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Effect of applied P on soil fractions in green manure-rice cropping system

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Abstract : Application of recommended level of P at 60 kg P_2O_5 ha^{-1} maintained higher available soil P (22.06 kg ha^{-1}). The amount of inorganic P varied significantly and the distribution of added P into different fractions was in the order of Ca-P> Fe-P> AL-P. Application of 50% P_2O_5 to rice recorded significantly higher P uptake. *(Key words : Available P, Inorganic P and P uptake)*

Efficient utilization of P is of utmost importance in rice based cropping systems. Nad and Goswamy (1984) suggested that for sustainable agriculture production, application of higher levels of P alone or in association with organic matter can enhance the contents of total P, available P and different P fractions. These fractions have been reported to supply P throughout the growth period of crops. (Dhillon and Dev,1990).

An attempt was made to study the effect of different levels and methods of P application on the changes in the available P fractions of soil in green manure - rice eco system under varying nitrogen levels.

Materials and Methods

A field experiment was conducted during the *rabi* season of 1993 and 1994 at Agricultural College and Research Institute , Madurai. The soil was sandy clay loam with pH value 7.1 & 7.4, electrical conductivity 0.5 & 0.46 dS m^{-1}, 0.42 & 0.39 per cent organic carbon and 240.0, 13.5 and 290.0 & 241.0,12.9 and 293.0 kg ha^{-1} of available NPK in the *rabi* 1993 & 1994 experimental sites respectively. The experiment was laid out in split-split plot design with three replications comprising of three P levels (30,45 and 60 kg ha^{-1}) as main plot treatments, methods of P application (100 per cent P_2O_5 to green manure alone, 50 per cent P_2O_5 each to green manure and rice and 100 per cent P_2O_5 to rice alone) as sub-plot treatments and N levels (50,75 and 100 per cent of recommended N) as sub-sub plot treatments.

After the incorporation of 55 days old *Sesbania rostrata*, green manure each main plot combination was equally divided in to three sub-sub plots and N levels were imposed as per the treatment schedule. Rice (IR 20) was transplanted in rows of 20 cm apart on 23rd August' 1993 and 27th August 1994 and harvested on 5th January' 1994 and 13th January' 1995 respectively. Soil and plant samples were collected at tillering, flowering and at harvest stages of rice to monitor the changes in available P content, P uptake and other P fractions.

Results and Discussions

Soil available P

In general, the available P was at its peak at tillering and declined as the age advanced (Table 1). Applied P levels had a profound effect on soil available P at all the stages. Recommended level of P at 60 kg P_2O_5 ha^{-1} maintained higher available soil P over lower levels at tillering stage in both years. Lower two levels were comparable at flowering in both the years. The content of P decreased with stages, which may be ascribed to removal of P by the crop (Gupta amd Sharma, 1987).

Among the methods of P application, rockphosphate application at 50 per cent to GM and 50 per cent to rice recorded higher soil available P than 100 percent to GM and 100 per cent to rice. However, the application of 50 per cent P_2O_5 each to green manure and rice was comparable with the application of 100 percent P_2O_5 to green manure alone at harvest stage in first year and at tillering in second year. This findings are in conformity with of Chakravarthy *et al.* (1982). Direct application of rockphosphate to rice resulted in lower soil available P at all the stages in both the years due to lesser solubility of the applied rockphosphate.

Application of 120 kg N ha^{-1} registered significantly higher available P in soil at all the stages of crop growth except at harvest wherein the N levels failed to influence the soil available P in both the years.

Inorganic P fractions

The amount of inorganic P varied significantly and the distribution of added P into different fractions was in the order of Ca-P>Fe-P> A1-P(Table 2 a & b). The P in all forms exist in all soils but A1-P and Fe-P are more abundant in acid soils, while Ca-P in neutral and alkaline soils (De Datta, 1988). Application of P @ 60 kg P_2O_5 ha^{-1} maintained higher Ca-P, Fe-P and A1-P as compared to other levels in

Table 1. Soil available phosphorus (kg ha^{-1}) at different growth stages of rice

Treatments	1993-94 Tillering	1993-94 Flowering	1993-94 Harvest	1994-95 Tillering	1994-95 Flowering	1994-95 Harvest
P_1	22.06	17.39	15.89	21.96	17.52	15.91
P_2	21.04	16.12	15.41	21.24	16.30	15.12
P_3	20.12	15.92	14.69	20.22	16.12	14.51
SE_d	0.12	0.32	0.51	0.17	0.22	0.41
CD	0.34	0.89	NS	0.46	0.62	NS
Methods of P application						
M_1	23.40	16.27	16.16	23.16	15.96	15.02
M_2	23.96	17.98	17.41	23.51	17.41	17.12
M_3	21.49	15.59	13.12	21.67	14.97	13.72
SE_d	0.19	0.51	0.67	0.29	0.29	0.61
CD	0.41	1.12	1.46	0.46	0.63	1.33
N levels						
N_1	22.49	16.51	15.92	22.62	16.26	14.76
N_2	21.12	15.39	15.82	22.31	15.16	14.13
N_3	21.92	15.12	14.91	20.12	14.92	14.02
SE_d	0.17	0.41	0.62	0.19	0.26	0.46
CD	0.34	0.82	NS	0.39	0.52	NS

Table 2a. Inorganic P fractions (mg g^{-1}) in soil at post harvest of (1993-94)

Treat-ments	Fe-P			Al-P			Ca-P		
	P_1	P_2	P_3	P_1	P_2	P_3	P_1	P_2	P_3
M_1	37.50	27.75	25.00	10.75	8.50	7.75	49.50	44.00	43.75
M_2	42.25	36.50	33.75	13.50	10.10	8.25	53.00	51.25	47.75
M_3	26.50	25.50	15.00	10.00	7.00	6.50	43.10	40.75	37.50
N_1	33.50	30.25	27.25	13.00	11.75	9.25	48.50	43.75	42.10
N_2	30.25	29.75	26.25	11.75	12.25	7.75	41.50	40.25	39.75
N_3	28.75	25.50	23.25	10.25	7.75	5.25	40.75	39.50	39.10

Data not statistically analysed

both the years.

Regarding method of P application, addition of 50 per cent P to GM and 50 per cent P to rice registered higher values of Ca-P, Fe-P and Al-P fractions as compared to other two methods of application. In general, application of rockphosphate either 100 or 50 per cent P to GM maintained higher inorganic P fractions in the soil than direct application to rice. These findings are inline with the reported work of Nad and Goswamy (1984).

Table 2b. Inorganic P fractions in soil (mg g^{-1}) at post harvest stage of rice (1994-95)

Treat-ments	Fe-P			Al-P			Ca-P		
	P_1	P_2	P_3	P_1	P_2	P_3	P_1	P_2	P_3
M_1	29.75	21.50	19.50	10.50	9.75	6.50	44.75	42.15	40.00
M_2	40.50	35.00	32.50	13.75	11.50	10.10	46.50	44.50	40.00
M_3	27.00	24.10	16.50	9.75	9.00	8.50	38.75	33.50	30.50
N_1	32.50	30.75	26.50	12.00	9.50	9.25	46.50	42.10	38.50
N_2	29.75	20.75	23.00	10.75	9.50	8.75	44.10	41.10	37.50
N_3	27.50	24.50	22.50	9.50	8.10	7.50	40.75	40.10	31.75

* Data not statistically analysed

Table 3. Phosphorus uptake (kg ha^{-1}) at different growth stages of rice

Treatments	1993-94			1994-95		
	Tillering	Flowering	Harvest	Tillering	Flowering	Harvest
P levels						
P_1	10.01	27.12	38.99	10.10	28.02	37.96
P_2	9.52	26.09	36.40	9.69	25.86	35.39
z P_3	8.72	24.12	33.82	8.71	23.39	32.10
SE_d	0.21	0.15	0.52	0.24	0.19	0.60
CD	0.59	0.42	1.46	0.67	0.53	1.68
Methods of P application						
M_1	9.38	27.92	38.05	9.29	26.86	39.12
M_2	10.45	28.99	41.32	10.37	28.12	42.10
M_3	8.50	24.41	36.88	8.47	24.04	37.32
SE_d	0.40	0.20	0.71	0.36	0.29	0.74
CD	0.87	0.44	1.55	0.78	0.63	1.61
N levels						
N_1	10.08	28.07	39.10	10.12	27.96	39.45
N_2	9.72	26.95	36.86	9.84	25.85	37.12
N_3	8.95	23.86	33.24	9.07	22.12	33.62
SE_d	0.32	0.18	0.66	0.30	0.22	0.69
CD	0.65	0.36	1.33	0.61	0.44	1.39

Phosphorus uptake

The effect of levels and method of P application at varying N levels on P uptake was significant at all stages of crop growth (Table 3). In general, the P uptake was higher at maturity stage. With regard to levels of P, application of 60 kg $P_2O_5 ha^{-1}$ significantly maintained higher P uptake at all the stages of crop growth than the other levels in both the years. This may be due to the increased P uptake of rice at higher levels of applied P consequent to the root proliferation.

Appliction of 50% P_2O_5 to green manure + 50 per cent P_2O_5 to rice recorded significantly higher P uptake followed by 100 per cent P_2O_5 to green

manure and 100 per cent P_2O_5 to rice at all the stages of crop growth in both the years. This supports its earlier findings by Sudhakar (1985).

Varying levels of N also significantly influenced the P uptake. Application of 100% N significantly maintained higher levels of P uptake over other levels of N at all stages of crop in both the years. This might be due to the complementary effect between N and P.

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Sustainable weed management programme for rainfed cotton based cropping system

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Abstract : Field experiments were conducted for two seasons (September '97 to April '98 and October'98 to May '99) at Fredrick Institute of Plant Protection and Toxicology (FIPPAT), Padappai, to develop a sustainable weed management programme in rainfed cotton. Results revealed that, intercropping of soybean and sesame led to weed suppression in rainfed cotton to the extent of 39.6 and 28.4 per cent respectively. The seed cotton yield obtained from cotton + soybean intercropping system under unweeded conditions was similar (1196 kg ha^{-1}) to the yield of sole cotton supplemented with single hand weeding alone (1220 kg ha^{-1}). Similarly, single hand weeding operation in the cotton + soybean cropping system resulted in a substantially higher seed cotton yield (1528 kg ha^{-1}), than the yield of sole cotton crop supplemented with two hand weedings (1432 kg ha^{-1}). So, the adoption of Soybean, as a intercrop in rainfed cotton is an effective method for checking the weeds population as well as enhancing the yield potential in rainfed cotton and also labour saving, by minimising to one hand weeding. Similar effects were also found in cotton + sesame intercropping system. Furthermore, in labour scarce situation, the application of pre-emergence herbicide Fluchloralin @ 1.0 kg a.i ha^{-1} in cotton-soybean intercropping system could be an alternative method. *(Key words : Weed management, Rainfed cotton, Fluchloralin)*

Rainfed farming has a distinct place in Indian Agriculture, occupying 67 per cent of the total cultivated area, contributing 68 per cent fo the rainfed area under cotton. Cotton, the most fibre crop of the world, stands with an area of 33.73 million hectares and a production of 19.7 million tonnes (1997-1998) which showed a meagre increase of 0.72 per cent over the previous year. Whereas in India, it showed a decrease of about 21.8 per cent, registering an estimated production of 111.5 lakh bales for 1997-98 as compared with 1996-97 (142.5 lakh bales) as per the report of International Cotton Advisory Committee (ICAC). India has a yield of 530 kgs per hectare under irrigated conditions and 170 kg per hectare under rainfed conditions. One of the major constraints observed in its cultivation under rainfed