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EFFECT OF CONTINUOUS MANURING AND FERTILIZATION ON THE FRACTIONS OF SOIL POTASSIUM

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The surface and sub-surface samples from the Permanent Manurial Experiment being conducted at Madurai analysed for various fractions of soil potassium to assess the influence of continuous manuring and fertilization over eight year period revealed that continuous organic manuring significantly increased the fixed K, exchangeable K and available K in the surface as well as in sub-surface soils. Among the organics, FYM increased the water soluble K fraction appreciably whereas the fixed K, available K and exchangeable K fractions were significantly more in compost applied plots. Continuous application of green leaf manure did not influence the different fractions of K.

Appreciable changes on different forms of soil K fractions are likely to occur due to continuous application of manures and fertilizers. Informations about the changes in soil fractions of K under rice-rice cropping system for a long period is inadequate, specially in Alfisols of Tamil Nadu. Hence an attempt has been made to evaluate the changes on the K fractions of soils of Madurai Agricultural College farm due to continuous cultivation of rice-rice cropping system since 1975.

MATERIALS AND METHODS

A permanent manurial experiment with 32 treatments (four main plots and eight sub-plots) laid out in split plot design replicated twice is in progress since 1975. The main plot treatments include three organic sources, viz., FYM, green leaf manure and compost and a control. The eight sub-plot treatments are N, P and K individually and in combination plus a control. The annual crop rotation of rice-rice is being adopted since 1975 and eleven crops have been raised till the start of the present investigation. The twelfth (Vaigai) and thirteenth (IR 50) rice crops were used for the study. The N, P_2O_5 and K_2O were applied at 120:60:60 kg/ha/crop in the form of urea, single superphosphate and muriate of potash respectively. The green leaf manure (Glyricidia 12.5 t/ha), FYM and compost (25 t/ha) were applied a fortnight before transplanting. The initial (before raising the 12th crop of rice) and post-harvest (after 13th crop of rice) soil samples were collected at 0-15 and 15-30 cm depths.

The initial surface and sub-surface soil samples collected from the control plot were found to be loamy

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sand and sandy clay loam with a pH of 8.1 and 8.3 and EC of 0.57 and 0.52 m. mhos/cm respectively. The initial values of available, water soluble, exchangeable, fixed and tenaciously held K were 90.7, 10.4, 80.0, 130.0 and 480.0, in the surface soil and 60.8, 8.6, 50.6, 118.0 and 388.0 ppm for the sub-surface soil. The available, water soluble and exchangeable fractions were estimated by the method of Totn and Prince (1949) and the fixed K was determined by the method of Wood and De-Turk (1940). The differences between the total K (Jackson, 1973) and the sum of water soluble, exchangeable and fixed K gave the amount of tenaciously held K.

RESULTS AND DISCUSSION

All the K fractions declined due to eight years of intensive cropping without any K addition (Tables- 1 and 2). The extent of shortfall in different fractions of K was 22.2, 23.1, 6.3, 7.7 and 6.7 per cent in available K, water soluble K, exchangeable K, fixed K and tenaciously held K respectively in surface soil and 12.8, 30.2, 9.1, 5.9, and 13.4 per cent in sub-surface soil. The extent of reduction was more in available and water soluble K fractions in both surface and sub surface soil. This could be due to varying release pattern of K besides crop uptake by intensive cropping. Similar results in depletion pattern of K in a wheat-pearlmillet rotation have been reported by Mittal *et al.* (1983).

Available potassium

The organic manured plots had higher available K content than control in both initial and post-harvest samples. The compost treated plots contained significantly higher amount of available K than FYM and green leaf manured plots. The sub-soil sambles contained less amount of available K than the surface samples.

The K treated plots invariably had higher available K content than the other fertilizer treatments. Similar results have been reported by Negi *et al.* (1981). Among the K combinations the NPK recorded lesser available K which might be due to the higher yield as observed in those plots continuously (Table 3). Invariably the N treated plots had lower available K than the other treatments. This is in conformity with the work of Venkatesh Bharadwaj *et al.* (1982).

In manurial and fertilizer treated plots, the available K was found to be more than control in both depths indicating the build up of available K due to continuous manuring.

Potassium fractions

Water soluble potassium : The FYM and compost treated plots recorded higher amount of water soluble K

Table 1 Effect of continuous application of manures and fertilizers on soil available K, watersoluble K and exchangeable K fractions (ppm)

Treatments	Available K				Water soluble K				Exchangeable K			
	Initial*		Post-harvest**		Initial		Post harvest		Initial		Post-harvest	
	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	0 - 15 cm	15 - 30 cm
Organic manures												
Control (without organic manure)	118	76	107	64	14	9	11	7	105	68	97	62
FYM	215	106	213	99	23	13	17	10	193	93	197	93
GLM	157	98	151	81	17	10	11	9	141	90	141	73
Compost	239	122	232	126	20	13	15	15	219	109	216	114
SEd	1.3	1.4	1.0	2.4	0.4	0.4	0.6	1.2	0.5	5.3	0.1	0.8
CD (0.05)	4.8	4.5	3.2	7.5	1.1	1.4	2.0	3.9	1.7	16.7	0.3	2.7
Fertilizer combinations												
Control (without fertilizer)	153	99	177	87	16	10	11	10	138	90	167	78
N	160	70	153	67	18	8	11	8	142	63	143	65
P	190	105	190	96	17	10	14	9	173	96	176	89
K	226	125	218	118	23	13	18	12	204	111	201	95
NP	172	86	150	74	17	10	12	8	156	76	138	72
NK	195	91	184	99	19	12	15	9	176	80	170	87
PK	200	115	193	115	21	13	13	11	179	102	181	105
NPK	164	115	141	96	19	12	16	11	146	103	126	86
SEd	1.2	2.9	1.9	2.7	0.9	0.8	0.7	0.5	0.7	6.6	0.6	1.3
CD (0.05)	2.5	5.9	3.9	5.5	1.8	1.6	1.5	0.8	1.5	13.6	1.3	2.6
1982 Absolute control (without manures & fertiliser)	—	—	70.6	53.0	—	—	8.0	6.0	—	—	75.0	46.0
1975 Initial sample	—	—	90.7	60.8	—	—	1.04	8.6	—	—	80.0	50.6

*Before 12 th Crop

** After the harvest of 10 th crop

Table 2 Effect of continuous application of manures and fertilizers on soil fixed K and tenaciously held K fractions (ppm)

Treatments	Fixed K				Tenaciously held K			
	Initial*		Post-harvest**		Initial		Post-harvest	
	0—15 cm	15—30 cm	0—15 cm	15—30 cm	0—15 cm	15—30 cm	0—15 cm	15—30 cm
Organic manures								
Control (without organic manures)	184	175	200	187	1060	750	768	735
FYM	246	211	328	291	776	733	801	631
GLM	207	189	314	241	753	594	1197	622
Compost	259	269	355	306	646	520	977	568
SEd	0.7	4.8	0.7	0.6	0.6	2.1	9.0	1.9
CD (0.05)	2.2	15.3	2.3	2.0	2.0	6.7	28.8	6.2
Fertilizer combinations								
Control (without fertilizer)	225	216	253	188	722	583	1257	600
N	206	172	291	183	960	642	816	633
P	198	196	306	250	1013	777	817	562
K	228	217	329	288	597	783	628	593
NP	231	198	277	269	909	588	1025	714
NK	267	201	327	297	801	686	914	554
PK	237	262	300	278	739	617	794	694
NPK	241	234	312	302	732	521	1235	564
SEd	1.2	6.6	0.8	1.1	1.1	3.6	13.6	47.6
CD (0.05)	2.5	13.4	1.7	2.3	2.1	7.4	27.9	97.5
1982 Absolute control (without manures and fertilizers)	—	—	120.0	101.0	—	—	448.0	336.0
1975 Initial sample	—	—	130.0	118.0	—	—	480.0	388.0

* Before 12th crop

** After the harvest of 13th crop

Table 3. Effect of continuous manuring and fertilization on yield and K uptake by rice (kg/ha)

Treatments	12th crop		13th crop		Total K uptake	
	Grain	Straw	Grain	Straw	12th crop	13th crop
Organic manures						
Control (without organic manures	2865	4450	1840	2630	38.91	24.05
FYM	4210	5860	2630	3665	67.14	42.13
GLM	4215	5545	2590	3250	51.69	32.08
Compost	4395	6355	2450	3300	67.14	39.03
SEd	5	25	25	12	0,21	0.002
CD (0.05)	16	80	80	38	0.68	0.005
Fertilizer combinations						
Control (without fertilizer)	2385	3990	1750	2505	34.49	23.86
N	4715	5605	2590	3485	58.17	37.14
P	3810	4895	1935	2730	46.54	27.05
K	2955	1555	1820	2600	47.17	29.21
NP	4495	6330	2575	3625	59.15	36.44
NK	4685	6285	2725	3365	66 74	39.82
PK	3370	5350	2140	2695	56.02	30.59
NPK	4950	6435	3475	4715	71.51	50.50
SEd	10	40	10	14	0.18	0.002
CD (0.05)	20	82	20	29	0.37	0.004

than control and GLM and this might be due to the well decomposed nature of the FYM and compost. Similar findings due to the addition of organic matter have also been reported by Kanwar and Prihar (1962) and Maclean and Doyle (1963).

The fertilizer combinations with K had significantly higher water soluble K than the other treatments. This is similar to the trend observed in available K states of soil. There was a positive significant relationship also between available K and water soluble K ($r = 0.838^{**}$).

Exchangable potassium

As in the case of available K the exchangeable K content was more in compost treated plots and also with the K fertilizer combinations. The low amount of exchangeable K recor ded in NPK and N treatments might be due to the continuous removal of higher amount of K through enhanced crop yield (Table 3). The reason for the trend in exchangeable K behaviour similar to that of available K is due to the fact that the exchangeab e K generally forms the major portion of available K fractions. This is also corroborated by the highly significant correlation obtained between available K and exchan geable K ($r = 0.998^{**}$).

Fixed potassium

The compost treatment had higher fixed K content than the other organic manure treatments and control. Generally the fixed K content was higher in K treated plots when compared to the combinations without K indicating the conversion of applied K into fixed K. Comparing the control, the fixed K content was found to be increased in organic manured plots and K fertilizer applied plots in both the initial and post-harvest samples indicating the build up of this fraction due to continuous manuring of the plots.

Tenaciously held potassium

The tenaciously bound K in the initial samples was significantly higher in the control plots than in the manured plots whereas in the post-harvest surface samples the organic manured plots contained higher amount of tenaciously held K than control, possibly due to the addition of K through the organic manures. The same trend as in the initial samples was maintained in the sub-surface samples. However, no specific trend regarding the influence of various treatments could be inferred in this case.

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