Spring Wheat Nitrogen Response X Fungicide Interactions

Purpose:

Recent research has shown synergy between fungicide (F) and nitrogen (N) in winter wheat (Hooker et al, 2015). This trial investigates if any similar synergy exists in spring wheat. The data generated from this trial will be used to validate, and/or update, the Provincial (Ontario) nitrogen recommendations for spring wheat (Agronomy Guide, Publication 811). Depending on the findings of this study, this may mean differential N recommendations for spring wheat grown with and without fungicide. Maximum Economic Rate of Nitrogen (MER-N) will be determined, both with and without fungicide, from the N response curves generated from the data obtained.

Methods:

Field scale trials were established in 2014 (4 sites) and 2015 (4 sites) across southwestern Ontario. Plot design was field scale, two replicate, randomized, 5 N rates, both with and without fungicides (total 20 plots/site). Small plot, 4 replicate trials were also conducted at Winchester and New Liskeard. Four field plots were also conducted in the Winchester area.

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

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. Check (No nitrogen applied) without fungicide
7. 60lbs Nitrogen (60N) without fungicide
8. 90lbs Nitrogen (90N) without fungicide
9. 120lbs Nitrogen (120N) without fungicide
10. 150lbs Nitrogen (150N) without fungicide

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. Fusarium damaged kernel (FDK) counts were complete on sites with high fusarium levels.

Results:

Plantings were extremely late in 2014 (as late as May 28th), due to a wet May. Plantings were timely in 2015, with nearly ideal early spring weather. In both years temperatures

remained in the warm zone throughout grainfill (<28°C), with no extremely hot temperatures, despite late plantings in 2014. This allowed for excellent yields in both years.
The average yield results from southern Ontario are summarized in Table 1 and the N response curve is shown in Figure 1. The results from Winchester and New Liskeard are summarized in Table 5.

Table 1: SouthWestern Ontario Yields With and Without Fungicide (bu/ac)

Treatment	With Fungicide		Trial Average	Gain	No Fungicide		Trial Average	Gain
	2014	2015			2014	2015		
0	63.0	63.8	63.3	-	62.7	59.7	61.4	-
60	79.1	75.8	77.7	14.4	69.5	64.7	67.5	6.0
90	84.0	73.3	79.4	1.7	73.9	67.9	71.3	3.9
120	82.6	77.0	80.2	0.8	77.6	66.9	73.0	1.7
150	89.7	78.1	84.7	4.5	77.2	68.0	73.3	0.2

Economic Analysis: Using urea at $557/tonne ($0.55/lb of actual N) and hard red spring wheat at $5.62/bushel (current values at time of writing), 2.9 bushels of wheat are required to cover the cost of 30lbs of N ($0.50/lb*30lbs= $16.50/$5.62/bu= 2.9 bushels). With the addition of fungicide application, you increase your costs by $24.00/ac (fusarium fungicide $14.00/ac + $10.00/ac application). To cover the cost of the fungicide, you would need an additional 4.3 bushels/ac ($24.00/$5.62)=4.3 bu).

Based on these assumptions and using the trend line from figure 1: MER-N was reached with 92 N/ac with fungicide and only 53 N/ac without fungicide. However N response varied between 2014 and 2015. Similar to winter wheat, MER-N rates are significantly higher with fungicide than without fungicide, for both years, indicating that a NXF synergy does exists. The MER-N values are significantly higher than currently recommended in the Agronomy Guide, Publication 811 (~90 lbs N/ac vs 63 lbs N/ac) when a fusarium fungicide is applied. More data needs to be generated before conclusions are drawn, but Agronomy Guide N rates do appear low based on current genetics and N response with fungicide.

On average, there was a significant and consistent yield increase to fungicide with high N rates. This is similar to winter wheat, where yields at zero N show little to no yield increase whether the fungicide is applied or not. As N rates increase, response with the fungicide applied increases dramatically. However, not every site showed this response. Five of the Southwestern Ontario sites had a large response to fungicide, averaging ~10 bu/ac, while the other two had minimal response to fungicide. These results are shown in Table 2. On average, fungicide applications were economical: the sites where fungicide response was not economical tended to have lower yield potential. Both non-responsive sites were grown on sandy soils in regions that received less moisture than most of southern Ontario. The lack of moisture likely limited yield potential, which limited the potential response to fungicide and N.

Figure 1: Southwestern Ontario Spring Wheat N Response Curves

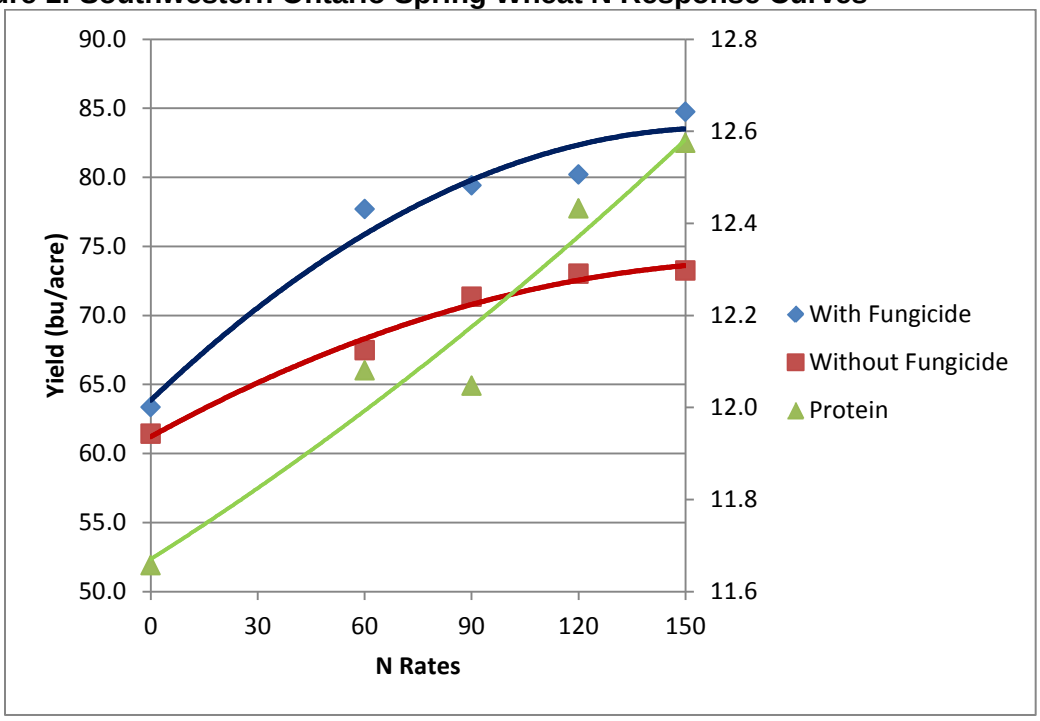


Table 2: Response to Fungicide

N Rate	5 Responsive Sites		2 Non Responsive Sites	
	Fungicide	No Fungicide	Fungicide	No Fungicide
0	63.9	61.8	61.5	61.1
30	79.3	73.7	65.0	73.6
60	80.6	76.4	69.9	75.0
90	82.4	74.8	72.5	74.2
120	88.1	76.2	72.0	76.4

Table 3: Breakdown of Protein With and Without Fungicide

Treatment	With Fungicide	No Fungicide
0 N	11.7	11.6
60 N	12.1	12.2
90 N	12.0	12.3
120 N	12.4	12.6
150 N	12.6	12.7

The average protein results are summarized in Table 3. Protein response to nitrogen was extremely variable across locations making it hard to draw any conclusions. One site had very little change in protein across all treatments, while another site had a 2% increase in protein from 0 N to 150 N. In general, protein increased with additional N, which is the expected response. There was very little difference in protein with or without fungicide for each N treatment.

The FDK results from a site near Owen Sound in 2014 are summarized in Table 4. Harvest was delayed due to wet weather until late September, which contributed to the high FDK counts. The results once again support the use of a fusarium fungicide in spring wheat production. FDK counts were significantly lower where a fusarium fungicide was used, and made the difference between Grade 2/3 wheat and feed. In this case, the fusarium fungicide resulted in increased return of over $100/acre. Only 2 of the 8 southern Ontario locations did not have a large enough yield increase to at least break even with a fusarium fungicide application.

Table 4: FDK Results

Treatment	With Fungicide	No Fungicide
0 N	1.1%	2.6%
60 N	1.0%	3.0%
90 N	1.0%	3.9%
120 N	1.3%	3.3%
150 N	1.4%	2.9%

No major differences in test weight or 1000 kernel weight are evident. Post-harvest nitrate results are still pending. Results will be available once samples have been analyzed.

Table 5: Winchester and New Liskeard Yield Data (bu/ac)

Treatment	With Fungicide		Without Fungicide	
	Winchester	New Liskeard	Winchester	New Liskeard
0 N	67.7	50.8	61.3	49.0
60 N	74.6	64.9	72.5	62.1
90 N	76.9	72.8	74.6	69.9
120 N	76.8	76.0	73.2	69.2
150 N	78.1	78.2	73.3	72.2

The N response curve from Winchester is shown in Figure 2. There is little response to fungicide at Winchester with 90N but yields tend to hang on better with high N rates when a fungicide is applied. Based on this data and the assumptions listed above (spring wheat @$5.62/bu and N @$0.55/lb) MER-N was reached with 45 N when fungicide was applied and 66 N with no fungicide. Results were variable across locations

with a few sites reaching MER-N with 0 N. If these 2 sites are removed from the data the MER-N was 68 N with fungicide and 77 N without. The MER-N values are slightly below the current recommends in the Agronomy Guide, Publication 811 (63 lbs N/ac).

Figure 2: Winchester Spring Wheat N Response Curve

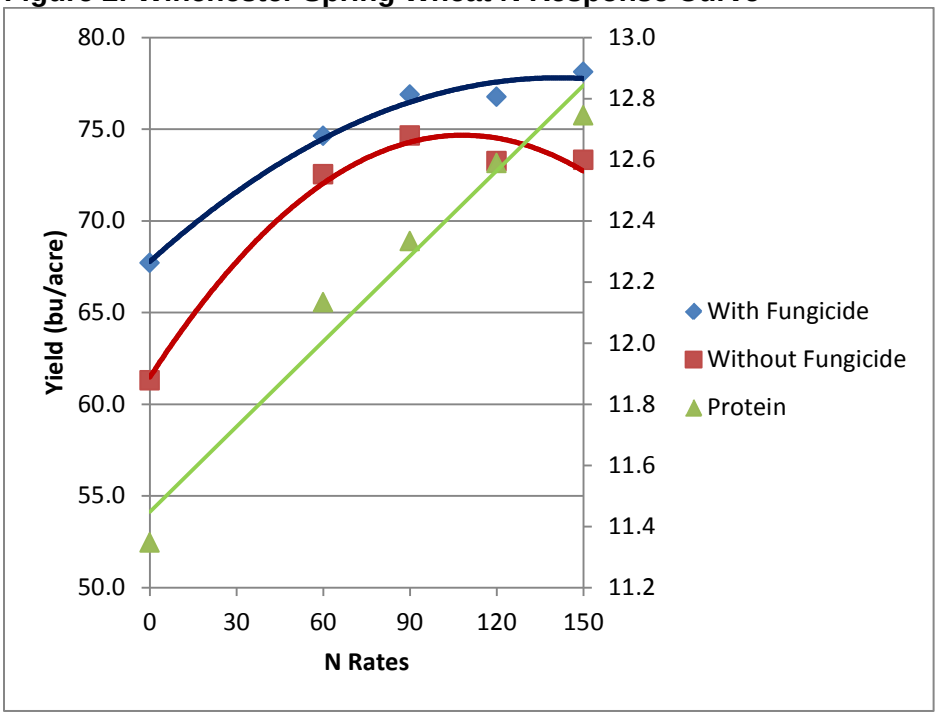
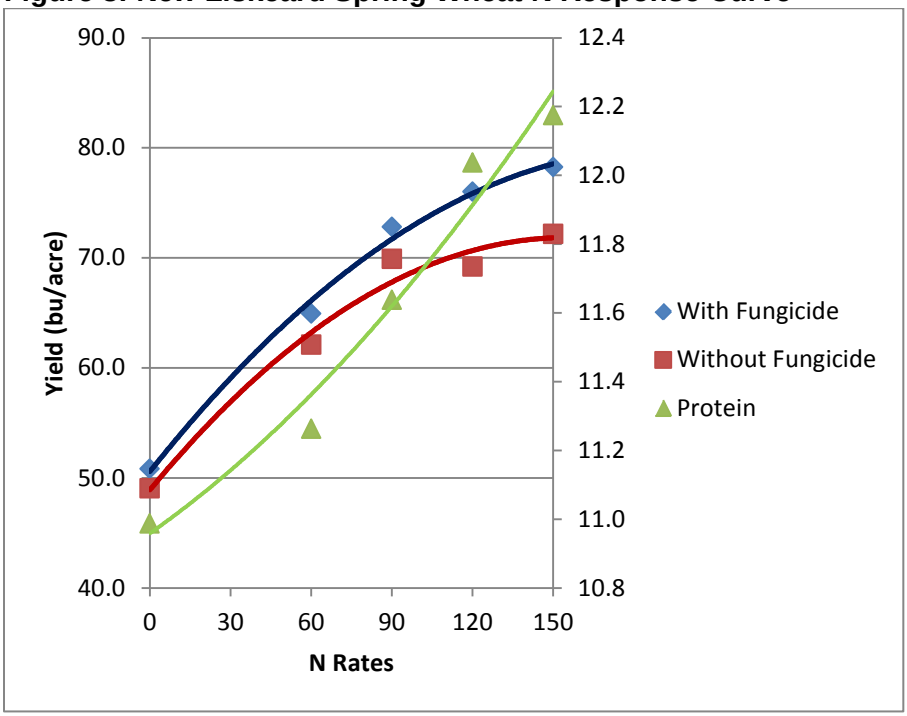


Figure 3: New Liskeard Spring Wheat N Response Curve



The N response curve from New Liskeard is shown in Figure 3. This data is only based on one site over 2 years (2 site years) so more data will be needed before any recommendations can be made. There does appear to be a NXF synergy as the gap between the fungicide and no fungicide curves begins to widen with high N rates. There is a strong response to added N at this location with MER-N occurring with 130 N when a fungicide is applied and 98 N without. The MER-N values are significantly higher than currently recommended in the Agronomy Guide, Publication 811 (63 lbs N/ac). This is based on very limited data: more research is required. Similar to oats and barley there was a large variation in MER-N between 2014 and 2015. Yields were extremely high in 2015 which resulted in a higher MER-N. There was little difference in protein with or without fungicide for each N rate.

Summary:

Preliminary results suggest that there is a NXF synergy in spring wheat. Based on the data to date, MER-N occurs with 90N/ac in southern Ontario when a fungicide is applied. MER-N was achieved with 60 to 70N at Winchester and 100 to 130N at New Liskeard. More data is need from Winchester and New Liskeard before any real conclusions can be made. These rates are based on limited data and there was a large variation in MER-N between 2014 and 2015.

The benefits of using a fusarium fungicide in southern Ontario are evident, with 6 of the 8 sites paying for the cost of the fungicide with yield alone. In the event harvest is delayed or we have a year where conditions are ideal for fusarium (like 2014), the returns from using a fungicide become very significant. There appears to be strong NXF interaction at New Liskeard (limited data). Yield response to fungicide at Winchester is variable but again any benefit in quality easily pays for a fusarium fungicide application.

Next Steps:

This is the second year for this project. Research will be gathered and continued for one more year (2014-2016). Anyone who is interested in participating in this trial is encouraged to contact Peter Johnson at peter.johnson@bell.net, or Shane McClure at shane_mcclure@hotmail.com. Data collected from this trial will be used in multiple articles, as well as presentations.

Acknowledgements:

Huge thanks to our co-operators, many of whom stick with us year after year. Thanks to summer assistant Alison Buckrell, Shane McClure, administrator Marian Desjardine, and statistician Ken Janovicek. This work would not be possible without the generous support of the Growing Forward 2 Program and the Grain Farmers of Ontario.

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