Mineral N Cycling in an Integrated Crop-Grazing System

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Introduction

A long-term integrated crop-grazing system study has been ongoing for nearly a decade at the Dickinson Research Extension Center in western North Dakota. Objectives of this study are to diversify cropping systems dominated by small grains with other crops as well as reduce costs in finishing beef animals by grazing high quality crops rather than all grain. Continuous hard red spring wheat (*Triticum aestivium* L.) (HRSW) is being compared to a 5 season rotation consisting of hard red spring wheat, winter triticale-hairy vetch (*Triticale hexaploid* Lart.-*Vica villosa* Roth), field pea-barley intercrop (*Pisum sativum* L.-*Hordeum vulgare* L.), mixed species cover crop, corn (*Zea mays* L.) and sunflower (*Helianthus annus* L.) under no-till management. Our previous work tracking residual mineral N (NH_4^+ + NO_3^-) in this system based on periodic profile N sampling to 0.6 m has indicated a substantial N availability (100 to 200 kg/ha) in the crop rooting zone throughout the growing season. This is in a region that is limited in rainfall (325-450 mm). We have also observed that with our study crop of HRSW, N fertilizer requirements based on soil tests have been declining as the system has “matured” while HRSW yields have been slightly increasing in the rotation plots.

Objective

To identify the differences in N mineralization ability between soils in continuous spring wheat and spring wheat grown in rotation with other crops that are grazed in place or harvested for livestock forage.

Materials and Methods

Soil were collected at six (6) points in time throughout the growing season in 2014 and four (4) points in time in 2016 to a depth of 0.6 m as recommended by NDSU for determining residual soil N (Table 1). We analyzed the surface 0-15 cm of the soil samples from the continuous and rotation HRSW plots that were collected in the season that HRSW was grown (either 2014 or 2016) for potentially mineralizable N (PMN) based on the methodology of Waring and Bremner (1964) and Keeney (1982). This utilizes an anaerobic incubation at 40°C for 7 days with determination of NH_4^+-N at the end of the incubation period. The NH4+-N produced indicates the availability of N from easily decomposable soil organic matter (SOM) during the growing season and is often used as an indicator of soil health. The mineralization for each soil was replicated four times. Data was statistically analyzed using SASv9.4.

Results and Discussion

Changes in mineral N cycling were observed as changes in PMN during the two seasons evaluated thus far in this study (Figures 1 and 2). Potentially mineralizable N is higher in the rotational HRSW (Figure 1) soils due to several factors:

1. A continuous system of diverse crops is growing in the rotational system which then are available for animal forage. This is an ideal system to consider the effects of cover crops in maintaining soil health over a long-term period. Some of the plant species/crops included are normally seeded as grain or forage crops but fall seeded crops such as the triticale/vetch crop also act as cover crops.

2. A diversity of crops that include legumes as forage crops enhance soil N because of the roots and crowns that remain in the soil after harvest/grazing.

3. Animals grazing the crops also distribute dung and urine across the field as they graze which add to the N budget of the soil.

4. These are not normally found in traditional systems similar to the continuous HRSW treatment.

5. In this semi-arid environment, the no-till system also conserves precious soil moisture to be utilized more efficiently by crops and providing a favorable environment for microorganisms in cycling N.

Regression analysis between SOM and PMN thus far indicate that about 8.4 mg N/1% SOM/kg soil are being mineralized across this study (n = 148, R^2 = 0.21***) Although the R^2 value for this data is relatively low (0.21), it is highly significant ($p > 0.001$) due to the large number of data points we have been able to collect to establish a clear relationship of SOM with PMN Early season sampling dates give higher PMN values than later sampling dates because of the effect of the previous season's crop residues that are decomposing while this season's crops are still growing and not contributing to the SOM pool (Figure 2).

Summary

Our work continues to show the dynamic nature of N cycling in an integrated crop-grazing system in a semi-arid environment. We have and are continuing to evaluate the soil PMN dynamics for the 2017 and 2018 cropping seasons with mineralization studies that are currently ongoing

Table 1. Soil sampling dates for 2014 and 2016 growing seasons.

2014 Sampling Dates	2016 Sampling Dates
June 2 (6/2)	June 2 (6/2)
June 16 (6/16)	July 27 (7/27)
June 30 (6/30)	August 31 (8/31)
July 14 (7/14)	October 13 (10/13)
August 11 (8/11)	
September 14 (/14)	

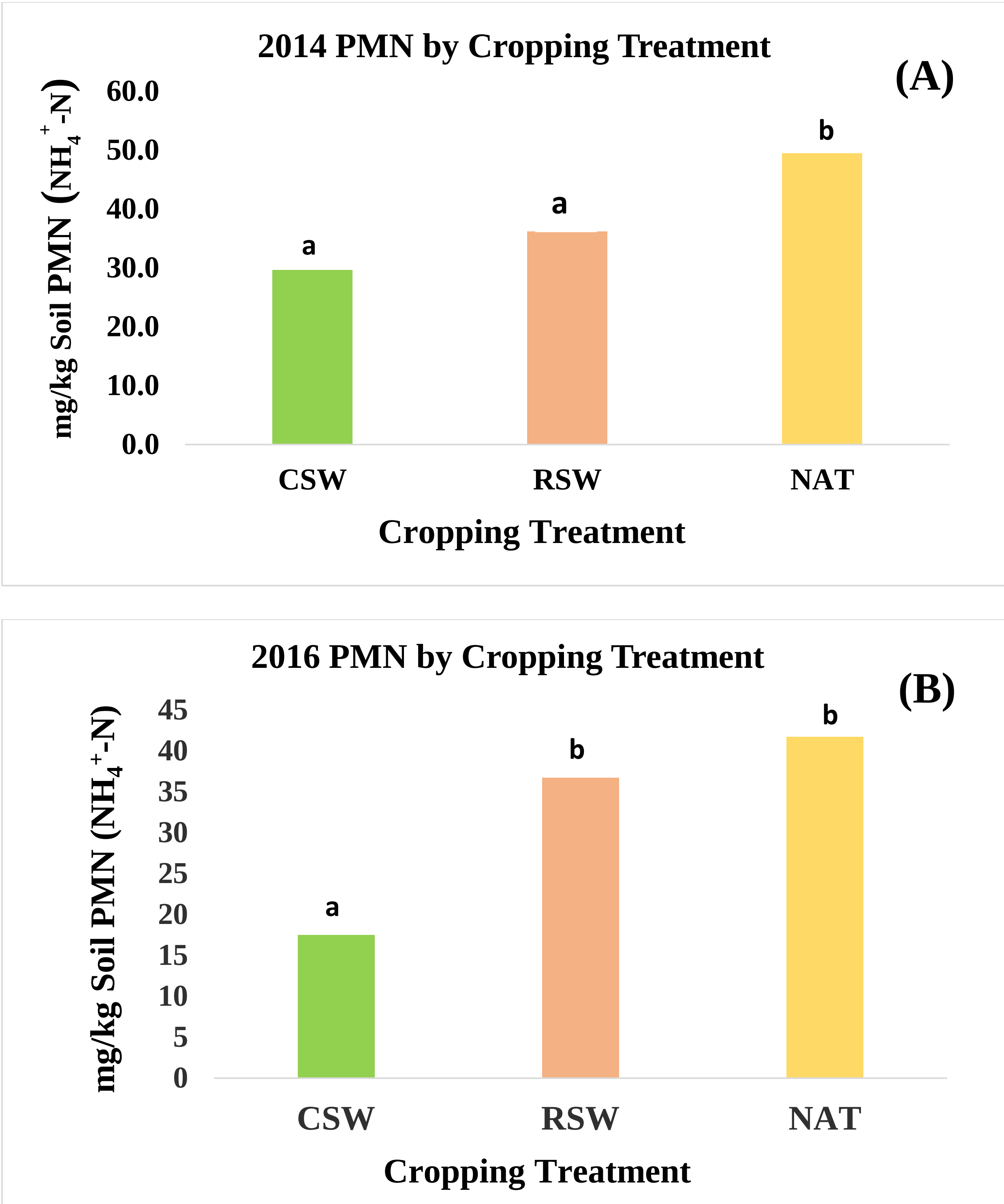

Figure 1. Potentially mineralizable N as influenced by cropping treatment for the 2014 (A) and 2016 (B) cropping seasons. CSW – continuous spring wheat; RSW – rotation spring wheat; NAT – native grassland. Bars with the same small case letters are not significantly different at the $P < 0.05$ level.

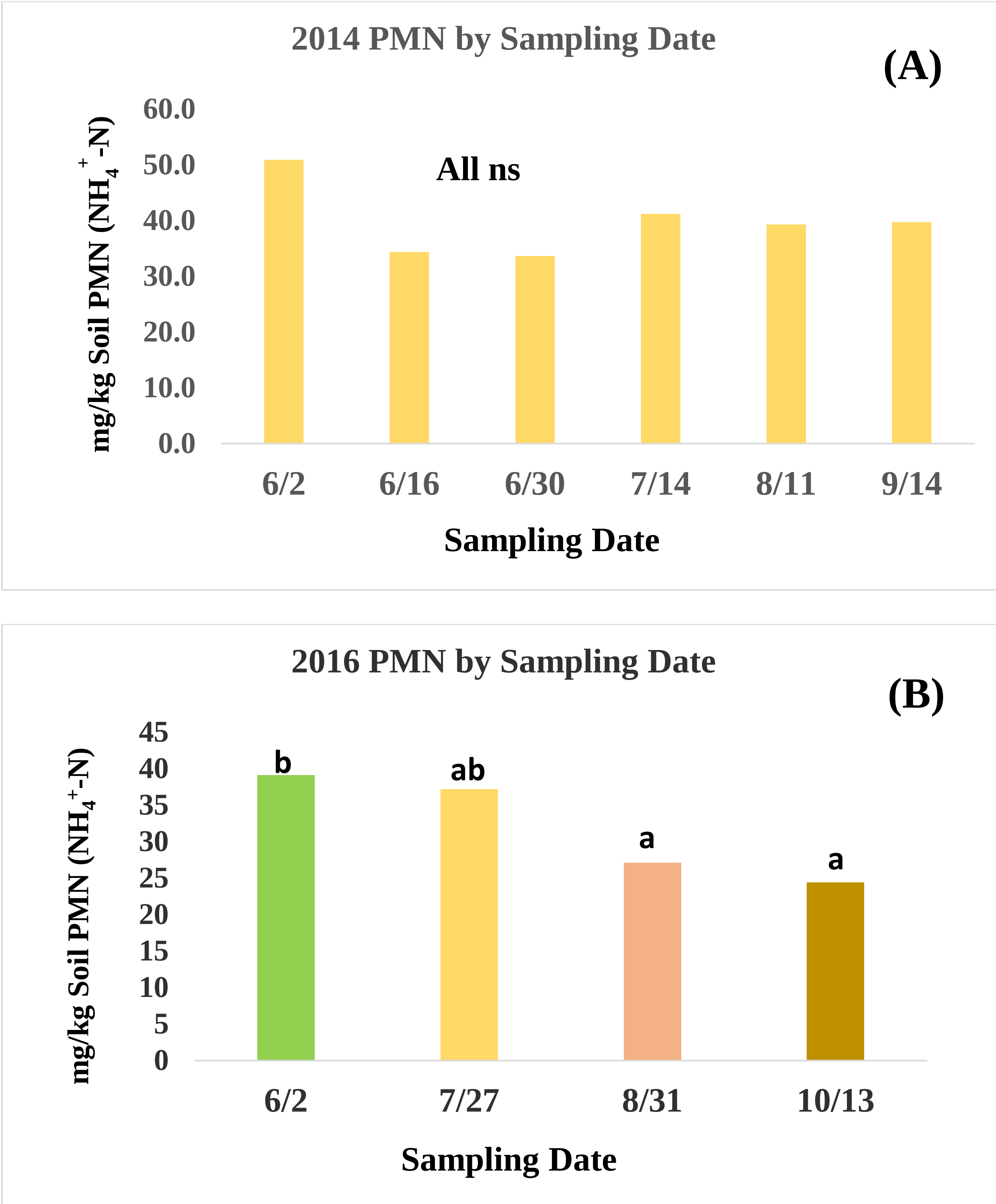

Figure 2. Potentially mineralizable N as influenced by sampling date for the 2014 (A) and 2016 (B) cropping seasons. Bars with the same small case letters are not significantly different at the $P < 0.05$ level. No significant differences between the 2014 sampling dates.

References

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