Winter Wheat Nitrogen Response X Fungicide Interactions

Purpose:

Until recently, winter wheat nitrogen recommendations were based on research conducted 30 years ago. Production practices have changed significantly, with increased yield potential through better genetics (varieties), use of fungicides, and growth regulators. In the pursuit of higher wheat yields using improved management techniques, N recommendations were found to be insufficient. N recommendations were increased (2012) based on research which is the precursor to this study (Hooker et al, 2014, Johnson and McClure previous CropAdvances).

This study continues the evaluation of nitrogen recommendations, with a shift in focus to the difference in response comparing where fungicides were and were not applied. A wheat nitrogen calculator is the goal to be developed from this and previous research efforts.

Methods:

Six trials were established in the spring of 2014 and 7 sites in 2015 across southwestern Ontario. Plot design was field scale, two replicate, randomized with 5 N rates, both with and without fungicides (total 20 plots/site). A 180 N treatment was added at specific locations each year. The treatments are as follows: treatments 6 and 12 were only included at 5 of the 13 sites.

1. Check (No nitrogen applied) with fungicide
2. 60lbs Nitrogen (60N) with fungicide
3. 90lbs Nitrogen (90N) with fungicide
4. 120lbs Nitrogen (120N) with fungicide
5. 150lbs Nitrogen (150N) with fungicide
6. 180lbs Nitrogen (180N) with fungicide
7. Check (No nitrogen applied) without fungicide
8. 60lbs Nitrogen (60N) without fungicide
9. 90lbs Nitrogen (90N) without fungicide
10. 120lbs Nitrogen (120N) without fungicide
11. 150lbs Nitrogen (150N) without fungicide
12. 180lbs Nitrogen (180N) without fungicide

Other than the nitrogen rate and fungicide applications, all variables at each field location were consistent, following the normal production practices of the producer. At all sites spring nitrogen was applied by broadcasting urea with a Valmar airflow applicator.

Urea applications were made between late April and the beginning of May. Data collected from these sites included yield, moisture, test weight, 1000 kernel weights,

protein, disease ratings and lodging. Post-harvest soil nitrate samples were collected to observe environmental impact with increase nitrogen application.

Results:

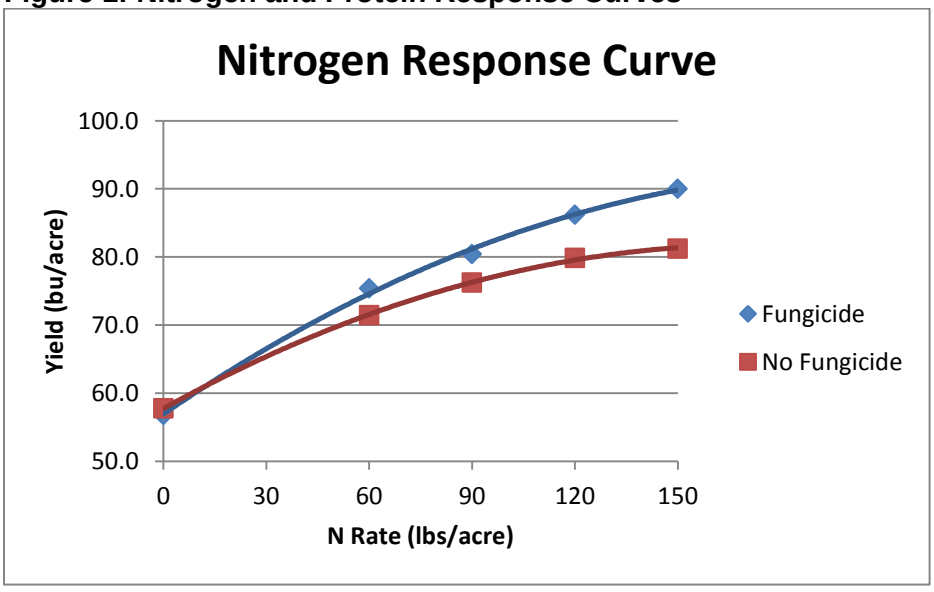
Yields increased with the addition of N (Table 1). Yield increase was greatest with the first addition of nitrogen, with subsequent increases being less with each addition of 30 lbs N. As indicated in previous research, zero N yields were essentially equal regardless of fungicide application. Yield increases are higher with fungicides applied than without fungicides for each additional increment of nitrogen (incremental gain). Additionally, without fungicides yield gains drop quickly above 90N, while yield gains with fungicides hold constant to 120N, and remain significant even to 150N.

There was no impact of N rates on test weight, moisture or thousand kernel weights.

Table 1: Breakdown of Yields With and Without Fungicide (bu/ac)

Trt	With Fungicide		Trial Avg	Gain	No Fungicide		Trial Avg	Gain
	2014	2015			2014	2015		
0	52.1	63.0	56.8	-	53.7	63.7	57.8	-
60	71.5	79.1	75.4	18.6	71.4	72.3	71.4	13.6
90	77.1	82.8	80.4	5.0	76.4	76.4	76.2	4.8
120	83.2	88.6	86.2	5.8	80.6	79.4	79.8	3.6
150	88.7	90.6	90.0	3.8	84.9	78.1	81.2	1.4

Figure 1: Nitrogen and Protein Response Curves



Economic Analysis: Using urea at $557/tonne ($0.55/lb of actual N) and soft red wheat at $6.00/bushel, 3 bushels of wheat are required to cover the cost of 30lbs of N ($0.55/lb*30lbs= $16.50/$6.00/bu= 2.8 bushels). With the addition of fungicide application, you increase your costs by $24.00/ac (fusarium fungicide $14.00/ac + $10.00/ac application). In order to cover the cost of the fungicide, you would have to have an increase of 4 bushels ($24.00/$6.00)=4 bu). Using these assumptions, the 150 N with fungicide is the most profitable treatment on average. Using the trend line (Figure 1), the maximum economic rate of nitrogen (MER-N) occurs at 158 lbs N/ac with fungicide and 117 lbs N/ac without fungicide. Economic gains are small above 90 N without fungicides, and 120 N with fungicides. MER-N rates vary by location, thus full average MER-N rates are not recommended: MER-N represents the point of zero return to added N. Growers should do their own evaluation of N response above 90 N without fungicides and 120 N with fungicides.

The interaction of nitrogen and fungicides is intriguing in this economic analysis. While 2014 and 2015 yields were lower than trend line due to harsh winter conditions and winterkill, the synergy between nitrogen and fungicide still exists. This indicates that even on crops with lower yield potential, management pays. Additionally, it is intriguing to note that while economic impact is small between 90, 120 and 150 N, it is only at the higher N rates that use of the fungicide becomes more profitable.

The results from the 5 sites containing the 180 N treatment are shown in Table 2. Yield increase is slight to the final 30 pound N increment. Although this is limited data (5 sites), previous trials have also verified little or negative response to 180N. Protein levels continue to increase with these higher N applications.

Table 2: Summary of Trials Including 180N Treatments

Locations (4 Sites)	Applied Fertilizer N (lbs/ac)					
	0N	60N	90N	120N	150N	180N
	Wheat Yield (bu/ac)					
With Fungicide	56.9	67.7	71.9	77.3	78.7	81.4
Without Fungicide	53.0	68.1	67.4	71.2	71.7	74.2

Table 3 contains the average protein results with and without fungicide. Protein slowly increased as nitrogen rate increased but there was no difference in response with and without fungicide.

Summary:

The results from this trial prove that there are great opportunities to increase yield through the use of N and fungicide. The synergy between N and fungicide in winter wheat was evident in both 2014 and 2015. Response to fungicide was very minimal in 2014, but response to fungicide in 2015 was very significant at higher N rates. At 90N there was only a 6.4 bu/acre yield increase from fungicide. At 120N yield response was

9.2 bu/acre and 150N it increased to 12.5 bu/acre. This shows the importance of using fungicide and increased nitrogen rates, to gain value from both.

Table 3: Average Protein (%)

Treatment	With Fungicide	Without Fungicide
0	9.8	9.8
60	9.8	9.9
90	10.1	10.0
120	10.3	10.3
150	10.4	10.5

Yield response to increasing N without fungicide was greater than expected: MER-N was 117N. Previous trials have shown 90 N to be the MER-N without fungicides applied.

The treatment with the highest profit was 150N with fungicide, with MER-N being calculated at 158N. However, differences in profit between the treatments above 90N were quite small. These differences are calculated on yield only: when factoring in fusarium and quality downgrades that occurred throughout Essex, Chatham-Kent and surrounding regions in 2015, increased quality and marketability improves the economics of high N rates with fungicide substantially. In some cases, this can add well over $100/acre to grower revenue.

Next Steps:

This is the second year of this project. Research will be gathered and continued for one more year (2014-2016). Data collected from this trial will be used in multiple articles, as well as presentations.

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