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Influence of organic manures and biofertilizers on growth, yield and quality of okra (*Abelmoschus esculentus* L. Moench)

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ABSTRACT

A field experiment was conducted at Horticulture Research Farm-II, Department of Applied Plant Science (Horticulture), Babasaheb Bhimrao Ambedkar University, Lucknow to assess the Influence of organic manures and biofertilizers on growth, yield and quality of okra (Abelmoschus esculentus L. Moench). Results revealed that the maximum plant height (150.63 cm), stem diameter (30.1 mm), number of flower buds (31.17), days of 50% flowering (41.33), number of fruit per plant (17.63), fruit yield ha^{-1} (19.56 t ha^{-1}), fruit fresh weight (15.53 g) were recorded at harvest with RDF + vermicompost treatment (T_{13}). The maximum total soluble solids (2.95^{0} Brix), ascorbic acid (19.57 mg/100g), reducing sugar (1.19%), non reducing sugar (2.14%), total sugars (3.33%), protein (16.50), phosphorus (56.43 mg/100g), calcium (69.90 mg/100mg), magnesium (50.22 mg/100g), were recorded with RDF + vermicompost treatment. The minimum values of yield attributes, yield and quality parameters were recorded in control treatment. Vermicompost proved superior to other organic manures and biofertilizer in respect of growth yield and quality parameters. On the basis of results, treatment RDF + Vermicompost showed the better performance for growth, yield and quality of okra under Lucknow conditions. The lowest values of all these parameters were recorded under control.

Keywords: Okra, Vermicompost, growth, yield, quality

INTRODUCTION

Okra (*Abelmoschus esculentus* L. Moench) belongs to *Malvaceae* family. The fresh fruit is a good source of vitamins, fiber, minerals, phosphorus, calcium and protein. Okra is commonly used for its tender pods. The dried stems and roots of okra are used for clarification of sugarcane juice in gur or jiggery manufacture in India. Fully ripen fruits and stem containing crude fibers are used in the paper industry. It is also an excellent source of iodine and is useful for the treatment of goiter. Fruit is useful against genito-urinary disorders, spermetorrhoea and chronic dysentery. Fruits are also dried of frozen for use during off-season. Dried fruit contain 13-22% edible oil and 20-24% protein and used for refined edible oil. Dry fruit skin and fibres are used in manufacture of paper, card board and fibres. The most important elements present in inorganic fertilizers are phosphorus, potassium and nitrogen which influence vegetative and reproductive phase of plant growth. Compared to inorganic fertilizers, the organic fertilizer having lower nutrient content, solubility, and nutrient release rates are typically low than inorganic fertilizers and therefore inorganic fertilizers are more preferred than organic fertilizers. Besides, application of organic manures not only produced the highest and sustainable crop yield, but also improved the soil fertility and productivity of land (Sanwal *et al.,* 2007). The INM is helpful in increasing the yields in crops as well as maintains soil fertility in better condition. The precise information on INM for maximum production and better quality will be of immense value to okra growers (Sachan *et al.* 2017). Vermicompost increases soil organic matter and nutrient content, improves the soil structure and cation exchange capacity. Earth worms utilize organic wastes as food and the undigested material excreted by them has gained the name 'Vermicompost'. The Vermicompost serves as organic manure, since it is a source of nutrients, such as nitrogen, phosphate, potassium and micronutrients etc. The conjugated use of biofertilizers increases the efficiency of nitrogen and improves soil health and controls soil pollution. They are cheap source of nutrients and sustainable. Bio-fertilizers include a range of nitrogen fixers, viz., *Azotobacter, Azospirillium*, Blue Green Algae and *Azolla*. Out of these the importance of *Azotobacter* and *Azospirillium* has been well recognized for vegetable crops and

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there are several reports that showed the role of nitrogen fixing through *Azotobacter* and *Azospirillium*. These bio-fertilizers are organic in origin and thus are absolutely safe, therefore, it is essential to adopt a strategy of integrated nutrient management using combination of chemical fertilizers, organic manures and biofertilizers so as to minimize the cost of production and to maintain biological productivity of soils, particularly because the farmers are reluctant to adopt recommended fertilizer doses due to the high cost and risk of crop failure on account of aberrant weather condition. Phosphate solubilizing bio-fertilizer native in soil and applied in inorganic fertilizers becomes mostly unavailable to crops because of its low levels of mobility and solubility and its tendency to become fixed in the soil. The PSB are life forms that can help in improving the phosphate uptake of plants in various ways. VAM is also known to increase the levels of important micronutrients in the plant parts of vegetable crops. An investigation was therefore, undertaken to assess the effect of organic manures and biofertilizers on growth, yield and quality of okra under Lucknow condition.

MATERIALS AND METHODS

Field experiment was conducted at Horticulture Research Farm-II of the Department of Applied Plant Science (Horticulture), Babasaheb Bhimrao Ambedkar University, Lucknow (U.P), during the kharif season of 2016. The experiment was laid out in randomized block design with three replication and 19 treatments. Treatment combinations were, T_0-Control , T_1- RDF (Recommended dose of fertilizer), T_2- FYM (Farmyard manure), T_3- Neem Cake, T_4- Karanj Cake, T_5- Bone Meal, T_6- Vermicompost T_7- Fish gyano, T_8- Mahua Cake, T_9- RDF + FYM, T_{10}- RDF + Neem Cake, T_{11}- RDF + Karanj Cake, T_{12} RDF + Bone Meal, T_{13}- RDF + Vermicompost, T_{14}- RDF + Fish gyano, T_{15}- RDF + Mahua Cake, T_{16}- RDF + *Azospirillum*, T_{17}- RDF + VAM *(Vesicular- Arbuscular Mycorrhiza*), T_{18}- RDF + PSB (Phosphate Solubilizing Biofertilizers). The plot size was 1.8 × 1.2 m and spacing followed was 45 × 30 cm to keep 16 plants per plot for each treatment. The land was brought to a fine tilth through tillage and ploughing. Bunds and irrigation channels were maintained properly. The seeds were sown directly to the field. Light irrigation was given after sowing. All other recommended cultural practices were followed to raise the healthy crop. The observations were recorded in five randomly taken and tagged plants for each replication on morphological traits viz., Plant height (cm), Stem diameter (mm), number of flower buds, day of 50% flowering, number of fruit per plant, fruit yield per ha^{-1}, fruit length (cm), fruit diameter (cm), fruit fresh weight were recorded at harvest, Titratable acidity (%), total soluble solids (TSS ^{0}Brix), ascorbic acid (Vitamin C) (mg/100g), reducing sugar (%), non reducing sugar (%), total sugars (%), protein, phosphorus (mg/100g), calcium (mg/100mg), magnesium (mg/100g) were determined by adopting standard procedures. The data based on the mean of individual plants selected for observations were statistically analyzed as described by Panse and Sukhatme (1967).

RESULTS AND DISCUSSION

Growth attributing traits

The growth attributing traits viz, plant height, branches, stem diameter, number of flower buds and early 50% flowering were affected significantly due to the increasing levels of vermicompost (Table 1). The maximum number of plant height 150.63 cm, stem diameter (30.10 mm), number of flower buds (31.17) were recorded at RDF + Vermicompost, while the minimum plant height (119.55 cm), stem diameter (17.75 mm), number of flower buds (16.33) were recorded with control treatment. The increasing levels of vermicompost significantly increased the vegetative growth of okra plant. The improvement in plant height be due to better moisture holding capacity, supply of micronutrients and availability of major nutrients due to favorable soil conditions. The increased nitrogen nutrition may also have accelerated the process of cell division and differentiation. Similar findings were also reported by Barani and Anburani (2004) in okra. Early 50% flowering was recorded with RDF + Vermicompost (41.33 days) which was on at par with RDF + FYM (41.67 days) and late 50% flowering was recorded control (48.11 days).

Early 50% flowering might be due to the enhanced production of growth positive influence on the physiological activity of the plants thereby resulting in early flowering. The result of this study is in agreements with the finding of Shahriazzaman *et al.* (2014) in okra.

Table 1: Effect of organic manures and biofertilizers on vegetative growth, yield and yield attributing traits in okra

Treatment No.	Plant height (cm)	Stem diameter (mm)	No. of flower buds	Days to 50% Flowering	No. of fruit per plant	Fruit yield / ha^{-1} (t)	Fruit Length (cm)	Fruit Diameter (cm)	Fruit fresh weight (gm)
T_0	119.55	17.7	16.33	48.11	12.48	11.11	9.8	2.0	12.25
T_1	138.05	24.6	26.33	43.33	15.68	15.93	11.6	2.3	14.07
T_2	139.45	25.0	26.73	43.00	15.90	16.22	13.7	3.1	14.30
T_3	122.75	18.9	18.45	46.22	13.05	12.37	11.2	2.4	12.62
T_4	126.42	20.5	20.70	45.33	14.10	13.63	11.4	2.3	13.17
T_5	123.63	19.6	19.43	45.89	13.43	12.89	10.6	2.2	12.87
T_6	139.87	25.6	27.40	42.67	16.12	16.67	14.0	3.2	14.41
T_7	124.94	20.0	20.43	45.56	13.85	13.26	13.2	3.0	13.00
T_8	121.04	18.2	17.68	46.67	12.87	11.93	10.4	2.1	12.46
T_9	147.82	29.2	30.10	41.67	17.25	18.59	16.2	3.8	15.17
T_{10}	137.25	23.6	25.40	43.55	15.38	15.48	13.0	2.9	13.80
T_{11}	126.75	21.6	21.96	45.00	14.58	14.07	11.6	2.5	13.29
T_{12}	135.12	22.6	24.90	43.89	15.23	15.19	12.8	2.8	13.67
T_{13}	150.63	30.1	31.17	41.33	17.63	19.56	15.5	3.6	15.53
T_{14}	129.67	21.5	23.20	44.67	14.67	14.37	12.2	2.6	13.43
T_{15}	132.34	22.0	23.50	44.33	14.98	14.74	12.4	2.7	13.55
T_{16}	143.07	26.6	27.80	42.44	16.48	17.04	14.4	3.3	14.58
T_{17}	145.67	28.4	29.35	41.89	16.97	18.07	14.7	3.4	14.86
T_{18}	144.57	27.3	28.38	42.11	16.78	17.48	15.2	3.5	14.70
CD(p=0.05)	3.65	3.61	2.16	1.74	1.41	2.39	0.11	0.48	0.75

Yield and yield attributing traits

Result revealed that the application of organic and inorganic source of nutrient in combination increased the yield attributes (Table 1). The yield and yield attributing traits were increased with RDF and Vermicompost alone and in combination. Application of RDF + Vermicompost recorded significantly higher yield attributes *viz,* fruit fresh weight (15.53 g), number of fruit per plant (17.6) and fruit yield per hectare (19.56 t ha^{-1}) followed by treatment RDF + FYM than other combination and significantly superior over control. The minimum yield attributes *viz,* fruit fresh weight (12.25 g), number of fruit per plant (12.48) and fruit yield per hectare (11.11 t ha^{-1}) were recorded in control. The reason for increase in yield and yield attributing traits might be solublization effect of plant nutrients by the addition of RDF and Vermicompost as evidenced by increase in the uptake of N, P, K, Ca, Mg etc.. These results are in accordance with those reported by Padamwar and Dakore (2011) in knol-khol. Okra plant fertilized with RDF + FYM recorded the highest fruit length (16.2 cm) and highest fruit diameter (3.8 cm) followed by RDF + Vermicompost, while the lowest fruit length (9.8 cm) and fruit diameter (2.0 cm) was recorded from control treatment. This might be attributed to the increased availability of NPK and water at the critical stages of the crop growth resulting early establishment, vigorous growth and development of plants leading to longer and wider fruits. Higher value in fruit diameter of okra observed due to integrated application of fertilizers as reported by Kumar (2017).

Quality parameter

There was significant variation among the treatments regarding titratable acidity, TSS, ascorbic acid, reducing sugar, non reducing, total sugars, protein, Phosphorus, calcium and magnesium of the fruit (Table 2).The data clearly indicates that Vermicompost treatments had

resulted in decreasing the percentage acidity of okra. The maximum titratable acidity (0.38%) was recorded from RDF + FYM), while the minimum of was recorded (0.12%) from control treatment. The data were found to be significant in decreasing acidity percentage. Similar result has also been reported by Meena *et al.* (2010) in tomato. The data indicates that the treatment T_{13} showed maximum TSS (2.95) of fruit. The plants with Vermicompost increased the T.S.S. of fruits over the control. Statistical analysis indicates that the treatment RDF + Vermicompost gave highest TSS followed by RDF +FYM, RDF +VAM, RDF +PSB and RDF + *Azospirillum*. Similar findings were also reported by Amiry *et al.* (2018) in okra. RDF + Vermicompost showed maximum vitamin-C (19.57 mg/100g) of fruit. The treatment RDF + Vermicompost gave highest vitamin-C followed by RDF +FYM, RDF +VAM and RDF +PSB. This might be due to the availability of nitrogen leading to balanced C:N ratio enhancing the vegetative growth resulting in high photosynthetic activity (Gayathri and Krishnaveni, 2015). The treatment RDF + Vermicompost showed significantly highest (1.19, 2.14 and 3.33 %) reducing sugar, non reducing sugar and total sugars respectively. These values were at par with treatment RDF + FYM (Table 2). The lowest values were recorded with treatment control. It could be due to readily available of major nutrients in RDF and Vermicompost which increased metabolism activity in plant and reflected in increasing sugar content as reported by Mishra *et al.* (2017).

Table 2: Effect of organic manures and biofertilizers on quality traits in okra

Treatment No.	Titratable Acidity (%)	TSS (^{0}Brix)	Ascorbic acid	Reducing Sugar (%)	Non Reducing sugar (%)	Total Sugars (%)	Protein	Phosphorus (mg/100g)	Calcium (mg/100g)	Magnesium (mg/100g)
T_0	0.12	1.20	13.80	0.78	1.19	1.97	12.90	49.15	56.35	39.85
T_1	0.30	2.30	17.25	1.05	1.75	2.80	13.50	51.12	63.00	41.80
T_2	0.31	2.45	17.60	1.05	1.78	2.83	15.12	54.37	63.87	47.45
T_3	0.17	1.35	14.45	0.75	1.40	2.15	13.67	50.73	57.30	42.50
T_4	0.23	1.70	15.40	0.81	1.56	2.37	13.95	51.48	59.08	43.33
T_5	0.18	1.48	14.85	0.74	1.48	2.22	14.95	50.20	58.18	46.90
T_6	0.32	2.56	18.00	1.08	1.79	2.87	15.33	54.77	64.80	48.02
T_7	0.20	1.60	15.15	0.79	1.51	2.30	13.35	53.90	58.68	41.25
T_8	0.16	1.30	14.15	0.77	1.33	2.10	13.20	49.60	56.70	40.67
T_9	0.38	2.88	19.20	1.18	2.02	3.20	16.23	56.17	68.62	49.50
T_{10}	0.29	2.21	16.90	1.01	1.74	2.75	14.70	53.41	62.37	46.40
T_{11}	0.27	1.75	15.70	0.85	1.61	2.46	14.47	51.85	61.02	45.00
T_{12}	0.28	2.10	16.60	0.98	1.65	2.63	14.33	53.02	60.23	44.56
T_{13}	0.36	2.95	19.57	1.19	2.14	3.33	16.50	56.43	69.90	50.22
T_{14}	0.24	1.80	16.00	0.89	1.65	2.54	14.58	52.25	61.52	45.70
T_{15}	0.25	1.90	16.30	0.94	1.63	2.57	14.18	52.63	59.53	43.82
T_{16}	0.33	2.63	18.33	1.12	1.79	2.91	15.52	55.10	65.55	48.47
T_{17}	0.35	2.82	18.87	1.18	1.93	3.11	16.01	55.65	67.83	49.42
T_{18}	0.34	2.75	18.60	1.18	1.81	2.99	15.75	55.35	66.95	48.95
CD (p=0.05)	0.03	0.98	1.06	0.27	0.32	0.39	0.93	1.44	1.27	1.70

The maximum protein content (16.50 %) was recorded in RDF + Vermicompost and minimum value (12.90 %) with the control. The increase in protein content was pronounced with the higher level of organic form applied in combination of inorganic form, favored by intense protein synthesis and its efficient storage in the presence of abundant supply of available nitrogen. Protein content was increased significantly by the application of different organic manures with nitrogenous fertilizers. Similar results were recorded by (Prabu *et al.*, 2002) in coriander and Amiry *et al.* (2018) in okra. Application of RDF + Vermicompost recorded higher nutritional values of okra *viz,* phosphorus (56.43 mg/100g), calcium (69.90 mg/100g) and magnesium (50.22 mg/100g) followed by RDF + FYM and other combination

and significantly superior over control. The minimum phosphorus (49.15 mg/100g), calcium (56.35 mg/100g) and magnesium (39.85 mg/100g) contents were recorded in control. This might be due to higher concentration of the nutrients in the Vermicompost. Similar finding were also reported by Padamwar and Dakore (2011) in knol-khol and Amiry *et al.* (2018) in okra.

From the results, it may be concluded that the application of RDF + Vermicompost showed the better performance for growth, yield and quality of okra except acidity, fruit length and fruit diameter and would be useful to enhance the productivity of okra. Thus integrated use of nutrients may be suggested for higher crop productivity along with over all betterment of okra under Lucknow conditions.

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