Spring Barley Nitrogen Response X Fungicide Interactions

Purpose:

Recent research has shown synergy between fungicide (F) and nitrogen (N) applications in winter wheat. (Hooker et al, 2015). This trial investigates if any similar synergy exists in spring barley. The data generated from this trial will be used to validate, and/or update, the Provincial (Ontario) nitrogen recommendations for spring barley (Agronomy Guide, Publication 811). Depending on the findings of this study, this may mean differential N recommendations for barley 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:

Four field scale trials were established across southern Ontario in the spring of 2014 and six in 2015. Plot design was field scale, two replicate, randomized N rates at each site, with and without fungicides. Small plot, four replicate trials were conducted at Winchester and New Liskeard. Post-harvest soil nitrate tests were collected to evaluate soil residual N and potential environmental impact from higher N applications.

Other than the nitrogen rate and fungicide (with, without), all variables at each field location were consistent across all treatments, following the normal production practices the producer would normally utilize. At 8 of the sites spring nitrogen was applied by broadcasting urea with a Valmar airflow applicator, while UAN (28% urea/ammonium nitrate solution) was used at 2 sites. The treatments are as follows:

1. Check (No nitrogen applied) with fungicide
2. 30lbs Nitrogen (30N) with fungicide
3. 60lbs Nitrogen (60N) with fungicide
4. 90lbs Nitrogen (90N) with fungicide
5. 120lbs Nitrogen (120N) with fungicide
6. Check (No nitrogen applied) without fungicide
7. 30lbs Nitrogen (30N) without fungicide
8. 60lbs Nitrogen (60N) without fungicide
9. 90lbs Nitrogen (90N) without fungicide
10. 120lbs Nitrogen (120N) without fungicide

Data collected from these sites included in season and harvest disease ratings, yield, moisture, test weight, 1000 kernel weight, protein, and post harvest soil nitrate.

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

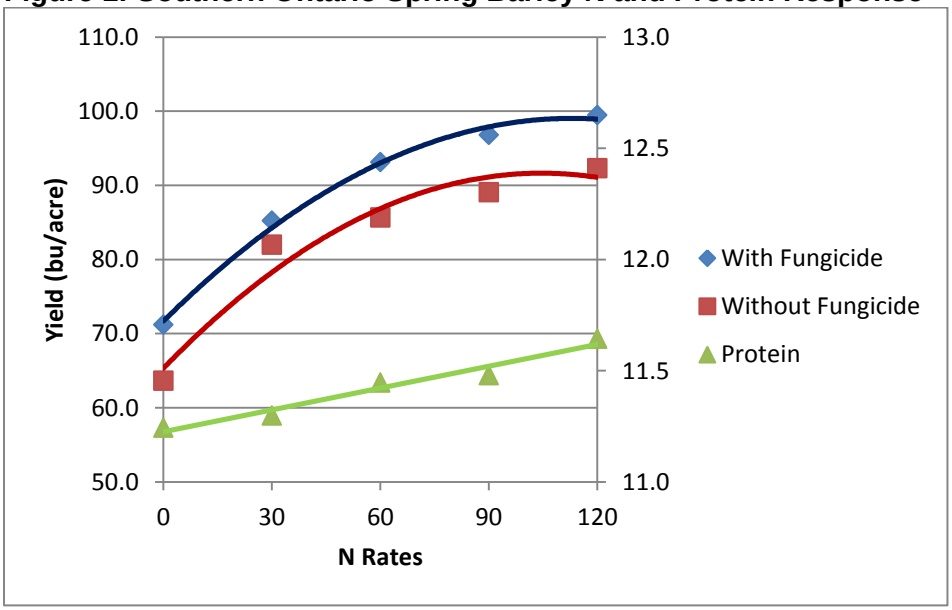
temperatures, even despite late plantings in 2014. This allowed for excellent yields in both years.

The average yield results for southern Ontario are summarized in Table 1. Yield results from Winchester and New Liskeard are shown in Table 4. Yields for both the fungicide and no fungicide treatments increased quickly as nitrogen was added. The treatments with fungicide did increase slightly faster but differences are small. The N response curve is shown in Figure 1.

Table 1: Barley Yield With and Without Fungicide (bu/ac)

Treatment	With Fungicide		Trial Average	Incremental Gain
	2014	2015		
0 N	70.5	69.7	**71.2**	-
30 N	86.4	86.1	**85.2**	14.0
60 N	98.6	92.7	**93.1**	7.9
90 N	103.9	94.0	**96.8**	3.7
120 N	108.2	96.7	**99.5**	2.7
Treatment	**No Fungicide**		**Trial Average**	**Incremental Gain**
	2014	**2015**		
0 N	64.7	62.9	**63.7**	-
30 N	81.8	85.5	**82.0**	18.3
60 N	89.1	87.0	**85.6**	3.7
90 N	94.0	91.1	**89.1**	3.4
120 N	100.1	91.8	**92.3**	3.2

Figure 1: Southern Ontario Spring Barley N and Protein Response



Economic Analysis: Using urea at $557/tonne ($0.55/lb of actual N) and spring barley at $3.96/bushel (current values Jan 2016), 4.2 bushels/acre of barley are required to cover the cost of 30lbs of N ($0.55/lb*30lbs= $16.50/$3.96/bu= 4.2 bushels). With the addition of fungicide application, costs increase by $18.00/ac. In order to cover the cost of the fungicide, an additional increase of 4.5 bushels/acre ($18.00/$3.96)=4.5 bu) are needed.

Based on the above assumptions and using the trend line from Figure 1: the MER-N is 83lbs N/ac with fungicide and 80lbs N/ac when no fungicide is applied. However, results did vary by location. There was a stronger response to high N in 2014 with MER-N being achieved with 95 lbs N/ac compared to 70lbs N/ac in 2015. Unlike winter wheat, MER-N rates were nearly identical with and without fungicide, for both years, indicating that no N x F synergy exists. However, the MER-N values are significantly higher than currently recommended in the Agronomy Guide, Publication 811 (~80 lbs N/ac vs 63 lbs N/ac). 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.

On average, there was a significant and consistent yield increase to the fungicide, even at the zero N rate. In winter wheat, yields at zero N show little to no yield increase whether the fungicide is applied or not. This is a significant difference in the response of the two crops. However, not every site showed a response to fungicide. Five of the Southwestern Ontario sites had a large response to fungicide, averaging 10 bu/ac, while the other four 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 be the more southerly (hotter) sites. It is possible that high temperatures limited grain fill at these sites, making the fungicide application of less value. Growers need to assess fungicide use based on disease levels and growing conditions within each field each year.

Table 2: Response of Barley to Fungicide

N Rate	5 Responsive Sites		4 Non Responsive Sites	
	Fungicide	No Fungicide	Fungicide	No Fungicide
0	77.7	68.0	63.1	58.3
30	86.3	79.0	83.8	85.7
60	93.4	82.8	92.7	89.2
90	99.1	86.2	93.9	92.6
120	100.5	90.7	98.1	94.3

The average protein results are summarized in table 3. Nine sites had very little change in protein across all treatments (<0.6%), while one site had a 2% increase in protein from 0 N to 120 N (protein data includes Petrolia 2015 site, no fungicide data). 2014 data shows a slight upward trend in protein with added N, but 2015 data was totally flat. For producers feeding their own barley, any increase in protein would bring added value, as less protein supplement would be required. For cash crop growers, there is no protein premium for barley, so any increase would be of no added value. There is no difference in protein response with or without fungicide.

Table 3: Barley Protein (%)

Treatment	With Fungicide		Trial Average
	2014	2015	
0 N	11.3	11.2	**11.2**
30 N	11.4	11.2	**11.3**
60 N	11.7	11.1	**11.4**
90 N	11.8	11.1	**11.5**
120 N	12.0	11.2	**11.6**
Treatment	**Without Fungicide**		**Trial Average**
	2014	**2015**	
0 N	11.4	11.4	**11.4**
30 N	11.5	11.4	**11.5**
60 N	11.6	11.2	**11.4**
90 N	11.9	11.4	**11.6**
120 N	11.8	11.3	**11.5**

No difference in test weight or 1000 Kernel weight is evident (data not shown). Post harvest nitrate results will be available after the samples are analyzed.

Table 4: Yield Results from Winchester and New Liskeard (bu/ac)

Treatment	With Fungicide		Without Fungicide	
	Winchester	New Liskeard	Winchester	New Liskeard
0 N	81.3	69.7	69.7	49.5
60 N	93.5	94.0	83.7	80.8
90 N	94.7	112.1	89.4	93.6
120 N	95.6	118.5	82.6	104.3
150 N	90.7	127.6	82.5	109.8

The N response curve from Winchester is shown in Figure 2. There is a strong response to fungicide at Winchester but little difference between the N response curves with and without N. Based on this very limited data and the assumptions used above (barley @ $3.96/bu and N @ $0.55/lb) MER-N was reached with 52lbs N/ac when fungicide was applied and 57lbs N/ac without fungicide. These MER-N rates are in line with current Agronomy Guide recommendations (~55lbs N/ac vs 63 lbs), but are significantly below Southwestern Ontario N response levels (55 lbs N/ac vs 80 lbs N/ac). Interestingly, corn N response also shows lower N requirements in Eastern Ontario than in Southwestern Ontario. N recommendations for the two regions may have to separate in barley, as they have done in corn. Previous crop was red clover in 2015: that may also be skewing the N response, and definitely more data is needed to determine actual MER-N. No protein data was available from Winchester.

The N response curve from New Liskeard is shown in Figure 3. Extremely high yields were achieved at New Liskeard, and unlike the data from both Southwestern Ontario

and Winchester, the data indicates that a synergy may exist between N and fungicide. There is a very strong response to N at the New Liskeard location. Based on these results, a 180 N treatment should have been included, as yields are only beginning to plateau: but this is based on data from only 1 location in the region over 2 years (2 site years). A field scale site in this region did not show this tremendous response to nitrogen, but no fungicides were applied at that site (Table 5). Based on this limited data and using the same assumptions as before (barley @$3.96/bu and N @ $0.55/lb) MER-N occurred with 127 N when fungicide was applied and 100 N without fungicide.

Figure 2: Winchester Spring Barley N Response

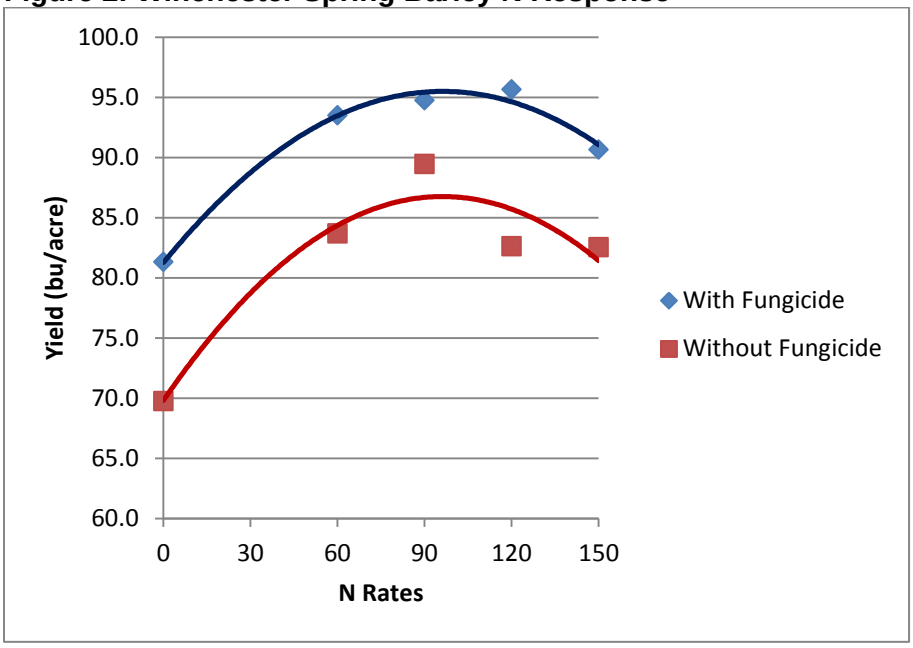
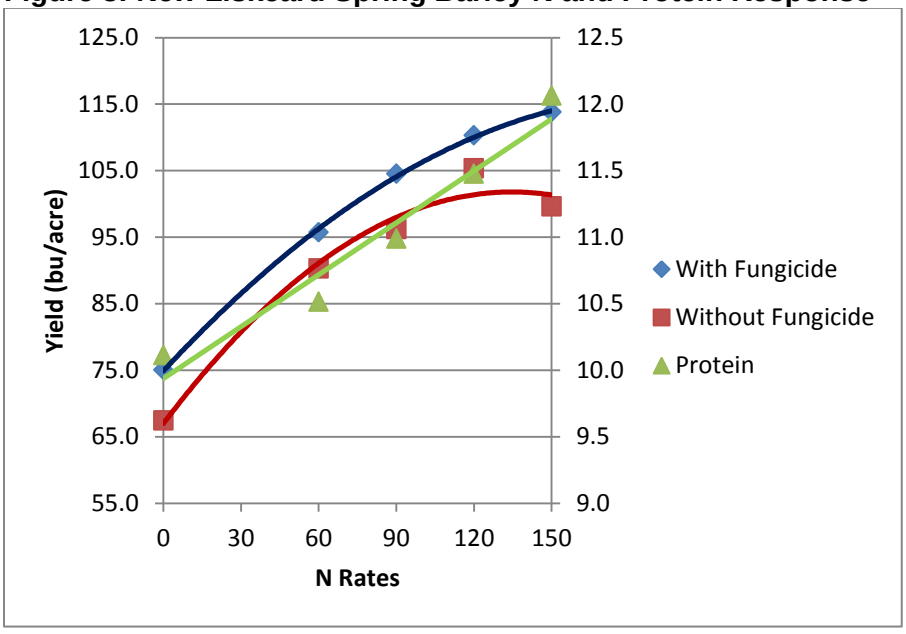


Figure 3: New Liskeard Spring Barley N and Protein Response



There was little difference in protein response between the fungicide and no fungicide treatments, but there was a tremendous increase in protein with nitrogen at this site.

These are much higher MER-N values, and much higher yields than in the other two regions. In winter wheat, the NXF synergy was not apparent until genetics were developed with high yield potential that could take advantage of high N, and fungicide was needed to maintain plant health, such that the crop could utilize the added N. It may be that the New Liskeard region simply has high enough yield potential to show the synergy, while the other 2 regions do not. Certainly, the MER-N's found far exceed the recommendations in the Agronomy Guide (100 to 127 lbs N/ac vs 63 lbs N/ac). More data needs to be generated before any conclusions are drawn, but these finding certainly indicate the need to reassess barley N rates in the New Liskeard region.

Three additional sites were conducted where fungicide was not applied. These sites cannot be included in the average dataset, but given the lack of differential response with and without fungicides, the data are of value and reported in Table 5. If all data is used in the final analysis, regardless of fungicide application, this data will be included.

Table 5: Additional N Rate Results Without Fungicide

Year	location	0 N	30 N	60 N	90 N	120 N	150 N
2013	Petrolia	48.3	54.5	59.1	56.0	57.9	-
2015	Petrolia	86.4	95.5	103.5	103.7	103.6	-
2015	New Liskeard	56.0	59.8	68.3	61.5	69.3	67.2

Summary:

There does not appear to be any NXF synergy in spring barley in Southwestern or Eastern Ontario. N response curves with and without N are nearly identical. However, the results suggest that a NXF synergy may exist in the New Liskeard region. Response to fungicide was economic on average, although 3 sites in Southwestern Ontario fell below economic response. The lack of response to fungicide at these 3 sites may be due to high temperatures. Fungicide response was highly economic at 5 of the 9 sites in Southwestern Ontario, as well as in Eastern Ontario and New Liskeard.

Based on the average data 80 N with fungicide was the most economical treatment in Southwestern Ontario, while 50 N with fungicide had the highest rate of return at Winchester (Eastern Ontario). New Liskeard had the highest response to N with 127 N and fungicide being the most economical treatment. MER-N was significantly different between the 2 years: more data is needed before any final conclusions on nitrogen rate are drawn. However, over both years in the Southwestern and New Liskeard regions, response to N was significantly greater than recommendations in the Agronomy Guide, Publication 811. These recommendations do need to be reassessed further. Growing conditions were excellent for spring cereals in both 2014 and 2015, with 2014 being very late planted, while 2015 plantings were completed on time. It will be interesting to see what results are obtained in 2016.

Next Steps:

This is the second year for this project. Research will be gathered and continued for one more year, to finish a third year of this study, if funding can be found to continue (unfortunately funding available ended in 2015). 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.

Knowledge Transfer: Data collected from this trial has and will be used in articles, presentations, in podcasts and available on the web (www.realagriculture.com, www.ontariosoilcrop.org). To date, numerous presentations have been given using parts of this data across Ontario, as well as in Manitoba, Saskatchewan, and Alberta.

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Location of Project Final Report:

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