NITROGEN RECALIBRATION FOR WHEAT IN NORTH DAKOTA

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Abstract

The rise in grain prices and fertilizer costs, as well as the need for more soil-specific recommendations has spurred recent research into N response of wheat in North Dakota. Combining data from 1970 to 1990, together with recent studies has shown that new recommendations are in order. There is a relationship of wheat yield to available N. The relationship is better when residual soil nitrate is considered. Different areas of the state partition out with different response curves. Using the "return to N" method, increases in grain price or decrease in N costs increase economic optimal N levels. Use of the "delta yield" method results in similar optimum N rate recommendations.

Introduction

A brief history of N calibration work and a description of current recommendations were provided by Franzen et al. (2007). Costs for fertilizer N increased nearly 3-fold between fall 2007 and fall 2008. Increased interest in site-specific strategies to increase N efficiency and reduce overall N-rates is growing. The purpose of this work is to investigate better N recommendation strategies for wheat in North Dakota.

Methods and Materials

A search of old files and published works, peer-reviewed and otherwise, was conducted. A total of about 80 site-years of N calibration data were collected. Most of the data was associated with a geographical location, usually a nearby town. Some of the data was associated with an organic matter analysis. All of the data was associated with a soil test nitrate-N analysis. Some of the data was associated with a legume as a previous crop. A legume N credit was added into the available N amount for those sites.

Beginning in 2005, new N calibration studies were initiated by some of the researchers at the Research and Extension Centers at Carrington, Minot and Langdon. In 2006, some limited funding was gathered from Georgia-Pacific Co. to test their slow-release N products against present commercial sources, and N calibration work was made possible out of several more locations. Additional funds were secured in 2008 through UAP, Tesserando-Kerley and Simplot for testing certain proprietary products that called for N rate comparisons. Additional support was also secured through the North Dakota State Board of Ag Research and Extension wheat committee. Through 2008, a total of about thirty-eight modern N calibration site-years have been collected. In all, with archived data and modern data, a total of about 400 data-points comparing yield/protein and N-rate/credits have been recorded.

Results

Using archived data and modern data from 2005-2008 (Figure 1), the response of yield to available-N is curvilinear. The zero-N rate does not product zero-yield. A zero-N rate produces about 20 bu/a. The rate of N determined to produce additional yield from 20 to 30 bu/a is about 5 lb N/a, not 2.5 lb N/a as our present formula is written The rate increases between 30 and 40 bu/a to about 10 lb N/bu.

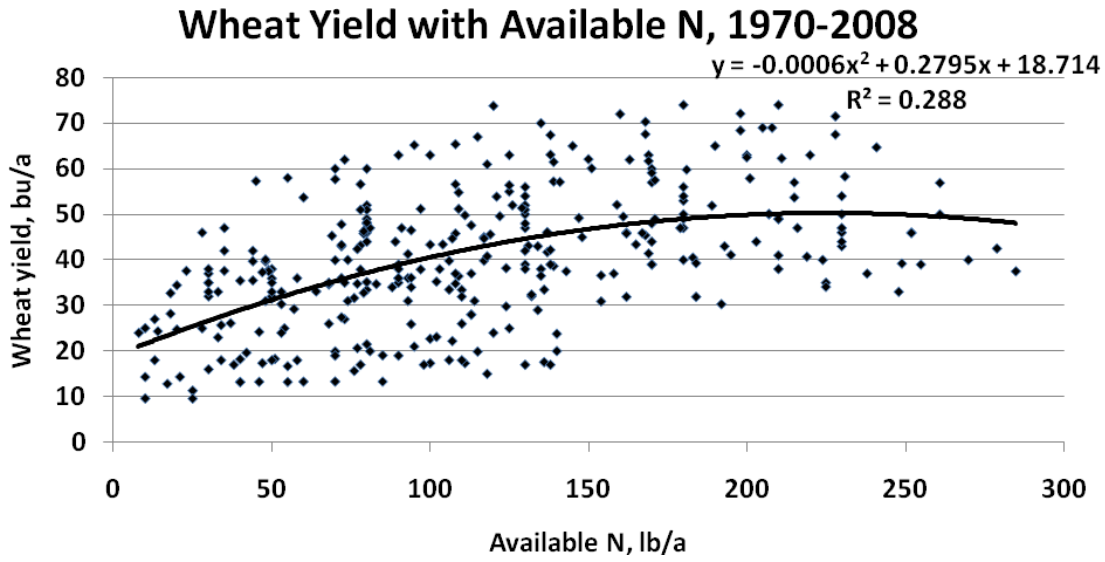

Figure 1. Wheat yield compared with N rate, 1970-2008.

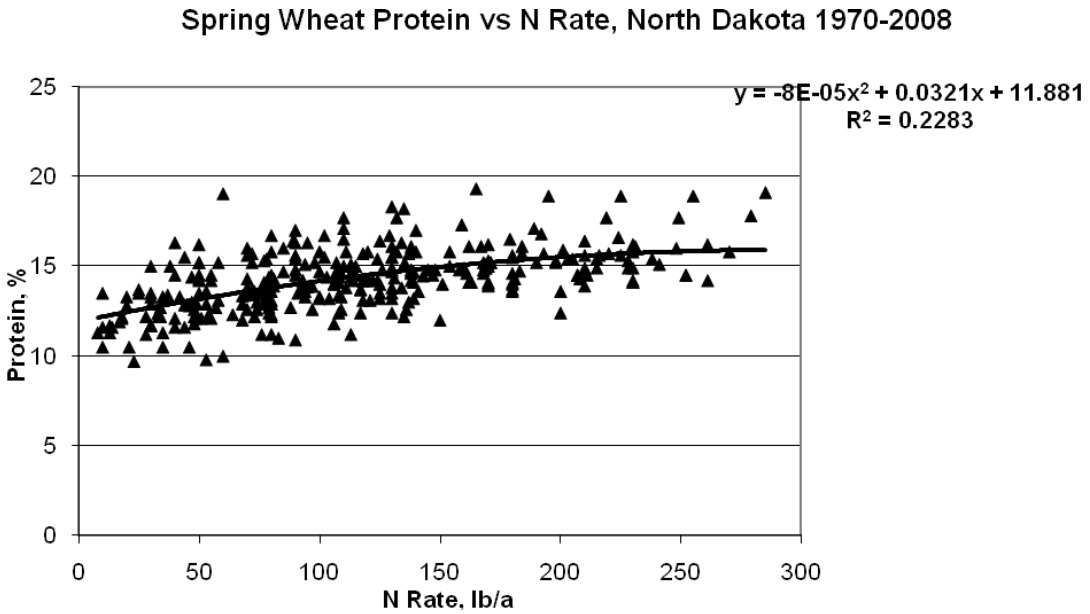

Figure 2. Wheat protein response with N-rate (total known available-N).

The protein response is also curvilinear (Figure 23). Maximum protein is achieved statewide in the archives with about 175-200 lb N/acre. Protein is an important component of economic analysis of wheat. When protein is less than 14%, there is a substantial dock. When protein is greater than 14%, up to a level of 15%, there is often, but not always a protein premium paid to growers. Beyond 15%, there are no additional incentives for protein. In some years, this premium is very large, but in most years it is about 1/3 the amount deducted as dockage for low protein.

Using the technique introduced by Nafziger and Sawyer (2005), the return to N using the state-wide archive was developed. Figure 3 shows the return to N using a $7/bu or $8/bu elevator price for wheat, with protein above or below 14% considered. For this and other return-to-N calculations, the protein predictive model from the protein response curve was incorporated into the spreadsheet for N rate and yield, and the economic result of the protein predicted from N rate was added or subtracted from the return in yield X wheat price.

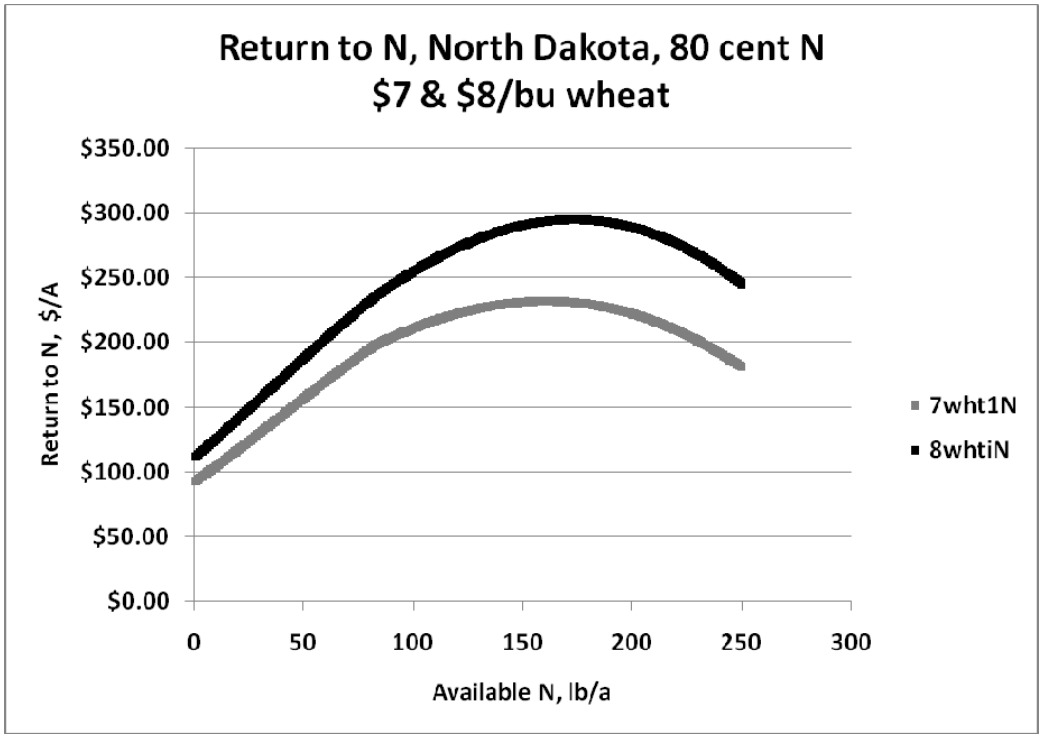

Figure 3. Return to N, 1970-2008 database, $7/bu and $8/bu wheat with protein above or below 14% considered.

Statewide, the economic optimum N available N rate was 180 lb N/a if wheat was $8/bu, and about 160 lb N/a if wheat was $7/bu (Figure 3).

North Dakota has several agri-climatology zones within the state. The plateau in the Langdon area is usually cooler and moister compared with other areas. The east is more humid and has more rainfall than the west. Therefore, data was divided into region and analyzed separately for return to N characteristics.

When these regionalized data were analyzed, the Langdon return to N for $6/bu spring wheat maximized return with $0.80 N was about 100 lb/a, and with $7 wheat about 110 lb N/a (Figure 4). Maximum return to N with $8/bu wheat was about 120 lb N/a.

The eastern ND dataset for $6-8/bu wheat the supplemental N is not profitable in $6 wheat with 80 cent N (Figure 5). N application is profitable in $7 and $8 wheat, but risk is high, with investments of $160 of N (200 lbs X $0.80 N) netting $25 and $60/a respectively in $7 and $8 wheat.

The western ND dataset for $6-8/bu wheat (Figure 6) shows profitable N returns for all wheat prices above $6/bu. The response curves for the west are steeper than the east, perhaps because of lower overall organic matter levels, and a drier environment that does not mineralize organic matter at a rate equal to the east.

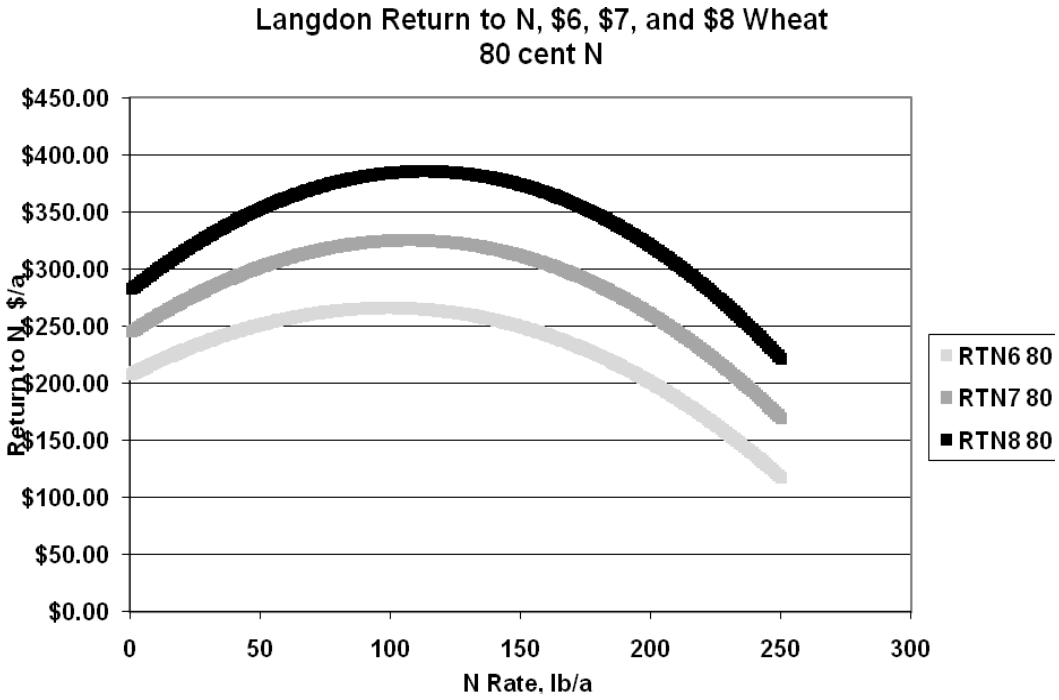

Figure 4. Return to N, Langdon and surrounding region dataset, $6-8/bu spring wheat.

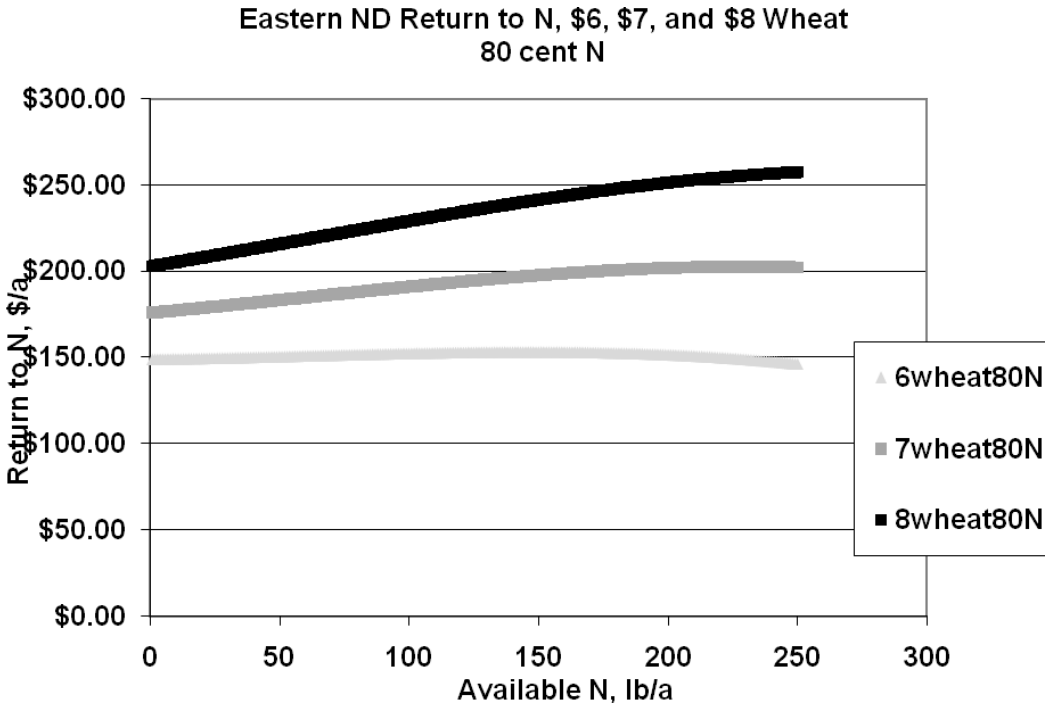

Figure 5. Return to N, Eastern ND less the Langdon region, $6 spring wheat.

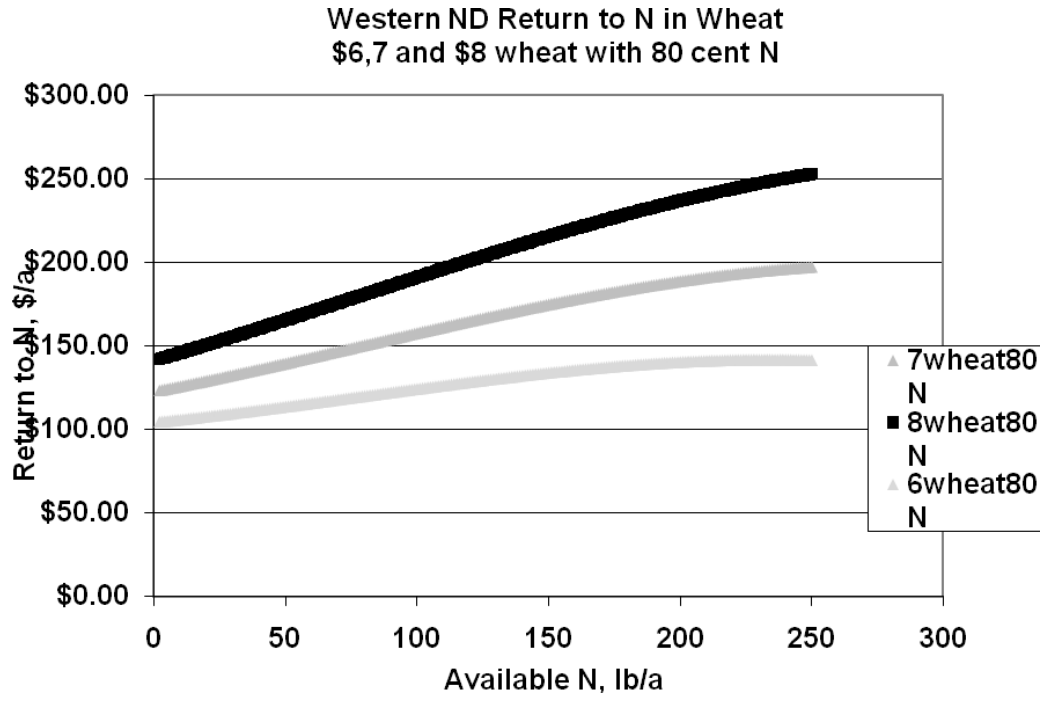

Figure 6. Return to N, western ND, $3 spring wheat.

We have begun to investigate the relationship between difference between the check plot and maximum N response yield in our experiments (delta yield) with available N. Fertilizer N rate and fertilizer N rate plus residual soil nitrate N plus legume credit (40 lb N/a) were compared. The comparison of delta yield of the experiments with total available N was most highly correlated (r^2=0.34) compared with fertilizer N rate alone (r^2=0.29). This relationship is shown in Figure 7. Given a common response of wheat to N of from 20-30 bu/a, the results of the delta yield comparison so far provides guidelines of between 120-150 lb/a, which is similar to several return to N scenarios.

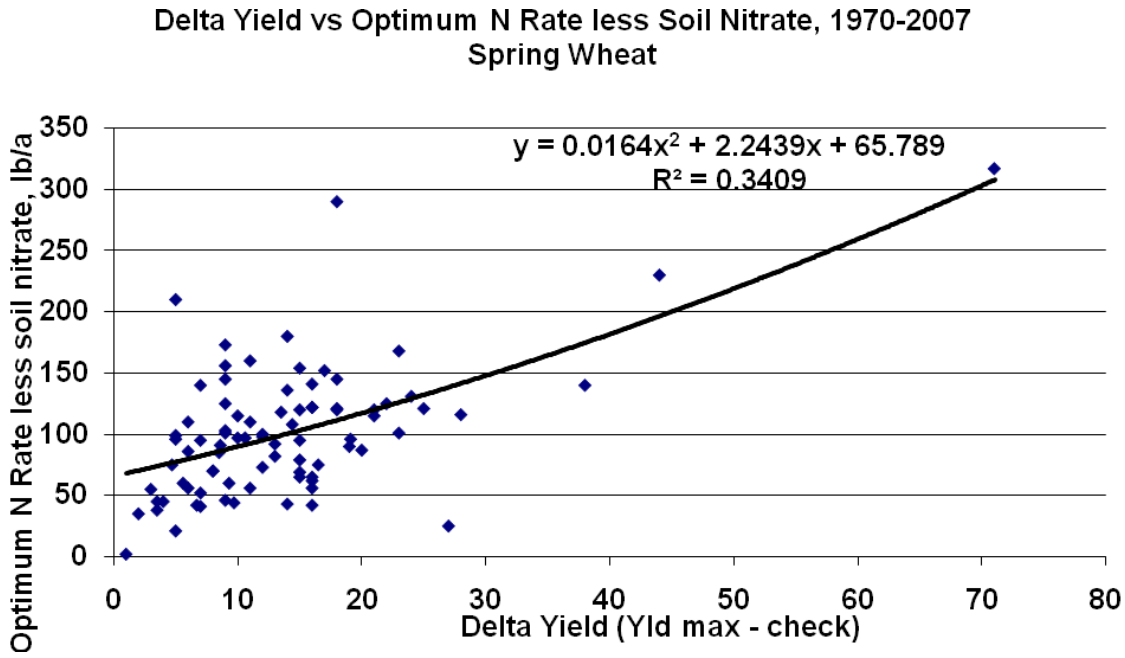

Figure 7. Relationship between experiments with delta yield data and optimum N rate less soil N.

Summary

Archived N calibration data from spring wheat/durum trials from 1970 to present were gathered, along with recent field N rate experiments since 2005. The results obtained to date confirm that our present N recommendations are not adequate to direct future production under our current economic conditions. There appear to be good reasons for segregating North Dakota into agriclimatology zones. Response curves are different in different areas of the state. The delta yield concept will be further explored, but its use may require individual growers to conduct ramp experiments on their farms to generate the appropriate factors.

References

Franzen, D.W., G. Endres, J. Lukach, R. Ashley and K. McKay. 2007. Nitrogen recalibration for wheat in North Dakota. p. 79-86. In 2007 Proceedings of the North Central Extension-Industry Soil Fertility Conference, 14-15 Nov., 2007. Des Moines, IA. IPNI, Brookings, SD

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Acknowledgements

Funding for this project was provided by Georgia-Pacific, UAP, Simplot, Tessenderlo-Kerley and the North Dakota State Board of Ag Research and Extension Wheat Committee.

PROCEEDINGS OF THE

THIRTY-EIGHTH NORTH CENTRAL EXTENSION-INDUSTRY SOIL FERTILITY CONFERENCE

Volume 24

November 12-13, 2008
Holiday Inn Airport
Des Moines, IA

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Published by:
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Web page: www.IPNI.net

Cover photo provided by Peggy Greb, USDA-ARS.