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# INFLUENCE OF HIGH DENSITY MULTISPECIES CROPPING ON THE P AND K FORMS IN THE SOIL*

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## ABSTRACT

An account of gain or loss of different fractions of P and K in the soil under the coconut based high density multispecies cropping system over a period of three years has been worked out in a light textured soil at C. P. C. R. I. Kasaragod. In general, all the P fractions increased due to the high density in three year period. Building up of Fe–P in the soil was not marked as compared to Al-P and Ca-P. The Al-P content in the soil of coconut basin of multispecies as well as monocrop is very high at 0-25 cm and 25-50 cms. Wide variation in this fraction in the interspaces of high density and monocropping was noticed. There was a general increase in all the fractions of K over a period of three years cropped with different species. However, soil sampled from breadfruit, nutmeg, coffee, pineapple and subabul showed negative gain. Fixed K showed an accumulation in the basins of the crop species over three years. Water soluble K was more in monocrop basin as compared to the multispecies at 0-25 and 25-50 cms depth. Soil from interspace showed reverse trend.

## INTRODUCTION

The philosophy of multiple cropping primarily consists of maximising crop production from a unit piece of land in unit time without causing soil deterioration. The multitude variables influencing the fertilizer use efficiency in this system (Engelstad and Russel, 1975) complicated due to selective use of fertilizer for individual crop. The root studies of coconut have shown that it utilises effectively about 23 per cent of the total area under cultivation. About 74 per cent of the roots do not extend beyond 2 meters from the base. On a depth basis 80 per cent of the roots are confined to 31 cm to 120 cm layer of the soil (Nelliat, Bavappa and Nair, 1974). This indicate that sufficient area is available to grow compatible intercrops in the coconut garden (Bavappa et al, 1986). Thus the multispecies system in the coconut garden not only influences the productivity but also the nutrient availability and microbial activity in the soil through efficient nutrient recycling process. The crop utilisation of applied nutrients is limited to the extent of its removal during specified period. The enrichment and depletion process of nutrients in the systems through biological and chemical means results in the accumulation of certain nutrients and faster depletion of other nutrients from the soil.

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Thus the present study has been aimed to evaluate the P and K distribution into various chemical forms in the soil as influenced by multispecies cropping as against monocropping system.

MATERIALS AND METHODS

Different species of crops were interplanted during 1983 in an 18 year old coconut plantation (1.2 ha) spaced at 8 x 8 m, in the experimental farm at CPCRI, Kasaragod. The soil is light textured sandy loam, well drained deep with 82 per cent sand, 13 per cent clay and 4 per cent silt (Aranic Peleustault). Soil pH ranged from 5.3 to 5.5, available P ranged from 37 to 47 ppm, available K ranged from 159 to 189 ppm. The coconut was grown as rainfed crop till the commencement of the present experiment where the perfo-spray irrigation was given during summer months (Dec. to May), The cultural and manurial practices recommended for each crop was followed. The fertilizer application was made at the rate of 1/3rd, 2/3rd and full quantity recommended for each crop in separate blocks as given in Table I. The P and K fractionation in the soil was carried out only in treatments receiving full dose of fertilizers.

Composite soil samples were drawn from 0-25 and 25-50 cm depth from basins of 3 coconut palms as well as component crops in each sub plot, receiving full dose of fertilizer, during pre-treatment as well as post-treatment 3 years after the commencement of the experiment. Similarly soil samples were drawn from monocropping plots. The samples were processed and analysed for P fractions according to Chang and Jackson (1957) and K fractions as per the procedure followed by Biddappa and Sarkunan (1981).

RESULTS AND DISCUSSION

The data on the P fractions of the soil collected from different crop basins have been summarised in Table II. In general, all P fractions have been increased over a period of 3 years. The saloid bound P has gained maximum in soils of coconut followed by nutmeg. The least amount of gain has been recorded in the soil cultured with subabul, banana and clove. A negligible gain was recorded in the soil of coffee. This indicates that some of these crops exhausted the loosely bound soil phosphorus quickly than that of coconut. Almost a similar trend of results were obtained for Al–P. The maximum Al–P

Table I. *Quantity of fertilizers applied per plant per year (full dose) (gms)*

| Crops | N (as urea) | $P_2O_5$ (as super phosphate) | $K_2O$ (as muriate of potash) | Crops | N (as urea) | $P_2O_5$ (as super phosphate) | $K_2O$ (as muriate of potash) |
|---|---|---|---|---|---|---|---|
| Coconut | 500 | 220 | 1000 | Clove | 300 | 250 | 750 |
| Lime | 300 | 250 | 750 | Banana | 200 | 200 | 400 |
| Breadfruit | 500 | 200 | 1000 | Pineapple | 8 | 4 | 12 |
| Nutmeg | 500 | 200 | 1000 | Subabul | — | 60 | 30 |
| Sapota | 300 | 250 | 750 | Pepper | 100 | 40 | 140 |
| Coffee | 12 | 9 | 12 | | | | |

Table II. *Influence of crop species in coconut garden on the P fractions*

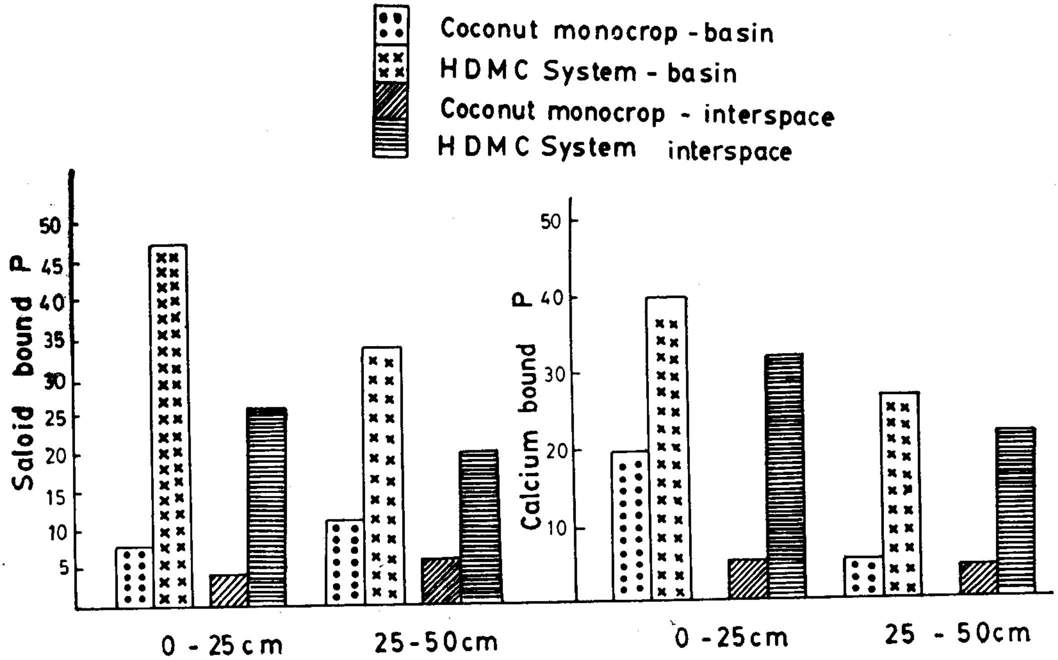
| Crop | Depth (cm) | Saloid bound P (ppm) | | Gain or Loss | Al–P (ppm) | | Gain or Loss | Fe–P (ppm) | | Gain or Loss | Ca–P (ppm) | | Gain or Loss |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1983 | 1986 | | 1983 | 1986 | | 1983 | 1986 | | 1983 | 1986 | |
| Coconut | 0–25 | 2.67 | 47.5 | 44.8 | 38.9 | 217.6 | 178.7 | 92.6 | 97.7 | 5.1 | 3.5 | 40.3 | 36.8 |
| | 25–50 | 2.03 | 34.4 | 32.4 | 15.1 | 277.7 | 262.6 | 54.2 | 85.8 | 31.6 | 3.9 | 27.0 | 23.1 |
| Lime | 0–25 | 2.1 | 16.0 | 13.9 | 32.7 | 65.0 | 32.3 | 86.8 | 123.5 | 36.7 | 4.6 | 10.0 | 5.4 |
| | 25–50 | 1.4 | 12.5 | 11.1 | 8.0 | 32.0 | 24.0 | 42.4 | 47.5 | 5.1 | 4.6 | 8.5 | 3.9 |
| Breadfruit | 0–25 | 2.1 | 6.0 | 3.9 | 32.7 | 56.0 | 23.3 | 86.8 | 95.0 | 8.2 | 4.6 | 12.5 | 7.9 |
| | 25–50 | 1.4 | 6.0 | 4.6 | 8.0 | 46.0 | 38.0 | 42.4 | 69.5 | 27.1 | 4.6 | 11.3 | 6.7 |
| Nutmeg | 0–25 | 2.1 | 26.0 | 23.9 | 32.7 | 81.0 | 48.3 | 86.8 | 86.6 | –0.2 | 4.6 | 12.5 | 7.9 |
| | 25–50 | 1.4 | 11.5 | 10.1 | 8.0 | 21.5 | 13.5 | 42.4 | 39.5 | –2.9 | 4.6 | 6.0 | 1.4 |
| Sapota | 0–25 | 2.1 | 5.0 | 3.9 | 32.7 | 42.0 | 9.3 | 86.8 | 71.5 | –15.5 | 4.6 | 8.2 | 3.6 |
| | 25–50 | 1.4 | 6.0 | 4.6 | 8.0 | 40.0 | 32.0 | 42.4 | 50.0 | 7.6 | 4.6 | 5.0 | 0.4 |
| Coffee | 0–25 | 2.7 | 1.0 | –7.7 | 38.9 | 50.9 | 12.0 | 92.6 | 74.3 | –18.3 | 3.5 | 88.7 | 85.2 |
| Clove | 0–25 | 2.7 | 5.4 | 2.7 | 38.9 | 34.2 | –4.7 | 92.6 | 71.2 | –21.4 | 3.5 | 134.0 | 130.5 |
| Banana | 0–25 | 2.7 | 3.0 | 0.3 | 38.9 | 93.9 | 55.0 | 92.6 | 82.1 | –10.5 | 3.5 | 269.8 | 266.3 |
| Pineapple | 0–25 | 2.7 | 15.5 | 12.8 | 38.9 | 54.4 | 15.5 | 92.6 | 91.9 | –0.7 | 3.5 | 126.9 | 125.4 |
| Subabul | 0–25 | 2.7 | 3.6 | 0.9 | 38.9 | 47.6 | 8.7 | 92.6 | 118.4 | 25.8 | 3.5 | 223.5 | 220.0 |
| Pepper | 0–25 | 2.7 | 7.7 | 5.0 | 38.9 | 321.4 | 282.5 | 92.6 | 187.3 | 94.7 | 3.5 | 199.3 | 195.8 |

was recorded in the soils of coconut followed by nutmeg. Low quantity of Al–P was recorded for the soil cultivated with subabul, sapota and coffee, whereas the soil collected from clove basin showed negligible gain of Al–P. This shows clove has removed more of Al–P from the soil as a source of P nutrition. The Fe–P showed considerable variation among different crops. The building up of Fe–P in the soil is not marked when compared to Al–P.

Soils collected from coconut, lime, breadfruit, subabul and pepper showed slight increase in Fe-P over a period of 3 years whereas rest of the crops showed a negative gain. This suggests that these crops removed the major portion of P from the iron source as corroborated from the uptake correlation worked out by Datta and Khera (1969). The results of Ca–P showed that the soil collected from coconut, coffee, clove, banana, pineapple, subabul and pepper recorded very high value compared to other crops which suggests that the Ca–P is not a major source of P to these crops. It is evident from the results that few crops such as sapota, nutmeg and breadfruit removed considerable amount of Ca–P from the soil thus leaving small amount to accumulate in the soil.

The data summarised in Fig. 1 indicates the build up of saloid bound P both in basins and interspaces of multispecies and monocropping system. The data shows that there is high content of saloid bound P in the soils collected from high density cropping both in basins as well as interspaces compared to monocrop. However, higher build up of this fraction was recorded in the basin. This is probably

Fig. 1. Concentration of saloid bound and calcium – phosphorus in the soils (ppm)



due to the continuous P fertilization over a period of 3 years. Almost a similar pattern of results were noticed for Ca–P and Al–P (Fig. 2). The magnitude of variation in Ca-P content between high density and monocropping is marginal. Even the Ca-P content between basin and interspaces was also narrow at both the depths of soil. On the other hand the Al–P content in the soil of coconut basin of multicrops as well as monocrop is very high at both the depths. There is also wide variation in this fraction in the interspaces of high density and monocropping. This clearly suggests that the major fraction of soil P was Al–P which would serve as a principal source of P for coconut as recorded in paddy red soil of Taiwan (Tseng, 1960). The Fe-P content in the basin of monocropping is more than the basin of high density in surface layer but the trend was reversed in the interspace and lower depth of the soil. This indicated that the exploitation of these forms of P is pronounced with increased density of surface feeding crop species.

The data presented in Table III depicts the K fractions in the soil cultivated with different crops in the coconut garden. In general, there was increase in all the fractions of K over a period of 3 years in the soils cropped with different species. The higher water soluble K was gained by the soil planted with coconut, lime, sapota, clove,

**Fig. 2. Concentration of Al – P and Fe – P in the soils (ppm)**

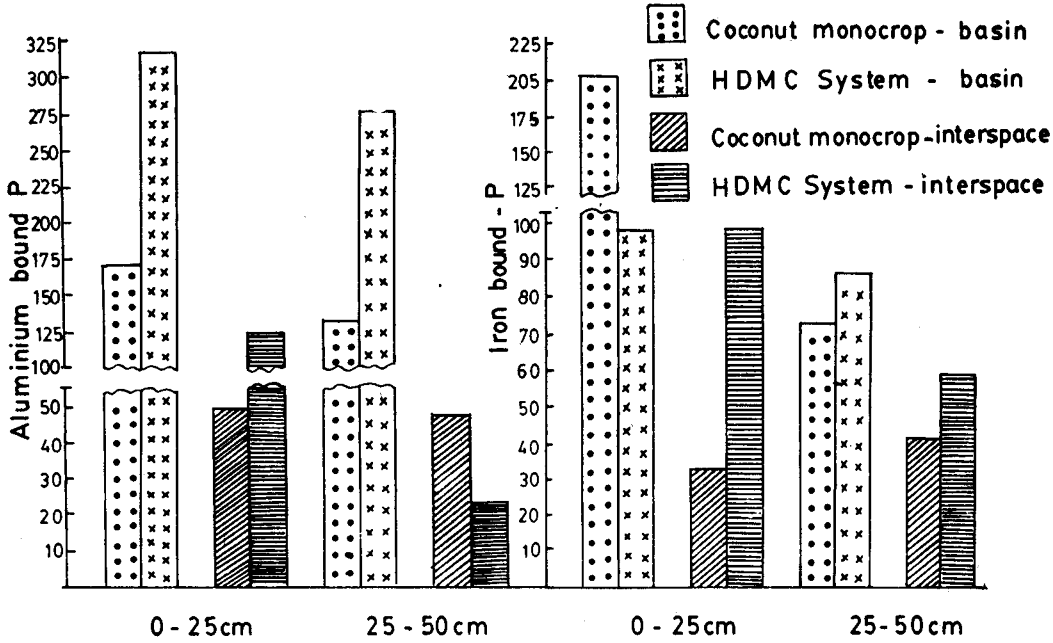


Table III. *Influence of crop species in coconut garden on K fractions in the soil*

| Crop | Depth | Water extract | | | $CaCl_2$ K | | | N $NH_4$ OAC-K | | | N $HNO_3$-K | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1983 | 1986 | g/l | '83 | '86 | g/l | '83 | '86 | g/l | '83 | '86 | g/l |
| Coconut | 0–25 | 7.2 | 18.7 | 11.5 | 13.5 | 46.3 | 32.8 | 23.3 | 46.0 | 22.7 | 5.1 | 90.7 | 85.6 |
| | 25–50 | 5.3 | 18.3 | 13.0 | 10.0 | 35.0 | 25.0 | 22.3 | 39.3 | 17.0 | 5.7 | 81.3 | 79.6 |
| Lime | 0–25 | 7.5 | 32.7 | 25.2 | 16.0 | 61.5 | 45.5 | 28.5 | 42.7 | 14.2 | 6·0 | 175.0 | 169.0 |
| | 25–50 | 7.5 | 19.8 | 12.3 | 13.0 | 29.8 | 16.8 | 28.5 | 23.8 | -5.3 | 6.4 | 54.6 | 48.2 |
| Breadfruit | 0–25 | 10.5 | 12.3 | 1.8 | 15.0 | 15.2 | 0.2 | 26.5 | 18.9 | -7.6 | 3.8 | 60.7 | 56.9 |
| | 25–50 | 5.0 | 8.5 | 3.5 | 8.5 | 9.5 | 1.0 | 21.0 | 15.2 | 5.8 | 3.8 | 58.8 | 55.0 |
| Nutmeg | 0–25 | 12.0 | 6.6 | -5.4 | 14.0 | 13.3 | -0.7 | 21.5 | 18.0 | -3.5 | 4.2 | 69.3 | 65.1 |
| | 25–50 | 5.0 | 6.6 | 1.6 | 8.5 | 12.3 | 3.8 | 18.5 | 18·0 | -0.5 | 4.8 | 58.8 | 54.0 |
| Sapota | 0–25 | 12.0 | 18.4 | 6.4 | 14.0 | 53.1 | 39.1 | 21.5 | 50.3 | 28.5 | 4.2 | 78.8 | 74.6 |
| | 25–50 | 5.0 | 5.7 | 0.7 | 8.5 | 9.5 | 1.0 | 18.5 | 16.0 | -2.5 | 4.8 | 69.3 | 64.5 |
| Coffee | 0–25 | 7.2 | 10.1 | 2.9 | 13.5 | 21.3 | 7.8 | 23.3 | 22.2 | -1.1 | 4.9 | 55.0 | 50.1 |
| Clove | 0–25 | 5.2 | 33.0 | 27.8 | 13.5 | 84.7 | 71.2 | 23.3 | 50.3 | 27.0 | 4.9 | 72.0 | 67.1 |
| Banana | 0–25 | 7.2 | 39.3 | 32.1 | 13.5 | 76.0 | 62.5 | 23.3 | 50.3 | 27.0 | 4.9 | 78.3 | 73.4 |
| Pineapple | 0–25 | 7·2 | 18.0 | 10.8 | 13.5 | 28.3 | 14.8 | 23.3 | 22.0 | 1.3 | 4.9 | 65.0 | 60.1 |
| Subabul | 0–25 | 7.2 | 17.6 | 10.4 | 13.5 | 19.3 | 5.8 | 23.3 | 23.6 | 0.3 | 4.9 | 64.2 | 59.3 |
| Pepper | 0–25 | 7.2 | 23.5 | 16.3 | 13.5 | 20.6 | 7.1 | 23.3 | 49.6 | 26.3 | 4.9 | 95.0 | 90.1 |

g/l–Gain or loss

banana, pineapple, subabul and pepper. Almost a similar pattern of results were recorded for CaCl2 extractable K where breadfruit and nutmeg recorded very low value compared to other crops. On the other hand the exchangeable K was gained by the soil grown with coconut, sapota, clove and banana. However, soil sampled from breadfruit, nutmeg, coffee, pineapple and subabul showed negative gain. In fact, the amount of exchangeable K decreased from 1983 to 1986, suggesting more K fertilization to be done to these crops. The data on the fixed K in the soil showed that there was net accumulation in all the soil collected from the basins of different crops over a period of 3 years. The maximum accumulation was noticed for lime, sapota, coconut and pepper.

The figure 3 depicts the K fractions in high density and monocrop of coconut along with the data for the interspaces. The data indicates that the water soluble K was more in monocrop basin compared to the multispecies in both the layers. However, interspace soil showed a reverse trend in the results. The loosely bound K (Ca $Cl_2$-K) showed slight increase in soils of high density at both the depths. The differences were marked in the soils of interspaces. The exchangeable K (Fig. 4) was slightly more in the soil from basin and interspaces of high density collected at both the depth. On the other hand

Fig. 3. Concentration of water soluble and Ca $Cl_2$ – K in the soil (ppm)

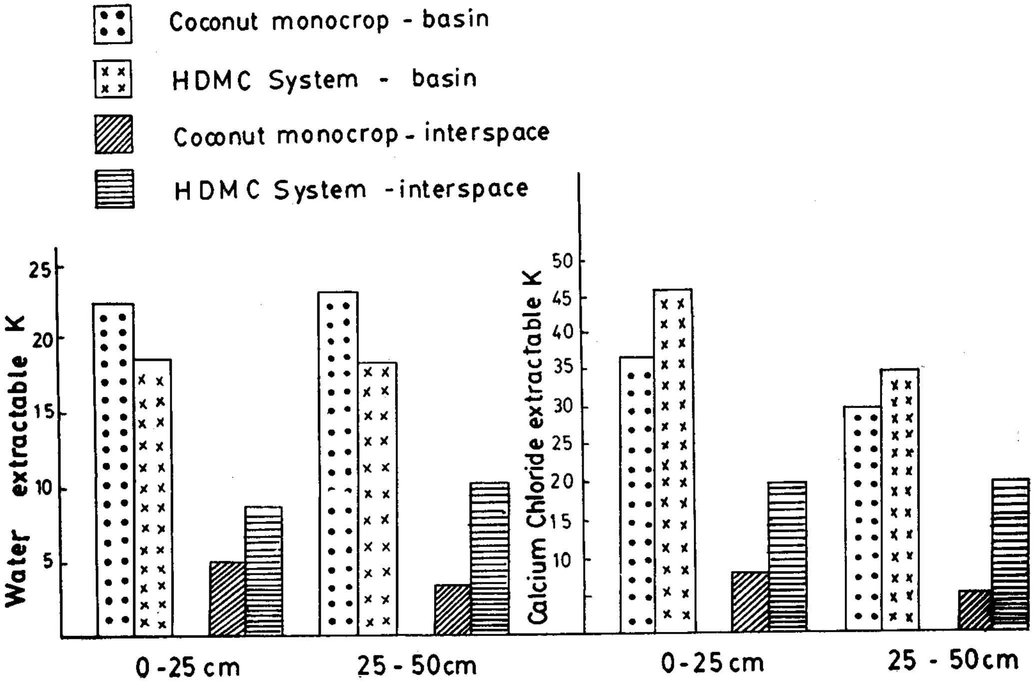
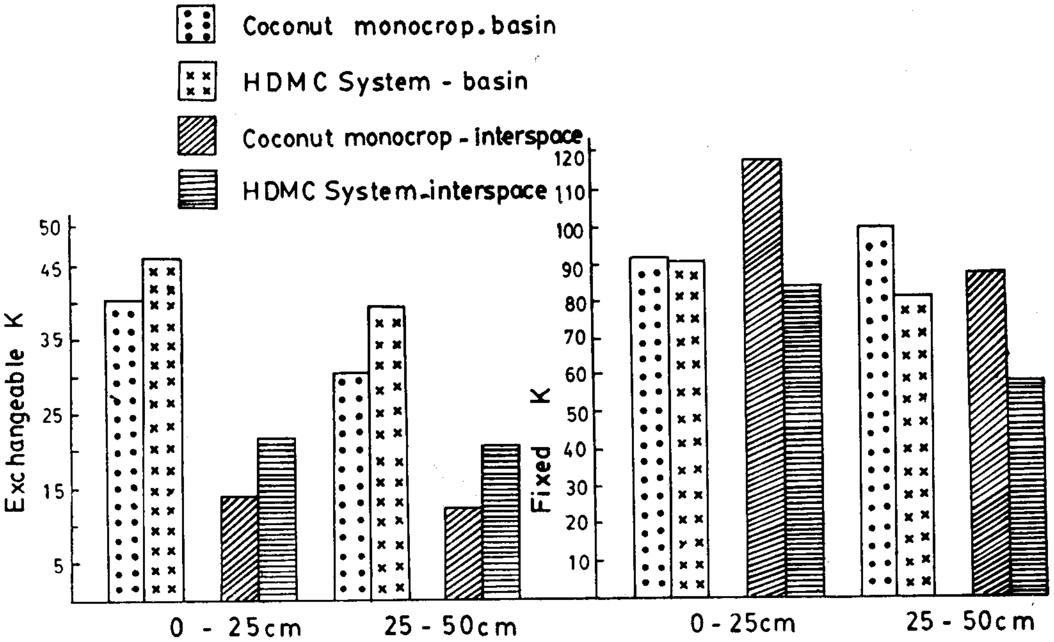


Fig. 4. Concentration of exchangeable and fixed K in the soil (ppm)



the fixed K showed a reverse trend, being high, for the soils collected from basins and interspaces of monocrop than the high density. This may be due to the fact that high root density of crop species in the soil would have foraged the water soluble K thus rendering non exchangeable form to a lower level.

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