A Minnesota-Wide Assessment of Critical Pre-Plant and in-Season Soil Nitrate for Adjusting Nitrogen Rate Guidelines

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ABSTRACT

Through a comprehensive statewide assessment of PPNT and PSNT data collected previously, we estimated and compared critical soil nitrate levels (CSNL) computed for various specific environmental and management condition as well as averaged across all the conditions (scenarios) present in the database. Preliminary results estimated as an average across all scenarios demonstrated that the PPNT has a lower CSNL for fields with soybean as the previous crop compared to corn as the previous crop and for sites with soil organic matter (SOM) < 4.6%, while a greater CSNL is required in fields with pH < 5.8 or with SOM > 4.8%. At pre-sidedress, CSNL requirement follows the same pattern as for PPNT, except that for fields with soil pH < 5.8 the CSNL was lower than for soils with higher pHs. While the results are preliminary, as currently only approximately 100 site years of data (approximately half of the site-years available) have been analyzed, the results indicate that soil conditions influence critical soil nitrate for both PPNT and PSNT.

INTRODUCTION

It is common to apply nitrogen (N) fertilizer prior to or at corn (*Zea mays* L.) planting in Minnesota. Residual soil nitrate testing can be used to quantify the amount of nitrate-nitrogen (N) present in the root zone and is an important nitrogen fertilizer management tool. It is among the practices recommended to be implemented under the Groundwater Protection Rule.

Pre-plant nitrate test (PPNT) and pre-sidedress nitrate test (PSNT) helps producers estimate if their fields have sufficient N to optimize yield. The PPNT provides an N credit for the N fertilizer rate and is determined based on soil testing performed prior to planting. The PSNT nitrate test is taken around V4 in mid-June at the 0- to 30-cm soil depth and helps determine if additional N is needed. Fields with soil test values (STV) less than 20-25 mg kg-1 are likely to respond but the PSNT does not provide an estimate of how much in-season fertilizer N should be applied.

The amount of residual nitrate in the soil depends on rainfall, soil texture and water holding capacity, organic matter, crop rotation, manure history and other factors. Since these factors varies regionally, the current BMPs from the University of Minnesota (U of M) has different recommendations across the state.

The current recommendations are based on research conducted nearly 40 years ago. They do not account for the generally wetter climate Minnesota is experiencing, advancements in fertilizer application technology including variable rate nitrogen fertilizer application, or in-season assessments of nitrogen needs including the use of in-season soil nitrate testing. They also do not align with the BMP regions used by the U of M for their other nitrogen fertilizer BMPs.

There is a need, therefore, to reevaluate the soil nitrate testing BMP recommendations to make them relevant and meaningful for current crop management practices and to establish an estimate of an in-season critical STV (CSTV) and the supplemental in-season N fertilizer rate that accounts for these unpredictable spring weather conditions is needed.

MATERIALS AND METHODS

The study inventory and assemble a dataset of existing corn grain yield responses to pre-and at-planting and in-season nitrogen fertilizer rates over contrasting spring weather conditions, soil textures, cropping rotations, and regions of Minnesota including data from University of Minnesota (U of M) research projects, Minnesota Department of Agriculture (MDA) nutrient management initiative, and other relevant studies. Based on the assembled data, it was evaluated the uses and applications of pre-plant soil nitrate test (PPNT) and pre-sidedress nitrate test (PSNT) for nitrogen rate adjustment.

Datasets contains:

- Site location
- Soil classification Previous crop
- N rate, source, application time and placement
- Soil sampling depth(s).
- Soil test method and the units reported.
- Soil sampling date and corn growth stage.
- Inclusion of multiple sampling dates, if measured, is desired (e.g. V4 and V8)
- Grain yield
- Data owner and custodian.

Additional Meta-data if available

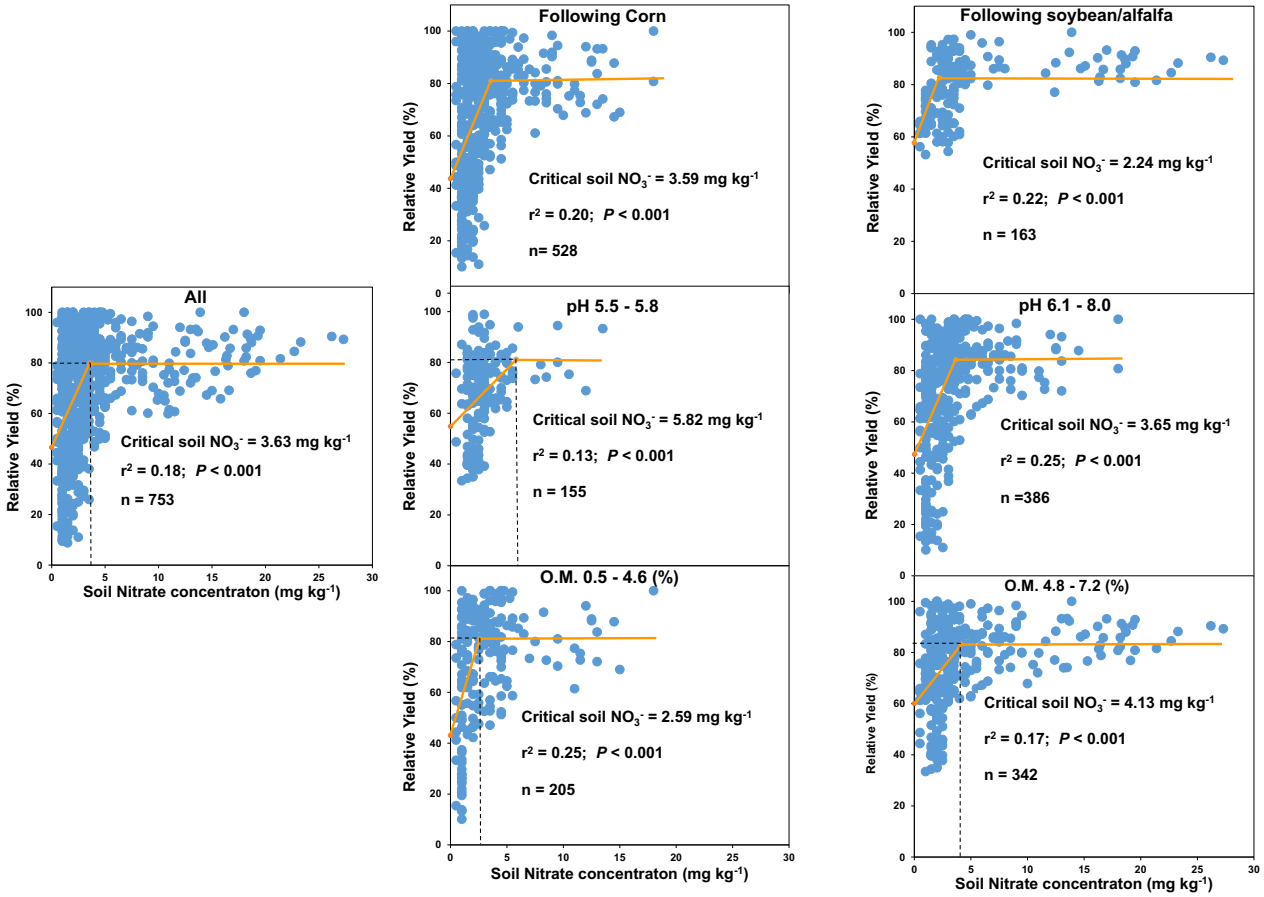
- Soil texture and soil attributes.
- Corn hybrid
- Tillage system
- Water regime
- Pre-plant soil test nitrate or 0-N check plot (depth, method, date)
- Aboveground plant N uptake at time of soil sampling
- Any publication details if previously published
- Field studies that include a pre-plant N rate response curve and in-season N rate response curve will be used for model validation

After screening and standardize units and variables, we estimated and compared critical soil nitrate levels (CSNL) computed for various specific environmental and management condition as well as averaged across all the conditions (scenarios) present in the database.

RESULTS

Preliminary results estimated as an average across all scenarios demonstrated that the PPNT has a lower CSNL for fields with soybean as the previous crop compared to corn as the previous crop and for sites with soil organic matter (SOM) < 4.6%, while a greater CSNL is required in fields with pH < 5.8 or with SOM > 4.8%. At pre-sidedress, CSNL requirement follows the same pattern as for PPNT, except that for fields with soil pH < 5.8 the CSNL was lower than for soils with higher pHs. While the results are preliminary, as currently only approximately 100 site years of data (approximately half of the site-years available) have been analyzed, the results indicate that soil conditions influence critical soil nitrate for both PPNT and PSNT.

- **Pre-plant critical nitrate**



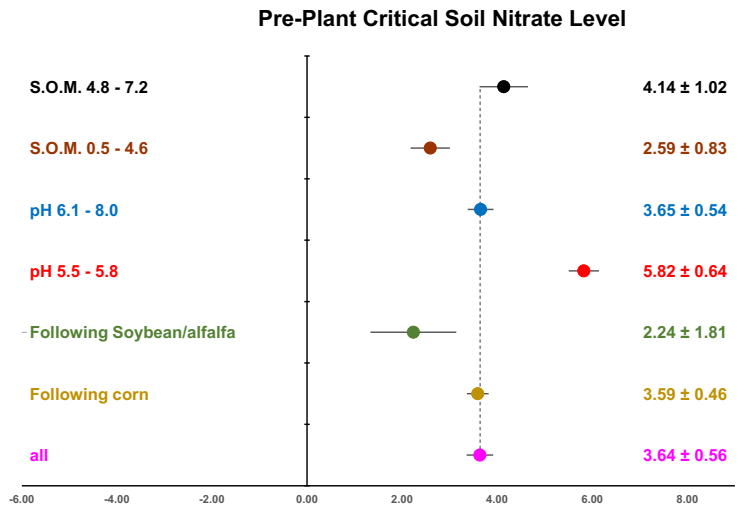
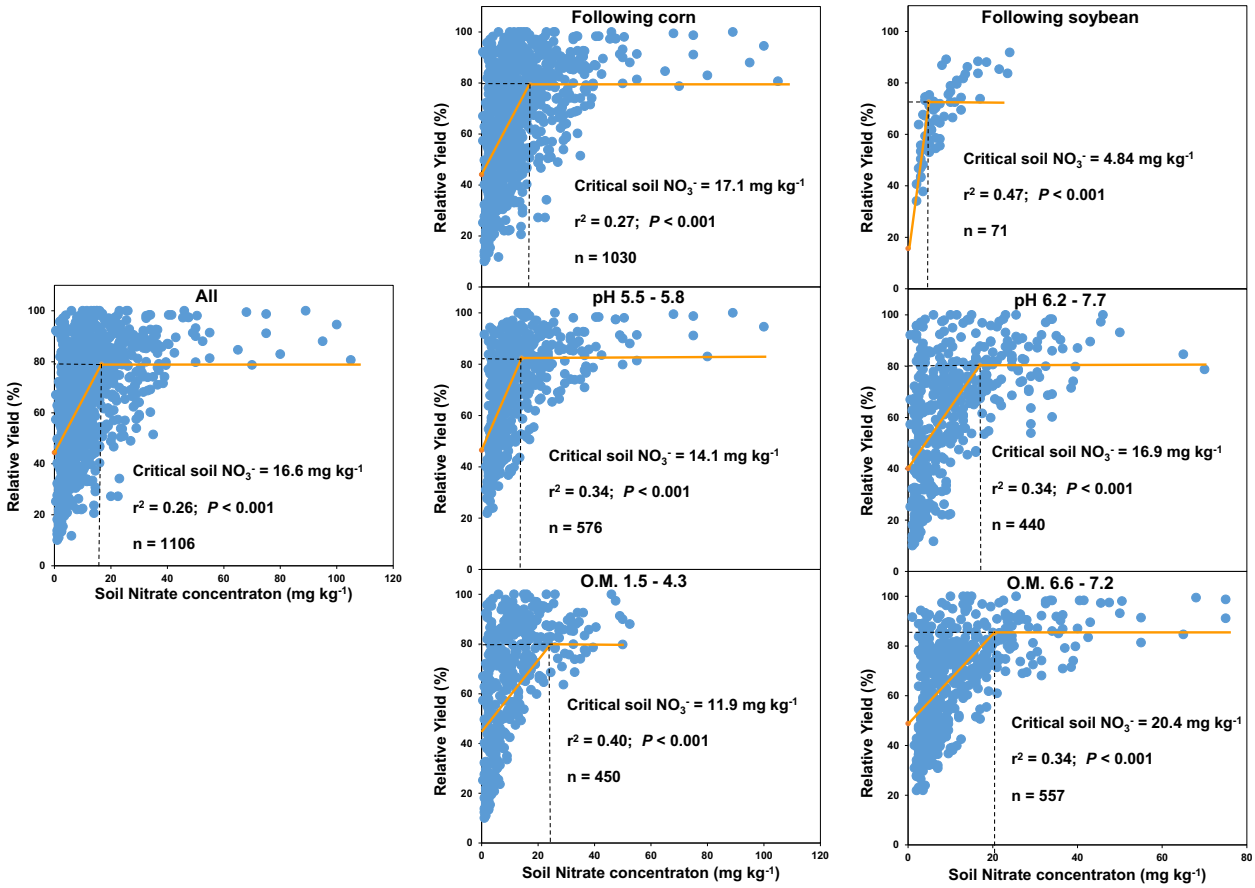
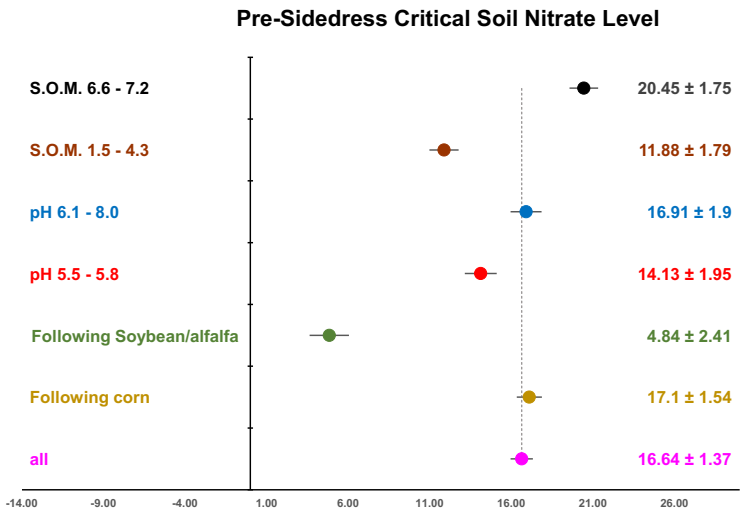


Fig. 2

- **Pre sidedress critical nitrate:**




Pre-Sidedress Critical Soil Nitrate Level
S.O.M. 6.6 - 7.2
20.45 ± 1.75
S.O.M. 1.5 - 4.3
11.88 ± 1.79
pH 6.1 - 8.0
16.91 ± 1.9
pH 5.5 - 5.8
14.13 ± 1.95
Following Soybean/alfalfa
4.84 ± 2.41
Following corn
17.1 ± 1.54
all
16.64 ± 1.37
-14.00
-9.00
-4.00
1.00
6.00
11.00
16.00
21.00
26.00