Effects of Amending Phosphatic Fertilizers with Clinoptilolite Zeolite on Phosphorus Availability and Its Fractionation in an Acid Soil

ABSTRACT

Soils of the tropics are highly weathered, acidic, and low in phosphorus (P) because of high contents of Al and Fe. Satisfactory P supply is essential to ensure optimum soil and crop productivity. Thus, there is a need for amending soils with zeolite to improve availability of P in acid soils as this mineral can fix Fe and Al instead of P. This study was undertaken to determine the transformations of P fertilizers in acid soils following application of Clinoptilolite zeolite (CZ) in laboratory (incubation) and pot trials. An acid soil was incubated with a recommended fertilization rate and a reduced amount of the existing recommended fertilization by 25% but substituting this reduction with an equivalent amount of CZ. Triple superphosphate (TSP), Egypt Rock phosphate (ERP), and Christmas Island Rock phosphate (CIRP) were used as P sources. Selected soil chemical properties, inorganic P fractions, available P, and total P of the native soil were determined before and after the laboratory and pot trials. Zea mays L. (test crop) plant dry matter production, P concentration, P uptake, and P use efficiency were also determined using standard procedures. Effects of the treatments with CZ compared to the recommended fertilization on P fixation were similar. In the laboratory study, the treatments with TSP showed lower dominance of Fe–P but more pronounced in Al–P, whereas for the RPs, Ca–P was dominant. In the pot study, Al–P, Ca–P, and Fe–P were rather pronounced in the treatments with TSP, ERP, and CIRP, respectively. There was a decrease in exchangeable Al and soil titratable acidity because of the ability of the CZ to increase soil pH. Although the availability of P was not significant with the inclusion of CZ in the incubation study, dry matter production, P concentration, P uptake, and P use efficiency in the pot trial were comparable with that of the existing/recommended fertilization, suggesting that the CZ is beneficial and could be used to reduce the P fertilizer requirement for Zea mays L. cultivation on acid soils. Regardless of type of P fertilizer, prevalence of the moderately labile P fractions (Al–P, Fe–P, and Ca–P) of the incubation and pot studies acted as slow-release P sources to contribute to long-term P release. Further studies on the potential of CZ to reduce fertilization and its effects on soil and crop productivity are essential. It is also important to determine the economic benefits of including CZ in Zea mays L. cultivation.