

Soil chemical attributes affected by superficial application of lime and silicate

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Abstract

The experiment carried out in Botucatu-SP, Brazil, on a clayey Oxisol was to evaluate the effects of lime and Ca+Mg silicate on soil chemical attributes, months after 6 superficial applications. The treatments consisted of two sources for acidity correction (lime and Ca+Mg silicate) and a control. Organic matter, pH, base saturation, extractable H+Al, P, Ca, Mg, Al³⁺ and Si levels were evaluated. Results were submitted to variance analysis and means were compared by the t test (LSD) at a probability level of 5%. Silicate and lime increased pH down to 0.10-0.20m and 0.00-0.05m, respectively. Both treatments decreased H+Al levels at the depths 0.00-0.05 and 0.10-0.20m. Ca and Mg levels increased at the depths 0.00-0.20 and 0.00-0.10m, respectively. Silicate increased extractable P levels down to 0.10m, emphasizing the influence of Si on P availability.

Key Words

Slag, calcium carbonate, base leaching.

Introduction

Liming is essential to successfully obtain high crop yields due to great benefits in soil acidity correction, Ca and Mg supply and aluminum toxicity decrease. In no tillage system, liming is superficially applied, with no incorporation. However, this method is still dubious, because of lime's low water-solubility and reactivity. Although lime is the most used product for soil correction, Ca and Mg silicates provided by slag are also efficient. These materials are similar to lime. Besides increasing pH, exchangeable Ca and Mg and P availability, they also decrease Fe, Al and Mn toxicity. These products also provide Si, which is not considered an essential element, but it is beneficial to some crops. The use of these materials in no tillage systems is a feasible alternative for soil acidity correction, considering that some silicate sources are more soluble than lime and thus contribute with better and faster correction in deeper layers, providing Si to plants. This study objective was to evaluate soil chemical attributes affected by superficial application of lime and silicate.

Methods

The experiment was carried out on Lageado Experimental Farm, College of Agricultural Sciences - UNESP, in Botucatu-SP, Brazil. The soil was a deep acid clayey Oxisol. According to the Köppen classification, climate is Cwa, with dry winter and hot rainy summer. The experimental design was a completely randomized block with sixteen replications. Treatments consisted of two sources for soil acidity correction (lime and Ca+Mg silicate) and a control. Plots were 5.4m wide and 10m long, totaling 54m². At random, six samples in the useful area of each subplot were taken in the interrows of the previous crop, to obtain a composite sample. As correction sources, dolomitic lime (ECC = 90%, CaO = 36% and MgO = 12%), Agrosilício[®] (Ca+Mg silicate / ECC = 80%, CaO = 34%, MgO = 10% and SiO₂ = 22%). Dolomitic lime was obtained in Formiga-MG, Brazil, because it was similar to the Agrosilício[®] for Ca and Mg levels. Doses of 4.0 and 4.5 t/ha of dolomitic lime and Ca+Mg silicate, respectively, were applied superficially, after moisture correction. In the same area, the soybean crop was cultivated. Soil chemical characteristics (pH, base saturation, H+Al, P, Ca, Mg and Al³⁺) were evaluated 6 months (April of 2007) after the application, at the depths 0.00-0.05m, 0.05-0.10m, 0.10-0.20m, 0.20-0.40m and 0.40-0.60m. Samples were dried and sieved and analyzed for pH, EC and extractable elements according to Raij *et al.* (2001). Data was submitted to variance analysis. Means for lime and silicate applications were compared by the t test (LSD) at a probability level of 5%. Chemical attributes of the soil profile, sampled 6 months after application, are shown individually for each product (lime, silicate and control, with no application).

Results

In Figure 1 are the pH (A), H+Al (B), Al³⁺ (C), base saturation (V%, D), Ca (E), Mg (F), P (G) and Si (H) values 6 months after application. For pH results, it was observed that both sources were efficient in the

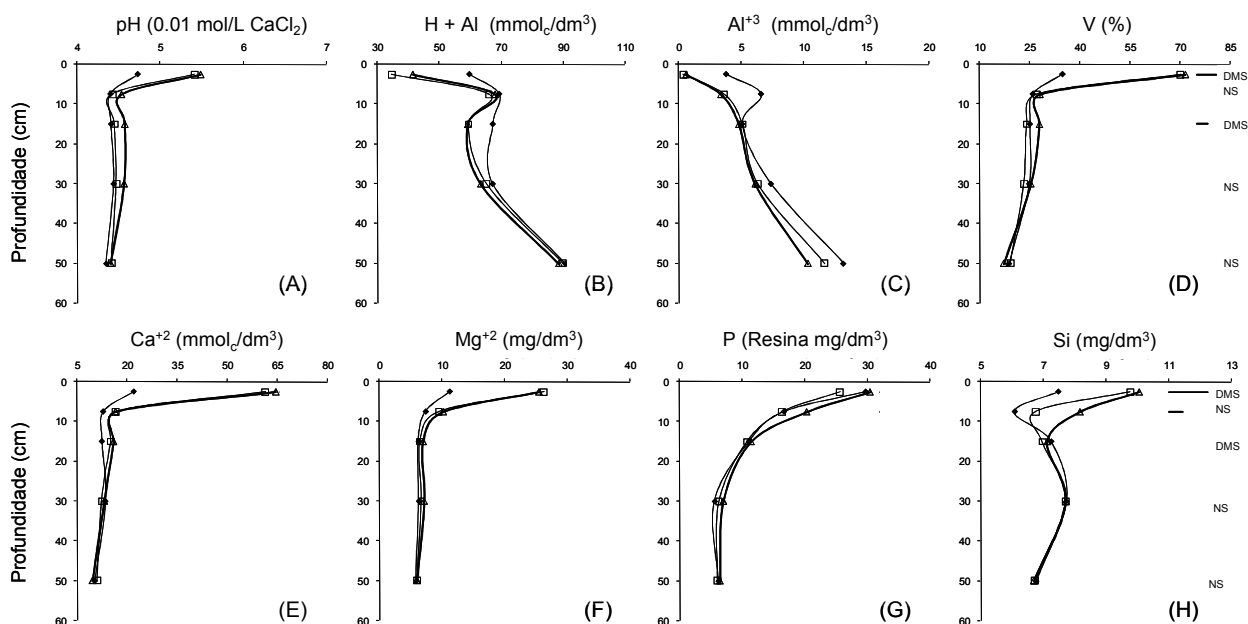


Figure 1. pH (A), H+Al (B), Al³⁺ (C), base saturation (V%, D), Ca (E), Mg (F), P(G) and Si (H) levels in soil affected by materials used for acidity correction (lime - □; silicate - Δ; control - ♦).

upper layer (0.00-0.05m). Conversely, at the depth 0.05-0.20m, only the silicate increased pH compared to the control. Corrêa *et al.* (2007) studied the effects of lime and silicate in soil profile and reported that silicate increased pH down to 0.40m by only three months after application. Meanwhile, the same dose of lime increased pH down to 0.05m. The authors inferred that silicate application increases ion mobility faster than lime. Alcarde (1985) concluded that silicate is 6.78 times more soluble than calcium carbonate and thus the benefits are observed in deeper layers faster than other materials. Silicate is considered a feasible alternative for superficial application aimed at soil acidity correction in no tillage systems.

Aluminum toxicity limits plant growth in acid soils, inhibiting root development and, consequently, nutrient uptake. H+Al values (Figure 1B) were significantly affected by the correction material. It was observed that soil potential acidity was lower at the depths 0.00-0.05 and 0.10-0.20m, which indicates the beneficial effects of these products in decreasing acidity values down the profile. Similar effects were found for exchangeable Al (Figure 1C), but only in the two upper layers. This occurs due to an increase in hydroxyl concentration, reacting with H⁺ from the soil solution, resulting in Al precipitation as Al(OH)₃, which is not toxic to plants (Pavan and Oliveira 2000).

Figure 1D showed that base saturation (V%) was considerably affected by the products for the depth 0.00-0.05m, reaching 70%, which is the value sought for the calculation of acidity correction. On the other hand, in the depth 0.10-0.20m, only the value for silicate application was higher than the control. These effects in deeper soil layers may be related to a higher water-solubility compared to lime and also because the area was already under an established no tillage system. As for Ca (Figure 1E), levels were higher down to 0.10-0.20m whenever any products were applied. The effects on Mg levels (Figure 1F) were observed only down to 0.05-0.10 m. Ca and Mg leaching occurs because when pH is increased in superficial layers, the HCO₃⁻ ion followed by Ca and Mg is mobilized down to deeper layers for acidity reaction, increasing the levels of these nutrients. In field conditions, Corrêa *et al.* (2007) found similar results. The authors observed higher Ca and Mg levels for the depth 0.00-0.10m only three months after silicate application. On the contrary, effects were only for the depth 0.00-0.05m when the same dose of lime was applied.

Silicate application increased extractable P levels down to 0.05m compared to liming, but it did not differ from the control (Figure 1G) However, silicate application increased P levels in the depth 0.05-0.10m compared to the other treatments. Pulz *et al.* (2008) studied the application of lime and silicate to poor soils and observed that P availability increased when soil acidity was corrected with silicate. According to Plucknet (1972), silicate application increases P solubility in soil and decreases fixation. Silicon (Figure 1H) increased in the superficial layer for both materials, even considering that lime does not provide this element directly. Liming increased Si levels in the depth 0.00-0.05m, probably due to solubilization of silica

components, because of pH increase and/or due to lower capacity of absorption sites, keeping higher levels in the soil solution. Nevertheless, for both Si values in the depth 0.05-0.10m (Figure 1H) and pH (Figure 1A), lime application did not show any effects, and only silicate increased Si levels. In deeper layers, both materials affected Si levels compared to the control. Positive effects of silicate on Si levels were expected, because it is considered an important source of this element for plants. Pulz *et al.* (2008) also observed higher Si levels for silicate application compared to liming.

Conclusion

Silicate and lime increased pH down to 0.10-0.20m and 0.00-0.05m, respectively. Both treatments decreased H+Al levels in the depths 0.00-0.05 and 0.10-0.20m. Silicate and lime increased Ca and Mg levels in the depths 0.00-0.20 and 0.00-0.10m, respectively. Silicate increased P levels down to 0.10m, emphasizing the Si influence on P availability.

References

- Alcarde JC (1985) Corretivos da acidez dos solos: características de qualidade. In 'Seminário sobre corretivos agrícolas'. (Ed E Malavolta) pp.97 – 117. (Piracicaba: Fundação Cargill).
- Corrêa JC, Büll LT, Crusciol CAC, Marcelino R, Mauad M (2007) Correção da acidez e mobilidade de íons em Latossolo com aplicação superficial de escória, lama cal, lodos de esgoto e calcário. *Pesquisa Agropecuária Brasileira* **42**, 1307-1317.
- Pavan MA, Oliveira EL (2000) Calagem em plantio direto. In: Encontro Nacional de Plantio Direto na Palha, 7, 2000, Foz do Iguaçu. *Resumos*. pp.125 – 129. (Foz do Iguaçu: Federação Brasileira de Plantio Direto na Palha).
- Plucknett DL The use of soluble silicates in Hawaii agriculture. *Univ. Queenl. Pap.* **1**, 203-223, 19
- Pulz AL, Crusciol CAC, Lemos LB, Soratto RP (2008) Influencia de silicato e calcário na nutrição, produtividade e qualidade de batata sob deficiência hídrica. *R. Bras. Ci. Solo* **32**, 1651-1659.
- Raij B van, Andrade JC, Cantarella H, Quaggio JA (2001) 'Análise química para avaliação da fertilidade do solo'. (Campinas: Instituto Agronômico).