Optimizing Nitrogen Management Under Conditions of Extreme Moisture

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Introduction

❖Effective nitrogen management strategies using the 4R nutrient stewardship (right source, rate, timing and placement) can help to reduce nitrogen losses and optimize profitability.

❖ The question of how best to manage risk to select an N management strategy that is a balance between effectiveness, profitability and environmental stewardship is complex.

❖ Soil moisture plays an important role in many nitrogen form conversions and loss pathways. On a practical level, however, the inability to accurately forecast moisture conditions hampers our ability to decide if and when specific N management practices should be applied.

❖ The objective of this study was to develop a data-based decision support information to help farmers assess and manage the potential risks associated with fall nitrogen fertilizer management under extreme moisture conditions.

Methodology

❖ Analyzed fifty two years (1961 – 2012) of historical weather data at sixty-six locations within the agricultural region of Manitoba (Figure 1).

❖To determine the likelihood of extreme moisture conditions occurring during critical periods of the year when N management decisions are being made (e.g., from Sept 1 to Nov. 10), the total precipitation over a three-day rolling periods were sorted into half-inch bins. The likelihood of occurrence is given as the frequency of occurrence (numerator) divided by the number of years of occurrence (denominator). Nov 10 is the last day for nutrient application in MB except when variance is issued by the province.

❖ The soil texture in each reporting district was divided into three broad categories: coarse, medium and fine. Observed soil moisture from 2016 – 2020 were used to determine the appropriate soil moisture range for each texture.

❖ Using the observed top 30 cm depth, the starting soil moisture conditions is divided into low, medium or high (Table 1). The additional moisture from the precipitation bins are used to determine the risk of nitrification (Table 2 and Figure 2). Green means very little nitrification expected, Yellow means substantial nitrification but little denitrification expected and Red means that very little nitrification but substantial denitrification expected.

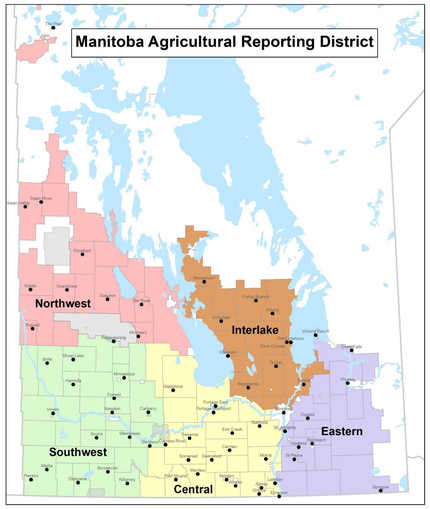

Figure 1: The location of weather stations analyzed.

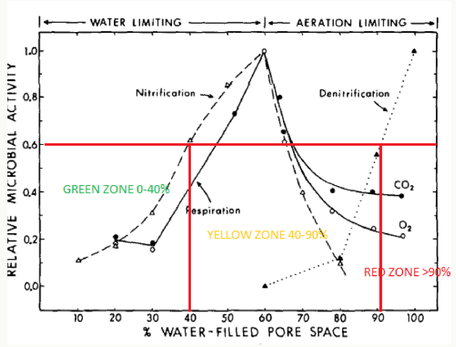

Figure 2: The relationship between water-filled pore space and relative amount of microbial nitrification (adapted from Linn and Doran, 1984).

Texture	Low (%VWC)	Medium (%VWC)	High (%VWC)
Coarse	< 16	16 – 24	> 24
Medium	< 23	23 – 32	> 32
Fine	< 27	27 - 37	> 37

Table 1: The soil moisture thresholds used to define the current soil moisture in each soil texture category. VWC is the Volumetric Water Content

3-day cumulative precipitation sorted into ½-inch bins

Period	Current	0.0" to 0.5"	0.5" to 1.0"	1.0" to 1.5"	1.5" to 2.0"	2.0" to 2.5"	2.5" to 3.0"	3.0" to 3.5"
September 1 to November 10	Low							
	Medium	30/1	5/1	1/1	4/10	2/10	5/100	2/100
	High							
September 15 to November 10	Low							
	Medium	23/1	3/1	10/10	3/10	1/10	4/100	
	High							
October 1 to November 10	Low							
	Medium	17/1	2/1	6/10	2/10	6/100	4/100	
	High							
October 15 to November 10	Low							
	Medium	10/1	1/1	3/10	9/100	4/100	3/100	
	High							
November 1 to November 10	Low							
	Medium	3/1	3/10	9/100	2/100	2/100		
	High							

Current soil moisture level

Likelihood of precipitation occurrence. i.e., an average of 5 events of 0.5 – 1.0 inch precipitation per year from Sept 1 – Nov 10

Table 2: This Central region, coarse-textured soil chart shows moisture-based nitrification/denitrification risks. Visit https://www.gov.mb.ca/agriculture/weather/pubs/optimizing-fall-n-mgt-under-conditions-of-extreme-moisture.pdf for full report, including tables for other regions and textures.

RESULTS

❖ To use the tables (e.g., table 2), first select the table for a specific region and texture, make a reasonable assumption of what the current soil moisture conditions are for the field, then use the likelihood of receiving precipitation to decide on a level of risk to assume.

❖ When high risk of N loss scenarios are likely, management decisions can be made to reduce the risk through the employment of improved management practices using 4R principles.

❖ This study provided a proof-of-concept that utilized historical weather data to determine the risk of extreme 3-day precipitation events, current soil moisture data for qualitative categorization of moisture status and soil textural class to determine the likelihood of fall applied N-loss to nitrification, and denitrification.

NEXT STEPS

❖A study designed to comprehensively validate the N-loss risk is required to improve the reliability of the results presented in the tables. Specifically, the experiment will review N loss under different water filled pore spaces and temperature to determine if the thresholds used in this study require adjustment.

❖ An integrated web application using field-specific soil physical characteristics and incorporating precipitation forecast.

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