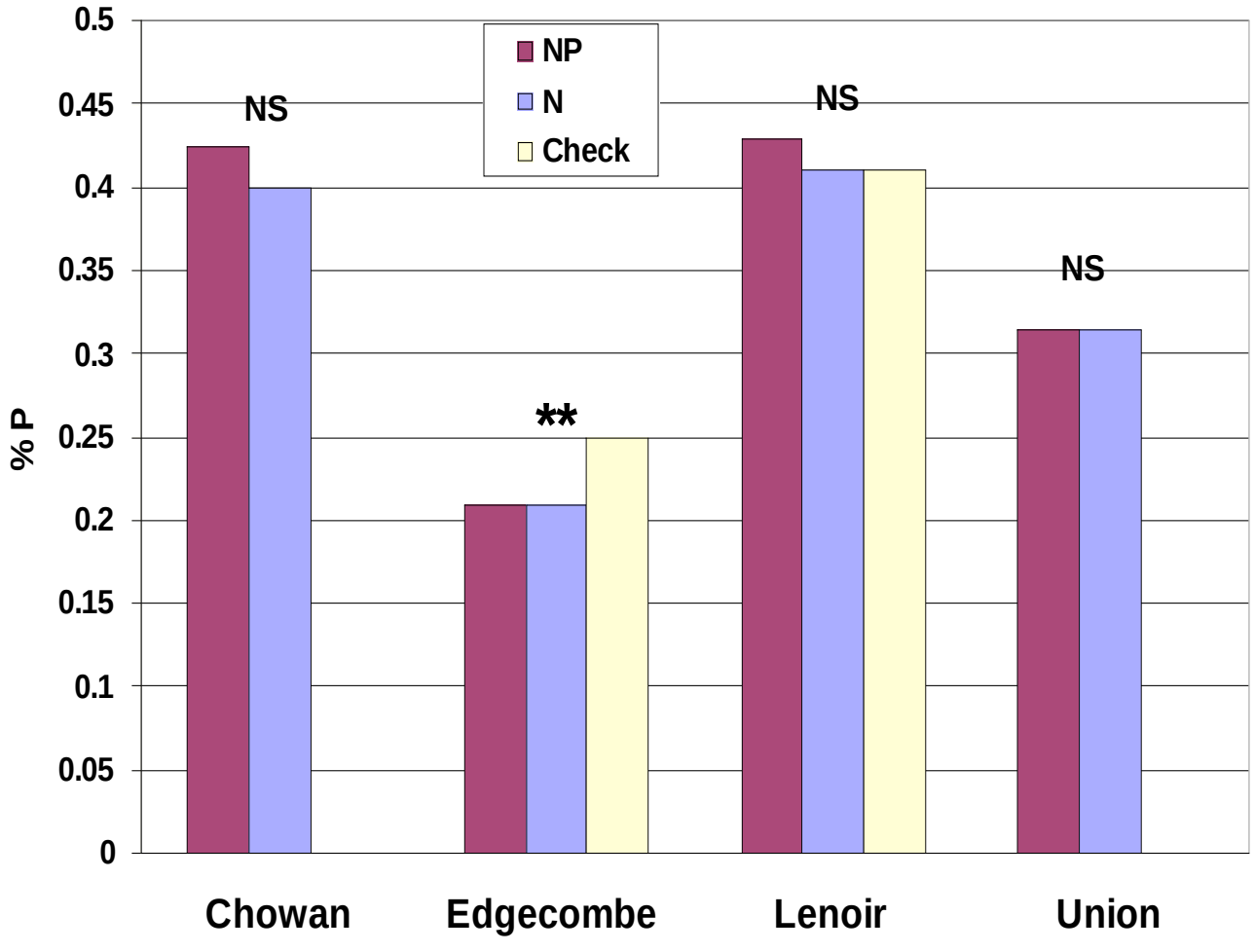
Cotton Height



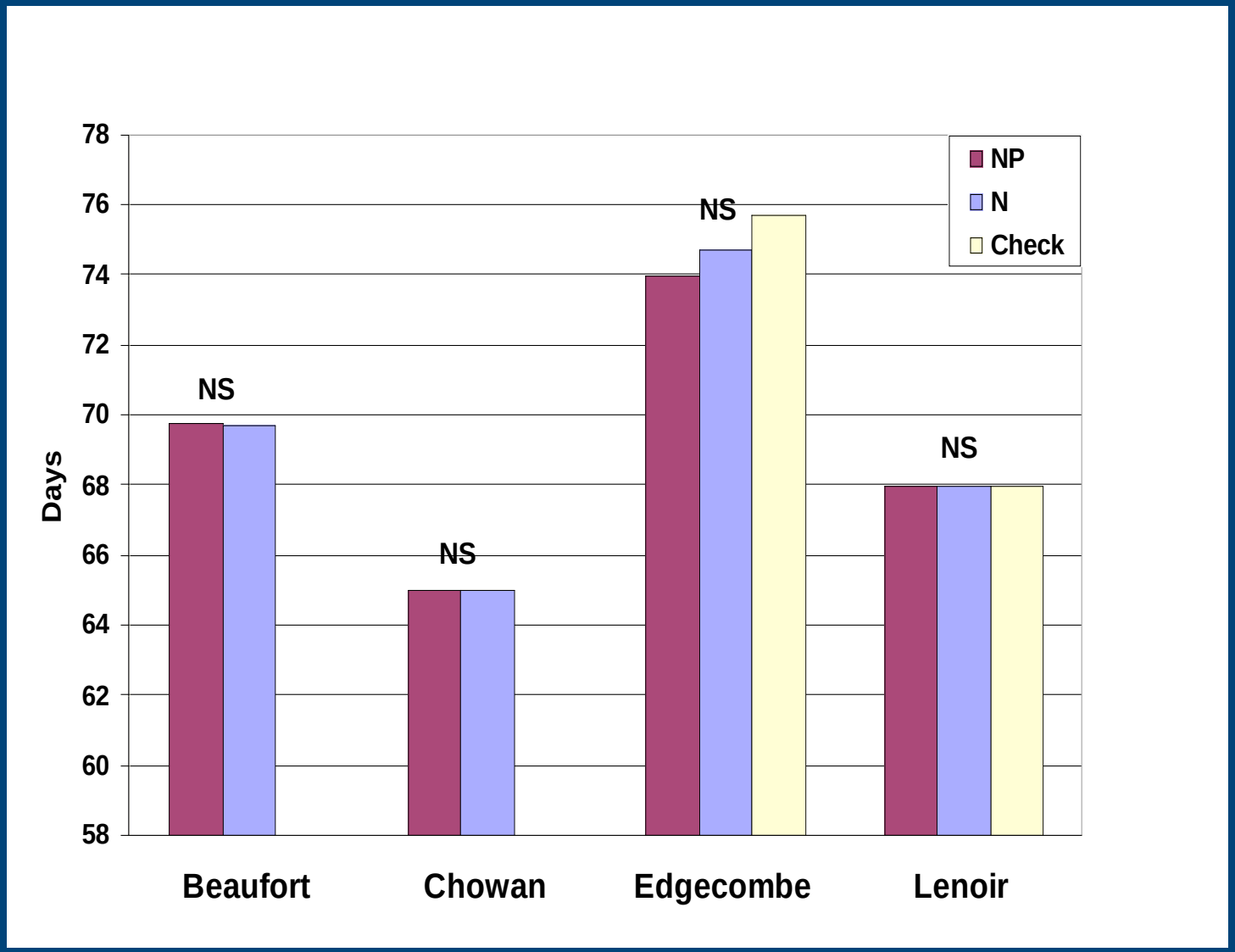
Cotton Petiole Tissue: %N



Cotton Petiole Tissue: %P



Days to Early Bloom



Conclusion

Is Starter P Necessary on Very High STP Soils?

- Data from 2005 & 2006 should have shown differences due to the cool, wet spring
- Across all locations, no difference
- Need to change NCCES recommendations for starter P
- Need to change NRCS recommendation for starter P