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Response of Integrated Nutrient Management on Growth, Yield and Benefit: Cost Ratio of Okra [*Abelmoschus esculentus* (L.) Moench]

Rudra Pratap Singh Gurjar[1], Ankit Kumar Goyal[2*], Sachin Kishor[1] and Amar Singh[3]
[1]School of Agriculture, ITM University, Gwalior (Madhya Pradesh), India.
[2]Department of Vegetable Science,
Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, (Uttar Pradesh), India.
[3]Department of Agricultural Statistics, CSSS PG College, Machhra, Meerut (Uttar Pradesh), India.

(Corresponding author: Ankit Kumar Goyal)*
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ABSTRACT: Okra [*Abelmoschus esculentus* (L.) Moench] is one of the most important vegetable crop during the rainy and summer season, belonging to the Malvaceae family. The indiscriminate use of chemical fertilizers reduces soil fertility as well as soil health and causes environmental pollution. However, integrated nutrient management refers to maintenance of soil fertility and plant nutrient supply to an optimum level for sustaining the desired crop productivity through optimization of the benefits from all possible sources of plant nutrients in an integrated manner. Thus, the present study was conducted at Agriculture Research Farm, School of Agriculture, ITM University, Sithouli, Gwalior, Madhya Pradesh, India to assess the response of Integrated Nutrient Management on growth, yield and benefit: cost ratio of okra. The trial was presented with an RBD design with eight treatment combinations namely T_1 - Control, T_2 - 100% Vermicompost, T_3 - 100% FYM, T_4 - 75% RDF + 25% FYM, T_5 - 75% RDF + 25% Vermicompost, T_6 - 50% RDF + 50% Vermicompost, T_7 - 50% RDF + 50% FYM, and T_8 - 50% FYM + 50% Vermicompost. Test results revealed that the treatment T_5 - 75% RDF + 25% Vermicompost was found to be the most advanced of all treatments in terms of growth and production parameter and it was followed by treatment T_6 - 50% RDF + 50% Vermicompost and T_7 - 50% RDF + 50% FYM. The benefit: cost ratio (B: C) was found to be the best in T_5 - 75% RDF + 25% Vermicompost.

Keywords: Benifit: cost ratio, FYM, INM, Malvaceae, Okra and Vermicompost.

INTRODUCTION

Okra is one of the most important vegetable crop during the rainy and summer season, belonging to the Malvaceae family. It is found in tropical and subtropical areas of Africa and also known as a lady's finger or Bhindi. The okra plant is straight, annual green, with a red stem. The leaves are 10-20 cm long and wide, palmately lobed with 5-7 lobes. The flowers are 4-8 cm wide, with five white to yellow petals, usually with red or purple spots on the underside of each petal. The fruit is a capsule up to 18 cm long containing many seeds. It is often cross pollinated when natural pollination is about to extent of 81.75 – 90.61% has been reported (Adilakshmi *et al.*, 2008; Akanbi *et al.*, 2010; Akande *et al.*, 2010).

The fresh and soft edible fruit contains 88% moisture and a large number of chemicals including vitamins A (88 IU), B (63 IU) and C (13 mg / 100 gm). Unripe okra fruit contains calorie energy (3100), protein (1.8 g), calcium (90 mg) and iron (1.0 mg) (Shiri *et al.*, 2020). Okra seeds have a good fat content of 17.3% which is a nutritious ingredient in cattle feed. It has Ayurvedic healing properties. Its leaves are used to prepare an anti-inflammatory drug. It is an excellent source of Iodine control for goiter (Chadha, 2001). The tender fruit can be cut into small pieces, boiled and served with soup. Ripe fruit and stem containing raw fibres are used in the paper industry. The roots and stems are used to extract the sugarcane juice in the preparation of "gur". The high iodine content of the fruit helps control goiter. Okra is said to be very useful in dealing with genito-urinary disorders, spermatorrhoea and chronic diarrhea. The value of a plant is enhanced by its extensive use. Dried seeds contain 14-23% good quality edible fats and 21-25% protein (Thamburaj, 2005). In many countries, the ripen seeds of okra are used as substitute of coffee particularly in Turkey (Mehta, 1959). In India, okra is cultivated nationally due to its unripe tender fruits, occupying more than 0.50 million hectares with a production of 5.8 million tons (Anonymous, 2011). In the world population is increasing due to this requirement of food is also increasing to meet out the requirement of food cultivation is largely depending on chemical fertilizers, pesticides, herbicides, etc. Results of increased production with the chemical farming have adversely affected the soil productivity and environment. The indiscriminate use of inorganic

fertilizers has resulted in reduced nutrient uptake, low vegetable quality and deteriorating soil health (Agrawal, 2005). Natural manure is a reliable source of macro and micronutrients and is useful for improving soil, chemical and biological health, reducing nutrient loss, increasing nutrient uptake and absorption leading to continuous production without harmful residues, besides improving vegetable quality (Acharya and Mandal, 2000). It has been observed that the use of only natural fertilizers or inorganic fertilizers cannot maintain soil fertility and crop production. However, their composition appears to be higher than the individual components in terms of yield, quality and nutrient uptake (Kumar *et al.,* 2017).

An integrated nutrient management system (INMS) can play an important role in stabilizing both soil health and long-term crop production, which can be achieved despite the combined use of all possible sources of nutrients. The combination of chemical fertilizers and organic fertilizers and biofertilizers can maintain soil health and soil fertility (Bhandari *et al.,* 2012). Vegetables and the vegetable system show that vegetable crops respond well to the supply of nutrients through organic fertilizers and chemical fertilizers (Kumar *et al.*, 2022).

MATERIALS AND METHODS

The experiment was carried out during *Kharif* season 2018 at Agriculture Research Farm, School of Agriculture, ITM University Gwalior (M.P.), India. Gwalior is situated between 23° 10′ N latitude and 79°54′ E longitudes on an elevation of 197 meters above from mean sea level. The experimental was laid out in Randomized Block Design with three replications and eight treatments *viz.*, T_1-Control, T_2 - 100% Vermicompost, T_3 - 100% FYM, T_4 - 75% RDF + 25% FYM, T_5 - 75% RDF + 25% Vermicompost, T_6 - 50% RDF + 50% Vermicompost, T_7 - 50% RDF + 50% FYM, and T_8 - 50 % FYM + 50% Vermicompost. The observations were recorded on growth characters like plant height (cm) was measured from soil surface to tip of the plant by using measuring scale, number of branches per plant, number of days taken to first flowering, number of leaves per plant, number of flowers per plant, number of days taken to first fruit set was counted manually. Yield and yield attributing traits like number of fruits per plant was counted manually, weight of fruits (g), yield per plant (g), yield per plot (kg), yield(t/ha) was measured by using weighing balance. The length of fruits (cm) was measured by using measuring scale. However, the aanalysis of variance was calculated by using a randomized block design was done for all the characters by ICAR-SPAR (Statistical Package for Agricultural Research).

RESULTS AND DISCUSSION

A. Growth parameters

The data on growth parameters like plant height (cm), number of leaves per plant, number of branches per plant, number of days taken to first flowering, number of flowers per plant, number of days taken to first fruit setting are presented in (Table 1). The integrated nutrient management exerted significant effect on all the growth parameters.From the experiment it was observed that application of treatment T_5 - 75% RDF + 25 % Vermicompost produced maximum plant height (126.86cm), number of leaves per plant (45.04), number of branches per plant (6.36), minimum number of days to first flowering (33.82), maximum number of flowers per plant (20.86), minimum number of days to first fruit formation (37.48) it was at par with T_6 - 50% RDF + 50% Vermicompost. This may be due to the continued release of nutrients during the growing period of crop. These findings clearly showed that vermicompost plays a key role in promoting the okra growth. The beneficial effect of vermicompost on plant growth may be due to the fact that worms make mineralized the macro and micronutrients during vermicomposting and are made available to cultivated plants for longer periods of time. In addition, they also improve soil structure, air permeability and water holding capacity of the soil. These results are closely related to the findings of Peyvast *et al.,* (2007); Abduli *et al*., (2012); Vanmathi *et al*., (2012).

Table 1: Response of integrated nutrient management on growth of okra [*Abelmoschus esculentus* (L.) Moench]

Treatments	Plant height (cm)	Number of leaves/plant	Number of branch/plant	Days to first flowering	Number of flowers/plant	Days to first fruit formation
T_1	113.16	31.83	2.05	38.66	11.43	44.52
T_2	116.00	36.98	2.40	35.96	14.80	39.72
T_3	114.03	37.93	3.32	36.52	14.14	40.57
T_4	115.96	38.60	3.45	34.84	17.43	39.89
T_5	126.86	45.04	6.36	33.82	20.86	37.48
T_6	123.01	43.86	5.70	34.36	19.77	38.23
T_7	121.04	43.05	4.51	35.47	19.33	39.49
T_8	115.71	40.00	3.73	36.44	18.37	37.63
F-test	S	S	S	S	S	S
S.Ed	0.41	1.05	0.27	1.16	1.001	1.68
C.D at 5%	0.88	2.27	0.59	2.49	2.14	3.61

Increase in plant height as well as leaf number may be due to higher metabolic activity because of optimum nitrogen application resulting in higher production of carbohydrates and phytohormones, which were manifested in the form of enhanced growth. Vermicompost has been reported to contain a few stimulants for plant growth, enzymes, beneficial bacteria and mycorrhizae (Gupta, 2005). Therefore, high nutrient availability, improved soil structure and increased activity of high-quality organisms may help to increase plant height, number of leaves and number of branches. This may be due to better availability and the uptake of plant nutrients especially N, P and K leading to better photosynthesis and protein synthesis (Kumar *et al.*, 2009). The use of the recommended N dose by using vermicompost significantly improved flower buds per plant. The 50% early flowering may be due to the higher of growth and it is also positive influence on the physiological activity of the plants thereby resulting in early flowering.

B. Yield and yield attributes

Yield parameters such as number of fruits per plant, weight of fruits (g), length of fruits (cm), yield (kg/plot), yield (tonn/ha) are presented in (Table 2). From the experiment it was observed that application of treatment T_5 - 75% RDF + 25 % Vermicompost produced maximum number of fruits per plant (21.46), Length of fruit (cm) (13.42cm), weight of fruit (12.77g) and yield (4.37 kg/plot and 18.86 tonn/ha), it was at par with T_6 - 50% RDF + 50% Vermicompost. The beneficial effect of vermicompost on crops and crop yields may be due to its ability to maintain nutritional status throughout the growing season. The moderate increase in C: N ratio may increase the concentration of carbohydrates with the final improvement in yield and yield characteristics (Chander *et al.*, 2005). These finding are also conformity with Kondappa *et al.* (2009); Sharma *et al.* (2009); Sharma *et al.* (2010); Yadav and Yadav (2010). The combined application of vermicompost and 75% NPK (RDF) resulted in almost significantly higher yield attributing parameters viz. weight of untrimmed head and average weight of trimmed over other nutrient source treatments. The high yield attributes from these nutrient sources may be due to increased growth and root parameters as a result of increased availability of all the essential plant nutrients as well as increased physico-chemical and biological properties of the soil. All these favourable conditions might have resulted in greater accumulation of dry matters and their translocation from source to the sink (reproductive organs) which, in turn, increased the higher yield attributing parameters. This result is in conformity with the finding of Yadav *et al*. (2001); Sharma *et al. (*2002).

C. Economics of treatments

The maximum gross return and net return (Rs. 188600ha^{1} and Rs 136400 ha^{1}) was obtained from T_5 (75% RDF + 25% Vermicompost) while minimum in T_1 control (Rs. 62700 ha^{1} and Rs. 7900) are presented in (Table 3). Maximum B: C ratio was observed in T_5 (75% RDF + 25% Vermicompost) 2.84, while the minimum was in T_3 (100% FYM) 1.13. It was may be due to the requirement of higher quantity of organics manure to fulfil the requirement the nutrients.

Table 2: Response of integrated nutrient management on yield and yield attributing traits of okra [*Abelmoschus esculentus* (L.) Moench].

Treatments	Number of fruits/plant	Yield (kg/plot)	Yield (tonn/ha)	Length of fruit (cm)	Weight of fruit (g)
T_1	9.2	1.74	6.27	7.68	7.83
T_2	10.33	2.25	8.71	9.28	8.79
T_3	11.87	1.64	8.59	9.57	8.63
T_4	15.78	2.47	11.46	10.41	9.83
T_5	21.46	4.37	18.86	13.42	12.77
T_6	20.62	3.90	18.07	12.45	11.98
T_7	13.58	2.34	10.83	11.42	10.74
T_8	16.63	2.73	12.63	10.43	10.24
F-test	S	S	S	S	S
S.Ed	0.60	0.22	6.89	0.78	0.459
C.D at 5%	1.29	0.48	20.67	1.69	1.285

Table 3: Response of integrated nutrient management benefit: cost ratio (B:C) of okra [*Abelmoschus esculentus* (L.) Moench].

Treatments	Cost of cultivation	Yield (q/ha)	Gross return (Rs./ha)	Net return (Rs./ha)	B:C ratio
T_1	54800	62.7	62700	7900	1.14
T_2	74800	87.1	87100	12300	1.16
T_3	69800	85.9	78900	9100	1.13
T_4	64950	114.6	114600	49650	1.76
T_5	66200	188.6	188600	136400	2.84
T_6	68000	180.7	180700	112700	2.66
T_7	65500	108.3	108300	42800	1.65
T_8	72300	126.3	126300	54000	1.74

CONCLUSION

On the basis of present study it may be concluded that the application of 75% RDF + 25% Vermicompost have been proved best for increasing the growth, yield and yield attributing traits of okra as well as benefit: cost ratio.

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