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CHANGES IN DIFFERENT FORMS OF K IN RICE RHIZOSPHERE UNDER K APPLICATION

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Abstract

A pot experiment was conducted with four soils from two locations (BAU farm, Mymensingh and BADC farm, Madhupur, Tangail) in order to monitor the transformation of added K (soil solution K, exchangeable K^+ and non-exchangeable K) in BRRI dhan-41 rhizosphere at saturation condition. There were six levels of K viz., 0, 30, 60, 90,120 & 150 kg/ha from MoP. Eight kg soil was taken into each pot. The K concentration in soil solution increased with increasing K addition and decreased with increasing incubation period. Soil solution K was drastically reduced at 45 days due to higher crop uptake. The amount of exchangeable K also increased with increment of added K and gradually decreased over time. The non-exchangeable K increased up to 45 days and then decreased up to 105 days.

Keywords: Rice rhizosphere, exchangeable K^+, non-exchangeable K.

Introduction

The positively charged K ions that are held at the edges of the clay layers and towards the outer edge of any interlayer space can be replaced easily by other cations. Quantities of K released from clay and silt fractions were comparable and twice as high as from sand fractions. Interlayer K released from silt and clay fractions, is important for plant K nutrition and thus, it should be considered in K fertilizer management. The released K comes into the soil solution from where it is taken up by plant roots. Potassium in the most interior phase in the interlayer space can only be exchanged slowly. A reverse of the above process occurs when the concentration of K in the soil solution is increased due to the addition of fertilizers and manures. The release of K is governed by the composition and concentration of the soil solution (Beckett, 1964). As a result of the later process, a reserve of potassium is built up in soils.

Fortunately, some soils contain considerable amount of non-exchangeable but slowly available forms of this element. But the capacity of soils to supply nutrients is gradually declining over time due to intensive cropping with high yielding varieties. For this reason, farmers routinely apply sufficient K containing

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fertilizer to meet plant needs (Johnston, 1997). Therefore, the present work was designed to understand the K transformation in soil, namely soil solution K, exchangeable K^+ and non-exchangeable K pools.

Materials and Method

An experiment was conducted with four soils (BAU-1, BAU-2, Madhupur-l, and Madhupur-2) from two locations (BAU farm, Mymensingh and BADC farm, Madhupur, Tangail) under net house condition at BAU, Mymensingh. The texture of soils was loam to silt loam. The pH of BADC farm soils was 4.83 to 5.22 and BAU farm soils 6.52 to 6.72. The organic matter (0.77 to 0.87%) and exchangeable K (0.087 to 0.097 cmol/kg) contents of BAU-l and Madhupur-1 soils were close to each other. The status of BAU-2 soil for both organic matter (1.18%) and exchangeable K^+ (0.146 cmol/kg) was found higher compared to BAU-l and Madhupur-1 soils and lower than Madhupur-2 soil. The Madhupur-2 soil contained higher amount of organic matter (1.29%) and exchangeable K^+ (0.706 cmol/kg) compared to the other soils. The CEC of Madhupur-2 and BAU-2 soils (12.58 and 12.51 cmol/kg) were very close and higher than BAU-1 (11.12 cmol/kg) and Madhupur-1 (9.50 cmol/kg) soils. Calcium and Mg contents were higher in BAU farm soil (4 to 5.50 cmol/kg) than in BADC farm soil (1.50 to 3.50 cmol/kg). Mica was higher in BADC farm soil (33-35%) while vermiculite was higher in BAU farm soil (14- 18%) (Table 1).There was six levels of K, such as 0, 30, 60, 90, 120 and 150 kg/ha. Nitrogen, P and S were used as basal application. The doses were 67 kg N/ha, 14 kg P/ha, and 5 kg S/ha for BAU-1 soil, 54 kg N/ha, 14 kg P/ha, and 4 kg S/ha for BAU-2 soil, 60 kg N/ha for Madhupur-1 soil and 52 kg N/ha for Madhupur-2 soil. Phosphorus and S fertilizers were not applied in Madhupur-I and Madhupur-2 soils as their status was sufficient for rice cultivation. The experiment was designed in CRD with 3 replications. Eight kg soil was taken into each plastic plot. There were 72 plastic pots for this experiment. Soil and soil solution samples were collected from each pot at 15–day intervals up to crop harvest. A porous plastic bottle wrapped with filter paper fitted with two 2-mm diameter rubber tubes were installed in the pot at rhizosphere. Soil solution was collected from each bottle using 50 mL plastic syringe and carried to the laboratory and analyzed for K. Potassium was determined in the soil solution by flame photometer. Saturated soil samples were collected from each plastic pot inserting an auger like spatula up to root zone pressing by hand and kept into air tightly polythene bags. Collected soil samples were taken to the laboratory and analyzed. Exchangeable K was determined in the samples using neutral IN NH_4OAC extraction method. Non-exchangeable K was also determined in the same samples using Modified Hunter and Pratt's method (1957).

Results and Discussion

Soil solution K: Soil solution was collected at 15–day intervals from transplanting (0 DAT) to maturity (105 DAT). The collected soil solution samples were analyzed for K. Soil solution K concentration was the highest at 0 DAT, decreased gradually and reached a steady state at 75 to 105 DAT (Fig. 1). Potassium concentration in soil solution gradually decreased with increasing growing period up to panicle initiation due to higher K uptake by rice (Yamakawa *et al.*, 2004; Filep, 2002). Conducting field experiment at BAU farm in Boro and T. Aman seasons, Abedin Mian *et al.* (1991) and Afroz (2009) found that the concentration of K in soil solution increased with the increasing rate of K application but decreased with time. The K concentration was always the highest in Madhupur-2 soil followed by Madhupur-1 and the lowest in BAU-1 soil.

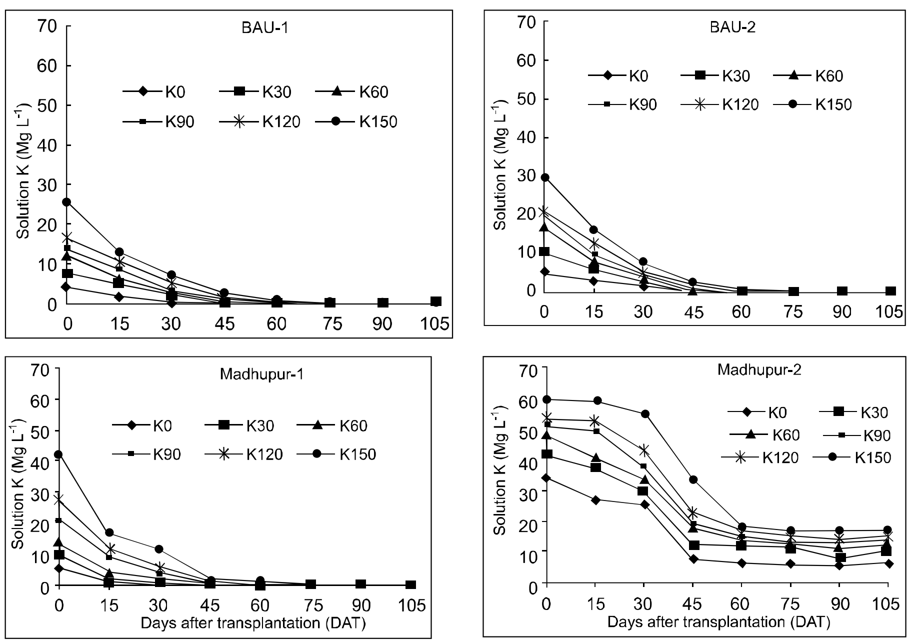

Fig. 1. Solution K in saturated soil under T. Aman rice culture

The initial soil solution K at 0 DAT was 4 mg/L in BAU-1 soil, 5 mg/L in BAU-2 soil, 6 mg/L in Madhupur-1 soil and 34 mg/L in Madhupur-2 soil. The concentration increased to 25, 30, 42, and 59 mg/L in BAU-1, BAU-2, Madhupur-l, and Madhupur-2 soils, respectively when K was applied to these soils. Soil solution K concentration decreased to 0.21 mg/L at 45 DAT in K0 pot of BAU-1, BAU-2, and Madhupur-1 soils, while solution K reached this level at 60 DAT in K_{30} pot of BAU-l, BAU-2 and Madhupur-1 soils. At 75 DAT, the soil solutions K in the pots of BAU-1, BAU-2, and Madhupur-1 soils, receiving 60 to 150 kg K/ha soil reached to 0.20 mg/L. The Madhupur-2 soil showed a higher level of K in soil solution throughout the growing season. The K control pot of Madhupur-2 soil showed 27 mg/L K at 15 DAT, which decreased to 6 to 8 mg/L during 60 to 105 DAT. Soil solution K concentration in K treated pots had 11 to 17 mg/L at 75 DAT, 8 to 17 mg/L at 90 DAT, and 7 to 14 mg/L at 105 DAT.

Exchangeable K: Results of exchangeable K^+ due to K application are presented in Fig. 2. The exchangeable K^+ ranged from 0.023 to 0.224, 0.035 to 0.280, 0.037 to 0.329 and 0.105 to 1.06 cmol/kg soil in BAU-1, BAU-2, Madhupur-1, and Madhupur-2, respectively, at 0 to 150 kg K/ha application. The exchangeable K was the highest at 0 DAT in all soils and then progressively decreased with the growing period of rice. Thippeswamy *et al*. (2000) reported that exchangeable K increased with increasing K doses up to 80 kg K/ha and then decreased with growth stages of crop from tillering to harvesting. The exchangeable K at 0 DAT was the highest in Madhupur-2 soil and the lowest was in Madhupur-1 soil. At 0 DAT, the exchangeable K in K_0 pot was 0.119, 0.134, 0.084, and 0.850 cmol/kg soil in BAU-1, BAU-2, Madhupur-1 and Madhupur-2 soils, respectively. Application of K fertilizer increased the exchangeable K^+ in all saturated soils at 0 DAT. Receiving K applications (150 kg/ha), exchangeable K increased to 0.224, 0.281, and 0.329 cmol/kg soil in BAU-1, BAU-2, Madhupur-l soils, respectively, and in K rich Madhupur-2 soil it increased to 1.06 emol/kg soil. The exchangeable K was drastically reduced to 0.035 cmol/kg soil at 60 DAT in K_0 pot of BAU-l soil, while this level reached in BAU-2 at 105 DAT. In Madhupur-l soil, the exchangeable K^+ drastically decreased in pot at 30 DAT. In Madhupur-2 soil, such reduction in exchangeable K^+ was also noted at 30 DAT. In all the 4 soils, the exchangeable K^+ in both treated and untreated pots progressively decreased at 75 DAT and maintained almost stable values between 90 and 105 DAT. The Madhupur-2 soil showed a higher level of K throughout the growing period of rice. The control pots of Madhupur-2 soil showed 0.853 cmol/kg soil, which decreased to 0.105 to 0.154 cmol/kg that was higher than that of other soils.

Non-exchangeable K: Changes in non-exchangeable K due to K application are shown in the Fig 3. In general, the amount of non-exchangeable K increased with the increasing incubation period irrespective of K levels up to 45 days and thereafter decreased up to 105 days. The highest amount of non-exchangeable K (3.49 me%) was found in BAU-l soil compared to other soils due to presence of higher vermiculite (18%) and the lowest value was exhibited in Madhupur-l soil due to absence of vermiculite (Table 1). Similar results were reported by (Singh and Moniker, 1976; Kansal and Sekhon, 1976; Talele *et al.*, 1993).

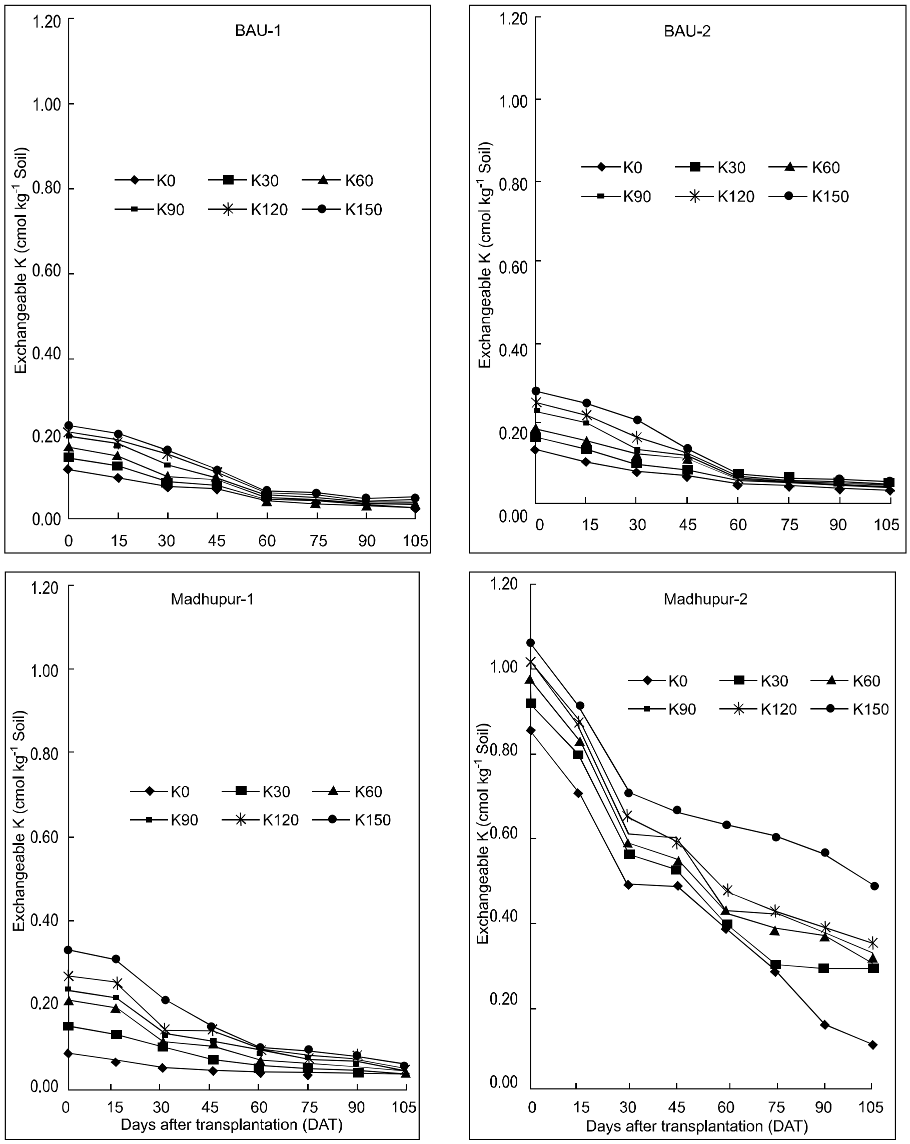

Fig. 2. Exchangeable K in saturated oil under T.Aman rice culture

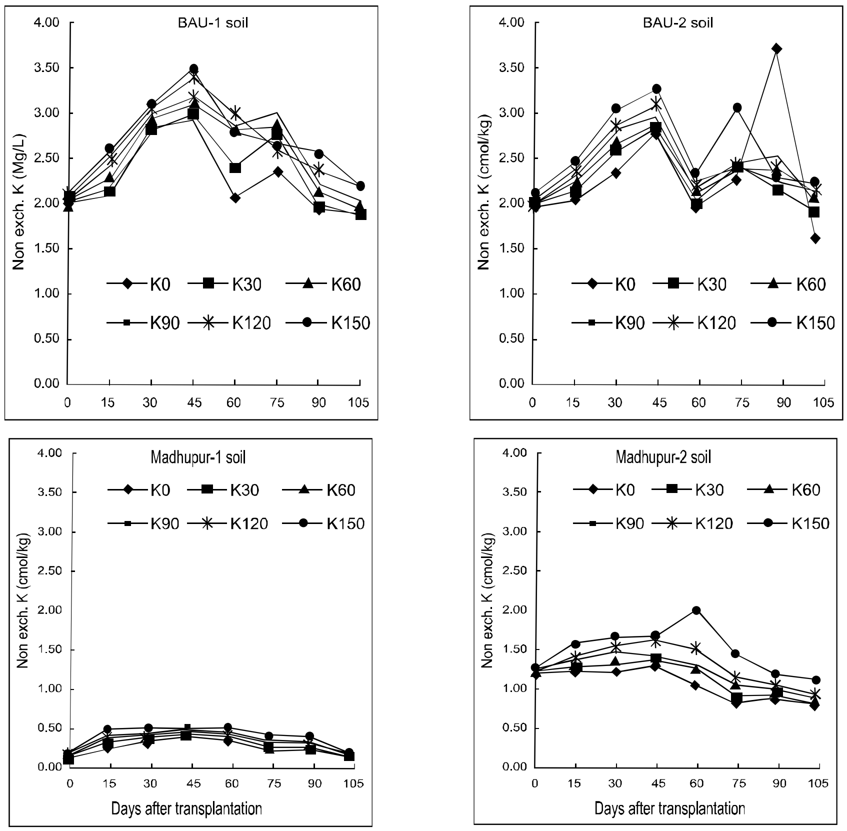

Fig. 3. Non-exchangeable K in saturated under T. Aman rice culture.

Table 1. Mineralogical properties of BAU and BADC farm soils (0-15 cm)

Clay minerals (%)	Soils			
	BAU-1	BAU-2	Madhupur-l	Madhupur-2
Mica	24.0	32.0	33.0	35.0
Smectite	-	1.0	-	-
Vermiculite	18.0	14.0	-	11.0
Chloride	17.0	26.0	6.0	8.0
Kaolinite	7.0	13.0	19.0	26.0
Vermiculite- Chlorite	18.0	-	7.0	-
Vermiculite-Smectite	-	-	26.0	7.0
lnterstratified Mica— Chloride	6.0	4.0	-	-
Quartz	3.0	5.0	7.0	9.0
Goethite	2.0	1.0	1.0	-
Lepidocrocite	4.0	1.0	-	1.0
Feldspar	1.0	3.0	1.0	3.0

Conclusion

Soil solution K and exchangeable K increased with added K. These forms of K decreased with time after crop transplantation and at 45 DAT drastic reduction was found. Thus, split application of K would give better result instead of single application. The amount of non- exchangeable K decreased inconsistently with time.

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