

Improving Quality Standards and Economics of Winter Wheat in Ontario through Innovative Management Strategies of Nitrogen Fertilizer

(Interim Report)

Purpose:

Approximately 85% of the bread wheat processed in Ontario is hard red spring wheat sourced from Western Canada. If Ontario growers were able to produce a high protein bread wheat suitable for the milling industry, it would give producers a premium of up to \$50/tonne and inject up to \$65 million per year into the farming sector. New technologies are available which may be used to improve the bread baking quality of the Ontario wheat crop. This is an ongoing project that will explore four separate, but potentially complimentary, opportunities for improving the quality of hard red wheat.

This project, to date, has generated data on some early and relatively late split nitrogen applications towards the development of consistently higher concentrations of protein. Optical sensing technologies were introduced and deployed toward the development of strategies to predict optimum N requirements of the wheat crop, for not only to maximize grain yield, but to increase quality in the seed harvested by fine-tuning N rates around heading. Early results indicate a potential for fine-tuning N rates for improved economics and wheat quality using sensors; these preliminary datasets will be used later in the overall project to fine-tune N rates and timing strategies in hard red wheat.

Methods:

Small plot trials were planted in the fall of 2007 to investigate the effect of genetics on quality through combinations of N rates and timing of split applications. A repeat of these trials will be planted in the fall of 2008. Early results show an increase in protein with N rates up to 120 kg/ha in early spring applications, but more importantly, a further increase of between 0.5 to 1.0% with 30 kg/ha of N streamed on as 28% several days after heading. The highest protein concentrations were achieved more consistently with the late application of 28% after heading. The data also indicates that the newest wheat genetics responds to higher N rates than current older wheat varieties. Once this has been confirmed with additional on-farm research later in the study, protein concentrations may be higher and more consistent with a split-application of N that would be directed more toward building protein than making up for lost yield because of under-application of nitrogen in early spring.

Several farm fields that were planted into hard red wheat in the fall of 2007 have been designated for nitrogen treatments and sensor measurements in the spring of 2008. The data collected to date has been added to the Wheat Nitrogen Database, towards the development of a wheat nitrogen calculator, similar to the Corn N Calculator. Progress to date will have a significant impact on the balance of the project, not only with data, but with through a refinement of protocols in future experiments in the overall project. Preliminary results indicate that this project has the potential to have a significant economic and environmental benefit to Ontario Agri-Food production. Increasing product quality through more efficient nitrogen management will have a significant impact on all aspects of the wheat industry in Ontario.

Results:

Trials of variety x nitrogen management treatment were established at two locations and proposed treatments applied. Preliminary data are presented, but data on agronomic traits, diseases, yield, protein, and baking quality are currently being analyzed further. Sites at Nairn and Palmerston were established by collaborators Hyland and C&M Seeds (Figure 1). The standard varieties Harvard and Warthog were included in all trials, along with new breeding lines from each company.

In strips where 90 kg N/ha was applied early, an additional N application after heading at 30 kg N/ha increased protein concentrations from 11.4 to 11.9% at Palmerston, and from 11.7 to 12.5% at Nairn (Figures 3 and 4). Where 120 kg N/ha was applied early, protein increased from 12.0 to 12.2% in Palmerston and from 12.7 to 13.6% at Nairn. The addition of late N increased grain yields up to 0.30 t/ha.

Grain yields of Harvard and Warthog were most economical with 90 (Hyland) and 120 (C&M) kg/ha of N at an early spring application, whereas the two newest Hyland varieties responded economically to the highest N rate of 120 kg/ha. The addition of 30 kg/ha of N at heading did not reduce yield in any of the varieties despite some burn on the flag leaf and heads from the 28% solution (Figure 2). Selected treatment combinations will be processed for the determination of milling and baking quality at Hayhoe Flour Mills this winter. The trials for 2008 have been seeded.

Research was initiated using the GreenSeeker in 2006, and continued in 2007, toward the major Project goal of incorporating new technologies and N management techniques for improving the quality of hard red wheat in Ontario. The main project was to commence in the fall of 2006 for two growing seasons (2007 and 2008). Pilot work was performed in the 2006 crop on a small scale as a step toward more extensive plans for the fall of 2006 and in preparation for 2007 (Figures 5 and 6); however, only a small acreage of winter wheat was planted in Ontario in the fall of 2006 due to wet weather, and therefore, the small pilot studies continued for 2007, mainly in preparation for 2008 and 2009.

Two fields were acquired during each of 2006 and 2007 where N rates and their timing were investigated on wheat yield and protein concentrations. N was applied at various rates during March or April for the early application; more N was applied in a second application around flowering. There was an economical response to an early N application up to approximately 90 kg N ha⁻¹. In 2006, protein concentrations did not respond to late application of N in the one field, while samples still need to be analyzed for protein the second field. We expected little protein response from the first field because of extremely high yields and the relatively low rate of N in the second application at flowering, but we expect higher protein concentrations in the second field because of lower yields compared to the other field. Protein concentrations need to be determined for the two farm-scale trials in 2007.

Summary:

Most of the data collected have yet to be analyzed in later stages of the project, but early results and comparisons indicate useful trends for practical application for Ontario conditions. Our data indicate that algorithms developed for the N predictions in the United States will need to be calibrated for Ontario conditions. These first data will be incorporated with subsequent datasets for calibration, which holds promise to fine-tune N requirements for hard red winter wheat and for attaining higher and more consistent protein concentrations at harvest. Currently, no such recommendations exist in Ontario.

Figure 1. Overview of a small plot N trial.



Figure 2. Leaf burn caused by 28% water solution.



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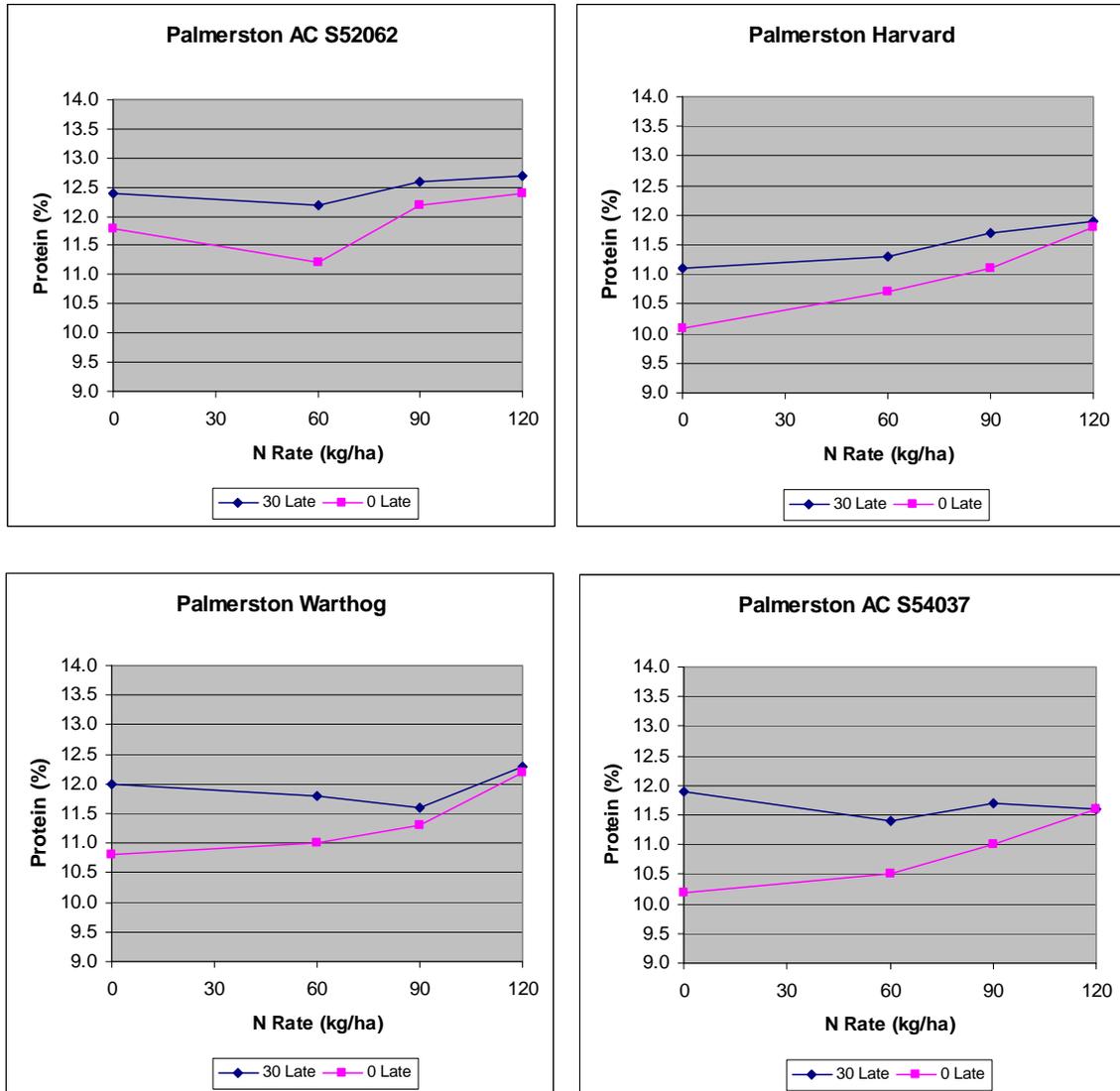


Figure 3. Protein response to N rates applied early (x-axis) with the split applied late (30 Late) compared to no N applied late (0 Late) in four hard red wheat varieties in Palmerston, 2007.

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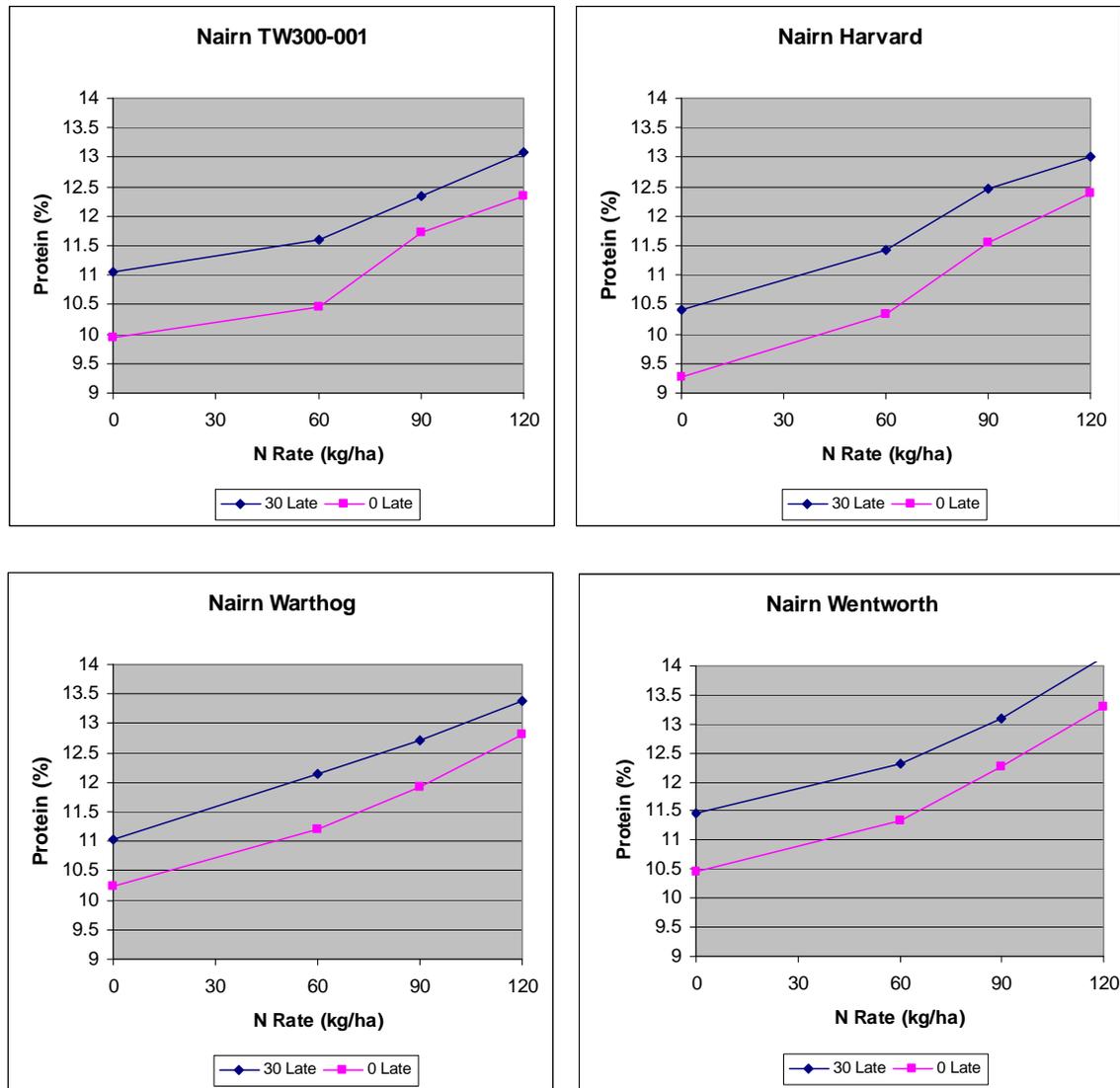


Figure 4. Protein response to N rates applied early (x-axis) with the split applied late (30 Late) compared to no N applied late (0 Late) in four hard red wheat varieties in Nairn, 2007.

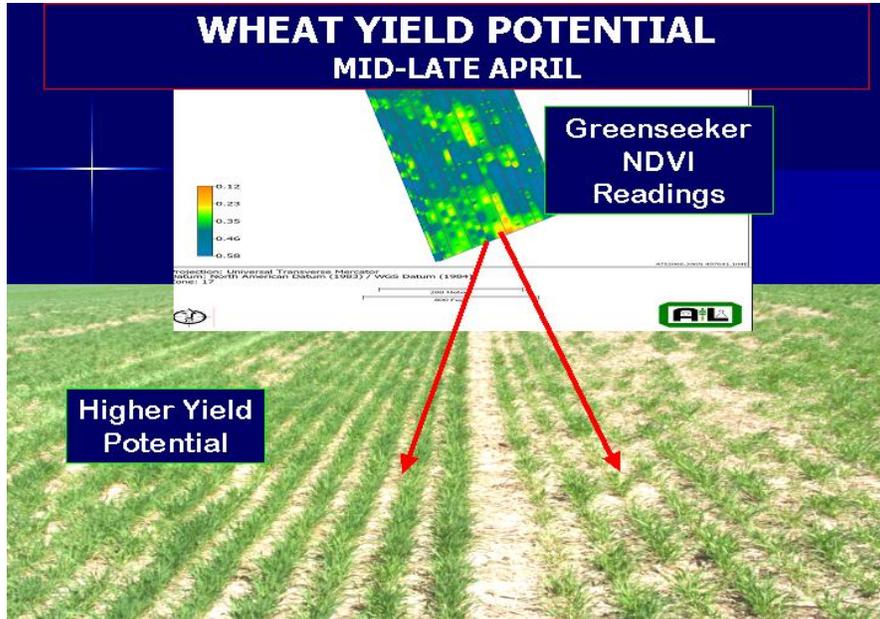


Figure 5. Wheat yield potential map generated from optical sensing tool in mid-late April.

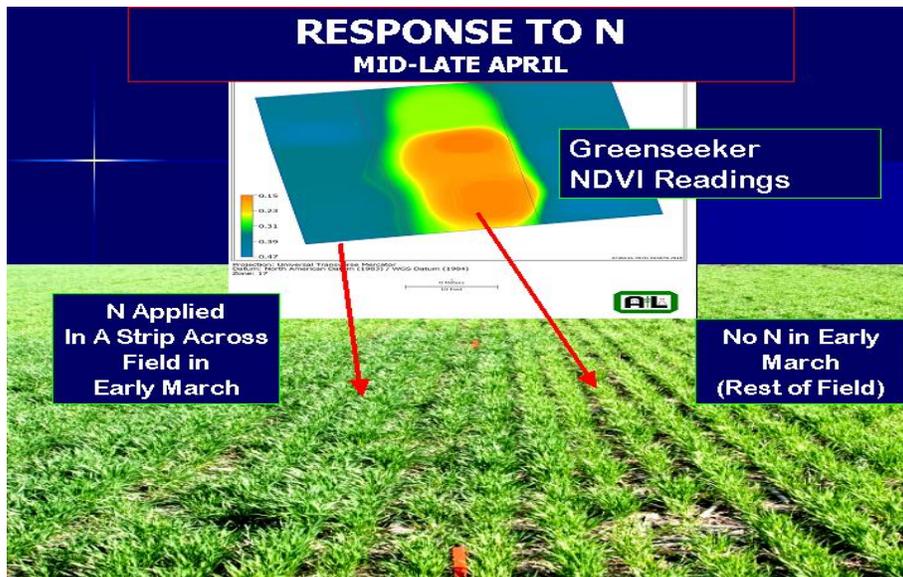


Figure 6. Response to N from an early application in March during mid-late April. The difference in the response is related to the amount of mineralized N in the soil solution, and the wheat crop is used as the indicator to determine the response to N fertilizer. When we couple the N response with the yield potential, N rates may be fine-tuned from our current recommendations.

Next Steps:

Continuation of small plot cultivar by nitrogen rate and nitrogen timing with GreenSeeker investigations will occur in 2008. Field scale trials will be conducted in Golden

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