The Andhra Agric. J 61(2): 339-343, 2014

Influence of Phosphorus Levels, FYM and PSB on Soil Physical, Physic-chemical and Biological Properties in *Bt* Cotton

V S L Raj Rushi K, P Prasuna Rani, P Anil kumar, P R K Prasad, and P Madhu vani
Department of Soil Science and Agricultural Chemistry, Agricultural College, Bapatla 522101, Andhra Pradesh

ABSTRACT

A field experiment was conducted in a clay loam soil at Agricultural College Farm, Bapatla, Andhra Pradesh to study the individual and combined effect of inorganic phosphorus, farm yard manure (FYM) and phosphorus solubilising bacteria (PSB) on soil properties using *Bt* cotton as test crop. Results revealed no significant influence of treatments on bulk density, pH, EC and CEC of soils. However, FYM treated plots recorded significant influence on OC content. Bacterial counts showed significant increase in soils treated with RDP + PSB + FYM when compared to RDP alone. The alkaline and acid phosphatase activities, though slightly high in treatments integrated with all components, were not influenced by the treatments significantly.

Key words : Bacterial population, Phosphatase activity, Organic carbon.

At present, the intensive land use in association with continuous use of high analysis chemical fertilizers has found to realize increased production but only at the cost of soil health. Hence a major research priority is to sustain soil productivity and to monitor changes in soil physical, chemical and biological properties as affected by management (Larson *et al.,* 1981). It is well established that use of biofertilizers and organic amendments to the soil can positively affect soil productivity (McInroy and Kloepper, 1994; Glick, 1995) by improving soil properties including microbial and enzymatic activities. Phosphorus is one of the major nutrients for plants and it plays an important role in plant metabolism by supplying energy required for metabolic processes (Lal, 2002). However, there has been little research to document the effects of integrated use of inorganic P, PSB and FYM on soil characteristics under *Bt* cotton, particularly the bacterial population and soil enzyme activities. Hence, the present study was carried out to assess the effect of integrated use of the above said components on soil properties.

MATERIAL AND METHODS

The experiment was carried out at the Agricultural College Farm, Bapatla, Guntur district, Andhra pradesh, during *kharif,* 2011 with 10 treatments replicated thrice in a randomized block design. The treatments comprised of T_1 = RDP (60 kg P_2O_5 ha^{-1}); T_2 = RDP+PSB; T_3 = 50% RDP+PSB; T_4 = PSB; T_5 = RDP+FYM; T_6 = 50% RDP+FYM; T_7 = FYM; T_8 = RDP+PSB+FYM; T_9 = 50% RDP+FYM and T_{10} = PSB + FYM. During experimentation the study area experienced the average maximum and minimum temperatures of 32.24 ^{0}C and 21.90 ^{0}C, respectively with a total rainfall of 627.8 mm with 30 rainy days. The experimental soil was clay loam in texture, slightly alkaline in reaction (pH 7.8), non saline (EC 0.39 dS m^{-1}) and medium (5.5 g kg^{-1}) in organic carbon content. The bulk density and cation exchange capacity were 1.39 Mg m^{-3} and 37.60 cmol (p^+) kg^{-1} soil, respectively. The soil physical and physico-chemical properties were estimated by standard procedures in soil at harvest. The bacterial population was estimated by serial dilution and spread plate technique using nutrient agar medium (Dhingra and Sinclair, 2000) and phosphatase activity was analyzed following the method of Tabatabai and Bremner (1969) at 45, 90 DAS and at harvest. Prior to the experiment the bacterial population, alkaline and acid phosphatase activities were 1.3 X 10^6 CFU g^{-1} soil, and 54.36 and 49.94 µg of Pavanitrophenol (PNP) h^{-1} g^{-1}, respectively.

RESULTS AND DISCUSSION

Bulk density:

Bulk density of the experimental soil was not influenced significantly by the imposed treatments (Table 1). However the plots treated with FYM alone or in combination with PSB recorded lesser bulk density values which could be due to the influence of organics in improving the soil condition through enhanced aggregation of soil particles and inturn soil porosity. Similar results were reported by Halvorson *et al.* (1999). Further Bhatnagar *et al.* (1992) reported that the total porosity was significantly higher in the treatments receiving organic amendments.

Soil reaction and Electrical conductivity

Application of FYM and PSB alone or in combination did not show any significant effect on pH (Table 1) of the soil at harvest of the crop. However, the pH values were slightly less in the FYM treated soils, which could be due to the production of organic acids during decomposition of FYM. The EC values of the soil were not significantly influenced by PSB and FYM either alone or in combination at different levels of phosphorus.

Cation exchange capacity

The cation exchange capacity values of the soil after harvest of the crop (Table 1) were not significantly influenced by the experimental treatments. The CEC values ranged between 35.67 and 38.67 cmol (p^+) kg^{-1}. The highest value (38.67 cmol (p^+) kg^{-1} soil) was recorded by T_7 while the lowest (35.67cmol (p^+) kg^{-1} soil) was recorded in T_2.

Organic carbon

The organic carbon content of the soil (Table 1) significantly influenced by the integrated treatments. All the treatments that were supplied with FYM or FYM + PSB (T_5 to T_{10}) were statistically on a par with one another and significantly superior over the remaining treatments. The lowest organic carbon content (5.60 g kg^{-1}) was noticed in plots treated with only inorganics i.e., 60 kg P_2O_5 ha^{-1}(T_1). The highest organic carbon content (6.90 g kg^{-1}) was recorded in the treatment that received 60 kg P_2O_5 ha^{-1} + PSB + FYM (T_8).

Organic carbon content of the soil was improved with application of FYM either alone or in combination with PSB indicating the negligible contribution of PSB towards the buildup of soil organic carbon. The FYM, having 26.6 per cent of organic carbon could have helped in increased biomass as well as carbon content of the soil. The increased organic carbon content in organics applied plots may also be due to addition of more or little root residue during crop growth. Positive effects of FYM application on soil organic carbon have been reported by several researchers (Yang *et al.*, 2005; Singh *et al.*, 2005).

Bacterial population

The bacterial population was maximum at 45 DAS (Table 2). This could be due to more availability of nutrients in the soil, less uptake by plants and release of high quantities of root exudates which might have encouraged the multiplication of zymogenous organisms in rhizosphere during earlier days.

Higher bacterial counts at 45 DAS were recorded in treatments supplied with PSB + FYM followed by individual application of FYM and PSB at a given level of phosphorus. Highest value (10.40 X 10^6 CFU g^{-1} soil) was recorded in T_8 and the lowest value (5.30 X 10^6 CFU g^{-1} soil) was recorded in T_1.

At 90 DAS and harvest all the treatments that received FYM alone or in combination with inorganic P and/ or PSB were found superior over inorganic or inorganic + PSB treated plots. Plots treated with only FYM along with different levels of P were superior over remaining treatments (T_1 to T_4). The PSB treated plots with variable levels of phosphorus were on a par with T_1. At 90 DAS and harvest the maximum bacterial populations (8.4 X 10^6 and 7.70 X 10^6 CFU g^{-1} soil, respectively) were reported in the treatments T8 (60 kg P_2O_5 ha^{-1} + PSB + FYM) and T_9 (30 kg P_2O_5 ha^{-1} + PSB + FYM), while the minimum population (3.70 X 10^6 and 4.23 X 10^6 CFU g^{-1} soil, respectively) was recorded in T_1 treatment which was supplied with only inorganics (60 kg P_2O_5 ha^{-1}).

Critical analysis of data revealed that there was no significant increase in population with increase in the phosphorus dose. At a given dose of phosphorus more bacterial count was recorded in the treatment where PSB and FYM were applied

Table 1. Effect of phosphorus levels, PSB and FYM on soil physical and physico-chemical properties

Treatments	BD ($Mg\ m^{-3}$)	pH	EC (dSm^{-1})	CEC (cmol (p+) kg^{-1})	OC ($g\ kg^{-1}$)
T_1- RDP (60 kg P_2O_5 ha^{-1})	1.36	7.7	0.24	36.33	5.60
T_2- 50% RDP +PSB	1.36	7.7	0.25	35.67	5.80
T_3- RDP +PSB	1.36	7.7	0.21	36.33	5.80
T_4-PSB	1.36	7.7	0.24	37.00	5.70
T_5- 50%RDP +FYM	1.36	7.6	0.23	36.67	6.70
T_6- RDP +FYM	1.35	7.6	0.24	37.33	6.50
T_7-FYM	1.34	7.6	0.23	38.67	6.80
T_8- RDP +PSB+FYM	1.35	7.6	0.24	37.33	6.90
T_9- 50% RDP +PSB+FYM	1.35	7.6	0.23	38.00	6.80
T_{10}-PSB+FYM	1.35	7.6	0.24	37.45	6.80
SEM±	0.02	0.04	0.01	2.31	0.02
CD@0.05	NS	NS	NS	NS	0.04
CV (%)	2.74	3.08	10.52	8.11	4.1

PSB @ 5 kg ha^{-1}; FYM @ 10 t ha^{-1}

Table 2. Effect of levels of Phosphorus, PSB and FYM on bacterial population in soils.

Treatments	*CFU X 10^6 g^{-1} soil		
	45 DAS	90 DAS	Harvest
T_1- RDP(60 kg P_2O_5 ha^{-1})	5.30	3.70	4.23
T_2- 50%RDP +PSB	6.93	4.23	4.80
T_3- RDP +PSB	7.20	3.93	5.10
T_4-PSB	6.70	4.00	4.63
T_5- RDP +FYM	8.80	6.70	6.90
T_6- 50%RDP +FYM	8.10	7.10	6.70
T_7-FYM	9.20	6.90	7.10
T_8- RDP +PSB+FYM	10.40	8.40	7.40
T_9- 50% RDP +PSB+FYM	9.70	7.90	7.70
T_{10}-PSB+FYM	9.90	7.70	6.87
SEM+	0.50	0.40	0.42
CD@0.05	1.48	1.18	1.24
CV(%)	10.5	11.37	11.77

PSB @ 5 kg ha^{-1}; FYM @ 10 t ha^{-1}

*CFU : colony forming units

Table 3. Effect of phosphorus levels, PSB and FYM on phosphatase activity in soils.

Treatments	Alkaline phosphatase activity			Acid phosphatase activity		
	(μg *PNP $h^{-1}g^{-1}$ soil)					
	45 DAS	90 DAS	Harvest	45 DAS	90 DAS	Harvest
T_1- RDP(60 kg P_2O_5 ha^{-1})	114.00	82.67	58.57	90.00	81.53	53.99
T_2- 50% RDP +PSB	129.83	87.73	62.80	102.83	91.13	57.60
T_3- RDP +PSB	130.67	96.77	66.30	98.67	84.10	53.17
T_4-PSB	112.00	93.80	61.73	97.47	87.50	57.33
T_5- RDP +FYM	132.83	108.43	59.33	112.00	101.73	58.50
T_6- 50% RDP +FYM	125.00	110.50	62.57	109.67	93.93	55.67
T_7-FYM	136.17	106.90	61.07	110.00	97.50	61.30
T_8- RDP +PSB+FYM	137.33	106.17	61.43	118.67	104.43	59.07
T_9- 50% RDP +PSB+FYM	122.67	102.17	55.40	111.73	100.27	62.33
T_{10}-PSB+FYM	130.67	102.47	60.87	115.00	97.33	61.50
SEm$\pm$	7.04	6.56	3.10	6.12	5.48	3.15
CD @ 0.05	NS	NS	NS	NS	NS	NS
CV(%)	9.59	11.40	8.79	9.95	10.11	9.41

PSB @ 5 kg ha^{-1}; FYM @ 10 t ha^{-1}

* PNP: para nitro phenol

together. Inoculation with PSB recorded significant increase in population only at 45 DAS later it was on a par with T_1.

The organic addition coupled with N, P and K fertilization might have exerted stimulating influence on the preponderance of bacteria emphasizing the importance of easily degradable carbonaceous compounds in proliferation of bacterial population in soil (Mukherjee *et al.* 1990). The increase in bacterial population in PSB inoculated plots may be due to the proliferation of inoculated PSB as well as others due to the positive relation between the inoculated and the native organisms present in the soil.

Phosphatase activity (alkaline and acid phosphatases)

The alkaline phosphatase activity was considerably higher (Table 3) than that of acid phosphatase activity irrespective of the treatments and this could be ascribed to slightly alkaline soil reaction as evidenced by Dick (1994) who observed a close relation between phosphatase activity and soil pH.

Among different stages, maximum phosphatase activity values were recorded at 45 DAS. The data indicated that comparatively higher values were recorded in integrated treatments. At 90 DAS higher alkaline and acid phosphatase activities recorded in plots treated with FYM alone or in combination with PSB at all levels of phosphorus. At harvest also the phosphatase activity was not significantly varying among different treatments. The higher (66.3 5 μg PNP $h^{-1}g^{-1}$soil) alkaline phosphatase activity was found in T_3 (30 kg P_2O_5 ha^{-1} + PSB) where as acid phosphatase activity was maximum in T_9 (30 kg P_2O_5 ha^{-1} + PSB+FYM-62.3 5Øßg PNP $h^{-1}g^{-1}$soil) and minimum alkaline and acid phosphatase activities were observed in T_1 and T_3 treatments (55.4 and 53.2 5Øßg PNP $h^{-1}g^{-1}$soil), respectively.

The increased phosphatase activity in organic treated plots may be due to the positive relation between the organic carbon, microbial population and phosphatase activity, it may also be due to more soil moisture content retained in organics treated plots for longer period as compared to others (Sridevi *et al*., 2011).

The data indicated no marked influence of levels of P on phosphatase activity. Though considerable research carried on phosphatase activity emphasized the inhibitory action of applied inorganic P, such effect was not observed in the present study. The maximum dose of inorganic P tested (60 kg P_2O_5 ha^{-1}) might not be inhibitory under the prevailing conditions.

From this study it can be concluded that the soil properties mentioned in the article were not markedly influenced by the levels of inorganic P applied. FYM @ 10 t ha^{-1} alone or in combination with recommended dose of inorganic P and PSB could significantly enhance the organic carbon content and bacterial population. Though, phosphatase activity was non significantly influenced by the treatments, relatively higher values were reported in FYM treated plots. Performance of applied PSB in the presence of FYM was more pronounced than without FYM. Based on the above observations it can be reiterated that integration of all the sources of nutrients can sustain soil health.

LITERATURE CITED

Bhatnagar V K, Kundu S and Ved Prakash 1992 Effect of longterm application of manuring and fertilization on soil-physical properties under soybean (Glycine max)-wheat (*Triticum aestivum*) cropping sequence. *Indian journal of Agricultural Sciences,* 3. 212- 214.

Dick R P 1994 Soil enzyme activities as indicators of soil quality. In: Doran JV, Coleman DC, Bezdicek, D.F, Stewart, B.A (Eds.). Defining Soil Quality for a Sustainable Environment. *Soil Science Society of America, American Society of Agriculture, Madison*, 107-124.

Dhingra O D and Sinclair J B 2000 Basic plant pathology methods. *CRC publications and Distributors*, New Delhi. 335.

Glick B R 1995 The enhancement of plant growth by free living bacteria. *Canadian Journal of Microbiology,* 41: 109-117.

Halvorson A D, Reulle C D and Follett R F 1999 Nitrogen fertilization effects on soil carbon and nitrogen fertilization effects on soil carbon and nitrogen in a dry land cropping system. *Soil Science Society of American Journal,* 63. 912-917.

Lal L 2002 Phosphaticbiofertilizers. Agrotech, Publishers Academy, Udaipur, India. 224.

Larson W E, Walsh L M, Stewart B A and Boelter D H 1981 Soil *and Water Resources: Research Priorities for the Nation. Soil Science Society of America*, Madison.

McInroy J A and Kloepper J W 1994 Studies on indigenous endophytic bacteria of sweet corn and cotton. In: O'Gara F, Dowling D N, Boesten B, eds. Molecular ecology Rhizosphere Microorganisms: Biotechnology and the release of GMOs. Winheim: VCH Verlagsgesellschaft, pp: 19-28.

Mukherjee D, Ghosh S K and Das A C 1990 A study on the chemical and microbiological changes during the decomposition of straw in soil. *Indian Agriculture,* 34: 1-10.

Srider Singh G, Jalota S K, Sidhu B S 2005 Soil physical and hydraulic properties in a rice-wheat cropping system in India: effect of rice straw management. *Soil Use and Management*,21. 17-21.

Sridevi S, Venkata Ramana M and Swarupa Rani S 2011 Soil enzyme activity and nutrient availability as influenced by different nutrient management practices in maize-onion cropping system. *Journal of research ANGRAU*, 39(3): 32-37.

Tabatabai M A and Bremner J M 1969 Use of p-nitrophenyl phosphate for assay of soil phosphatase activity. *Soil Biology and Biochemistry,* 1:301-307.

Yang C, Yang L, Ouyang Z 2005 Organic carbon and its fractions in paddy soil as affected by different nutrient and water regimes. *Geoderma*, 124. 133-142.

(Received on 31.07.2012 and revised on 30.09.2012)