Effects of liming on soil pH, soil nitrogen balance, and grain yield under varying fertility management in a long-term cereal-forage rotation

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Introduction

- Acidification of agricultural soils is intensified by the continuous use of nitrogen and sulfur-based fertilizers.
- Low soil pH can impair root development, nutrient and water uptake, and plant growth, reducing yields of acid-sensitive crops (Fig. 1).
- Soil acidity limits crop choices in rotations and mixed cropping systems.
- Liming increases soil pH and reverses associated challenges.
- Prairie studies on the benefits of long-term liming under different crop management practices are limited and dated.
- This study aims to evaluate the long-term effects of liming and different fertility management on soil pH, soil nitrogen, grain yield, and grain & straw nitrogen recovery in a 5-year rotation.

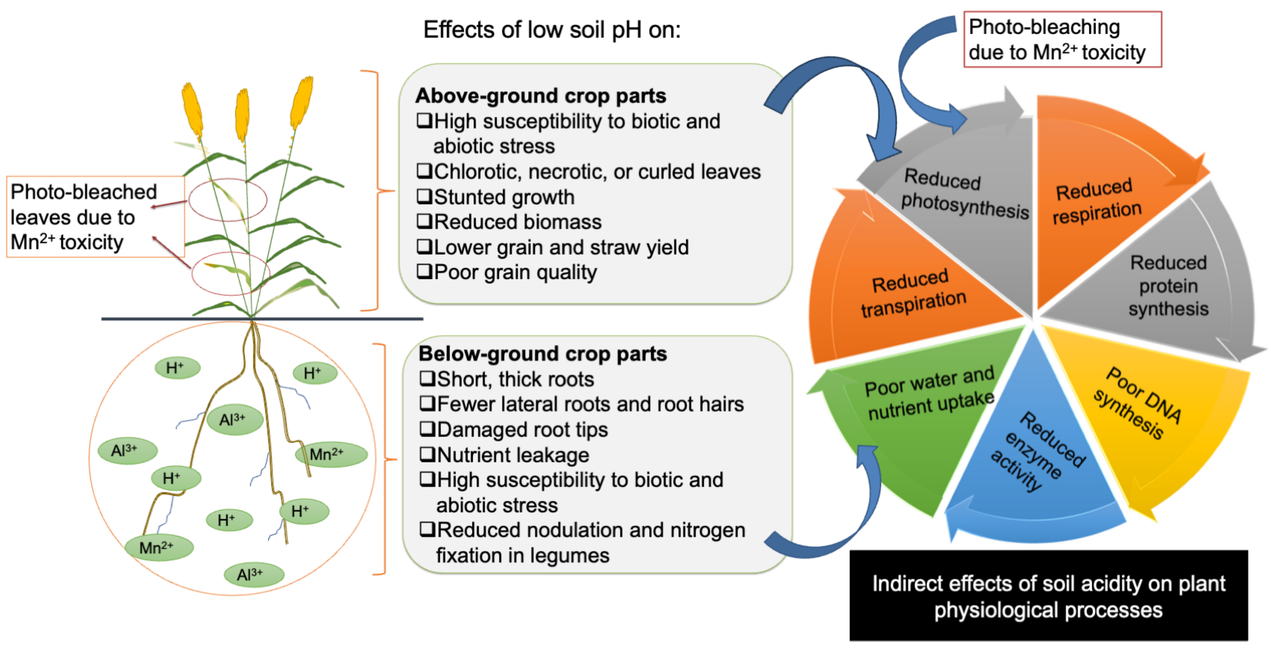
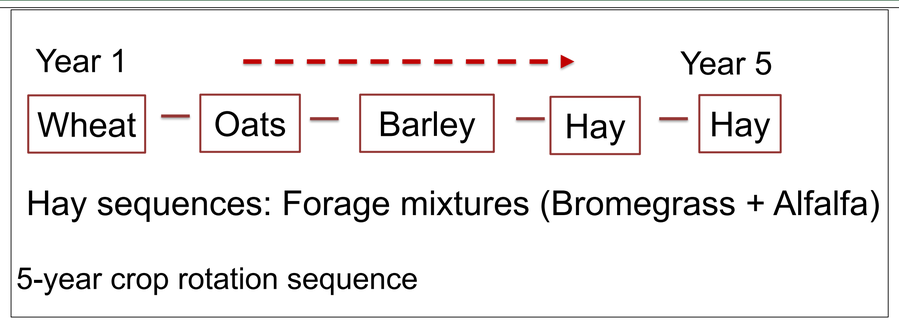


Figure 1: Effects of low soil pH on plant physiological processes and associated agronomic parameters

Materials and methods

Figure 2: Experiment layout at The Breton Classical Plots, Alberta, Canada.



Hay sequences: Forage mixtures (Bromegrass + Alfalfa)

5-year crop rotation sequence

Treatments evaluated:

✓ Four (4) nutrient management practices

✓ Lime vs. no-lime

Table: Nutrient management

Nutrient treatments	Crop sequences			
	Wheat	Oat	Barley	Hay
	N-P-K-S (kg ha^{-1})			
Control	0-0-0-0	0-0-0-0	0-0-0-0	0-0-0-0
Manure	50-*-*-*	75-*-*-*	50-*-*-*	0-0-0-0
NPKS	50-22-46-20	75-22-46-20	50-22-46-20	0-22-46-20
PKS	0-22-46-20	0-22-46-20	0-22-46-20	0-22-46-20

* Varies according to source

Results and discussions

Soil pH and nitrogen

Yield and N recovery in Crop sequences

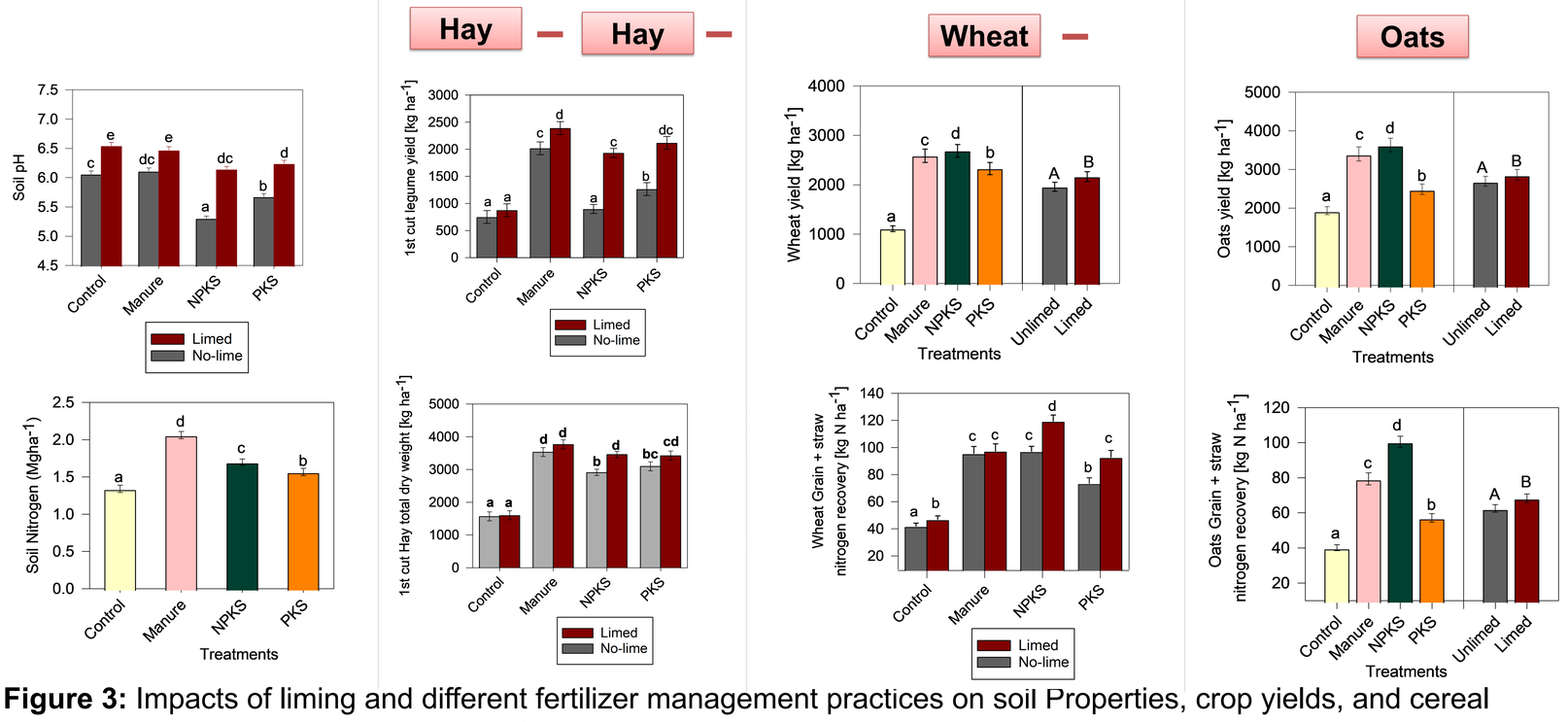


Figure 3: Impacts of liming and different fertilizer management practices on soil Properties, crop yields, and cereal nitrogen recovery in a cereal-forage system

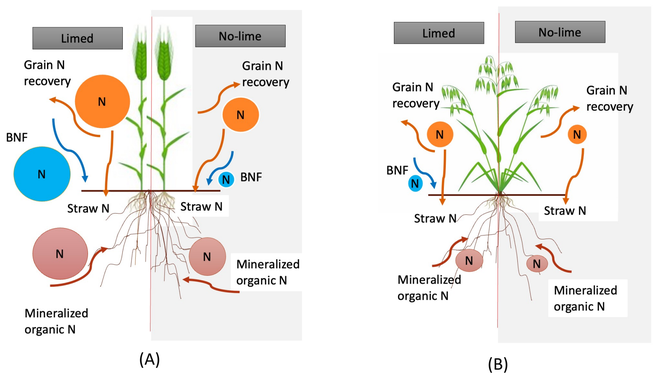


Figure 4: Indirect effect of carryover acidity affecting BNF in legume forages, reducing N availability to subsequent wheat (A) and oats (B) in the 5-year crop rotation.

- All the nutrient management practices reduced soil pH.
- Biological N fixation by legumes in the hay sequences in limed NPKS and PKS treatments significantly increased N availability to subsequent cereal crops, resulting in greater N recovery and yield in the limed halves.

Conclusions

- The most significant reduction in soil pH was observed with N and sulfur-based fertilizers.
- Soil pH may affect N recovery and grain yield indirectly in rotations.
- Lime is required to maintain soil pH and sustain yields in agricultural fields with long-term, annual fertilizer applications.
- Offsetting fertilizer applications with manure can slow down soil acidification.

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