Beet Lime Impacts on Spring Wheat

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Introduction

Soil pH is the measure of the concentration and activity of the hydrogen ion. North Dakota soil pH has historically been above 6. However, in areas west of highway 83, many are observing soil pH levels below 5.5. These acidic soils reduce yields because of reduced soil microbial activity, aluminum toxicity, and phosphorus tie-up. The cause of the soil acidification is believed to be caused by nitrogen fertilizers. As nitrogen fertilizers convert into plant available nitrate, hydrogen is released and acidifies the soil. Over time, hydrogen accumulates and can turn the soil acidic which reduce yields. Acidic soils can be managed by the application of lime. Lime is calcium-carbonate. Lime raises soil pH from carbonates reacting with the hydrogen ion. This produces free calcium, carbon-dioxide, and water.

Many states have developed lime recommendations based on their clay type, parent materials, and climate. Acidic soils in North Dakota is a new issue and consequently, lime recommendations have not been developed here. Commercial ag lime is not readily available in North Dakota. However, beet lime (a by-product of the sugarbeet refining process) is readily available from sugarbeet processing factories. Beet lime was used as the liming agent for this project. On a separate note, 100 tons of beet lime was hauled from Sidney Sugars in Sidney Montana to Minot for $41/ton. Whereas one ton of ag lime was quoted as $150/ton delivered to Minot.

Materials & Methods

This study occurred in Minot and Dickinson. Climate and soil parent material is different between the two environments. Soil samples were collected and tested prior to planting. Beet lime was surface applied at rates of 0, 0.25, 0.5, 1, 2, 3 and 4 tons/ac. Beet lime does contain nutrients (Table 1). All plots were fertilized for 50 bu/ac hard red spring wheat with urea and potash by mid-row band. Monammomium phosphate was applied in furrow.

Plots were 5ft by 25ft and assembled in a randomized complete block design with five replications. To reduce influence from an adjacent treatment, a one planter pass buffer strip of wheat was planted between each plot.

Spring wheat was planted by a no-till methods and grown using normal best management practices. A previous study at Dickinson observed that variety selection can influence the severity of acidic soil issues (Beutow, 2018). This project paired lime treatments with the wheat varieties Lanning (Montana State University) and Soren (Syngenta). Soils will be sampled in the spring of 2020 to determine lime effects to soil pH.

Table 1. Chemical analysis of beet lime.

pH	Nitrate	Phosphorus	Potassium	Moisture	CCE*	EC**
	----------ppm----------			--%--		mmhos/cm
8.6	213	2576	434	13	77	1.6

*Calcium carbonate equivalence

**Electrical conductivity

Results

Beet lime treatments did impact yield at Minot (Table 2). However, beet lime did not impact yield at Dickinson. Aluminum toxicity can be exacerbated by adequate rainfall and banded phosphorus. Both study sites received phosphorus. However, Minot was much drier than Dickinson which may have caused the lack of a yield response from beet lime at Dickinson.

Table 2. Lime treatment impacts on spring wheat yield in Minot.

Treatment	Yield (bu/ac)
4 t/ac	19.3a
0.25 t/ac	18.2ab
3 t/ac	17.5ab
Check	17.0ab
1 t /ac	16.0bc
2 t/ac	15.8bc
0.5 t/ac	14.0bc
P-value	<0.05

A similar study on soybean did not observe a yield or quality impact from beet lime. However, surface applied beet lime did increase soil pH to a depth of 4 inches. The initial soil pH was measured at the end of the May. The change in pH was determined by soil collected the first week of October (Table 3).

Table 3. Surface applied beet lime effects on soil pH by depth and soil horizon.

Depth (in)	Horizon*	Initial pH	2 Beet Lime (ton/ac)	4 Beet Lime (ton/ac)
		----------pH----------		
0-2	Ap	5.33ax**	6.5bx	6.7bx
2-4	Ap	5.4ax	6.1bx	6.2bx
4-6	Ap	5.4ax	5.6ay	5.7ay
6-12	Bt	5.8ay	5.9ay	5.9ay
12-24	BtK	7.7az	7.7az	7.7az

*Horizons were determined by observing push probe samples.

**a and b show significance across treatments. x, y, and z show significance across depths within a treatment. Significance is at the 0.05 level.

Conclusions

Surface applied beet lime can improve soil pH over the course of a growing season. However, beet lime may not improve yields as observed by hard red spring wheat grown at Dickinson and soybean grown in Minot. More research is needed to develop a method to recommend lime applications to surface applied soil.

References

Buetow, R. 2018. Acidic soils in southwest, ND. p. 66-67 *In* Thirty-fifth annual western Dakota crops day research report 2018. NDSU Dickinson Research Extension Center, Dickinson, ND and NDSU Hettinger Research Extension Center, Hettinger, ND.

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