Indian Journal of Agricultural Sciences **85** (8): 1092–6, August 2015/Article

Effect of integrated nutrient management on seed yield and quality in okra (*Abelmoschus esculentus*)

ASHWANI KUMAR[1] and V K PANDITA[2]

ICAR-Indian Agricultural Research Institute, Regional Station, Karnal, Haryana 132 001

Received: 6 June 2014; Accepted: 8 May 2015

ABSTRACT

Organic manures and biofertilizers improve soil, physical, chemical and biological properties and thus enhance crops productivity and quality. Hence a study was carried out to assess interactive effect of inorganic fertilizers, vermicompost, Vesicular Arbuscular Mycorhizae (VAM) and biofertilizers [*Azotobactor* and Phosphate solubilizing bacteria (PSB)] inoculation on seed yield and quality of okra (*Abelmoschus esculentus* (L). Moench). The experiment was conducted in a randomized block design for two consecutive cropping season, *kharif* 2012 and 2013, with ten INM treatments including control (100% RDF). The INM treatments differed significantly for plant height, seed yield, number of pods/plant, number of seeds/pod and seed quality parameters. Integrated use of 100% RDF or NPK + BF (Biofertilizer mixture of *Azotobactor* + PSB + VAM 10 kg/ha) + vermicompost 2.5 t/ha (7.96, 7.25 q/ha) performed significantly better than the control (7.11, 5.95 q/ha) for seed yield and its attributes as well as seed quality parameters during *kharif* 2012 and 2013, respectively. Treatment 50% RDF + BF was found to be the least performer. Also, the mean cost benefit ratio (1.75) was highest for 100% RDF + BF + vermicompost. The highest average net returns (₹ 40 510/ha) was obtained with (T8) the conjunctive use of inorganic fertilizer (100% NPK) and organic manure (vermicompost) and VAM along with bio-inoculants followed by 100% NPK + biofertilizers (₹ 35 410/ha), 100% RDF (₹ 34 190/ha) and lowest by 50% RDF + biofertilizers (₹ 19 530/ha).

Key words: Biofertilizers, Okra, Seed quality, Vermicompost

Okra (*Abelmoschus esculentus* L.) is a multiple use crop. It is grown practically in all agro-ecological zones mainly for its immature fruits which are eaten as cooked vegetable or added to soups. It contains upto 20% protein and the fibre from okra canes is a possible paper pulp source, while the dried canes are a fuel source. In the country okra is cultivated over an area of 531 thousand hectares with an annual production of 6350 thousand tonnes (Anonymous 2013). The basic concept of integrated nutrient management system is the maintenance of plant nutrients supply to achieve a given level of crop production by optimizing the benefits from all possible sources of plant nutrients in an integrated manner, appropriate to each cropping system and farming system (Mahajan and Sharma 2005). The advantage of combining organic and inorganic sources of nutrients in integrated nutrient management has been proved superior to the use of each component separately (Palaniappan and Annadurai 2007). Organic manures improve soil physical, chemical and biological properties and thus enhance crop productivity vis-à-vis maintain soil health. Organic manures contain plant nutrients though in small quantities, in comparison to the chemical fertilizers, the presence of growth hormones and enzymes make them essential for improvement of soil fertility and productivity. In addition to this, the organic manures help in improving the use efficiency of inorganic fertilizers (Singh and Biswas 2000). Quality seed production in okra is a cumbersome job due to biotic and abiotic stresses and labour intensiveness. The present investigation was undertaken with a view to study the effect of integrated nutrient management on seed yield and seed quality of okra.

MATERIALS AND METHODS

Field experiments were undertaken during the *kharif* seasons of 2012 and 2013 in the experimental research farm of Indian Agricultural Research Institute, Regional Station, Karnal, India. The location stands at 29.1-29.5° N and 76.3-77.1° E, at an elevation of 243m above mean sea level. The climate is sub-tropical with mean maximum temperature ranging between 34-39° C in summer and mean minimum temperature ranging between 6-7°C in winter. The mean annual rainfall is around 744mm. The soil on site was clay to clay loam, deep, well drained and productive for growing a large variety of different crop. The soil was neutral to alkaline in reaction (pH-7.6), electrical conductivity of 0.45 ds/m. with deficient (0.27%) soil organic carbon, medium

[1]Senior Scientist (Seed Technology) (e mail: ashakmash@gmail.com), [2]Principal Scientist (Horticulture) (e mail: vndpandita@yahoo.com)

Table 1 Details of experimental treatments.

Notations	Treatments
T_1	Control (100% RDF or NPK) recommended dose of fertilizer; N -100, P_2O_5 -60, K_2O -50 kg/ha
T_2	100% RDF + BF (Biofertilizer mixture of *Azotobacter* +PSB + VAM 10 Kg/ha)
T_3	75% RDF + BF
T_4	50% RDF + BF
T_5	100% RDF + VC (Vermicompost 2.5 t/ha as band application in the soil)
T_6	75% RDF + VC
T_7	50% RDF + VC
T_8	100% RDF + BF + VC
T_9	75% RDF + BF + VC
T_{10}	50% RDF + BF + VC

Only N (three splits–basal= 25DAS+ 50 DAS) and P_2O_5 (basal dose) doses were reduced to 75% and 50%. *Azotobacter* + PSB-Phosphate solubilizing bacteria as seed treatment; VAM-Vesicular Arbuscular Mycorhizae as band application in the soil, it makes the plant root system to get easy access to the usable form of nutrients.

(28.63 kg/ha) phosphorus, medium (190 kg/ha) potash and sufficient (14.57 ppm) sulphur. It has sufficient amount (3.46, 6.58, 3.25 ppm) of micronutrients, viz. Zn, Fe and Mn, respectively. Vermicompost used in experiments was having pH 7.4, nitrogen 1.75%, phosphorus 1.25%, potassium 1.95%, sulphur 120 ppm, Zn 1.06 ppm, Fe 14.78 ppm and Mn 8.74 ppm. Experiment was conducted to evaluate the performance of okra variety, Pusa A4 under different nutrient management practices to recommend the best suited management package for seed production. Seeds were sown on 18 July 2012 and 08 July 2013 in the experimental field. Plot sizes of 3 m × 3 m with 60 cm row to row and 30cm plant to plant spacing were laid out in Randomized Block Design (RBD) with three replications. Altogether ten integrated nutrient treatments including control were used. The treatment details are given in Table 1.

Plant stand, plant height (cm) and number of pods of ten randomly selected plants, pod length (cm) and number of seeds of twenty five randomly selected pods of each treatment and replication were recorded at maturity. Mean of five samples of 1 000 randomly selected seeds of each treatment and replication were recorded and expressed as 1 000-seed weight (g). All the pods excluding 2-3 terminal pods were threshed for seed yield. Weight of total quantity of harvested seeds from per plot for each treatment and replication was taken and the yield per hectare was calculated and expressed in q/ha.

For seed quality assessment germination test was conducted using the paper towel method as prescribed in ISTA rules (1996), by providing the optimum conditions. The germination counts was made on normal seedlings and expressed in per cent. Vigour indices were computed by adopting the following formula as suggested by Abdul Baki and Anderson (1973) and expressed in number.

Vigour Index I = Germination (%)×Seedling length (cm)
Vigour Index II=Germination (%)×Seedling dry weight (g)

Cost of cultivation was calculated on the basis of prevailing market prices and inputs used in cultivation of okra. The produce obtained from different treatments was converted into gross return (₹/ha) by multiplying the produce with the NSC sale price of okra seed. Net return from the produce was calculated by deducting the cost of cultivation from the gross return. The benefit cost ratio, which implies the return per rupee invested, was worked out for different treatments by dividing the gross return with the corresponding cost of cultivation.

Analysis of observation taken on different variable was carried out to know the degree of variation among all the treatments. The results were obtained through analysis of variance (ANOVA) and SPSS software- version 20, 2011. Means were separated with Duncan's Multiple Range Test.

RESULTS AND DISCUSSION

In general, mean performance of plant stand per plot, plant height (cm), seed yield (q/ha) and yield attributing traits, viz. number of pods/plant, pod length (cm), number of seeds/pod, 1 000-seed weight was higher in *kharif* 2012 than 2013 due to year to year climatic variations during crop growth period. The yield attributing traits showed decreasing trend with reduced doses of inorganic fertilizers alone and in combinations with biofertilizers and vermicompost (Table 2).

The INM treatments differed significantly for plant height, seed yield, number of pods/plant and number of seeds/pod; and mean performance trends were similar for these traits during both years. Treatment T_8 (100% RDF+BF+VC) gave the significantly higher seed yield in *kharif* 2012, 2013 (7.96, 7.25 q/ha, respectively) than control (7.11, 5.95 q/ha, respectively), i.e. T_1 (100% RDF) and at par with T_5 (100% RDF+VC) and T_2 (100% RDF+BF) in 2012 and T_5 in 2013. Number of pods per plant were highest in T_8 (15.8, 15.2, respectively) statistically superior than control (13.2) in 2013; and at par with T_5, T_2, T_9 (75% RDF+BF+VC) and T_1 (Control) in 2012 and T_5, T_2, T_9 and T_6 (75% RDF+VC) in 2013. This might be due to sole or integrated application of inorganic fertilizers (100% RDF or 75% RDF) along with vermicompost (5 t/ha or 2.5 t/ha) and biofertilizers which increased the availability and uptake of nutrients for a longer duration. Both vermicompost and biofertilizer might have been involved in the various endogenous hormonal functions in the plant tissues which might be responsible for enhanced pollen germination and pollen tube growth and ultimately increased the fruit set as well as increased numbers of fruits per plant. Similar findings of significantly higher number of fruits per plant by integrated application of chemical fertilizer, organic manures and biofertilizers were reported by Mal *et al.* (2014) and Prabhu *et al.* (2003), Bairwa *et al.* (2009) in okra. The maximum number of fruits per plant was reported by Neeraja *et al.*

Table 2 Effect of INM treatments on seed yield and yield attributes in okra

Treatment	Plant stand/plot		Plant height (cm)		No. of pods/plant		Pod length (cm)		No. of seeds/pod		1000-seed weight (g)		Seed yield (q/ha)	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
100% RDF (Control)	43.0	42.3	96.3 b[a]	94.7bc	14.2ab	13.2b	13.6	13.6	47.3b	45.6b	67.3	66.7	7.11b	5.95bc
100% RDF+BF	43.7	44.0	100.1ab	98.3ab	14.6ab	13.8ab	14.0	13.6	48.7ab	44.1b	67.3	67.3	7.26ab	6.12bc
75% RDF+BF	40.7	41.0	94.1bc	92.1c	13.4b	12.8bc	13.8	13.4	41.6b	38.4b	66.1	65.3	6.46bc	5.41c
50% RDF+BF	40.7	40.0	88.7c	88.9c	12.2b	11.2c	13.6	13.1	40.2b	38.0b	63.7	62.7	5.92c	4.65c
100% RDF+VC	44.3	45.7	101.3a	99.4ab	14.8ab	14.2ab	14.6	14.0	51.3ab	48.4ab	70.5	70.0	7.28ab	6.51ab
75% RDF+VC	42.7	43.3	94.7bc	93.1bc	14.0ab	13.4ab	14.2	13.9	44.7b	40.3b	66.9	66.7	6.64bc	5.58bc
50% RDF+VC	41.3	41.3	91.3c	90.5c	13.2b	12.6bc	13.8	13.2	42.1b	38.2b	63.3	62.7	6.53bc	4.87c
100% RDF+BF +VC	45.7	46.7	103.7a	102.7a	15.8a	15.2a	14.7	14.3	56.3a	54.2a	70.7	70.0	7.96a	7.25a
75% RDF+BF +VC	44.3	43.7	96.3b	97.1b	14.4ab	13.8ab	14.1	13.8	52.3ab	49.6ab	67.7	67.3	6.61bc	6.26b
50% RDF+BF +VC	43.3	43.3	92.3bc	92.7bc	13.4b	12.8bc	13.8	13.5	45.4b	41.0b	65.1	64.7	6.11c	5.55bc
CD 0.05	NS	NS	4.9	4.7	2.0	1.8	NS	NS	8.7	8.5	NS	NS	0.83	0.76

[a] Values in a column followed by the same letter are not significantly different, DMRT, $P \leq 0.05$.

(2002) in okra due to application of organic nutrients which resulted in better vegetative growth with higher number of fruits per plant. During 2012 and 2013 number of seeds per pod found maximum (56.3, 54.2, respectively) in treatment T_8 (100% RDF+BF+VC) which was significantly higher than control T_1 (47.3, 45.6, respectively) and at par with T_5, T_2, T_9 in 2012 and T_5, T_9 in 2013. Treatment T_8 (100% RDF+BF+VC) gave the significantly more plant height (103.7, 102.7cm, respectively) than control (96.3, 94.7 cm, respectively) and at par with T_5 (100% RDF+VC) and T_2 (100% RDF+BF) in 2012 and 2013. It was quite evident from the results that okra is an exhaustive crop and requires more fertilization as T_8 (100% RDF+BF+VC) gave the maximum and T_4 (50% RDF+BF) minimum seed yield during both the years. There were significant differences observed in the seed yield due to combined application of organic and inorganic fertilizers as compared to sole application of NPK (100%) with biofertilizers (*Azotobacter* +PSB + VAM) and vermicompost. Mal *et al*. (2014) also observed significant differences in the fruit yield due to combined application of organic and inorganic fertilizers as compared to sole application of NPK (100% or 75%) with FYM and in control (FYM @10 t/ha) and integrated application of FYM (10 t/ha), 100% NPK, vermicompost (5 t/ha) along with biofertilizers, *viz. Azotobacter*, *Azospirillum* and PSB (12 kg/ha) gave maximum fruit yield. Dahama (2003) reported that the favourable C/N ratio and optimal level of nutrients available for longer period due to slow release might be the possible reasons to influence fruit yield of okra. The activity of biofertilizers in promoting fruit yield was more pronounced, when it was enriched with decomposed organic manures. Similar report of increased yield in okra was observed due to additional application of vermicompost with RDF by Tripathy *et al.* (2004). Inoculation of PSB secretes both organic and inorganic acids such as citric acid, formic acid, acetic acid etc., which solubilize the insoluble form of phosphorus to soluble form and make available to plants (Bora *et al.* 2002). Increased growth and yield in okra due to inoculation of PSB have been reported by Anandan (2000). Similar findings of increased yield due to combined effects of inorganic fertilizers, biofertilizers with FYM were reported by Patil *et al*. (2000), Prabhu *et al*. (2003) and Shanthi and Vijayakumari (2002) in okra. Use of biofertilizers and Vermicompost could not reduce the application of the recommended dose of nitrogen and phosphorus chemical fertilizers. It is evident from the experiments that there was enhancement in seed yield and its attributes by the application of NPK 100% plus VAM @10 kg/ha and vermicompost @2.5 t/ha and the inoculation with biofertilizers.

Mean performance of seed quality parameters and showed decreasing trend with reduced doses of inorganic fertilizers alone and in combinations with biofertilizers and vermicompost (Table 3). The INM treatments differed significantly for the quality parameters, viz. seed germination (%), seedling length (cm), seedling dry weight (g), seed vigour index I and seed vigour index II during *kharif* 2012 and 2013. INM treatment T_8 (100% RDF+BF+VC) gave significantly higher seed germination percentage (84.1, 87.3), vigour index I (2245, 2261) and II (17.89, 18.80) than control (77.2, 80.0; 1752, 1792; 13.58, 13.91, respectively), i.e. T_1 (100% RDF). T_8 was at par with T_5 (100% RDF+VC) in 2012 and T_5, T_2 (100% RDF+BF) and T_9 (75% RDF+BF+VC) in 2013 for seed germination; and at par with T_5 (100% RDF+VC) in 2012 for seed vigour index I. The enhanced seed germination and seed vigour indices

Table 3 Effect of INM treatments on seed quality parameters in okra

Treatment	Seed germination (%)		Seedling length (cm)		Seedling dry weight (g)		Seed vigour index I		Seed vigour index II	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
100% RDF	77.2bc[a]	80.0b	22.7bc	22.4b	0.176bc	0.174c	1752bc	1792bc	13.58cd	13.91c
100% RDF +BF	79.0ab	81.8ab	23.3b	23.4ab	0.186bc	0.186bc	1841b	1914bc	14.67bc	15.19bc
75% RDF +BF	75.7bc	78.9bc	20.1c	19.8c	0.170c	0.167cd	1522c	1562c	12.89cd	13.18c
50% RDF +BF	69.8c	73.8c	17.6c	16.8d	0.157c	0.155d	1228d	1240d	10.94d	11.42d
100% RDF +VC	81.7ab	84.2ab	24.7ab	23.5ab	0.198ab	0.196b	2018ab	1979b	16.14b	16.49b
75% RDF +VC	78.3b	80.4b	21.3bc	20.9bc	0.180bc	0.177c	1668bc	1680c	14.10c	14.26c
50% RDF +VC	71.7c	74.9bc	17.6c	16.5d	0.164c	0.162cd	1262cd	1236d	11.78d	12.14d
100% RDF +BF+VC	84.1a	87.3a	26.7a	25.9a	0.213a	0.215a	2245a	2261a	17.89a	18.80a
75% RDF +BF+VC	79.7ab	81.8ab	23.0bc	21.3bc	0.189b	0.187bc	1833b	1742bc	15.05bc	15.28bc
50% RDF +BF+VC	72.3c	75.1bc	20.3c	19.1cd	0.171c	0.169cd	1468cd	1434cd	12.37d	12.70cd
CD P = 0.05	5.3	5.6	2.8	2.5	0.017	0.016	264	259	1.65	1.67

[a] Values in a column followed by the same letter are not significantly different, DMRT, $P<0.05$.

might be due to the favourable C/N ratio and optimal level of nutrients available for longer period due to their slow release. Similar findings regarding integrated use of different chemical and biofertilizers and vermicompost showed significant increase in % germination, root-shoot length of seedlings and SVI compared to non-treated plants. It has already been reported by Dar *et al*. (2010a, 2010b) in okra, Mishra and Jain (2013) in *Andrographis paniculata* (Kalmegh) Assiouty and Sedera (2005) in spinach; Shashidhara (2000) in chilli; Firuzsalari *et al*. (2012) in corn. It is evident from the experiment that application of NPK 100% plus VAM @ 10 kg/ha and vermicompost @ 2.5 t/ha and the inoculation with biofertilizers reflected on the seed quality.

There is a great variation in economics of okra cultivation due to application of different levels of chemical fertilizers and vermicompost along with biofertilizers and VAM was observed (Table 4). The average total cost of cultivation in okra cv. Pusa A4 varied between ₹ 46 533 to ₹ 54 553/ha under different INM treatments. Combined use of 100% NPK as inorganic fertilizers with vermicompost 2.5 t/ha as organic sources, VAM 10 Kg/ha and bio-inoculants in 2012 recorded the highest gross return (₹ 99 500/ha) while the lowest gross return (₹ 74 000/ha) was obtained where only 50% NPK plus biofertilizers (VAM 10 kg/ha and bio-inoculants) was applied. In 2013 the respective gross returns were ₹ 90 625/ha and ₹ 46 533/ha. The respective mean gross returns were Rs. 95 063/ha and ₹ 66 063/ha.The highest average net returns (₹ 40 510/ha) was obtained with (T_8) the conjunctive use of inorganic fertilizer (100% NPK as chemical fertilizers) and organic manure (vermicompost) and VAM along with bio-inoculants followed by T_2 (₹ 35 410/ha), 100% NPK plus biofertilizers and T_1 (₹ 34 190/ha), 100% RDF. However, the lowest mean net return of ₹ 19 530/ha was obtained when 50% RDF + biofertilizers (T_4) were applied. Similar findings of

Table 4 Economics of okra seed production as influenced by INM treatments.

Treatment	Total expenditure (₹/ha)			Gross return (₹/ha)			Net return (₹/ha)			Benefit cost ratio		
	2012	2013	Mean	2012	2013	Mean	2012	2013	Mean	2012	2013	Mean
100% RDF	46 220	48 650	47 435	88 875	74 375	81 625	42 655	25 725	34 190	1.92	1.53	1.73
100% RDF +BF	46 980	49 450	48 215	90 750	76 500	83 625	43 770	27 050	35 410	1.93	1.55	1.74
75% RDF +BF	46 195	48 625	47 410	80 750	67 625	74 188	34 555	19 000	26 778	1.75	1.39	1.57
50% RDF +BF	45 340	47 725	46 533	74 000	58 125	66 063	28 660	10 400	19 530	1.63	1.22	1.43
100% RDF +VC	52 395	55 150	53 773	91 000	81 375	86 188	38 605	26 225	32 415	1.74	1.48	1.61
75% RDF +VC	51 515	54 225	52 870	83 000	69 750	76 375	31 485	15 525	23 505	1.61	1.29	1.45
50% RDF +VC	50 635	53 300	51 968	81 625	60 875	71 250	30 990	7 575	19 283	1.61	1.14	1.38
100% RDF +BF+VC	53 155	55 950	54 553	99 500	90 625	95 063	46 345	34 675	40 510	1.87	1.62	1.75
75% RDF +BF+VC	52 275	55 025	53 650	82 625	78 250	80 438	30 350	23 225	26 788	1.58	1.42	1.50
50% RDF +BF+VC	51 395	54 100	52 748	76 375	69 375	72 875	24 980	15 275	20 128	1.49	1.28	1.38

Maximum mean benefit cost ratio (1.75) was obtained by combined application 100% RDF plus vermicompost @ 2.5 t/ha and VAM @ 10 kg/ha along with biofertilizers.

enhanced profitability by use of INM treatments in okra were reported by Mal *et al.* (2014), Kumar *et al.* (2013) and Dar *et al.* (2010b).

From the above results, it can be concluded that integrated use of 100% RDF or NPK + BF (Biofertilizer mixture of *Azotobactor* + PSB + VAM 10 kg/ha) + vermicompost 2.5 t/ha proved to be the best combination during both years of experiment as it gave 12%, 22% more seed yield; 9.0%, 9.1% better germination; 28%, 26% more vigour index I; 32%, 35% more vigour index II as compare to the control (100% RDF) during *kharif* 2012 and 2013, respectively. It was also most remunerative with average net return of ₹40 510/ha.

REFRENCES

Abdul Baki A A and Anderson J D. 1973. Vigor determination in soy-bean by multiple criteria. *Crop Sci.* **13**: 630–3.

Anandan M. 2000. Integrated approach of bio-fertilizer for sustainable agriculture. *Intensive Agriculture* **38** (1-2): 9–11.

Anonymous. 2013. Indian Horticulture database. http://national hort. Database (Feb. 2014).

Assioty-EL FMM and Sedera ABO SA. 2005. Effect of bio and chemical fertilizers on seed production and quality of spinach (*Spinacia olereacea* L.). *International Journal of Agriculture and Biology*: 947–52.

Bairwa H L, Mahawer L N, Shukla A K, Kaushik R A and Mathur S R. 2009. Response of integrated nutrient management on growth, yield and quality of okra (*Abelmoschus esculentus* (L.) Moench). *Indian Journal of Agricultural Sciences* **79**(5): 381–4.

Bora S S, Singh A P and Kumar N 2002. Biofertilizers: natural cheap source of nutrients. *Farmers Digest* **35**: 11–2.

Dahama A K. 2003. *Organic Farming for Sustainable Agriculture.* Agrobios (India), Jodhpur.

Dar R A, Gupta A K and Samnotra R K. 2010. Effect of integrated nutrient management on seed yield contributing parameters of okra. *Asian Journal of Horticulture* **4**(2): 263–6.

Dar R A, Gupta A K, Chopra S and Samnotra R K. 2010. Effect of integrated nutrient management on seed yield contributing parameters of okra *(Abelmoschus Esculentus* (L). Moench*). Journal of Research, SKUAST J* **9**(1): 70–8.

Firuzasalari Shirin Mokari, Mirshekari Bahram, Khochebagh.2012. Effect of seed inoculation with bio fertilizer on germination and early growth of Corn. *International Research Journal of Applied and Basic Sciences* **3**(5): 1 097–1 102.

International Seed Testing Association (ISTA). 1996. International rules for seed testing. *Seed Science and Technology* **24** (Suppl.): 1–335.

Kumar T, Kumar M, Singh M K, Kumar V, Kumar A, Kumar S and Singh B. 2013. Impact of integrated nutrient management (INM) on growth and economic yield of okra. *Annals of Horticulture* **6**(1): 107–14.

Mahajan A and Sharma R. 2005. Integrated nutrient management (INM) system- concept, need and future strategy. *Agrobios Newsletter* **4**(3): 29–32.

Mal B, Mahapatra P and Mohanty S. 2014. Effect of diazotrophs and chemical fertilizers on production and economics of okra (*Abelmoschus esculentus* L.) cultivars. *American Journal of Plant Sciences* **5**: 168–74.

Mishra S and Jain A. 2013. Impact of biofertilizers, chemical fertilizers and vermicompost on seed quality attributes of *A. paniculata. International Journal of Science and Nature* **4**(2): 369–70.

Neeraja G, Gautham B and Reddy I P. 2002. Comparative yield trial in okra (*Abelmoschus esculentus* L) hybrids under Southern Telangana Zone of Andhra Pradesh. *Orissa Journal of Horticulture* **30**(2): 20–2.

Palaniappan S P and Annadurai K. 2007. *Organic Farming: Theory and Practices,* p169. Scientific Publishers, Jodhpur.

Patil M B, Jogdand S D and Jadhar A S. 2000. Effect of organic and bio-fertilizers on yield and quality of okra. *Journal of Maharashtra Agricultural Universities* **25**(2): 213–4.

Prabhu T, Narwadekar P R, Sannindranath A K and Rofi M. 2003. Effect of integrated nutrient management on growth and yield of okra (*Abelmoschus esculentus* (L.) Moench) cv. Parbhani Kranti. *The Orissa Journal of Horticulture* **31**(1): 17–21.

Sajindranath A K, Narwadekar P R, Prabu T and Rathod N G. 2002. Effect of biofertilizers and growth regulators in okra *(Abelmoschus esculentus* (L).Moench*). Indian. Horticulture* **50**: 538–42.

Shanthi N and Vijayakumari B. 2002. Effect of NPK with different organic manures on biometric parameters of bhendi (*Abelmoschus esculentus* L. var. Arka Anamika). *Journal of Phytological Research* **15(**2): 209–12.

Shashidhara G B. 2000. Integrated nutrient management for Chilli (*Capsicum annum* L.) in Alfisops of Northern Transition Zone of Karnataka. M Sc, (Agri.) thesis, University of Agricultural Science, Dharwad, Karnataka.

Singh G B and Biswas P P. 2000. Balanced and integrated nutrient management for sustainable crop production. *Indian Journal of Fertilizers* **45**(5): 55–60.

Tripathi P, Bhattacharyay B and Maity T K. 2004. Response of okra (*Abelmoschus esculentus* L. Moench) to integrated nutrient management system. *Orissa Journal of Horticulture* **32**(2): 14–8.