**PROGRESS REPORT
TO
NORTH CAROLINA SMALL GRAIN GROWERS ASSOCIATION, INC.**

TITLE: **Identifying Management Practices for Increasing Kernel Number In Soft Winter Wheat**

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REPORT: The key objective of this study is to identify key management practices that lead to increases in kernel number in soft winter wheat. Specific objectives are: 1) to determine if combining pre-jointing applications of N with essential micronutrients such as B and Mg can improve kernel number and weight, and 2) to identify management systems (combinations of variety selection, planting date, and nutrients) that would promote more kernels being developed.

In the fall of 2019 two locations were chosen for this study. One site was located in Gates County near Hobbsville, NC and the other in Beaufort County near Belhaven, NC. Two varieties of soft red winter wheat (Dyna-Gro Shirley and VA Hillard) were planted. Dyna-Gro Shirley was planted on 6 Nov in Gates County and VA Hillard was planted on18 Nov in Beaufort County. At both locations the experimental design was a split-split plot with wheat variety as the main plot, N management as the sub-plot, and micronutrient application as the sub subplot. N management consisted of two factors – N rate (either 120 or 180 lbs of N per acre) and N application timing (early split at GS23 and GS30, single application at GS30 and a late split at GS30 and GS36. Micronutrient application consisted of one of three approaches – B, Zn, and Mg applied at planting, B, Zn, and Mg applied at GS36, or no B, Zn, or Mg applied. At both sites the early split N application was made on 11 Feb, the GS30 applications were made on 18 Mar and the GS36 applications were made on 15 April. Prior to harvest (26 June at both sites), head samples were taken to measure the number of kernels per spike and grain weight. At harvest, grain yield, moisture, and test weight were recorded from each plot using a Kincaid 8XP plot combine equipped with a Harvestmaster weigh system.

Results: While we have not finished measuring kernels number per spike from the 2020 harvest samples previous results from 2018-2019 indicated a strong relationship between kernel number per spike and grain yield within each of the three varieties tested (Figure 1). Differences in kernel number accounted for 57 to 74% of the variability in grain yield. In contrast tiller number only varied from 39 to 60 tillers per square foot across these three varieties and there were no significant relationships between tiller number and grain yield (data not shown). Early counts from the 2020 data in Beaufort County show a similar pattern. This research clearly shows that kernel number is the key yield component in determining final yield.
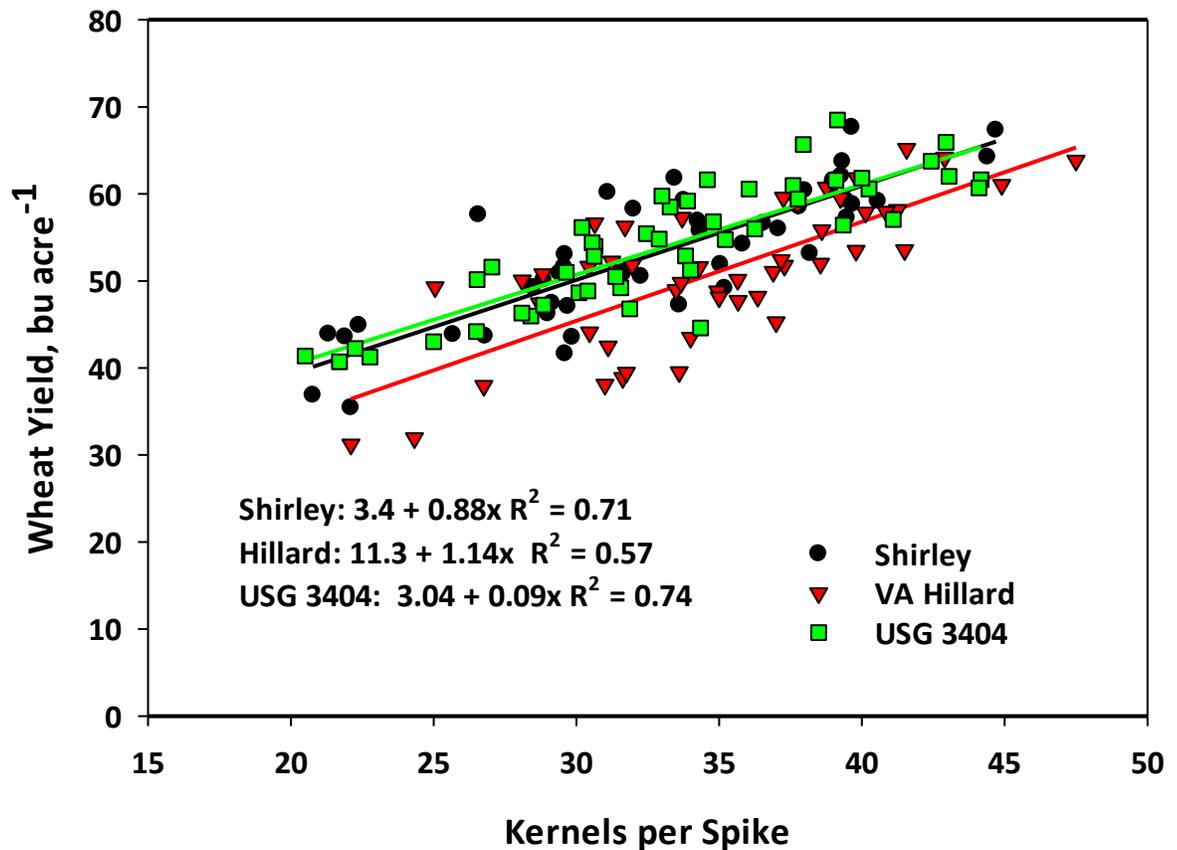
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Figure 1. Relationships between kernel number per spike and grain yield for three wheat varieties measured in 2019.

Relationships Between Kernel Number and Plant Growth or Tissue N Concentration

Previous research in hard wheat had shown that two factors are important influencers of kernel number in wheat. First, is the concentration of N in the spike of the wheat plant at or near anthesis. Figure 2 shows the relationship between N concentration in the flag leaf at anthesis and kernel number at the Beaufort location in 2020. The data indicate a strong relationship between N concentration in the flag leaf and the number of kernels that are formed. For every increase of 1% N in the flag leaf the plant increased kernel number by 4.89 kernels. This relationship held across all three varieties.

The other important factor in determining kernel number is the rate of growth (amount of biomass the plant is accumulating) just prior to anthesis. This study measured the change in biomass per day from GS36 (just prior to boot stage) to anthesis (full bloom). Figure 3 shows the relationship between growth rate and kernel number at the Beaufort location. There was a significant influence of growth rate on final kernel number just as we found in 2017-2018 and 2018-2019.. While growth rate has less influence than N concentration on kernel number (accounted for 32% of the variability in kernel number compared with 54% with N concentration) growth rate still is clearly an important factor in determining kernel number in soft red winter wheat.
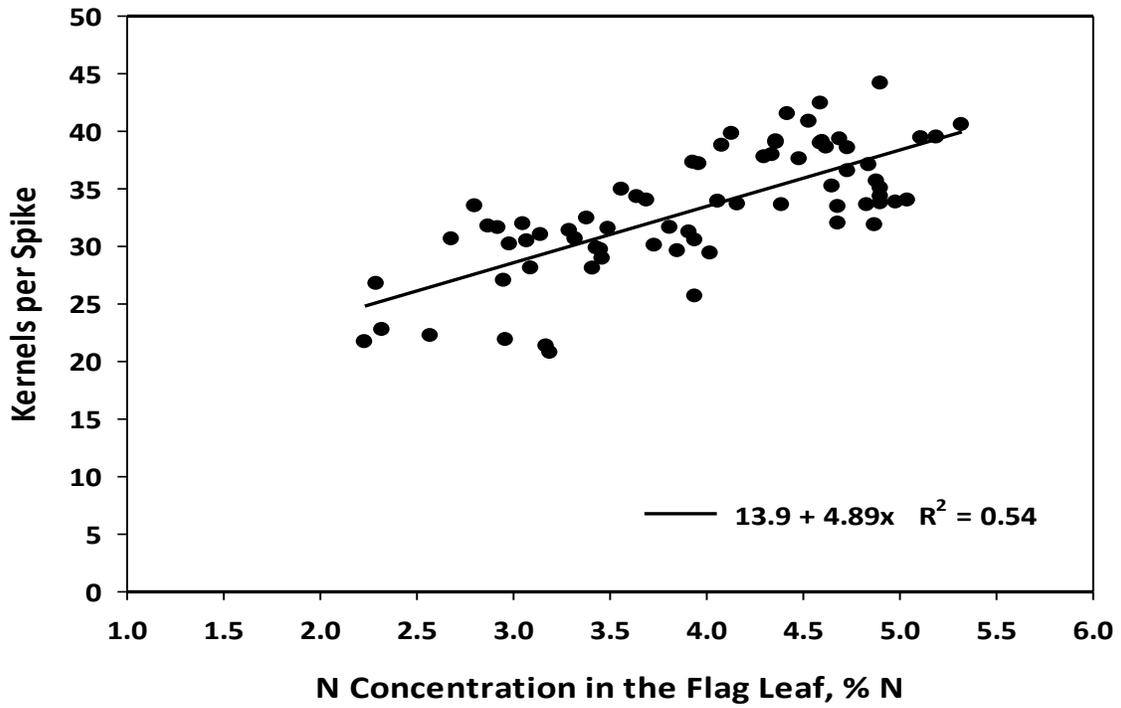
Figure 2. Relationship between N concentration in the flag leaf at anthesis and kernel number measured at harvest.
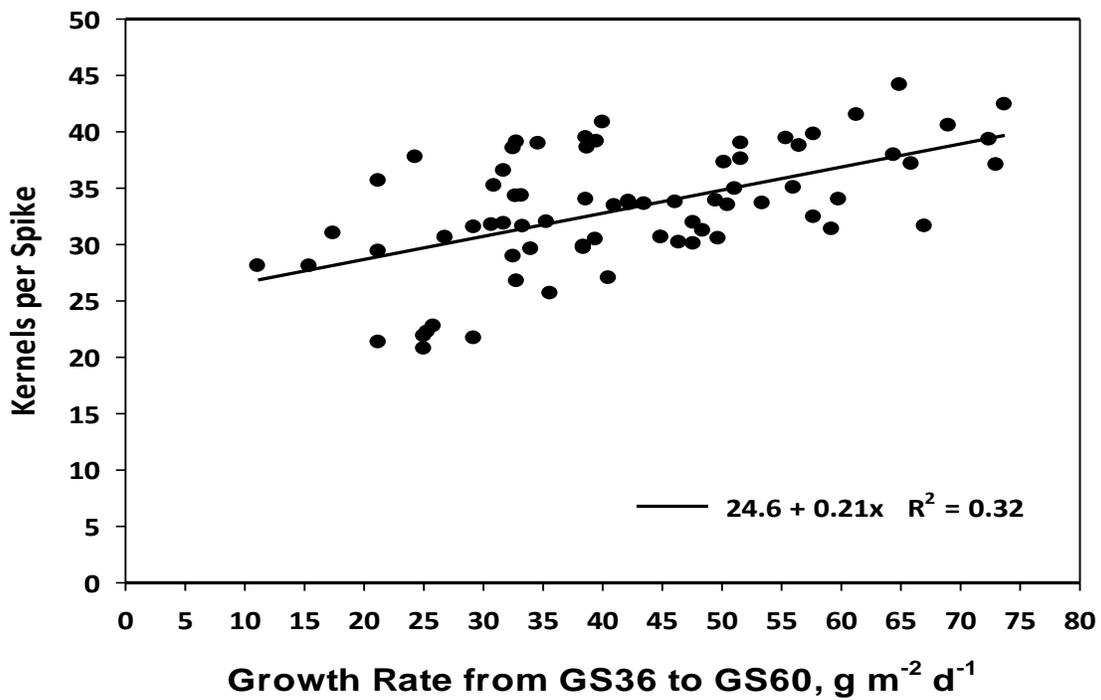

Figure 3. Relationship between growth rate from boot to anthesis and kernel number per spike at the Beaufort location.

Influence of N Timing and Rate on Grain Yield in 2020

Statistical analysis found significant main effects of N timing and rate for yield at both Gates and Beaufort County locations (kernel numbers are still being counted as of this date). The split applications of N at either GS20 and GS30 or at GS30 and GS60 resulted in significantly greater yield when compared with a single N application at GS30 at both locations (Figure 4). The lowest yield was produced by the lower rate of N applied in a single application at jointing.
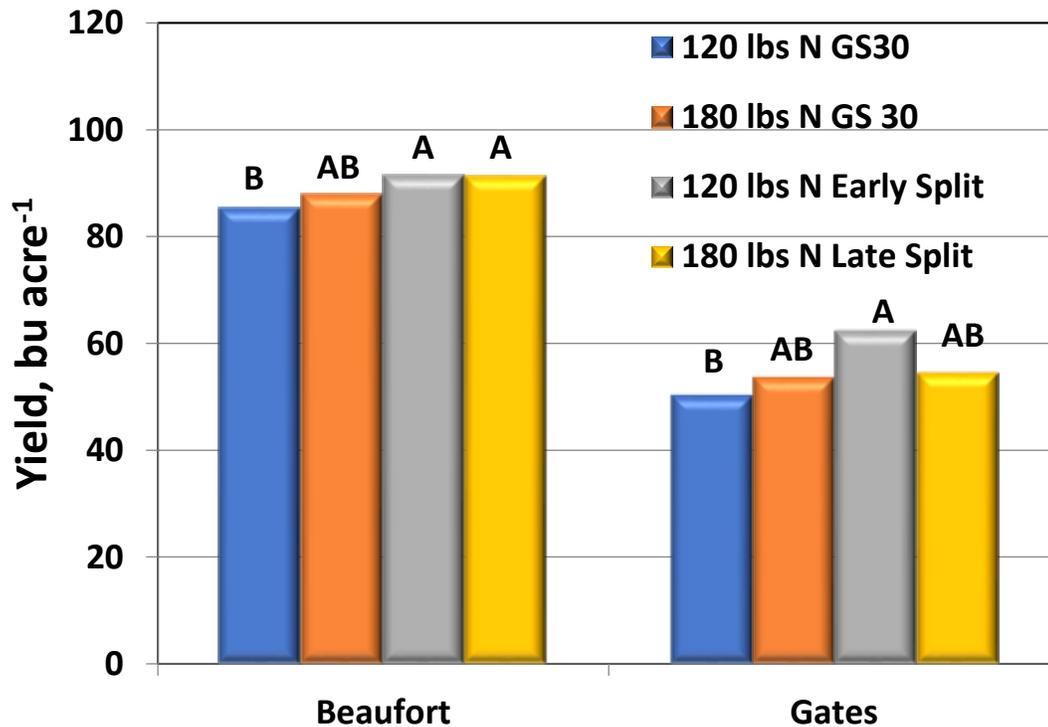

Figure 4.   Impact of N treatments consisting of different rates and timing on grain yield in 2020.

Conclusions

The results from the 2019-2020 research confirms the initial trends we found in 2017-2018 and 2018-2019 .   The significant findings of this research are:

1.   Kernel number per spike is the key determining factor in setting yield in soft red wheat.

2. Both N concentration in the flag leaf of the plant and the rate of growth from boot stage through anthesis are critical to determining how many kernels a wheat plant will set on a spike.

3. Nitrogen must be managed carefully to support both the amount of N in the plant at anthesis and the rate of growth of the wheat plant. Split applications of N are the best approach. The early split improves both biomass and flag leaf N concentration by improving root development prior to GS30. In contrast, a late split (GS30 and GS60) primarily improves flag leaf N concentration. The worst treatment over all three years for improving kernel number and yield has been the single N treatment of 120 lbs N acre^{-1} applied at GS30 This treatment does not provide enough support for rapid growth and results in less N available during anthesis. Given that this is the standard treatment for applying N to wheat in North Carolina, NC wheat growers should strongly consider changing their approach to making spring N applications to wheat.

4. While the use of micronutrients (B, Mg, Zn) in 2018-19 did not significantly improve yield they did show some advantages in increasing kernel number. This research trial supports the observation that micronutrients are important in helping increase rate of growth during the period from boot stage to anthesis and help improve N uptake. This trial showed clear advantages to using micronutrients at planting to increase kernel number and grain yield. More work needs to be done to help identify which micronutrient is most important or if other micronutrients are needed.

BUDGET / EXPENDITURE UPDATE:

Of $13,000 awarded for the 2019-20 funding cycle $12,738 has been spent, as expected.

We still have a small amount of hourly salary to pay for finishing the analysis of the kernel number samples. The bottom line is that we are on track to use this money as requested to complete this project. My sincere thanks to the Small Grain Growers Association for making this project possible.

IMPACT STATEMENT:

The significant findings of this research are: 1) Kernel number per spike is the key determining factor in setting yield in soft red wheat, 2) Both N concentration in the flag leaf of the plant and the rate of growth from boot stage through anthesis are critical to determining how many kernels a wheat plant will set on a spike, 3) Nitrogen must be managed carefully to support both the amount of N in the plant at anthesis and the rate of growth of the wheat plant, and 4) North Carolina wheat growers should consider switching to split N applications to improve kernel number and yield.