Journal of the Andaman Science Association Vol. 21(2):21-26 (2016)
ISSN 0970-4183, Printed in India

Effect of Organic and Inorganic Sources of Nutrients on Growth and Yield of Okra [*Abelmoschus esculentus* (L.) Moench] under island ecosystem

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Abstract

The experiment was carried out at Multipurpose farm, Diglipur, North Andaman to find out the effect of various organic and inorganic sources of nutrients on growth, yield attributes and yield of okra var. Arka Anamika, during 2015 and 2016. There were 14 treatment combinations replicated thrice in RBD. The results indicated that the application of 100 % recommended dose of NPK (T_2) recorded higher plant height, number of branches and attained early flowering and at par with T_6 (75% recommended dose of NPK + FYM @ 2.5 t ha^{-1} + NC @ 0.5 t ha^{-1} + VC @ 1.25 t ha^{-1}. However, yield attributes such as pod length, number of fruits per plant, fruit weight of okra were found to be maximum in T_6 (75% of recommended dose of NPK + FYM @ 2.5 t ha^{-1} + NC @ 0.5 t ha^{-1} + VC @ 1.25 t ha^{-1}) and at par with T_8 (50% of recommended dose of NPK + VC @ 5.0 t ha^{-1}) as compared to other treatments. Similarly, the treatment T_6 (75% of recommended dose of NPK + FYM @2.5 t ha^{-1} + NC @ 0.5 t ha^{-1} + VC @ 1.25 t ha^{-1}) recorded higher pod yield (12.57 and 11.00 t ha^{-1}) and net return (Rs. 2,98,289 and Rs. 2,69,474). However, higher B: C ratio was registered in T_6 (4.79 and 4.42) followed by T_2. From the results of the experiments, it can be concluded that application of 75% of recommended dose of NPK + FYM @ 2.5 t ha^{-1} + NC @ 0.5 t ha^{-1} + VC @ 1.25 t ha^{-1} is highly profitable and economically viable for the cultivation of okra under Andaman Island condition.

Key words: *Okra, yield, inorganic and organic nutrients and Island*

Introduction

Okra [*Abelmoschus esculentus* (L.) Moench] is an important vegetable crop in India. It is cultivated over an area of about 5.33 lakh ha with an annual production of about 63.46 lakh tonnes with the productivity of 11.90 t/ha (NHB, 2015). In Andaman and Nicobar Islands, 4600 tonnes of okra is produced from 850 ha during 2015. Though the temperatures prevailing in Andaman and Nicobar islands (23 – 34 °C) are conducive for Okra, its productivity is very low (5.41 t ha^{-1}) as compared to national average due to imbalanced use of fertilizers with more nitrogen and less phosphorus and potassium and virtual absence of micronutrients. Indiscriminate use of inorganic fertilizers has resulted in decreased nutrient uptake, poor quality of vegetables and deterioration of soil health (Agarwal, 2003). As it is a short duration crop, the growth and yield parameters are largely influenced by suitable nutrient management practices (Suchitra and Manivannan, 2012 and Iqbal *et.al.*,2014). Organic manures constitute a dependable source of macro and mico nutrients and are helpful in improving physical, chemical and biological health of soil, reduce nutrient loss, increases nutrient availability and uptake leading to sustainable production besides improving quality of vegetables (Acharya *et. al.*, 2002). Similarly, organic manures from different sources could be an effective substitute of chemical fertilizers which improve the crop yield and soil properties as well (Jamwal, 2005). Many researchers reported that the application rates of nutrients have been found to be reduced with the use of organic manures in conjunction with chemical fertilizers. Bekunda *et. al.,* 2010 found that the cost consumed on inorganic fertilizers can be decreased to a great extent by the application of plant nutrients through organic sources . Moreover, the Andaman & Nicobar Islands are organic by default and the higher cost and less availability of fertilizers are major concern for farmers. Hence, the organic wastes available in Andaman and Nicobar Islands (5,77,672 MT per annum) should be effectively utilized for vegetable production (Velmurugan *et.al.*,(2014). Since

very few works have been conducted under Andaman islands conditions in this regard, an investigation has been conducted to study influence of various organic sources along with different levels of inorganic fertilizers on growth parameters, biomass yield and yield parameters and quality attributes of okra under Andaman Island conditions.

Materials and Methods

A field experiment was conducted during kharif 2015 and 2016 at Multipurpose farm, Diglipur, North Andaman. The soil of the experimental plot was clay loam in texture, acid in reaction, medium in organic carbon, low in available nitrogen and phosphorus and medium in available potassium. The experiment was laid out in Randomised Block Design (RBD) with three replications, each replication comprised of 14 treatments which include T_1- Control (no manure), T_2- 100 % of recommended dose of NPK, T_3- 75% of recommended dose of NPK + FYM @ 5.0 t ha^{-1}, T_4- 75% of recommended dose of NPK+VC @ 2.5 t ha^{-1}, T_5- 75% of recommended dose of NPK +NC @1.25 t ha^{-1}, T_6- 75% of recommended dose of NPK + FYM @ 2.5 t ha^{-1}+ VC @ 1.25 t ha^{-1} +NC @ 0.5 t ha^{-1}, T_7- 50% of recommended dose of NPK + FYM @ 7.5 t ha^{-1}, T_8-50% of recommended dose of NPK + VC @ 5.0 t ha^{-1}, T_9-50% of recommended dose of NPK+NC @ 2.5 t ha^{-1}, T_{10}-50% of recommended dose of NPK + FYM @3.75 t ha^{-1} + VC @ 2.5 t ha^{-1} + N C @ 1.25 t ha^{-1} ,T_{11} -25% of recommended dose of NPK + FYM @10 t ha^{-1}, T_{12} - 25% of recommended dose of NPK +VC @7.5t ha^{-1}, T_{13}-25% of recommended dose of NPK +NC @5.0 t ha^{-1} and T_{14} - 25% of recommended dose of NPK + FYM @5.0 t ha^{-1} + VC @ 3.75 t ha^{-1}+ NC @ 2.5 t ha^{-1}. The seeds of okra cv. Arka Anamika were sown in the last week of April at spacing of 60 x 30 cm during both the years. Full dose of phosphorus, potash and ½ dose nitrogen was applied as basal, while remaining ½ dose nitrogen was applied as split dose at 30 and 60 days after sowing. The inorganic source of N, P and K were urea, diammonium phosphate and muriate of potash respectively. Well decomposed farm yard manure, vermicompost and neem cake were applied one week before sowing. All the cultural practices were followed as per recommendations. Need based plant protection measures were also followed. Observations on growth and yield attributes were recorded from five randomly selected plants in each plot. The recorded data were analyzed as per method suggested by Gomez and Gomez (1984). The data pertaining to the experiment were subjected to statistical analysis by analysis of variance method suggested by Gomez and Gomez (1984). Wherever the treatment differences were found significant (F test) critical difference was worked out at five percent probability level and the values furnished. The treatment difference that were non significant are denoted by NS.

Results and Discussion

Growth parameters

Growth parameters were significantly influenced by various treatments (Table 1). Application of 100 % recommended dose of NPK (T_2) recorded higher plant height (125.32 and 127.47 cm) during both the years, which is at par with application of 75% recommended dose of NPK + FYM @ 2.5 t ha^{-1} + NC @ 0.5 t ha^{-1}+ VC @ 1.25 t ha^{-1} (T_6) and 50 % of recommended dose of NPK + VC @ 5.0 t ha^{-1} (T_8) and the treatment T_{10}. The results are in agreement with the findings of Gayathri and Shyam Sunder Reddy (2013) who reported higher plant height (104.42 cm) with the application of 100 % recommended dose of fertilizers over lower doses of fertilizers. Sole application of 150 kg NPK ha^{-1} fertilizer gave the highest growth as reported by Olaniyi *et.al*., (2010). Similarly the treatment which received 100 % recommended dose of NPK (T_2) attained early flowering (39.15 and 41.31 days) followed by 75% recommended dose of NPK + FYM @ 2.5 t ha^{-1} + NC @ 0.5 t ha^{-1}+ VC @ 1.25 t ha^{-1} (T_6) and 75% recommended dose of NPK + V.C @ 2.5 t ha^{-1}(T_4) and T_8. This may be due the readily available N from inorganic fertilizers for promoting better plant height as also reported by Patel *et. al.*,(2009). However, the higher stem girth (5.67 and 5.03 cm) was recorded by 75% recommended dose of NPK + FYM @ 2.5 t ha^{-1} + NC @ 0.5 t ha^{-1}+ VC @ 1.25 t ha^{-1} (T_6) and at par with 50 % of recommended dose of NPK + VC @ 5.0 t ha^{-1} (T_8). The increased stem girth in combined application of organic and inorganic source of nutrients might be due to beneficial effect of organic manures with inorganic fertilizers that improved the plant growth.

The use of organic sources would have facilitated better aeration, adequate drainage and created a favourable soil environment for deeper penetration of roots and higher nutrient extraction from soil (Sabir *et. al.,* 2013). Similarly, Babatola (2006) reported that application of 80 kg N ha^{-1} enhanced both growth parameters of okra plant. The number of branches per plant was significantly influenced by various treatments of nutrient application. The plants treated with 100 % recommended dose of NPK (T_2) had produced maximum number of branches (2.87 and 3.02) and at par with 75% recommended dose of NPK + FYM @ 2.5 t ha^{-1} + NC @ 0.5 t ha^{-1} + VC @ 1.25 t ha^{-1} (T_6). Similar findings were also reported by Ravi *et.al*. (2009) in Okra.

Table 1. Effect of organic and inorganic sources of nutrients on growth attributes of okra

Treatments	Plant height at harvest (cm)		Days to 50 % Flowering		Stem girth at harvest (cm)		No. of branches	
	2015	2016	2015	2016	2015	2016	2015	2016
T_1	78.65	81.23	52.34	50.21	3.38	3.3	1.80	1.87
T_2	125.32	127.47	39.15	41.31	4.27	4.29	2.87	3.02
T_3	101.54	110.53	45.35	43.50	3.72	3.65	2.20	2.63
T_4	109.17	113.27	42.52	41.85	3.88	3.86	2.40	2.66
T_5	104.43	109.64	44.02	43.41	4.55	4.33	2.57	2.67
T_6	123.90	125.88	41.52	42.21	5.67	5.03	2.67	2.93
T_7	108.91	109.52	45.27	44.59	4.72	4.63	2.20	2.59
T_8	120.56	117.79	43.26	43.02	5.23	4.92	2.50	2.54
T_9	101.80	103.77	45.62	45.17	4.66	4.52	1.60	2.12
T_{10}	115.22	115.33	47.90	47.71	4.33	4.30	2.27	2.37
T_{11}	90.49	92.94	50.68	49.85	3.57	3.46	1.88	2.00
T_{12}	91.91	92.07	50.64	48.62	4.84	3.93	2.10	2.13
T_{13}	86.02	88.91	49.86	50.19	3.47	3.55	1.60	1.92
T_{14}	95.23	96.45	49.67	47.49	3.61	3.66	1.97	1.91
SEd	1.13	7.10	3.61	2.51	0.34	0.31	0.17	0.26
CD(0.05)	2.32	14.58	7.42	5.16	0.71	0.63	0.35	0.54

Yield parameters

The yield attributes viz., pod length, pod weight, number of pods per plant and yield were significantly influenced due to different treatments (table 2). The maximum pod length (18.4 and 16.3 cm) was observed with application of 75% of recommended dose of NPK + FYM @ 2.5 t ha^{-1} + VC @ 1.25 t ha^{-1} +NC @ 0.5 t ha^{-1}(T_6) and at par with 50% of recommended dose of NPK + VC @ 5.0 t ha^{-1} (T_8), T_{10} and T_2. The increased pod length in the combined treatment of organic and inorganic nutrients may be due to the continuous availability of nutrients as reported by Seren *et. al*., 2010. Similarly, the number of fruits per plant was significantly influenced by the application of chemical nutrients at higher level in combination with organic manures. the highest number of fruits (15.97 and 14.61) were obtained with T_6 (75% of recommended dose of NPK + FYM @ 2.5 t ha^{-1} + VC @ 1.25 t ha^{-1} + NC @ 0.5 t ha^{-1}) and at par with T_8 (50% of recommended dose of NPK + VC @ 5.0 t ha^{-1}) and T_{10} (50% of recommended dose of NPK + FYM @3.75 t ha^{-1} + VC @ 2.5 t ha^{-1} + N C @ 1.25 t ha^{-1}). The results of the experiment is in agreement with the findings of Suchitra and Manivannan (2012) who have reported that the enhancement in yield parameters of okra when supplied with integrated treatment like combination of organic sources with chemical fertilizers. Similar findings were also reported by Akande *et. al,*. (2010). Similarly,

the treatment T_6 (75% of recommended dose of NPK + FYM @ 2.5 t ha^{-1} + VC @ 1.25 t ha^{-1} +NC @ 0.5 t ha^{-1}) has recorded maximum single fruit weight (17.31 and 16.70 g) and at par with T_8 (50% of recommended dose of NPK + VC @ 5.0 t ha^{-1}). This might be due to accelerated mobility of photosynthates within the plant as influenced by combined effect of chemical fertilizers at higher levels and organic nutrients.

Table 2. Effect of organic and inorganic sources of nutrients on yield attributes and yield of okra

Treatment	Pod length (cm)		No. of fruits		Fruit weight (g)		Yield (g/plant) (g)		Yield (t/ha)	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
T_1	9.70	8.50	8.50	8.10	12.65	12.38	107.78	98.12	4.86	4.36
T_2	16.30	15.50	13.17	12.77	14.34	13.71	189.13	172.66	8.53	7.86
T_3	14.60	13.50	12.87	12.43	14.19	13.78	182.93	171.68	8.25	7.74
T_4	15.70	15.20	13.83	13.30	15.26	14.68	211.12	191.43	9.52	8.63
T_5	15.00	14.25	13.23	12.63	14.59	13.99	194.03	189.72	8.75	8.00
T_6	18.40	16.30	15.97	14.61	17.31	16.70	278.76	244.11	12.57	11.00
T_7	15.60	14.65	13.80	13.33	15.22	14.90	210.83	185.92	9.50	8.98
T_8	17.80	16.20	15.60	14.48	16.30	16.24	254.15	225.10	11.46	10.62
T_9	14.60	13.30	12.90	12.70	13.68	13.03	176.74	165.42	7.97	7.46
T_{10}	16.60	15.75	14.60	14.03	15.33	14.83	223.69	207.62	10.08	9.36
T_{11}	13.00	11.90	11.47	11.00	13.52	12.70	154.76	138.54	6.98	6.25
T_{12}	13.20	12.15	11.65	10.75	14.31	13.13	166.44	139.34	7.50	6.28
T_{13}	12.40	10.20	10.90	10.33	12.58	12.60	137.25	134.05	6.19	5.87
T_{14}	13.70	12.55	12.07	11.30	13.02	12.76	157.68	151.97	7.11	6.48
SED	1.13	0.87	0.97	0.83	0.93	0.87	26.78	16.8	1.21	0.70
CD(0.05)	2.13	1.71	2.00	1.71	1.90	1.8	55.06	34.55	2.48	1.56

Yield

Integration of individual organic sources with inorganic fertilizer exhibited higher yield in okra during both the years (Table 2). The treatment T_6 (75% of recommended dose of NPK + FYM @ 2.5 t ha^{-1} + VC @ 1.25 t ha^{-1} + NC @ 0.5 t ha^{-1}) has registered higher yield per plant (278.76 and 244.12 g) which has resulted in higher pod yield per hectare (12.57 and 11.00 t) during both the years which was at par with yield obtained in the treatment T_8, as compared to other treatments. Integrated management of nutrients growth and yield attributes and brought significant improvement in yield over other treatments. This is in conformity with the findings of Tripathi et. al., (2004) who reported that combined application of 75% NPK + vermicompost @ 5 t ha^{-1} produced significantly higher yield of okra. Similar results were also reported by Vennila and Jayanthi (2008) and Mal *et. al.* (2013)

Economics

The economics of the okra worked out in the present study (Table 3) revealed that maximum net return (Rs. 2,98,289 and Rs. 2,69,474) was registered by the treatment T_6 (75% of recommended dose of NPK + FYM @ 2.5 t ha^{-1} + NC @ 0.5 t ha^{-1} + VC @ 1.25 t ha^{-1}) during both the years followed by T_8 (50% of recommended dose of NPK + VC @ 5.0 t ha^{-1}) out of other treatments tried, indicating that these treatment combinations are profitable. Similarly, treatment T_6 (75% of recommended dose of NPK + FYM @ 2.5 t ha^{-1} + NC @ 0.5 t ha^{-1} + VC @ 1.25 t ha^{-1}) recorded higher B: C ratio (4.79 and 4.42) followed by T_2 (100 % RDF through NPK) during both the years. Though the treatment T_8 (50% of recommended dose of NPK + VC @ 5.0 t ha^{-1}) recorded higher yield attributes and yield as compared to T_2, recorded lower B: C ratio (3.25 and 3.15) due to higher cost of Vermicompost. Similar observations have also been made by Bairwa *et .al.,* (2009) and Kumar *et. al.,* (2009).

Table 3. Effect of organic and inorganic sources of nutrients on economics of okra

Treatments	Pod yield (t/ha)		Gross return (Rs./ha)		Net return (Rs./ ha)		BCR	
	2015	2016	2015	2016	2015	2016	2015	2016
T_1	4.86	4.36	145764	137340	96021	87597	2.93	2.76
T_2	8.53	7.86	255776	238914	199772	182910	4.57	4.27
T_3	8.25	7.74	247394	226233	178401	157240	3.59	3.28
T_4	9.52	8.63	285519	255140	204026	173647	3.50	3.13
T_5	8.75	8.00	262412	217677	197269	152534	4.03	3.34
T_6	12.57	11.00	376992	348177	298289	269474	4.79	4.42
T_7	9.50	8.98	285126	271007	210763	196644	3.83	3.64
T_8	11.46	10.62	343706	320345	238093	214732	3.25	3.03
T_9	7.97	7.46	239023	229908	166110	156995	3.28	3.15
T_{10}	10.08	9.36	302524	289616	203886	190978	3.07	2.94
T_{11}	6.98	6.25	209294	177124	129561	97391	2.62	2.22
T_{12}	7.50	6.28	225100	188951	95367	59218	1.74	1.46
T_{13}	6.19	5.87	185618	169510	96285	80177	2.08	1.90
T_{14}	7.11	6.48	213252	186051	91219	64018	1.75	1.52

Conclusion

Generally integrated nutrient management favoured for better performance of okra compared to sole application of nutrients. Application of 75% of recommended dose of NPK + FYM @ 2.5 t ha^{-1} + NC @ 0.5 t ha^{-1} + VC @ 1.25 t ha^{-1} was highly favourable for higher growth, yield of okra. Increased net return and B: C ratio were associated the integrated nutrient management ie., 75% of recommended dose of NPK + FYM @ 2.5 t ha^{-1} + NC @ 0.5 t ha^{-1} + VC @ 1.25 t ha^{-1}. Hence, from the results of this experiment it is finally concluded that 75% of recommended dose of NPK + FYM @ 2.5 t ha^{-1} + NC @ 0.5 t ha^{-1} + VC @ 1.25 t ha^{-1} is highly profitable and economically viable for the cultivation of okra at Andaman Island condition.

Acknowledgements

The authors are thankful to Dr. S. Dam Roy, Director, ICAR-CIARI, Port Blair for the help rendered during the research period. We sincerely acknowledge the support of Officers and staff of Department of Agriculture, Sceintists and technical staffs of CIARI, Port Blair.

References

Acharya, C.L & Mandal, K.G (2002). Integrated plant nutrient supply in vegetable crops.pp 79-104. In: *Compendium Recent Advances in Vegetable Production Technology*. Proceeding of Winter School, 2-23 December, 2002, Indian Institute of Vegetable Reseach Varanasi(U.P).

Agarwal, A. K. (2003). Role of organic enrichers in the management of soil salinity. *Agribios* 2: 21-23.

Akande, M.O., Oluwatoyinbo, F.I., Makinde,E.A., Adepoju, A.S. & Adepoju, I.S. (2010). Response of okra to organic and inorganic fertilization. *Nature and Science*, 8(11):261-266.

Babatola, L. A. (2006). *Annal of Agricultural Sciences.*, (1): 24-29.

Bairwa, H. L., Mahawer, L. N., Shukla, A. K., Kaushik, R. A., & Sudha, A. K. (2009). Response of integrated nutrient management on yield and quality of okra(*Abelmoschus esculentus (*L.) Moench). *Indian Journal of Animal Science*.79(5): 381-384.

Bekunda, B., Sanginga, N. & Woomer, P.L. (2010). Restoring Soil Fertility in Sub-Sahara Africa. *Advances in Agronomy*, 108:184-236.

Gayatri, K. & Shyam Sunder Reddy, P. (2013). Effect of integrated nutrient management on growth and yield of okra (*Abelmoschus esculentus (*L.) Moench) cv. Arka Anamika. *Vegetable Science*. 40 (2):246-248.

Gomez, K.A. & Gomez, A. A. (1984). Statistical procedures for Agricultural Research.John Wiley and sons Publications,New York.

Iqbal, S., Khan, H.Z., Ehsanullah & Yaseen, M. (2014). Impact of level and source of compost based organic material on the productivity of autumn maize (*Zea mays* L.). *Pakistan Journal of Agricultural Sciences*, 51(1): 41-47.

Jamwal, J.S. (2005). Productivity and economics of maize (*Zea mays* L.)-wheat (*Iriticum aestivum* L.) cropping system under integrated nutrient supply system in rainfed areas of Jammu. *Indian Journal of Agronomy*, 50:110-12.

Kumar, R. P., Singh, O.N., Singh, Y., Dwivedi, S., Singh, J.P. (2009). Effect of integrated nutrient management on growth, yield, nutrient uptake and economics of french bean (*Phaseolus vulgaris*). *The Indian Journal of Agricultural Sciences*. 79(2): 56-61.

Mal, B., Mahapatra, P. Mohanty, S & Mishra, H.N (2013). Growth and yield parameters of okra(*Abelmoschus esculentus*) influenced by Diazotrophs and chemical fertilizers. *Journal of Crop and Weed*, 9(2): 109-102.

Olaniyi, J.O., Akanbi, W.B., Olaniran, O.A and Ilupeju, O.T.(2010). The Effect of organo-mineral and inorganic fertilizers on the growth, fruit yield, quality and chemical compositions of okra. *Journal of Animal & Plant Sciences*. 9, Issue 1: 1135-1140.

Patel, A.P., Tandel, Y.N., Patel, C.R., Patel, M.A., & Patel P.B. (2009).Effect on combined application of organic manures with inorganic fertilizers on growth and yield of okra cv. PARBHANI KRANTI. *Asian Journal of Horticulture*. 4(1):78-81

Ravi, S., Kempe Gowda, K. & Krishnamanohar, R. (2009). Effect of integrated nutrient management on yield and quality parameters in bhindi (*Abelmoschus esculentus (*L.) Moench) cv. Arka Anamika. *Vegetable Science*. **36** (1): 109-110.

Sabir, M., Hanafi, M.M., Aziz, T., Ahmad, H.R., Rehman, M.Z.U., Saifullah, Murtaza, G. & Hakeem, K.R. (2013). Comparative Effect of Activated Carbon, Pressmud and Poultry Manure on Immobilization and Concentration of Metals in Maize (*Zea mays*) Grown on Contaminated Soil. *International Journal of Agriculture and Biology*, 15(3):559-564.

Seren, T.H., Srikrishnah, S. & Ahamed, M.M.Z. (2010). Effect of diferent levels of inorganic fertilizers and compost as basal application on the growth and yield of onion (*Allium cepa* L.). *J. Agric. Sci.* 5(2):64-70.

Suchitra, S. and Manivannan, K. (2012). Studies on the influence of organic inputs on the growth and yield of bhendi, vegetable cowpea in various seasons. *Indian Journal of Plant Sciences,* 1(2-3):124-132.

Tripathy, P., Bhattacharya, B. & Maity, T.K. (2004). Response of okra to integrated nutrient management system. *The Orissa Journal of Horticulture*. 32(2): 14-18.

Velmurgan. A, Swarnam.T.P., Ravisankar, N. & Dam Roy, S. (2014). Prospects for organic farming Andaman and Nicobar Islands. *Journal of the Andaman Science Association* Vol. 19(2):116-125.

Vennila, C. & Jayanthi, C. (2008). Response of okra to integrated nutrient management system. *Journal of Soils and Crops*.18(1): 36-40.