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# INFLUENCE OF $NH_4$-EXCHANGED CLINOPTILOLITE ON NUTRIENT CONCENTRATIONS IN SORGHUM-SUDANGRASS

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## ABSTRACT

The ability of $NH_4$-exchanged clinoptilolite to influence the uptake of nutrients by sorghum-sudangrass was tested in greenhouse experiments in soil-phosphate rock (P-rock)-ammonium ($NH_4$)-zeolite systems in which soil pH decreased with increasing $NH_4$-clinoptilolite content (Weld and Red Feather soils, classified as Aridic Argiustoll and Lithic Cryoboralf, respectively) and in which the amount of $NH_4$-clinoptilolite had little influence on soil pH (Keith soil, a Typic Argiustoll). Clinoptilolite-P-rock ratios of 0 to as much as 7.5 were used, with P rates of 100 to as much as 400 mg P/kg soil. Top growth was harvested at 3- to 6-week intervals to obtain 5 or 6 cuttings. Nutrient uptake was studied by analysis of dried plant tissues, and the available nutrients remaining in the soil were determined using ammonium bicarbonate diethylenetriaminepentaacetic acid (AB-DTPA) extraction. The addition of $NH_4$-clinoptilolite increased yields by as much as 65% over control experiments and significantly increased the concentrations of nutrient elements in plant matter. For example, P was increased by as much as 100%, Cu by 100%, Mn by 450%, Ca by 50%, Mg by 30%, and Zn by 70%. Uptake of some nutrients may have been enhanced by an increase in their solubility due to a lowering of soil pH by as much as 2 units caused by nitrification of $NH_4$ ions with time. The concentrations of Cu and Mn in sudangrass, however, increased 23% and 12%, respectively, with increasing $NH_4$-clinoptilolite application rate independent from a pH effect for the Keith soil, suggesting that an ion-exchange mechanism may have enhanced availability. This concept is supported by an increase in AB-DTPA extractable soil elements (e.g., as much as 250% increase for Cu) with increasing clinoptilolite/P-rock ratio (0 to 6) for the Keith soil-P-rock-zeolite system used in plant growth experiments.

Similar extraction experiments using mixtures of $NH_4$-clinoptilolite and P-rock without soil at constant pH also demonstrated an increase in the availability of nutrients over that expected from simple mixtures (e.g., a two orders of magnitude increase in extractable Cu was noted over that predicted from a simple mixing of P-rock and zeolite), further emphasizing the importance of chemical reaction (i.e., ion-exchange) to nutrient release. The $NH_4$-clinoptilolite may have inhibited the uptake of K by plant tissues by as much as 50% in some experiments, suggesting that K-saturated clinoptilolite be used in K-poor soils.

## INTRODUCTION

Zeolites are a class of non-swelling, porous, aluminous, tectosilicate minerals that have a large cation-exchange capacity (100 to 300 meq/100 g) and a large water-holding capacity (Mumpton, 1984). The most exploitable zeolites occur in enormous, near-