

AVAILABLE SOIL K AND Ca IN THE RHIZOSPHERE OF RICE, MAIZE, SOYBEAN AND JUTE¹

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ABSTRACT

The extent to which roots of rice, maize, soybean and jute affect the availability (exchangeable plus water soluble) of K and Ca by inducing changes in the rhizosphere soil was measured at different stages of plant growth under field conditions. The rhizosphere of all crop species maintained higher level of available K and Ca than non-rhizosphere soil. The efficiency of the different species in maintaining available K was in the order, soybean > maize > capsularis jute = olitorius jute > lowland rice > upland rice. In maintaining available Ca the effect of capsularis jute was maximum followed by that of soybean and olitorius jute. The effect of other crop species followed the order, maize > upland rice > lowland rice. However, at 45 days of growth stage, the sequence of species differences changed, the greatest effect being shown by soybean and maize followed by capsularis jute.

KEY WORDS : Available Ca, Available K, Rhizosphere

INTRODUCTION

A knowledge of the concentration changes of nutrient elements in the rhizosphere of different crop species would be useful for a better understanding of the mechanisms of nutrient uptake by crops. In a recent study it was found that $\text{NH}_4\text{-N}$ and $\text{NO}_3\text{-N}$ concentrations in the rhizosphere soil vary with crop species and their growth stages (Ahad and Debnath, 1988). This study was extended to determine the extent to which roots of rice, maize, soybean and jute affect availability of K and Ca in the rhizosphere. The results are discussed in this paper.

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MATERIALS AND METHODS

The experiment was conducted in the District Seed Farm of Bidhan Chandra Krishi Viswavidalaya, West Bengal, India. The soil was alluvial with pH 8.6, organic C 0.49%, total N 0.05%, 0.5 M NaHCO₃ extractable P 11.2 ppm, CEC 8.8 me/100 g soil, NH₄⁺ — N 8.7 ppm, NO₃⁻ — N 6.6 ppm, exch. Ca 6.6 me/100 g soil and exch. K 0.80 me/100 g soil. The crops used in the study were capsularis jute (*C. capsularis* L.) cv JRC—7447, olitorius jute (*C. olitorius* L.) cv JRO—632, soybean (*Glycine max* L.) cv Improved Pelikan, maize (*Zea mays* L.) cv Population'61 and rice (*Oryza sativa* L.) cv IR—36. The rhizosphere effect of rice was studied both under upland and lowland conditions. The plot size of the experiment was 2m × 2m. The experiment was laid out in a randomized block design with 3 replicates. In each replicate there was a plot which was kept fallow. Thus in all there were 7 treatments. The crops were grown without any fertilizer. In growing the crops recommended cultural operations were followed. The fallow plots were kept free of weeds throughout the growing season of the crops. At intervals of 45, 75 and 105 days after sowing rhizosphere and non-rhizosphere soil samples were collected as described in an earlier study (Sarkar *et al.*, 1979; Ahad and Debnath, 1988). The soils were then air-dried under shade, ground and analysed. Exchangeable K and Ca were extracted by leaching the soil with neutral 1N NH₄ OAc. Potassium was determined by flame photometry and Ca by EDTA titration using EBT and Calcon indicators (Hesse, 1971).

RESULTS AND DISCUSSION

Exchangeable plus water soluble K (Available K)

The results of the rhizosphere effect of different plant species on the exchangeable plus water soluble K, designated as available K, are presented in Table 1. The main effects of the species show that all the species of crop maintained higher level of available K in the rhizosphere soil than in the non-rhizosphere soil. The magnitude of the effect was maximum in soybean followed by that in maize. The effects of other four crops were in the order, lowland rice, two species of jute and upland rice. The two species of jute were similar in their effect. The main effect of growth stages shows that with the advancement of crop growth available K of soil slightly increased. The interaction between

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the growth stages and the species was significant. At the 45 day growth stage maize and lowland rice did not significantly differ from the non-rhizosphere soil, whereas both at 45 and 75 days of growth stages, upland rice had lower level of available K than the non-rhizosphere soil. At 105 days of growth stage however upland rice maintained higher available K in its rhizosphere which was higher than that of the jute species.

Exchangeable plus water soluble Ca (Available Ca)

The results of the effect of rhizosphere of different crop species on the available soil Ca are presented in Table 2. The main effect of the species shows that on an average, all the species of crop maintained higher available Ca in the rhizosphere than in the non-rhizosphere soil. The effects of different crop species were in the order, capsularis jute > soybean = olitorius jute > maize > upland rice > lowland rice. On an average, available Ca level of soil was minimum at 75 days of growth stage. The interaction between the crop species and growth stages was significant. Though in the main effect capsularis jute ranked first followed by soybean, olitorius jute and maize, at 45 days of growth stage soybean and maize showed the highest effect followed by capsularis jute. In other two growth stages (75 and 105 days) the species differences followed the same sequence as in the main effect.

These results were similar to those obtained by Barber and Ozanne (1970). Using autoradiography they found that Ca accumulated around the roots of ryegrass, subclover and capeweed as a result of much less Ca absorption compared to that provided by mass flow. Calcium accumulation was greatest for ryegrass and least for capeweed. It is relevant to mention that Riley and Barber (1970) who measured accumulation of salt by extracting soil from the rhizosphere and non-rhizosphere of soybean found that the accumulation of salts in the rhizosphere tended to reach a maximum value that was 5 to 15 times the salt content in the non-rhizosphere soil.

The increase in available K and Ca in the rhizosphere is probably due to solubilization of K and Ca by CO_2 and other organic acids produced by the root and microbial activities. The reason for higher microbial

population in the rhizosphere may be due to organic exudates from roots, debris from root cap cells and stuffing of root hair and exodermal cell (Rovira and Davey, 1974).

The species differences in maintaining available K or Ca may be due to differences among the crop species in the quantity and composition of the organic compounds formed by them. The variations in the amount of acids produced in the rhizosphere of different crops species may not always be reflected in the soil pH because of the fact that the acids produced may be utilized in chemical reactions leading to the solubilisation of insoluble forms of K, Ca etc.

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Table 1. Rhizosphere effect of some species of crop on available soil K at different growth stages

<i>Crop species</i>	<i>Exchangeable plus water soluble K (mg/100 g)</i>			
	<i>Days after sowing</i>			<i>Mean</i>
	<i>45</i>	<i>75</i>	<i>105</i>	
Jute (<i>Capsularis</i>)	31.7	31.2	31.9	31.6
Jute (<i>Olitorius</i>)	31.3	30.8	33.2	31.8
Soybean	36.1	42.2	45.6	41.3
Maize	30.2	36.6	41.0	35.9
Upland rice	28.3	28.9	35.0	30.7
Lowland rice	30.3	33.4	33.5	32.4
Non-rhizosphere	30.1	30.3	30.8	30.4
Mean	31.1	33.3	35.9	—

CD at 0.05 level

(a) Main effect of days	0.196
(b) Main effect of species	0.313
(c) Interaction (days × species)	0.547

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Table 2. Rhizosphere effect of some species of crop on available soil Ca at different growth stages

<i>Crop species</i>	<i>Exchangeable plus water soluble Ca (mg/100 g)</i>			
	<i>Days after sowing</i>			<i>Mean</i>
	<i>45</i>	<i>75</i>	<i>105</i>	
Jute (<i>Capsularis</i>)	140.0	138.6	144.2	141.2
Jute (<i>Olitorius</i>)	138.8	134.7	142.5	138.7
Soybean	142.2	133.9	141.9	139.3
Maize	140.6	131.4	133.4	135.1
Upland rice	125.2	117.9	131.4	124.8
Lowland rice	121.0	113.6	128.9	121.2
Non-rhizosphere	103.2	105.1	102.9	103.7
Mean	130.3	125.0	132.2	—

CD at 0.05 level

(a) Main effect of days	0.696
(b) Main effect of species	1.064
(c) Interaction (days × species)	1.846