Tropical Agricultural Research Vol. 1 1989

Changes of Potassium Reserves in an Alfisol under Irrigated Paddy at Different Potassium and Nitrogen Levels

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ABSTRACT. Mobility of K reserves in an Alfisol under irrigated paddy was studied at different K and N levels at 0-20, 20-40 and 40-60 cm depths. The design was a RCBD with three replicates. K and N levels studied were 0, 45 and 90 kg/ha, and 0, 45, 90, 130 and 180 kg/ha respectively. Soil samples were drawn from each plot at transplanting, one month and two months after transplanting and at harvest. K reserves were determined by HF/HCl digestion.

All treatments showed considerable changes in K reserves. During the first month after transplanting a decreasing tendency of K was observed irrespective of treatments. The tendency of change of K reserves during the second month after transplanting up to the harvest was increasing. Generally lowest K reserves were observed at the 3rd sampling. This may have been caused by the intensive K uptake. The observed latter increases reaching almost the initial reserve levels could be due to low rate of K uptake and supply of K by TDM and irrigation water.

There were no significant differences of K reserves related to different K levels and different sampling stages. This phenomenon was common for first and third depths whereas only in the second depth the differences were significant.

INTRODUCTION

In soils potassium occurs in soluble, exchangeable and non-exchangeable forms, and it has been postulated that an equilibrium may exist between these forms. It can be shown that plants absorb required potassium from the soil solution and that the rate of uptake depends on the potassium concentration in the soil solution. If the exchangeable and water soluble potassium of a soil do not change after cropping, it indicates that an amount equalent to that taken up by the plant has been released from non-exchangeable sources, which are sometimes considered as K reserves. Therefore, it would be worthwhile to investigate the mobility of potassium reserves to find out the contribution of this pool towards the potassium nutrition of plants. It has been demonstrated by many studies that the availability of potassium is governed by the complimentary ions on the exchangeable complex and soil properties such as pH, texture, type of clay minerals, content of calcium carbonate and content of organic matter etc. (Guptha *et al.*, 1977).

Plants fulfill a part of their potassium requirements by contact exchange. The major phenomenon of potassium uptake is the replacement of potassium ions from the exchange complex to the soil solution from where plants take up potassium easily. The potassium ions present on soil exchange complex thus have to be primarily replaced by other cations to bring those in to soil solution. Therefore, such cation replacements also play an important role in potassium availability to plants.

Complimentary ions like ammonium play a major role in potassium dynamic mainly due to their similarity in ionic radii (Tisdale *et al.*, 1985).

Van Diest (1980) showed that an application of nitrogen positively influences the availability of non-exchangeable potassium.

However, not much work has been carried out to examine the mobility of non-exchangeable pool in Sri Lankan soils. As paddy cultivation plays a significant role in the Sri Lankan economy, this study was undertaken mainly to examine the changes of non-exchangeable potassium pool of an Alfisol in relation to different levels of nitrogen as well as K applications and K uptake by irrigated paddy at different soil depths.

MATERIALS AND METHODS

An Alfisol in Mahailluppallama under irrigated rice was selected for the field experiment. An experimental procedure was adopted to study the periodical changes of reserve potassium at different potassium levels, at three different depths and five different levels of applied nitrogen. Field design was a RCBD with three replicates.

The K levels studied were 0, 45 and 90 kg/ha and N levels studied were 0, 45, 90, 130 and 180 kg/ha. It was indicated as N1, N2, N3, N4 and N5. The depths considered were; 0 – 20, 20 – 40 and 40 – 60 cm.

Composite soil samples were drawen from each plot at 1. transplanting, 2. at one month and 3. at second month after transplanting as well as 4. at harvest. All soil samples were stored in the deep freezer, to minimize any changes due to drying. The reserve K in the fresh soil samples were extracted using HF/HCl method as described by Silva and Bremner (1966), and the concentration of each extraction was measured using an atomic absorption spectrophotometer, (Perkin Elmer, Model 2380).

RESULTS AND DISCUSSION

The behaviour of potassium reserves in all treatments considered in this study is illustrated in the Figures 1, 2 and 3.

All treatments showed considerable changes in potassium reserves with time. However, during the first month after transplanting a general decreasing tendency of potassium was observed irrespective of treatments except for the N_4 K_2 combination at the third depth. Similarly, the tendency of change the K reserves during second month after transplanting up to the harvest was increasing except for N_3 K_0 combination of the first depth. Generally, lowest the K reserves were observed at the second month after transplanting. The possible reason for this decrease of potassium reserves up to the second month may have been due to the intensive potassium up take by plants. The observed latter increases could be considered as results of the low rate of potassium uptake as well as potassium fertilizers and potassium in irrigation water.

Potassium in irrigation water should be the only source for increasing K reserves in K – 0 level. The concentration of irrigation water during the experimental period was between 2 – 7 ppm.

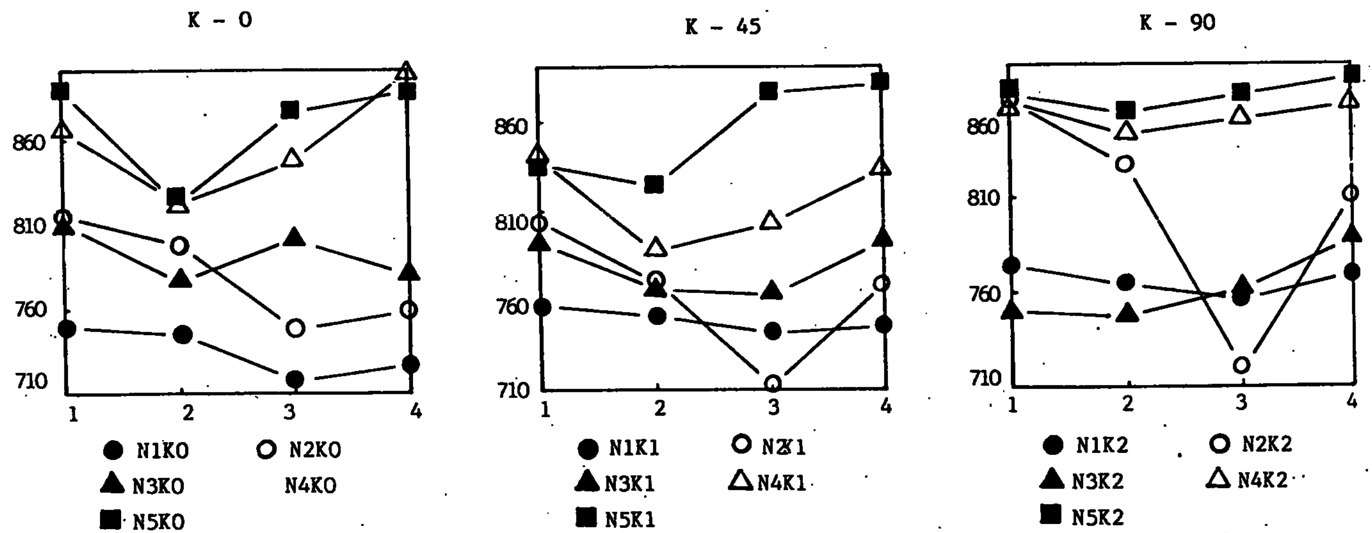

Fig.1. Periodical changes of K - reserves in the 0 - 20 cm depth.

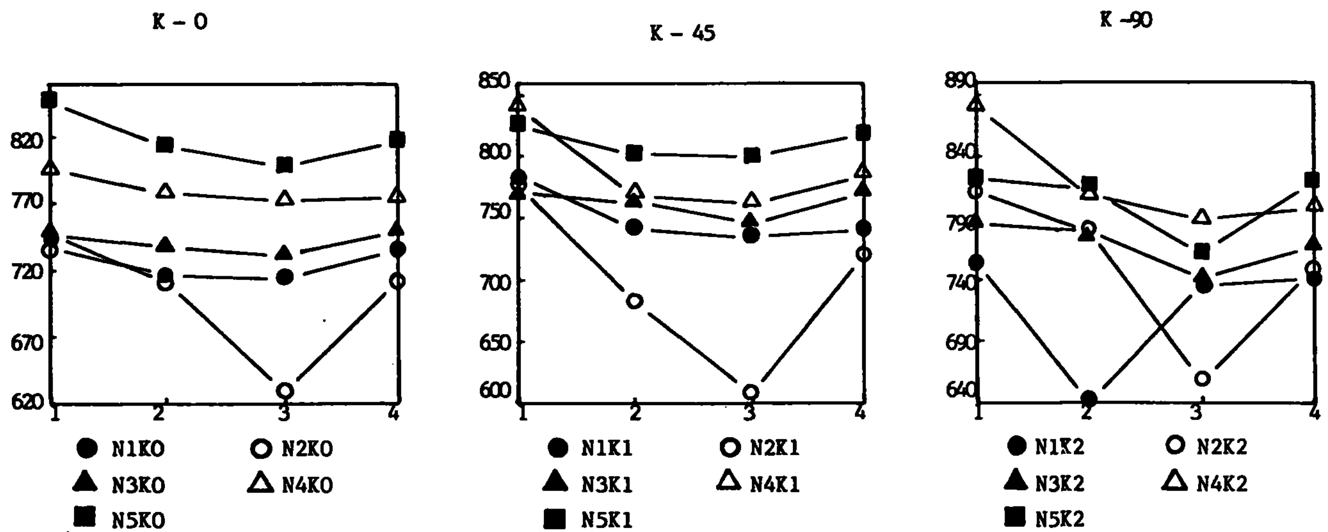

Fig.2. Periodical changes of K - reserves in the 20 - 40 cm depth.

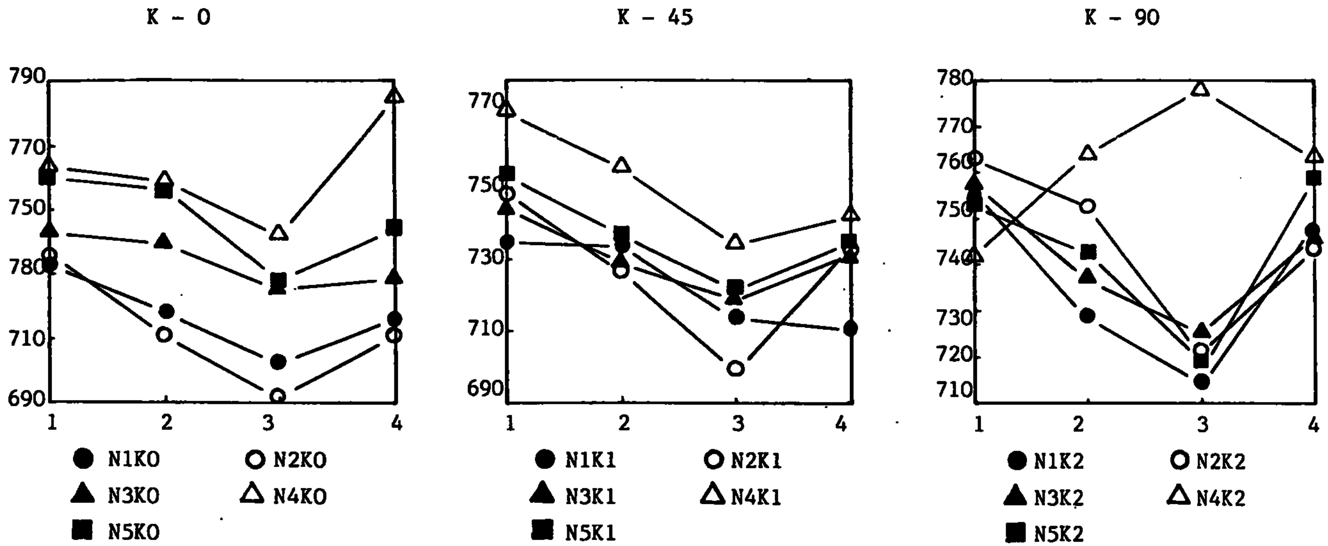

Fig.3. Periodical changes of K - reserves in the 40 -60 cm depth.

Possible rooting depth of rice may vary up to 1 meter. During the period between first and the second month after transplanting, some roots may have reached the depth 20 – 40 cm and even the depth 40 – 60 cm. These roots also take up potassium. This phenomenon may have also contribute to the decreasing potassium reserves very rapidly at depths 20 – 40 cm.

Statistical analysis revealed, that there were no significant differences of potassium reserves to different potassium levels as well as different sampling stages. This phenomenon was common for the first and third depth where as only in the second depth, significant differences were observed. (Table 1).

Table 1. Changes of mean K reserves at sampling stages and different K levels.

Stages	K – 0	K – 45	K – 90
1	774.54 a	799.85 a	810.91 a
2	751.36 a	751.17 b	763.63 b
3	728.28 a	729.73 b	736.69 b
4	756.81 a	766.72 b	774.84 b

In a column means followed by a common letter is not significantly different at 5% level.

When the aspect of various nitrogen levels was considered related to mean K reserves, the first and second depth significant differences were observed as indicated in the Tables 2, 3 and 4.

Table 2. Mean K reserves at different nitrogen levels at depth 0 – 20 cm (first depth).

Nitrogen levels	Mean values (ppm)
0	749.71 b
45	782.68 b
90	777.23 b
135	842.74 a
180	862.51 a

In a column means followed by a common letter is not significantly different at 5% level.

Table 3. Mean K reserves at different nitrogen levels at depth 20 – 40 cm (second depth).

Nitrogen levels	Mean values (ppm)
0	731.04 bc
45	715.45 c
90	757.13 b
135	795.68 a
180	810.95 a

In a column means followed by a common letter is not significantly different at 5% level.

Table 4. Mean K reserves at different nitrogen levels at depth 40–60 cm (third depth).

Nitrogen levels	Mean values (ppm)
0	725.61 a
45	728.12 a
90	735.44 a
135	758.10 a
180	742.13 a

In a column means followed by a common letter is not significantly different at 5% level.

Similarly Tables 5, 6 and 7 indicate mean K reserves at different K levels and N levels at respective depths. These also indicate significant differences between different N levels, specially between the lower and higher levels.

Table 5. Mean K reserves at different K levels and different N levels at depth 0–20 cm (first depth).

Nitrogen	K – 0	K – 45	K – 90
0	734.60 b	748.94 c	765.57 bc
45	779.68 b	763.79 bc	804.55 ab
90	791.75 b	778.38 bc	761.52 bc
135	858.52 a	815.92 ab	853.76 a
180	869.03 a	854.10 a	864.37 a

In a column means followed by a common letter is not significantly different at 5% level.

Table 6. Mean K reserves at different K levels and different N levels at depth 20 – 40 cm (second depth).

Nitrogen	K – 0	K – 45	K – 90
0	725.54 c	749.62 bc	717.95 bc
45	700.11 c	697.11 c	749.12 bc
90	740.80 cb	726.64 c	767.91 ab
135	779.35 ab	788.76 ab	818.91 a
180	817.93 a	811.21 a	803.68 a

In a column means followed by a common letter is not significantly different at 5% level.

Table 7. Mean K reserves at different K levels and different N levels at depth 40 – 60 cm (third depth).

Nitrogen	K – 0	K – 45	K – 90
0	717.37 a	720.10 a	736.34 a
45	712.43 a	727.04 a	744.86 a
90	734.00 a	730.80 a	741.49 a
135	762.03 a	750.76 a	761.49 a
180	747.00 a	736.35 a	743.00 a

In a column means followed by a common letter is not significantly different at 5% level.

The changes in K reserves thus illustrated that there was an influence of N levels. At higher nitrogen levels (135 and 180 kg/ha) higher amounts of K reserves were observed which was common for the first and second depth. The information available does not elaborate the exact reasons for such differences. Results of this study show low difference in reserves specially at higher level of N applied when stages are considered indicating a reduced uptake.

ACKNOWLEDGEMENTS

The financial support provided by CIDA/NARESA is greatfully acknowledged. Our thanks are also due to Mr. P.T. Bandara, R.A.R.S., Maha-Illuppallama for his invaluable assistance and help in conducting field experiments.

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