Determining Topdress Nitrogen Needs for Winter Grains

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Introduction

Nitrogen (N) management is a key challenge for optimizing the yield and protein levels of winter small grain crops. Winter grains need little N in the fall, so it is recommended to split N applications between a small amount applied before planting (10-20 lbs/acre) and the remainder applied as a topdress application in early spring. This avoids overwinter N loss and maximizes N use efficiency. But how do you decide when and how much N to apply in the spring? Nitrogen applied early can stimulate tillering and increase the number of seed heads per square foot, but too much N can lead to lodging and less productive tillers.

Growers in other regions use tiller numbers at spring "green up" to guide their N topdress decisions. This is when the plants first resume growth in the spring and is also referred to as Zadok growth stage 25 (GS25). Nitrogen applied at this stage can stimulate tillering but if tiller counts are adequate it is better to delay topdressing until just before stem elongation (at the "hollow stem" stage or GS30) and the crop's most rapid phase of growth and N uptake, for the most efficient use of nitrogen by the crop. As well, later N applications are more effective at increasing grain protein than earlier ones.

To determine tiller numbers, count the number of tillers including the main stem in a one-foot section of row, and do this 10-15 times per field. (A tiller must have at least three fully emerged leaves to be counted.) To calculate tillers per square foot, take the average tiller number per foot of row, divide by your row spacing (in inches), and multiply by 12. Topdress applications should be reduced or delayed for fields with tiller numbers above a critical level, which, for other states, ranges from 50 to 90 tillers per square foot for winter wheat. Figure 2 shows recommendations from Virginia Cooperative Extension as an example.

Research questions

➔ Can we use tiller counts to predict topdress N needs for winter grains in New England?
➔ If so, do we need to adjust the recommendations for our region and for non-wheat crops?

What was done

We conducted five experiments on three farms during 2014, as part of a Northeast SARE Research and Extension grant project (LNE13-325). Two farms located in northern Maine each had two experiments with winter rye (sites 1 and 2 at Farm A and sites 3 and 4 at Farm B) and one farm in Massachusetts had one experiment with winter wheat (site 5). In Maine, sites 1 and 3 had no preplant N applications whereas sites 2 and 4 each received 10 lbs of N per acre before planting. Topdress N was applied at spring greenup at five rates (0, 20, 40, 60, 90 lb

N/acre). The Massachusetts site received 38 lbs of N per acre at planting and topdress N was applied at four rates (0, 30, 60, 90 lb N/acre) either at spring greenup (GS25) or just before stem elongation ("hollow stem", GS30). At all sites, the topdress treatments were replicated three times. We measured tiller and plant number at GS25; spike number, grain yield, and lodging at harvest; and grain protein for wheat at site 5.

Results

Did N topdressing increase spike numbers?

Yes. Topdressing increased spike numbers relative to the no topdress control treatment at all sites (see Table 2). Spike numbers increased with increasing N rates up to 60 lb N/acre. Timing of application was not significant. Note that for sites with high initial tiller numbers (3, 4 and 5), final spike numbers were lower than initial tiller numbers, so topdressing did not increase tillering but rather increased the portion of tillers that developed into productive spikes.

Did N tropdress application affect grain yield?

Yes. Figure 1 shows grain yields at Farm A to demonstrate how maximum yields were obtained at different topdress N rates for different sites. Yields were positively affected by N topdressing and reached maximum levels at 40 lb N/acre where preplant N was applied (site 2) and 60 lb N/acre where no preplant was used (site 1). These yield max N rates are recorded in Table 1.

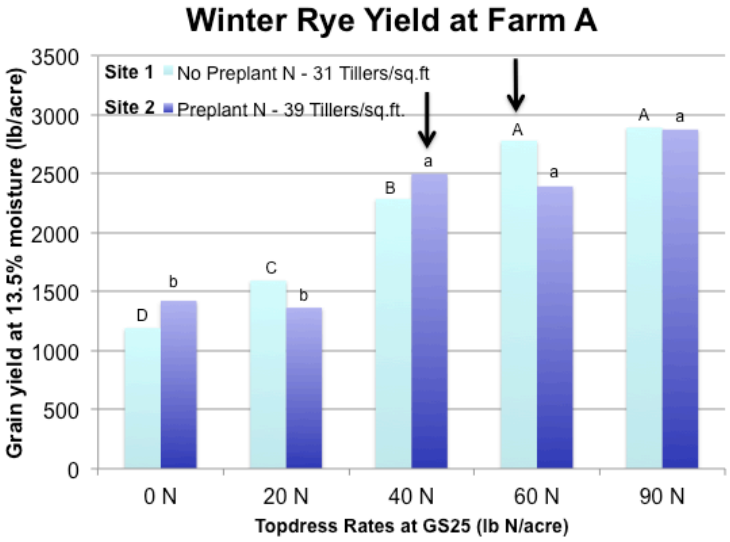

Figure 1: Winter rye yields at farm A, both preplant N and no preplant sites, as affected by topdress N application rate at spring greenup (GS25). Values that share the same letter are not significantly different from one another (using Fisher's Least Significant Difference tests). Arrows indicate the N rate where the yield maxed out for each site.

See Tables 1 and 2 for results from the other sites. At site 3, where initial tiller numbers were high, the yield max N rate was 20 lb N/acre. At site 4, which received preplant N and had high initial tiller counts, topdressing did not affect yield. At site 5, yield maxed out at 30 lb N/acre for the GS25 application, but 90 lb N/acre was required at GS30 to see the same effect. At sites 3, 4, and 5, severe lodging at the higher topdress N rates may have reduced yields.

At site 5, the only site with wheat, higher topdress N rates resulted in higher winter wheat grain protein concentrations. No differences were observed between the two timings.

Can we use tiller counts at spring greenup to predict topdress N needs for winter grains?
Our results suggest, yes. Table 1 shows that for sites with tiller numbers above 50 per square foot, yields maxed out with little or no topdress N (sites 3, 4, and 5). In contrast, sites 1 and 2 had low initial tiller numbers and required twice as much topdress N to produce maximum yields. Also note that at sites with high initial tiller counts, topdressing caused more lodging at lower rates than the low tiller count sites.

Table 1: Average tiller counts and the spring greenup topdress N rate that produced maximum yield.

Site	Average tiller count (#/sqft)	Topdress N rate when yield maxed out (lbs N/ac)
Site 1 – No preplant (rye)	31	60
Site 2 – Preplant N (rye)	39	40
Site 3 – No preplant (rye)	86	20
Site 4 – Preplant N (rye)	65	0? (lodging)
Site 5 – Preplant N (wheat)	71	30

Do we need to adjust recommendations for our region and non-wheat crops?
The graph in Figure 2 shows Virginia recommendations for N application at GS25 according to the number of tillers found at the greenup stage, assuming there will be another later application made before jointing. Our results in Table 1 for winter rye and winter wheat roughly match these recommendations, taking into account that other factors besides N affect yields.

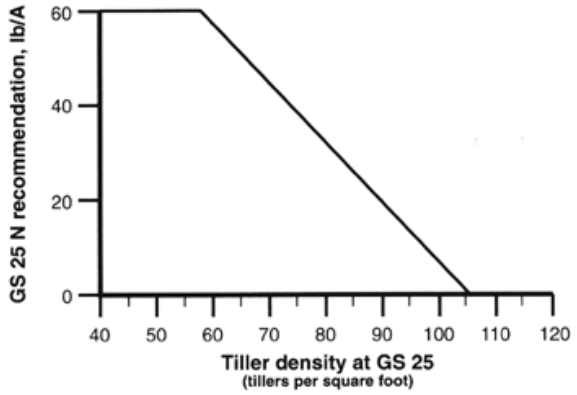

Figure 2: Topdress N recommendation for the first application in a split based on tiller density. From "Nitrogen Management for Winter Wheat: Principles and Recommendations," Virginia Coop Extension.

Conclusions

- Counting tillers at spring greenup (GS25) shows promise as a tool to guide N applications for winter rye and winter wheat in our region.
- We are conducting further on-farm trials and extensive research station experiments to determine critical levels for GS25 tiller numbers and economically appropriate application rates.

Table 2: Results of the winter rye and winter wheat topdress trials at five sites.

Site / Tiller #	Greenup N appl. rate	Spike Count @ maturity	Grain Yield	Lodging severity	Crude protein at 12% moisture
	lb/acre	no./sqft	lb/acre	5=worst	%
Site 1 - Rye	0	28 c	1192 d	1.0	
No preplant	20	34 c	1595 c	1.0	
	40	49 b	2289 b	1.0	Not measured
31 tillers/ft^2	60	54 ab	2782 a	1.7	
	90	65 a	2893 a	1.7	
Statistical difference?		yes	yes	no	
Site 2 - Rye	0	42 b	1423 b	1.0 b	
Preplant N	20	40 b	1365 b	1.0 b	
	40	45 b	2500 a	1.0 b	Not measured
39 tillers/ft^2	60	60 ab	2394 a	1.7 ab	
	90	64 a	2876 a	2.3 a	
Statistical difference		yes	yes	yes	
Site 3 - Rye	0	24 c	1296 b	2.0 bc	
No preplant	20	37 b	2138 a	1.0 c	
	40	42 b	1887 ab	1.7 bc	Not measured
86 tillers/ft^2	60	43 b	2075 a	3.2 ab	
	90	62 a	1176 b	4.8 a	
Statistical difference		yes	yes	yes	
Site 4 - Rye	0	34 b	1817	1.3 b	
Preplant N	20	38 b	1771	1.3 b	
(10 lbs/ac)	40	48 ab	1480	3.7 a	Not measured
65 tillers/ft^2	60	62 a	1211	4.7 a	
	90	56 a	1393	4.7 a	
Statistical difference		yes	no	yes	
Site 5 -	0	29 c	1598 d	0.0 c	10.4 c
Winter	30	36 bc	2855 ab	2.33 b	10.8 bc
wheat	60	48 a	3054 a	4.67 a	11.4 bc
71 tillers/ft^2	90	45 ab	2963 a	4.67 a	12.6 a
	Hollow stem N appl. rate				
	0 0	29 c	1598 d	0.0 c	10.4 c
	0 30	37 bc	2223 c	0.0 c	11.7 ab
	0 60	42 ab	2541 bc	2.0 bc	11.4 bc
	0 90	44 ab	3147 a	3.67 ab	12.7 a
Statistical difference		yes	yes	yes	yes

Averages within a site that share the same letter are not significantly different from one another (using Fisher's Least-Significant Difference Tests). No letters means the treatment effect was not significant.