

**Optimum Nitrogen Fertilizer Management Strategies for Modern Corn Hybrids in Manitoba**  
**Final Project Report to the Manitoba Corn Growers Association**

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October 10, 2020

**a) Project background and results** - For detailed results of this study, please refer to the final technical report.

In summary, the scope of this project addressed all four “R’s” in the “4R Nutrient Stewardship” framework for N fertilization of modern corn hybrids in Manitoba: applying the right rate, at the right source, in the right place, and at the right time. In more detail, this project had the following more specific objectives:

- Determine appropriate rates for N, based on soil test reserves of N and a realistic range of yield goals for modern corn hybrids (e.g., the overall supply of N required on a per bushel basis)
- Determine the most effective and efficient combinations of timing, placement and source, especially for supplemental applications during the growing season
- Evaluate some innovative soil tests for measuring the amount of organic soil N that can be released by mineralization during the growing season
- Develop decision tools such soil testing, tissue testing and leaf colour for evaluating nitrogen sufficiency at various stages before planting and throughout the growing season.

These experiments were conducted across southern Manitoba at two levels of intensity, gold and silver, during the 2018 and 2019 growing seasons. The 4 “gold” level sites were managed entirely by the University of Manitoba and included more treatments and measurements than for the 13 “silver” level sites (1 more than originally planned for), which were hosted within commercial corn growers’ fields. Overall, corn grain yields in 2018 and 2019 were limited by inadequate moisture at many of the field sites. In addition, wet and cold weather during late fall delayed harvest of the plots and also delayed and prevented some of the soil sampling that was planned for. Therefore, several sites were not fully soil sampled to 4 ft deep for every plot after harvest, as planned for.

Some of the key findings from this study include:

- Economic optimum supplies of soil test N plus fertilizer N were determined using four methods. The optimum total supply of N varied substantially with the method of calculation, ranging between 1.1 and 1.4 lb N/bushel for 11 site-years where the yield potential exceeded 130 bushels/acre, assuming prices of \$4.50/bu for corn and \$0.45/lb for N fertilizer. The equivalent range of optimum N supplies for 7 lower yielding site-years where yields were less than 130 bu/acre was 1.5 to 2.1 lb N/bushel. Therefore, similar to the results of studies in the U.S., this study showed that situations with the potential for greater corn yields require less N per bushel at the optimum rate of N. However, the optimum supply of N on a per acre basis was remarkably similar for both yield groups, generally in the range of 150-190 lb N/acre, including soil test plus fertilizer N. Part of the reason for this similarity for the two yield groups was the more efficient N use at the higher yielding site-years, but part was due to more release (mineralization) of soil organic N during the growing season at the higher yielding site-years.
- Within a similar rate of N fertilization application, there were no significant differences in corn grain yield among different sources and placements. This lack of difference between sources was not surprising, given that both growing seasons were relatively dry, resulting in low risk of N losses

by leaching or denitrification. In addition, the relatively dry conditions resulted in the lowest rate of N used in these comparisons (80 lb N/acre) being close to the optimum N rate determined in the rate study, making any potential yield response differences between sources very small and difficult to detect.

- Split application did not increase yield at any site years and decreased yield in three site-years where soil test nitrate concentrations and rates of N fertilizer applied at planting were low
- Although late season leaf colour ratings and pre-harvest stalk nitrate concentrations are well documented as being useful indicators of N sufficiency for corn grown under moist conditions, these indicators may require some modification to be useful for the semi-arid and sub-humid conditions in the Canadian Prairies.
- After harvesting the corn plots, post-harvest soil nitrate-N tests measuring less than 20 lb N/acre to 24 inch soil depth indicated that the previous corn crop was probably deficient in N. A soil test value of 20-50 lb N/ac to 24" indicated that the previous corn crop was not excessively fertilized. And residual soil test values greater than 50 lb N/acre probably indicated that there was probably excess N available for the crop.
- None of the soil test measurements, including soil organic matter and an incubation test, were useful for predicting the soil's capacity to mineralize additional N from soil organic matter under field conditions.

**b) Equipment** - There were no significant purchases of equipment with the funds for this project. All field operations were performed with equipment owned by the University of Manitoba and paid for on an hourly or daily operational charge basis. All of the plant and soil analyses except for soil moisture and soil texture were conducted by commercial laboratories.

**c) Project photos** - Photos are available upon request and have already been used in popular ag media (e.g., see last page for article on this project published in Top Crop Manager)

**d) Project public information materials and activities** - Interim results for the project have been presented through the following:

- oral presentation by Lanny Gardiner at the AGVISE Soil Fertility Seminar in Portage la Prairie on March 14, 2018 (~120 participants)
- the principles of the project were demonstrated by Don Flaten and John Heard at Crops-A-Palooza in Portage in July 25, 2018 (~400 participants, e.g., see following photo from Minister Eichler's tweet)
- feature article in a Top Crop Manager article in December 2018 (see last page).
- poster by Lanny Gardiner at the Manitoba Soil Science Society meeting in February 7-8, 2019 (~80 participants)
- tour by Lanny Gardiner, as part of the MCGA summer corn research tour, August 1, 2019 (~30 participants)
- Lanny Gardiner prepared an oral presentation for the AGVISE Soil Fertility Seminar in Portage la Prairie that was scheduled for March 17, 2020. Although the seminar was cancelled due to COVID-19, the presentation is posted on the AGVISE website at: <https://www.agvise.com/wp-content/uploads/2020/03/MB-4-Gardiner-seminar-2020-corn-n.pdf>



**e) Publications** - none to date, except for reports.

**f) Acknowledgements** - Manitoba Corn Growers Association has been prominently acknowledged in all oral and poster presentations.

**g) Final Financial Statements** - The University of Manitoba Budgets and Grants Office has prepared a comprehensive financial statement that summarizes the total income and expenditures for this research grant. Please note that in addition to the funding provided by the MCGA, the project has been supported by a grant from Nutrien (formerly Agrium). That funding has been used to support additional activities or purchases outside the scope of the MCGA grant (e.g., the Nutrien funding was used to purchase and install additional parts on our plot combine to improve its performance for harvesting corn).



PHOTOS COURTESY OF DON FLATEN

## FIGURING OUT NITROGEN FOR CORNY YIELDS

*There are many ways to manage nitrogen.*

by Bruce Barker

**T**wo hundred bushels of corn without any nitrogen (N) fertilizer? That happened in 2016 at St. Adolphe, Man., and is one of the more surprising results of a Manitoba Agriculture research trial.

“Some soils have huge nitrogen mineralization. Unfortunately to date we’ve not been able to predict it, even based on organic matter content,” says John Heard, a soil fertility specialist based in Carman, Man.

Heard has been conducting nitrogen trials on corn for many years. In 2018, the University of Manitoba under the direction of soil scientist Don Flaten with masters’ student Lanny Gardiner started a two-year trial looking at all four factors in the 4R Nutrient Stewardship program – rate, source, timing and placement. Mario Tenuta at the university is also conducting an intensive corn N fertilization study looking at greenhouse gas emissions at a few sites across Canada including one in Manitoba.

“The previous nitrogen recommendations for corn in Manitoba were outdated, and there was some contradictory information on how

much nitrogen is needed to produce a bushel of corn,” Flaten says.

The last N research done at the University of Manitoba was in 1981 through 1983, and the Manitoba Soil Fertility Guide (2007) and the Guide to Corn Production in Manitoba (2004) publications have top yield targets of 130 bushels per acre – numbers that now feel outdated when corn yields in Manitoba now hit 200 bushels per acre or more in some areas.

The nitrogen recommendations for a 130 bushel per acre corn crop with a soil test of 30 pounds per acre are 195 pounds of nitrogen (lbs. N) from the Manitoba Fertility Guide and 225 pounds per N from the Guide to Corn Production. Those rates mean 1.7 to two lbs. N uptake per bushel of corn. For a 200-bushel corn crop, these recommendations would suggest 340 to 400 lbs. N per acre is required.

**ABOVE:** John Heard (Manitoba Agriculture Crop Nutrition Specialist), Jeremy Gladish (U of M summer student), Lanny Gardiner (U of M masters’ student) and Kelly McDougall (U of M summer student) in a research plot that did not receive N fertilizer near Stephenfield, Man.