SMART Wheat: “Managing Wheat Intensively to Assess Yield Potential”

Purpose:

Many trials have been done investigating the impact of single factors on winter wheat yields. However, information from the United Kingdom and elsewhere indicate a strong interaction between nitrogen and fungicide inputs. Studies of these as independent variables may overlook these interactions. This project was undertaken to assess if an interaction exists in Ontario, as well as to assess what the maximum yield potential of wheat might be under Ontario environmental conditions, and what the economic implications would be. Environmental impacts of higher nitrogen applications were assessed.

Methods:

Two replicate field scale trials were initiated on 52 farms in southwestern Ontario across a wide geographic distribution over the crop years 2008-2010 (20 sites 2008, 16 sites 2009, 16 sites 2010). Predominantly fields planted to soft red winter wheat were considered as soft red wheat is considered to have the highest yield potential. No hard red winter wheat fields were included. Treatments were applied in the spring of each year, and included a check (~90 lbs actual N, no fungicides), a fungicide treatment (~90 lbs actual N, a weed control fungicide and a head fungicide applied), and a high N treatment (~150 lbs actual N, both fungicides applied, and often a plant growth regulator to prevent lodging). Leaf disease ratings were taken on a weekly basis, head disease ratings were taken bi-weekly following heading, and lodging scores taken prior to harvest. Harvest measurements included yield, moisture, test weight, thousand kernel weight (TKW), protein, and fusarium damaged kernel (FDK) scores. Soil nitrate samples were collected and analyzed post harvest.

Results:

Yields increased dramatically with the addition of extra nitrogen with the fungicide applications. Response to fungicide only was much more modest, in line with what previous studies had shown.

Standability was surprisingly good at most locations over the three years of the trial, even high rate nitrogen strips without a growth regulator. Leaf disease ratings remained relatively low in most years across locations, although check treatments (untreated) did show higher disease levels. Head disease ratings ranged from low to moderate across locations over years. Moisture was not significantly different across treatments.

Table 1-3 summarize yield data for 2008-2010. There was an average yield increase of 7.3 bu/ac over all trials for the fungicide applications alone. This is consistent with fungicide data collected over previous years. This level of yield increase would not be sufficient to cover the costs associated with two fungicide applications.

There was an amazing 20.4 bu/ac average yield increase over years with the addition of higher N rates coupled with the fungicide. This is above what would be expected from a simple additive effect, and is very profitable (return double the cost). Selected data from the small plot component of this research effort is presented in Table 5, which support this field scale result. There is only a 6.4 bu/ac yield increase between 90 N and 150 N without fungicides, but this yield gain increases to 11.4 bu/ac when 150 N in applied.

Table 4 shows selected sites from the 2010 season. This shows the level of variability that can exist. The Rodney location was a very sandy site, where no rain was received from May 20th to July 10th. In this location, there was a yield penalty to added nitrogen, likely due to the lack of rainfall, higher nitrogen rates causing more canopy, which in turn created more water demand. This is the only location of the 52 sites over 3 years which showed a negative response to higher N, thus the risk is low of this occurring. The Melbourne location shows tremendous response to fungicide with no response to added N, however in previous years this site showed excellent response to added N. The Forest location was the opposite to the Melbourne location, with no response to fungicide but significant response to added N. The St. Thomas location was a more average location. These selected data show that profitable yield increases are not a guarantee at every site every year, but the majority of the sites (51 out of 52) responded positively to the added inputs.

The inclusion of a growth regulator was a part of these plots. In most cases this was not a significant impact. However, the Arva location in 2009 (data not shown), experienced a significant negative impact of the growth regulator/herbicide/fungicide combination applied to the high nitrogen strip. The injury symptomology was extremely short, green plants that did not mature normally, which is consistent with cycocel injury. Despite this injury, there was only a 3 bu/ac yield penalty to this treatment. Growth regulators require further investigation in this regard.

Table 1: 2008 Average Wheat Yields

Treatment	Yield (bu/ac)	Gain
90 N	91.3	
90 N plus fungicide	98.9	+7.6
150 N plus fungicide	112.6	+21.3

Table 2: 2009 Average Wheat Yields

Treatment	Yield (bu/ac)	Gain
90 N	86.0	
90 N plus fungicide	92.4	+6.4
150 N plus fungicide	107.2	+21.2

Table 3: 2010 Average Wheat Yields

Treatment	Yield (bu/ac)	Gain
90 N	91.3	
90 N plus fungicide	99.2	+7.9
150 N plus fungicide	109.7	+18.4

Table 4: Selected 2010 Yield Data

Location	Treatment Yield (bu/ac)			
	90 N	**90 Fung**	**120 Fung**	**150 Fung**
Rodney	82	90	85	80
Melbourne	71	92	93	93
Forest	112	112	122	129
St Thomas	86	90	103	115
Average	**91**	**99**	**105**	**109**

Table 5: Average Small Plot Wheat Yields

	Yield (bu/ac)		
	90N	**120N**	**150N**
No fungicide	93.0	96.7	99.4
T3 fungicide	99.9	105.1	108.6
T1 + T3 fungicide	99.7	106.2	111.1

Higher nitrogen rates increase average protein levels by 0.8% in 2009 and 2010, and 0.5% in 2008. This outcome is anticipated, and well supported in research literature. The impact of this increased protein is less clear. Tests are currently underway to determine the functionality of this increased protein. Domestic users generally prefer low protein soft wheat, while export buyers prefer high protein. 50% of our SRW currently is exported, but the domestic market is the most consistent and important to supply. Whether this added protein is a benefit or detriment remains open to debate.

There is a small average increase in test weight with fungicides and an additional small increase from added nitrogen. However, these results were quite variable. On years with low test weight issues, these increases could hypothetically increase the grade, but variability in the data makes true outcomes impossible to predict.

There was a significant increase in TKW results when fungicides were applied. Higher nitrogen rates had no effect. TKW is a significant factor in the seed industry, which shows the value of fungicides when producing seed. There is no other economic impact of increased TKW.

Summary:

These results show an exciting opportunity to dramatically increase wheat yields in Ontario. The inclusion of higher N rates with fungicide applications will significantly increase yields at a profitable level to the grower. Lodging concerns are real with this higher level of inputs, and growers need to proceed cautiously. Where lodging has not been an issue over the past several years, it is essential that growers try strips of an additional 30 lbs N/ac with a fungicide, to see if these results are repeated on their own farm. Protein levels and thousand kernel weights are increased. Baking impacts of higher protein levels is under investigation.

Next Steps:

This project is complete. SMART II is underway, looking at additional inputs of higher seeding rates and split N applications. Anyone interested in cooperating should contact Peter Johnson at peter.johnson@ontario.ca.

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Location of Project Final Report:

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