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Phosphorus and Potash Availability in the Salt Affected Soil of Bhal Region (Gujarat) as Influenced by Natural Drying, Levels of Phosphorus Sources and FYM

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Abstract : Incubation of a 'Bhal' soil with or without farm yard manure (FYM) and phosphorus from different sources showed that application of FYM markedly decreased the soil pH and significantly enhanced the P and K availability in the soil. The P and K availability of soil reduced significantly when moisture was depleted from 40 to 10%. Again on rewetting the soil, nutrients availability was restored. Application of diammonium phosphate significantly increased the Olsen's P in the soil as compared to that with monocalcium phosphate.

Key words : P K availability, salt-affected soil, moisture regime, P sources and levels, FYM.

In Gujarat state, Bhal region is known for growing durum wheat. Most of the soils of this region are clay to clay loam in texture. Average rainfall of this region is 600 mm. But, soils get flooded even with a small amount of rainfall because of flat topography and poor water transmission characteristics (Patel *et al.*, 1993). Durum wheat (*rabi*) is grown in this area with the help of residual moisture (30 to 40%) conserved in sub-soil during monsoon. Farmers apply only nitrogen in the form of urea along with the seed. Though most of the soils are deficient in phosphorus and marginal in zinc availability, deficiency symptoms are not noticed on wheat crop (Motiramani *et al.*, 1990).

In this context, an incubation study was carried out in the laboratory to understand the changes in nutrient availability of the soil at different moisture regimes simulated by natural drying of the saturated soil with or without addition of FYM and P from different sources, and rewetting.

Materials and Methods

A bulk soil (clay loam) sample (0 to 20 cm) was collected from a farmer's field (Arnej, Bhal area), air dried and powdered (2 mm). The physico-chemical characteristics of the soil were $pH_{2.5}$ 7.76, $EC_{2.5}$ 0.9 dS m^{-1}, CEC 33.27 C mol kg^{-1}, ESP 19.1, maximum water holding capacity 50%, organic matter 0.65%, $CaCO_3$ 9.34%, total N 0.04%, Olsen's P 9.41 kg ha^{-1} and ammonium acetate extractable K 255 kg ha^{-1} (Jackson, 1973).

Plastic containers were filled with 150 g of treated soil. Various treatments consisted of three levels of P (0, 25 and 50 kg P_2O_5 ha^{-1}) from two sources (AR Diammonium phosphate and monocalcium phosphate), two levels of FYM (0 and 13.5 t ha^{-1}) and five moisture regimes (M_{40}, M_{30}, M_{20}, M_{10}, MR_{40}). Soils under each treatment were incubated for three weeks under flooding condition and then allowed to dry naturally to desired levels of moisture. It took 30, 60, 85, 115 days drying after three weeks flooding to obtain 40, 30, 20 and 10% moisture in the soil, respectively.

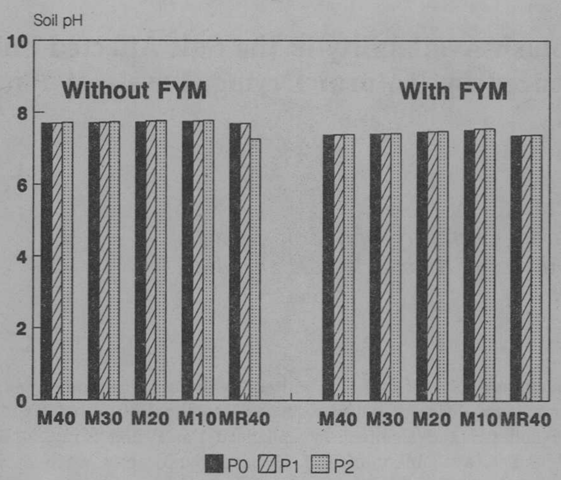

Fig. 1. Average effect of moisture regimes and FYM on soil pH.

Such wetting-drying cycle normally occurs in Bhal area. In case of MR_{40} treatment, after the completion of first cycle of wetting-drying, the above process was repeated to bring the soil to 40% moisture. Each treatment was replicated twice. The wet soil samples at different moisture levels/periods were immediately analyzed for moisture content, pH, Olsen's P and ammonium acetate extractable K using standard methods. Per cent P fixed was also computed by subtracting P increased over P_0 from the applied phosphorus. The data were statistically analysed using completely randomized design.

Results and Discussion

Soil reaction

The pH values increased when the moisture reduced from 40 to 10%. Application of FYM markedly decreased the soil pH from 7.73 to 7.44 (Fig. 1). The different treatment combinations of moisture regimes with amounts of P did not show any marked effect on soil pH. The results clearly indicated that moisture and FYM had a marked role in decreasing the soil pH. The reduction in soil pH at higher moisture level could be attributed to the depletion of oxygen, accumulation of CO_2 and building up of the partial pressure of CO_2 in alkaline and calcareous soil (Ponnamperuma, 1977). The decrease in soil pH due to FYM application could be attributed to the production of H_2CO_3 and other organic acids during microbial decomposition of organic matter (Singh and Lal, 1976).

Olsen's P content

Moisture : The data in Table 1 show that Olsen's P was significantly decreased when the soil moisture was depleted from 40 to 10%, the decrease was as high as 73%. The decrease in P at M_{20} and M_{30} was 26 and 51%, respectively. Also the effect of M_{40} and MR_{40} on the available P content in the soil was similar. Thus, the availability of P was restored on rewetting the soil.

The significantly higher available P content with the increase in the level of P application was observed at each moisture regime. However, with the depletion in moisture at each level of P, the availability of P decreased. The maximum P availability was observed under P_2 level at each moisture level. The decreased availability of P with the depletion in moisture could be attributed to the oxidation

Table 1. Effect of moisture regimes, amount and sources of P and FYM on estimates of plant-available P (ppm) in soil*

	M_{40}	M_{30}	M_{20}	M_{10}	MR_{40}	Mean
Phosphorus						
P_0	6.54	5.35	4.51	3.92	6.58	5.38
P_1	10.23	7.94	6.69	6.01	9.18	8.01
P_2	12.26	9.72	8.01	6.88	13.12	10.00
Source						
S_1	8.42	6.58	5.51	5.06	9.34	6.98
S_2	10.94	8.76	7.12	6.13	9.92	8.57
FYM						
F_0	5.96	4.93	4.02	3.55	5.48	4.79
F_1	13.39	10.41	8.79	7.66	13.78	10.81

* Olsen's extractable.

CD 5%, M = 0.201, P = 0.156, F/S = 0.127, M x P = 0.349, M x S/F = 0.285.

of more soluble ferrous phosphate to insoluble ferric phosphate and also due to precipitation of calcium phosphate under reduced concentration of CO_2 (Ponnamperuma, 1967, 1972). Such a change is supported by increase in pH (Fig. 1) and fixation of P with depletion in soil moisture content (Fig. 2).

P source : There was significant increase in Olsen's P with the increase in level of P application. When P was applied through DAP (S_2), the available P in the soil was significantly higher (22%) than in the case of MCP (S_1) due to less P fixation under former one (Fig. 2). The significantly more available P content was observed with P_2S_2 treatment combination over rest of the treatments.

Farm yard manure : Application of FYM (13.5 t ha^{-1}) significantly increased (more than double) the Olsen's P in the soil at all the levels of moisture, with maximum P availability under $M_{40}F_1$ or $MR_{40}F_1$ treatment combinations. The data also revealed that the Olsen's P content was significantly increased (59%) even with only FYM application in absence of P. However, the increase was more than

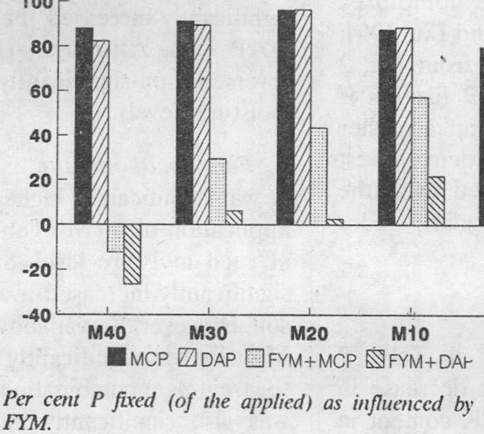

Fig. 2. Per cent P fixed (of the applied) as influenced by moisture regimes and FYM.

Table 2. Effect of moisture regimes, amount and sources of P and FYM on estimates of plant available K (kg ha^{-1}) in soil

	M_{40}	M_{30}	M_{20}	M_{10}	MR_{40}	Mean
Phosphorus						
P_0	332	316	275	249	331	301
P_1	340	324	284	258	337	307
P_2	348	330	288	255	344	313
Source						
S_1	341	322	281	250	340	307
S_2	339	325	284	254	335	307
FYM						
F_0	320	322	276	239	311	291
F_1	361	325	289	265	363	324

CD 5%, M = 8.0, P = 2.3, F = 1.9, M x F/S = 4.3.

double with P_1F_1 and about three times more with P_2F_1 treatment combination over that of P_1F_0 and P_2F_0, respectively.

Furthermore, Olsen's P in the soil was significantly higher (24%) when P was applied through DAP (S_2) than through MCP (S_1) in the presence of FYM.

The increased availability of P on FYM application may be due to either directly by release of P from iron and/or aluminium phosphate or by influencing: (i) the decrease in redox potential, (ii) pH changes (Fig. 1), and (iii) mobilization of P by complex formation between Fe and Fulvic acid or formation of soluble fluvic iron phosphate complexes (Bradley and Sieling, 1953; Yu and Liu, 1964; Sinha, 1972). It is also evident from Fig. 2 that in the presence of FYM, P fixation is drastically reduced when P was applied either through DAP (S_2) or MCP (S_1), being lowest under DAP. Data also indicated even the release of P due to FYM, particularly under higher moisture levels.

Potassium availability

Moisture : Data presented in Table 2 clearly indicated the significant decrease in ammonium acetate extractable K content in soil with the depletion in moisture from 40 to 10% (M_{40} and MR_{40} were at par). It could be attributed to fixation of K in the lattice of the mountmorillonitic Bhal-soil (Nedeco, 1968) during drying period and again release of K on rewetting (Savant *et al.*, 1981; Grewal and Kanwar, 1967).

P source : The data revealed that application of P at both the levels significantly increased the K availability in the soil. However, the increase was very meagre, being 2.2 and 4.1% with P_1 and P_2 levels, respectively. In general, P sources did not differ significantly in K availability. However, under MR_{40} treatment, application of P through MCP (S_1) significantly increased the K availability over DAP (S_2). Although, the behaviour was reversed (non-significantly) at 30, 20 and 10% moisture levels.

Farm yard manure : The availability of K was significantly higher (11.3%) with the application of FYM (Table 2). Furthermore, at each moisture level, application of FYM significantly increased available K content in soil. However, K availability under $M_{40}F_1$ and $MR_{40}F_1$ was significantly higher over rest of the treatment combinations. The K availability was also significantly increased with FYM application at all P levels, being maximum in the case of P_2F_1. Similarly, significantly more K availability was observed when DAP (S_2) was applied along with FYM. The beneficial effect of FYM in enhancing the K availability may be due to addition of K (5279 ppm) through FYM. Brar and Sekhon (1987) also noted positive significant correlation between organic carbon and exchangeable K in five bench mark soil series of northern India.

The results of the present investigation suggest that preapplication of P through DAP, along with 13.5 t ha^{-1} FYM and sowing at 40% soil moisture level to P deficient calcareous soil of Bhal area, could favourably influence the P and K nutrition of durum wheat.

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