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Short communication

Effect of integrated nutrient management on soil fertility, organic carbon and productivity of okra

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ABSTRACT

A field experiment was conducted at Vegetable Research Farm, JNKVV, Jabalpur (M.P.) for four seasons with the object to assess the effect of integrated nutrient management on soil fertility and organic carbon in okra. Total of 15 treatments including three doses of vermicompost (3, 4 and 5 t ha^{-1}) and three levels of chemical fertilizers, 40:30:30, 60:45:45 and 80:60:60 kg NPK ha^{-1} alone and in combinations were arranged in randomized block design with three replications. It was observed that incorporation of vermicompost 5 t ha^{-1} alongwith the 80:60:60 kg NPK ha^{-1} resulted significantly higher fruit yield (91.0 q ha^{-1}) as well as plant height (104.6 cm), nodes plant^{-1} (15.8), root length (53.4 cm) and root dry weight (4.87 g plant^{-1}). This treatment also increased the porosity in terms of bulk density (1.325 mg m^{-3}), organic carbon content (5.8%) and available NPK after harvest of four succeeding crops. The pH value of the soil was also decreased with incorporation of vermicompost either alone or in combination with chemical fertilizer as compared to chemical fertilizer alone.

Key words: Bulk density, okra, organic manure, vermi-compost.

The integrated nutrient management (INM) practices, which include the use of organic resources and inorganic fertilizers (off-farm input), are known to modify the fertility status of the soil as well as the soil conditions. Till now, very little attention has been paid to sustain the soil productivity while minimizing the dependence on chemical fertilizers. Consequently, the use of organic manures supplemental source of fertilizers declined the production substantially. The continuous cropping with cereal after cereal crop rotation raised the question of sustainability of the system, which is highly dependent on chemical fertilizers and crop has started to give the signals of declining in yield. However, integrated approach of plant nutrient management system improves soil fertility and maintains soil health without affecting the yield of crops by (Bandanur *et al.*, 1). Combined application of vermicompost alongwith recommended levels of NPK fertilizers have been reported to enhance the nutrient status of soil with improvement in organic carbon as well as soil physical properties (Vyas *et al.*, 10) keeping the above points in view the present study was planned and executed accordingly.

A field experiment was conducted at Vegetable Research Farm, JNKVV, Jabalpur during four seasons for two years. The soil of the experimental field was sandy loam, which was neutral in reaction (7.2 pH), low in organic carbon (0.41%), medium in available nitrogen (234.8 kg ha^{-1}), phosphorous (12.6 kg ha^{-1}) and potassium (335.4 kg ha^{-1}). There were 15 treatment combinations comprising three doses of vermicompost (V_1: 3 t vermicompost ha^{-1}, V_2: 4 t vermicompost ha^{-1} and V_3: 5 t vermicompost ha^{-1}) and three fertility levels of chemical fertilizers (NPK), *i.e.* (F_1: 40:30:30 kg NPK ha^{-1} (50% RDF), F_2:60:45:45 kg NPK ha^{-1} (75% RDF), and F_3: 80:60:60 kg NPK ha^{-1} (100% RDF). These treatments were arranged in a randomized block design with three replications. Vermicompost contained 1.5% N, 1.2% P_2O_5 and 1.2% K_2O. The full dose of phosphorous and potassium as well as vermicompost was applied as basal as per the treatments. The nitrogen was given in three split doses, 1/3rd as basal, and remaining 2/3rd in two equal split doses at 30 and 45 DAS. The seeds of okra variety Parbhani Kranti were sown and recommended agronomical practices were followed to grow successful crop during summer and *kharif* season for two years. The data pertaining to number of nodes per plant, fruits per plant, root length and dry weight and yield were recorded. Change in available soil nitrogen, phosphorous and potassium contents, organic carbon content and pH were recorded after four succeeding crops following standard procedures.

The plant height, number of nodes, root length, and root dry weight were significantly influenced due to application of vermicompost and fertilizers (Table 1). Incorporation of vermicompost as a source of nutrients improved the yield and yield attributes significantly. The tallest plants (104.6 cm), higher

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Table 1. Effect of integrated nutrient management on physico-chemical composition of soil and yield of okra (pooled of four seasons).

Treatment	Plant height (cm)	No. of node (plant^{-1})	Root length (cm)	Root dry weight (g plant^{-1})	Yield (q ha^{-1})	Bulk density (mg m^{-3})	Organic carbon (%)	pH	Available nutrient in post harvest soil (kg ha^{-1})		
									N	P	K
Vermicompost 3 t ha^{-1}	58.9	8.5	28.1	3.91	48.5	1.380	0.47	7.5	230.4	13.7	335.6
Vermicompost 4 t ha^{-1}	62.0	10.9	30.2	4.11	50.8	1.380	0.47	7.6	232.8	14.2	340.7
Vermicompost 5 t ha^{-1}	64.7	11.6	34.2	4.25	52.0	1.370	0.49	7.6	236.9	14.4	342.4
40:30:30 NPK kg ha^{-1}	65.5	8.1	27.5	4.05	44.1	1.385	0.43	7.0	229.9	12.3	343.7
Vermicompost 3 t + 40:30:30 NPK kg ha^{-1}	68.6	10.4	39.4	4.25	49.7	1.363	0.48	7.4	236.3	14.4	345.5
Vermicompost 4 t ha^{-1} + 40:30:30 NPK kg ha^{-1}	74.2	11.5	46.5	4.33	57.8	1.340	0.48	7.5	238.8	15.4	349.8
Vermicompost 5 t ha^{-1}+ 40:30:30 NPK kg ha^{-1}	79.6	13.3	49.3	4.42	60.9	1.340	0.49	7.5	240.8	16.9	352.1
60:45:45 NPK kg ha^{-1}	84.7	9.9	29.5	4.14	52.0	1.383	0.43	7.5	230.2	12.8	345.2
Vermicompost 3 t + 60:45:45 NPK kg ha^{-1}	88.3	10.8	47.4	4.38	55.5	1.355	0.50	7.2	243.6	15.8	351.9
Vermicompost 4 t + 60:45:45 NPK kg ha^{-1}	90.8	13.8	47.8	4.64	68.1	1.340	0.54	7.5	248.1	16.4	354.9
Vermicompost 5 t + 60:45:45 NPK kg ha^{-1}	94.5	16.9	53.2	4.79	88.3	1.333	0.55	7.6	254.3	16.8	352.6
80:60:60 NPK kg ha^{-1}	93.7	12.2	31.1	4.23	65.7	1.380	0.45	7.3	234.7	13.6	351.7
Vermicompost 3 t + 80:60:60 NPK kg ha^{-1}	98.6	13.7	51.5	4.7	73.3	1.365	0.54	7.5	243.8	15.5	353.8
Vermicompost 4 t + 80:60:60 NPK kg ha^{-1}	101.2	15.8	52.3	4.77	80.6	1.338	0.57	7.5	248.6	15.6	355.8
Vermicompost 5 t + 80:60:60 NPK kg ha^{-1}	104.6	15.8	53.4	4.87	91.0	1.325	0.58	7.5	255.6	17.3	362.6
CD at 5%											

nodes plant^{-1} (15.8), root length (53.4 cm), and root dry weight (4.87 g) as well as the yield (91.0 q ha^{-1}) were noted with vermicompost 5 t alongwith 80:60:60 kg NPK ha^{-1}. These parameters and yield were reduced with the reduction of vermicompost levels. The beneficial effect of vermicompost on root shoot growth and production of fruits might be attributed to the mineralization the macro- and micro-nutrients during the process of vermicomposting into the available form. Further, vermicompost has several bio-humic substances, which highly beneficial to plants (Masciandaro *et al.*, 4). These hormones based humic substances promote plant growth, induction of flowers and formation of lateral roots, which enhanced the uptake of nutrients by the plants (Shroff and Devasthali, 7). The increasing levels of fertilizer from 40:30:30 kg NPK ha^{-1} alongwith vermicompost 5 t ha^{-1} increase the fruit yield of 60.9 to 90.09 q ha^{-1}. Further, it was noted the integration of chemical fertilizer and vermicompost might increased the availability of nutrients and presence of growth promoting substances required for branching, flowering, and fruit set, which ultimately resulted in increased fruit yield.

Application of organic manures and inorganic fertilizer significantly increased the buildup of available N in the soil. The amount of average nitrogen contents in soil gradually increased over the season and initial amount (234.8 kg ha^{-1}) in respect to crop treatment (Table 1). The higher amount of N (255.6 kg ha^{-1}) was recorded in the treatment where recommended levels of NPK alongwith 5 t ha^{-1}vermicompost was applied closely followed by 75 per cent RDF + 5 t ha^{-1} vermicompost (254.3 kg ha^{-1}). Addition of vermicompost improves the physical properties of soil thus creating the favourable conditions for microbial activity resulting in better nutrient availability. These findings are in agreement with the results of Mishra *et al*. (6), which might be due to application of organic matter releasing nitrogen under the process of mineralization (Maiti *et al.*, 3). Further, it was also noted that, increasing dose of vermicompost and percentage of RDF increased the amount of N content in soil. The combined application of RDF and vermicompost proved to be superior over subsequent higher percentage of RDF alone. Earlier, Islam *et al*. (2) enhancement in available N content of soil due to addition of organic and inorganic fertilizer in cabbage-brinjal-red amaranth cropping system.

The amount of average P and K in soil also recorded in gradual increase with the increase in dose of vermicompost used either alone or in combination of RDF. The highest amount of P (17.3 kg ha^{-1}) and K (312.0 kg ha^{-1}) was recorded where 5 t vermicompost was applied with 100% of RDF. Furthermore, 75 percent of RDF along with either of the dose of vermicompost registered its superiority over 100% RDF alone in case of phosphorus and potassium content in soil. Such increase in P and K in soil might be explained by release of P from the applied organic matter after mineralization and K due to positive interaction with the micronutrients like Zn and Mn present in the vermicompost. Moreover, release of P and K in the soil from unavailable to available form because of reaction of organic acid produced after decomposition of organic manure (Singh *et al.*, 8). Earlier, Tiwari *et al.* (9) who observed improvement in P and K content of soil with the application of NP & K alongwith manures (15 t ha^{-1}).

Significant improvement in physico-chemical properties of soil was observed by use of different nutrient sources of (Table 1). The mean changes in soil pH showed the significant variation among different treatments. The change in pH varied from 7.20 to 7.63 recorded after three season crops, being significantly increased in pH (7.63) over the initial value (7.20) in the treatment receiving 5 t ha^{-1} vermicompost alongwith 100% RDF followed by 4 t ha^{-1} vermicompost. The decrease in soil pH may be attributed to the continuous use of vermicompost, which releases various organic acids upon its decomposition and leaching of salt to lower soil layers during raining season. These results are in close conformity with the findings of Masciandaro *et al*., 7). Singh *et al*. (14) reported decrease in pH and EC of soil under farm yard manure application due to the higher activities of Al^{3+} and continuous release of basic cations upon it decomposition.

The amount of organic carbon content in soil significantly increased in subsequent years with respective INM treatments. The maximum amount of organic carbon content (0.58%) was recorded after harvest of four crops under 100 per cent RDF (NPK) alongwith vermicompost 5 t ha^{-1} closely followed by 100 per cent RDF(NPK) + vermicompost 4 t ha^{-1}. Further, it was also noted that increasing dose of vermicompost significantly increase the organic carbon. The amount of organic carbon was higher where vermicompost was applied. An increase in organic carbon may be due to application of vermicompost, which might have added organic matter directly to the soil (Korwar *et al*., 4; Methew and Nair, 10; Rajendra *et al*., 12). Addition of vermicompost either alone or in combination of recommended dose of fertilizer in okra crop markedly. Change in porosity of soil reflected in the form of bulk density. The plots receiving 4 and 5 t ha^{-1} vermicompost either applied alone or in combination of 75 and 100% recommended dose of NPK recorded the lowest value (1.33 to 1.34 mg

m^{-3}). Further, lower dose of vermicompost did not brought out significant change over RDF alone. The porosity of soil increased due to addition of vermicompost and thus brought significant change in bulk density and higher bulk density values under fertilizer alone (1.38 mg m^{-3}). Effect of vermicompost was more pronounced when it was applied with recommended dose of fertilizers. The increasing dose of vermicompost showed positive deterioration in bulk density and compactness of the soil particles. These findings are in agreement with the results of Mishra *et al.* (11).

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