Research Article

Utility of Different Sources of Organic Manures and Bio-fertilizers on Quality and Economics of Okra *var*. Chameli

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Abstract

A field experiment was conducted to study the Utility of different sources of organic manures and bio-fertilizers on quality and economics of okra during rainy season 2016-17 at Horticulture Farm, S.K.N. College of Agriculture, Jobner (Jaipur) with consisted of 16 treatments combinations *viz.*, organic manures (Control, FYM, Poultry Manure and Vermicompost) and bio-fertilizers (Control, *PSB*, *VAM* and *Azotobacter*) tested in randomized block design with three replications. The application of vermicompost @ 8 t ha^{-1} and *Azotobacter* alone to the okra crop significantly increased the nitrogen and protein content in fruit (%) as compared to control, FYM and poultry manure, whereas the application of vermicompost also significantly increased the phosphorus and potassium content in fruit (%) as compared to control and FYM but statistically at par with poultry manure, while, the application of *Azotobacter* also significantly increased the K content in fruit (%) as compared to control and *VAM* but statistically at par with *PSB* but P content in fruit (%) significantly increased with application of *PSB* as compared to control and *Azotobacter* which was statistically at par with *VAM*. The combined application of vermicompost @ 8 t ha^{-1} + *Azotobacter* as seed inoculation proved to be most superior treatment combination gave maximum net return of `283690 ha^{-1} and B:C ratio 3.07:1.

Keywords: Okra, Organic Manures, Bio-fertilizers, NPK and Protein content and Economics.

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Introduction

Okra [*Abelmoschus esculentus* (L.) Moench] is indigenous to tropical Africa and grown throughout the tropics and subtropics. Fruits are immature tender and plant is erect, herbaceous annual green and belongs to family Malvaceae. It can be fried or cooked with necessary ingredients. The tender fruit can be cut into small pieces, boiled and served with soup. Matured fruits and stem containing crude fibres are used in the paper industry. The roots and stems are used for clearing cane juice in preparation of 'gur'. High iodine content of fruits helps to control goiter. Okra is said to be very useful against genito-urinary disorders, *spermatorrhoea* and chronic dysentery [1]. The significance of crop further enhances due to its multiple uses. The dry seed contains 13-22 per cent good quality edible oil and 20-24 per cent protein. The green fruits contain water 88.6 g, energy 36 kcal, protein 2.1 g, carbohydrate 8.2 g, fat 0.2 g, fibre 1.7 g, Ca 84 mg, P 90 mg, Fe 1.2 mg, β-carotene 185 µg, riboflavin 0.08 mg, thiamin 0.04 mg, niacin 0.6 mg and ascorbic acid 47 mg per 100 g edible portion. Leaves are also used in making a soup, which is a rich source of iron and forms an important diet of West Africans. Its seeds are generally consumed as a substitute for coffee in many parts of Africa [2].

In India, the mixed farming system with livestock raising is an integral part of crop production of Indian farmers. Farm yard manure is rich in nutrients basically using cow dung, cow urine, waste straw and other dairy wastes. The organic manure FYM not only provides nutrient to the plant but also improves the soil texture by binding effect of soil aggregates. Organic manure increases cation exchange capacity, water holding capacity and phosphate availability of the soil beside improving the fertilizer use efficiency and microbial population of soil, it reduces nitrogen loses due to slow release of nutrients [3]. Vermicompost is a slow nutrient releasing organic manure which have most of the macro as well as micro nutrients in chelated form and fulfill the nutrient requirement of plant for longer period. Vermicompost is being a stable fine granular organic matter, when added to soil, it loosens the soil and improves the passage to the entry of air. The soil enriched with vermicompost provides additional substances that are not found in chemical fertilizers. Vermicompost is made up primarily of C, H and O and contains nutrients such as NO_3, PO_4, Ca, K, Mg, S and micronutrients which exhibit similar effects on plant growth and yield as inorganic fertilizers applied to soil [4]. Vermicompost an organic source of plant nutrients contains a higher percentage of nutrients necessary for plant growth in readily available forms [5]. Poultry manure is a valuable fertilizer and can serve as a suitable alternate to chemical fertilizer. Poultry manure application registered over 53 per cent increases of N level in the soil, form 0.09 per cent to 0.14 per cent and exchangeable cations increase with manure application [6]. In agriculture, the main reasons for applying poultry manure include the organic amendment of the soil and the provision of nutrients to crops [7]. Poultry manure was readily available and in the best form for easy absorption by the plant roots, hence there was a boost in the morphological growth of the plant [8].

Bio-fertilizers liberate growth promoting substances and vitamins and help to maintain soil fertility. Phosphate solubilizing Bacteria (PSB) significantly helps in the release of this insoluble inorganic phosphate and makes it available to the plants. PSB are a group of beneficial bacteria capable of hydrolysing organic and inorganic phosphorus from insoluble compounds. P-solubilization ability of the microorganisms is considered to be one of the most important traits associated with plant phosphate nutrition. It is generally accepted that the mechanism of mineral phosphate solubilization by PSB strains is associated with the release of low molecular weight organic acids through which their hydroxyl and carboxyl groups chelate the cations bound to phosphate, thereby converting it into soluble forms. In addition, some PSB produce phosphatase like phytase that hydrolyse organic forms of phosphate compounds efficiently. PSB have been introduced to agricultural community as phosphate 'Biofertilizer' [9]. *VAM* fungi as a bio fertilizer, in terms of cost effectiveness, energy saving and as environment friendly, is a promising perspective.Mycorrhizae are the root-symbionts which obtain their nutrients from the plant and provide mineral elements like N, P, K, Ca, S and Zn to the host plant. This review is an attempt to explore the suppressing abilities of *Arbuscular Mycorrhizal* Fungi (AMF) against soil borne pathogens (root feeding nematodes and fungi), infecting various crops. AMF to increase the productivity of cereal crops, fruits and vegetable crops [10]. *Azotobacter* has beneficial effects on crop growth and yield through, biosynthesis of biologically active substances, stimulation of rhizospheric microbes, producing phyopathogenic inhibitors. Modification of nutrient uptake and ultimately boosting biological nitrogen fixation. The presence of *Azotobacter sp*. in soils has beneficial effects on plants, but the abundance of these bacteria is related to many factors, soil physico-chemical (*e.g.* organic matter, pH, temperature, soil moisture) and microbiological properties [11].

Materials and Methods

A field experiment entitled Utility of different sources of organic manures and bio-fertilizers on quality and economics of okra [*Abelmoschus esculentus* (L.) Moench] was conducted at Horticulture Farm, S.K.N. College of Agriculture, Jobner in randomized block design comprising of 16 treatment combinations *viz.*, organic manures (Control, FYM, Poultry Manure and Vermicompost) and bio-fertilizers (Control, *PSB*, *VAM* and *Azotobacter*) during *Kharif* season 2016. The treatments were randomly allocated to different plots using random number table of **[12]**. Healthy seeds of variety *Chameli* were dibbled 2 cm deep maintaining uniform distance of 45 x 60 cm in two successive hills. FYM and Poultry Manure were applied in the beds as per treatments and was thoroughly incorporated in to the soil before sowing and at the time of seed sowing according to RDF of okra (102:60:60 NPK). We calculated FYM @ 24 t ha^{-1}, Poultry Manure @ 6 t ha^{-1} and Vermicompost @ 8 t ha^{-1} was supplied about 3-4 cm deep at the time of sowing. Application of biofertilizers was done as per treatment *Azotobacter* (200ml ha^{-1}) as seed treatment. 2-3 ml *Azotobacter* in Liquid form was mixed in one litre of water. Then seeds are soaked in this solution for 25 minutes. *PSB* also applied as seed treatment @ 5g/kg seed for this 125 g of Jaggery was mixed in one litre of boiled water. Appropriate quantity (2g) of was poured in Jaggery solution separately and stirred well. The seeds were allowed to air dry in shade. *VAM* @15kg ha^{-1} applied as soil application.

Statistical Analysis

To test the significance of variance in the data obtained from the various quality characters and economics the technique of analysis of variance was adopted as suggested by [12] for randomized block design. Significance of difference in the treatment effect was tested through 'F' test at 5 percent level of significance and CD (critical difference) was calculated, wherever the results found significant.

Results and Discussion

Utilization of organic manures to quality attributes

A closer review of data (**Table 1** and **Figure 1**) revealed that application of vermicompost produced significantly maximum N (0.31 %), P (0.68 %) and K (1.54 %) content in fruit over control, FYM and poultry manure, while minimum were recorded under control. However, treatment vermicompost (M_3) was statistically at par with M_2 (poultry manure) in case of both P and K content in fruit. Application of vermicompost might have the ability to increase the availability of other nutrients like nitrogen, phosphorus and potassium probably due to higher rate of mineralization and favourable condition for microbial and chemical activity, which in turn increased the N, P, K and protein content in okra fruits. Another reason might be the increased activity of nitrate reductive enzymes which helped in synthesis of certain amino acids and protein [4] and [5]. Improvement in quality attributes of okra fruits due to poultry manure could be attributed to their nutritional richness and stimulatory behavior as reported by [13] and [14].

Table 1 Utilization of organic manures and bio-fertilizers on quality and economics of okra

S. No.	Treatments	N content in fruit	P content in fruit	K content in fruit	Protein content in fruit	Net return	B:C Ratio
A. Organic manures							
1.	Control (M_0)	0.19	0.58	1.36	1.19	96925	1.84
2.	FYM @ 24 t ha^{-1}($M_{1)}$	0.25	0.62	1.39	1.56	137436	1.94
3.	Poultry Manure @ 6 t ha^{-1}(M_2)	0.28	0.66	1.44	1.75	168149	2.19
4.	Vermicompost @ 8 t ha^{-1}(M_3)	0.31	0.68	1.54	1.94	205147	2.21
	S.Em.±	0.01	0.02	0.03	0.04	3332	0.07
	CD (P=0.05)	0.02	0.05	0.10	0.11	9621	0.19
B. Bio-fertilizers							
1.	Control (B_0)	0.20	0.58	1.36	1.25	87258	1.18
2.	PSB (B_1)	0.27	0.69	1.45	1.66	165429	2.24
3.	VAM (B_2)	0.24	0.66	1.40	1.52	141660	1.88
4.	Azotobacter (B_3)	0.32	0.62	1.51	2.01	213310	2.90
	S.Em.±	0.01	0.02	0.03	0.04	3332	0.07
	CD (P=0.05)	0.02	0.05	0.10	0.11	9621	0.19

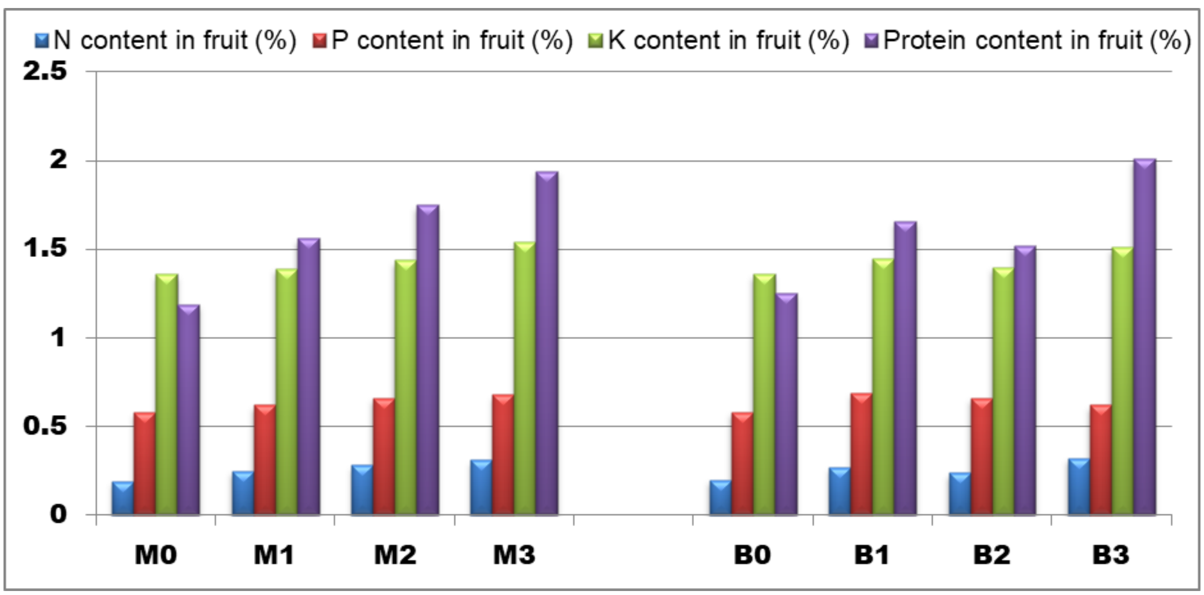

Figure 1 Utility effect of organic manures and bio-fertilizers on NPK and protein content in fruit (%)

The critical examination of data exhibited that protein content in fruit significantly increased by different organic manures (Table 1 and Figure 1). The maximum protein content in fruit (1.94 %) was recorded under vermicompost (M_3). while minimum protein content of fruit (1.19 %) was recorded under control. The protein content in fruit under treatment M_3 was found to be 63.15, 24 and 10.71 per cent more over treatment control, FYM and poultry manure, respectively. The increase in N, P, K and protein content might be due to more availability of NPK to plants due to application of FYM which might have improved chemical and biological properties of soil and enabled plant roots to resulting in better utilization of nutrients by crop. The protein content in fruits is in fact a manifestation of nitrogen content. The increase in nitrogen content in fruits resulted in higher protein content in fruits. These results are in close conformity with findings of [3].

Utilization of bio-fertilizers to quality attributes

Application of different bio-fertilizers significantly increased the NPK content in fruit (Table 1 and Figure 1). Application of *Azotobacter* resulted in significantly higher N (0.20 %) and K (1.51 %) content in fruit over control, *PSB* and *VAM*, while maximum P (0.69 %) content in fruit was recorded under *PSB* (B_1) followed by B_3 (0.62 %), B_2 (0.66 %), while minimum NPK content was recorded under control (M_0). Treatment *Azotobacter* (B_3) remained statistically at par with treatment *PSB* (1.45 %) in K content of fruit. These beneficial effects of *Azotobacter* on plants is attributed mainly to an improvement in root development, an increase in the rate of water and mineral uptake by roots, displacement of fungi and plant pathogenic bacteria and, to a lesser extent, biological nitrogen fixation. Besides N_2 fixation, *Azotobacter* synthesizes and secretes considerable amounts of biologically active substances like vitamins B, nicotinic acid, pantothenic acid, biotin, heteroxins, gibberelins *etc.* which enhance root growth of plants. Another important characteristic of *Azotobacter* association with crop improvement is secretion of ammonia in the rhizosphere in the presence of root exudates, which helps in modification of nutrient uptake by the plants. The ability of *Azotobacter* to produce plant growth regulatory substances along with N_2 fixation stimulate plant growth, productivity and thereby quality. The changes that occur in the plant roots help in transport of minerals and water. All these factors produce positive effects on crop yield especially for vegetables and cereals [15].

The maximum protein content in fruit (2.01 %) was recorded in *Azotobacter* while minimum (1.25 %) was recorded under control. The protein content in fruit under treatment *Azotobacter* was found to be 61.11, 20.23 and 31.82 per cent more over control, *PSB* and *VAM*, respectively, (Table 1 and Figure 1). The *Azotobacter* maximum enhanced the N, K and protein content in fruits over control, *PSB* and *VAM* seems to have ability to increase the availability of nutrients like nitrogen, which in turn increased the nitrogen, potassium and protein content *etc*. in okra fruits. *PSB* also enhance N, P, K and protein content in fruit by the nutrient availability in the root zone and solubilization of the native phosphate in soil by *PSB*. Phosphorus solubilizing bacteria enhances the availability of phosphorus to plants and gives to better utilization of nutrients by the crop which might have in turn greater root development. Thus increase in availability of N and P might have resulted in greater content and uptake in okra. The nutrient content is due to higher functional activity of microbes in the root zone for longer duration under inoculation of *PSB* [16]. *VAM* increased nutrient uptake through reduction of the distance that nutrient use diffuse to plants by accelerating the rate of nutrient absorbing surface and finally by chemically modifying the availability of nutrient for uptake by plant through *mycprrhizal* Fungi [17].

Economics of treatments

A critical study of data revealed that vermicompost (M_3) and *Azotobacter* significantly increased the net return (Table 1 and **Figure 2**). Maximum net return was recorded under vermicompost (′205147) and *Azotobacter* (′213310), while minimum net return (′96925 and ′87258) was recorded under control. The data presented in (Table 1 and **Figure 3)** explicated that different organic manure and bio fertilizers significantly increased the B:C ratio of okra. Significantly maximum B:C Ratio was recorded under treatment vermicompost (2.21) and *Azotobacter* (2.90) alone, while it was recorded minimum (1.84 and 1.18) under control. However, vermicompost remained statistically at par with treatment poultry manure followed by FYM and control in case of organic manure, respectively.

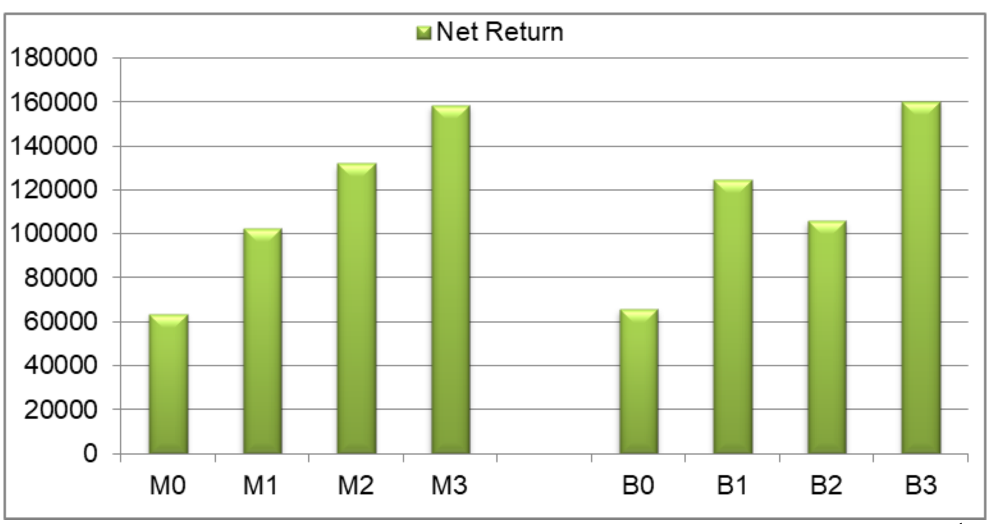

Figure 2 Utility effects of organic manures and bio-fertilizers on net return (′ha^{-1})

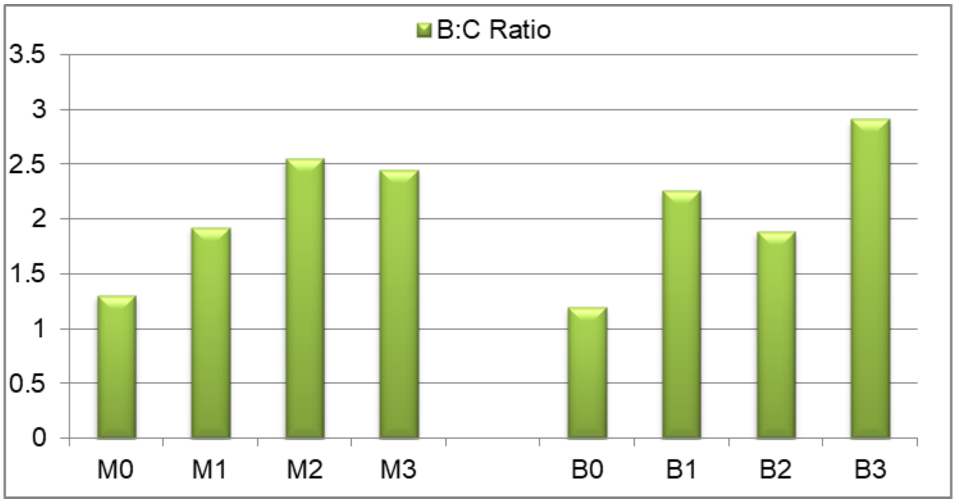

Figure 3 Utility effect of organic manures and bio-fertilizers on B:C ratio

Conclusion

On the basis of result obtained in present investigation concluded that application of vermicompost @ 8 t ha^{-1} along with *Azotobacter* (M_3B_3) proved to be the most superior treatments in respect of NPK content in fruit, fruit yield, net return and B:C ratio of okra.

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