Oat Nitrogen Response Curve

Purpose:

This trial will validate and/or update the current Provincial (Ontario) nitrogen (N) response recommendations for oats, with and without fungicides where appropriate. Recent research has shown synergy between fungicide and nitrogen in winter wheat (Hooker et al, 2015). This trial investigates if any similar synergy exists in oat, in Northern and Eastern Ontario.

The Maximum Economic Rate of Nitrogen (MER-N) will be calculated from data generated by nitrogen response trials. This information will be used to support or adjust current N recommendations in the OMAFRA Agronomy Guide, Publication 811. In 2006, existing genetic resistance to crown rust in oat was overcome by the development of a new crown rust strain in Southwestern Ontario. This strain spread rapidly to Eastern Ontario, but has not yet reached Northern Ontario. Crown rust in oat is a particularly devastating disease. Due to the lack of genetic resistance to crown rust in any current varieties, the trials were only conducted under a fungicide spray regime in southwestern Ontario. Data generated where crown rust develops would not measure the response to N, thus there was no purpose in N response trials without fungicide in this region.

Methods:

Field scale trials were established at 2 sites in 2014, and 5 sites in 2015 across southern Ontario. Plot design was field scale, two replicate, randomized N rates at each site. Small plot, 4 replicate trials were also conducted at the Winchester (Eastern Ontario) and New Liskeard (Northern Ontario) Research Stations.

Other than the nitrogen rate and fungicide, all variables at all locations were consistent across all treatments, following the normal production practices of the producer. Fungicides were used at all southern Ontario sites. The sites at Winchester and New Liskeard were conducted with and without fungicide.

Treatments, Southwestern Ontario

1. Check (No nitrogen applied) with fungicide
2. 30 lbs Nitrogen (30N) with fungicide
3. 60 lbs Nitrogen (60N) with fungicide
4. 90 lbs Nitrogen (90N) with fungicide

Treatments, New Liskeard and Winchester

1. Check (No nitrogen applied) with fungicide
2. 60 lbs Nitrogen (60N) with fungicide
3. 90 lbs Nitrogen (90N) with fungicide
4. 120 lbs Nitrogen (120N) with fungicide
5. 150 lbs Nitrogen (150N) with fungicide

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

Data collected from these sites included yield, moisture, test weight, 1000 kernel weight, protein, lodging, and post harvest nitrate levels. Post-harvest soil nitrate samples were collected to observe environmental impact with increased nitrogen application.

Results:

Plantings were extremely late in 2014 (as late as May 28th), due to a wet May. These conditions resulted in a significant reduction in the number of sites able to be completed in 2014 in Southwestern Ontario. 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 the late plantings in 2014. This allowed for excellent yields in both years.

The average yield results are summarized for Southwestern Ontario in Table 1: Winchester and New Liskeard are summarized in Table 3.

Table 1: Oat N Response, Southwestern Ontario (bu/ac)

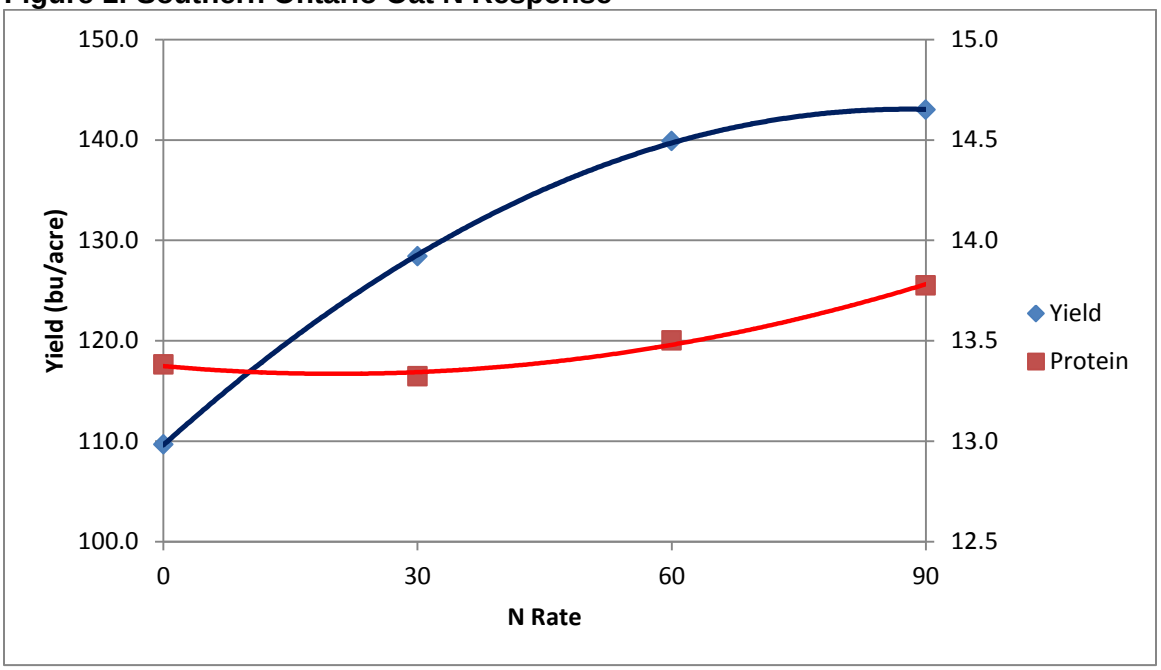
Year	Location	0 N	30 N	60 N	90 N
2014	Conestogo	77.3	118.6	136	139.2
2014	Paisley	-	100.9	112.6	113.7
2015	Ilderton	110.6	122.4	145.3	144.0
2015	Lindsey	88.2	102.4	113.2	119.1
2015	Shelburne	141.2	149.0	150.2	142.8
2015	Strathroy	84.5	118.0	142.5	150.5
2015	Conestogo	156.3	160.0	151.9	162.3
Trial Average		**109.7**	**128.4**	**139.9**	**143.0**

Economic Analysis: Using urea at $557/tonne ($0.55/lb of actual N), and oats at $3.00/bushel (current value January 2016), 5.5 bushels of oats are required to equal the cost of 30lbs of N ($0.55/lb*30lbs= $16.50/$3.00/bu= 5.5 bushels). For New Liskeard and Winchester, the addition of a fungicide application increases costs by $18.00/ac. In order to cover the cost of the fungicide, an additional increase of 6.0 bushels/acre ($18.00/$3.00)=6 bu) is needed.

Based on the above data, 60 N has the highest economic return of all the treatments in Southwestern Ontario. 5 of the 7 sites had the highest economic response with the 60N treatment. Based on the calculated trend line MER-N was reached at 67lbs N/ac. These N responses are well above recommendations in the OMAFRA Agronomy Guide, Publication 811 (60 lbs N/ac vs 32 lbs N/ac). This is based on limited data: more

research will need to be done before any recommendations or changes in Agronomy Guide recommendations can be made. However, it does show the need for a reassessment of Agronomy Guide N recommendations.

Figure 1: Southern Ontario Oat N Response



The protein results are summarized in table 2. While there is little total change in the protein levels, the response noted is quite interesting. This is a textbook yield/protein response to nitrogen. Yield goes up dramatically with the first added nitrogen, so much so that the protein actually drops slightly (dilution). As more nitrogen is added, the yield response is less, and more of the N goes into added protein, increasing the protein level. This is an interesting outcome in these trials.

Unfortunately, growers are not paid for protein, so any increase in protein does not add to the growers' returns. In the few cases where a grower is feeding the oat crop to their own livestock, increased protein may have value in reducing the amount of protein that must be added to balance the ration.

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

The N response curve from Winchester is shown in Figure 2. There is a major response to fungicide at Winchester, but response to N was variable, and very low. Previous crop was red clover in 2015 at this location, and is the likely cause of the lack of response to N at this site. Crown rust was an issue at Winchester in 2015, with yield results showing just how devastating this disease can be. Lodging was a major problem with high N rates. It is unfortunate that a 30 N treatment was not included: with fungicide applied there appears to be the possibility of response up to 60 N, even with the red clover, before lodging became the overriding factor. If plant growth regulators (PGR's) were applied to prevent lodging, response to nitrogen may have continued at higher N rates.

Based on very limited data, it appears we are approaching maximum oat yields with 60 N, following red clover, and without the use of PGR's. Again, this would be much higher N rate application than currently recommended in the Agronomy Guide (60 lbs N/ac vs 32 lbs N/ac). No protein data was available from Winchester.

Table 2: Protein Response to Nitrogen

Year	Location	0 N	30 N	60 N	90 N
2014	Conestogo	11.4	11.3	11.8	12.1
2014	Paisley	-	10.9	11.0	11.0
2015	Ilderton	14.0	14.3	14.3	14.9
2015	Lindsey	14.2	14.1	14.4	14.6
2015	Shelburne	13.4	13.3	13.4	13.4
2015	Strathroy	14.0	13.7	13.7	14.0
2015	Conestogo	-	-	-	-
Trial Average		**13.4**	**13.3**	**13.5**	**13.8**

Table 3: Winchester and New Liskeard Yield Data (bu/ac)

Treatment	With Fungicide		Without Fungicide	
	Winchester	New Liskeard	Winchester	New Liskeard
0 N	87.8	96.1	59.7	101.6
60 N	92.8	121.5	43.0	118.9
90 N	85.5	121.2	40.4	130.4
120 N	75.1	129.3	55.9	123.5
150 N	89.6	127.5	42.8	122.6

The N response curves from New Liskeard are shown in Figure 3. At New Liskeard there does appear to be a shift in the N response curves with and without fungicide. However, there was also a significant year to year variation in response to N: in 2015, MER-N was 100 lbs N/ac with fungicides. When 2014 and 2015 are averaged, MER-N drops to 82 lbs N/ac. On average, with fungicide applied MER-N was reached with 82lbs N/ac while without fungicide MER-N was 67lbs N/ac. These finding indicate both the potential of a synergy between NXF, and also that N response is much higher than currently recommended in the Agronomy Guide, Publication 811 (67 to 82 lbs N/ac vs 50 lbsN/ac). There was no difference in protein response between the fungicide and no fungicide treatments.

Summary:

These results suggest that 60 N is the most economic N rate in southern Ontario and at Winchester, while lodging continues to be a major issue with high N applications. The Winchester data shows how critical it is to protect the flag leaf with a fungicide in areas

Figure 2: Winchester Oat Nitrogen Response

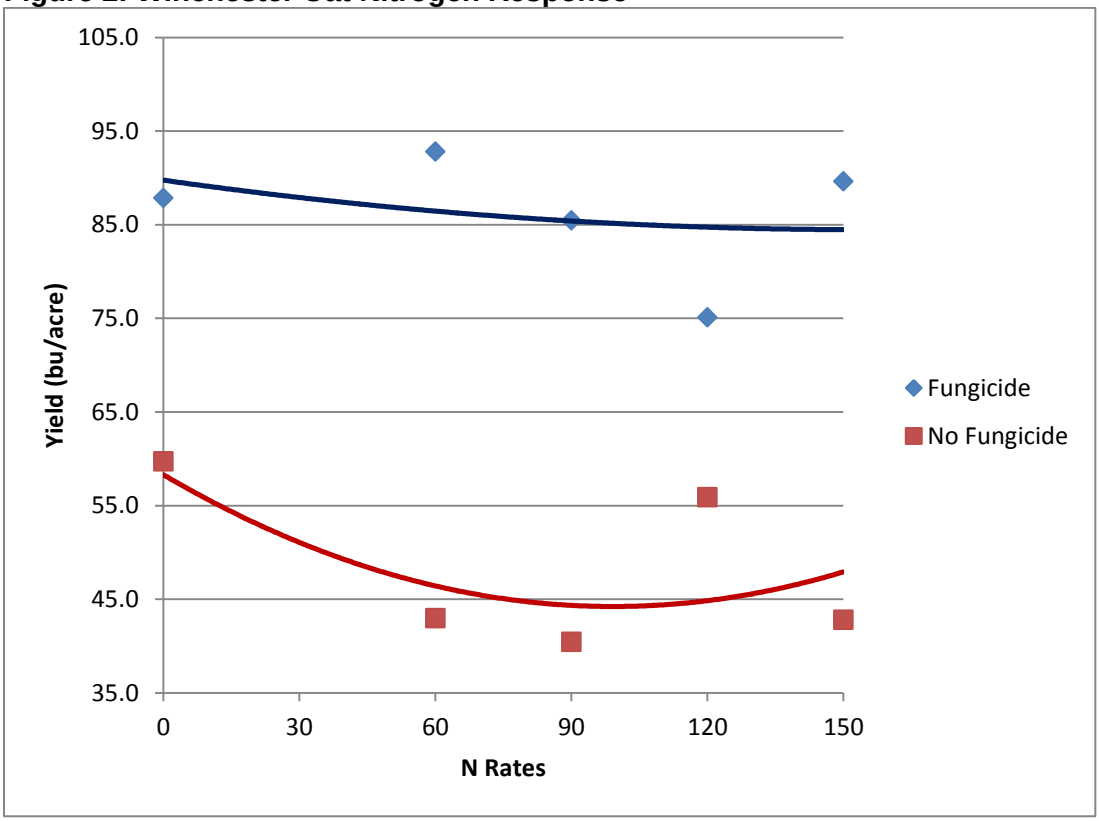
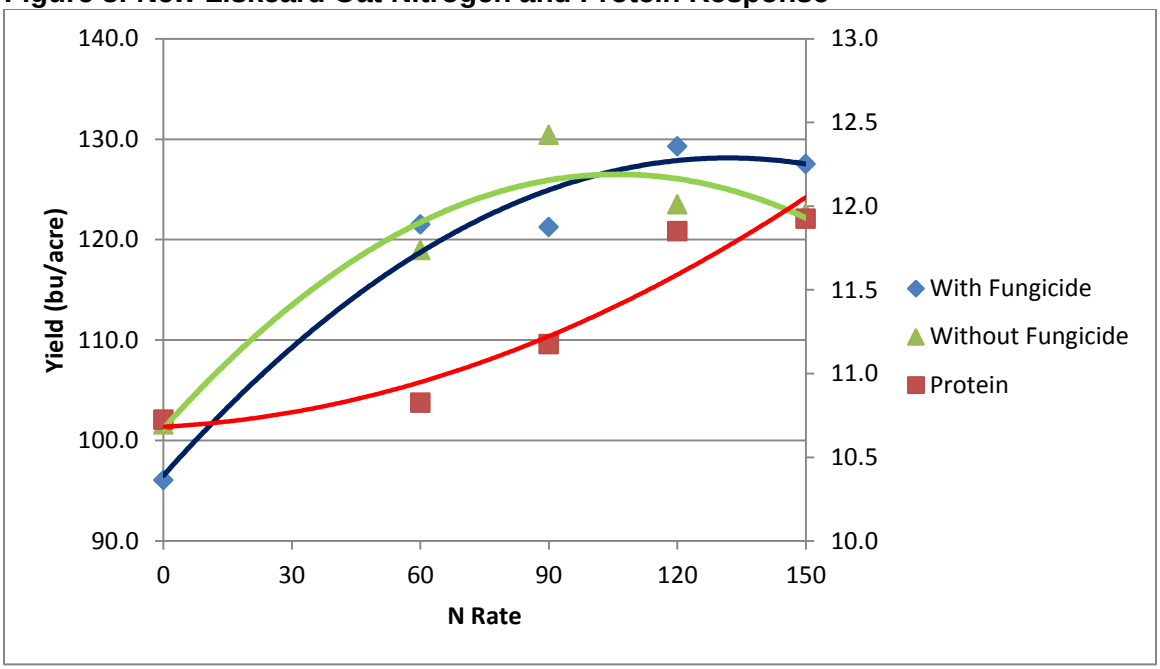


Figure 3: New Liskeard Oat Nitrogen and Protein Response



where crown rust is a concern. In New Liskeard region fungicides seem to have less impact on yield, but differential response may be showing (based on very limited data). The New Liskeard data supports higher N rates in Northern Ontario, reaching MER-N with 80 N with fungicide and 65 N without fungicide. In all regions, N response appears to be greater than current recommendations in the Agronomy Guide. More data is needed to support these conclusions on nitrogen response. Great growing conditions existed for spring cereals in 2014 and 2015: it will be interesting to see if similar results are obtained in the third and final year of this study.

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:

Peter Johnson