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Effect of sources of nutrients and their levels on yield, quality and economics of summer season okra

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ABSTRACT

A field experiment was conducted during summer season of 2005 and 2006 to assess the effects of sources of nutrients and their levels on the performance of okra. Four doses of vermicompost (0, 3, 4 and 5 t ha^{-1}) and four levels of chemical fertilizer, 0,40:30:30, 60:45:45 and 80:60:60 kg NPK ha^{-1} were arranged in randomized block design with three replications. It was observed that incorporation of vermicompost 5 t ha^{-1} resulted significantly higher fruit yield (69.2 q ha^{-1}) and protein content (18.0%) as well as B:C ratio (2.11). Whereas plant height (97.7 cm), nodes plant^{-1} (14), fruit length (10 cm), fruit diameter (1.8 cm), yield (73.8 q ha^{-1}) as well as protein content (18.5%) were recorded with the fertility of level 80:60:60 kg NPK ha^{-1}. This treatment also recorded the highest net return of Rs. 46,152 ha^{-1} and gave maximum benefit:cost ratio of Rs. 2.68. Increasing dose of vermicompost and fertilizer in combinations significantly increased the yield and yield attributes, nutrient contents and B:C ratio over preceding lower levels. Maximum fruit yield of 86.4 q ha^{-1} alongwith the B:C ratio of Rs. 2.66 were noted with the combination of vermicompost 5 t and 80:60:60 kg NPK ha^{-1}.

Key words: Vermicompost, nutrient management, okra, quality, yield, economics.

INTRODUCTON

Okra (*Abelmochus esculantus* (L) Moench) is one of the export oriented nutritious vegetable. It occupies 3.58 lakh hectares area with annual production of around 35.25 lakh metric tonnes (Chamber *et al.*, 1). Now-a-days, it is being increasingly realized that organic manure is the cheapest eco-friendly resource for providing nutrients to crop plants and help in curtailing the use of external resources of the chemical fertilizers. Manures not only supply plant nutrients but also add organic matter which improve physical conditions of soil (Ludwick and Johnstone (8). Beside this, it plays a significant role in creating favourable environment to the soil flora and fauna. Therefore, it is necessary to explore the potential of vermicompost and possibility of supplementing chemical fertilizers. The vermicompost has been found to be an ideal organic source of nutrients as it is rich in macro- and micro-nutrients and helps to harvest more yield (Hidalgo, 4; Pashanasi *et al.*, 13), and Pashanasi *et al.* (13). So far, meagre work has been done on integration of nutrients for enhancing growth and productivity of okra particularly with the use of vermicompost. Keeping the above facts in view, present study was undertaken to study the effect of vermicompost with different fertility levels on yield and quality of okra.

MATERIALS AND METHODS

A field experiment was conducted at Vegetable Research Farm, JNKVV, Jabalpur during summer season of 2005 and 2006. 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 sixteen treatment combinations comprising four doses of vermicompost (V_0: without vermicompost, V_1: 3 t vermicompost ha^{-1}, V_2: 4 t vermicompost ha^{-1} and V_3: 5 t vermicompost ha^{-1}) and four fertility levels of chemical fertilizers (NPK), i.e. (F_0: without fertilizer, F_1: 40;30:30 kg NPK ha^{-1}, F_2: 60:45:45 kg NPK ha^{-1} and F_3: 80:60:60 kg NPK ha^{-1}). 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 dose as per 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 recommended agronomical practices were followed to grow successful crop during both the years. Seeds of variety Parbhani Kranti were sown in rows at a distance of 30 cm apart using seed rate of 12 kg ha^{-1} on 22nd and 26th February during 2005 and 2006, respectively. The data pertaining to plant height, number of nodes and fruits per plant, fruit length, fruit diameter and yield were recorded. Nutrient uptake was computed on the basis of concentration of nutrients and dry matter accumulation. Ten fruits were randomly collected at each picking. These fruits were chopped and air-dried followed by oven at 60 ±

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2°C and composite sample was prepared and used for determination of nitrogen, phosphorus and potassium content in fruits as per the methods suggested by McDonald (10), Koeing and Jhonson (7), and Hanway and Haidal (3), respectively. The crude protein in fruits was also computed by multiplying N content with the conversion factor of 6.25 and protein yield (kg ha^{-1}) was worked out. Economic of different treatments were calculated on the basis of prevailing market rate of produce and inputs used. As the trend of data was similar in both the years, pooled data are presented.

RESULTS AND DISCUSSION

The plant height, root length, number of nodes, fruit size as well as number of pickings were significantly influenced due to application of vermicompost and fertilizers (Table 1). The maximum shoot length (82.4 cm), nodes plant^{-1} (14.1), number of fruits plant^{-1} (10.1), fruit length (10.4 cm), fruit diameter (1.9 cm), number of pickings (12) as well as the yield (69.2 q ha^{-1}) were noted with vermicompost 5 t ha^{-1}. The yield and its attributes were reduced with the reduction of vermicompost levels. The beneficial effect of vermicompost on growth and production of fruits might be attributed to the fact that the earthworms mineralized the macro- and micro-nutrients during vermicomposting and made available to crop plants. Moreover, vermicompost contain several bio-humic substances this was the view of Masciandaro *et al.* (11). This is also due to the hormones like auxins and cytokinins reported by Muscolo *et al.* (12). These hormone-based humic substances promote plant

Table 1. Effect of vermicompost and fertility levels on yield attributing characteristics of okra.

Treatment combination	Plant height (cm)	Root length (cm)	Root biomass (g plant^{-1})	No. of nodes plant^{-1}	No. of fruits plant^{-1}	Fruit length (cm)	Fruit dia. (cm)	No. of pickings
F_0: Without fertilizer	57.8	29.4	3.15	9.9	6.1	6.3	1.5	8
F_1: 40:30:30 NPK kg ha^{-1}	69.8	40.4	3.88	11.0	7.5	8.0	1.7	9
F_2: 60:45:45 NPK kg ha^{-1}	87.5	43.6	4.40	12.9	9.6	9.2	1.8	11
F_3: 80:60:60 NPK kg ha^{-1}	97.7	46.4	4.67	13.9	12.0	10.0	1.8	14
CD at 5%	2.82	4.89	0.41	2.13	1.09	1.30	0.19	0.98
V_0: Without vermicompost	73.7	28.0	3.51	9.7	6.9	6.1	1.4	8.5
V_1: Vermicompost 3 t ha^{-1}	77.1	41.2	3.92	11.2	8.5	7.9	1.6	10
V_2: Vermicompost 4 t ha^{-1}	79.5	43.8	4.19	12.7	9.6	9.3	1.8	11
V_3: Vermicompost 5 t ha^{-1}	82.4	46.8	4.48	14.1	10.1	10.4	1.9	12
CD at 5%	2.82	4.89	0.41	2.13	1.09	1.30	0.19	0.98
$F_0 V_0$	52.4	23.5	3.79	7.0	5.5	4.9	1.1	6.3
$F_0 V_1$	58.9	28.1	3.88	8.5	5.9	5.8	1.4	8.5
$F_0 V_2$	62.0	30.2	4.05	10.9	6.4	7.8	1.5	9.6
$F_0 V_3$	64.7	34.2	4.24	11.6	6.6	8.2	1.8	9.6
F_1V_0	65.4	27.5	4.04	8.1	6.1	6.2	1.4	7.9
$F_1 V_1$	68.5	39.4	4.24	10.4	7.4	7.6	1.6	10.0
$F_1 V_2$	74.2	46.5	4.32	11.5	8.8	9.0	1.8	12.3
$F_1 V_3$	79.6	49.3	4.39	13.3	9.3	10.5	2.0	12.9
$F_2 V_0$	84.7	29.5	4.13	9.9	7.5	6.6	1.5	8.6
$F_2 V_1$	88.3	47.4	4.36	10.8	9.9	8.9	1.8	10.8
$F_2 V_2$	90.7	47.8	4.57	13.8	10.6	11.0	1.9	15.9
$F_2 V_3$	94.5	53.2	4.74	16.9	12.6	12.1	2.1	17.7
$F_3 V_0$	93.7	31.1	4.21	12.2	9.1	7.8	1.8	13.2
$F_3 V_1$	98.6	51.5	4.66	13.7	13.1	10.5	1.9	14.7
$F_3 V_2$	101.2	52.3	4.75	15.8	13.8	11.4	2.0	18.3
$F_3 V_3$	104.5	53.4	4.82	15.8	13.8	12.4	1.9	19.1
CD at 5%	5.64	NS	NS	NS	NS	NS	NS	NS

growth, induction of flowers and formation of lateral roots which enhanced the uptake of nutrients by the crop plants (Sinha *et al.*, 18). Similar results have also been reported by Shroff and Devasthali (15).

The increasing levels of fertility significantly increased the growth of root and shoot of the plant as well as number of nodes plant^{-1}, fruit length, fruit diameter, number of fruits, number of fruit pickings and fruit yield. The maximum plant height (97.7 cm), root length (13.9 cm) and root biomass (4.67 g plant^{-1}), number of nodes plant^{-1} (13.9) number of fruits plant^{-1} (12) , fruit length (10.0 cm), fruit diameter (1.8 cm) and number of pickings (14) were recorded under 80:60:60 kg NPK ha^{-1}. The fruit yield markedly increased with an application of 60:45:45 and 80:60:60 kg NPK ha^{-1} and gave 34.1 and 60 per cent higher yield, respectively, over control. Improvement in growth and root dry matter accumulation in okra plants might be due to balance of fertilization, build-up of adequate food reserves for formation and elongation of cells, which enhanced the photosynthetic activity by increasing the leaf area and rate of photosynthesis. The synthesised photosynthets might have translocated into growing fruits having more demand of assimilates which consequently lead to greater length, diameter and biomass as reported by Mani *et al.* (9).

Table 2 Effect of fertility levels and doses of vermicompost on yield and yield attributing characteristics of okra.

Treatment combination	Yield q ha^{-1}	Dry matter accumulation (q ha^{-1})	Nutrient in fruits (%)			Protein content (%)	Nutrient uptake (kg ha^{-1})			Net return Rs. ha^{-1}	B: C ratio
			N	P	K		N	P	K		
F_0:Without fertilizer	47.5	22.2	2.41	0.40	3.28	15.1	22.2	4.4	26.1	25,788	1.76
F_1:40:30:30 NPK kg ha^{-1}	51.1	27.1	2.64	0.48	3.59	16.5	31.2	6.5	34.3	28,015	1.76
F_2:60:45:45 NPK kg ha^{-1}	63.7	35.2	2.84	0.53	3.80	18.5	43.4	9.1	46.8	37,940	2.29
F_3:80:60:60 NPK kg ha^{-1}	73.8	40.3	2.96	0.57	3.92	18.5	51.2	11.0	55.0	46,152	2.68
CD at 5%	4.49	2.18	0.31	NS	NS	1.39	2.62	2.15	8.72	-	-
V_0:Without Vermicompost	50.3	27.9	2.41	0.40	3.34	15.1	31.4	5.3	32.9	31,173	2.68
V_1:Vermicompost 3 t ha^{-1}	55.5	31.1	2.74	0.47	3.68	17.2	36.3	7.5	40.4	31,157	1.93
V_2:Vermicompost 4 t ha^{-1}	61.6	32.3	2.81	0.54	3.76	17.6	38.9	8.7	43.1	35,196	2.00
V_3:Vermicompost 5 t ha^{-1}	69.2	33.5	2.88	0.57	3.82	18.0	41.3	9.6	45.7	40,366	2.11
CD at 5%	4.49	2.18	0.31	0.09	NS	1.39	2.62	2.15	8.72	-	-
$F_0 V_0$	41.6	20.40	1.98	0.31	3.01	12.4	16.85	1.30	9.80	26,919	2.98
$F_0 V_1$	48.5	22.60	2.47	0.38	3.29	15.5	22.15	2.18	13.55	25,555	1.74
$F_0 V_2$	50.8	22.80	2.56	0.43	3.40	16.0	23.60	2.53	13.95	25,765	1.59
$F_0 V_3$	52.0	22.80	2.62	0.49	3.47	16.4	24.90	2.78	14.30	24,865	1.40
$F_1 V_0$	44.1	23.05	2.35	0.39	3.26	14.7	24.05	2.10	12.88	26,682	2.34
$F_1 V_1$	49.7	27.05	2.65	0.45	3.59	16.6	30.85	3.00	17.15	25,537	1.60
$F_1 V_2$	57.8	28.45	2.72	0.52	3.65	17.0	33.30	3.55	18.45	29,427	1.68
$F_1 V_3$	60.9	29.55	2.83	0.56	3.77	17.7	36.30	4.08	20.05	30,412	1.61
$F_2 V_0$	52.0	31.35	2.59	0.43	3.47	16.2	38.35	3.10	19.10	31,593	2.62
$F_2 V_1$	55.5	35.00	2.83	0.52	3.77	17.7	41.85	4.28	23.08	29,448	1.78
$F_2 V_2$	68.1	35.90	2.93	0.58	3.89	18.3	45.05	4.98	24.85	38,433	2.12
$F_2 V_3$	88.3	38.40	3.00	0.61	3.97	18.8	48.05	5.63	26.90	52,283	2.67
$F_3 V_0$	65.7	36.75	2.72	0.47	3.53	17.0	44.85	3.95	23.30	39,499	3.10
$F_3 V_1$	73.3	39.45	3.00	0.55	4.02	18.8	50.30	5.15	27.15	44,044	2.55
$F_3 V_2$	80.6	41.95	3.03	0.61	4.03	19.0	53.75	6.18	28.95	47,159	2.52
$F_3 V_3$	91.0	42.90	3.07	0.65	4.11	19.2	55.90	6.65	29.98	53,904	2.66
CD at 5%	9.01	4.36	NS	0.18	NS	NS	NS	NS	NS	-	-

Cost of treatment input (Rs. kg^{-1}): Nitrogen = 10.97, phosphorous = 20.00, potassium = 7.67 and vermicompost = 1.50

Sale price of produce (Rs. kg^{-1}): Summer 2005 = 7.00, and summer 2006 = 10.00

The interaction of treatments showed that increasing level of fertilizer from 40:30:30 to 80:60:60 kg NPK ha^{-1} alongwith vermicompost 5 t ha^{-1} gave significantly higher fruit yield of 86.4 q ha^{-1} and found at par to preceding level of fertilizer. However, vermicompost 5 t ha^{-1} proved superior over 4 t ha^{-1} with the same level of fertilizer. 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 setting, which ultimate increased the fruit yield, this was the view of Crane (2). Similar results have also been reported by Singh and Asrey (17).

Both the sources of nutrients significantly increased the content of nitrogen, phosphorous and potassium as well as the protein over their respective control. Application of vermicompost 5 t ha^{-1} enhanced the concentration of N, P and K nutrients in shoot and fruit of okra. This might be ascribed due to the increased availability of nutrient in soil and proliferated root system enhanced the absorption capacity of root for the nutrients. These findings are in close conformity with the findings of Raghuwanshi and Umat (14). The concentration of nitrogen, phosphorous and potassium significantly increased with the increasing levels of NPK fertilizer upto 80:60:60 kg ha^{-1} and found significantly superior over rest of the levels except 60:45:45 kg NPK ha^{-1} in shoot and fruit both. Whereas, the lowest concentration in shoot and fruit was recorded under control but it was found at par to 40:30:30 kg NPK ha^{-1} in case of fruit only. The increase in these nutrients concentration in okra with increasing levels of nutrients was also reported by Singh *et al.* (16).

Okra crop removed significantly higher NPK under 5 t vermicompost ha^{-1} over lowest dose of 3 t ha^{-1} and control which found to be at par to 4 t ha^{-1}. Similar results have also been reported by Yadav and Kumar (19). The maximum uptake of major nutrients was observed under 80:60:60 kg NPK ha^{-1}. The effect was quite obvious as the crop of okra respond to the fertilizer application in terms of dry matter production. The increased uptake of major nutrients might be related to the development of root, which accelerates the absorption of nutrients. These results are in close conformity with the findings of Jaga (5) .

Out put analyses (Table 2) reveal that the maximum net return of Rs. 46,152 and 40,366 ha^{-1} was recorded with 80:60:60 kg NPK ha^{-1} and vermicompost 5 t ha^{-1}. Similarly, return per rupee investment was computed (Rs. 2.68 and 2.11) and found higher under these treatments, respectively. The interaction effect between fertility levels (80:60:60 kg NPK ha^{-1}) and vermicompost (5 t ha^{-1}) was found significant with respect to fruit yield. The yield was further enhanced significantly over the separate application of each treatment. Thus, the net return and cost : benefit ratio were automatically increased. These results are in accordance with the finding of Jayanthi *et al.* (6).

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