International Journal of Farm Sciences **3(1)** : 51-57, 2013

Nutritional status of organically amended soils of sub-tropical humid climate of Tripura

BRITAN RAHMAN and DIPAK NATH

Krishi Vigyan Kendra, Cachar
Assam Agricultural University, PO Arunachal, Silchar 788025 Assam
Email for correspondence: britan_rahman@rediffmail.com

ABSTRACT

Maintenance or enhancement of soil quality is important for sustainable agricultural production. Quantitative assessment of soil quality is possible only through addition of organic amendments. A three year fertility experiment was conducted in farmers fields of three villages of Bishalgarh sub-division of West Tripura district. Surface soil samples were collected from the fields of farmers treated with vermicompost @ 5 tonnes per hectare. Comparison was made with control plot where no treatment was made. Mean values of organic carbon (OC) (0.88%) and available NPK (283.45: 35.4: 269.85 kg/ha) were found higher in the farmer fields which were very low in control plot viz 0.33 per cent, 130.67: 9.32: 87 kg/ha respectively for OC, N, P and K. Lower mean pH (4.73) was recorded in the farmer fields which was higher in the control plot (5.70). Earthworm activity reflected by earthworm castings (no/m^2) was also found to be more (9.16) in vermicompost treated plots. In vermicompost treated soils the resilience was increased in the form of earthworm population.

Keywords: Soil nutrient status; vermicompost; farmer fields

INTRODUCTION

Fertility status of soil determines the selection of a crop in any area. The nutrients removed by the plants from the soil solution are replaced by the fresh supply of nutrient ions which depends on the rate of their uptake by the plants. The replacement is faster in case of fertile soil. The whole process of uptake and replacement also depends on the soil particle size/texture and acidity of soil/soil reaction.

Use of chemicals over years has resulted in impoverishing soils of organic matter and earthworms. It is possible to reclaim degraded lands with simple, eco-friendly practices like application of compost and vermicompost, mulching and polyculture cropping. Organic wastes like animal dung, agricultural waste, forestry wastes, city leaf litter, paper, and cotton clothes are commonly used for composting. Enhancement of soil quality by organic amendment especially vermicomposting is becoming increasingly popular among farmers as a source of soil fertility and also as a source of income generation. Most of the farmers in the plains of West Tripura still practice the mono-crop system where one major crop is grown annually. Ignorance in terms of manure and fertilizer application with respect to the fertility status is one of the major factors leading to the low productivity of the crops. The return therefore is not a constant and reliable factor for the farmers resulting in their low financial status. In order to evaluate the requirement of balanced fertilizers to be applied in the field analysis of soil for available nutrients is quite necessary. A study was undertaken to find out the effect of organic amendments on some physico-chemical and biological soil parameters after three years application of vermicompost applied @ 5 tonnes per hectare during the year 2007-2009 in 48 farmer fields.

MATERIAL AND METHODS

Surface soil samples (0-15 cm depth) were collected from the fields of 48 farmers of three different villages viz Chandranagar, Pathalia and Ramchara of Bishalgarh sub-division, West Tripura between 14 and 18 January 2010. Samples were analyzed in the Soil and Water Testing Laboratory, Krishi Vigyan Kendra, West Tripura. Fields considered for the study had been applied vermicompost (@ 5 tonnes/ ha) in last three years. A sample from the control plot where common practices were followed was also collected for comparison.

The pH of the soil was determined in a suspension of soil to water ratio of 1: 2.5 using glass electrode (Jackson 1973). Organic carbon content in the soil was estimated by the procedure given by Walkley and Black (1934), available N by modified Kjeldahls method (Subbiah and Asija 1956). Available P_2O_5 was analyzed colorimetrically by Brays I method using an extracting solution of 0.03 N NH_4F+0.02 N HCl (Jackson 1973). Available K_2O was analyzed by equilibrating the soil with an exchanging cation made of solution of neutral normal ammonium acetate in a given soil:solution ratio. K content in the equilibrium solution was estimated flame photometrically (Jackson 1973) and soil texture was determined by International pipette method. Earthworm population was determined by counting earthworm cast in a frame of 1 m^2 grid. From each replicated plot, 3 observations were recorded.

RESULTS AND DISCUSSION

Data presented in Table 1 show that on an average the entire soils of the three villages were strongly acidic in reaction with few pockets moderately acidic. The pH of the soils varied from 4.60 to 5.21 with an average of 4.83 in village Chandranagar, from 4.01 to 5.41 with an average of 4.66 in village Pathalia and from 4.15 to 5.10 with an average of 4.72 in village Ramchara.

Table 1. Soil nutrient status of three villages of Bishalgarh sub-division of West Tripura

Location	pH	OC (kg/ha)	Available N (kg/ha)	Available P_2O_5 (kg/ha)	Available K_2O castings	Earthworm (no/m^2)
Chandranagar						
L1	5.20	1.08	280.00	34.32	138.16	11.0
L2	5.21	0.51	280.00	34.74	77.95	9.3
L3	5.06	0.48	289.33	29.33	92.20	10.0
L4	4.94	1.44	364.00	30.50	239.50	12.0
L5	5.03	0.48	298.67	44.91	101.88	7.0
L6	4.73	0.45	280.00	50.84	92.47	9.0
L7	4.68	0.48	280.00	44.06	99.46	8.3
L8	4.67	0.51	289.33	49.67	78.49	11.0
L9	4.75	0.51	317.33	49.57	106.71	7.3
L10	4.72	0.48	289.33	43.21	96.77	8.0
L11	4.60	0.51	270.67	46.18	87.63	7.0
L12	4.63	0.48	242.67	20.76	120.15	7.3
L13	4.65	0.48	289.33	53.80	107.25	8.0
L14	4.80	0.45	280.00	42.37	218.00	8.0
Mean	4.83	0.59	289.33	41.00	118.33	8.8
Pathalia						
L1	4.43	0.57	345.33	90.24	729.79	8.0
L2	4.46	0.99	298.67	38.55	312.08	9.3
L3	4.45	0.42	130.67	32.62	300.52	8.0
L4	4.20	0.66	196.00	23.72	315.57	8.0
L5	4.01	0.84	196.00	48.72	280.36	9.0
L6	4.68	0.81	214.67	9.32	220.15	8.3
L7	4.48	0.51	177.33	22.03	455.08	7.6
L8	4.50	0.54	158.67	39.82	269.07	7.3
L9	4.54	0.81	289.33	58.89	284.39	9.3
L10	4.95	0.45	186.67	29.66	159.67	7.0
L11	4.73	1.05	214.67	35.59	219.07	11.3
L12	4.67	0.90	233.33	23.30	231.97	9.0
L13	4.25	0.84	280.00	24.15	357.24	8.3
L14	5.05	0.93	205.33	38.98	295.14	12.0
L15	5.04	0.60	168.00	42.37	18.01	7.0
L16	4.90	0.57	168.00	24.67	543.51	7.0
L17	4.85	0.69	168.00	29.66	102.95	7.3
L18	5.41	0.36	121.33	27.96	466.64	7.0

	L19	4.95	0.78	476.00	10.59	795.92	7.6
	Mean	4.66	0.70	222.53	34.25	334.58	8.3
Ramchara							
	L1	4.94	1.62	392.00	43.64	287.08	12.0
	L2	4.76	1.53	401.33	8.47	228.75	12.0
	L3	4.70	1.50	392.00	12.71	536.79	12.0
	L4	4.59	1.53	392.00	30.08	302.13	11.0
	L5	4.50	1.35	373.33	25.42	550.50	10.0
	L6	4.80	1.05	345.33	4.66	133.32	9.3
	L7	4.55	1.17	420.00	6.35	176.87	12.0
	L8	4.62	1.47	317.33	25.42	226.06	13.3
	L9	5.01	1.65	336.00	31.35	263.16	13.0
	L10	4.90	1.47	308.00	42.37	1121.43	9.6
	L11	4.55	1.53	354.67	15.68	11.83	8.6
	L12	4.15	0.39	214.67	14.40	354.82	7.0
	L13	4.70	1.38	336.00	51.26	630.60	8.6
	L14	5.10	1.08	224.00	115.23	167.46	8.6
	L15	4.90	1.62	270.67	37.28	359.12	9.0
	Mean	4.72	1.36	338.49	30.95	356.66	10.4
	Control	5.70	0.33	130.67	9.32	87.00	6.0

Data are mean of three replications

The pH of the control plot was found to be 5.70 higher than the treated plot. A reduction in the pH value was observed in the treated plot which was due to conversion of vermicompost and subsequent releases of protons [H+] (Yaduvanshi et al 1985, Kumar and Yadav 1993). The decrease in pH may also be attributed to the higher production of CO_2 and organic acids in vermicompost added soils (Yaduvanshi 2001).

The organic carbon content of the soil varied from 0.45 to 1.44 per cent with an average of 0.60 per cent in village Chandranagar, from 0.36 to 1.05 per cent with an average of 0.70 per cent in village Pathalia and from 0.39 to 1.65 per cent with an average of 1.36 per cent in village Ramchar indicating medium status of the soils with respect to organic carbon in former two villages and higher in the latter. Organic carbon content in vermicompost treated soils was significantly more than the control plot. Application of organic manure resulted in stabilizing C:N ratio (Parr and Papendick 1978). Dry matter production in this treatment was found to be more. Proportionately higher amount of residues was also returned to soil and these residues stabilized organic carbon in the soil.

Available nitrogen content of the soil varied from 242.67 to 364.00 kg/ha with an average of 289.33 kg/ha in village Chandranagar, from 121.33 to 476.00 kg/ha with an average of 222.53 kg/ha in village Pathalia and from 214.67 to 420.00 kg/ha with an average of 338.49 kg/ha in village Ramchara indicating low status of the soils in respect of available nitrogen at former two and medium at the third location. The available nitrogen content of the control plot was quite low (130.67 kg/ha) which might be due non application of organic amendment (Powlson and Johnston 1992). However it was observed that available N could be maintained at relatively higher level by application of organic manure. Organic sources might also release organic acid and other microbial products during decomposition which solubilizes the insoluble compounds (Patrick et al 1965) and enhance the nitrogen availability in soil (Bhandari et al 1992, Hegde and Dwivedi 1992).

The available P_2O_5 content of soils varied from 20.76 to 53.80 kg/ha with an average of 41.00 kg/ha at Chandranagar, from 9.31 to 90.24 kg/ha with an average of 34.25 kg/ha at Pithalia and from 4.66 to 115.23 kg/ha with an average of 30.95 kg/ha at Ramchara while the content of P_2O_5 was very low (9.32 kg/ha) in the control plot. Incorporation of P in soil through organic sources along with inorganic sources caused such increase in the level of available P (Powlson and Johnston 1992, Babhulkar et al 2000, Bharadwaj and Omanwar 1994). Mineralization of organic P and release of P from insoluble forms by production of organic acids also resulted in increased level of available P in soils (Patel et al 1979). In this study organic matter content of soil was found to be more than that of control.

The available K_2O content of the soil varied from 77.95 to 239.50 kg/ha with an average of 118.33 kg/ha at Chandranagar, from 18.01 to 795.92 kg/ha with an average of 334.59 kg/ha at Pithalia and from 11.83 to 1121.43 kg/ha with an average of 356.66 kg/ha at Ramchar while the content of K_2O was very low (87.00 kg/ha) in the control plot. Application of organic amendment was even effective in keeping available K content at higher level compared to control. Higher level of available K in the treated soil could be a result of increased organic carbon content and subsequent solubilizing action of organic acids produced during vermicompost decomposition and also its greater capacity to hold K in the available form (Yaduvanshi 2001). The K+ ions could leach to lower depth much easily but addition of vermicompost enhances capacity to hold K (Powlson and Johnston 1992, Mishra and Sharma 1997).

Earthworm cast production in soil treated with vermicompost was found higher compared to the control. The cast number varied from 7.0 to 12.0 with an average of 8.8 and 8.3 in village Chandranagar and Pithalia respectively and from 7.0 to 13.3 with an average of 10.4 at Ramchar while the number was very low (6.0) in the control. Filser et al (1995) reported that OC provided energy for better activity of earthworm and hence the presence of vermicompost in the treatment might be the reason for highest earthworm cast.

CONCLUSION

From the above experiments it can be concluded that the organic amendments play an active role in improving the soil fertility. Soil character like pH, OC, N, P, K and earthworm population varies with the addition of vermicompost in soil pH was found to decrease with the addition of vermicompost while the other factors given above increased with the addition of vermicompost in soil. Earthworm activity counteracts leaching by bringing up nutrients from deep in the soil and depositing them on the soil surface as castings. The burrows of earthworm also allow roots to easily go down deeper into the soil they could not ordinarily reach and get nutrients. Earthworms eat the litter and leave the nutrients in their castings for plants to use as a natural fertilizer that is non-polluting. Earthworms make plant nutrients more available by concentrating minerals in their castings in a form that is easy for plants to absorb. Plant growth stimulants such as auxins are produced in the castings which stimulate root to grow faster and deeper. Worms also neutralize soil pH. Cast analysis shows that the produce coming out of the back end of a worm is closer to neutral than what goes in the front end. Analysis of earthworm castings reveal that they are richer in nutrients than surrounding soil, often 3 times more calcium, several times more nitrogen, phosphorus and potassium. Worms stimulate microbial populations. Nitrogen fixing bacteria in a worm's gut and casts help to destroy harmful chemicals and breakdown organic wastes and higher nitrogenase activity. That means higher rate of nitrogen fixation is found in casts as compared to surrounding soil.

The present investigations show encouraging results of using vermicompost in soils as organic amendment as these are safe as against chemical fertilizers.

ACKNOWLEDGEMENTS

The authors are grateful to Indian Council of Agricultural Research, New Delhi for the financial support. The interest and encouragement shown by Dr AK Gogoi, Zonal Project Director, Zone-III, ICAR, RCNEHR, Barapani, Shillong and President and General Secretary of SRSK, Kolkata are highly appreciated.

REFERENCES

Babhulkar PS, Wandile RM, Badole WP and Balpande SS 2000. Residual effect of long-term application of FYM and fertilizers on soil properties (vertisols) and yield of soybean. Journal of Indian Society of Soil Science **48(1):** 89-92.

Bhandari AL, Sood A, Sharma KN and Rana DS 1992. Integrated nutrient management in a rice-wheat system. Journal of Indian Society of Soil Science **40:** 742-747.

Bharadwaj V and Omanwar PK 1994. Long-term effects of continuous rotational cropping and fertilization on crop yields and soil properties-II. Effect on EC, pH, organic matter and available nutrients of soil. Journal of Indian Society of Soil Science **42(3):** 387-392.

Filser J, Fromm H, Nagel RF and Winter K 1995. Effects of previous intensive agricultural management on microorganisms and the biodiversity of soil fauna. Plant Soil **170:** 123-129.

Hegde DM and Dwivedi BS 1992. Nutrient Management in rice-wheat cropping system in India. Fertilizer News **37(2):** 27-41.

Jackson ML 1973. Soil chemical analysis. Prentice Hall of India Pvt Ltd, New Delhi, 498p.

Kumar A and Yadav DS 1993. Effect of long-term fertilizer on soil fertility and yield under rice-wheat cropping system. Journal of Indian Society of Soil Science **41(1):** 178-180.

Mishra VK and Sharma RB 1997. Influence of integrated nutrient management on soil health and energy requirement of rice based cropping systems. Oryza **34(2):** 165-170.

Parr JF and Papendick RI 1978. Factors affecting decomposition of crop residues by microorganisms. In: Crop residue management system (WR Swchwald ed). ASA, CSSSA, SSA, Madison, WI, USA, pp 101-129.

Patel RB, Rajashekarrappa BJ, Viswanth OP and Shantaram MV 1979. Solubilization and immobilization of phosphate by some microorganisms and P availability to plant. Journal of Indian Society of Soil Science **12:** 550-556.

Patrick WH, Mahapatra JR and Jorawar IC 1965. Transformation and availability of rice to nitrogen and phosphorus in waterlogged soils. Advances in Agronomy **20:** 331-338.

Powlson DS and Johnston AE 1992. Long-term field experiments: their importance in understanding sustainable land use. In: Proceedings of a symposium on soil resilience and sustainable land use, Budapest, Hungary, 28 September-2 October 1992, pp 367-393.

Subbiah BV and Asija GL 1956. A rapiod procedure for estimation of available nitrogen in soils. Current Science **25(8):** 259-260.

Walkey A and Black IA 1934. An examination of the Degtjareff method for determining organic carbon in soils: effects of variations in digestion conditions and of inorganics and of inorganic soil constituents. Soil Science **63:** 251-263.

Yaduvanshi HS, Tripathi BR and Kanwar RS 1985. Effect of continuous manuring on some soil properties of an Alfisol. Journal of Indian Society of Soil Science **33:** 700-703.

Yaduvanshi NPS 2001. Effect of five years of rice-wheat cropping and NPK fertilizer use with and without organic and green manures on soil properties and crop yields in a reclaimed sodic soil. Journal of Indian Society of Soil Science **49(4):** 714-719.

Received : 12.7.2012 *Accepted : 21.8.2012*