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THE EFFICACY OF STARTER FERTILIZER PHOSPHORUS FOR CORN AND COTTON PRODUCTION ON SOILS TESTING VERY HIGH FOR PHOSPHORUS

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The research on which this report is based was supported in part by funds provided by the North Carolina Water Quality Workgroup Initiative. Contents of the publication do not necessarily reflect the views and policies of the State of North Carolina or the Department of Environmental and Natural Resources, nor does mention of trade names or commercial products constitute their endorsement by the State of North Carolina

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EXECUTIVE SUMMARY

Phosphorus from agricultural lands poses a problem to North Carolina's water resources. In fiscal year 2003, over 48% of soil samples submitted to the NCDA&CS soil testing laboratory from around the state, tested *very high* in soil P (>100 P-Index). This result is a concern because as soil test P increases, the risk for off-site losses of P increases, either through erosion, soluble P runoff or leaching. When soils test above a *high* soil test P level (P-Index = 50-100), no yield response from fertilizer additions is expected. Therefore, yield should not be negatively affected by excluding starter-P on soils having excessive P. Studies in New York, Delaware, and Iowa have shown this assessment to be true. However, there has been no study of the effects of starter-P fertilizer on soils with *very high* P-status in North Carolina. Therefore, we undertook a study to determine if the use of starter-P fertilizer would affect the growth of corn and cotton on different soils in North Carolina having *very high* soil test P. If farmers do not need to apply starter-P, the amount of excess agricultural P that is vulnerable to loss can potentially be reduced.

Overall, our results indicate that treatment differences existed for only a few, relatively subjective crop growth parameters, such as color index. The one exception to this finding was the significant treatment effect of yield, a measure that is less prone to biases, from study sites in Beaufort County. However, when these locations were segregated by soil type, mineral or organic, no significant difference in yield occurred. Therefore, a need to analyze mineral soils and organic soils separately may be indicated. Analyzing by physiographic region produced inconsistent results, with the 'N+P' treatment being greater than the 'N only' treatment in some corn parameters, while the opposite was true for cotton parameters. Therefore, it is difficult to conclude that starter-P fertilizer is warranted on fields with *very high* soil test P values. The need for more growing years and study sites to provide more conclusive data is recognized.

INTRODUCTION

Off-site losses of phosphorus (P) from agricultural activities into water resources are of concern throughout North Carolina. Specific watersheds (Chicod Creek) and river basins, such as the Tar-Pamlico, have rules to maintain or reduce P losses. As soil test P increases, the risk for off-site loss of P increases, either through erosion, soluble P runoff or leaching (Sharpley et al., 1994). Recently, the NC Department of Environment and Natural Resources (NCDENR) recognized this concern and partnered with NC State University and the Natural Resources Conservation Service (NRCS) to develop the NC Phosphorus Loss Assessment Tool (PLAT), which estimates potential off-site losses of P. Data from agricultural fields across North Carolina showed increased risk of P loss with increasing soil test P. Eight percent of fields with a soil test P-Index (PI) of 100-200 had a High or Very High PLAT rating, whereas sites with a PI in excess of 200 were found on 31% of the fields with a High (21%) or Very High (10%) PLAT rating (Johnson et al., 2005). For reference purposes, it is important to recognize that one PI unit is equivalent to 4.9 lb P_2O_5 ac^{-1}.

The Agronomic Division- NCDA&CS analyzes approximately 250,000 soil samples every year. Approximately 85% of these samples are agricultural soils. In fiscal year 2003, over 48% of soil samples, state-wide, tested *very high* in soil P (>100 PI) (NCDA&CS, 2003). No yield response from fertilizer additions is expected for soils testing above a *high* soil test P level (PI = 50-100). As long as starter fertilizers are used, soil-test P levels will not be reduced from these *very high* index values (Kamprath, 1999).

Currently, the NRCS 590 Nutrient Management Standard allows fields with PLAT ratings of High or Very High to receive starter-P fertilizer (USDA-NRCS, 2001). Recommended P from starter fertilizers ranges from 10 to 40 lb P_2O_5 ac^{-1} (Zublena, 1997a). The amount of P that most agronomic crops remove, however, is generally no more than 40 lb P_2O_5 ac^{-1} (Zublena, 1997b). As a consequence, P levels will continue to remain *very high* in these soils. This was confirmed through research in North Carolina by a 15-year starter-P fertilizer study on soils with *very high* PI. At the end of 15 years, the soil test P level remained the same for those soils receiving yearly applications of 40 lb P_2O_5 ac^{-1}, whereas when no starter was applied, soil P levels declined (Kamprath, 1999). There were no yield differences. Even on soils with high P-fixing ability (Piedmont soils), 8 ppm of extractable P was sufficient and starter-P did not increase yields (Kamprath, 1967).

Recently, starter-P fertilizer was evaluated on *high*-P soils in New York over a three-year time period. Trials were conducted on 62 farm fields and 9 research stations to determine if band-applications of fertilizer P were needed for optimum corn silage yield and quality on fields testing *high* or *very high* in soil test P. Results indicated that for sites that test *high* in P and have no manure applications planned for the season, no yield or quality penalty is expected when P-starter levels are reduced below 25 lbs P_2O_5 ac^{-1}. On sites that test *very high* in P or when manure is applied to *high* testing sites, there is a low probability of a starter response and P could be eliminated from the starter without a yield or quality penalty (Ketterings et al., 2004).

Recent research in Delaware on the use of starter fertilizer has shown some benefits of nitrogen (N) in starter fertilizers but results for P are inconclusive to date. Binford et al. (2004) conducted a number of strip trials with corn on *high*-P soils from 2000 to 2002, with the treatments being either no starter or a traditional N and P two-by-two placement of starter fertilizer. The starter fertilizer cost on average $12 per acre, requiring an extra 5 bu ac^{-1} corn to recover costs. The starter fertilizer strips yielded an extra 7 bu ac^{-1} on average, but the study was not able to identify whether the increased yield was due to applied N or P.

In separate plot studies, Binford et al. (2003) examined 19 combinations of starter fertilizer placements and types at three locations, but starter fertilizer did not lead to any significant increases in yield at any of the sites due to a high degree of variability. Although the results of these studies are inconclusive, they show the importance in evaluating the need for starter fertilizers with N, or with N and P. If it can be shown that starter fertilizer N but not P is necessary, this will lead to economic benefits to the farmer, in addition to alleviating surplus P additions to agricultural soils and potential environmental problems.

Bordoli and Mallarino (1998), working in Iowa, showed that starter-P fertilizer did not increase yields except when soil test P measured *low* or *very low*. Three different starter-P placement treatments were used (broadcast, regular band, and deep band), but placement did not affect yields even when there was a response to the starter fertilizer. Based on results from across the United States, it appears that when soil test P measures at least *high*, there is no yield response of crops to starter-P fertilizer.

Currently, there are only a few county agents in North Carolina that occasionally evaluate the need for starter-P fertilizer. There has been no study of the effects of starter-P fertilizer on soils with *very high* P status.

PURPOSE AND GOALS

Therefore, the objective of this research was to determine the need for starter-P fertilizer in two agronomic crops (cotton and corn) on different soils in North Carolina having *very high* soil test P. If farmers do not need to add starter P, then soil test P levels could be reduced slowly and the potential for off-site losses would be lowered.

METHODOLOGY

Our goal was to obtain approximately 40 test sites for corn (20 Coastal Plain, 10 Piedmont, and 10 Mountain) and 30 sites for cotton (20 Coastal Plain and 10 Piedmont). In reality, we were only able to sample from 27 corn sites (13 Coastal Plain, 2 Piedmont, and 10 Mountain) and 7 cotton sites (6 Coastal Plain and 1 Piedmont). Sampling in all three physiographic regions ensured that a range of soil types as well as different climates would be included. Either NC Cooperative extension agents and/or NCDA&CS regional agronomists established the test plots.

Collaborators were instructed to locate fields testing greater than 100 PI for mineral soils or greater than 80 PI for organic soils, although this did not always happen because field soil test averages were used to select the fields and soil test values within the smaller plots may be very different than the field average. Approximately seven sites had plots testing below this requirement. Once a site was selected, the predominant soil-mapping unit was identified. Each treatment plot was approximately 0.10 ac (~4,500 square feet).

Treatments were randomly assigned to receive starter fertilizer containing both N and P (30 lb of both N and P_2O_5 ac^{-1}) or receive only starter-N fertilizer without P (30 lb N ac^{-1}). These two treatments will subsequently be referred to as 'N+P' and 'N only'. Kamprath (1987) reported that if soil test P levels were in the *high* range, early uptake of P was controlled more by N than by soil P levels. Four replications per treatment were established. Location also served as replication when analyzing all plots collectively. We attempted to minimize fertilizer placement differences through selection of growers; however, research generally finds no effect due to placement, so this issue was not of great significance. To the extent possible, varieties were standardized (corn: DKC 69-71 RR/YG or cotton: DP 451 B/RR).

On the day of planting, soil samples were taken from each plot from the inter-row space, unless P fertilizer had already been banded or dribbled. In this case, a sample was taken elsewhere in the study plot. Soil samples were sent to the NCDA&CS Agronomic Division, Soil Testing Laboratory for analysis of soil test P.

The following data was collected from each plot during the growing season:

- Early plant height, taken at 3 weeks after germination; corn plants were measured from the ground to the whorl while cotton plants were measured from the cotyledon to the terminal.
- Early season plant tissue; whole plant at 10 to 12- inch height for corn, and most fully developed leaf at approximately the 8-leaf stage for cotton.
- Relative color index at the same time that plant height was measured, using the following scale: dark green = 4, green = 3, light green = 2, yellow or purple = 1.
- Days to silking (corn); Days to early bloom (cotton), when there are 5-6 white blooms per 25 foot row or within 5-7 days after first bloom.
- Number of nodes at first bloom (cotton); Number of nodes above white flower in August and total nodes (cotton).
- Yield; cotton yield was reported after ginning.

Yield, plant height, relative color index, days to silking, number of nodes and nodes above white flower were consistently taken from plants contained in a10 feet long section in the two middle rows of the study plot. Tissue samples were taken outside the sampling plot and they were sent to the NCDA&CS Agronomic Division, Plant Tissue Laboratory.

The data were compared using ANOVA with statistical software (SAS, 1998). Three different analyses were performed to examine treatment effects: (1) all locations of each crop were analyzed together with a location effect included to account for site variability; (2) locations were grouped into physiographic regions and a region effect included to account for site variability; and (3) each individual county was analyzed for treatment effects within that county; if a particular county had more than one location, a location effect was also included. Each of the above analyses was performed excluding check plots and for two sample populations: (1) with all plots regardless of soil test P level, and (2) including only plots having a soil test P >100 PI for mineral soils and >80 PI for organic soils. In addition, corn plots in Beaufort County were analyzed by accounting for variability due to soil type (mineral vs. mineral-organic or shallow organic).

RESULTS

Although a check treatment was not specified in the experimental design of this study, some collaborators chose to include one. Check plots, however, were not standardized as these were not part of the protocol. (See Appendix C for more information.) check plots for corn had no P applied and the N ranged from 0 lb N ac^{-1} (Craven County) to 238 lb N ac^{-1} (Lincoln County). Similarly for cotton, no P was applied to the check plots but N was either 0 lb N ac^{-1} (Lenoir County) or 20 lb N ac^{-1} (Edgecombe County). For many parameters, significant differences were seen when the check plots were included, with the check treatment being much lower in a given parameter than either the ‘N only’ or ‘N+P’ treatments. However, because the main focus of this study was to evaluate whether the use of P-starter fertilizer affected crop growth, given similar applications of N fertilizer, the control plots were not included in the statistical analysis nor was a discussion of control plot effects. For an evaluation of treatment differences when check plots were included, see Appendix I.

In theory, study plots were to have a soil test P of >100 PI. In practice, however, a number of sites were selected that did not fit this criterion. Because our hypothesis was that P starter fertilizer does not significantly affect crop growth parameters when soil test P is greater than 100 PI, statistical analysis was performed including only those plots with soil P level >100 PI. In addition, all study plots were analyzed, regardless of PI level. Results of both analyses are shown in some figures. If not stated, figures contain results of statistical analysis performed only on plots having a soil test P >100 PI.

The effect of location was included the statistical analyses involving more than one study site. In this way, any variation due to site location is excluded in the determination of whether a treatment effect is present or not. In addition, separate analyses were performed to examine any differences due to physiographic region by grouping all locations into one of three regions, Coastal Plain, Piedmont or Mountain. Specific parameters in which location or region effects occurred are reported in Appendix B.

Crop Yield

When analyzing all plot locations together, no significant differences in yield existed between the two fertilizer treatments for either corn or cotton (Fig. 1). When study locations were grouped into physiographic regions, yield was significantly different among regions for both corn and cotton (Fig. 2), with corn yield being greater in the Mountains than either the Coastal Plain or Piedmont, and cotton yield being greater in the Coastal Plain than in the Piedmont. Examining treatment differences within each region, a significant treatment difference for corn plots in the Coastal Plain was apparent (Table 1). In this case, yield in the 'N+P' treatment was greater than yield in the 'N only" treatment. In an effort to inspect this result further, individual counties were analyzed for treatment differences (Figs. 3-5). Considering both corn and cotton, the only county in which yield experienced a significant treatment effect was Beaufort County, with plots receiving both N- and P-starter having a greater corn yield than plots receiving only N-starter fertilizer (Fig. 3). Please note that P was mistakenly applied to the N-only treatment in Wilson County. Thus the comparison for Wilson County is actually between different rates of starter P; the N+P treatment had 50 lb P_2O_5 ac^{-1} added at planting, while the N treatment had 20 lb P_2O_5 ac^{-1} added at planting (Appendix C).

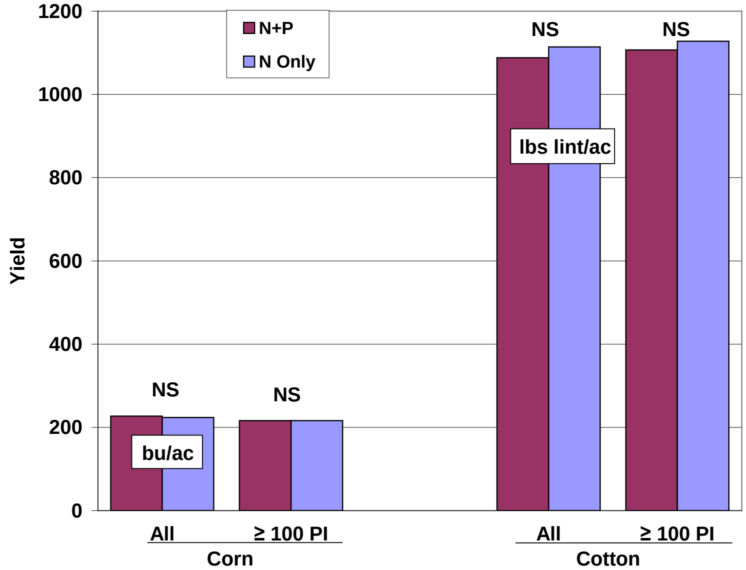

Fig. 1. Mean crop corn and cotton yields from all study locations.

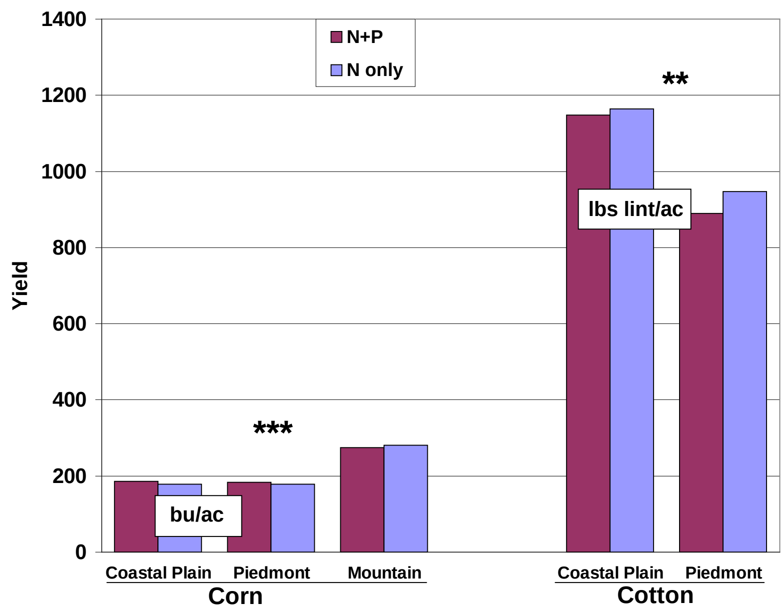

Fig. 2. Regional comparisons of mean corn and cotton yields.

Table 1. Results of treatment comparisons for corn and cotton when analyzing each region individually. Plots below a P Index of 100 were not included in analysis results reported here.

Parameter	**Corn**			**Cotton**	
	Region				
	Coastal Plain	**Piedmont**	**Mountain**	**Coastal Plain**	**Piedmont**
Yield	*	NS	NS	NS	NS
Plant Population	*	NS	NS	NS	NS
Plant Height	***	NS	NS	NS	NS
Tissue N	NS	NS	NS	NS	NS
Tissue P	NS	NS	NS	NS	NS
Color Index	***	NS	NS	NS	NS
STP	NS	*	NS	NS	NS
Days to Silking	NS	NS	NS	n/a	n/a
Days to Early Bloom	n/a	n/a	n/a	NS	--
Nodes at First Bloom	n/a	n/a	n/a	**	--
Total Nodes	n/a	n/a	n/a	NS	NS
Nodes Above White Flower	n/a	n/a	n/a	NS	NS

***, **, * correspond to statistical significance levels of P<0.0001, P<0.01, P<0.05, respectively. NS indicates no statistical significance was found.

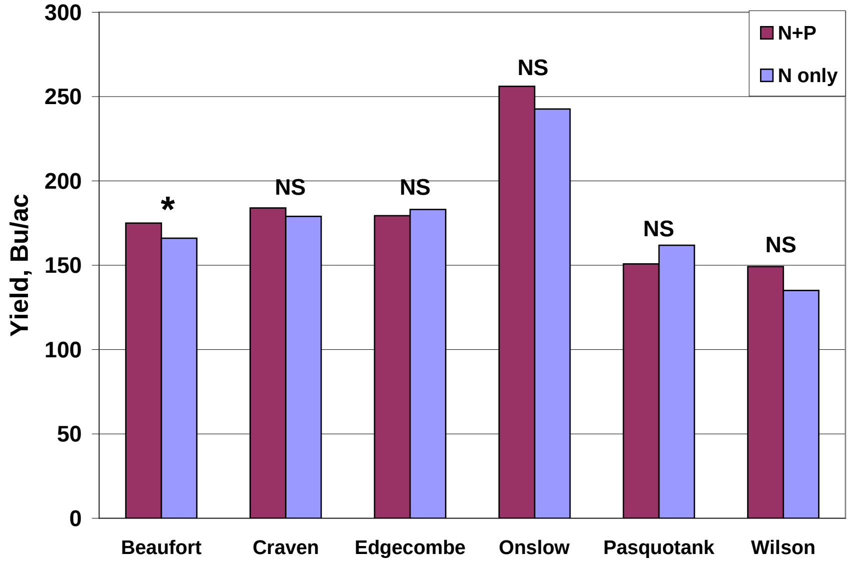

Fig. 3. Mean corn yield in Coastal Plain counties.

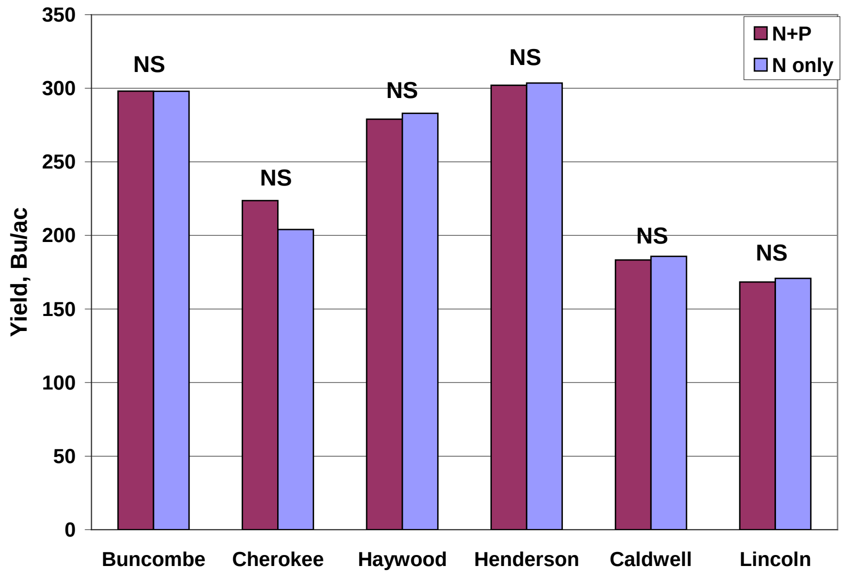

Fig. 4. Mean corn yield in Mountain and Piedmont counties.

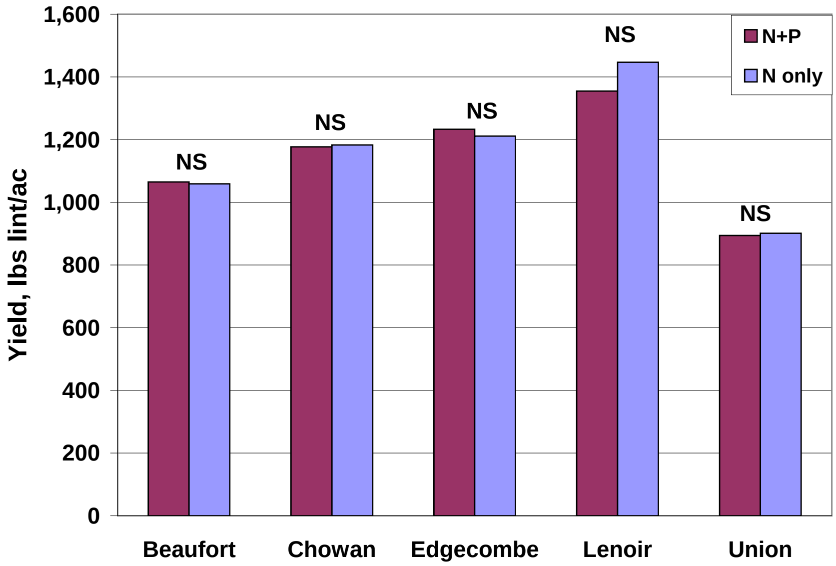

Fig. 5. Mean cotton yield in Coastal Plain and Piedmont counties.

Some of the study sites in Beaufort County were located on shallow organic soils which are thought to release more P over time than mineral soils (Daughtrey et al., 1973). Thus, the soil test level at which no beneficial effect of further P additions is experienced for these unique soils was determined to be 80 PI. Because two fundamentally different soil types occur on study plots in this county, mineral and organic, and because corn sites from Beaufort County represent the only treatment difference seen for crop yield, we investigated whether differences in soil type could explain the differences seen between the two treatments.

Initially, soils at each Beaufort County location were classified based on the soil mapping unit, and our analysis showed no significant differences between the two soil types. However, because soil mapping units usually do a poor job of accurately taking into consideration variability at the relatively small scale we were interested in, we instead used the designation provided by the NCDA&CS Soil Testing Laboratory (STL). In this case, three of the seven locations for corn were either shallow organics or mineral-organics or a combination thereof, as opposed to only one location when using the much broader soil mapping unit classification. Differentiation of mineral soils and mineral organic or shallow organic soils is probably more accurately done by the STL, as their determination was based on a soil sample taken directly from the study plot whereas a soil survey may generalize over a large area.

When statistical analysis was based on the STL classification of soil at each location, we found that, although plots in Beaufort County with organic soil types had a greater corn yield than sites with mineral soils when all sites were analyzed together, this difference was not significant when only *high* (>100 PI for mineral, and >80 PI for organic) soil test P-plots were analyzed (Table 2 and Fig. 6). In addition, when soil types were analyzed separately, yield was not significantly different between the two treatments in either mineral or organic soils (Table 3). Therefore, the treatment differences for corn yield in Beaufort County seen in Fig. 3 cannot be explained by differences in soil type. An interesting conclusion can be made, however; mineral soils and organic soils may behave differently, but at soil test P levels >100 PI (or >80 PI for organic soils), no differences existed (Table 2). In fact, mineral and organic soils performed similarly in terms of corn yield, despite the fact that sites with organic soils had a significantly lower soil test P than sites occurring on mineral soils (Fig. 6). However, this level of soil test P is above the 100/80 PI benchmark, supporting our theory that differences in treatment are less apt to appear when soil P is already built up to a *very high* PI level.

Table 2. Differences in treatments and soil type for corn growth parameters of Beaufort County sites. Comparisons were made within each soil type for (1) all plots regardless of PI value, and (2) only those plots with a P Index >100.

Parameter	**Treatment Effect**		**Soil Effect**	
	Sample Population			
	All	**≥100 PI**	**All**	**≥100 PI**
Yield	*	NS	**	NS
Plant Population	NS	NS	**	NS
Plant Height	NS	NS	NS	NS
Tissue N	NS	NS	NS	NS
Tissue P	NS	NS	NS	NS
Color Index	NS	NS	NS	NS
STP	NS	NS	***	**

, **, * correspond to statistical significance levels of ***P<0.0001, ***P***<0.01, ***P***<0.05, respectively. NS indicates no statistical significance was found.

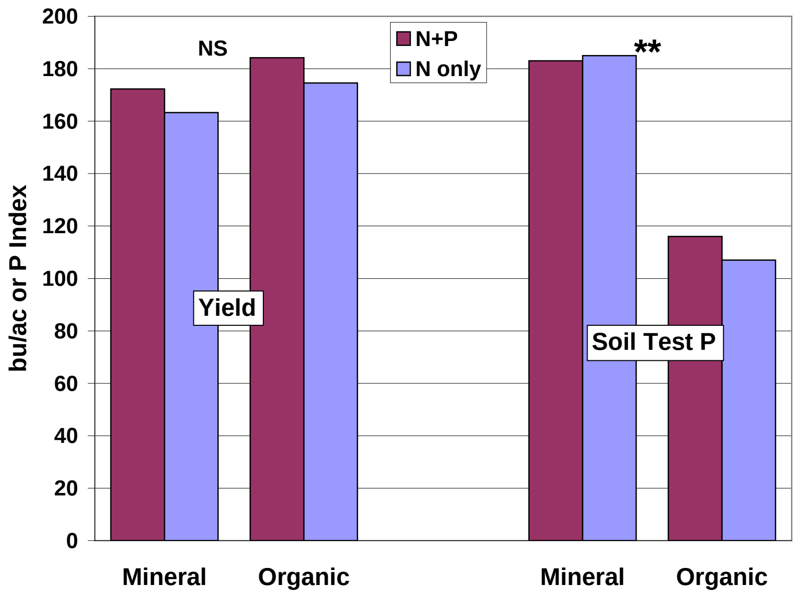

Fig. 6. Comparison of corn yield and soil test P in two different soil types found in Beaufort County.

Table 3. Results of treatment comparisons for Beaufort County corn plots having either a mineral soil type or an organic soil type, as classified by the NCDA&CS Soil Testing Laboratory. Comparisons were made within each soil type for (1) all plots regardless of PI value, and (2) only those plots with a P Index >100.

Parameter	**Mineral Soils**		**Organic Soils**	
	Sample Population			
	All	**≥100 PI**	**All**	**≥100 PI**
Yield	NS	N S	NS	NS
Plant Population	NS	NS	NS	NS
Plant Height	**	***	**	*
Tissue N	NS	NS	NS	NS
Tissue P	NS	NS	NS	NS
Color Index	**	***	NS	NS
Soil Test P	NS	NS	NS	NS

***, **, * correspond to statistical significance levels of $\boldsymbol{P}<0.0001$, $\boldsymbol{P}<0.01$, $\boldsymbol{P}<0.05$, respectively. NS indicates no statistical significance was found.

Plant Population

Treatment differences did not exist for plant populations of either corn or cotton (Fig. 7), nor where there any significant regional differences (Fig. 8). A significant treatment difference occurred in sites within the Coastal Plain region, with the 'N+P' treatment having greater plant populations of corn than the 'N only' treatment (Table 1). No significant treatment differences appeared in any individual county (Figs. 9-11), but a significant soil effect occurred in Beaufort County when incorporating all sites, regardless of PI level. As with yield, sites with organic soils had a greater corn population than sites with mineral soils, although the effect disappeared when only the >100/80 PI sites were used in the analysis (Table 2).

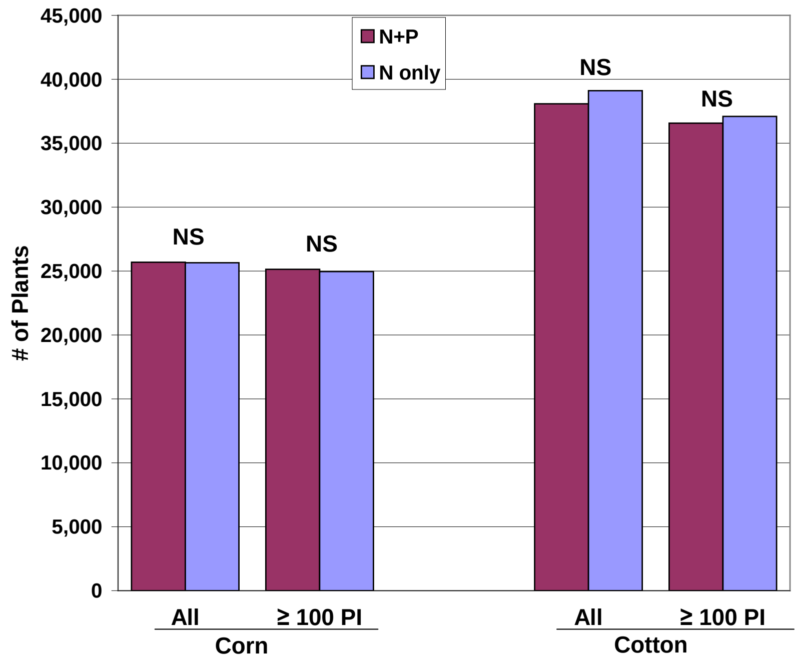

Fig. 7. Mean corn and cotton populations from all study locations.

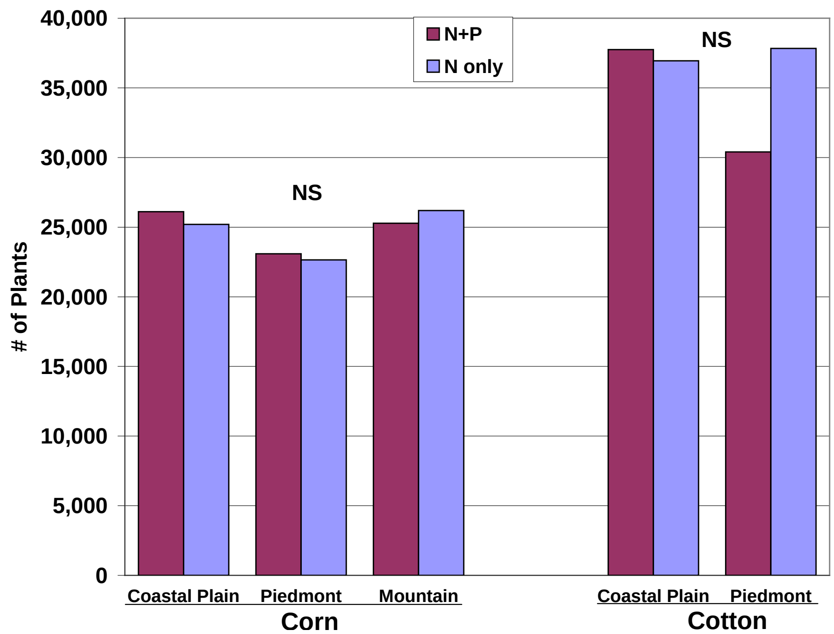

Fig. 8. Regional comparisons of mean corn and cotton plant populations.

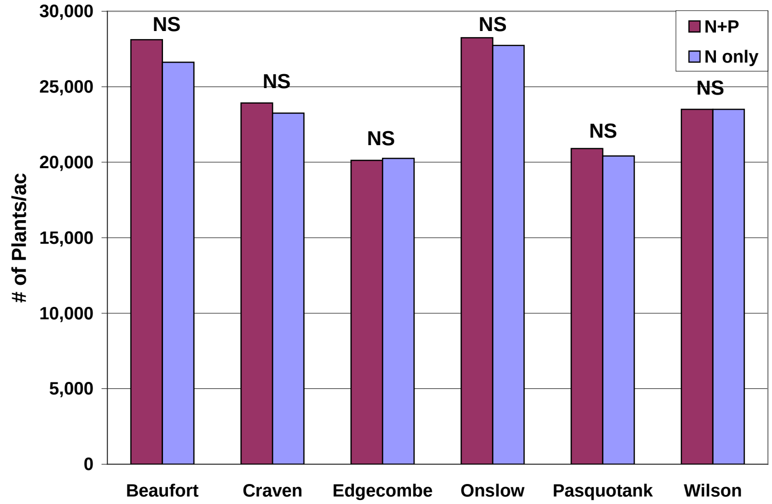

Fig 9. Mean plant population of corn plots in Coastal Plain counties.

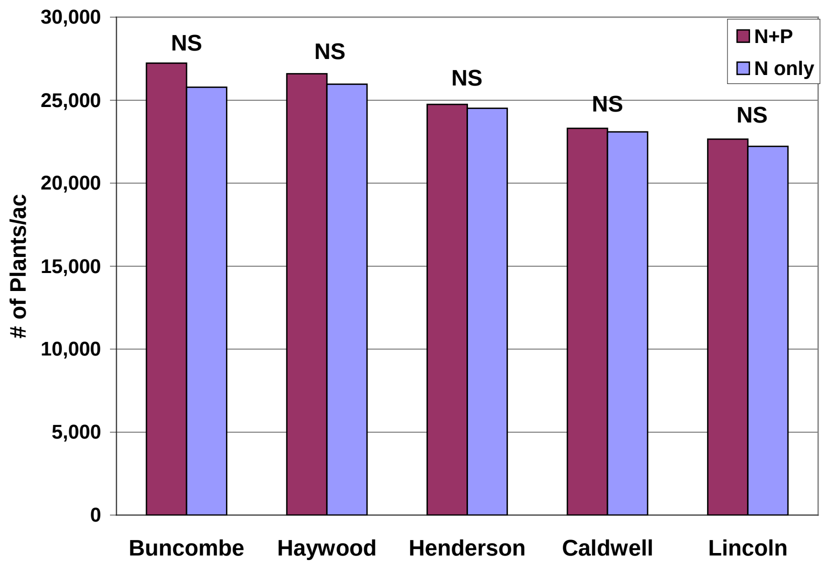

Fig. 10. Mean plant populations of corn in Mountain and Piedmont counties.

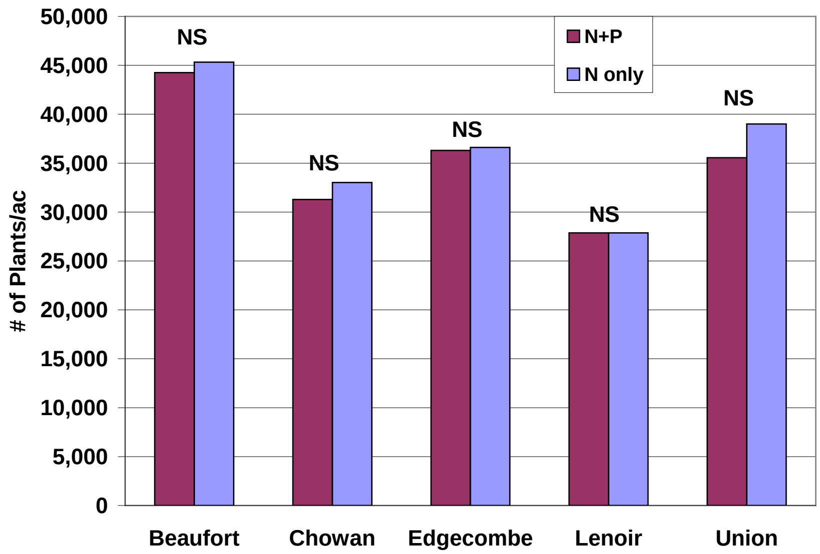

Fig. 11. Mean plant populations of cotton plants in Coastal Plain and Piedmont counties.

Plant Height

Statistical treatment differences existed for plant height on corn plots when all locations were analyzed together (Fig. 12). The 'N + P' treatment was significantly greater, in the case of both sample populations, than the 'N only' treatment. No appreciable regional differences were present (Fig. 13), although plant height was considerably greater in the 'N+P' treatment within the Coastal Plain locations on which corn was grown (Table 1). Examining individual counties, plots receiving both P-and N-starter fertilizer had greater plant heights in corn plots of Beaufort and Craven Counties (Figs. 14-16). No other counties had significant treatment differences with the exception of a treatment effect in Henderson County, with the 'N+P' treatment again producing greater heights in corn plants there. In Beaufort County, although no differences due to soil type were seen (Table 2), when analyzing each soil type individually, plant height was once again significantly greater in the 'N+P' treatment of both mineral soil and organic soil locations (Table 3).

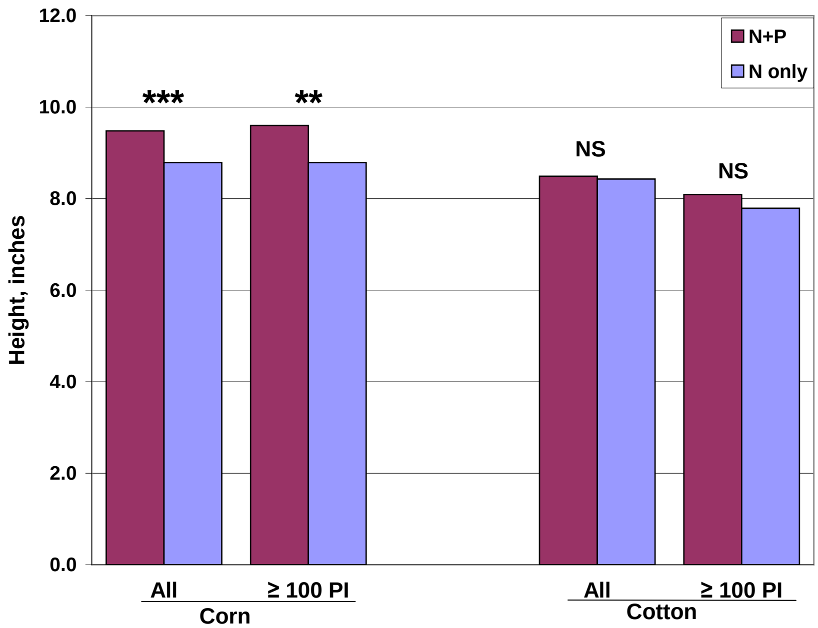

Fig. 12. Mean heights of corn and cotton plants from all study locations.

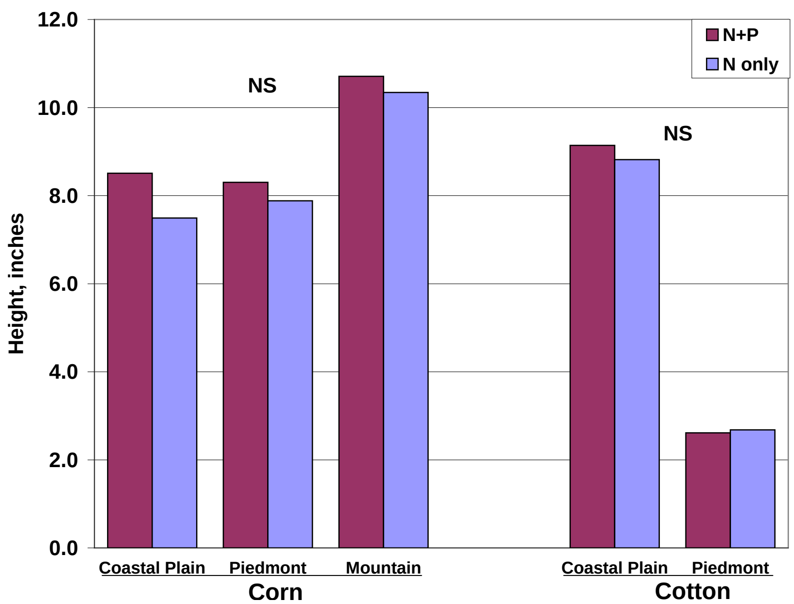

Fig. 13. Regional comparisons of mean corn and cotton plant heights.

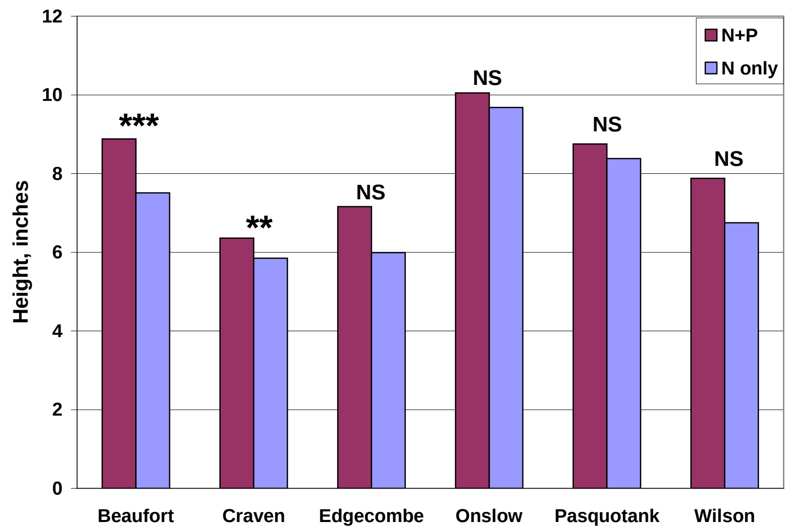

Fig. 14. Mean plant height of corn in Coastal Plain counties.

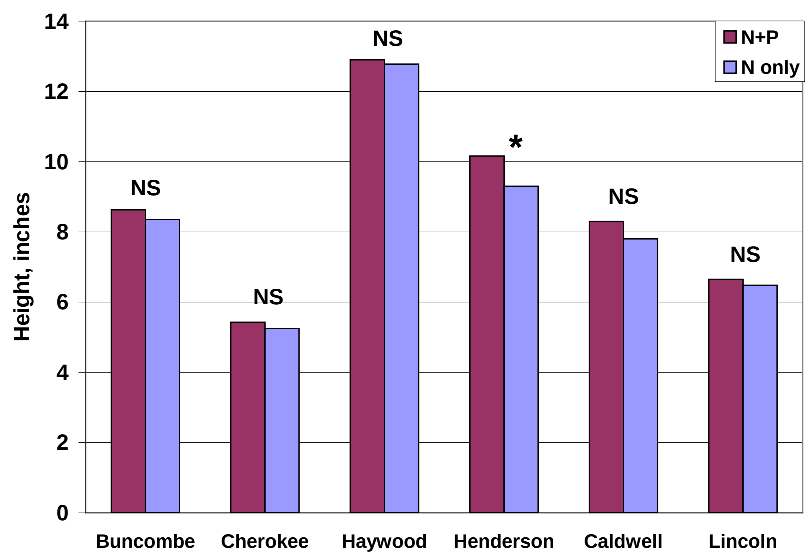

Fig. 15. Mean plant height of corn plants in Mountain and Piedmont counties.

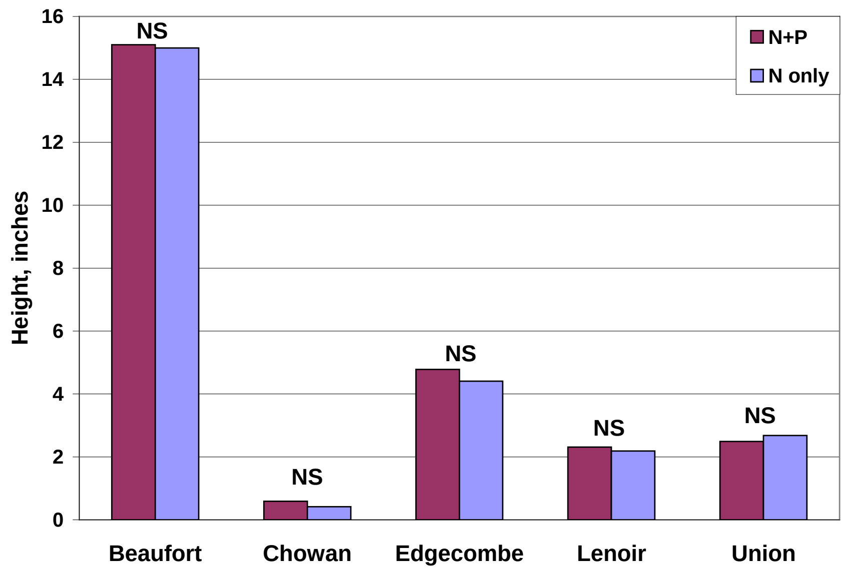

Fig. 16. Mean plant height of cotton plants in Coastal Plain and Piedmont counties.

The measurement of plant height may be prone to certain biases. Plant height, as well as some of the other parameters, was most likely measured at slightly different growth stages at the study locations. A consideration of location was introduced into the statistical model in order to account for variation in soil types, climates, growing period, etc, but if measurements were not taken at consistent times within the growing cycle (at silking, for example) at each location, they may not be directly comparable. For an example of this, see Fig. 16. Therefore, it is difficult to make conclusions about the effect of the different treatments on plant height.

Color Index

The 'N+P' treatment plots had a statistically higher color index value than the 'N only' treatment in corn, but not in cotton (Fig. 17). Significant regional differences occurred for both corn and cotton plots, with Piedmont locations having a lower mean color index value than other regions (Fig. 18). In addition, within individual regions, the 'N+P' treatment performed better, in terms of plant color index, than did the 'N only' treatment in Coastal Plain sites (Table 1). In analyzing treatment differences in individual counties, sites in both Beaufort and Edgecombe County had higher color index values when both N- and P-starter were used as opposed to just N-starter (Figs. 19-21). Within Beaufort County, although a significant soil effect was not present for color index (Table 2), locations in the county that occurred on mineral soil types had a higher color index value from the 'N+P' treatment as well (Table 3). This effect was not evident in organic soil types.

Although it suffers from the same "temporal" bias as plant height and perhaps some of the other parameters, color index additionally experiences potential biases related to the subjectivity

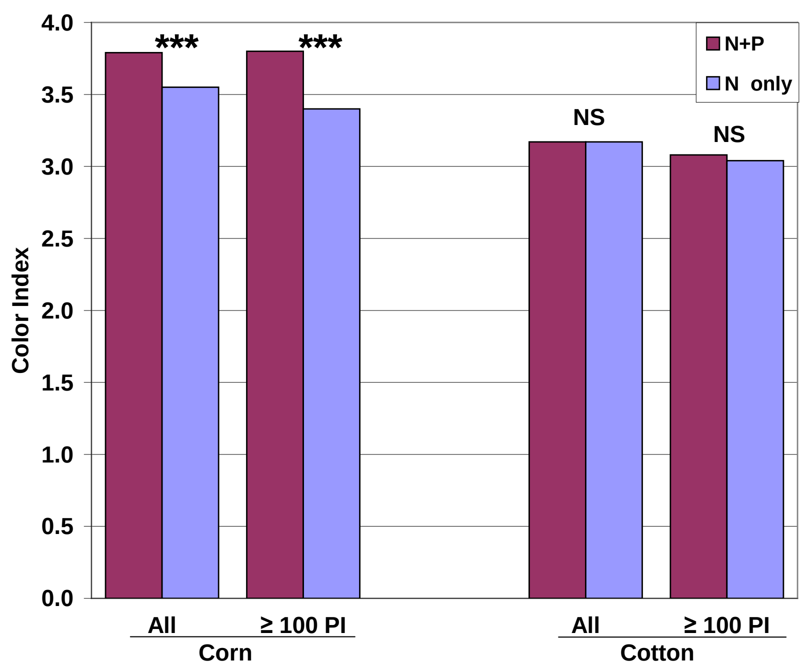

Fig. 17. Mean color index values of corn and cotton from all study locations.

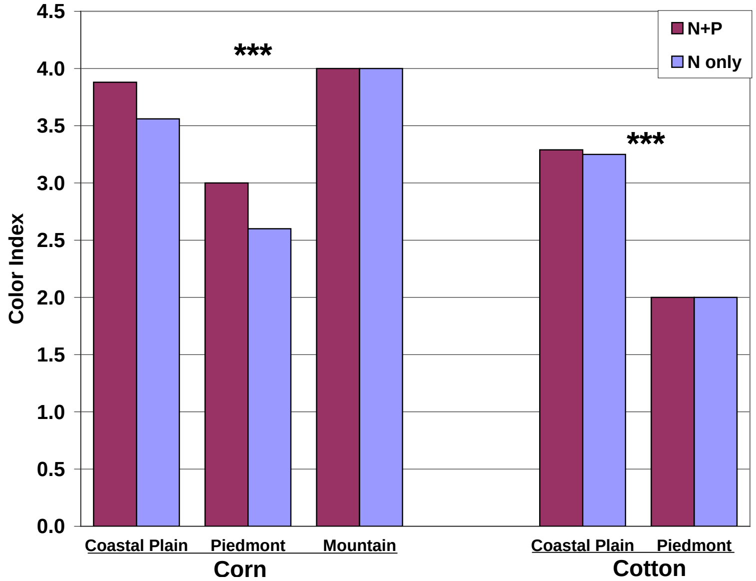

Fig. 18. Regional comparisons of mean color index values for corn and cotton

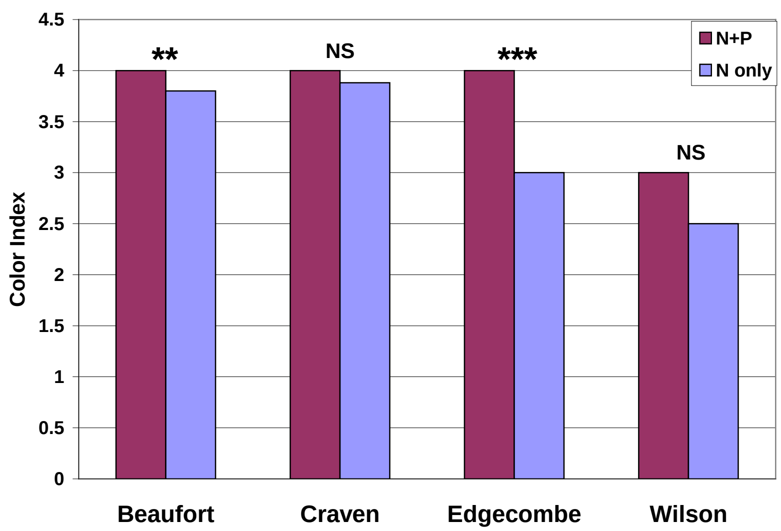

Fig. 19. Mean color index values for corn in Coastal Plain counties.

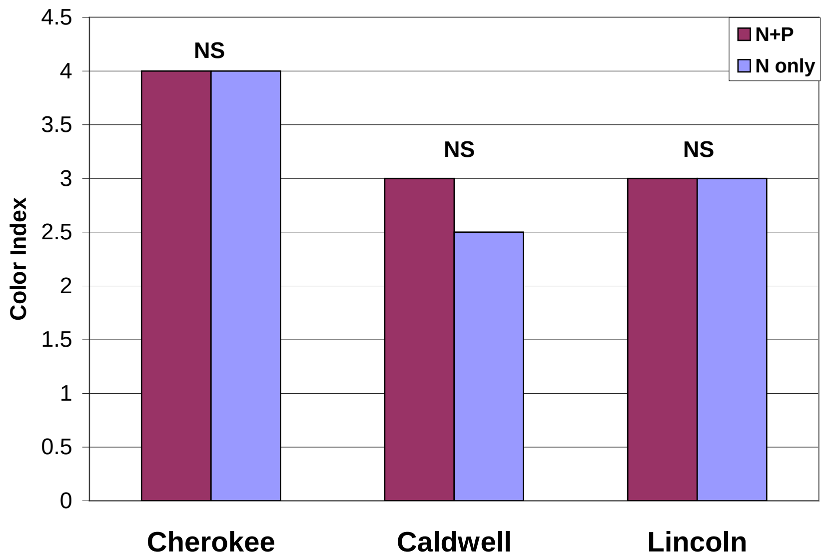

Fig. 20. Mean color index value of corn plants in Mountain and Piedmont counties.

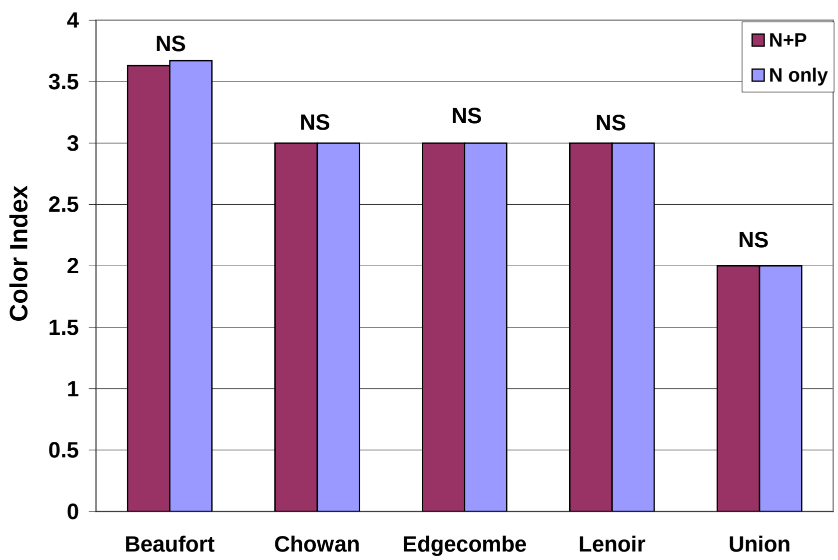

Fig. 21. Mean color index values of cotton plants in Coastal Plain and Piedmont counties.

of determining colors. The distinction of “green” versus “light green”, for example, is subject to different interpretations. Color index is the most subjective parameter that was measured. Therefore, it is felt that any inferences about treatment differences made based on color index would be questionable.

Tissue N and P

Plant tissue N and P were not significantly different among treatments and were, in general, higher in cotton plants than corn (Figs. 22, 23). Regional differences, on the other hand, occurred in corn plots for both tissue N and P, as corn growing in the Coastal Plain had lower tissue N and P than the other regions (Figs. 24 and 25). Again, these results would be somewhat dependant on when plants were sampled for tissue analysis, thereby potentially preventing direct comparisons. Treatment comparisons within regions resulted in no significant differences (Table 1). No treatment differences occurred in individual counties with the exception of Edgecombe County, in which the ‘N+P’ treatment had a greater mean tissue P than the ‘N only’ treatment (Figs. 26-31). Soil type had no significant effect on tissue analysis results from Beaufort County corn plots (Table 2).

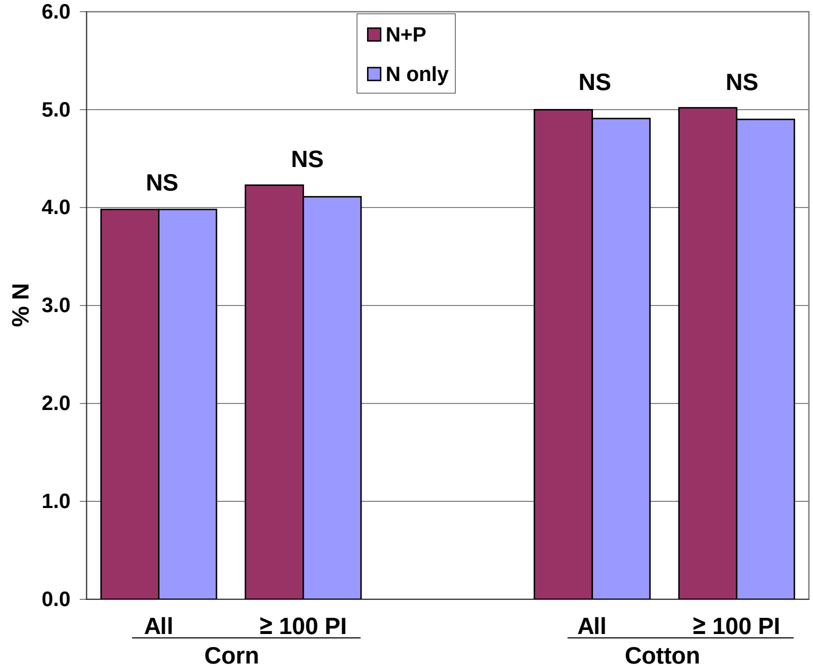

Fig. 22. Mean tissue N content of corn and cotton plants from all study locations.

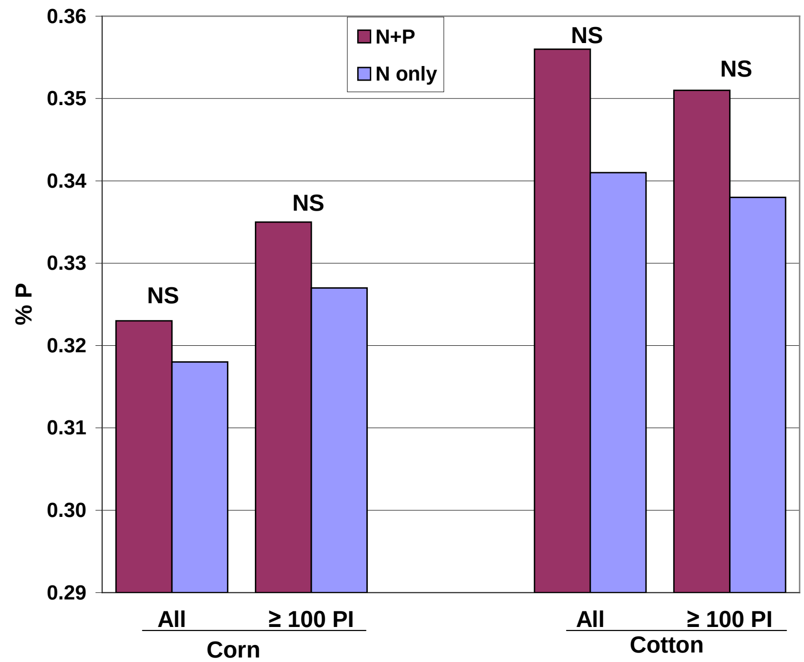

Fig. 23. Mean tissue P content of corn and cotton plants from all study locations.

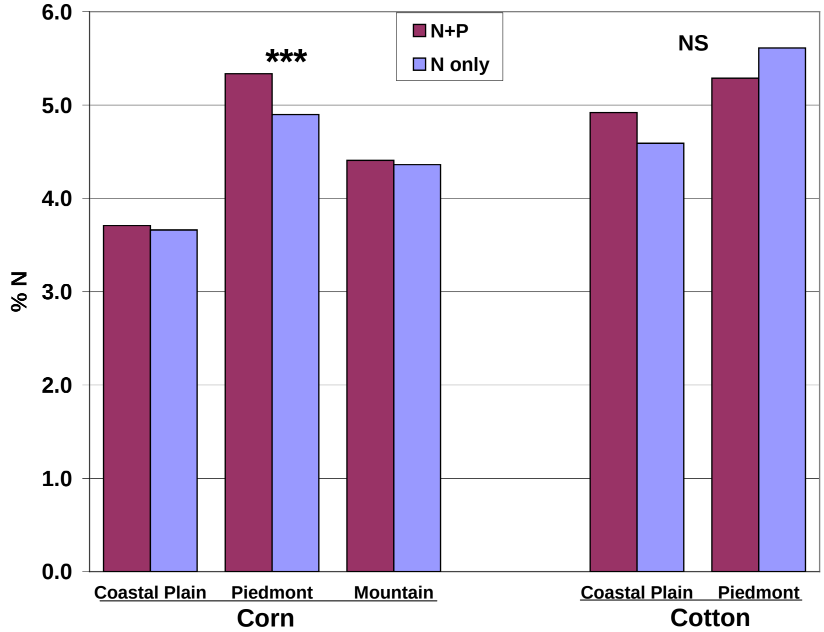

Fig. 24. Regional comparisons of mean tissue N content of corn and cotton plants.

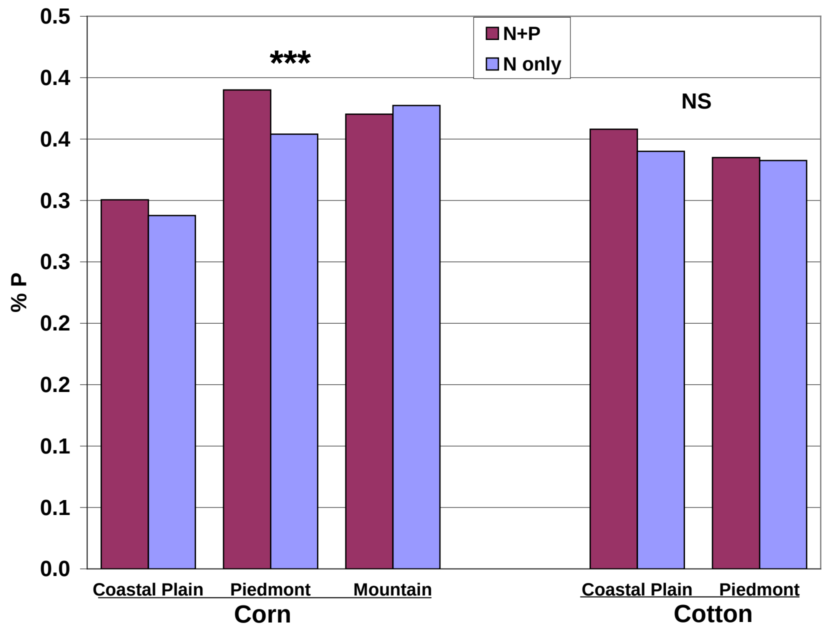

Fig. 25. Regional comparisons of mean tissue P content of corn and cotton plants.

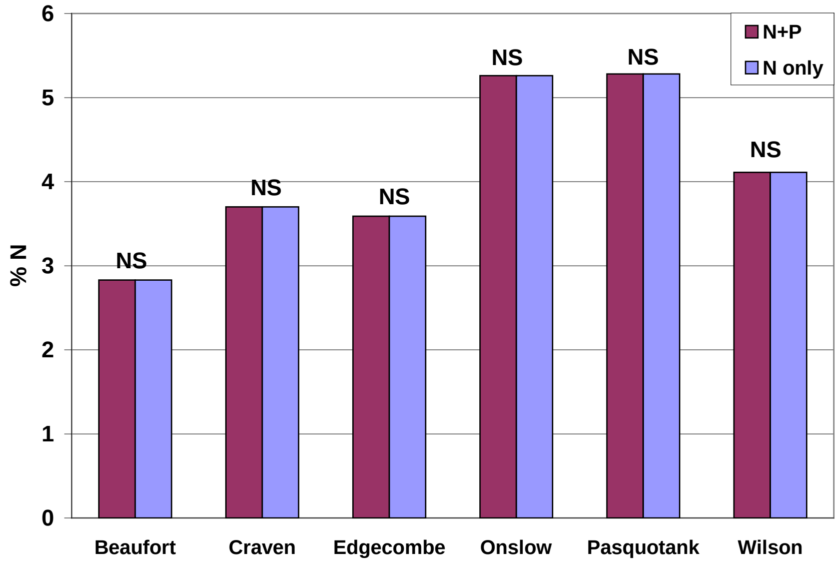

Fig. 26. Mean plant tissue N of corn plants in Coastal Plain counties.

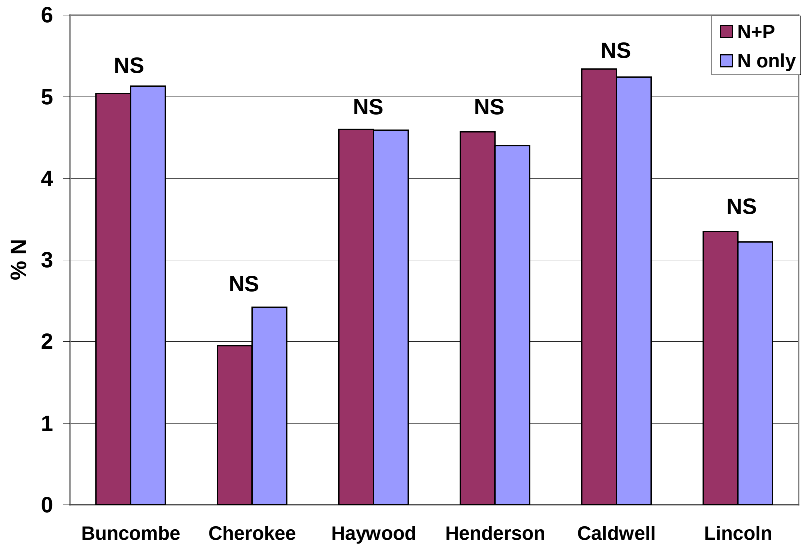

Fig. 27. Mean plant tissue N of corn plants in Mountain and Piedmont counties.

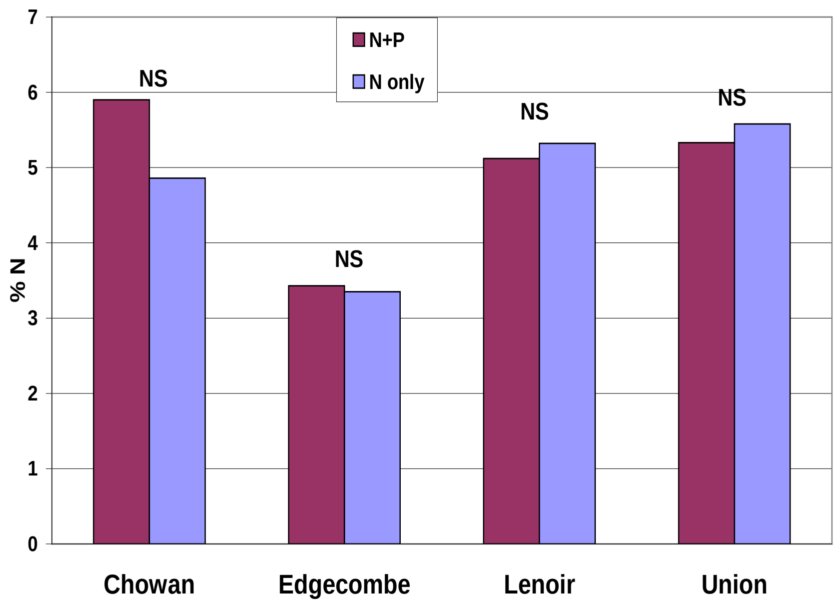

Fig. 28. Mean plant tissue N of cotton plants in Coastal Plain and Piedmont counties.

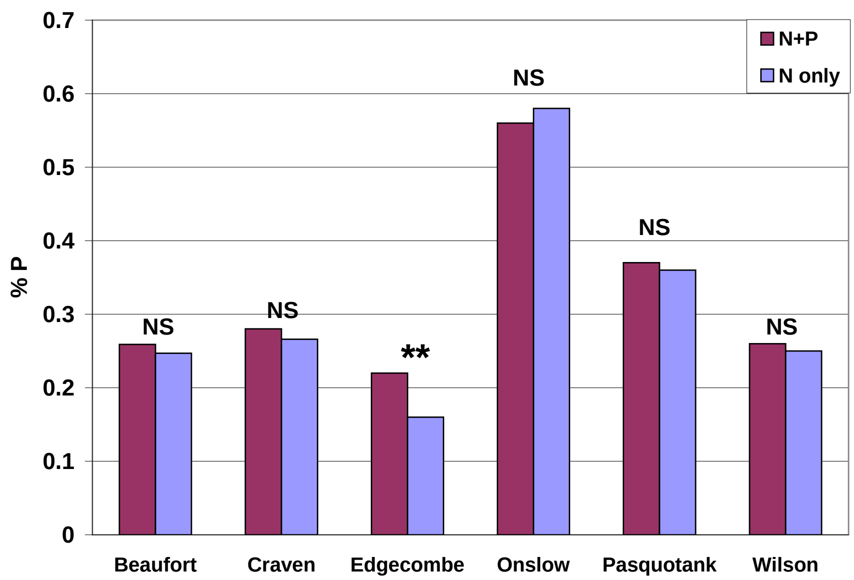

Fig. 29. Mean plant tissue P of corn plants in Coastal Plain counties.

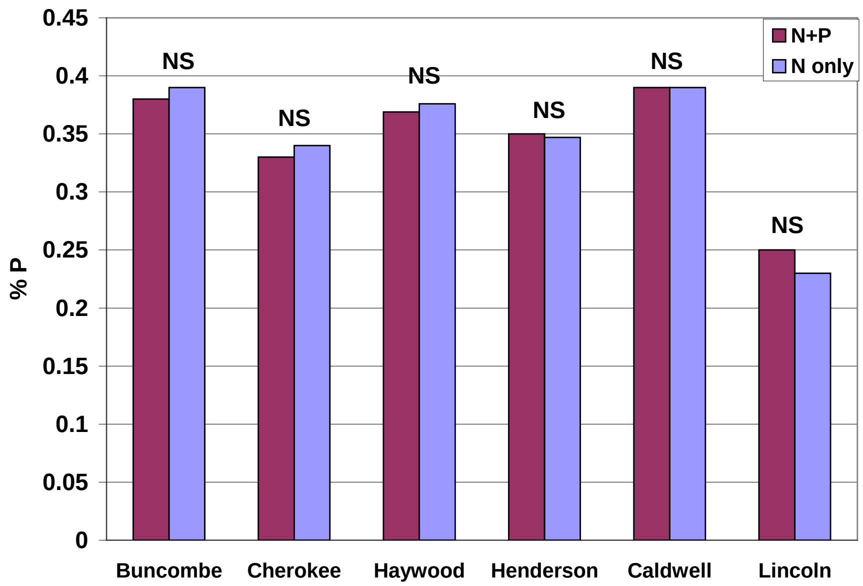

Fig. 30. Mean plant tissue P of corn plants in Mountain and Piedmont counties.

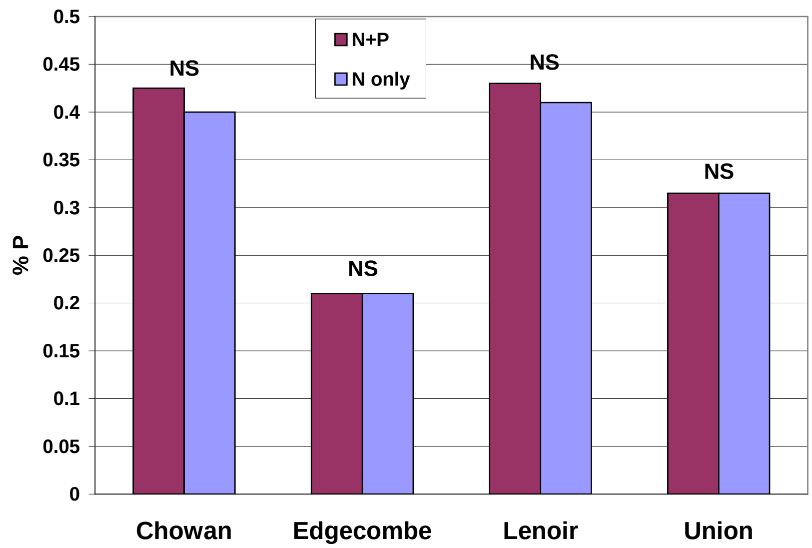

Fig. 31. Mean plant tissue P of cotton plants in Coastal Plain and Piedmont counties.

Days to Corn Silking and Early Cotton Bloom

Neither days to silking in corn plants, nor days to early bloom in cotton plants, experienced significant treatment effects when all locations were considered in the analysis (Fig. 32). Regional comparisons showed that the Mountain region had a statistically greater number of days to corn silking than either the Piedmont or Coastal Plain regions, although this finding is most likely due to differences in growing season (Fig. 33). ‘Days to early bloom’ was not measured from cotton sites in Union County, and because this was the only Piedmont location of corn, differences due to region cannot be examined. No significant treatment differences were apparent within physiographic regions (Table 1). Figures 34 and 35 illustrate the lack of differences in ‘days to silking’ for each county with corn sites, and Figure 36 in ‘days to early bloom’ for each county with cotton sites.

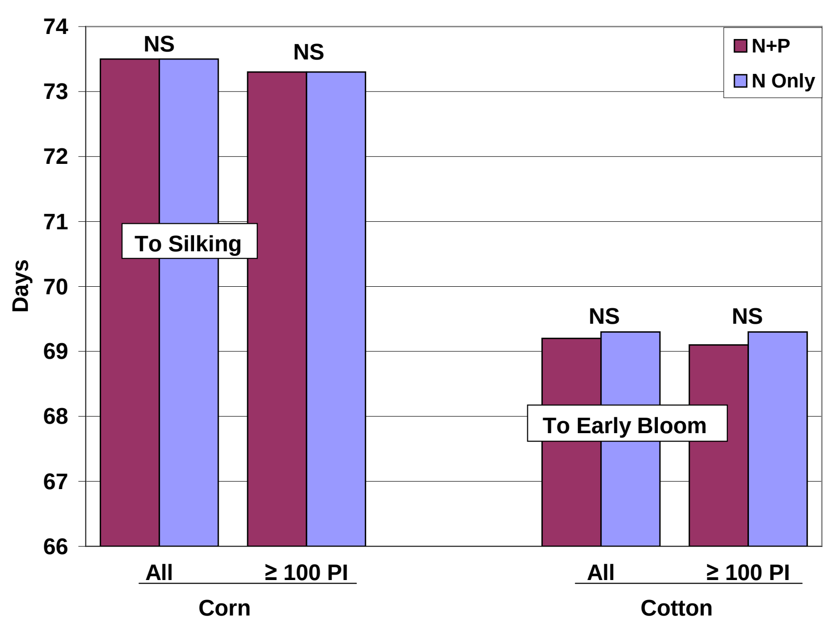

Fig. 32. Mean number of days to corn silking and early cotton bloom from all study locations.

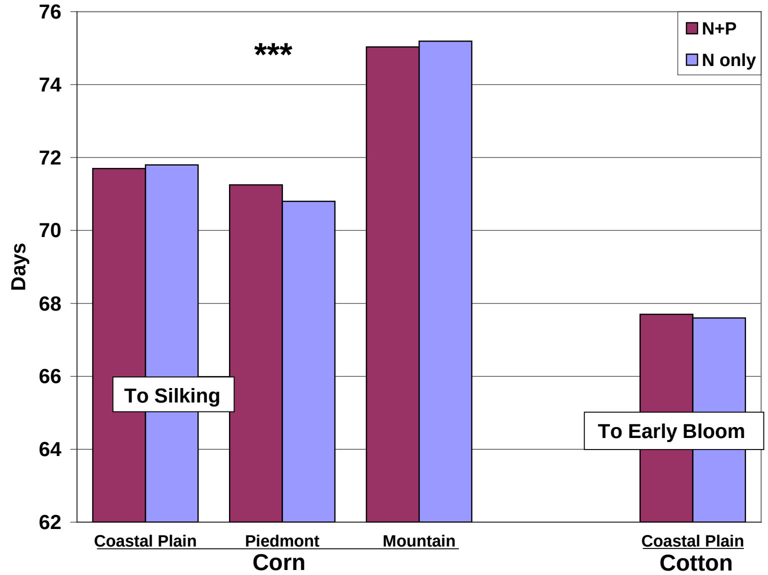

Fig. 33. Regional comparisons of days to corn silking and early cotton bloom.

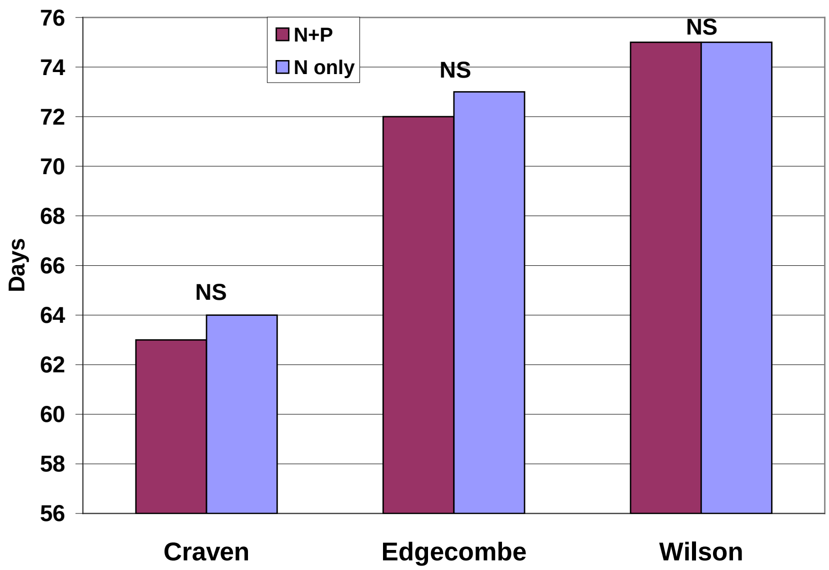

Fig. 34. Mean number of days to silking of corn in Coastal Plain counties.

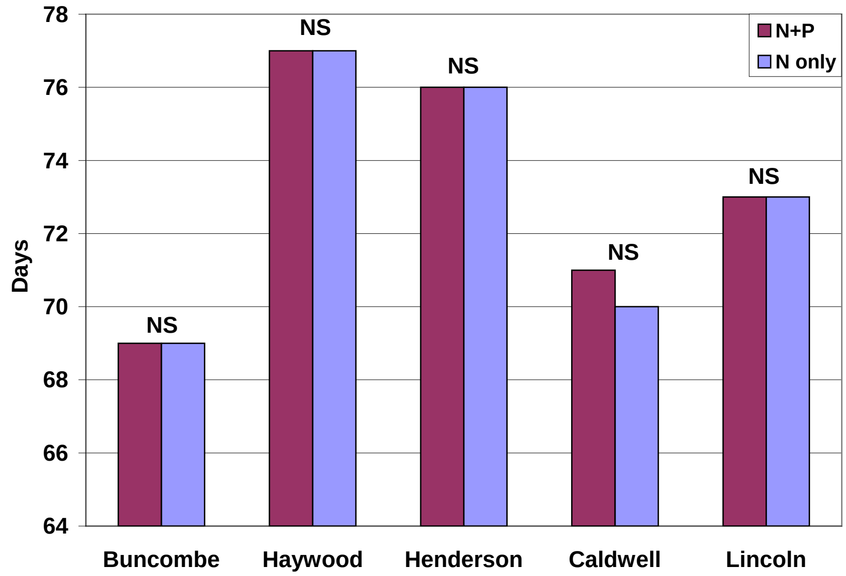

Fig. 35. Mean number of days to silking of corn plants in Mountain and Piedmont counties.

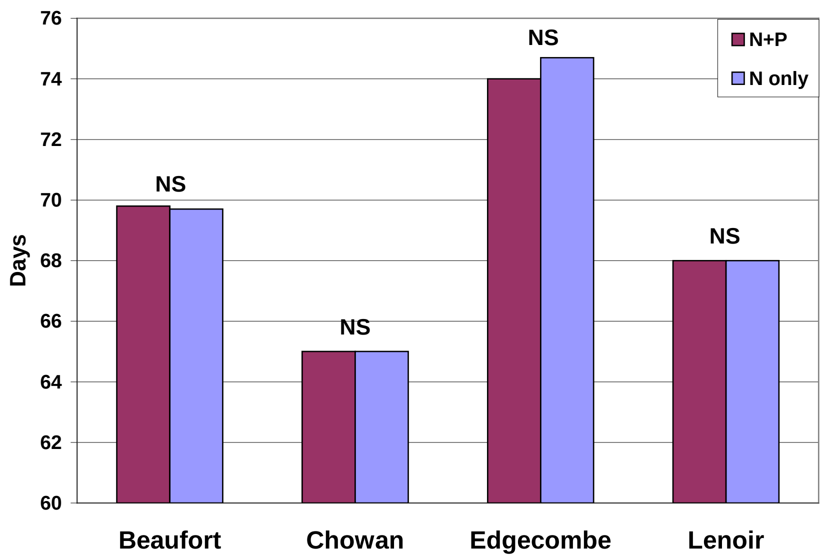

Fig. 36. Mean number of days to early bloom of cotton plants in Coastal Plain counties.

Number of Nodes

A significant treatment difference occurred for nodes at first bloom, while the treatment difference in number of total nodes was only significant when all sample locations were included (Fig. 37). No treatment difference in nodes above white flower was present. Nodes at first bloom presents somewhat of an anomaly relative to other parameters, as the 'N only' treatment performed "better", in terms of cotton production, than the 'N+P' treatment. This was the only instance of the treatment receiving only N-starter surpassed the 'N+P' treatment in terms of plant health. The reason for this result is unknown. In terms of regional comparisons, no region effect was present for any of the node parameters (Fig. 38) but the number of nodes at first bloom experienced a treatment difference within Coastal Plain locations (Table 1); again the 'N only' treatment was significantly higher than the 'N+P' treatment. The significantly greater number of nodes at first bloom that occurred when analyzing all cotton plots together, did not arise in any individual counties, nor did any other parameter (Figs. 39-41). None of the counties that had cotton plots consisted of more than one location; this lack of replication may be related to the scarcity of treatment differences found.

'Nodes at first bloom' is another parameter, with color and plant height, that may be subject to differences in human interpretation. The time at which "first bloom" appears, although it will undoubtedly differ by geographical location, may be defined differently by different individuals, and thus the number of nodes at first bloom may have some measurement bias not accounted for simply by inclusion of location in the analysis.

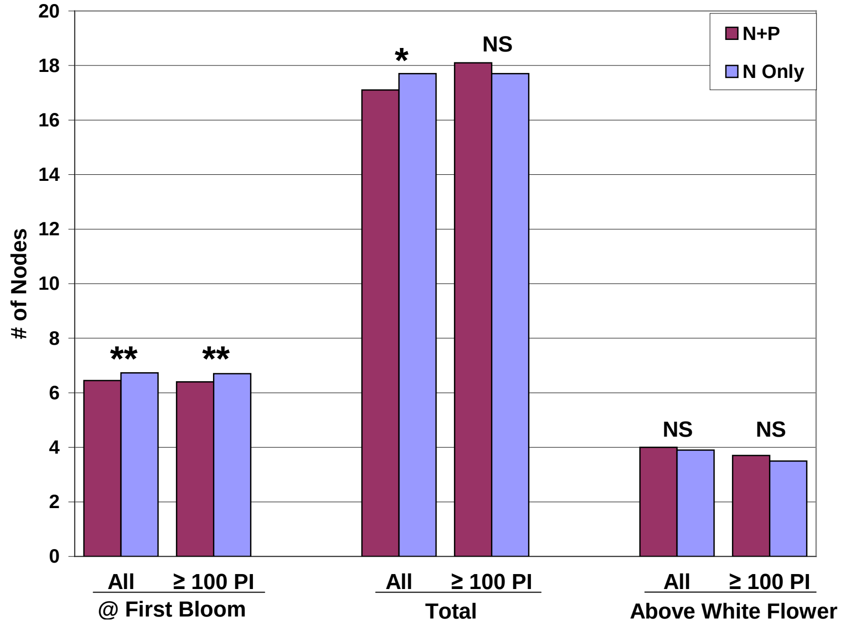

Fig. 37. Mean number of nodes at first bloom, total nodes, and nodes above white flower of cotton plants from all study locations.

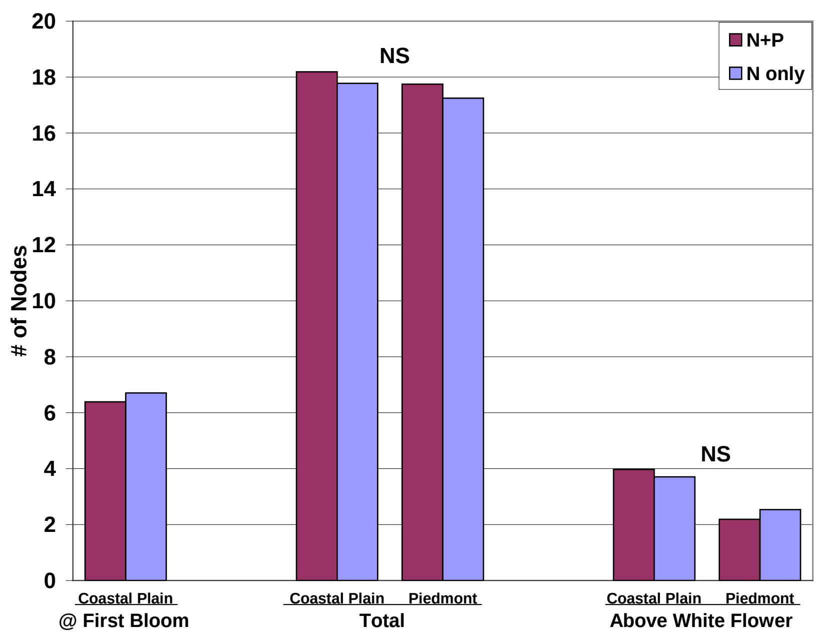

Fig. 38. Regional comparisons of mean number of nodes at first bloom, total nodes and nodes above white flower of cotton plants.

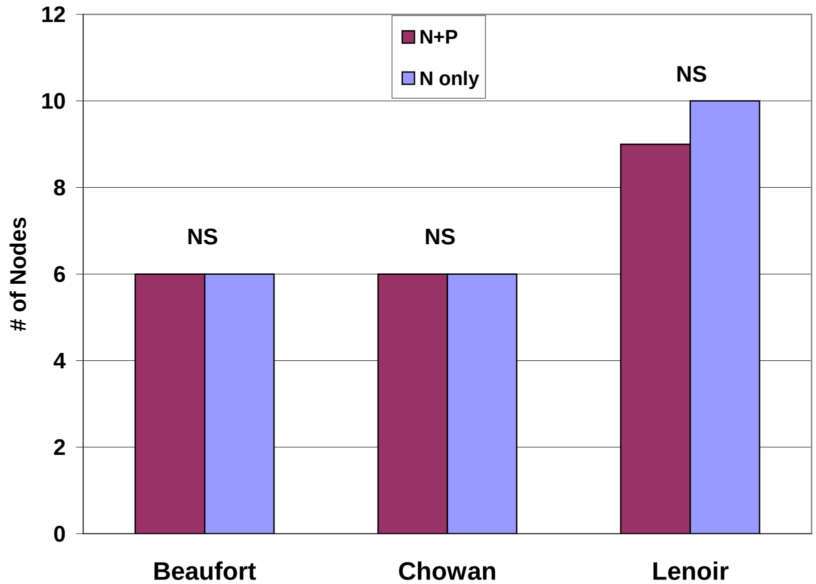

Fig. 39. Mean number of nodes at first bloom of cotton plants in Coastal Plain counties.

Fig. 40. Mean number of total nodes of cotton plants in Coastal Plain counties.

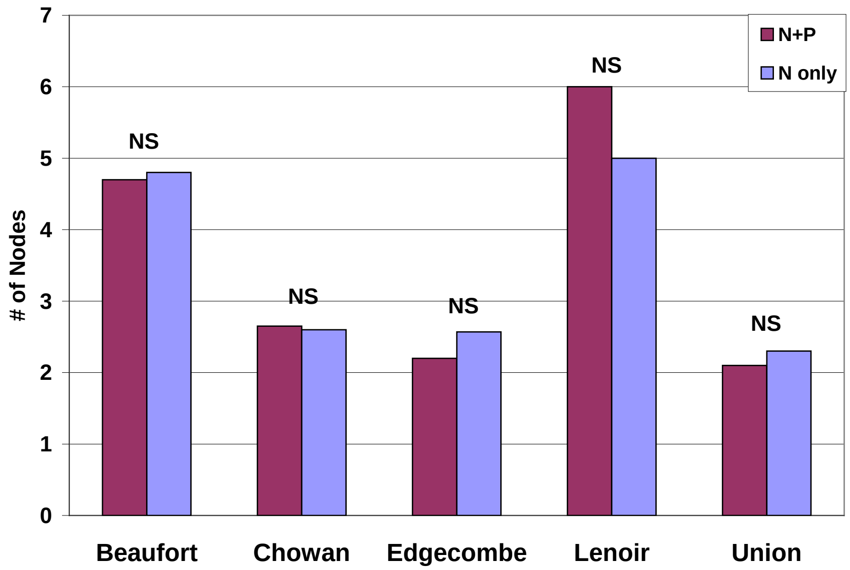

Fig. 41. Mean number of nodes above white flower of cotton plants in Coastal Plain counties.

Soil Test P

The level of soil test P was not appreciably different between the two treatments in either corn or cotton plots (Fig. 42). Therefore, any differences seen in crop growth parameters should be due to the addition of P fertilizer, or lack thereof, and not due to differences in soil P. Significant regional differences occur in soil test P, as Mountain locations on which corn was grown had a much lower soil test P level than other regions, and Piedmont cotton plots had a significantly greater level of soil test P than Coastal Plain sites. The significantly lower soil test P found on Mountain sites apparently did not affect corn growth, as these sites were the highest, or among the highest, sites in all parameters measured. The finding of higher soil test P of cotton plots in the Piedmont may be due to the fact that only one Piedmont location was involved in the study and this county has one of the highest average soil test P levels, due to the prevalence of animal agriculture. However, based on the fact that the study site in this Piedmont location was not statistically higher than Coastal Plain cotton sites in any of the crop parameters measured, the greater soil test P appears not to be affecting cotton growth.

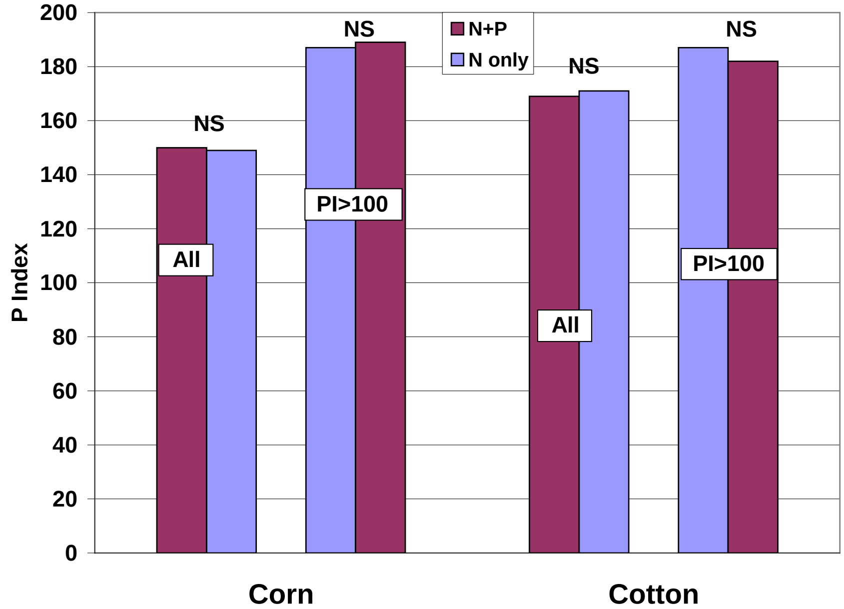

Fig. 42. Treatment differences in mean soil test P levels for two sample populations of corn and cotton.

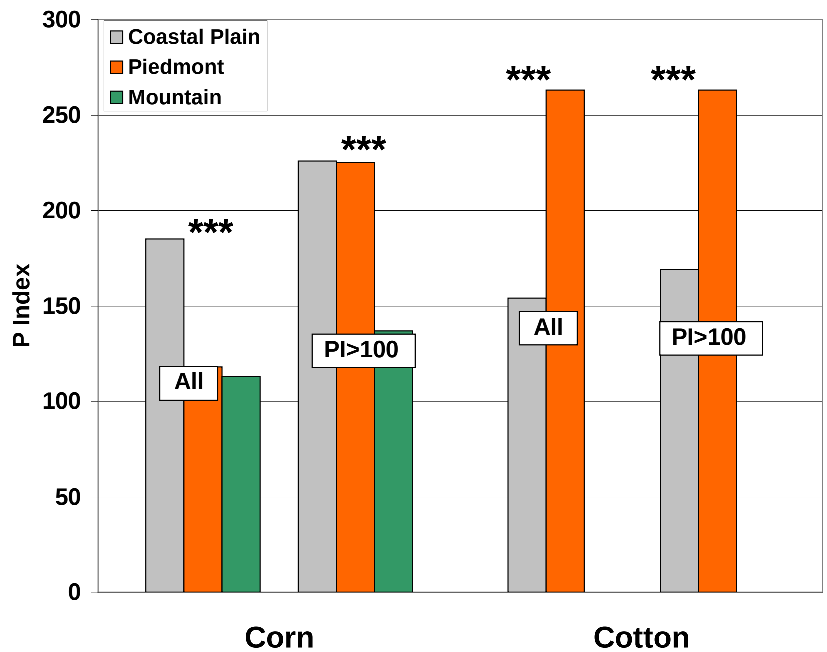

Fig. 43. Regional differences in mean soil test P levels for two sample populations of corn and cotton.

CONCLUSIONS

Given the dearth of consistent treatment differences, it appears that the addition of starter-P fertilizer to *high*-P Index soils does not improve the growth of corn or cotton plants. When considering all locations collectively by crop, the only significant differences between treatments that were apparent were plant height and color index in corn plots and nodes at first bloom in cotton plots. In the case of plant height and color index, the 'N+P' treatment was greater than the 'N only' treatment, while the number of nodes at first bloom were greater in the 'N only' treatment. However, these parameters seem to be relatively subjective and much less conclusive than would be a highly significant treatment difference in a more "rigorous" parameter such as yield. Color index value, for example, includes bias due not only to subjectivity of defining and differentiating between shades of green, but to the time at which a color "measurement" is taken as well.

Significant regional differences existed for most corn parameters, indicating that corn plants in the same physiographic region tended to behave similarly to each other and differently than corn growing in other regions. Grouping all locations into three regions better allows us to make generalizations based on geographic area while still accounting for differences in corn growth imposed by different climates and soils. Corn plots in the Mountain had higher levels of most crop parameters than did the Piedmont and Coastal Plain, despite the differences in soil test P. The lack of major regional differences in cotton suggests that grouping all locations into regions did not better account for site variability, although the scarcity of cotton sites may have been a factor; whereas 27 study locations were available for corn, only 7 different cotton locations were available and all but one was in the Coastal Plain.

Within each physiographic region, treatment differences existed for yield, plant population, plant height and color index for corn plots in the Coastal Plain. In each case, the 'N+P' treatment was greater than the 'N only' treatment. No other region had treatment differences in corn parameters. The only significant treatment difference seen in cotton plots was a statistically greater number of nodes at first bloom in 'N only' treatment plots of the Coastal Plain.

The corn parameters which had significant treatment differences in individual counties were: yield, color index and plant height in Beaufort County, and tissue N and color index in Edgecombe County, with the 'N+P' treatment being greater than the 'N only' treatment in all cases. For cotton parameters, Beaufort County was the only county to have a treatment difference and it occurred with nodes at first bloom. Again, however, we run into the potential problem of subjectivity across locations with measurements of color index and plant height. Yield, on the other hand, is a more rigorous measurement, so to speak, that is more resistant to temporal (within the growing season) biases. In this situation, the 'N+P' treatment performed significantly better than did the 'N only' treatment. However, of all the counties sampled, in either corn or cotton, Beaufort County was the only county to show this result.

Because corn plots in Beaufort County were the only study locations to experience a statistically significant treatment difference in yield, we performed more detailed analysis on these sites by segregating plots by soil type. In this way, any effect of soil type on the treatment differences that were found could be accounted for. The only significant soil effect that was found was a greater soil test P at sites with mineral soils as opposed to sites with organic soils. This result, however, did not affect crop growth parameters at organic sites.

Overall, these results indicate that treatment differences exist for only a few, relatively subjective, crop growth parameters, such as color index, with the one exception of yield from study sites in Beaufort County. Where treatment effects did occur, the ‘N+P’ treatment was generally the better treatment when considering corn parameters, while the opposite was true of cotton parameters. Our results, however, do not seem to suggest that the use of starter-P fertilizer is warranted on fields with *very high* soil test P values (>100 PI).

Since growing seasons are never the same, it is important to have several years of data before recommendations are changed. In future years, it will be important to have as many replications and locations as possible in order to obtain more conclusive data. This work, however, gives us an excellent start into investigating whether to keep the current starter-P fertilizer recommendations or revise them.

BUDGET

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APPENDIX A

Treatment and Regional Comparisons for Crop Parameters When Control Plots Were Included in Statistical Analysis

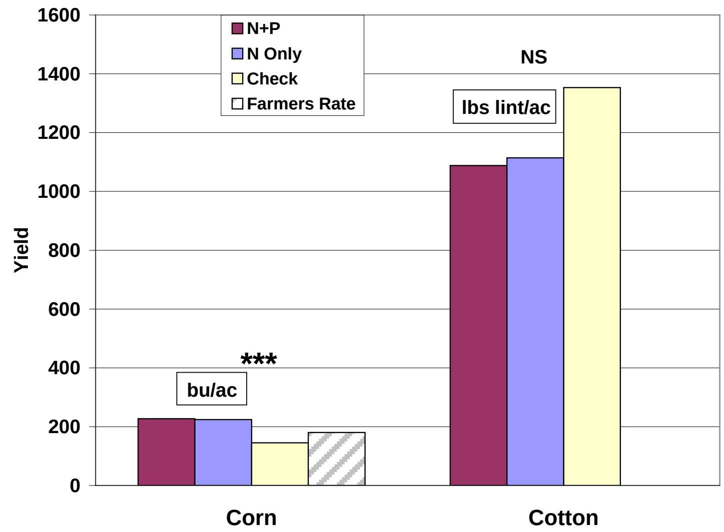

Fig. A1. Mean crop corn and cotton yields from all study locations.

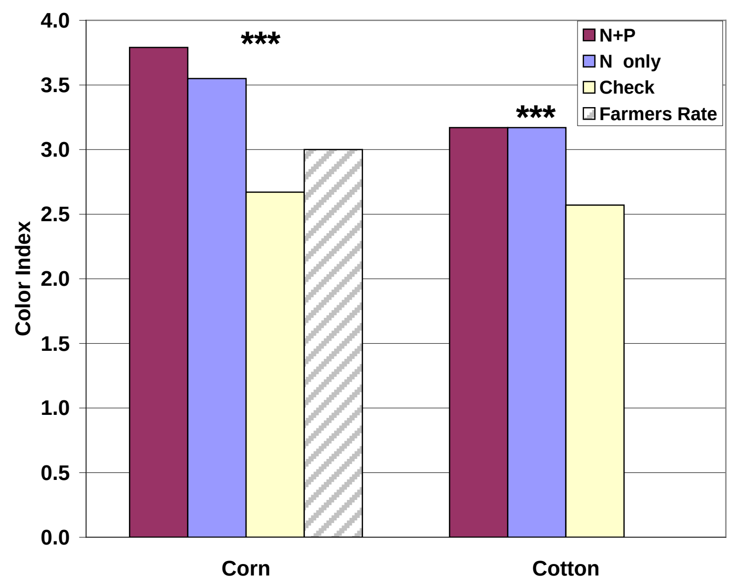

Fig. A2. Mean color index values of corn and cotton from all study locations.

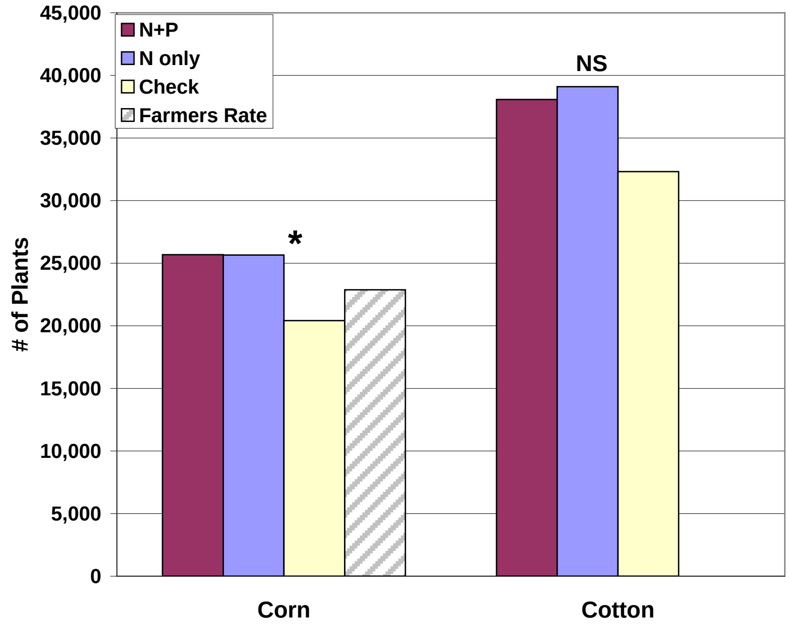

Fig. A3. Mean corn and cotton populations from all study locations.

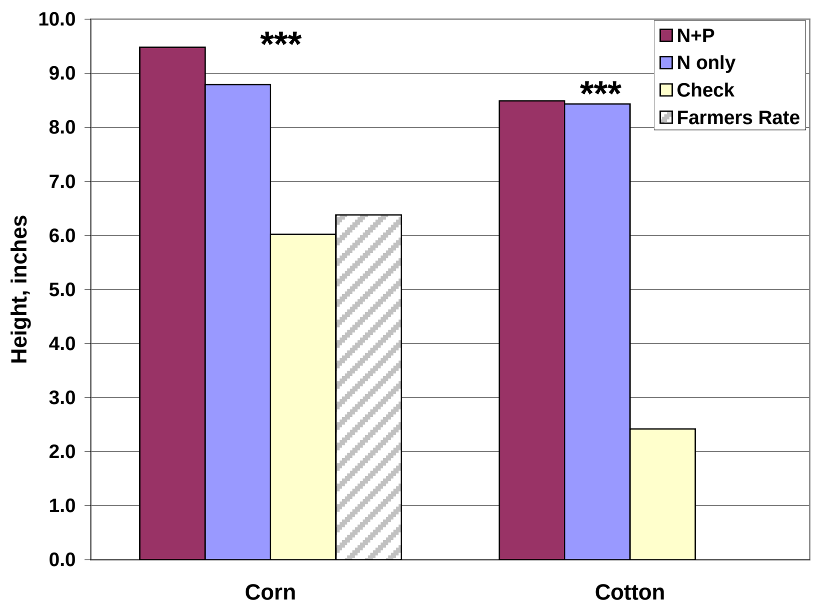

Fig. A4. Mean heights of corn and cotton plants from all study locations.

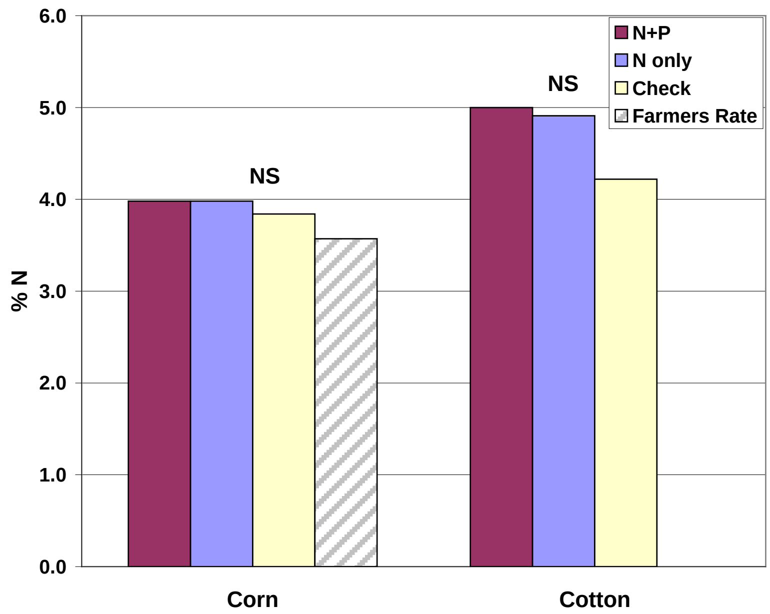

Fig. A5. Mean tissue N content of corn and cotton plants from all study locations.

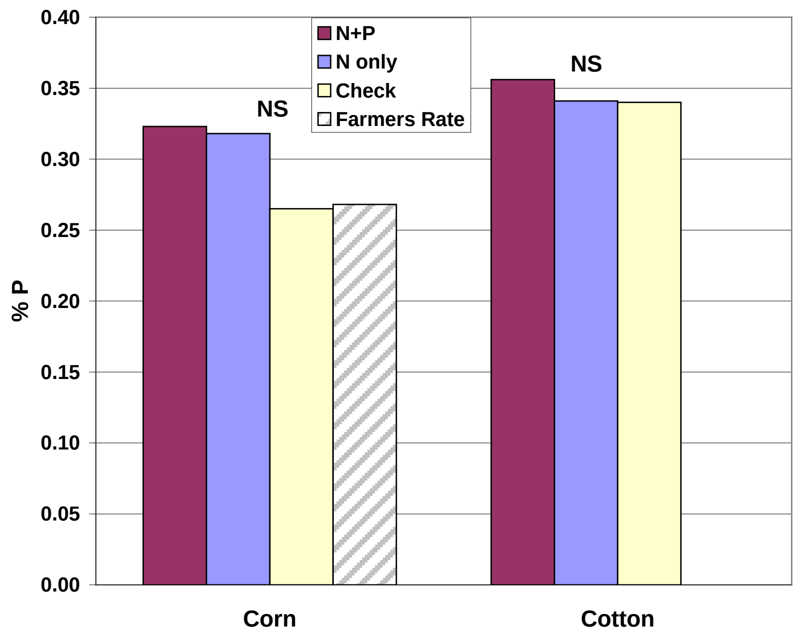

Fig. A6. Mean tissue P content of corn and cotton plants from all study locations.

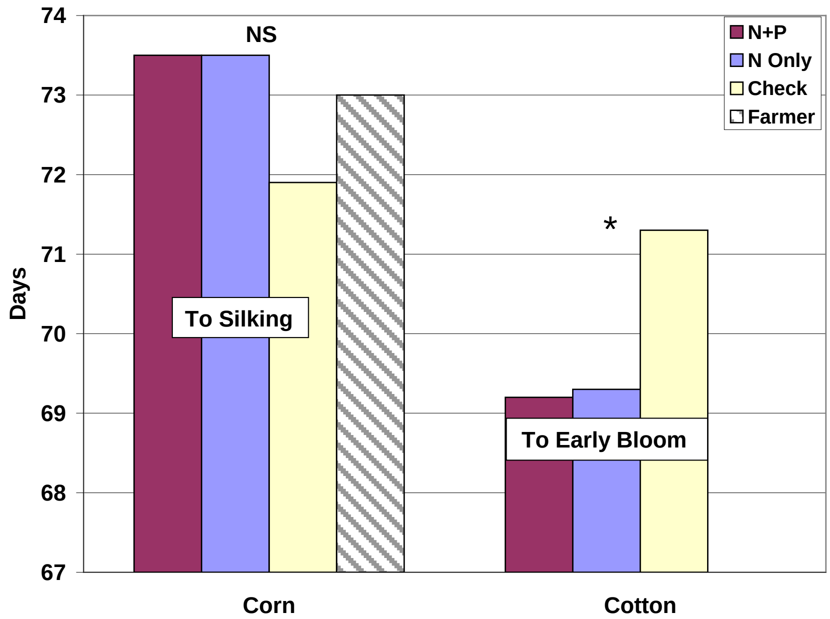

Fig. A7. Mean number of days to corn silking and early cotton bloom from all study locations.

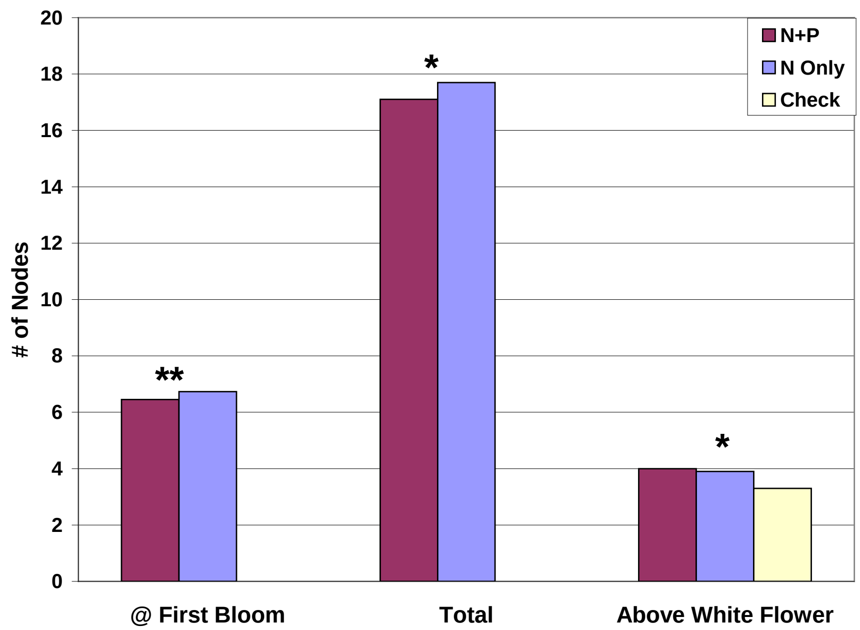

Fig. A8. Mean number of nodes at first bloom, total nodes, and nodes above white flower of cotton plants from all study locations.

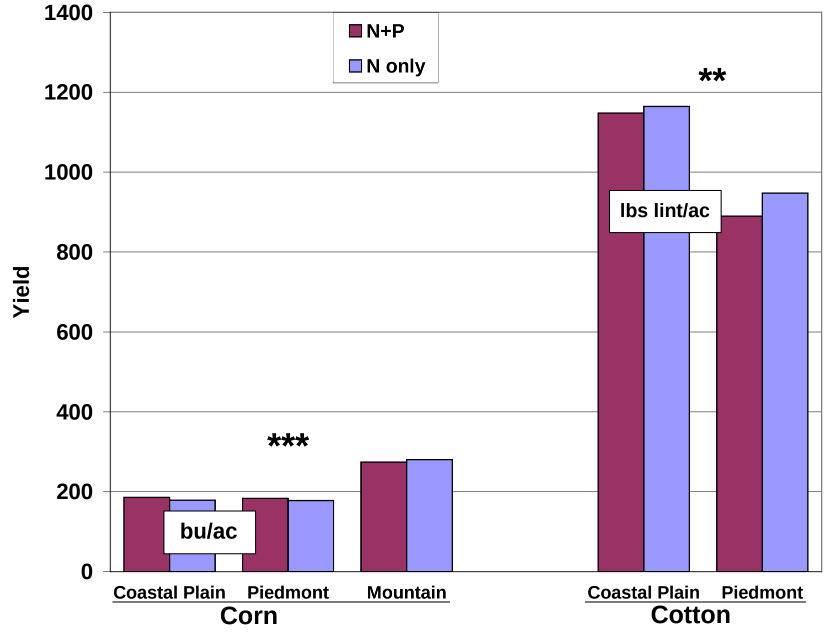

Fig. A9. Regional comparisons of mean corn and cotton yields.

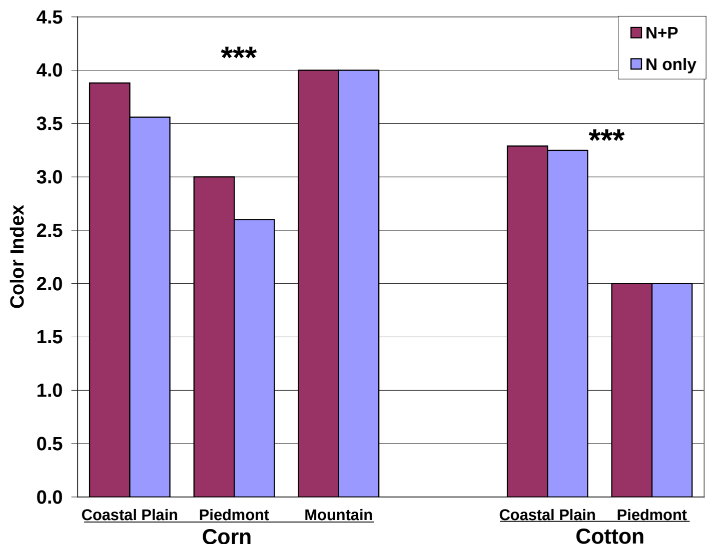

Fig. A10. Regional comparisons of mean color index values for corn and cotton.

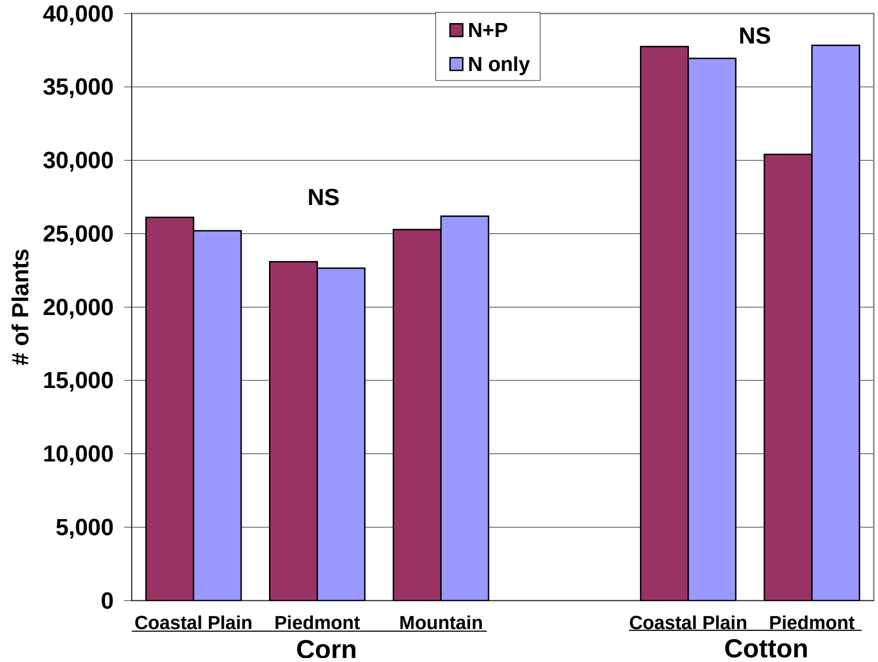

Fig. A11. Regional comparisons of mean corn and cotton plant populations.

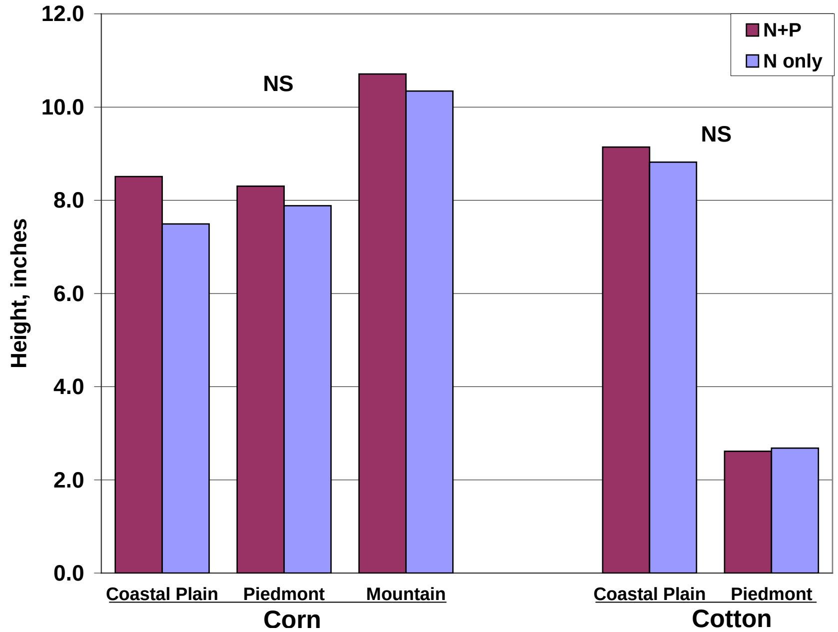

Fig. A12. Regional comparisons of mean corn and cotton plant heights.

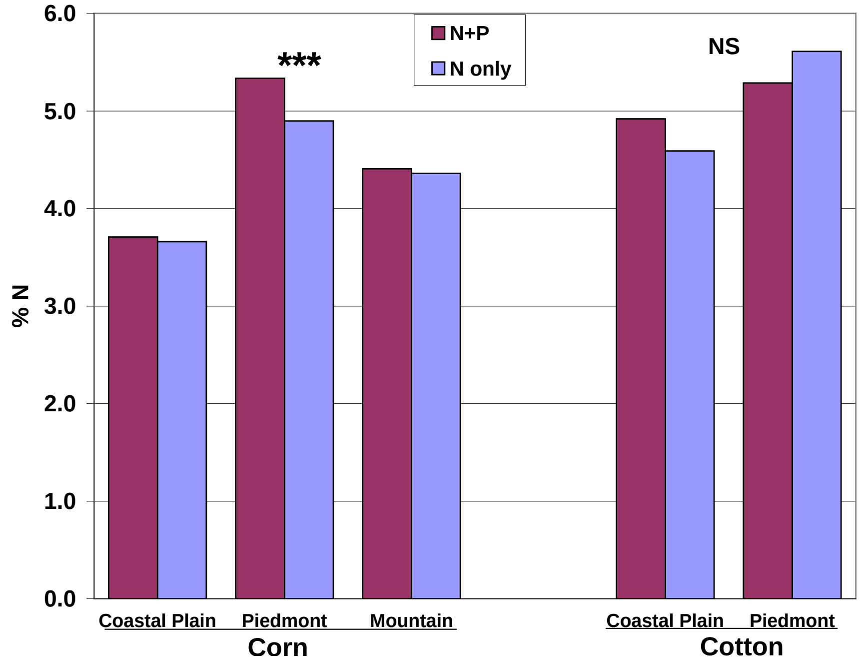

Fig. A13. Regional comparisons of mean tissue N content of corn and cotton plants.

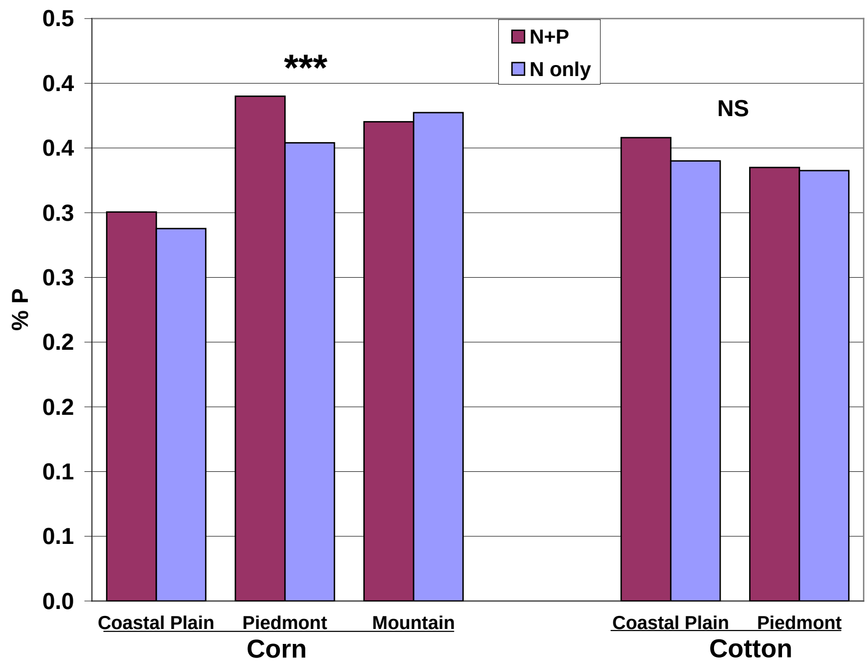

Fig. A14. Regional comparisons of mean tissue P content of corn and cotton plants.

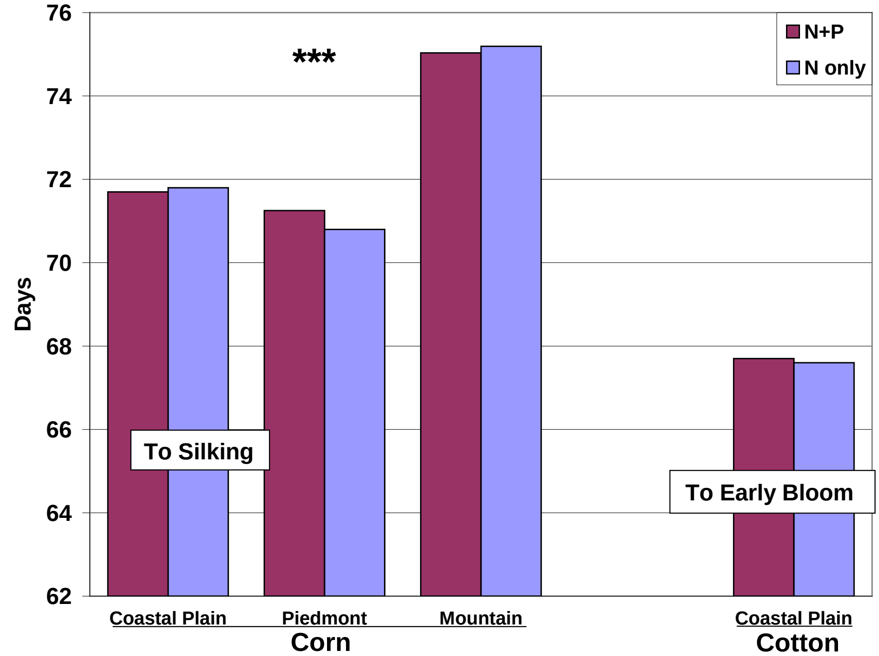

Fig. A15. Regional comparisons of days to corn silking and early cotton bloom.

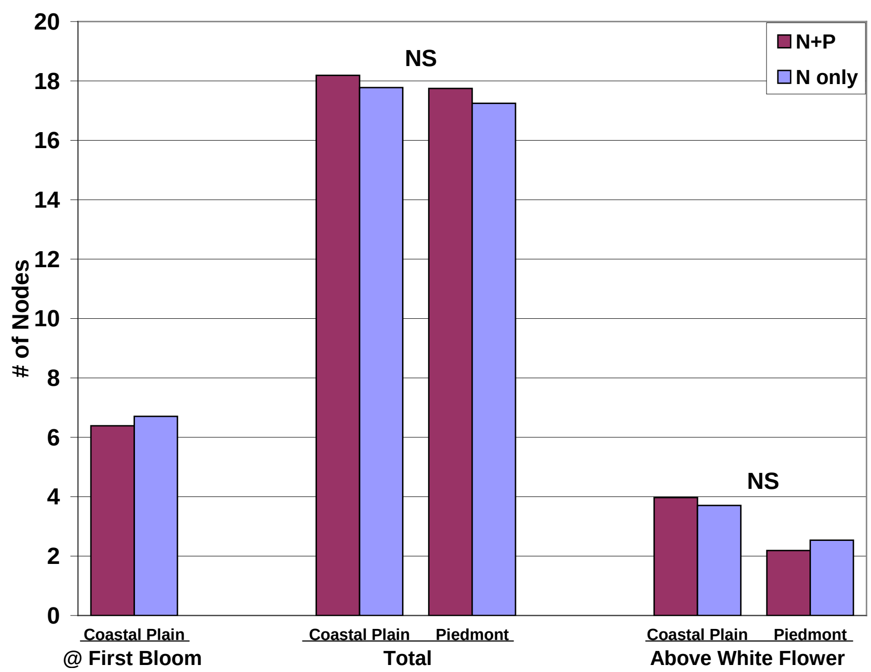

Fig. A16. Regional comparisons of mean number of nodes at first bloom, total nodes and nodes above white flower of cotton plants.

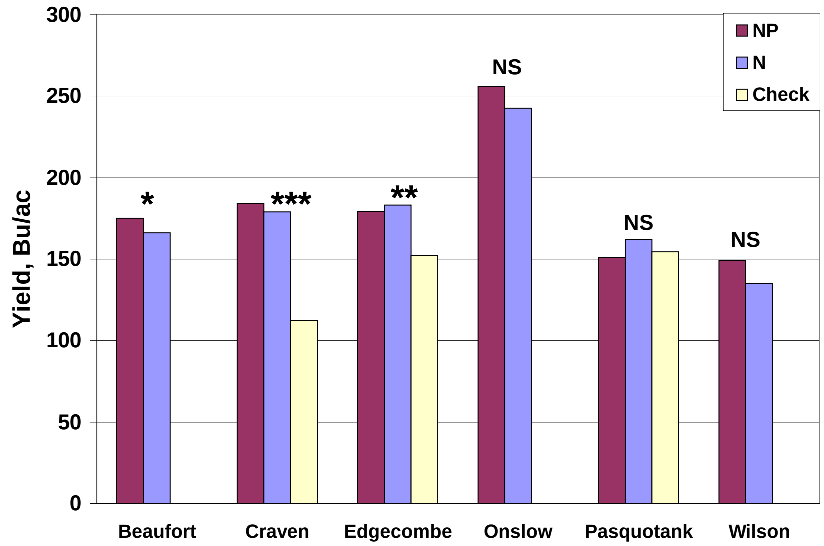

Fig. A17. Mean corn yield in Coastal Plain counties.

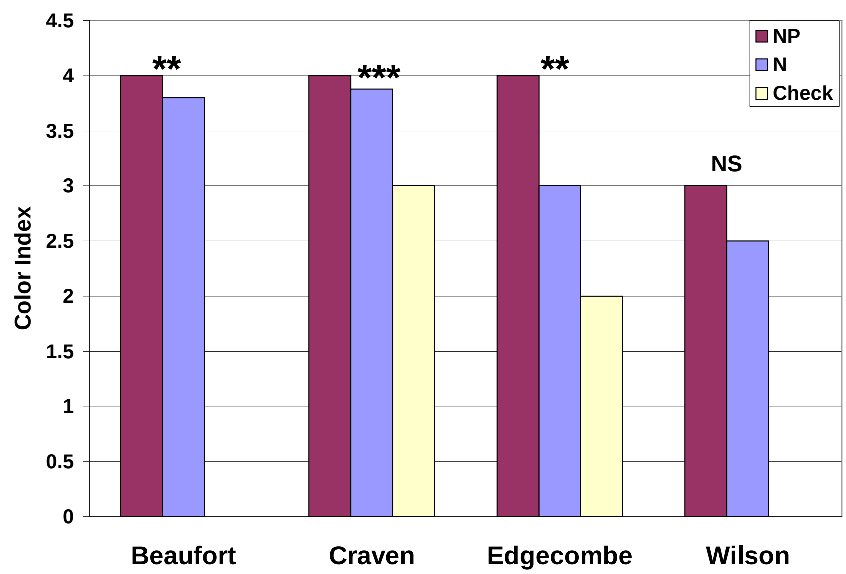

Fig. A18. Mean color index values for corn in Coastal Plain counties.

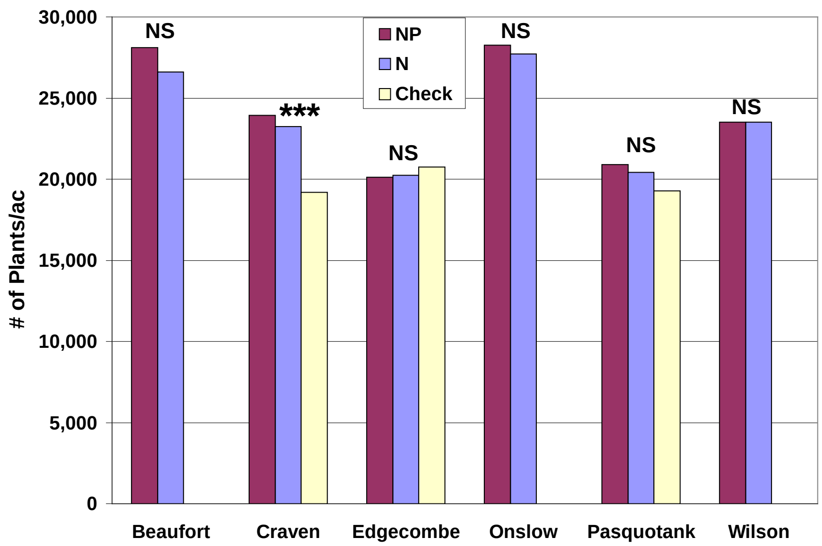

Fig. A19. Mean plant population of corn plots in Coastal Plain counties.

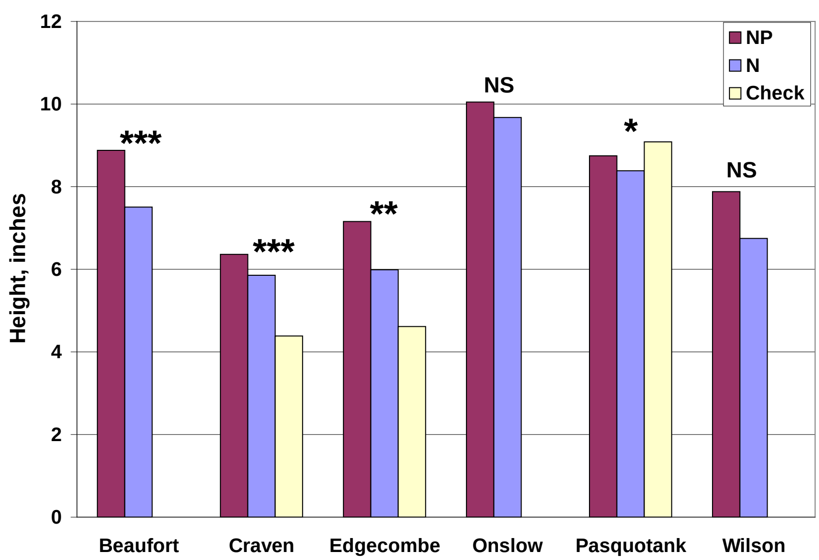

Fig. A20. Mean plant height of corn plants in Coastal Plain counties.

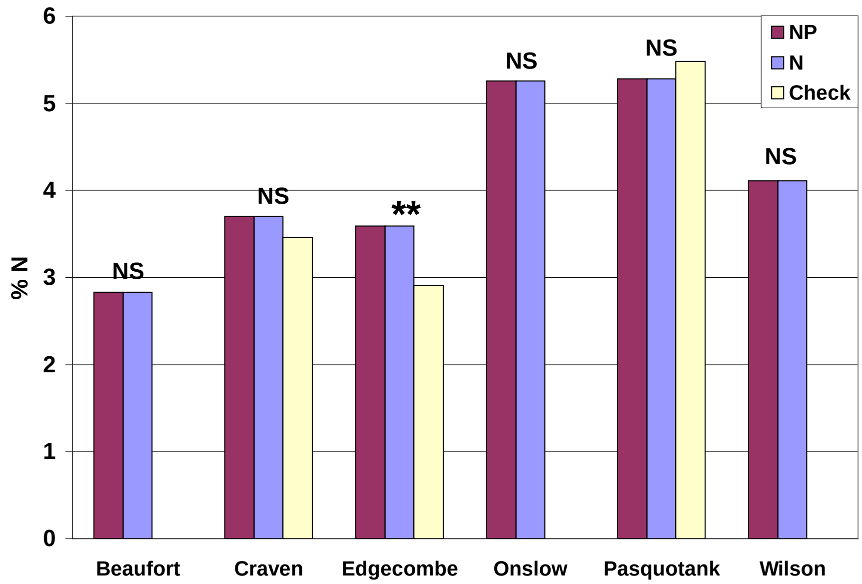

Fig. A21. Mean plant tissue N of corn plants in Coastal Plain counties.

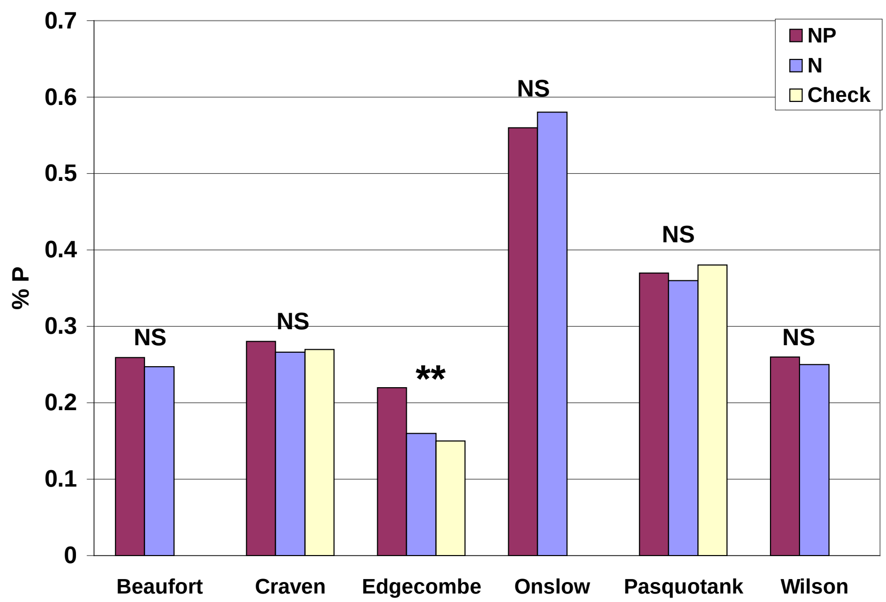

Fig. A22. Mean plant tissue P of corn plants in Coastal Plain counties.

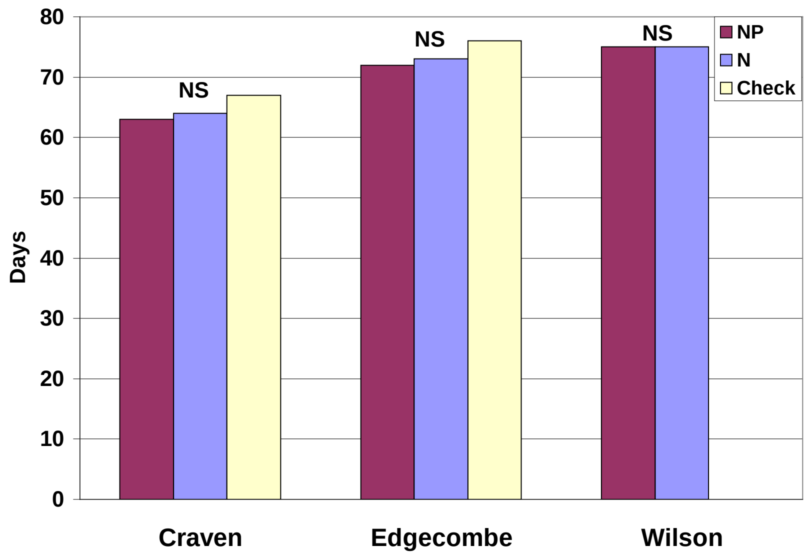

Fig. A23. Mean number of days to silking of corn in Coastal Plain counties.

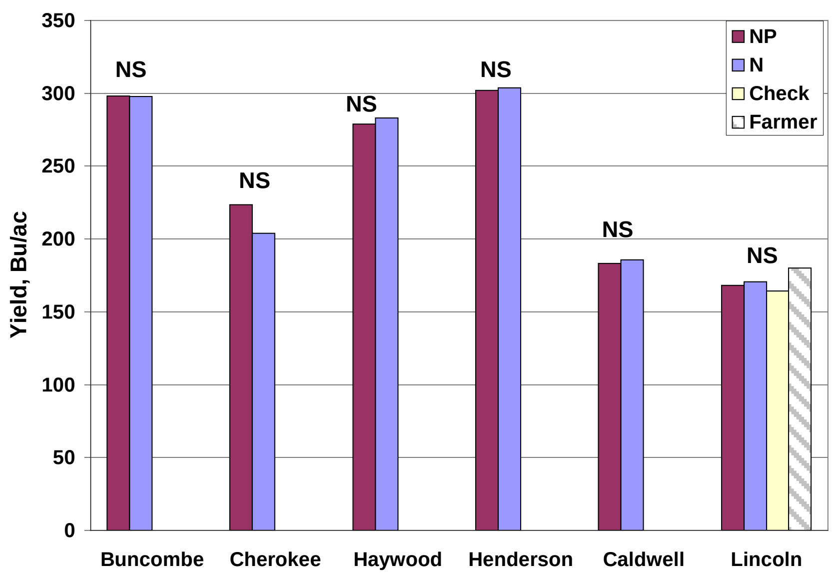

Fig. A24. Mean corn yield in Mountain and Piedmont counties.

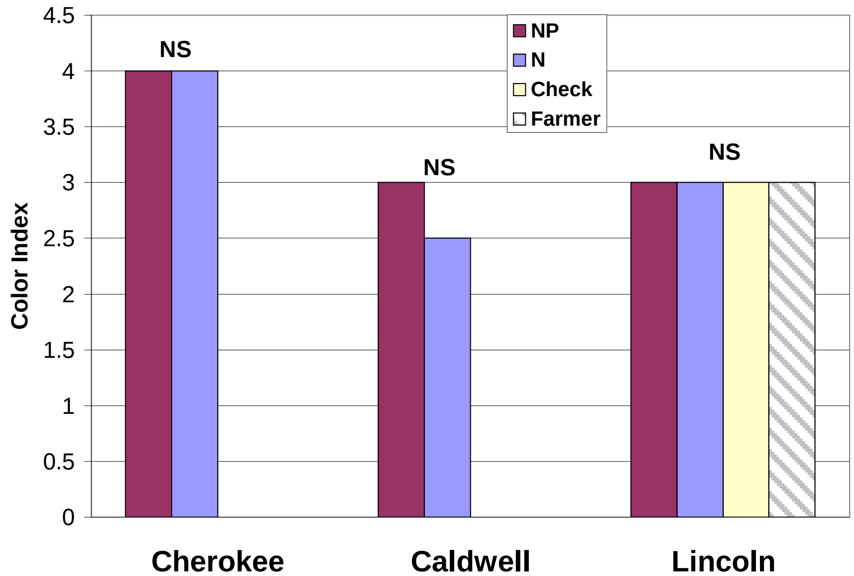

Fig. A25. Mean color index value of corn plants in Mountain and Piedmont counties.

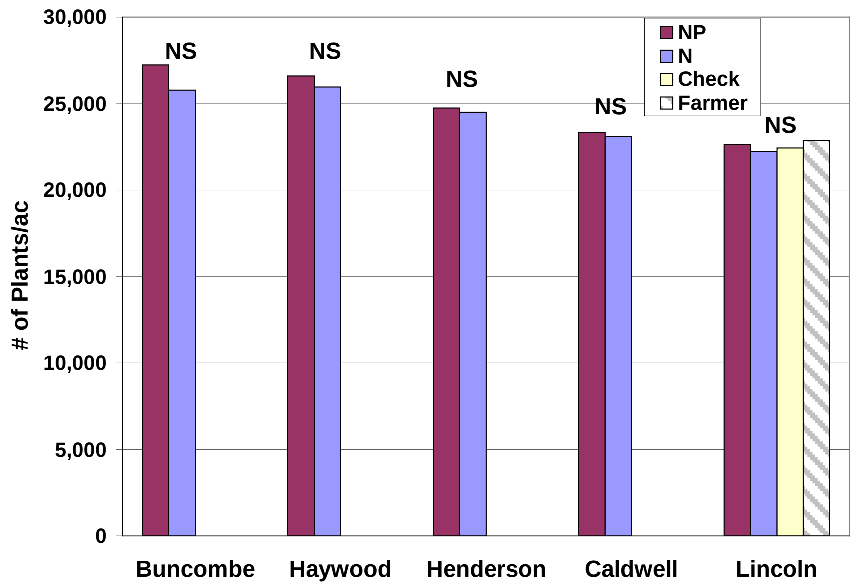

Fig. A26. Mean plant populations of corn in Mountain and Piedmont counties.

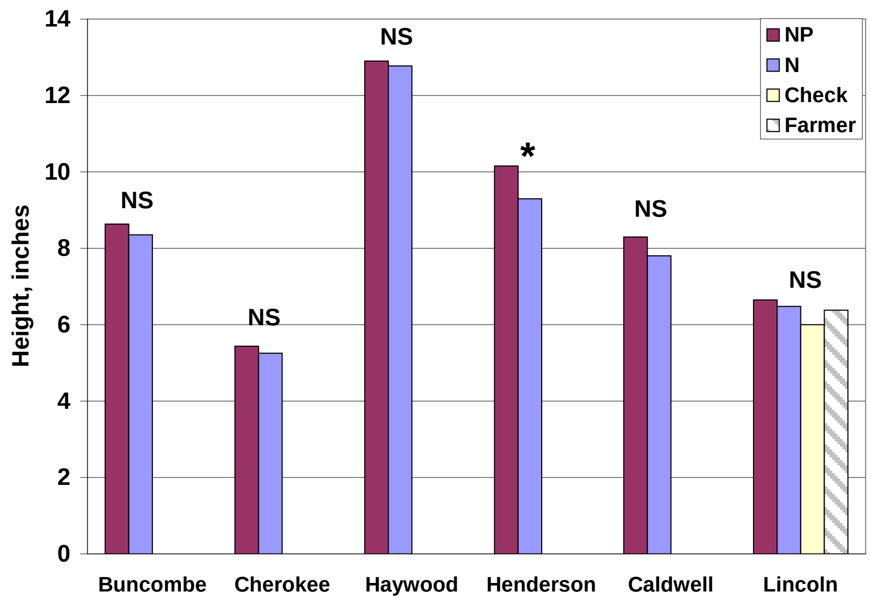

Fig. A27. Mean plant height of corn plants in Mountain and Piedmont counties.

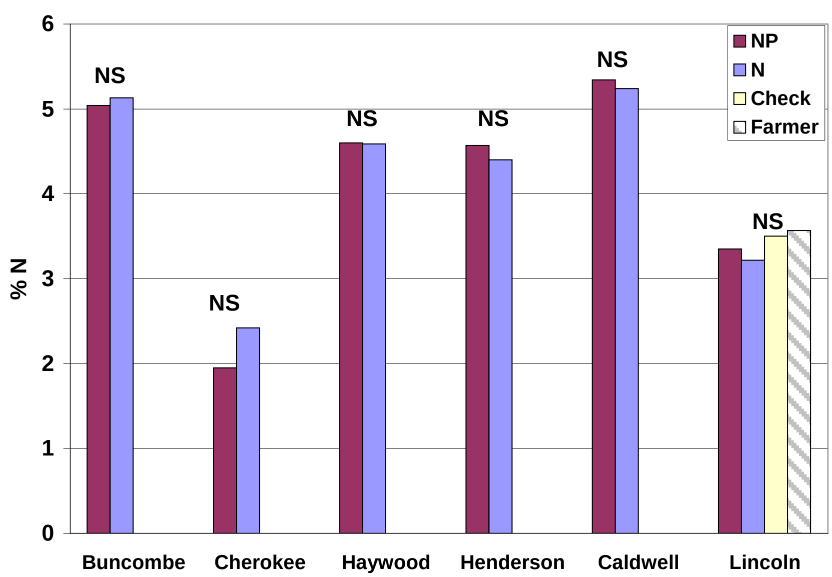

Fig. A28. Mean plant tissue N of corn plants in Mountain and Piedmont counties.

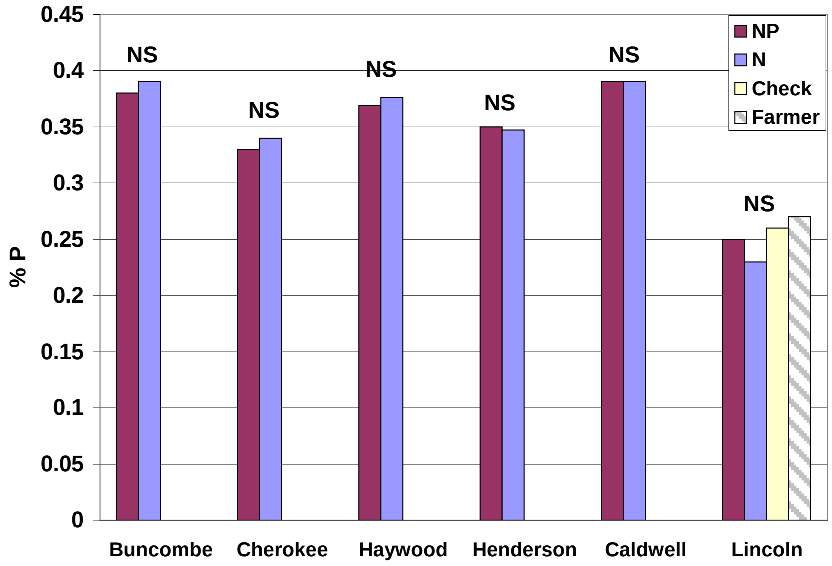

Fig. A29. Mean plant tissue P of corn plants in Mountain and Piedmont counties.

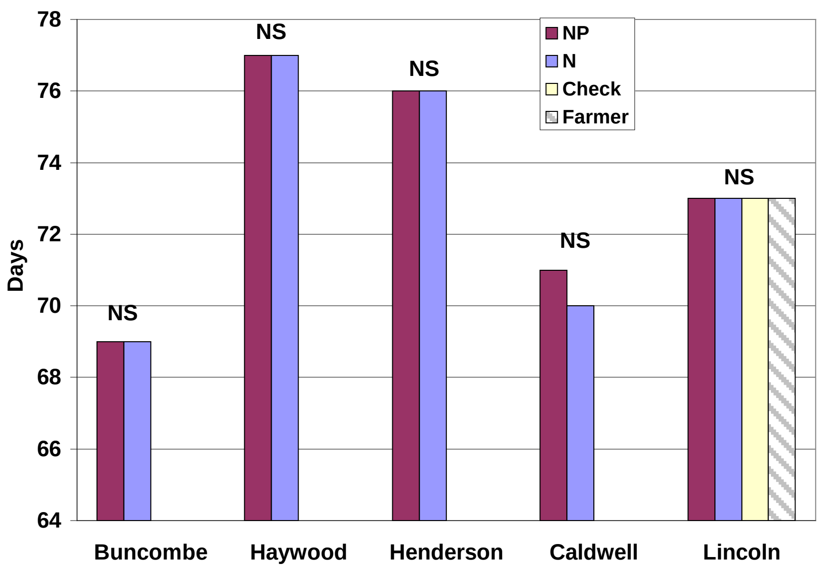

Fig. A30. Mean number of days to silking of corn plants in Mountain and Piedmont counties.

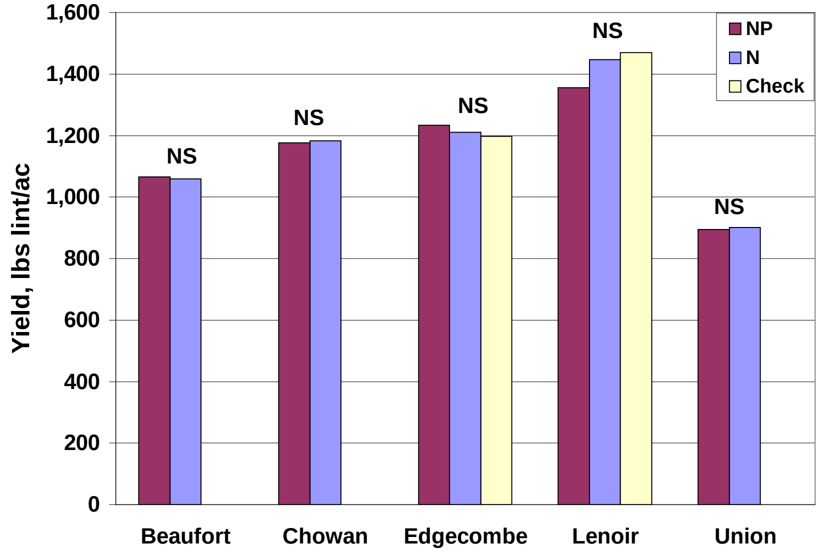

Fig. A31. Mean cotton yield in Coastal Plain and Piedmont counties.

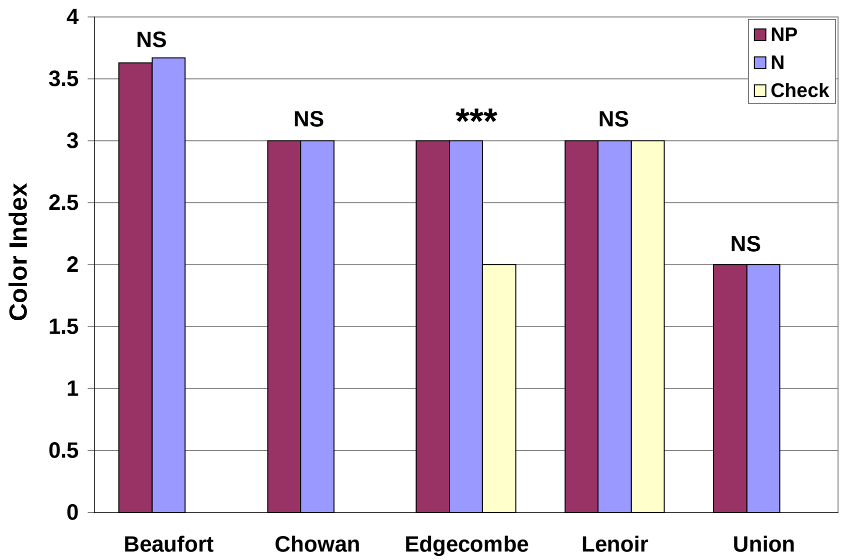

Fig. A32. Mean color index values of cotton plants in Coastal Plain and Piedmont counties.

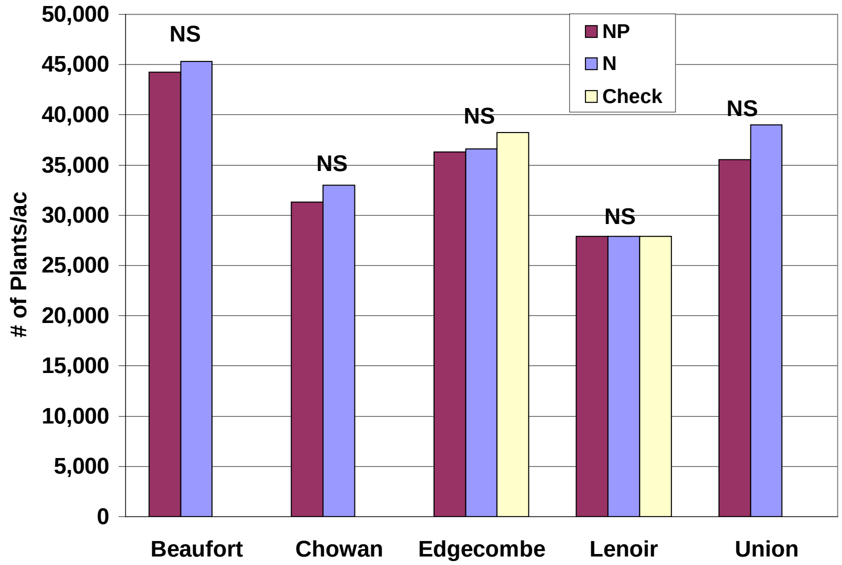

Fig. A33. Mean plant populations of cotton plants in Coastal Plain and Piedmont counties.

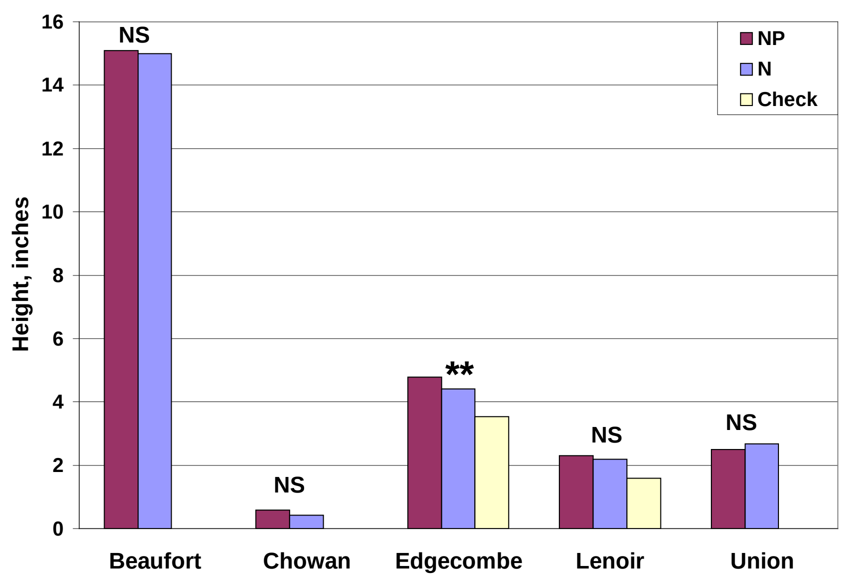

Fig. A34. Mean plant height of cotton plants in Coastal Plain and Piedmont counties.

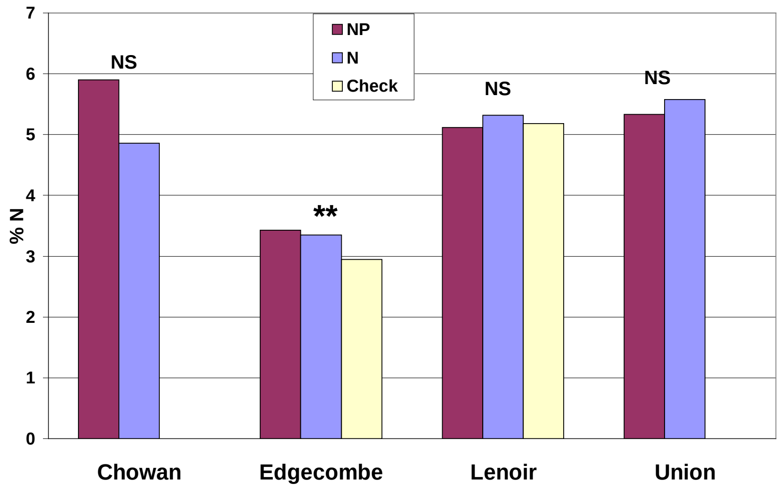

Fig. A35. Mean plant tissue N of cotton plants in Coastal Plain and Piedmont counties.

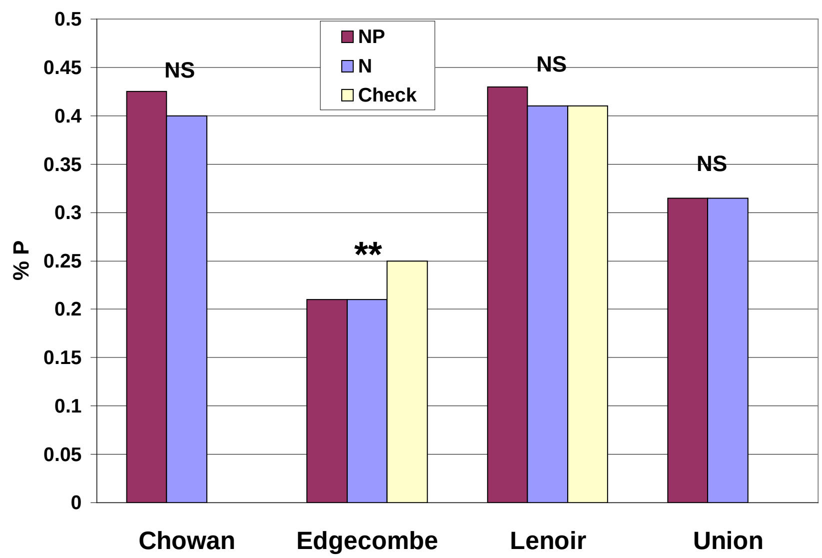

Fig. A36. Mean plant tissue P of cotton plants in Coastal Plain and Piedmont counties.

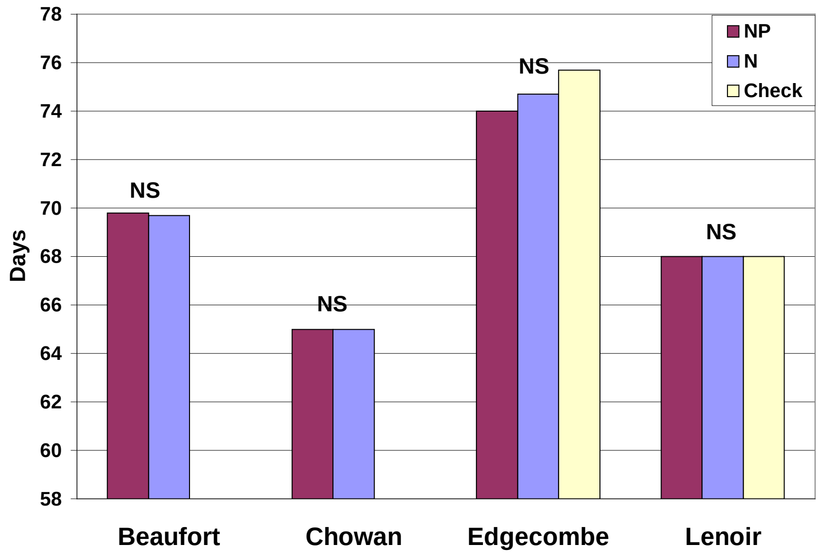

Fig. A37. Mean number of days to early bloom of cotton plants in Coastal Plain counties.

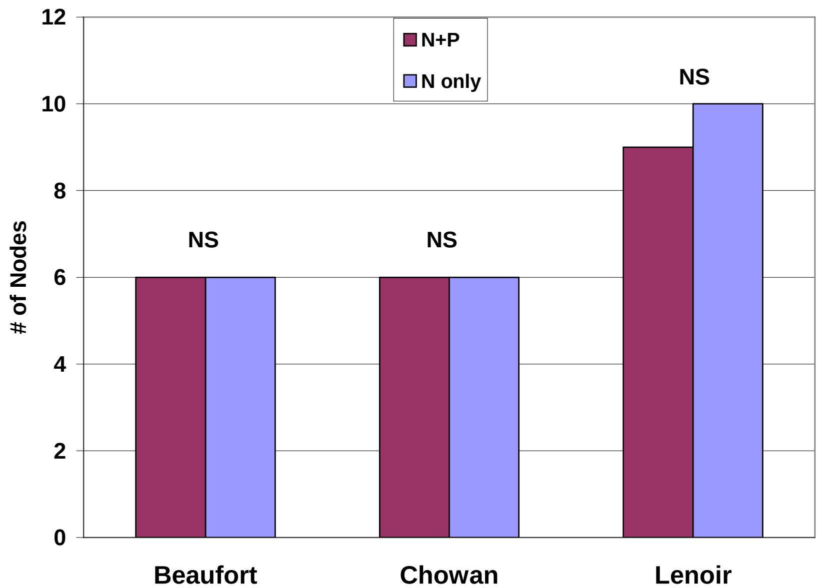

Fig. A38. Mean number of nodes at first bloom of cotton plants in Coastal Plain counties.

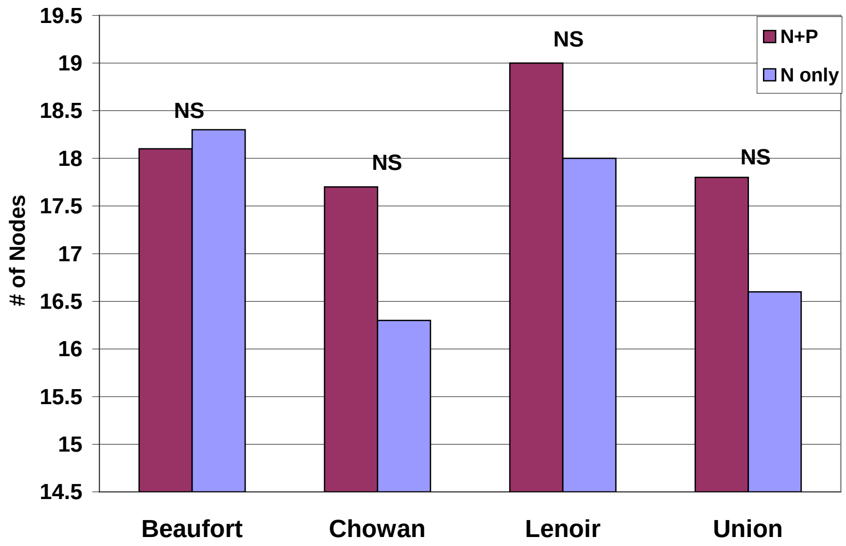

Fig. A39. Mean number of total nodes of cotton plants in Coastal Plain counties.

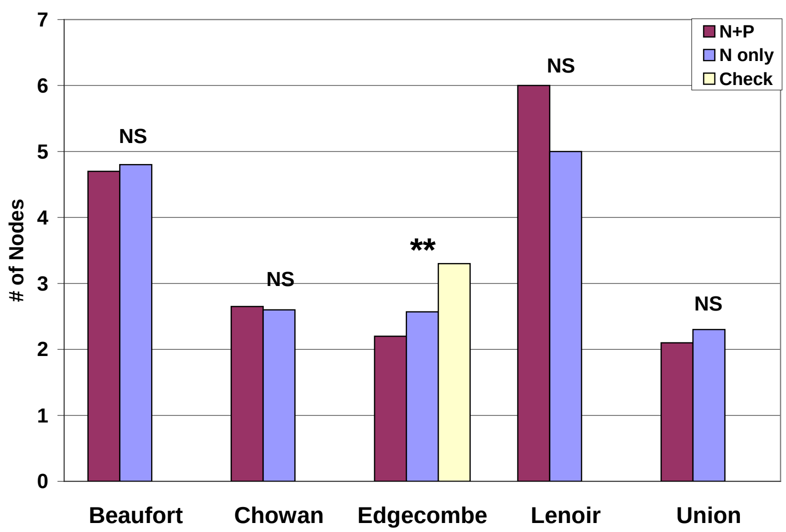

Fig. A40. Mean number of nodes above white flower of cotton plants in Coastal Plain counties.

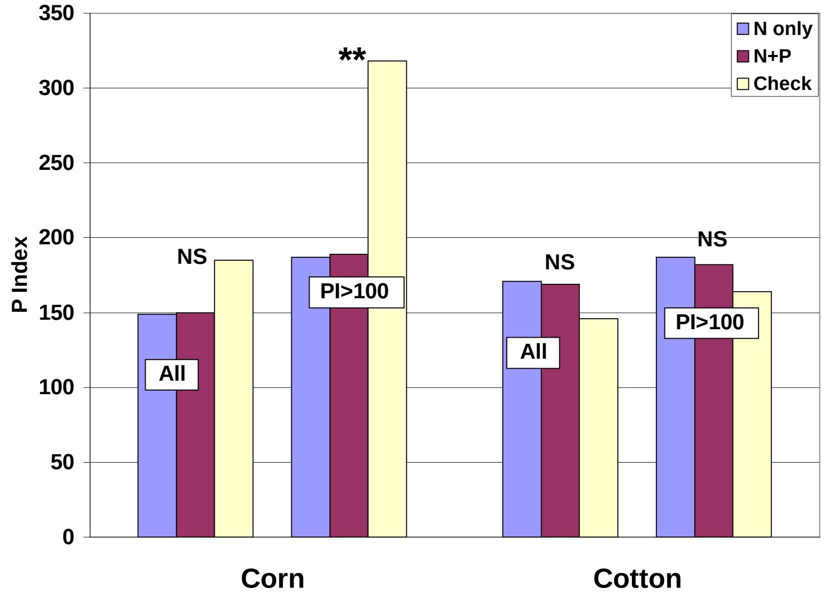

Fig. A41. Treatment differences in mean soil test P levels for two sample populations of corn and cotton.

APPENDIX B

Location and Region Effects of Statistical Analysis Performed on Corn and Cotton Plots

Table B1. Results of variability due to location and, when locations were grouped based on region, to region. Only results for analysis done on those plots with a P Index >100 are shown.

Parameter	Corn		Cotton	
	Location Effect	**Region Effect**	**Location Effect**	**Region Effect**
Yield	***	***	***	**
Plant Population	***	NS	***	NS
Plant Height	***	NS	***	NS
Tissue N	***	***	***	NS
Tissue P	***	***	***	NS
Color Index	***	***	***	***
STP	***	***	***	***
Days to Silking	***	***	n/a	n/a
Days to First Bloom	n/a	n/a	***	--
Nodes @ Early Bloom	n/a	n/a	***	--
Total Nodes	n/a	n/a	***	NS
Nodes Above White Flower	n/a	n/a	***	NS

***, **, * correspond to statistical significance levels of P<0.0001, P<0.01, P<0.05, respectively. NS indicates no statistical significance was found.

APPENDIX C

Fertilizer Applications, Yield and Soil Test P by Region

Table C1. Corn in Coastal Plain counties.

County	**Treatment**	**N Fertilization** (lbs N/ac)	**P fertilization** (lbs P_2O_5/ac)	**Mean Yield** (bu/ac)	**Mean Soil Test P** (PI)
Beaufort	**N+P**	160	24	175	166
	N	160	0	166	165
Craven	**N+P**	148	45	184	189
	N	149	0	179	186
	Check	0	0	112	52
Edgecombe	**N+P**	150	30	179	230
	N	150	0	183	224
	Check	150	0	152	266
Onslow	**N+P**	190	30	256	231
	N	192	0	243	240
Pasquotank	**N+P**	188	30	151	363
	N	188	0	162	359
	Check	150	0	154	371
Wilson	**N+P**	176	50	149	200
	N	176	20	135	195

Table C2. Corn in Piedmont and Mountain counties.

County	**Treatment**	**N Fertilization** (lbs N/ac)	**P fertilization** (lbs P_2O_5/ac)	**Mean Yield** (bu/ac)	**Mean Soil Test P** (PI)
Buncombe	**N+P**	210	30	298	132
	N	210	0	298	124
Caldwell	**N+P**	147	0	183	213
	N	147	0	186	257
Cherokee	**N+P**	217	12	224	DNA
	N	217	0	204	DNA
Haywood	**N+P**	210	30	279	113
	N	210	0	283	108
Henderson	**N+P**	210	30	302	112
	N	210	0	304	106
Lincoln	**N+P**	268	30	168	56
	N	268	0	171	82
	Check	238	0	164	53
	Farmer	266	84	180	45

Table C3. Cotton in Coastal Plain and Piedmont counties.

County	**Treatment**	**N Fertilization** (lbs N/ac)	**P fertilization** (lbs P_2O_5/ac)	**Mean Yield** (lbs lint/ac)	**Mean Soil Test P** (PI)
Beaufort	**N+P**	99	34	1065	133
	N	99	0	1059	129
Chowan	**N+P**	105	37	1065	133
	N	100	0	1059	129
Edgecombe	**N+P**	78	20	1233	186
	N	78	0	1211	199
	Check	78	0	1198	184
Lenoir	**N+P**	93	29	1355	117
	N	94	0	1446	109
	Check	0	0	1469	108
Union	**N+P**	96	27	894	289
	N	96	0	901	281

APPENDIX D

Management and Location Details by County

Table D1. Beaufort County.

Parameter	**Corn, Field #1**	**Corn, Field #2**	**Corn, Field #3**	**Corn, Field #4**	**Corn, Field #5**
Variety	Dekalb 63-81	Dekalb 63-81	Dekalb 63-81	Pioneer 34B94	Dekalb 63-81
Seed Treatment	None	None	None	None	None
Insecticide	Poncho 1250	Poncho 1250	Poncho 1250	Poncho 1250	Poncho 1250
Herbicide	Roundup + Dual	Roundup + Bicep	Roundup + Bicep	Roundup + Harness	Accent + Atrazine
Planting Date	4/19	4/19	4/18	4/21	4/21
Harvest Date	9/7	9/7	10/17	8/26	8/26
Row Spacing (inches)	36	36	36	30	36
Soil Type	Goldsboro fsl	Craven fsl	Arapahoe fsl	Tomotley fsl	Perquimans sil
RYE (bu/ac)	125	115	130	130	135

Table D1 cont.

Parameter	**Corn, Field #6**	**Corn, Field #7**	**Cotton, Field #8**	**Cotton, Field #9**	**Cotton, Field #10**
Variety	Pioneer 34B94	Dekalb 63-81	DP444BR	DP451BR	DP449BR
Seed Treatment	None	None	None	None	Gaucho
Insecticide(s)	Poncho 1250	Poncho 1250	Temik	Temik	Temik
Herbicide(s)	Harness	Roundup + Harness	Roundup	Roundup	Roundup
Planting Date	4/25	4/20	4/28	4/29	4/28
Harvest Date	8/26	8/26	12/1	11/3	11/18
Row Spacing (inches)	30	30	30	30	36
Soil Type	Tomotley fsl	Fork fsl	Roanoke fsl	Portsmouth fsl	Cape Fear fsl
RYE Units	**bu/ac**		**lbs lint/ac**		
RYE	130	125	800	850	850

Table D2. Buncombe County.

Parameter	Corn, Field #1	Corn, Field #2
Variety	Dekalb 697	Dekalb 697
Seed Treatment	None	None
Insecticide(s)	Lorsban	Lorsban
Herbicide(s)	Bicep	Bicep
Planting Date	5/24	5/24
Harvest Date	11/18	11/18
Row Spacing (inches)	36	36
Soil Type	French sil	French sil
RYE (bu/acre)	155	155

Table D3. Caldwell County.

Parameter	Corn
Variety	Pioneer 31G98
Seed Treatment	Cruzier
Insecticide(s)	None
Herbicide(s)	Roundup + Bullet
Planting Date	4/28
Harvest Date	9/14
Row Spacing	30
Soil Type	Appling sl
RYE (bu/ac)	130-150

Table D4. Cherokee County.

Parameter	**Corn**
Variety	Pioneer 33V15
Seed Treatment	Poncho 250
Insecticide(s)	None
Herbicide(s)	Harness + 24-D + Banvel
Planting Date	5/12
Harvest Date	10/19
Row Spacing (inches)	30
Soil Type	Arkaqua l
RYE (bu/acre)	150

Table D5. Chowan County.

Parameter	**Cotton**
Variety	DP 451 B/RR
Seed Treatment(s)	Hodiac + Gaucho
Insecticide(s)	None
Herbicide(s)	Roundup, Envoke
Planting Date	5/13
Harvest Date	10/27
Row Spacing (inches)	38
Soil Type	Echaw
RYE (lbs lint/acre)	600

Table D6. Craven County.

Parameter	**Corn, Field #1**	**Corn, Field #2**
Variety	Pioneer 31G68	Pioneer 34897
Seed Treatment	Poncho 1250	None
Insecticide(s)	None	Counter 15G
Herbicide(s)	Harness + Atrazine	Lariat + Roundup
Planting Date	5/5	4/6
Harvest Date	10/20	8/30
Row Spacing (inches)	15	36
Soil Type	Lynchburg	Pantego/Rains
RYE (bu/acre)	125	135

Table D7. Edgecombe County.

Parameter	**Corn, Field #1**	**Cotton, Field #2**
Variety	Pioneer 31G98	DP 432 RR
Seed Treatment	None	Kodiac
Insecticide(s)	None	Gaucho
Herbicide(s)	Roundup + Valor + Bicep	Roundup + Valor
Planting Date	4/18	5/4
Harvest Date	9/6	10/3
Row Spacing (inches)	36	36
Soil Type	Goldsboro fsl	Aycock vfsl
RYE Units	**bu/acre**	**lbs lint/acre**
RYE	130	925

Table D8. Haywood County.

Parameter	**Corn, Field #1**	**Corn, Field #2**	**Corn, Field #3**	**Corn, Field #4**
Variety	DeKalb 697	DeKalb 697	DeKalb 697	DeKalb 697
Seed Treatment	None	None	None	None
Insecticide(s)	Lorsban	Lorsban	Lorsban	Lorsban
Herbicide(s)	Bicep + Gramoxone	Bicep + Gramoxone	Bicep + Gramoxone	Bicep + Gramoxone
Planting Date	5/17	5/17	5/17	5/17
Harvest Date	11/7	11/7	11/7	11/7
Row Spacing (in)	36	36	36	36
Soil Type	Braddock	Braddock	Braddock	Braddock
RYE (bu/acre)	109	109	109	109

Table D9. Cont.

Parameter	**Corn, Field #5**	**Corn, Field #6**
Variety	DeKalb 697	DeKalb 697
Seed Treatment	None	None
Insecticide(s)	Lorsban	Lorsban
Herbicide(s)	Bicep + Gramoxone	Bicep + Gramoxone
Planting Date	5/17	5/17
Harvest Date	11/7	11/7
Row Spacing (in)	36	36
Soil Type	French	French
RYE (bu/ac)	116	116

Table D10. Henderson County.

Parameter	**Corn, Field #1**	**Corn, Field #2**	**Corn, Field #3**
Variety	DeKalb 697	DeKalb 697	DeKalb 697
Seed Treatment	None	None	None
Insecticide(s)	Lorsban	Lorsban	Lorsban
Herbicide(s)	Bicep	Bicep	Bicep
Planting Date	5/19	5/19	5/19
Harvest Date	11/21	11/21	11/21
Row Spacing (inches)	36	36	36
Soil Type	Codorus l	Codorus l	Codorus l
RYE (bu/acre)	140	140	140

Table D11. Lenoir County.

Parameter	**Cotton**
Variety	DP 444
Seed Treatment	None
Insecticide(s)	Temik
Herbicide(s)	Staple + Roundup
Planting Date	5/2
Harvest Date	10/17
Row Spacing (inches)	30
Soil Type	Lumbee sl
RYE (lbs lint/acre)	115

Table D12. Lincoln County.

Parameter	**Corn**
Variety	Pioneer 31G98
Seed Treatment	None
Insecticide(s)	Force
Herbicide(s)	Gramoxone + Atrazine + Simizine
Planting Date	4/11
Harvest Date	9/12
Row Spacing (inches)	30
Soil Type	Cecil scl
RYE (bu/acre)	150

Table D13. Onslow County.

Parameter	**Corn**
Variety	Dekalb 69-71
Seed Treatment	Poncho 250
Insecticide(s)	Counter
Herbicide(s)	Lariat
Planting Date	4/20
Harvest Date	8/30
Row Spacing (inches)	30
Soil Type	Foreston
RYE (bu/acre)	120

Table D14. Pasquotank County.

Parameter	**Corn**
Variety	Pioneer 34B98
Seed Treatment	Poncho 250
Insecticide(s)	None
Herbicide(s)	Gaurdsman Plus + Evik
Planting Date	4/19
Harvest Date	8/30
Row Spacing (inches)	40
Soil Type	Perquimans
RYE (lbs/acre)	140

Table D15. Union County.

Parameter	Cotton
Variety	DP449 BGRR
Seed Treatment	None
Insecticide(s)	Temik
Herbicide(s)	Roundup + Diuron + Cotoran
Planting Date	4/29
Harvest Date	10/21
Row Spacing (inches)	38
Soil Type	Tatum
RYE (lbs lint/acre)	114

Table D16. Wilson County.

Parameter	Corn
Variety	Pioneer 31G98
Seed Treatment	None
Insecticide(s)	None
Herbicide(s)	Lariat
Planting Date	4/22
Harvest Date	9/21
Row Spacing (inches)	30
Soil Type	Norfolk
RYE (lbs/acre)	110