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Surface Lime Application in Long-Term No-Till Crop Production with Stratified Soil pH

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Abstract

Lime application is a key management strategy to control the acidifying effects promoted by long-term application of nitrogen (N) fertilizers and is also a source of calcium for the crops. Two field studies located in Mitchell County was carried out during 3 years (2016-2018), exploring the effect of lime application in wheat (first year), corn (second year), and soybean (third year) crops. After the first year, there was an increase in wheat yield of up to 8% with lime application. For corn (second year), liming showed a yield response of up to 10%. Soybean (third year) yield response to lime showed a 17% yield increase in one location, however, soybean yield response was inconsistent at the second location. The magnitude of response to lime application would be dependent on the initial soil pH and the sensitivity of the crop to low soil pH. Results from this study showed that lime applied to the surface (and not incorporated), can result in yield response. However, soil pH stratification after multiple years of no-till with surface N fertilizer application, showed low soil pH only near the surface, and the soil profile maintained optimum pH levels at these locations.

Keywords

soil pH, soil acidity, liming

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Summary

Lime application is a key management strategy to control the acidifying effects promoted by long-term application of nitrogen (N) fertilizers and is also a source of calcium for the crops. Two field studies located in Mitchell County was carried out during 3 years (2016-2018), exploring the effect of lime application in wheat (first year), corn (second year), and soybean (third year) crops. After the first year, there was an increase in wheat yield of up to 8% with lime application. For corn (second year), liming showed a yield response of up to 10%. Soybean (third year) yield response to lime showed a 17% yield increase in one location, however, soybean yield response was inconsistent at the second location. The magnitude of response to lime application would be dependent on the initial soil pH and the sensitivity of the crop to low soil pH. Results from this study showed that lime applied to the surface (and not incorporated), can result in yield response. However, soil pH stratification after multiple years of no-till with surface N fertilizer application, showed low soil pH only near the surface, and the soil profile maintained optimum pH levels at these locations.

Introduction

The acidification of soil is a natural process where soil pH decreases over time. This process is accelerated by agricultural production with the use of N fertilizers and can affect both the surface and subsoil depending on the N fertilizer placement. Increasing the amounts of N fertilizer rates can accelerate the soil acidification process. As a consequence of low soil pH, an increase in soluble aluminum (Al) levels can affect root growth and therefore result in poor crop growth and production. Correction of the pH/Al problem by liming can allow for more efficient use of nutrients such as N and P, as well as water (Olsen et al., 2000). In the past, lime recommendations and lime application research have focused on thorough incorporation of the lime material to the soil. However, multiple years of surface applied N in no-tillage systems often lead to a decrease in soil pH near the surface, with a stratification of soil pH (Godsey and Lamond, 2001). The objective of this study was to evaluate crop response to surface lime applications under no-till with a stratified and low soil pH near the soil surface.

Procedures

Two field sites (A and B) were established in Mitchell County, KS and evaluated during 3 years (2016, 2017, 2018); exploring the effect of lime application in wheat (first year), corn (second year), and soybean (third year). Both sites were managed with no-till for more than 25 years. The lime used in the study had 87% of effective calcium carbonate (ECC) and it was not incorporated. The studies were set the fall of 2015 using 4 lime treatments: 1) control (no lime); 2) 0.5-ton/a ECC; 3) 1-ton/a ECC; and 4) 3-ton/a ECC. The experimental design was in randomized complete blocks with 4 replications. The experimental plots were 15-ft wide × 40-ft long. Initial soil tests before lime application are presented in Figure 1.

Results

Wheat

After the first year, there was an increase in wheat yield up to 8% with lime application. At Site A, the lime application of 0.5-ton/a ECC resulted in an increase of wheat yield of about 5.9% (Figure 2A). At Site B, the 0.5 and 1.0 t/acre rate showed a response of 8.1 and 7.8%, over the control respectively (Figure 2B). Combined across the two locations there was a 5.3% yield increase to lime application in wheat. The magnitude of the response was small, however there was a consistent benefit in yield (Figure 2C).

Corn

For corn (second year), liming showed yield response of up to 10% higher yields. Corn yields were increased at both sites (Figure 3A and 3B). Considering the relative response of corn yield to lime application across the two locations there was an increase of 6% in yield (Figure 3C).

Soybean

Soybean yield response to lime (third year) varied by site, with up to 17% yield increase at Site A, but variable response at Site B. (Figure 4). The relative response of soybean yield to lime application across the two sites showed an increase of 6.5% in yield (Figure 4C).

References

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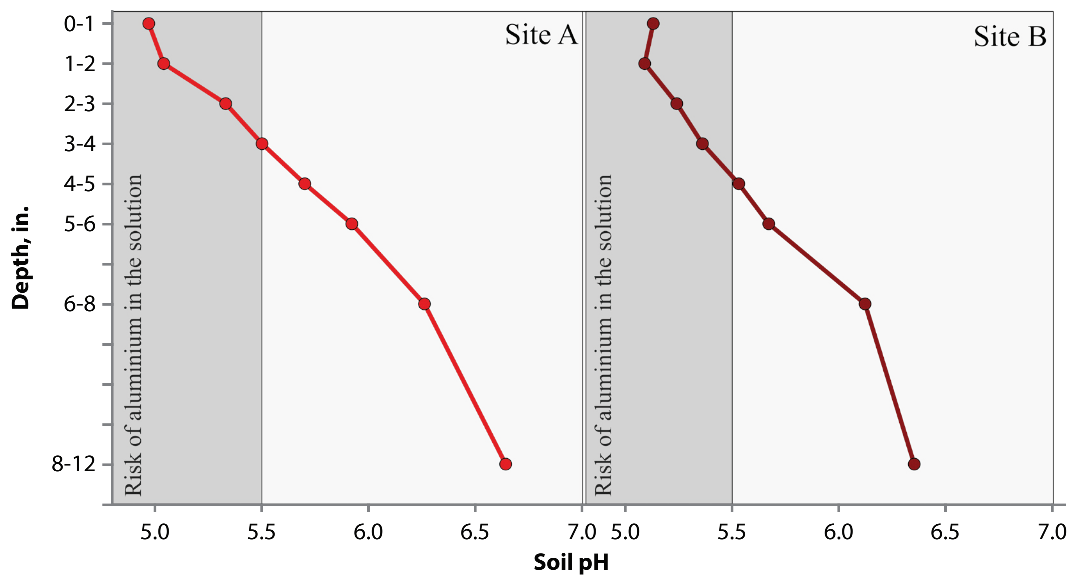

Figure 1. Initial soil pH in sites A and B in Mitchell County, KS, 2015.

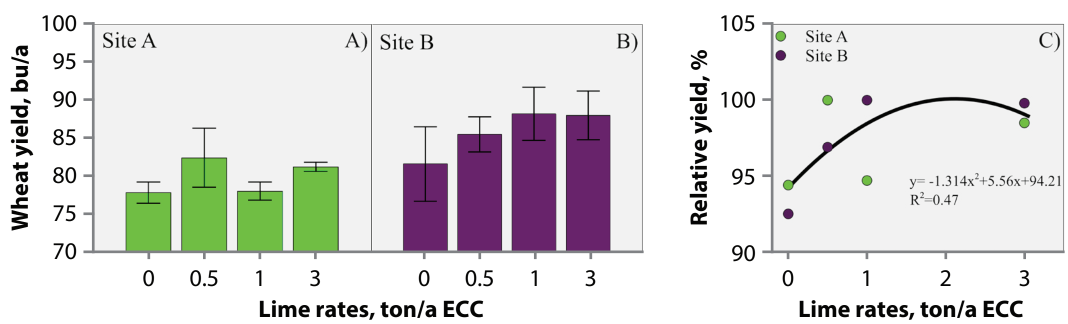

Figure 2. Wheat yield response to lime application (first year after application), 2016.

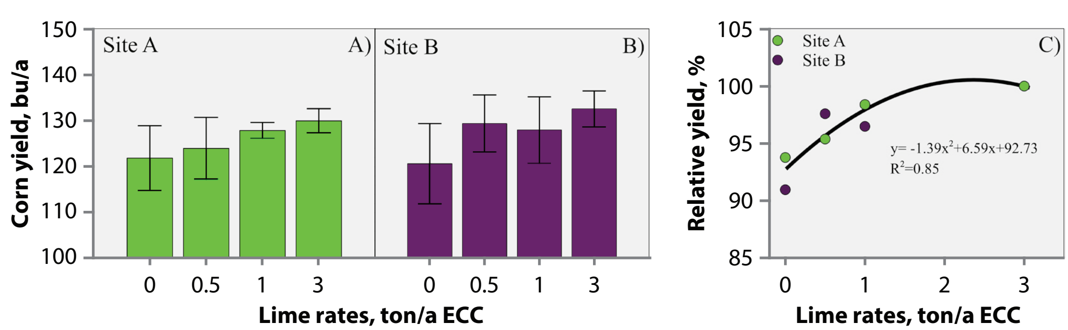

Figure 3. Corn yield response to lime application (second year after application), 2017.

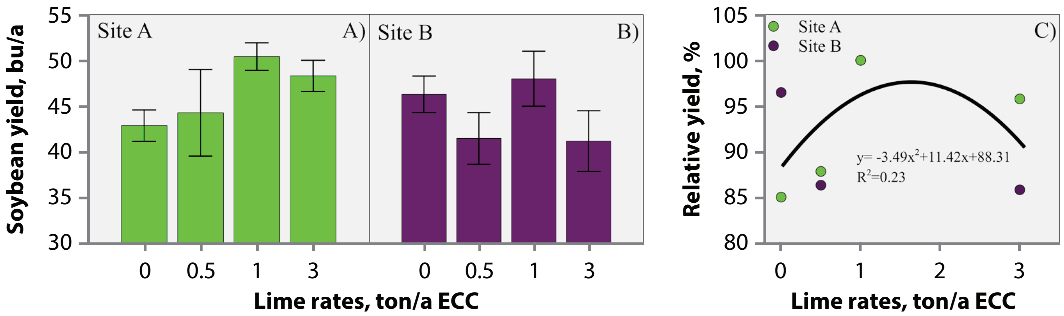

Figure 4. Soybean yield response to lime application (third year after application), 2018.