FERTILISER N EFFICIENCY IN RICE PRODUCTION: I. EVALUATION OF K, MG AND CU STATUS AND THEIR ADSORPTION BEHAVIOUR IN RICE SOILS UNDER MUDA IRRIGATION SCHEME

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Introduction

Most rice soils of Malaysia are deficient in N. Therefore, fertiliser N application is essential to meet the demands of the crop but if any one of the other essential nutrients is deficient in soil, crops cannot utilise the applied N properly and consequently efficiency of N becomes lower. Recent investigations showed that rice crops suffer from Cu and Mg deficiency in many sites in the Muda Irrigation Scheme, the largest rice growing area of Malaysia. Copper deficiency is due to low soil Cu status whereas Mg deficiency is attributed to high K content in soil, which restricts Mg uptake. Therefore, it is necessary to know the K, Mg and Cu status of the soils of this area to recommend proper fertiliser dose. When any nutrient element like K, Mg or Cu is applied to the soil, a substantial portion of it is adsorbed in the soil. The adsorption phenomenon depends on soil properties. It is also important to know the K, Mg and Cu adsorption behaviour of different soils to recommend appropriate fertiliser rate. The objective of this study was to evaluate K, Mg and Cu status of different rice soils and adsorption behaviour of these three elements in some selected rice soils in the Muda Irrigation Scheme, Kedah.

Materials and Methods

Soil samples were collected from fifteen locations under fifteen soil series from the Muda Irrigation Scheme, Kedah. The samples consisted of 11 marine alluvial soils and 4 riverine alluvial soils. The samples were analysed for exchangeable K, Mg and available Cu. Potassium and Mg were analysed by 1 N ammonium acetate extraction method. Available Cu was analysed by 0.05 N HCl extraction method. Copper adsorption study was carried out in three selected soils (Idris, Tebengau and Kangar), differing in pH, CEC and organic matter content. Different amounts of Cu (0, 100, 200, 300, 400 and 500 µg/g) were added to the soil samples and incubated at room temperature for 15 days. After 15 days, Cu content in the supernatant solutions was measured by atomic absorption spectrophotometer and the amount of Cu adsorbed (µg/g) was calculated. The adsorption data were fitted into Langmuir, Freundlich and Temkin equations. Maximum adsorption capacity was calculated from Langmuir equation while buffering capacity (capacity of soil to retain the adsorbed Cu) was calculated from Temkin equation. Similarly, K and Mg adsorption studies were carried out in three selected soils (Guar, Hutan and Kangar), differing in pH, CEC and organic matter content.

Results and Discussion

The contents of K, Mg and Cu ranged from 0.12 to 0.44 cmol/kg, 0.09 to 6.17 cmol/kg and 0.04 to 3.10 mg/kg, respectively. Deficiency of K, Mg and Cu was found in 4, 3 nd 6 soils, respectively. The average K and Mg contents of marine alluvial soils were higher than those of riverine alluvial soils. On the other hand, the average Cu content in marine alluvial soils was lower than that of riverine alluvial soils. Copper adsorption increased gradually with increasing level of added Cu in all the soils. The rate of increase was the highest in Kangar series followed by Tebengau and Idris, respectively. Correlation between Cu adsorption and pH was significant ($r = 0.772$) whereas correlation of adsorption with either organic matter content or cation exchange capacity was non-significant. In Idris and Tebengau series, Cu adsorption data fitted in Langmuir, Freundlich and Temkin equations whereas Cu adsorption data in other soil (kangar) fitted in Freundlich and Temkin equations. Maximum Cu adsorption capacity was 833 mg/kg in Tebengau series while it was only 588 mg/kg in Idris series. Copper buffering capacity was the highest in Kangar series (1030 mg/kg) followed by Tebengau (170 mg/kg) and Idris (116 mg/kg), respectively. Correlation between Mg adsorption and pH was significant ($r = 0.949$) whereas correlation of Mg adsorption with cation exchange capacity or organic matter content was not significant. Maximum adsorption capacity was the highest in Kangar (57 mmol/kg) followed by Hutan (48 mmol/kg) and guar (23 mmol/kg), respectively. Correlation between K adsorption and pH was significant ($r = 0.881$) whereas correlation between K adsorption with either organic matter content and cation exchange capacity was not significant. Maximum adsorption capacity was the highest in Guar (112 mmol/kg) followed by Kangar (50 mmol/kg) and Hutan (34 mmol/kg), respectively.

Conclusions

Deficiencies of K, Mg and Cu occur in different rice soils in the Muda Irrigation Scheme. It indicates the necessity to conduct experiments on K, Mg and Cu response of rice in order to recommend appropriate fertiliser rate in different soils to obtain higher yield over the present yield level. Adsorption of K, Mg and Cu depends on soil pH. In soils with higher adsorption capacity of an element, more fertiliser material containing that element may be needed to get immediate crop response.

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