PADDY CULTIVATION IN SODIC SOIL THROUGH VERMITECH

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ABSTRACT

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Present investigations were conducted at the farms of Uttar Pradesh Bhumi Sudhar Nigam at Shivri, Lucknow during the Kharif season in 1998-99 to assess the impact of organic amendment vermicompost in comparison to chemical fertilisers on paddy (variety-Sarju-52) in sodic soil and in relation to soil fertility, yield parameters and economics. Results indicated an increase in soil organic matter from 0.38 to 0.96 %, organic carbon from 0.22 to 0.56 %, available nitrogen (N) from 499.52 to 1245.44 kg /ha, carbonate ions from 0.20 to 0.23 meq/100 g of soil, calcium ions from 0.89 to 1.09 meq/100 g of soil and decrease in pH from 8.74 to 8.25, electric conductivity (EC) from 0.86 to 0.69 dSm^{-1}, sodium ions from 11.85 to 1.47 meq/100 g of soil and exchangeable sodium percentage (ESP) from 67.51 to 57.42, suggesting qualitative improvement of soil, in the plots amended with vermicompost. Paddy yield of 4975 kg/ha was recorded from plots amended with vermicompost while 4900 kg/ha, from plots amended with chemical fertilizers, as control. Cost benefit ratio was found to be 1:1.5 for cultivation of paddy using vermitech where as in case of chemical fertilisers, it was 1:1.06 suggesting that by the application of vermicompost in paddy, the cost of production could be reduced without compromising on harvest.

Keywords: Sodic soil, vermicompost, soil fertility, bio-remediation, sustainable agriculture

INTRODUCTION

Soils in India are affected by problems like salinity, alkalinity (sodicity) and water logging. Alkaline or sodic soil predominates in the northern plains of India characterised by pH greater than 8.5 and higher quantity of active sodium. Such soils have been deterred by human interference by way of inappropriate tillage and cropping practices, improper fertiliser application and water management. It is therefore necessary to use suitable organic amendments for proper soil management.

There are a number of organic amendments like bio-solids, straw, sawdust, manures including farm yard manure (FYM) and crop residues which have been used for bio-remediation of sodic soil but the most important among them is the compost. Addition of compost to soil results in the improvement of physical, chemical and biological characteristics of soil with increased crop production (Pera *et al.,* 1983).Vermicompost has been found to have a favourable influence on yield parameters of paddy, sugarcane and vegetables like, tomato, brinjal and okra (Ismail, 1997).

MATERIALS AND METHODS

Experiments have been conducted at the Shivri farm of Uttar Pradesh Bhumi Sudhar Nigam, Lucknow during the kharif season (1998-99), to assess the impact of organic amendment i.e, vermicompost compared to chemical fertilisers on paddy (variety-*Sarju*-52) in relation to sodic soil bio-remediation, fertility, plant growth, yield parameters and economics.

Plots each $250m^2$ (20m x 12.5m) were marked for trial (in triplicate), during 1998 (Kharif) at the Shivri farm of the Uttar Pradesh Bhumi Sudhar Nigam, Lucknow.

Composite soil samples were taken from the trial plots at pre-transplanting and post-harvesting stage and were subjected to chemical analysis [pH, electrical conductivity (EC), organic matter, organic carbon and available N, available P, available K, Na and Ca ions and exchangeable sodium percentage (ESP)].

Plot-A was amended using vermicompost and vermiwash produced at Shivri farm of UPBSN, Lucknow, using Vermitech (Ismail, 1993).Vermicompost and vermiwash used for the experiments, were analysed for the nutrient quality (pH, EC, organic carbon, total N, total P, total K, ferrous ions, zinc ions, copper ions). Plot-B was amended with chemical fertilisers according to standard recommendations prevalent there. Paddy (*Sarju*-52) was transplanted in experimental plots A and B in July 1998 in Randomised Block Design (RBD) with sub-plot size of $250m^2$.

Following crop data were recorded after 95 days of transplanting, before harvest: plant height (cm), number of tillers, number of panicles per hill, length of panicle (cm).

On harvest of crop, after 100 days, the following data were recorded: total yield (kg/ha), grain yield (kg/ha), weight of 1000 grains (grams).

RESULTS AND DISCUSSION

It is evident that there is an increase in organic matter content from 0.38 to 0.96 %, organic carbon from 0.22 to 0.96 %, available nitrogen from 499.52 to 1245.44 kg/ha, carbonate ions from 0.20 to 0.23 meq/100 g of soil, calcium ions from 0.89 to 1.09 meq/100 g of soil and decrease in pH from 8.74 to 8.25, EC from 0.86 to 0.69 dSm^{-1}, sodium ions from 1.85 to 1.47 meq/100 g of soil and ESP from 67.51 to 57.42, suggesting bio-remediation and qualitative improvement of sodic soil, in plot-A, amended with vermicompost (Table 1). There is reduction in pH by 5.61% and ESP by 14.95% in plot-A (vermicompost) while in plot-B (chemical) on the contrary there is an increase by 0.81% and 2.75% respectively. Organic carbon and available nitrogen increased by 154.55% and 149.33% in plot-A while in plot-B it was reduced by 40.74% and 41.82%.

Paddy yield of 4975 kg per hectare was recorded from plot-A amended with vermicompost and 4900 kg per hectare from plot-B amended with chemical fertilisers (Table 2). Weight of grains from plot-A (vermicompost) compared to plot-B (chemical), suggested, better quality, in case of paddy grown through Vermitech (Table 2).

Total cost of cultivation of paddy per hectare through conventional farming applying chemical fertilisers and pesticides was Rs 16,900, while the cost of cultivation of paddy through vermitech was Rs 18,100 (Table 3).

Net income per hectare from plot-A (vermicompost) = Rs 4492.50
Plot-B (chemical) = Rs 2970.00

Cost benefit ratio for plot-A = 1: 1.30
Plot-B = 1: 1.16

Economics of paddy cultivation suggest that practising organic cultivation through vermitech could reduce the cost of production (Table 4).

Table 1. Soil Fertility Status Report

S.No	Soil Parameters	Plot-A (vermicompost) (n=3)		Plot-B (chemical) (n=3)	
		Before transplanting	After harvest	Before transplanting	After harvest
1	pH (1:5)	8.74 ± 0.19	8.25 ± 0.19	8.6 ± 0.41	8.67 ± 0.45
2	EC (dSm^{-1})	0.86 ± 0.11	0.69 ± 0.18	1.06 ± 0.03	0.99 ± 0.04
3	Organic matter (%)	0.38 ± 0.27	0.96 ± 0.25	0.31 ± 0.04	0.28 ± 0.02
4	Organic Carbon (%)	0.22 ± 0.16	0.56 ± 0.14	0.27 ± 0.02	0.16 ± 0.01
5	Available N (Kg/ha)	499.52 ± 0.11	1245.44± 0.10	616.00 ± 0.06	358.40 ± 0.90
6	Available P (Kg/ha)	23.20 ± 5.17	21.60 ± 4.88	20.70 ± 5.30	24.55 ± 6.70
7	Available K (Kg/ha)	203.80 ± 23.5	172.30 ± 24.50	190.40 ± 14.30	176.40 ± 16.80
8	CO_3 (meq/100g of soil)	0.20 ± 0.09	0.24 ± 0.09	0.28 ± 0.07	0.14 ± 0.09
9	HCO_3 (meq/100g of soil)	1.22 ± 2.64	0.30 ± 0.06	0.48 ± 0.03	0.50 ± 0.04
10	Na^+ (meq/100g of soil)	1.85 ± 0.31	1.47 ± 0.32	1.18 ± 0.21	1.51 ± 0.32
11	Ca^{+2} (meq/100g. of soil)	0.89 ± 0.15	1.09 ± 0.10	0.38 ± 0.053	0.42 ± 0.067
12	ESP(Exchangeable Sodium Percentage)	67.51± 0.66	57.42 ± 0.44	75.64 ± 0.12	77.72 ± 0.57

Table 2. Effect of Vermicompost on Paddy (*Sarju*-52) during July- Oct. 1998 (Data mean of n=100)

S.No.	Parameters	Plot-A (vermicompost)	Plot- B (Chemical)
1	Plant Height (cm)	83.05 ± 5.78	73.8 ± 4.30
2	Number of tillers	4.58 ± 1.64	5.74 ± 1.97
3	Number of panicles/hill	12.85 ± 1.33	10.7 ± 1.20
4	Length of panicle (cm)	23.35 ± 2.15	22.25 ± 2.49
5	Weight of 1000 grains (grams)	21.46	20.50
6	Total yield (kg/ha)	12820	15900
7	Grain yield (kg/ha)	4975	4900

Table 3. Cost of production (Indian Rupees; 1 ₤ = 69.52)

S.No.	Activities	Plot-A (vermicompost)	Plot-B (chemical)
1	Land preparation	4300	4300
2	Transplanting	3000	3000
3	Seeds	600	600
4	Fertilisers	1350	2170
5	Pesticides	300	680
6	Weeding	1250	1250
7	Irrigation	4000	4000
8	Harvesting	2100	2100
	Total	16900	18100

Table 4. Economics of Paddy cultivation (Indian Rupees; 1 ₤ = 69.52)

I	Sale Price of Paddy per kg	4.30	4.30
II	Average yield (kg/ha)	4975.00	4900.00
III	Gross income /ha (I x II)	21392.50	21070.00
IV	Cost of production	16900.00	18100.00
V	Cost of production/kg (IV / II)	3.39	3.69
VI	Net income/ha (III – IV)	4492.50	2970.00
VII	Cost Benefit ratio (IV / III)	1:1.3	1:1.16

The high organic matter content of vermicompost (19.3%) promotes humification, increased microbial activity and enzyme production, which in turn increases aggregate stability of soil particles, resulting in better aeration (Haynes and Swift, 1990; Perucci, 1990).

Increase in soil nitrogen after harvest from plot-A (vermicompost) is likely to be due to an increase in the presence of nitrogen-fixing microbes through application of compost. Reduction in pH and increase in humus content of the sodic soils are observed due to the production of humic acid during decomposition thereby, reducing soil alkalinity in terms of pH, as also observed by Patcharapreecha *et al.,* (1990). The effectiveness of compost in sodic soil is due to the production of carbondioxide, humic acid, drop in redox potential and replacement of exchangeable Na^+ ions by Ca^{+2} ions leaching out of the root zone, thus reducing the ESP (Dagar, 1995).

Vermicompost has been found to have profound effect on plant parameters like height, number of tillers, panicles per hill, grain weight, total yield and grain yield in comparison to chemical fertilisers .The higher yield, reduced cost of cultivation, less cost benefit ratio and higher net income from paddy cultivation through vermitech compared to the use of chemical fertilisers correlates with the earlier works on economics of crops by organic methods (Ismail, 1997).Organic amendments like vermicompost facilitates humus formation and prevents leaching of nutrients from the soil by their slow release compared to the conventional farming by the use of chemical fertilisers (Thampan, 1995; Kale, 1996). Considering all the aspects such as soil studies, production and cost effectiveness, from the above investigations, vermitech could be applied in farming practices for sustainable bio-remediation of sodic soil.

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