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Singh Smriti
Department of Horticulture, Babasaheb Bhimrao Ambedkar University (A Central University) Vidya- vihar Rae-bareli Road, Lucknow Uttar Pradesh, India

RB Ram
Department of Horticulture, Babasaheb Bhimrao Ambedkar University (A Central University) Vidya- vihar Rae-bareli Road, Lucknow Uttar Pradesh, India

Correspondence
Singh Smriti
Department of Horticulture, Babasaheb Bhimrao Ambedkar University (A Central University) Vidya-vihar Rae-bareli Road, Lucknow, Uttar Pradesh, India

Effect of organic, inorganic and bio-fertilizers on yielding and fruiting traits of okra [*Abelmoschus esculentus* (L.) Moench]

Singh Smriti and RB Ram

Abstract
The present experiment was carried out at the Horticulture Research Farm of the Department of Horticulture, Babasaheb Bhimrao Ambedkar University, Lucknow, Uttar Pradesh, India during the year 2016-1017. The plant to plant and row to row spacing were maintained at 30x60 cm respectively. The experiment was carried under Randomized Block Design (RBD) with three replications. A single standard variety (Kasha pragati) released from IIVR Varanasi is sown with the different treatment combinations. The treatment combinations are given as – Treatment 1 (T1) control, T2 Farm yard Manure (FYM), T3 (Vermicompost), T4 Neemcake, T5 (50% RDF+FYM), T6 (50%RDF + Vermicompost) T7 (50% RDF+Neemcake), T8 (75% RDF+FYM), T9 (75%RDF+Vermicompost), T10 (75%RDF+Neemcake), T11 (50%RDF+Azotobacter), T12 (50%RDF+PSB), T13 (50%RDF+VAM), T14 (75%RDF+Azotobacter), T15 (75%RDF+PSB), T16 (5%RDF+VAM). On the basis of overall performance under the present investigation, it may be concluded that the application of 50% RDF + Vermicompost in 'Kashi Pragati' increased the growth, yield and nutritional quality of okra. It was, therefore, concluded that the use of organic manure in combination with inorganic fertilizers in the production of vegetables like okra should be encouraged as it is beneficial for the physical growth of okra plant.

Keywords: okra, cultivar, treatment, farm yard manure (FYM) and randomized block design (RBD)

Introduction

Okra or bhindi [*Abelmoschus esculentus* (L). Moench] belongs to the family Malvaceae Okra [*Abelmoschus esculentus* L. (Moench)], is an economically important vegetable crop grown in tropical and sub-tropical parts of the world. It is generally an annual plant. It is also known as lady's finger or *bhindi*, originated in tropical Africa. Because of its richness in nutrition, taste, medicinal and industrial value okra is one of the most popular vegetables in all section of people. Okra is cultivated for its fibrous fruits or pods containing round, white seeds. The fruits are harvested when immature and eaten as a vegetable. Okra is mainly propagated by seeds and has duration of 90-100 days. Okra can be grown in both the seasons *i.e.*, *Rabi* and *Kharif*. Okra requires a long, warm and humid growing period. Okra is a good source of vitamins, minerals, calories, and amino acid found in seeds and compares favourably with those in poultry, eggs and soybean, (Thompson, 1949; Schipper, 2000) [10]. All parts of okra (Ladies' fingers) likes fresh leaves, buds, flowers, pods, stems and seeds can be used for different purpose and hence it is a multipurpose crop in term of its use (Gemede *et al* 2015) [3]. The mucilage found in okra may be used for plasma replacement or blood expender (Madison D 2008 and Maramag RP 2013) [5]. Moreover, long term sustainability of productivity could be achieved only through the interaction of inorganic and organic sources of nutrients (Hedge *et al*., 1992 and Singh and Yadav, 1992). Nitrogen is a single most important nutrient which contributes to the proper growth of plant and yield. Organic manures improve the quality of green pods. Therefore, the applications of plant nutrients through organic sources like compost, farm yard manure and biofertilizers remains the alternative choice of the growers for maintaining its sustainable production. In India, Uttar Pradesh covering an area of 11.10 thousand hectares with a production of 128.80 thousand million tonnes and productivity of 11.31 metric tonnes per hectare (Anonymous, 2011). Indiscriminate use of inorganic fertilizers has resulted in decreased nutrient uptake, poor quality of vegetables and deterioration of soil health (Ganesh *et al.*, 2000, Agrawal, 2003). Okra produces fruit for a long time and needs balanced and sufficient supply of nutrients for higher yield and better quality) The objective of this experimental study is to evaluate the performance of integrated nutrient management on certain yielding, fruiting and flowering qualities parameters by using okra.

Materials and Methods

The field experiment with okra, cv. 'kashi pragati was conducted- at Horticulture Research Farm, Department of Horticulture Babasaheb Bhimrao Ambedkar University, Lucknow during September to December of 2017. The experiment was laid out in randomized block design with 16 treatments replicated thrice. Total numbers of plots were 48 and the net plot size was (3.6 m^2). The row to row and plant to plant distance of the experiment was maintained respectively 60cm and 30cm. The treatments involved were T1 (Control), T2 (FYM/Compost), T3 (Vermicompost), T4 (Neemcake), T5 (50%RDF+FYM/Compost), T6 (50%RDF+Vermicompost), T7 (50%RDF+Neemcake), T8 (75%RDF+FYM/Compost), T9 (75%RDF+ Vermicompost), T10 (75%RDF+Neemcake), T11 (50%RDF+Azotobacter), T12 (50%RDF+PSB), T13 (50%RDF+VAM), T14 (75%RDF+Azotobacter), T15 (75%RDF+PSB) and T16 (75%RDF+ VAM). The land was brought to a fine tilth through ploughing and tillage. Irrigation channels and bunds were maintained properly. The seeds were sown directly to the field. Light irrigation was given after sowing. The organic manures were applied as basal dose before sowing, for proper decomposition, full dose of phosphorus and potassium and half dose of nitrogen as per treatment were applied just before the sowing. The remaining half dose of nitrogen was applied 30 days after sowing. All cultural practices were followed regularly during crop growth and observations were recorded on vegetative characters i.e. days to germination (50%), days to germination (100%), plant height, stem diameter, number of branches per plant, number of leaves, number of nodes per plant, internodal length. flowering, fruiting and yield characters *i.e.* days to first flowering, days to 50% flowering, number of fruits per plant, fruit weight, fruit length, fruit diameter, days to first picking, fruit yield per plant, fruit yield per hectare, number of seeds per fruits and bio-chemical parameters *i.e* total soluble solids (^{0}Brix), ascorbic acid, reducing sugar, non-reducing sugar and total sugars. The data on these parameters were subjected to statistical analysis to draw logical conclusions.

Results

Among the treatments, highest days to 50% germination were recorded in T4 (Neemcake) and minimum is in T1 (control), highest rate of 100% germination was recorded in T16 (75%RDF+VAM) minimum in T1 (control), minimum plant height (48.65) recorded in control treatment T1 and T6 (50%RDF+Vermicompost) gave maximum plant heights (88.75) followed by T15(83.82), T14 (78.45), T13(75.80), T12(74.10), T11(65.65), T10(65.15), T9(64.31), T8(63.45), T7(62.40), T5(60.10), T16(59.45), T4(59.19), T3(52.15), T2(49.91), T1(48.65) respectively. Likewise Maximum number of leaves recorded (26.56) in T6 and minimum (16.19) in control treatment. Maximum no of branches 19.20 and minimum 11.37, maximum number of nodes recorded 23.39 & minimum 16.77, in case of stem diameter maximum stem diameter is 13.80 and minimum (9.89), maximum intermodal (9.71) was recorded in T6 and minimum (6.95) in T1(control), Organic manures helps in improving soil health and it ensures proper aeration in soil and improves water holding capacity of soil. All over the study of vegetative characters it was observed that half dose of organic and inorganic fertilizers perform better instead of sole application of chemical fertilizer.

The flowering, yielding and fruiting parameter results of okra obtained from the present investigation are presented in Table given below Maximum days to first flowering is (46.40), 50% flowering is (51.00) and maximum days to first picking is recorded (62.59) under the Treatment (T6), and minimum in Treatment 1 (T1) (35.30),. The maximum number of fruits per plant (28.50), maximum fruit yield per plot (0.11), maximum fruit yield q/ha (320.74) in T6 and minimum (158.98) in T1. likewise maximum fruit weight (47.70) was recorded in T6 and minimum (30.25) in T1, maximum fruit length (22.85) in T6 and minimum (14.48) was recorded in T1, maximum fruit diameter was recorded in T6 that is 26.45 and minimum was recorded in Treatment (T1) that is 18.24, maximum Number of seeds which is the last parameter of fruiting and yielding data was recorded 74.03 in T6 and minimum in T1(52.90).

Discussion

Farmyard manure has been used as a soil conditioner since ancient times and its benefit have not been fully harnessed due to large quantities required in order to satisfy the nutritional needs to crops Makinde *et al*., 2007; Pennington *et al*., 2015 [6] The primary goal of organic farming is to optimize the health and productivity of interdependent communities of soil life, plants, animals and people (Yuda *et al*., 2016) [11]. The variation in number of leaves and leaf area by the application of chemical fertilizer were also observed by Arora (1991) and Somkuwar (1997). Rajkhowa *et al*. (2003) [8] also found significant increase in nutrient uptake by combine use of fertilizer along with vermicompost. Manna *et al.* (2005) [4] reported that integrated nutrient management, including NPK improved soil organic carbon as well as crop productivity in different agro-ecosystems. Study analyses the best result of T6 in the whole experiment. The plant height and number of leaves, which were significantly higher when compared to glyricidia, FYM, poultry manure and vermicompost application alone (Channabasangowda *et al*., 2008; Mojeremane *et al*., 2015) [2]. This response may be due to better nutrient availability and its uptake by the plants (Roy and Singh, 2006; Achsah and Lakshmi Prabha, 2013) [9].

Table 1

Treatments	Days to germination 50%	Days to germination 100%	Plant height	Stem diameter	No of Branches per plant	No of Leaves	No of nodes per plant	Internodal length
T1	7.40	16.33	48.65	9.89	11.37	16.19	16.77	6.95
T2	8.15	18.66	49.91	10.23	11.83	16.80	17.35	7.19
T3	8.00	17.00	52.15	10.70	12.35	17.51	18.15	7.52
T4	8.67	17.00	59.19	12.27	14.25	20.15	20.81	8.63
T5	8.13	18.00	60.10	12.35	14.42	20.23	20.95	8.68
T6	7.79	18.00	88.75	13.80	19.20	26.56	23.39	9.71
T7	8.10	17.33	62.40	11.32	14.70	20.90	19.19	7.95
T8	8.25	17.66	63.45	11.85	15.16	21.53	20.09	8.32
T9	8.11	17.00	64.31	11.99	15.34	21.73	20.33	8.43
T10	7.50	17.66	65.15	12.18	15.57	22.05	20.66	8.56
T11	8.10	18.33	65.65	12.29	15.63	22.15	20.85	8.64

T12	8.00	19.00	74.10	12.84	17.93	24.24	21.79	9.02
T13	8.15	17.00	75.80	13.10	18.40	24.56	22.20	9.21
T14	8.10	19.00	78.45	13.21	18.55	24.81	22.41	9.28
T15	8.30	19.00	83.82	13.32	18.75	25.03	22.76	9.35
T16	8.11	21.00	59.45	12.13	14.02	19.85	20.56	8.52
S.E(d)	0.85	1.89	2.34	0.70	0.70	1.23	1.26	0.40
C.D	N.S.	N.S.	4.79	1.43	1.43	2.51	2.57	0.71

Table 2: Effect of organic, inorganic, and biofertilizers on flowering, fruiting and yielding parameters of okra cultivar.

Treatments	Days to first flowering	Days to 50% flowering	NO Of fruits per plant	Fruit weight	Fruit length	Fruit diameter	Days to first picking	Fruit yield per plot	Fruit yield q/ha	No. of seeds per fruits
T1	35.30	40.35	16.95	30.25	14.48	18.24	48.95	0.05	162.58	52.92
T2	36.50	41.60	17.59	31.30	15.03	18.82	50.80	0.06	169.11	54.89
T3	38.20	43.60	18.34	32.70	15.66	19.63	52.97	0.06	176.60	56.24
T4	43.80	47.90	21.05	37.55	17.98	21.43	60.80	0.07	203.67	60.51
T5	44.05	48.20	21.18	37.85	18.09	21.57	61.18	0.07	203.86	61.92
T6	46.40	51.00	28.50	47.70	22.85	26.45	62.59	0.11	328.00	74.03
T7	38.35	43.80	21.86	39.00	18.67	23.39	61.04	0.07	210.21	67.15
T8	40.20	44.85	22.58	40.00	19.28	24.15	61.55	0.07	216.93	68.33
T9	40.70	45.15	22.80	40.65	19.46	24.38	60.15	0.07	219.31	68.99
T10	41.40	46.30	23.16	41.30	19.79	24.79	60.20	0.08	222.73	70.16
T11	41.80	47.10	23.27	41.55	19.89	24.91	59.40	0.08	223.56	70.55
T12	43.60	47.85	26.31	45.90	21.95	25.35	60.05	0.09	256.51	71.40
T13	44.70	48.50	27.04	46.15	22.05	25.50	60.49	0.09	263.52	72.26
T14	45.10	49.30	27.31	46.60	22.30	25.79	60.70	0.09	272.32	73.11
T15	45.40	49.55	27.53	46.95	20.45	25.91	60.95	0.10	290.41	73.21
T16	41.20	45.15	20.78	37.05	17.74	22.23	58.95	0.07	200.50	64.82
S.E(d)	1.17	1.28	1.29	1.92	1.31	1.31	1.75	0.00	22.81	2.50
C.D	2.40	2.62	2.95	3.93	2.69	2.69	3.58	0.01	46.61	5.12

Conclusion

On the basis of present investigation, it could be concluded that the okra *var*. Kashi Pragati responded well in terms of growth, yield and net profit by the application of (50%RDF+Vermicompost) for highest yield per plot as well as yield per/ha. it could be concluded that the okra var. Kashi Pragati performed well with respect to growth, yield, quality and net profit by the application of (50% RDF+Vermicompost) for highest yield per plot as well as yield per/ha. Use of organic manures increased DTPA extractable Zn and Fe in soil through redistribution of Zn from non-available forms to readily available (water-soluble plus exchangeable) and potentially available forms in soil on the behalf of all the experiment we may conclude best result was observed in treatment 6 i.e. (50% RBD + Vermicompost) and then in T15 and likewise in Treatment 14 and so on….but the respond of control treatment was not observed good in the treatment control. hence it directly shows the impact of fertilizers on crop. Similar observations that the combined use of organic manures, inorganic fertilizer and bio-fertilizers supported better fruit yield in okra, have also been reported by Jadhav *et al*. (2008) and Islam *et al*. (2011). The pronounced effect in terms of all the above mentioned growth parameters (in the combined application of inorganic fertilizersplus biofertilizers) have also been brought to the notice by Nuruzzaman *et al*. (2003) [7], Ray *et al*. (2005) [7], Garhwal *et al* (2007), Nawalkar *et al*. (2007), Ingle *et al*. (2008), Panda *et al*.(2008) and Singh *et al*. (2010). In control treatment minimum yield was obtained which is very clear by the data analysed research Table below.

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