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Vermicompost, mycorrhiza and micronutrients mixture improve okra yield

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Abstract
A field experiment on okra (*Abelmoschus esculentus* L Moench) cv. Arka Anamika" was conducted during *Rabi season*, 2016-17 to study the effect of vermicompost, mycorrhiza and micronutrients mixture of 16 treatment combination *i.e.* vermicompost with two levels (2 tons/ha and 4 tons/ha), mycorrhiza with one level (Mycorrhiza seed treatment) and micronutrients mixture with two levels (50 ppm and 100 ppm) recorded the number of fruits per plant (20.23), length of fruits (16.82cm), diameter of fruits (1.66cm), fruits weight (20.12g), fruit yield per plant (407.13g), fruit yieldper plod (10.31kg), estimated fruits yield (183.24q/ha) maximum as compared to control.

Keywords: Okra, arka anamika, vermicompost, mycorrhiza and micronutrients mixture

Introduction
Okra (*Abelmoschus esculentus* (L.) Moench) popularly known as '*Bhendi*' is an important warm season vegetable, widely cultivated for its tender, green fruits. There are two cultivated types of okra (*Abelmoschus esculentus* L. Moench) and West African okra (*Abelmoschus caillei*). In India, okra mostly grown during kharif. It is also grown during early winter season of mid cool temperatures when price remains very high and farmers earn handsome remuneration from such an okra crop. Okra plays an important role in the diet by supplying carbohydrates, protein, fat, minerals and vitamins that are usually deficient in the staple food. Okra is basically low in calories and dry matter constituents. Generally, it is consumed in a meal with basic starchy food makes the food more palatable Savello *et al.* 1982 [12].

Okra therefore plays an important role in human diet. The green tender fruits of okra are highly nutritious containing 1107 mg calcium and 8.9 mg of Iron for every 1000 g edible portion and supplies fair amount of vitamins viz., A, B and C. It is also rich in protein and crude fiber (Sona and Indira, 2000) [14].

An organic fertilizer serves as a good and suitable source to supply soil food elements. Among the organic manures, vermicompost is one of the best which contains growth regulators like hormones which increase the growth and yield of crops (Canellas *et al*. 2002) [6].

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 mucous associated with the cast being hydroscopic absorbs water and prevents water logging and improves water holding capacity. The organic carbon in vermicompost releases the nutrients slowly and steadily into the system and enables the plant to absorb the nutrients. Organic sources are inputs containing microorganisms capable of mobilizing native elements from non-usable form to usable form though biological processes (Bahadur and Manohar, 2001) [3].

Mycorrhiza are the structures resulting from the symbiosis between fungi and plant roots and directly involved in plant mineral nutrition. The symbiotic root-fungal association increases the uptake of less mobile nutrients (Ortas *et al.* 2001) [10].

Micronutrients are those elements essential for plant growth which are needed in only very small quantities. Even though micronutrients are required in minute quantities, they are essential for healthy plant growth and profitable crop production. These micronutrients are often needed in quantities greater than the soil can supply, so they should be supplemented through foliar application to enhance the yield. They play an active role in the plant metabolic process from cell wall development to respiration, photosynthesis, chlorophyll formation, enzymatic activity, nitrogen fixation, assimilation, oxidation and reduction reactions and help in increasing the biomass and pod yield (Ballabh and Rana, 2012) [4].

Material method

Experimental design and cultivation practices

A field experiment was conducted at the Department of Vegetable Science, College of Horticulture and Forestry, Jhalrapatan city, Jhalawar during *Kharif* 2016-17. The soil organic carbon 0.56%, available nitrogen 336.29kg/ha, available phosphorous 22.72kg/ha, available potash 220.69kg/ha. The direct seed sowing of cv. Arka Anamika at the spacing 45×45 cm by check-basin method in RBD design.

S No.	Symbols	Treatments
1.	T_0	Control
2.	T_1	V_1 (Vermicompost 2ton/ha)
3.	T_2	V_2 (Vermicompost 4ton/ha)
4.	T_3	M (Mycorrhiza seed treatment)
5.	T_4	Z_1 (Micronutrients mixture @50 ppm)
6.	T_5	Z_2 (Micronutrients mixture @100 ppm)
7.	T_6	V_1+M (Vermicompost 2ton/ha + Mycorrhiza seed treatment)
8.	T_7	V_1+Z_1 (Vermicompost 2ton/ha + Micronutrients mixture @50 ppm)
9.	T_8	V_1+Z_2 (Vermicompost 2ton/ha + Micronutrients mixture @100 ppm)
10.	T_9	V_1+M+Z_1 (Vermicompost 2 ton/ha + Mycorrhiza seed treatment + Micronutrients mixture @50 ppm)
11.	T_{10}	V_1+M+Z_2 (Vermicompost 2 ton/ha + Mycorrhiza seed treatment + Micronutrients mixture @100 ppm)
12.	T_{11}	V_2+M (Vermicompost 4 ton/ha+ Mycorrhiza seed treatment)
13.	T_{12}	V_2+Z_1 (Vermicompost 4 ton/ha + Micronutrients mixture @50 ppm)
14.	T_{13}	V_2+Z_2 (Vermicompost 4 ton/ha + Micronutrients mixture @100 ppm)
15.	T_{14}	V_2+M+Z_1 (Vermicompost 4 ton/ha + Mycorrhiza seed treatment + Micronutrients mixture @50 ppm)
16.	T_{15}	V_2+M+Z_2 (Vermicompost 4 ton/ha + Mycorrhiza seed treatment + Micronutrients mixture @100 ppm)

she observations recorded on number of fruits per plant, fruits length (cm), fruits diameter (cm), fruits weight (g), fruits yield per plant (g), fruits yield per plot (kg) and estimated fruits yield per he (q/ha) over control.

Statistical Analysis: The experimental data was expressed as mean ± S. E. One way analysis of variance (ANOVA) and Least Significant Difference (RBD) was carried out using MS Excel to determine difference from control and between the treatments ($p \leq 0.05$).

Results and Discussion

The effects ofvermicompost, mycorrhiza and micronutrients mixture on various yield parameters *viz*number of fruits per plant, length of fruits, diameter of fruits, fruits weight, fruit yield per plant, fruit yield per plod, estimated fruits yield are presented in Table 1.

Table 1: Effect of vermicompost, mycorrhiza and micronutrients mixture onyield of okra

Treatment	Number of fruit/plant	Length of fruits (cm)	Diameters of fruit (cm)	Fruit weight (g)	Fruits yield/plant (g)	Fruit yield/plot (kg)	Estimated fruit yield (q/ha)
T_0 Control	15.17	12.10	1.31	14.10	213.91	5.34	95.00
T_1 (V_1)	15.61	13.37	1.35	15.42	240.53	6.10	108.51
T_2 (V_2)	16.06	13.51	1.38	15.37	246.75	6.17	109.63
T_3 (M)	16.64	13.59	1.42	16.09	267.74	6.69	118.94
T_4(Z_1)	16.12	13.87	1.43	15.31	246.94	6.17	109.70
T_5 (Z_2)	16.50	13.88	1.43	15.45	255.16	6.37	113.31
T_6 (V_1 + M)	18.44	14.07	1.46	17.15	316.23	7.90	140.45
T_7 (V_1 + Z_1)	17.25	14.74	1.40	16.64	286.88	7.17	127.47
T_8 (V_1 + Z_2)	17.70	14.69	1.43	16.90	299.17	7.48	132.93
T_9 (V_1+M+Z_1)	18.59	13.47	1.41	17.16	319.07	7.97	141.76
T_{10} V_1+M+Z_2)	19.25	13.48	1.42	17.48	336.50	8.41	149.46
T_{11} (V_2 + M)	19.13	14.17	1.48	18.67	357.01	9.02	160.31
T_{12} (V_2 + Z_1)	18.96	14.81	1.47	18.33	347.64	8.69	154.50
T_{13} (V_2 + Z_2)	19.20	14.82	1.55	18.62	354.41	8.85	157.40
T_{14} (V_2+M+Z_1)	19.83	15.05	1.58	19.54	387.36	9.69	172.04
T_{15} (V_2+M+Z_2)	20.23	16.82	1.66	20.13	407.13	10.31	183.24
CD at 5%	1.39	0.64	0.08	0.19	22.11	0.60	10.60
S. Em. ±	0.68	0.31	0.04	0.09	10.97	0.29	5.19

The combined effect of vermicompost, mycorrhiza and micronutrients mixture play on important role in increasing the yield attribute over control. The treatment T_{15} (vermicompost 4 tonnes/ha + mycorrhiza + micronutrients mixture @ 100 ppm) significantly increased the number of fruits per plant, fruits length (cm), fruits diameter(cm), fruits weight (g), fruits yield per plant (g), fruits yield per plot (kg) and estimated fruits yield per he (q/ha) over control.

the maximum values of yield and yield attributes i.e. number of fruit per plant (20.23), length of fruit (16.82 cm), diameter of fruit (1.66 cm), fruit weight (20.13 g) yield per plant (407.13 g), yield per plot (10.31), and yield per hectare (183.24), was recorded with treatment (T_{15}) and minimum under control (T_0). These results are in accordance with the findings of Naruka *et al.* (2000) [9] in okra, Raj *et al.* (2001) [11] in brinjal, Yadav (2001) [16] in cowpea, Chander *et al.* (2005) [5] in okra, Das *et al.* (2014) [7] in okra, Sidhya *et al.* (2015) [13] in okra and Anisha *et al.* (2016) [2] in okra. Further combination of vermicompost with Mycorrhiza, it is well known that mycorrhiza aredirectly involved in plant mineral nutrition. The symbiotic root-fungal association increases the uptake of less mobile nutrients (Ortas *et al.* 2001) [10], particularly phosphorus (P) but also of micronutrients like zinc (Zn) and copper (Cu), the symbiosis has also been reported for augmenting water uptake. Mycorrhiza can also benefit plants by stimulating the production of growth regulating substances, increasing photosynthesis, improving osmotic adjustment under drought and salinity stresses and

increasing resistance to pests and soil borne diseases thus increases yield (Al-Karaki, 2006) [1]. The increase in yield attributes may be due to effective root colonization, which enhanced phosphorus uptake of roots due to exploration of soil volume and increase in the surface area for absorption of nutrients (Tinker *et al.* 1978) [5]. Further the combination of vermicompost, mycorrhiza and micronutrients mixture had rapidly provided nutrients in proper amount, required by plants for its growth and development. The micronutrients play an important role in physiology of crop and these are a part of enzyme system and acts as a catalyst in enzymatic reactions. Amongst these role of micronutrients (boron, zinc, copper and iron) seems to be one of the factors that may enhance fruits yield. Increased yield due to micronutrient application may be attributed to enhanced photosynthesis activity, resulting into the increased production and accumulation of carbohydrates and favourable effect on vegetative growth and retention of flowers and fruits, which might have augmented increased number and weight of fruits. They act as stimulant in chlorophyll formation, photosynthesis, energy system and catalysts in many metabolic processes of the plants. Some of them act as enzyme formers in these activities (Kumari, 2012) [8].

Conclusion

It is postulated that the vermicompost 2tons and 4tons + mycorrhiza seed treatment + micronutrients mixture 50ppm and 100ppm may positively regulate the okra yield improved. The increase number of fruit per plant (20.23), length of fruit (16.82 cm), diameter of fruit (1.66 cm), fruit weight (20.13 g) yield per plant (407.13 g), yield per plot (10.31), and yield per hectare (183.24) over the control.

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