Optimize Nitrogen for Alabama Wheat Yields with and without Fall Tillage

By Kipling S. Balkcom and Charles H. Burmester

Increased no-till or reduced tillage within Alabama wheat fields has raised research questions on how the trend might impact optimal N fertilizer rates and timings. Monitoring tiller growth as a means to predict N requirements was another option assessed across major soil types within the region.

Alabama wheat farmers are changing management practices to maximize yields and reduce trips across their fields. Some recent changes include using higher N fertilizer and wheat seeding rates, and planting wheat in no-till or reduced tillage systems. Non-inversion tillage has been widely adopted in summer row crops, particularly cotton on Alabama's Coastal Plain soils (Simoes et al., 2009), while conservation tillage at planting has become a primary method on silt loam soils in the Limestone Valley (Schwab et al., 2002). However, there are concerns that tillage systems that maintain surface residue will slow vegetative growth and reduce tillering in wheat (Weisz and Bowmann, 1999). Questions have been raised about N fertilizer rates and application timings according to tillage practices used at planting. The practice of monitoring wheat tillering is also being used in some wheat-growing areas to adjust spring N fertilizer rates. As a result, tillage practices, rates and times of N fertilizer application, and tiller counts need further evaluation under Alabama growing conditions.

Experimental Design

Four locations were used across Alabama during the 2008, 2009, and 2010 wheat-growing seasons resulting in eight site-year comparisons. These locations were at the Tennessee Valley Research and Extension Center (TVS) in Northern Alabama, the E.V. Smith Research Center (EVS) in Central Alabama, the Wiregrass Research and Extension Center (WGS) in Southeast Alabama, and the Gulf Coast Research and Extension Center (GCS) in Southwest Alabama. The TVS location represents Limestone Valley soils, while the other three locations represent Coastal Plain soils. Diversity among soil types and regions, as well as seed supplies, required using different wheat cultivars across locations. Wheat cultivars used were USG 3209 (TVS-2008, TVS-2009, EVS-2009), Pioneer 26R31 (GCS-2009, WGS-2009), and AGS 2060 (all 2010 locations). Each cultivar was treated with a fungicide and had a target seeding rate of 22 seed/ft on a 7.5-in. row spacing.

Each wheat location followed cotton and consisted of a split plot design with tillage as the main block and all N fertilizer treatments as subplots with each treatment replicated four times. At TVS, tillage variables included fall chisel plowing versus no-tillage before planting. At all other locations, surface tillage consisting of disking twice, chisel plowing, and field cultivation was compared to a KMC Gen II subsoiler-leveler (Kelley Manufacturing Com., Tifton, GA). The subsoiler-leveler operation was performed immediately after planting wheat to avoid tractor wheel ruts within the small plots. Nitrogen fertilizer treatments for each tillage system are listed in **Table 1**. At each location, fall N was applied by hand at planting as granular urea at TVS, and as NH_4NO_3 at the other locations. Streaming fertilizer tips were used to apply 28-0-0-5S liquid urea-ammonium nitrate (UAN) fertilizer to corresponding treatments at Zadoks Growth Stage (GS) 25 and GS 30 (Zadoks et al., 1974) using a self-propelled plot sprayer or spray apparatus mounted on a four-wheeler. Wheat tillering counts were determined at GS 25 by counting all tillers with three or more leaves within a 1 ft² section of each plot. Wheat yields were harvested from the center of each plot using a small, self-propelled combine designed for small plot research.

View of treatment differences among N fertilizer rates and application times for wheat grown with different tillage systems in Alabama.

Table 1. Nitrogen fertilizer rates and timings tested in wheat across four locations in Alabama.

Treatment	Fall applied	GS 25	GS 30
	-------- lb N/A --------		
1	0		60
2	0		90
3	0		120
4	0	30	30
5	0	45	45
6	0	60	60
7	20	40	
8	20	70	
9	20	100	
10	20		40
11	20		70
12	20		100

Tiller Counts

All tiller counts were collected at each location prior to UAN application at GS 25. Therefore, fall N and fall tillage were the only experimental variables examined in this study that could influence tiller counts. For the Limestone Valley soil (TVS), fall tillage had no impact on GS 25 tiller counts

Abbreviations and Notes: N = nitrogen; NH_4NO_3 = ammonium nitrate; S = sulfur.

View of subsoiler-leveler operation in the fall.

Sprayer set-up to apply liquid UAN.

Table 2. Tiller counts affected by tillage system and fall N application for each location during the 2008-2010 growing seasons in Alabama.

	Tiller counts, no /ft^2					
	---------- Fall tillage ----------			------ Fall N ------		
Location	Conventional	Non-inversion	P ≤ 0.10	0	20 lb/A	P ≤ 0.10
TVS-08	110	125		118	117	
TVS-09	94	76		87	83	
TVS-10	57	60		54	64	x
EVS-09	80	102	x	85	96	x
EVS-10	48	56		48	55	x
GCS-09	84	84		80	88	x
WGS-09	63	75	x	60	78	x
WGS-10	39	49	x	42	46	x

(**Table 2**). At three of the five site-years within the Coastal Plain, non-inversion tillage used to limit surface soil disturbance to maintain surface crop residues while maximizing below-ground disruption, enhanced tiller counts compared to traditional conventional tillage. Although cotton, a low residue producing crop (Daniel et al., 1999), was the previous crop across all locations, these data indicate that maintaining surface residue did not hinder early season wheat development across the Limestone Valley soil, and can enhance its development across Coastal Plain soils. Fall-applied N promoted early season tiller development across all Coastal Plain site-years and one site-year (TVS-10) from the Limestone Valley.

A balance must be obtained between fall-applied N and wheat development. High fall-applied N rates could promote excessive vegetative development that can result in wheat being more susceptible to early freeze damage. Previous research in the upper Coastal Plain has related tiller development at GS 25 to subsequent N applications that maximize final yields. Weisz et al. (2001) reported a critical tiller density < 50/ft^2, which indicates that N should be applied at GS 25 to optimize no-till wheat yields. The relationship between tiller counts measured at GS 25 and wheat yields is shown in **Figure 1** across all eight site-years. Unfortunately, this relationship does not show a plateau, which would identify a critical tiller density at GS 25 to optimize wheat yields. Grouping site-years into Limestone Valley and Coastal Plain locations did not help identify a plateau response (data not shown). However, it should be noted that within site-years at TVS, EVS, and WGS, higher

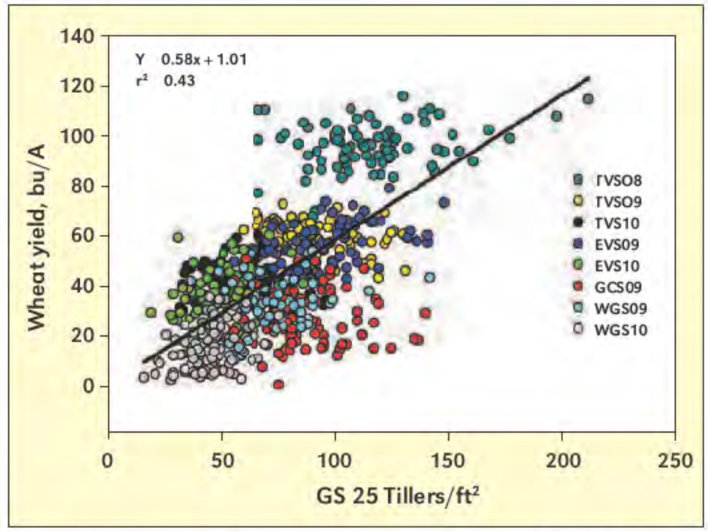

Figure 1. Relationship between GS 25 tiller counts/ft^2 and wheat yields across eight site-years in Alabama from 2008-2010. All counts were collected prior to spring applied UAN.

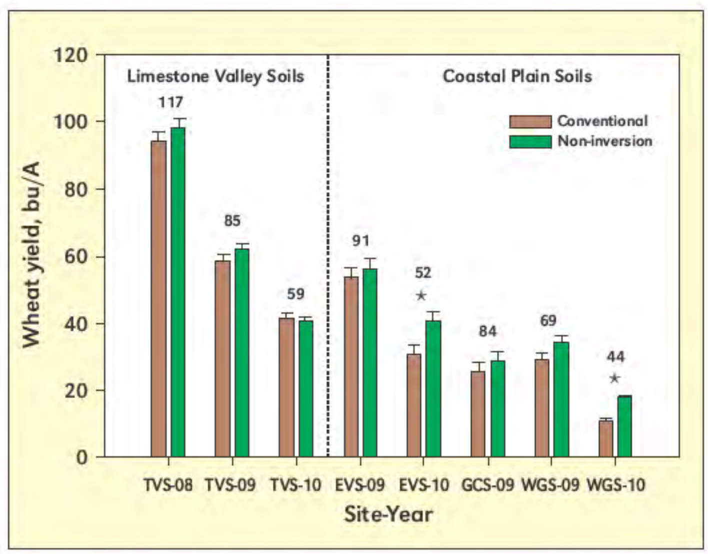

Figure 2. Wheat yields measured across conventional and non-inversion tillage systems for eight site-years from 2008-2010 in Alabama. Numbers above each site-year are the average tiller counts/ft^2 measured at GS 25 across all plots. * Indicates significant difference at 0.10 level of probability.

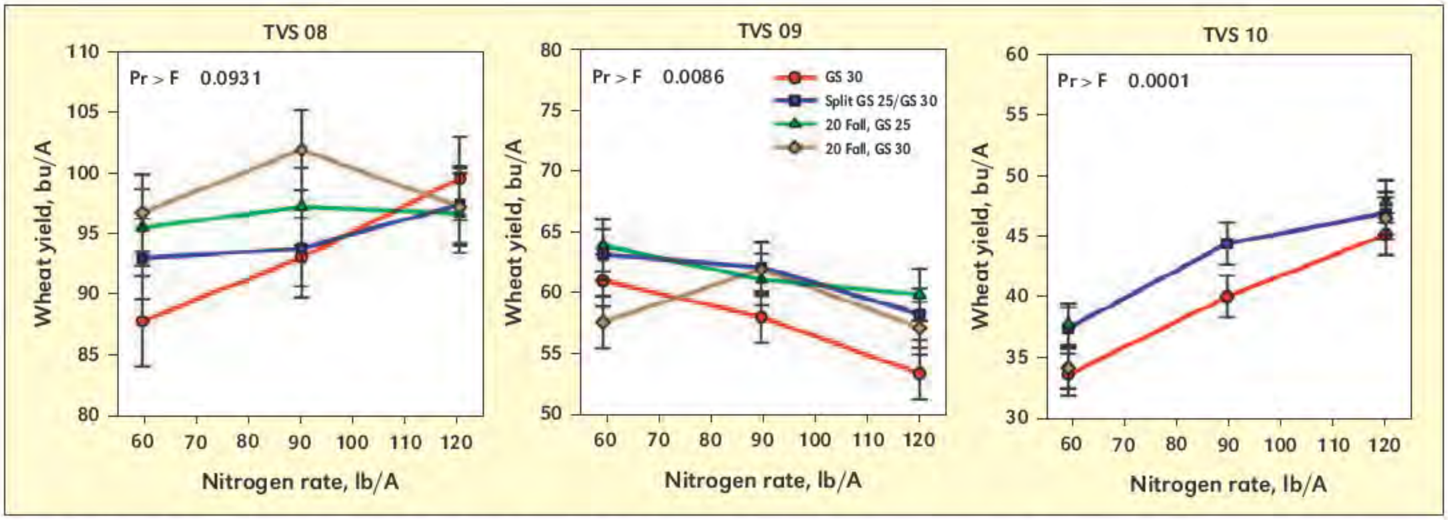

Figure 3. Wheat yields measured across different N rates and times of application for a Limestone Valley soil located in North Alabama across three site-years.

tiller densities at GS 25 resulted in higher final wheat yields.

Wheat yields

No differences were observed between wheat yields for conventional and non-inversion tillage systems at six of the eight site-year locations in Alabama **(Figure 2)**. For the remaining two site-years, non-inversion tillage wheat yields were increased 33% (EVS-10) and 64% (WGS-10) compared to conventional tillage. These results indicate that concerns about slow wheat development associated with surface residue and subsequently cooler soils (Weisz and Bowmann, 1999; Weisz et al., 2001) are not warranted in Alabama with cotton as the preceding crop.

Figure 2 also clearly illustrates wheat yield variability (< 20 to 96 bu/A) observed across all eight site-years. Some of this variability was caused by increased Hessian fly damage in 2009 and head scab disease in 2009 and 2010. The highest average number of tillers/ft^2 at GS 25 produced the highest

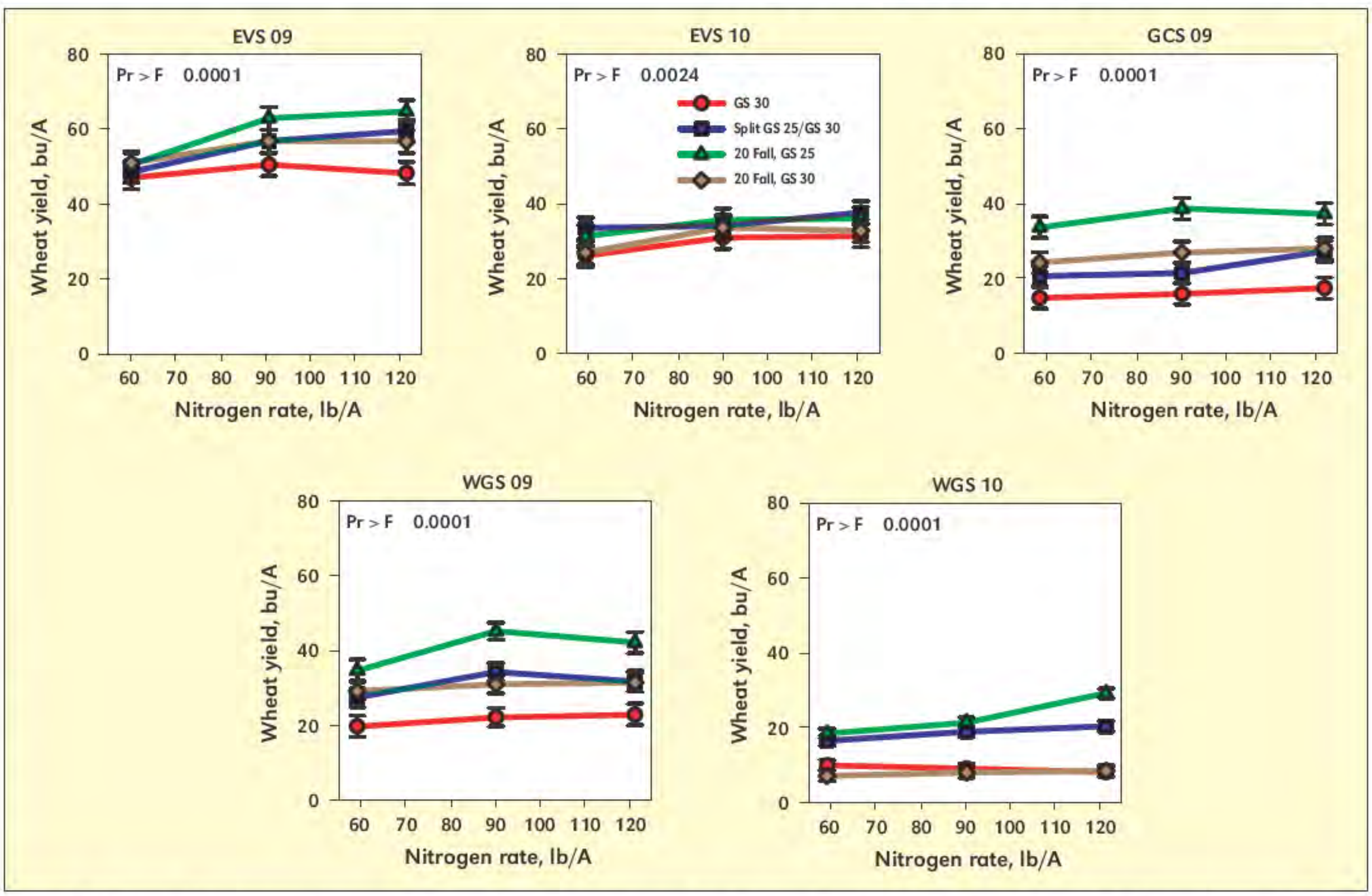

Figure 4. Wheat yields measured across different N rates and times of application for Coastal Plain soils located in Central and South Alabama across five site-years.

observed wheat yields, while the lowest number of tillers/ft^2 at GS 25 produced the lowest wheat yields. However, increased tiller counts/ft^2 did not correspond to increased wheat yields, which is also supported by data shown in **Figure 1**. For example, tiller counts measured at GCS-09 were 84/ft^2 at GS 25, but final yields were only about 25 bu/A. This observation highlights how yield potential can be decreased through the season by disease, insects, weather, or insufficient utilization of soil moisture and nutrients.

Although tiller counts at GS 25 can indicate the need for additional N, the amount required must also be determined for a specific region. In Alabama, differences between soil types created a natural distinction among site-years. For the Limestone Valley, results were inconsistent across site-years and incomplete for TVS-10 due to harvest issues **(Figure 3)**. Total N required to maximize wheat yields was different each year, and no clear response to fall-applied N was observed on this soil. This indicates some residual N may be available on these soils to the wheat crop following cotton, but it can be variable by year. This may be a function of winter rainfall levels or low temperatures that can inhibit N uptake from cold soils.

On the Coastal Plain, wheat yields were generally lower compared to the Limestone Valley. Fall-applied N followed by the remainder of N at GS 25 consistently maximized yields across all site-years **(Figure 4)**. Three out of five site-years showed that 20 lb N/A in the fall followed by 70 lb N/A at GS 25 produced maximum yields. However, WGS-10 required 100 lb N/A at GS 25 to complement the fall applied N and EVS-10 produced consistent yields regardless of N application or timing. The need for fall-applied N indicates no residual N was present for wheat following cotton on these sandy soils. This is not surprising considering the N leaching potential of sandy soils in a humid environment (Scharf and Alley, 1994).

Summary

Conclusions from this research are confined to wheat following cotton based on eight site-years, but some general conclusions were observed. Non-inversion tillage on the Coastal Plain soils and no-till on the Limestone Valley soils produced comparable or superior wheat yields across Alabama compared to conventional tillage. Fall-applied N was not necessary to optimize yields on Limestone Valley soils, but necessary for Coastal Plain soils. The N application window was wider for Limestone Valley soils, while Coastal Plain soils required all N applied by GS 25. Tiller counts were inconclusive as an effective tool to predict N requirements, but additional research may improve relationships between tiller/ft^2 and final wheat yields.

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