Winter Wheat Nitrogen Response

(Interim Report)

Purpose:

Current nitrogen recommendations are based on research conducted 20 years ago. Yield potential has changed significantly since then through changes in production practices including better genetics (varieties), fungicides, and growth regulators. As producers pursue higher wheat yields using these improved management techniques, current N recommendations may not be sufficient. This study evaluates the Maximum Economic Rate of Nitrogen (MER-N) under current management regimes.

Multiple nitrogen rates were applied to generate nitrogen response curves and determine MER-N. Additional treatments were included at selected sites to evaluate the impact of fall nitrogen on wheat yield and economic return. Post harvest soil nitrate tests were collected to determine if higher N rates increased fall residual soil-N, which could be an environmental concern if not managed properly.

Methods:

Two replicate, randomized field scale trials were established in 2010 (3 sites), 2011 (9 sites) and 2012 (14 sites). Except for nitrogen rate, all other variables at each location were held constant following the producer's normal production practices. At 18 of the 26 sites, spring nitrogen was applied by broadcasting urea with a Valmar airflow applicator. The remaining 8 sites had 28% UAN applied with the cooperators equipment. Treatments are listed below although not all the treatments were included at every site.

1. Check (No Nitrogen applied)
2. 60N spring applied[1]
3. 90N spring applied
4. 120N spring applied
5. 150N spring applied
6. 30N fall + 90N spring applied
7. 30N fall + 120N spring applied

[1]Rates are lbs./ac actual N

Treatment 6 and 7 were included at 5 sites in 2010 and 9 sites in 2011. 30 pounds of actual N was applied in the fall using the Valmar airflow. In 2010 urea fertilizer was broadcast between Nov - 11th while in 2011 ammonium nitrate was applied between Oct 10th and Nov 7th. Harvest measurements included yield, moisture, test weight, 1000 kernel weights, and protein. Soil nitrate samples were collected post harvest to examine the environmental implications of increased nitrogen application.

Results:

Yields increased dramatically with the addition of N (Table 1). There was a whopping 23 bushel gain from 0 N to 60 N. Additional N continued to increase yield: 6.7 bu/ac gain from 60 N to 90 N, 6.1 bu/ac from 90 N to 120 N. An average 2.7 bu/ac was gained from 120 N to 150 N. Further analysis reveals that only 4 of 26 sites reached MER-N at 90 N

and surprisingly over 60% of the sites had MER-N of 150 N or greater (no higher rates were applied, thus calculation of MER-N at these sites is difficult).

Table 1: Average Wheat Yields (22 Locations)

Treatment	2010	2011	2012	Trial Average	Gain Over Check
0N	67.2	52.8	53.5	56.2	
60N	85.5	74.2	78.7	79.2	+23.0
90N	91.0	81.4	83.4	85.9	+29.7
120N	95.7	87.6	90.9	92.0	+35.8
150N	94.9	89.5	94.1	94.7	+38.5

Economic analysis: Using urea at $600/tonne ($0.59/pound of actual N) and soft red wheat at $6.34/bushel, 2.8 bushels of wheat are required to cover the cost of 30 units of N ($0.59/lb*30lbs= $17.75/$6.34/bushel= 2.8 bushels). At these values there is a clear financial return, on average, up to 120 N, with 150 N breaking even. Further analysis by location reveals that 10 of the 26 sites had a significant financial gain at 150 N. 5 other locations showed a slight financial gain to 150 N but the additional returns were not significant (less than $7/acre).

Only 5 sites had a maximum economic nitrogen rate below 120 N. It is interesting to note that of these 5 sites, 4 of them did not receive any fungicides. Table 2 contains a comparison of the sites with fungicide versus sites without. The sites without fungicide actually reached a maximum yield with 120 N and only saw a slight economic return adding more than 90 N. The sites with fungicide tell a completely different story. There was a substantial yield increase of 7.1 bushels between 90 and 120 N. This supports recent research that has shown an interaction between nitrogen and fungicides (SMART trials). An additional 4.1 bushels was gained by increasing to 150 N.

Table 2: Breakdown of Yields with and without Fungicide

Treatment	19 sites Fungicide	Incremental Gain	6 sites no Fungicide	Incremental Gain
60	77.0		82.0	
90	86.2	9.2	86.2	4.2
120	93.3	7.1	89.8	3.6
150	97.4	4.1	89.0	-0.8

Four of the six sites without fungicide reached MER-N at 90 N. The other two sites achieved MER-N at 120 N. Only 1 of the 20 sites with fungicide (Thamesville 2010, Table 3) required less than 120 N to reach MER-N. This site had biosolids applied, reached a maximum yield at 60 N, and MER-N was 0. Clearly the biosolids supplied sufficient N. This site indicated the potential negative impact excess N can have: lodging in the 150 N strips resulted in a loss of 6.2 bushels/acre.

Table 3: Biosolid Implications of Wheat Yield (bu/ac)

Location	0N	60N	90N	120N	150N
Thamesville	92.1	95.1	95.1	95.1	88.9

Wheat yield responses from fall applied N are summarized in Table 4. Fall N had no significant impact on yield, moisture, test weight, 1000 kernel weight, or protein. There was a 2.6 bu/ac advantage from 30 N in the fall with 90 N in the spring, versus 90 N spring only. However, when the full 120 N is spring applied, there is a 6.8 bu/ac gain over 90 N only. Calculating this, it quickly becomes apparent that fall N does not pay. Even less gain was seen with the 30+120 N treatment. Add to this that fall nitrogen applications are a potential environmental concern, and clearly fall N should not be recommended by anyone in the Province of Ontario!

Table 4: Fall N Wheat Yields (13 Locations)

Treatment	2011	2012	Trial Average	Gain Over 90N
90N	81.4	84.6	83.4	
120N	86.4	91.9	90.2	6.8
150N	88.9	95.2	93.0	9.7
30N Fall+90N Spring	82.0	88.4	85.9	2.6
30N Fall+ 120N Spring	86.5	92.6	90.3	6.9

As N rates increased, protein levels in the grain increased. Differences in protein levels between 0 and 60 N were minimal to even negative, as yield increase were so large that all additional N went to yield, rather than protein. As N rates were increased further, protein levels consistently increased by 0.4% for every additional 30 units of N. Protein levels increased by 1.2% from 60 to 150 N. The impact of this increase is depended on the market being targeted. Some domestic users prefer low protein soft wheat, while other markets and export buyers prefer high protein. In general, increased protein levels would fit the majority of market opportunities somewhat better, but there is no price premium associated with this increase.

Summary:

The results from this trial show a great opportunity to increase wheat yields with additional N. The data strongly supports recent research that has proven an interaction between N and fungicides. If no fungicide is applied, responses to additional N are minimal and fit the older N rate recommendations very well. If fungicides are applied responses to N become much more significant, and new N recommendations are in order. Concern over lodging, originally thought to be a major issue at high N rates, has failed to materialize as a major problem. However, negative impacts of lodging due to excess N were shown at the Thamesville location. Growers are warned to proceed with caution as they increase N rates. Where lodging has not been an issue in the past several years it is important that growers place 2 test strips of an additional 30lbs N/ac to see if these results are repeated on their farm. Fall N has proved unsuccessful based on

3 years of data. Responses were slightly better in 2012 than 2011 following a delayed planting season in the fall of 2011 but were still insignificant.

Next Steps:

This project will continue in 2013. Fall nitrogen strips have been applied at 6 sites through Huron, Perth, Lambton, Middlesex, Elgin, and Brant counties. Spring nitrogen rates ranging from 0lbs to 180lbs will be applied at these 6 sites plus a number of additional “spring only” locations.

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