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Interaction effects of organic materials and lime on grain yield and nutrient aquisition of three maize varieties grown in an Oxisol of the Colombian eastern plains

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Abstract

An experiment was conducted in order to study the effects of some interactions resulting from the addition of organic materials (Cowpea residues and chicken manure) and two levels of lime, (0 and 1500 kg ha^{-1} dolomite lime) on the grain yield and nutrient acquisition of three maize genotypes with contrasting genetic background. The experiment design was a randomised block with factorial arrangement and four replications. Grain yield increased in treatments that received either 5t ha^{-1} cowpea, residues 5 t ha^{-1} chicken manure, or 1500 kg ha^{-1} dolomite lime. Yield improvement was higher in the Al sensitive variety, (ICA-V 109) than in the Al tolerant variety, (Sikuani-V110). Treatments that received only chicken manure had grain yield slightly higher than treatments with 1500 kg ha^{-1} of lime. There was a positive effect on grain yield and nutrient acquisition in treatments both, organic materials and dolomite lime. Leaf concentration of N, P, Ca, Mg and K were higher with the incorporation of cowpea residues, chicken manure and lime. The Al tolerant variety Sikuani V-110 had higher leaf concentrations of Al, N, P, Mn and Fe. The results indicated that the varieties which are more efficient in nutrient uptake under aluminum stress had a good chance to grow well in acid soils low in nutrients. Furthermore, the results also confirmed the importance to preserve and/or increase the soil organic matter in agricultural production systems which is particularly recommended for the acid soils of the Eastern Plains of Colombia.

Introduction

Soil acidity, high Al saturation and low soil fertility are the major soil constraints for agricultural production in the savannas of the Eastern Plains of Colombia (Blamey *et al.*, 1990). Limestone incorporation and genotype tolerance to Al are some of the strategies to overcome soil acidity (Valencia and Leal, 1996). The use of organic matter is another way to diminish the toxic effect of Al in plants and also to increase the availability and uptake of mineral nutrients in plants (Hargrove and Thomas, 1981; Rodriguez, 1998).

Materials and methods

The study was conducted in a fine, kaolinic soil, isohypertermic tropeptic haplorthox of the Eastern Plains of Colombia. Two sources of organic matter, chicken manure and cowpea residues, at two rates, (0 and 5 t ha^{-1}), two lime levels, (0 and 1.5 t ha^{-1}) and three maize varieties were evaluated in a randomised complete block design with factorial arrangement of treatments. Maize genotypes with contrasting genetic background were use in this study: Sikuani V-110 (Al tolerant variety), Clavito (traditional maize cultivar) and ICA V 109 (Al susceptible variety) Grain yield was obtained by harvesting three main rows from each plot. For analysis of nutrient concentrations ear leaves were collected at initial silk stage.

Results

A positive interaction was observed for grain yield when 5 t ha^{-1} of chicken manure or cowpea residues were incorporated into the soil together with 1.5 t ha^{-1} of dolomite lime (Tab. 1). The grain yield increase was more pronounced in the Al susceptible variety ICA V 109 than in the Al tolerant genotype and the traditional cultivar. The Al susceptible variety ICA V 109 had the highest grain yield (4481 kg ha^{-1}) with applications of 5 t ha^{-1} of chicken manure and 1.5 t ha^{-1} of dolomite lime. The increases of grain yield of maize varieties were higher with the incorporation of 5 t ha^{-1} of chicken manure than with the application of 1500 kg ha^{-1} of dolomite lime (Tab. 1).

Genotypical differences were found in Al and P concentrations of maize leaves. The Al tolerant cultivar Sikuani V 110 had five times higher leaf Al concentrations than the Al susceptible variety ICA V 109 and the traditional cultivar Clavito (Tab. 2). Leaf P concentration were higher in maize grown with 5 t ha^{-1} of chicken manure. No significant increase was found in leaf P concentrations with the addition of lime or cowpea residues (Tab 3). Leaf P concentrations in all varieties ranged between 3.2 mg g^{-1} and 6.1 mg g^{-1}. Similar as with P, the Al tolerant variety had higher N, Mn and Fe than the Al susceptible and the traditional cultivar.

Discussion

The results from this study indicate that the Oxisols of the Eastern Plains of Colombia could be used successfully for agriculture production if the soil chemical constraints have been resolved. The positive interaction between dolomite lime and chicken manure increased the grain yield of the maize genotypes and improved the uptake of mineral nutrients by the plants. Similar results have also

been found by Ahmad and Tan (1986) and Estrada et al. (1995).

The Al tolerant genotypes Sikuani V 110 is highly efficient in uptake and utilization of mineral nutrients under Al stress. Therefore, this genotype had a great advantage in growth and production in acid soils low in mineral nutrients like the Oxisol of the Eastern Plains. The high leaf Al concentration in the Al tolerant genotype indicates that genotypic differences among species in the ability to tolerate high amounts of toxic Al in the soil should be chosen (Taylor 1987).

The results also confirm the importance to preserve and/or increase the soil organic matter content of agri-cultural production systems which is highly recommend-ed for the acid soils of the Eastern Plains of Colombia.

References

Ahmad F and Tan KH 1986 Soil Sci. Soc. Am. J. 50, 656-661.

Blamey F, Wheeler D, Edwards D and Christie R 1990 J. Plant Nutr. 13, 713-728.

Estrada G, Diaz AL and Figueiredo AF 1995 Suelos Ecuatoriales 25, 57-60. Bogotá Colombia.

Hargrove WL and Thomas GW 1981 *In* Chemistry in the Soil Environment, American Society of Agronomy and Soil Science of America. pp. 151-165. Wisconsin USA.

Rodríguez HF, Lozano Y and Rojas LA 1998 Trabajo de Grado, Departamento de Química, Universidad Nacional de Colombia: Santa fe de Bogotá D.C.

Taylor GJ 1987 J. Plant Nutr. 10, 1213-1222.

Valencia R and Leal D 1996 Suelos Ecuatoriales 26, 35-44.

Table 1. Grain yields of three maize genotypes (kg ha^{-1}) as affected by application of organic matter and lime.

Variety	Not Organic matter		Cowpea residues		Chicken manure	
	Without lime	1.5 t ha^{-1} lime	Without lime	1.5 t ha^{-1} lime	Without lime	1.5 t ha^{-1} lime
Sikuani	3723	3796	3820	4027	4122	4333
Clavito	1734	2541	2748	2669	3103	3331
ICA V109	2201	2988	3262	3402	3762	4481

C.V= 7.8. r^2= 0..91. L.S.D.=106

Table 2. Concentration of Al in leaves (mg g^{-1}) as affected by application of organic matter and lime.

Variety	Not Organic matter		Cowpea residues		Chicken manure	
	Without lime	1.5 t ha^{-1} lime	Without lime	1.5 t ha^{-1} lime	Without lime	1.5 t ha^{-1} lime
Sikuani	500	580	770	400	420	690
Clavito	70	30	70	120	30	30
ICA V109	80	40	60	20	80	80

C.V= 177.6. r^2= 0..57. L.S.D.=230

Table 3. Concentration of P in leaves (mg g^{-1}) as affected by application of organic matter and lime.

Variety	Not Organic matter		Cowpea residues		Chicken manure	
	Without lime	1.5 t ha^{-1} lime	Without lime	1.5 t ha^{-1} lime	Without lime	1.5 t ha^{-1} lime
Sikuani	4.6	4.4	4.4	4.6	5.6	6.1
Clavito	3.2	3.6	3.5	3.7	5.0	4.0
ICA V109	4.0	4.2	3.9	4.3	5.2	5.4

C.V= 13.4. r^2= 0.74. L.S.D.=0.30