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LONG-TERM EFFECT OF FYM AND NITROGEN FERTILIZER ON THE DISTRIBUTION OF K FRACTION IN SOIL UNDER PEARL MILLET-WHEAT CROPPING SYSTEM

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SUMMARY

The present study evaluated the effect of farmyard manure and fertilizer-N doses on distribution of different K fractions in a long-term field experiment. The long-term field experiment was conducted since 1967 in Department of Soil Science on a coarse loamy, Typic Ustochrept soil using a pearl millet-wheat cropping sequence. Total-K content of soil increased with the application of FYM. Water soluble-K, exchangeable-K, non exchangeable-K and lattice-K were ranged from 35-77 mg/kg, 155-1117 mg/kg, 2215-4346 mg/kg and 11076-15407 mg/kg, respectively in surface soil. The water soluble-K, exchangeable-K, non exchangeable-K and lattice-K were higher in surface soil. Farmyard manure applied in **rabi** season had more effects as compared to **kharif** season. Application of fertilizer-N had deleterious effect on all K fractions. The percent contribution of different K fractions towards total K in surface and sub-surface soil followed the order: water soluble-K < exchangeable-K < non exchangeable-K < Lattice-K.

Key words : Fertilizer-N, FYM, long-term, pearl millet, potassium fractions and wheat

A knowledge regarding the different forms of K in soil and the conditions controlling its availability to growing crops is an important for the appraisal of the available K in soil. Intensive cultivation of high yielding crops varieties tends to deplete K reserve of the soil at a fast rate. To formulate sound fertilizer recommendations, knowledge of potassium supplying capacity of soil is essential. This will depend on the K content of soils and their releasing capacity that may be predicted from the different forms of K and their relationship with physico-chemical properties and the equilibrium existing among them. There is need to revive the old age practice of FYM application to retain the productive nature of soil and also to supplement essential plant nutrients. Application of FYM may supply K directly to the crops and also mobilize native soil K and application of N through FYM or fertilizer-N may accelerate the mining of native K from soil and adversely affects the productivity in due coarse of time. Therefore, the objective of this experiment was to study the impact of doses and time of FYM along with fertilizer-N levels (urea) on the distribution of different K fractions in soil.

MATERIALS AND METHODS

A field experiment was started in November, 1967 to study response of N to pearl millet (*Pennnisetum typhoides*) and wheat (*Triticum festival*) crops grown in sequence on coarse loamy, calcareous, Typic Ustochrept soil. The experiment was conducted at research area of Deptt. of soil Science, CCS HAU, Hisar. The pH (1:2) of soil was 8.2, organic carbon 0.47 per cent, $CaCO_3$ 1.12 per cent. Available N, P and K were 100, 13 and 249 mg/kg, respectively. The average nutrient composition of farmyard manure (FYM) applied in the experiment during this period is given in Table 1. The treatments for this study consists of 3 doses of FYM (15, 30 and 45 Mg/ha) applied in three different modes i.e. in kharif, in rabi and in both (kharif and rabi) seasons. There was one control plot without FYM. These ten treatments (3 FYM levels x 3 mode of FYM application+1 control without FYM) were assigned in main plot and each main plot was divided in to 3 sub plots receiving fertilizer-N at 0, 60 and 120 kg/ha applied through urea. The plot size was 10 x 6 m and each

TABLE 1
Nutrient composition of FYM used for in experiment

Nutrients	Contents
C (%)	39.53
N (%)	1.21
P (%)	0.58
K (%)	4.26
Zn (mg/kg)	57
Cu (mg/kg)	239
Fe (mg/kg)	2214
Mn (mg/kg)	28

treatment was replicated four times. The experiment was carried out in split plot design with four replication. Surface (0-15 cm) and sub-surface (15-30 cm) soil samples from each plot were collected after the harvest of wheat crop (April-2004), passed through 2 mm sieve and stored for further analysis. Each soil sample was analysed for total K (Jackson, 1973) and water soluble K (Grewal and Kanwar, 1966), exchangeable K (Pratt, 1965), non-exchangeable K (Wood and De Turk, 1941) and lattice-K (Wiklander, 1954).

RESULTS AND DISCUSSION

Water soluble-K

The water soluble-K content at both depths increased significantly with increasing levels of FYM (Table 2). The increase in water soluble-K content is attributed to the additive effect of this form of K with increasing levels of FYM in soil. Increase in water soluble-K with FYM application was also reported by Santhy *et al.* (1998). Sub-surface soil had less water soluble-K as compared to surface soil. Higher water soluble -K in surface soil was also reported by Madzumdar *et al.* (2014). Time of FYM application also influence the water soluble-K content of soil. The proportionate increase in water soluble-K was slightly higher when FYM was applied in rabi season as compared to applied in kharif season. Application of N significantly decreased the water soluble-K content of soil.

Exchangeable-K

The data on exchangeable-K in the soil samples under different treatment combinations suggest that increasing levels of FYM from 0 to 45 Mg ha^{-1} significantly increased exchangeable-K content from 155 to 1117 mg/kg and 78 to 749 mg/kg in surface and sub-surface soil, respectively (Table 2). This is due to the fact that long-term application of FYM increased the cation exchange capacity of the soil, which in turn held more exchangeable-K. Increase in exchangeable-K with FYM application was also reported by Madzumdar *et al.* (2014).

TABLE 2
Effect of long-term FYM and N application on different K fractions of soil

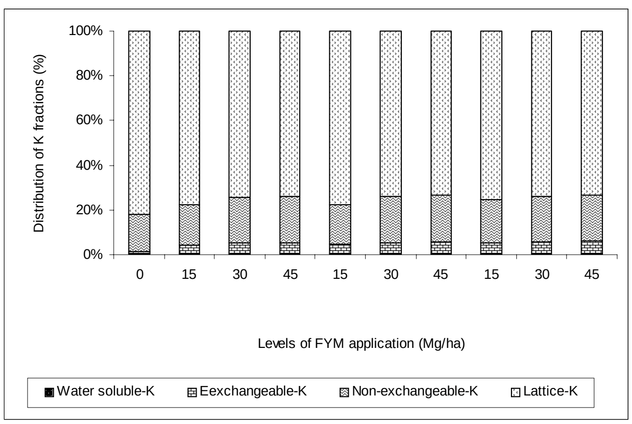
Treatments	Water soluble-K		Exchangeable-K		Non Exchangeable-K		Lattice-K		Total-K	
	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
FYM levels (Mg/ha)										
0	35	32	155	78	2215	1530	11076	9410	1.29	1.11
15	59	40	852	613	3505	2397	14657	14816	1.84	1.79
30	68	48	1006	727	4212	2945	15078	15265	1.96	1.90
45	77	54	1117	749	4346	3305	15407	14881	2.02	1.90
CD (p=0.05)	1.1	0.5	39.7	14.4	65.2	56.9	646.8	536.9	0.06	0.05
Mode of FYM application										
Kharif	52	40	724	496	3460	2397	13789	13520	1.74	1.65
Rabi	58	43	749	520	3537	2567	13901	13579	1.76	1.67
Both	69	47	874	645	3711	2669	14475	13580	1.84	1.71
CD (p=0.05)	0.9	0.6	34.4	12.4	56.5	49.2	560.2	NS	0.05	0.45
Nitrogen levels (kg/ha)										
0	62	44	790	562	3601	2573	14529	13952	1.83	1.71
60	60	43	782	552	3563	2544	13833	13432	1.76	1.66
120	57	43	755	547	3544	2516	13802	13395	1.75	1.65
CD (p=0.05)	1.8	0.9	NS	NS	NS	NS	NS	NS	NS	NS

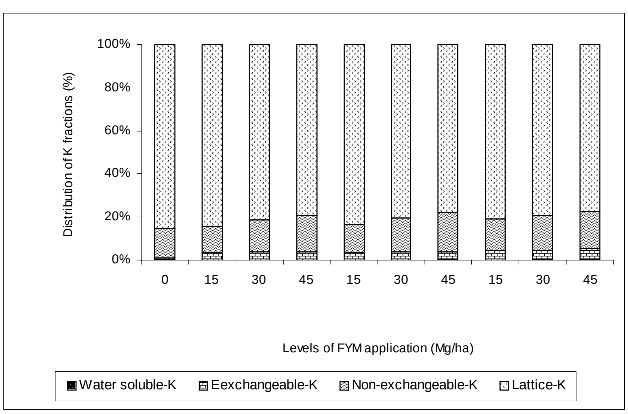
Application of FYM in rabi season contributed more towards build up of exchangeable-K as compared to the applied in **kharif** season. The exchangeable-K fraction was higher in surface soil as compared to sub-surface soil. Setia and Sharma (2004) also reported similar results. Application of N decreased the exchangeable-K at both the soil depths.

Non exchangeable-K/ Fixed-K

Increasing levels of FYM from 0 to 45 Mg/ha increased non exchangeable K from 2215 to 4346 mg/kg and 1530 to 3305 mg/kg in surface and sub-surface soil, respectively (Table 2). The higher amount of fixed K in FYM treated soil also reported by Kaur and Benipal (2006).

FYM applied in **rabi** season had more influence on increasing the non-exchangeable K content of soil as compared to the applied in kharif season. Sub-surface soil had lower non exchangeable-K content as compared to surface soil. Higher non exchangeable K in surface soil was also reported by Pharande and Sonar (1996). Application of N had deleterious effect on non exchangeable K content of soil.





Lattice-K

The lattice-K content at both depths increased with long term use of FYM (Table 2). Dhanorkar *et al.* (1994) reported increase in lattice-K with FYM application. Time of FYM application also influence the Lattice-K content of soil. The FYM applied in rabi season contributed more towards lattice-K as compared to the applied in kharif season. Sub-surface soil has higher lattice-K content as compared to surface soil. Nitrogen application had deleterious effect on lattice-K content of soil.

Total-K

Organic manuring is associated with minimizing the losses from leaching by retaining K^+ ion on exchange sites, solubilizing the insoluble component through the action of organic acids released during decomposition and minimizing losses due to fixation in 2:1 minerals. Therefore, long-term applications of FYM increase the total-K content of the soil (Table 2). Higher value might be attributed to supply of K through organic residues in the form of FYM. A slight increase in values of total K was observed with the addition of rice straw and FYM reported by Kaur and Benipal (2006). Application of FYM in rabi season had more effect on increasing the total-K content of the soil as compared to the applied in **Kharif** season. Surface soil has greater value of total-K as compared to sub-surface soil. Nitrogen application had deleterious effect on total-K content of the soil.

Percent contribution of different K fractions towards total K

The percent contribution of different K fractions towards total K both in surface and sub surface soil layers has been depicted in Figure 1 and Figure 2, respectively. It is evident that the percent contribution of different K fractions towards total K in surface and sub- surface soil followed the order: water soluble K < exchangeable K < non exchangeable K < lattice-K.

Water soluble-K fraction contributed least towards total-K i. e. 0.27 to 0.43 per cent and 0.22 to 0.32 per cent in surface and sub-surface soil, respectively. Exchangeable-K fraction contributed from 1.21 to 5.86 and 0.70 to 4.93 per cent towards total K in surface and sub-surface soil, respectively. Non exchangeable-K fraction contributed from 17.17 to 21.92 and 12.09 to 18.13 per cent towards total K in surface and sub-surface soil, respectively. Lattice-K fraction contributed highest i. e. 76.09 to 85.86 per cent and 77.66 to 85.77 per cent in surface and sub-surface soil, respectively. In general, water soluble-K and exchangeable-K fractions contribution increased whereas lattice-K contribution decreased with increasing level of FYM application at both depths.

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