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National Academy of Agricultural Science (NAAS)
Rating : 3. 03

Effect of Integrated Nutrient Management on Growth, Yield and Economics of Okra (*Abelmoschus Esculentus* (L). Moench) Under Nimar Valley conditions of Madhya Pradesh

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Abstract: *An experiment was conducted at farmers' fields in Khargone (M.P.) to assess the effect of integrated nutrient management on the growth, yield and economics of okra cv. Arka Anamika under Nimar Valley conditions of Madhya Pradesh during the Kharif seasons of 2011 and 2012 on okra cv. Arka Anamika. The experiment comprised two treatments viz. T_2 (75 % of Recommended dose of NPK @ 100: 50: 50 kg ha^{-1} + Farm Yard Manure (FYM) @ 20 t ha^{-1} + Bio-fertilizers: Azotobactor, Azospirillum and PSB (1:1:1) @ 6 kg ha^{-1}) and T_1 (100 % Recommended dose of NPK @ 100: 50: 50 kg ha^{-1}) as control. The maximum plant height (105.00 cm), plant girth (3.21 cm), number of nodes per plant (14.60) and inter nodal length (6.63 cm) with least number of days to 50 % flowering (32.40 days), days to first picking (38.60 days), maximum number of fruits per plant (17.00), maximum fruit length (17.00 cm), maximum fruit weight (16.20 g), maximum fruit yield per plant (244.00 g), maximum yield per ha (134.40q) higher gross returns of Rs 1,27,615ha^{-1} net returns Rs 92491 ha^{-1} and cost: benefit ratio (3.63) were recorded in (T_2). However the minimum growth, yield and net return were recorded in control (T_1). The study led to a conclusion, that the maximum growth parameters, highest yield and yield attributing characters of okra could be achieved by integrated use of farm yard manure, biofertilizers, and chemical fertilizers.*

Keywords: *Bio-fertilizers, FYM, Growth Parameters, Okra.*

INTRODUCTION

Okra (*Abelmoschus esculentus* (L.) Moench.) is one of the most important vegetable crops grown in almost all parts of the world. India ranks first in the world with a production of 6346.4 thousand MT from an area of 532.7 thousand ha. (2013-14). Okra is an important vegetable crop which supplies valued nutrition (carbohydrates, fats, protein, minerals and vitamins) to our diet. Owing to its short duration, growth and yield parameters are largely influenced by appropriate nutrient management practices (Singh *et al.*, 11; Suchitra and Manivannan, 12 and Iqbal *et al.*, 2). Sole application of chemical fertilizers to meet the crop nutrient demand is deleterious for both soil a well environment health (Tolessa and Friesen, 14). As the costly inputs are not within reach of the farmer at peak season. Integrated use of organic and inorganic fertilizers may improve crop productivity (Satyanarayana *et al.*, 9). Many researchers reported that the cost consumed on inorganic fertilizers can be decreased to a great extent by the application of plant nutrients through organic sources (Bekunda *et al.*, 1). This would increase nutrient use efficiency

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Table 1
Effect of integrated nutrient management on growth parameters of okra (Pooled data for 2 years).

Treatments	*Plant height (cm)*	*Stem girth (cm)*	*Number of nodes per plant*	*Inter nodal length (cm)*	*Days to 50 per cent of flowering*	*Days to first picking*
T_1 (100 % Recommended dose of NPK @ 100: 50: 50 kg ha^{-1})	91.40	2.14	11.40	8.26	36.20	43.20
T_2 (75 % of Recommended dose of NPK @ 100: 50: 50 kg ha^{-1} + Farm yard manure (FYM) @ 20 t ha^{-1} + Bio-fertilizers: *Azotobactor, Azospirillum* amd PSB (1:1:1) @ 6 kg ha^{-1})	105.00	3.21	14.60	6.63	32.40	38.60
The value of *t* 18.779421	18.173764	65.730856		5.487955	163.000	5.171145
The two-tailed P value	5.40E-05	0.00001	0.00537	0.00001	0.006647	4.70E-05

The result is significant at $p \leq 0.05$.

Significant at 5% level of significance.

and soil fertility, besides enhancing crop productivity and quality attributes of crop. Inoculation with biofertlizers (*Azospirillum* , *Azotobacter* and PSB) in okra helped fixing atmospheric N, increased phosphate availability produced growth promoting and antifungal substances and finally increased the total yield. The demand for vegetables is increasing every year; there is an ample scope for enhancing production and export of vegetables from India. Therefore present investigation is aimed at studying to the effect of integrated nutrient management on growth, yield and economics of okra (*Abelmoschus esculentus* L.) under Nimar Valley conditions of Madhya Pradesh.

MATERIALS AND METHODS

The field experiments with okra, cv. Arka Anamika was conducted for two consecutive years *i.e.* 2011 and 2012 during Kharif season on five farmers' field of village Piprata, block Kasravad, district Khargone (M.P.) of the valley which is situated between 20° 40′ and 22° 50′ North latitude and 74° 42′ and 77°20′ East longitude, where the maximum temperature ranges from 43° to 46°C during summer season and minimum temperature fluctuates between 6°C to 10°C during winter season. The average annual rainfall is 835 mm. The treatments comprised T_1 (control) (100 % Recommended dose of NPK @ 100: 50: 50 kg ha^{-1}) and T_2 (INM: 75 % of Recommended dose of NPK @ 100: 50: 50 kg ha^{-1} + Farm yard manure (FYM) @ 20 t ha^{-1} + Bio-fertilizers: *Azotobactor, Azospirillum* and PSB (1:1:1) @ 6 kg ha^{-1}) replicated at five farmers field. The source of N, P and K were urea, diammonium phosphate and muriate of potash respectively.

Fertilizers were applied in split doses during the cropping period. FYM was applied in the experiment @ 20 t ha^{-1}. The soil was inoculated with bio-fertilizers *i.e. Azotobactor, Azospirillum* and PSB (1:1:1). The recommended cultural practices of crop production and protection were followed. Ten plants were selected from each plot to record the biometric observations at various stages of crop growth. Growth parameters include plant height (cm), stem girth (cm), number nodes per plant, inter nodal length (cm), days to 50 percent of flowering, days to first picking. Post harvest observations *viz.*, number of fruits per plant, fruit length (cm), single fruit weight (g), fruit yield per plant (g), fruit yield (q/ha) and dry weight of plant(g) of the crop were recorded after harvesting. The paired "t" test was used to determine level of significance. The Least Significant difference (LSD) was worked out at the level of 5%.

RESULTS AND DISCUSSION

Growth and Yield Characters

The perusal of result indicated that (Table 1) okra plants fertilized with integrated nutrient management (FYM@20 t ha^{-1} +75% RDF + biofertilizer) gave

Table 2
Effect of integrated nutrient management on yield and yield attributing characters of okra (Pooled data for 2 years).

Treatments	*Number of fruits per plant*	*Fruit length (cm)*	*Fruit weight (g)*	*Fruit yield per plant (g)*	*Fruit yield (q ha^{-1})*	*Yield increase over control %*
T_1 (100 % Recommended dose of NPK @ 100: 50: 50 kg ha^{-1})	12.20	14.20	12.60	163.00	95.40	28.91
T_2 (75 % of Recommended dose of NPK @ 100: 50: 50 kg ha^{-1} + Farm yard manure (FYM) @ 20 t ha^{-1} + Bio-fertilizers: *Azotobactor, Azospirillum* and PSB (1:1:1) @ 6 kg ha^{-1})	17.00	17.00	16.20	244.00	134.40	
The value of *t*	8.231932	7.483315	3.88198	20.124612	13.703203	–
The two-tailed P value	0.001187	0.001705	0.017811	3.60000E-05	0.000164	–

The result is significant at $p \leq 0.05$.

Significant at 5% level of significance.

maximum plant height (105.00 cm), plant girth (3.21 cm), number of nodes per plant (14.60) and Inter nodal length (6.63 cm) with shortest span for days to 50% flowering (32.40 days) and days to first picking (38.60 days). The beneficial effect of application of organic manures along with inorganic manures reflected in enhanced vegetative growth of plant. This may be attributed to the synergistic effect of organic manures in making available more plant nutrient by improving the soil physical and chemical conditions and solubilizing the nutrients. Moreover, the organic manures are also significant sources of major and micronutrients much needed by the plants as reported by (Rafi *et al.*, 8). Comparatively less vegetative growth was recorded with T_1.

However Days to 50 per cent flowering in T_2 shows significant superiority over T_1 which may be attributed to increased photosynthetic activity and uptake of food nutrients resulting in early flowering as reported Patel *et al.* (4) in okra. The minimum number of days to 50 per cent flowering (32.40 days) was recorded in T_2 and the maximum number of days (36.20 days) was recorded in T_1. This could be due to the synergetic effect of nitrogen and other inputs like FYM and biofertilizers resulted in easily the differentiation of buds resulting in earlier flowering. Earliness in days to flowering in okra was also observed with the integrated nutrient application (chemical fertilizers, organic manures and biofertilizers) by Prabhu *et al.* (5).

Yield and Yield Attributes

Maximum number of fruits per plant (17.00), maximum fruit length (17.00 cm), maximum fruit weight (16.20 g) maximum fruit yield per plant (244.00 g) and maximum yield (134.40 q ha^{-1}) was obtained by application of INM (75 % of Recommended dose of NPK @ 100: 50: 50 kg ha^{-1} + Farm yard manure (FYM) @ 20 t ha^{-1} + Bio-fertilizers: *Azotobactor, Azospirillum* and PSB (1:1:1) @ 6 kg ha^{-1}) (T_2). However the lowest number of fruits per plant (12.20), fruit length (14.20 cm) and fruit weight (12.60 g) were recorded by control (T_1) treatment. Application of organics with inorganic sources resulted in enhanced fruit length and ultimately increased the average fruit weight of *A. esculentus* which is in agreement with findings of Thirunavukkarasu and Balaji (13) who had reported that the organic fertilizer plus NPK fertilizers had recorded higher number of fruits per plant of *A. esculentus* is due to organic manures which enhanced plant growth and development when compared to untreated controls and also it provide better nutrition to okra and attain maximum yields.

The numbers of fruits per plant, maximum fruit length and maximum fruit weight are the most important factors of fruit yield in okra which were significantly influenced by the combined application of chemical fertilizers, FYM and biofertilizer as compared to control (T_1). This might be due to the better availability and uptake of nutrients by plants for a longer duration of crop growth.

Table 3
Effect of integrated nutrient management economics of okra (Pooled data for 2 years).

Treatments	*Gross return (Rs./ha)*	*Cost of cultivation (Rs./ha)*	*Net return (Rs./ha)*	*Cost: benefit ratio*
T_1 (100 % Recommended dose of NPK @ 100: 50: 50 kg ha^{-1})	81110*	33238	47872	2.44
T_2 (75 % of Recommended dose of NPK @ 100: 50: 50 kg ha^{-1} + Farm yard manure (FYM) @ 20 t ha^{-1} + Bio-fertilizers: *Azotobactor, Azospirillum* and PSB (1:1:1) @ 6 kg ha^{-1})	127615#	35124	92491	3.63
The value of *t*	18.952213	8.104840	18.679768	16.239020
The two-tailed P value	4.60E-05	0.00126	4.80E-05	8.40E-05

The result is significant at $p \leq 0.05$.

Significant at 5% level of significance

*Average market rates of okra @ Rs 850/q for T_1.

#Average market rates of okra @ Rs 950/q for T_2

Similar findings of higher number of fruits per plant by integrated application of fertilizers have also been reported by Prabhu *et al*. (2003) in okra. The maximum yield (134.40 q ha^{-1}) was recorded in T_2 which was significantly superior to T_1 (95.40 q $ha^{-1)}$. It is evident from the experiment that the enhancement in plant growth attributes by the application of FYM @20 t ha-1, RDF as 75% of the needed requirements and the inoculation with biofertilizers reflected in the enhanced fruit yield. Similar results were reported earlier by Mal *et al*. (3). Higher yield response due to organic manures is ascribed to improvement in physical and biological properties of the soil resulting in better supply of nutrients which lead to good crop growth and yield. These results are in line with the findings of Premsekhar and Rajashree (7).

ECONOMICS

The economics of cultivation in the presented in table 3 showed that among the treatments, application of INM (75 % of Recommended dose of NPK @ 100: 50: 50 kg ha^{-1} + Farm yard manure (FYM) @ 20 t ha^{-1} + Bio-fertilizers: *Azotobactor, Azospirillum* and PSB (1:1:1) @ 6 kg ha^{-1}) (T_2) resulted in higher gross returns of Rs 1,27,615ha^{-1} net returns Rs 92491 ha^{-1} and cost: benefit ratio (3.63) as compared to (T_1). Similar findings have been reported by Sharma *et al.* (10).

CONCLUSION

The findings revealed that the application of INM (75 % of Recommended dose of NPK @ 100: 50: 50 kg ha^{-1} + Farm yard manure (FYM) @ 20 t ha^{-1} + Bio-fertilizers: *Azotobactor, Azospirillum* and PSB (1:1:1) @ 6 kg ha^{-1}) were effective and significantly improved the growth attributes and yield of okra crop *(A. esculentus)* such as plant height, stem girth, number of nodes per plant, inter nodal length, number of fruit per plant, fruit length, fruit weight, fruit yield per plant and fruit yield ha^{-1}. The amount of organics required for optimum crop production can reduce the inorganic fertilizer requirement for *A. esculentus* and also combined application of organic and inorganic fertilizers may be a sound soil fertility management strategy to get higher yield of the okra crop.

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