Intensive Nitrogen Management of Soft Red Winter Wheat

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The current system of making nitrogen recommendations for wheat in the Eastern cornbelt assumes that nitrogen fertilizer required is a simple function of yield potential. The higher the yield potential, the more N fertilizer needed. The problem with this assumption is that factors such as soil type and ability of a site to release N through mineralization, climate, variety, disease pressure and management practices all affect nitrogen use efficiency, and are not considered in making nitrogen recommendations. With the tremendous variability in soils and climate present across the region, all of these factors can and do have a significant impact on N utilization.

A high percentage of the wheat in the region is now grown using intensive management systems. Farmers using this type of management typically use higher rates of nitrogen than normally recommended by universities. In addition to higher rates of N, many farmers also use multiple applications of N as a means of reducing both lodging and disease, and as a tool to reduce N loss. Research on multiple top dressings of nitrogen has been limited and the results have been inconsistent. Research has shown that multiple N applications can be beneficial in certain years (Alcoz et al., 1985). But no definitive study has been conducted which can tell under what conditions multiple N application should be recommended.

Because of the questions concerning N fertilization being asked by farmers, a study was established with the following objectives:

1). To determine the optimum rate of nitrogen fertilizer needed by soft red winter wheat across Indiana.
2). To determine if varieties that differ in their yield potential, growth habits, and climate adaptations respond differently to nitrogen fertilizer.
3). To determine if soils differing in texture, CEC, organic matter content and yield potential require different N rates.
4). To determine under what conditions multiple nitrogen applications would be more beneficial than a single topdress nitrogen application.
5). To determine whether the chlorophyll meter can be used to predict late season nitrogen need.

Materials and Methods:

Field experiments were carried out at four locations during both the 1995-96 and 1996-97 growing seasons. Because of severe head scab infestation in 1996, only the data from the

1997 harvest will be discussed. The research sites were located on Purdue Agricultural Research Centers. Locations and soils used in this study were:

Southwest Purdue Ag Center (SWPAC), Conotton Sandy Loam,
Southeast Purdue Ag Center (SEPAC), Avonburg Silt Loam,
Throckmorton Purdue Ag Center(TPAC), Octagon Silt Loam,
Northeast Purdue Ag Center (NEPAC), Boyer Sandy Loam.

Four varieties, Beck's 109, Pioneer 2552, Freedom, and Patterson, all commonly grown in Indiana, were used at each location. The varieties differed in their yield potential, growth habit, and climate adaptation. A split plot experimental design with three replications was used at each location. Varieties served as the main plots with nitrogen treatments as sub-plots. Individual plots were 15 ft x 60 ft.

Thirty lb. N per acre was incorporated prior to planting on all plots. This is a standard recommendation in this N deficient region. Twelve nitrogen treatments consisting of combinations of "green-up" and "boot stage" applications of N were used. Nitrogen rates of 0, 30, 60, or 90 lb. N per acre were applied shortly after green-up (Feekes growth stage 2-3 or Zadoks' Scale 20-29). An additional 0, 30 or 60 pounds of N was applied at boot (Feekes 9-10 or Zadoks' 39-45). All N treatments were applied as 28% UAN solutions using streamer bars. Streamer bars are designed to produce a thin, low pressure stream of liquid spaced about six inches apart. Only minimal leaf damage from the nitrogen solution was observed.

Chlorophyll readings were taken on each plot using a Minolta SPAD 502 chlorophyll meter at Feekes growth stages 6, 7, 8, and 9. An average of ten readings were obtained from each plot at each growth stage. Flag leaf samples were obtained from all plots at Feekes growth stage 10.5 (Emergence of Inflorescence complete). Some yield components were also taken to determine how yields where influenced by nitrogen application. Number of heads per foot of row were counted from all plots. Seed samples were collected at harvest to determine 100 seed weights, bushel weight and grain protein levels. Grain yield was measured by harvesting a 5 x 50 foot area in the center of each plot using a Winterstieger plot combine. Grain yields were adjusted to a uniform 13.5% moisture. Statistical analysis was performed using the ANOVA procedure on micro SAS, at a significance level of 10% (alpha level = 0.10).

Results and Discussion:

Objective 1 was to determine the optimum N rate for soft red winter wheat in Indiana. Figure 1 presents the effect of total topdress N applied, ignoring timing, on wheat yields. At three of the four locations, a total topdress N application of 90 pounds per acre was required for highest yield. At the fourth site, the lowest yielding due to head scab, 120 pounds of total topdress N produced the highest yields. Current N recommendations for 70 bushel wheat are for 75 pounds of total N with 15 to 30 pounds of the N recommended applied prior to seeding and the balance, 45 to 60 pounds topdressed. This would suggest that current recommendations may not be supplying adequate N for high yield production.

Objective 2 was to determine if N rate should be adjusted for varieties. Significant yield differences were observed between varieties at two of the four locations (data not shown). However no difference in N response was observed with the four varieties tested. This would suggest that variety specific N recommendations are not necessary at this time. It also raises further questions about the validity of yield based N recommendations.

Objective 3 was to determine if soil properties such as texture or CEC would influence yield potential The study was designed to have both a sandy loam and silt loam soil location in both southern and northern Indiana. The purpose of this was to determine not only if climatic differences would effect N response, but also how soil differences might effect both N rate and multiple application responses. Nitrogen response at three of the four locations was very similar, with 90 pounds of N topdressed giving highest yields. The fourth location, SEPAC, is a silt loam soil, with poor internal drainage. At this site 120 pounds of N was required for maximum yield. This would suggest that there may be reason to look more closely at N loss potential when designing fertilizer management programs for wheat.

Objective 4 addresses the advantage or disadvantage of multiple N applications. In this study the first topdress application was applied within a few days of green-up in the spring. Under the conditions common in Indiana in the spring, N loss from fertilizer applied at that time would be expected to be low, since the wheat would be actively growing and taking up N. The response to single versus multiple N applications at different N rates is presented in Figure 2. It is very clear from this figure that the wheat plant requires a large amount of N shortly after green-up to support tillering and early growth. Holding back a portion of the N application until boot. approximately 2 months delay, reduced yields in all cases. This included sandy soils prone to leaching losses and poorly drained soils prone to denitrification.

One question which was not answered by this study deals with the potential loss of N from early winter applications of N during plant dormancy. Many farmers with a large number of wheat acres begin to apply N in early January. This is a risk management tool to ensure being able to get all acres covered prior to green-up. In that situation with the N applied as much as 6 to 8 weeks prior to green-up, would a split application be preferred. That is a question that this study was not designed to address but is worthy of future work.

One point that was clear in regards to late, boot stage, N applications is that a N deficient plant will respond to N at this late date with a significant yield increase. That would suggest that a system of routine single topdress applications, at rates higher than currently recommended, coupled with some means of evaluating N sufficiency later in the season to determine if additional N is required would be a good system for those interested in intensive management systems.

Objective 5 addresses the issue of using the chlorophyll meter to quantify late season N sufficiency for wheat. Previous work has shown that the chlorophyll meter can be used to determine late nitrogen need in many crops. The chlorophyll meter has been used successfully in determining sidedress requirements for corn in Pennsylvania (Fox and Piekielek, 1992). Work in Kentucky has also shown a relationship between greenness and wheat N status (Murdock et al., 1994). The chlorophyll data from this study has not been fully analyzed yet. However preliminary analyses suggest strongly that using a relative greenness approach can successfully predict response to a late season application.

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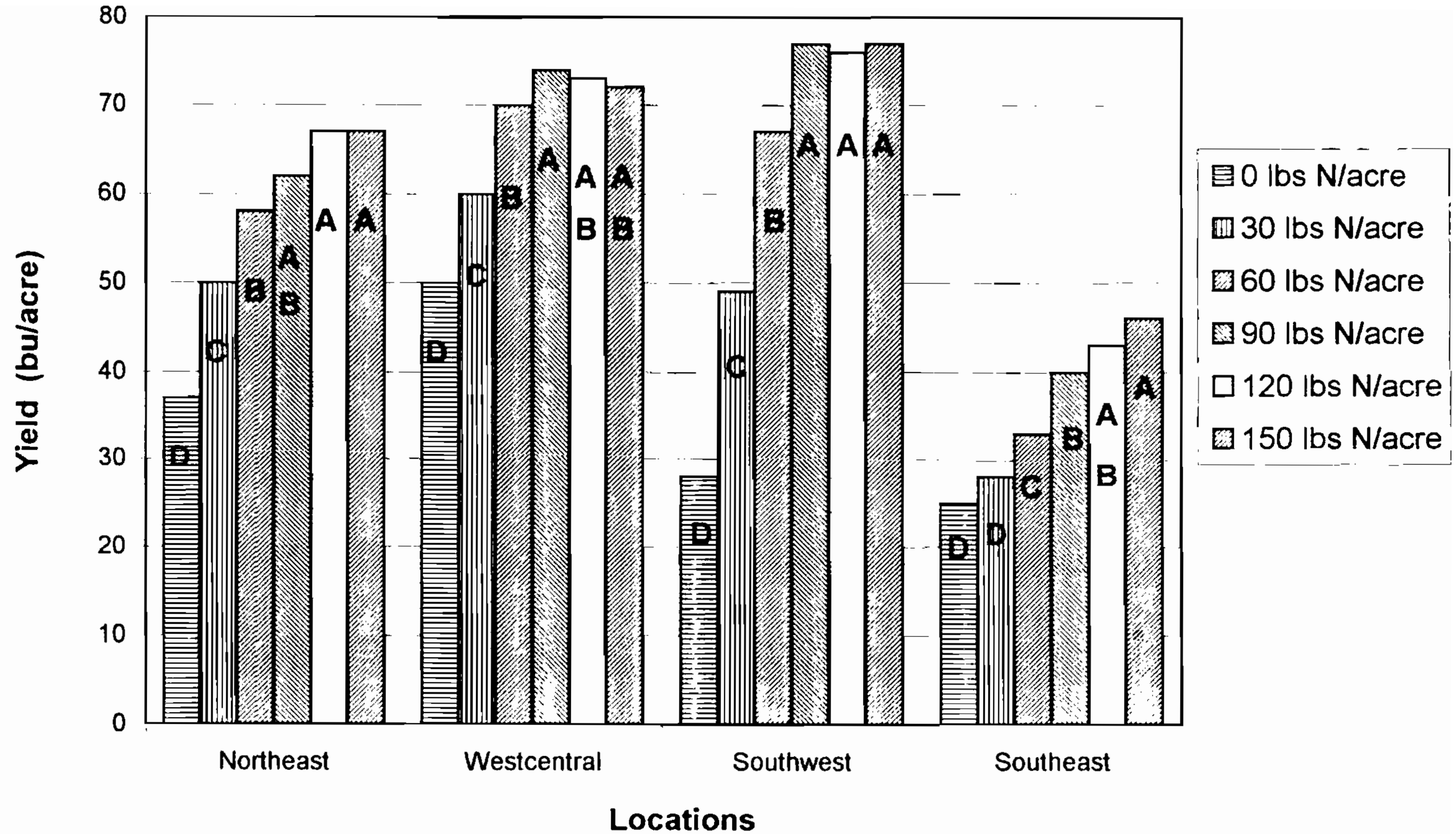

Figure 1. Nitrogen Response of Wheat at Four Locations in Indiana

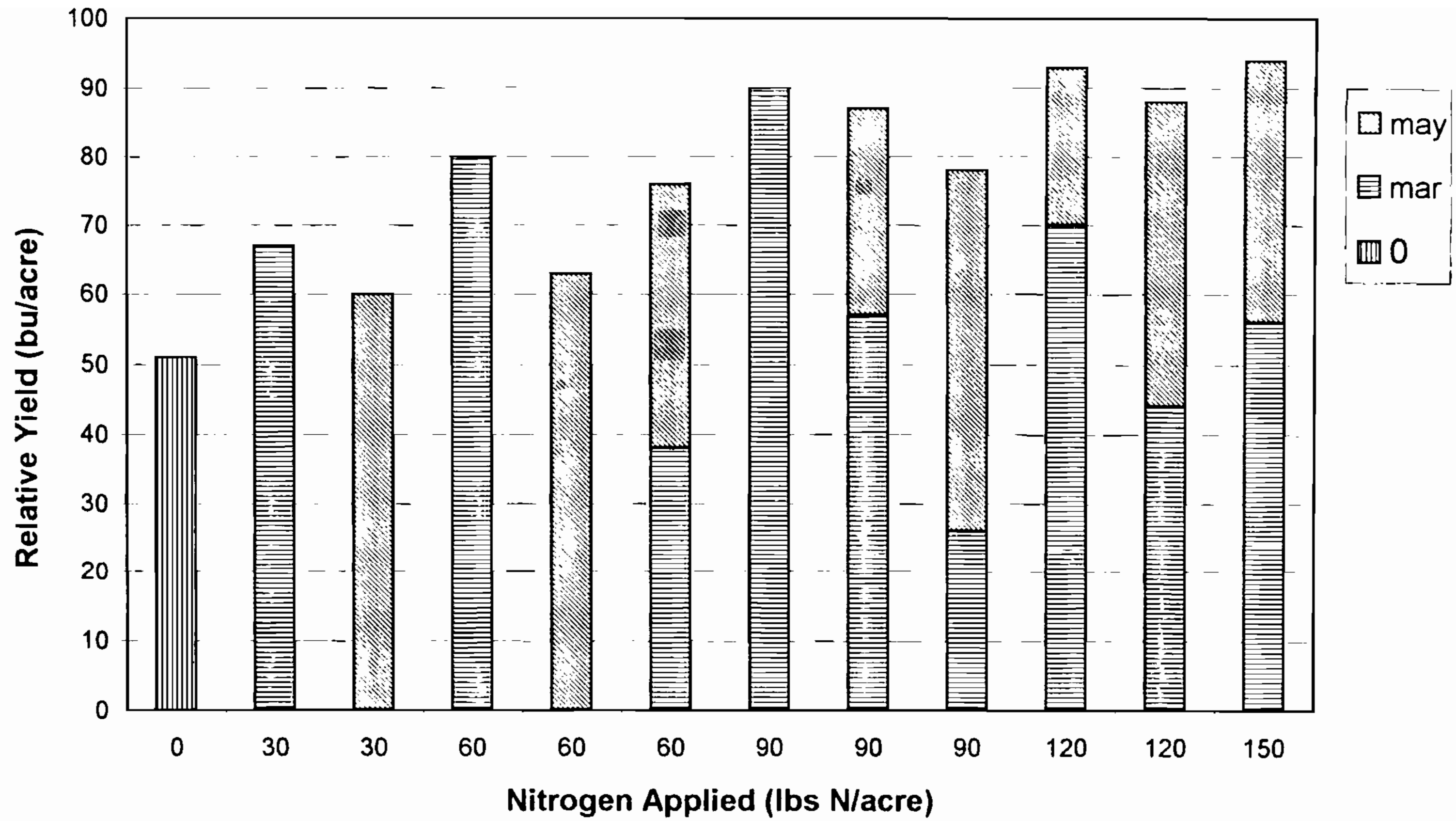

Figure 2. Nitrogen Timing Response of Wheat

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