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RESEARCH ARTICLE

EFFECT OF INTEGRATED NUTRIENT MANAGEMENTON GROWTH AND YIELD OF OKRA

Raju Miah[a], Nusrat Jahan Methela[a,b], Roksana Aftab Ruhi[b]*

[a] Department of Agriculture, Noakhali Science and Technology University, Noakhali-3814, Bangladesh.
[b] Department of Plant Pathology, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh.
Corresponding Author Email: ruhi435@outlook.com

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ABSTRACT

This study was carried out at Subarna Agro-Based Initiative's (SABI) field, Noakhali, Bangladesh during the period of Rabi Season, 2018. The objectives of this study were to evaluate the growth and yield performances of okra in different types of organic fertilizers and to identify the possible fertilizer treatment which enhances both growth and yield of okra [*Abelmoschus esculentus* (L.) Monech] .BARI Okra-1 was taken for the study. A Randomized Complete Block Design (RCBD) was used and there were 4 treatments namely; Farm Yard Manure (T1), Vermi-Compost (T2), FYM + Vermi-Compost (T3) and Integrated Nutrient Management (T4) were replicated three times. Plant height (cm), number of leaves, total flower, total number of fruits, fruit length (cm) and fruit weight (g) data were taken as parameters on the growth and yield of the plant. Though fruit weight was observed higher for the effect of T3 (72.78 g) but in case of Integrated Nutrient Management (T4) the other characters such as plant height, number of leaves, total flowers, total number of fruits, fruit length were observed higher. The T4 showed a comparatively better result of growth and yield than other treatments. This study clearly indicated that Integrated Nutrient Management which contains the micronutrients with minimum inorganic and organic manure may be a potential source for better growth and high yield in okra.

KEYWORDS

Okra, Integrated Nutrient Management, Growth, Yield

1. INTRODUCTION

Vegetable cultivation is one of the major enterprises in horticulture which is becoming more popular due to the greater appreciation of their food values Vitamins and minerals, Okra is a vegetable crop that belongs to the genus *Abelmoschus*, family Malvaceae (Siemonsma, 1982; Gardner, 2004). It is also known in as ladies's fingers, bhindi, bamia, ochro or gumbo (Khandaker,2017). It is a very good source of dietary fiber, Mg, Mn, K, vitamin K, vitamin C. The okra seed oil is rich in unsaturated fatty acids which is essential for human nutrition. Moreover, it is beneficial on diabetes and some cancers. Okra mucilage from the immature pods was found to be suitable for industrial and medicinal applications (Badrie, 2016). In Bangladesh, vegetable production is not uniform round the year, plenty in winter but less in summer. Around 30% of total vegetables are produced during summer and 70% in winter (Hossain, 1992).

The present consumption of vegetables in Bangladesh is 112 g/day/capita (23 g leafy vegetables, 89 g non leafy vegetables), which is far below the minimum average requirement of 400 g/day/capita (FAO/WHO, 2003). Therefore, there is a big gap between the requirement and the supply of vegetables in Bangladesh. Successful okra production may contribute partially in solving vegetable scarcity in summer. Total production of okra was about 240 thousand tons from 7287.5 ha in 2009 and the average yield was about 3.38 t/ha in Bangladesh (Chowdhury et al., 2015). The requirements of fertilizers in okra are important for the early growth and total production of fruit yield. Integrated use of organic and inorganic fertilizers can improve crop productivity (Mal et al., 2013). Okra requires heavy manuring for its potential production but the use of inorganic fertilizers leads to nutrient imbalance in soil causing ill effect on soil health and therefore it is need to reduce the use of chemical fertilizers and encourage the application of organic sources to the maximum possible level.

Organic sources are inputs micro-organisms which are capable of mobilizing native elements from unusable form to usable form through biological processes (Bahadur and Manohar, 2001). Organic manures such as farmyard manure, poultry manure, vermi-compost etc. are very active and important for soil. Application of vermi-compost subsequently increases yield attributes and yield of okra (Sameera et al., 2005). Organic fertilizers are defining as those derived exclusively from decomposed or

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decomposing plant or animal remains (Buob, 2008). The present study was carried out by choosing *Abelmoschus* the main crop to study on the effect of integrated nutrient management on growth and yield of okra .Organic fertilizers used in this study are using different types of animal and plant manure such as farm yard manure, vermin-compost and combination of farm yard manure, vermin-compost and integrated nutrient management. Thus, the study was conducted to investigate which organic fertilizer is the best to be applied on okra plants that enhances both growth and yield of okra.

2. Materials and Methods

2.1 Experimental site

On the basis of this paper potentiality the research had been done in Noakhali, Bangladesh from 26th January, 2018 to 19th April, 2018 (Rabi Season).The study was conducted in the field of Subarna Agro-Based Initiative's (SABI) field near Noakhali Science and Technology University (NSTU) located in between 22'38' and 22'59' north latitudes and in between 90'54' and 91'15' east longitudes which fall under the AEZ 18 i.e. Young Meghna Estuarine Flood plain. The experimental site is indicated on the map of AEZ of Bangladesh. Noakhali has sub- tropical climate and the soil was slightly saline soil having pH 8.6. Furthermore, the average annual temperature and the annual rain fall is about 25.6 °C and 3,302 mm respectively.

Figure 1: Experimental Sites with GPS

2.2 Experimental Materials

The research material was BARI Okra-1 seed. The research material was collected from Dotterhat Seed House, Noakhali. Farmyard Manure (FYM) and Integrated Nutrient Management (INM) were collected from Subarna Agro-Based Initiatives (SABI) and Vermi- Compost was collected from Krishi Store, Dhaka.

2.3 Experimental Treatment

Table 1 showed the treatments used in the experiment included in the trial.

Table 1: Treatments with the Recommended Dose (t/ha)

Treatment No.	Fertilizers	Recommended Dose(t/ha)
T_1	FYM	11.5
T_2	Vermi-Compost	9
T_3	Farm Yard Manure + Vermi-Compost	5(2.5+2.5)
T_4	Integrated Nutrient Management (Organic+Inorganic)	2.5+NPK(40:50:30)

2.4 Experimental Design

Seeds were planted at a spacing of 35 cm × 15 cm where in per hole there were two seeds and later thinned to one seedling per stand after their germination. Each plot consisted of 4 plants with total of 4 plots in each seedbed. Overall the plants including all three beds are 48 plants with each bed consisted of 16 plants. The area of each plot was 1.75m^2. Organic fertilizers were applied 2 weeks before the planting and the inorganic fertilizer was applied 2 weeks after the planting. It was applied in both of the individual and combined applications.

2.5 Seed sowing

Two healthy seeds were dibbled 2 cm deep on 9th February, 2018 maintaining a uniform distance about 35 x 15 cm in two per pit which were later thinned out one seedling per stand after their germination. The soil was compacted over the seeds in order to provide good contact between the seed and soil particles which facilitate seed germination.

2.6 Data Collection

After sowing at 14 days (DAS) data of plant height, leaf numbers, number of flowers per plant, number of fruits per plant, per fruit weight, per fruit length to assess plant growth were taken from 4 plants/plot. Fruits were harvested at five day intervals with 8th harvesting.

2.6.1 Plant Height (cm)

Plant height was measured in centimeter (cm) with the help of measuring tape from the base to the tip of the last leave. Average plant height of all three replications were calculated.

2.6.2 Number of Leaves per Plant

This was done by counting the number of leaf on every tagged plant in the net plot. The average number of leaf was then determined.

2.6.3 Number of Flower per Plant

This includes the physical counting of all the flowers that emerged on the plants.

2.6.4 Number of Fruits per Plant

This includes the physical counting of all the fruits.

2.6.5 Per Fruit Weight (g)

This includes the weighting of all the okra fruits harvested from individual plant in together.

2.6.6 Per Fruit Length (cm)

Fruit length was measured in centimeter (cm) with the help of measuring tape from the base to the tip of fruit.

2.7 Data analysis

The experiment was arranged in Randomize Complete Block Design (RCBD) statistical methods. The collected data were subjected to Analysis of Variance (ANOVA) with Fisher's- RBD and One Sample t-Test using SPSS software (version 15.0.) to check the significant differences among treatments at 5% probability according to Gomez and Gomez (1984).

2.8 Cultural practices

2.8.1 Irrigation

Okra requires enough soil moisture for seed germination. It was maintained by pre-sowing heavy irrigation. Further irrigations were given at an interval of 6th -10th days.

2.8.2 Thinning and Hoeing

To maintain the proper plant population thinning was done at 25th days after sowing, leaving single plant per hill. Hoeing was done twice i.e. at 30th and 55th days after sowing.

2.8.3 Weeding

Regular weeding was carried out on the field in order to prevent competition and infestation of pests and diseases and also to ensure maximum growth of crops. It was carried out manually and as frequent as the weeds emerged.

2.8.4 Plant Protection Measures

To protect the crop from the attack of insect pests viz., jassids and whitefly, spray of Imidacloprid 17.5 SL (0.25%) was done after 30 days of sowing, sprays of Diamethoate 30 EC (0.03%) were done as and when needed to control fruit borers in okra crop.

2.8.5 Picking of Fruits

The fruits were picked manually when they were green tender and at marketable size. The picked fruits were weighed and subjected to other observations immediately.

3. RESULTS

3.1 Plant Height

In the figure 2, application of Integrated Nutrient Management consistently enhanced plant height throughout the period of sampling on 42 DAS and 56 DAS i.e 92.4 cm and 65.5 cm respectively but decrease at the 28DAS i.e 38.13 which was less than the Vermi-Compost and mixture of FYM+ Vermi-Compost .On the contrary, the other treatment continuesly increased in 28DAS, 42DAS and 56DAS respectively .It showed that Integrated Nutrient Management gave the highest plant height (92.4 cm) took in 56 DAS while the lowest number of plant height was recorded from Vermi-Compost treatment (17.68cm) in 28 DAS.

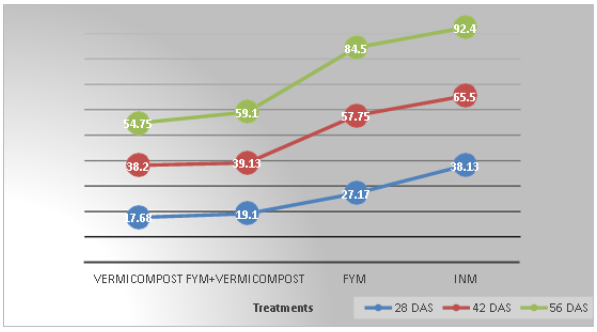

Figure 2: Effect of Treatments on Plant Height (cm)

3.2 Number of Leaves

Number of leaves were significantly differencing among the treatments at 28th to 56th DAS. Number of leaves were highest in Integrated Nutrient Management treatment, 18 at 56DAS than the other treatment at 28DAS, 42 DAS and 56 DAS respectively. It was observed thatthe highest leaf number increased as the increased of age and height of the okra plant. In the figure 3, it illustrated that the Integrated Nutrient Management treatment gave the highest number of leaves 14, 16 and 18 whereas Vermi-Compost and FYM+ Vermi-Compost both gave the lowest 8, 10 and 14 respectively. The data was enlisted in 28DAS, 42DAS and 56DAS respectively.

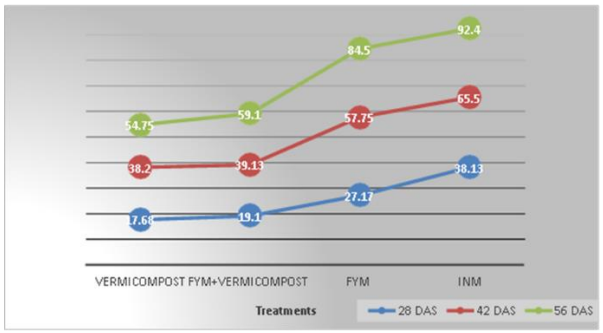

Figure 3: Effect of Treatments on Plant Leaves

Table 2: Effect of Treatments on Plant Height and No. of Leaves

Plant Height (cm)				No. of Leaves(per plant)		
Treatments	**28DAS**	**42DAS**	**56DAS**	**28DAS**	**42DAS**	**56DAS**
T1	17.68	38.2	54.75	8	10	14
T2	19.1	39.13	59.1	10	8	14
T3	27.17	57.75	84.5	11	15	16
T4	38.13	65.5	92.5	14	16	18
CV (%)	36.79	27.19	25.55	23.56	31.53	12.35

Table 2 illustrated the height and number of leaves per plant at three replications. Plant height changes it's parameter with the change of treatments as well as the time. The height of the plants increased from 28DAS to 56DAS.The maximum height was about 92.5cm at the 56 DAS which was the result of the T4 application whereas the minimum ones was 17.68 cm at the 28DAS when T1 applied alone on the plant. Furthermore, the leaves number was highest at 56DAS when T4 applied and the lowest number was recorded when T1 applied which was 8 at the 28DAS.

3.3 Fruit Weight (g)

Farm Yard Manure was significantly different from others as it gave the highest fruit weight (72.78) as compared to the Vermi-Compost which gave the lowest (71.99) Although there was no significant difference between Integrated Nutrient Management and FYM+ Vermi-Compost i.e 72.58 and 72.46 respectively which were observed in 56DAS (Fig.4)

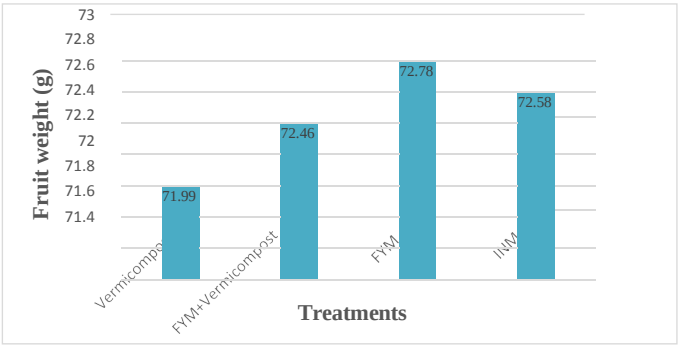

Figure 4: Effect of Treatments on Fruit Weight (g)

3.4 Fruit Length (cm)

Fruit length were statistically significant when Integrated Nutrient Management was applied. In the figure 5, it showed that Integrated Nutrient Management the highest fruit length, 14.55 cm and there was no significant difference in Vermi-Compost (13.89cm) and FYM+ Vermi-Compost (13.85) at 56 DAS.

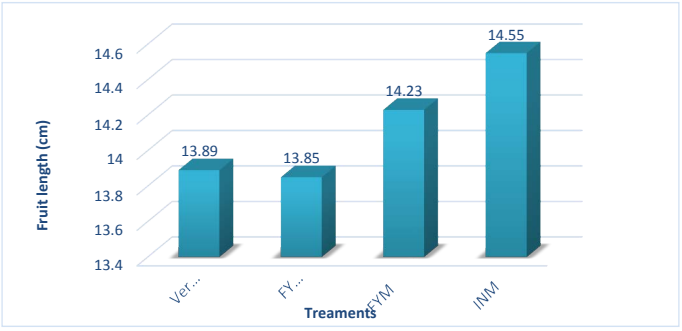

Figure 5: Effect of Treatments on Fruit Length (cm).

Table 3: Effect of Treatments on Number of Fruits, Weight, Length and Flowers per Plant

56 DAS (Mean)				
Treatments	**No. of Fruits**	**No. of Flowers (per plant)**	**Length(cm)**	**Weight(g)**
T1	30	30	13.89	71.99
T2	31	31	13.85	72.46
T3	32	32	14.23	72.78
T4	32	33	14.65	72.58
CV (%)	4.66	3.71	2.32	0.46

3.5 Number of Total Fruit

The highest number of fruit was found in Integrated Nutrient Management treatment 33 whereas Vermi-Compost gave the lowest number of fruit ,29 .Although there was no significant difference between FYM and FYM+ Vermi-Compost as they gave 32 and 31 number of fruits per plant respectively. The data were recorded at the 56 DAS in the growth. (Fig. 6).

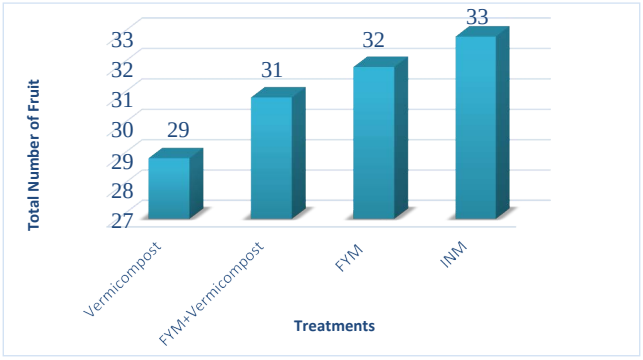

Figure 6: Effect of Treatments on Number of Total Fruit.

3.6 Total Number of Flower per Plant

Highest number of flower per plant seen in Integrated Nutrient Management was 33 and lowest in Vermi-Compost was about 30 recorded in the plants which took in 56DAS of its growth. (Fig.7).

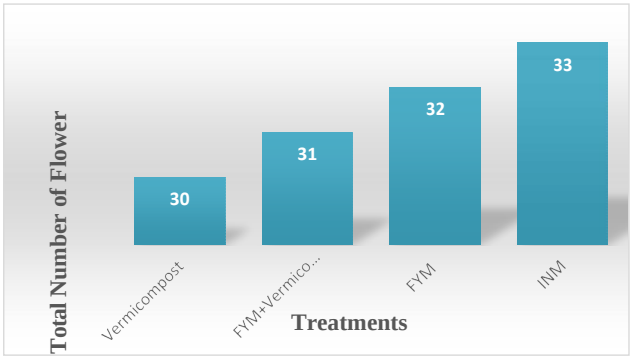

Figure 7: Effect of Treatments on Total Number of Flower per Plant

The total number of fruits and flowers per plant were recorded in the 56 DAS separately .In table 3, it showed that T3 and T4 produce equal number of fruits (32, individually) which was the highest value in the total number of fruit in all treatments. But in the case of production of flowers per plant and the length of fruits were different in all the treatments and the maximum flowers was bloomed when T4 applied on the plant which is 33 in number while themaximum length of fruits was 14.65 cm due to the application of T4. The application of T3 resulted maximum weight in fruits which is value 72.78g that was higher than the other three treatments.

4. Discussion

Fertilizer is one of the most important inputs contributing to crop production because it increases productivity and improves yield quantity and quality. Organic manures such as farmyard manure, poultry manure, vermi-compost etc. are very active and important for soil. It furnishes large portion of macro and micronutrients, protects soil against erosion, supplies the cementing substance for desirable soil aggregate formation and loosen soil. Results obtained before planting indicated that Integrated Nutrient Management had higher values of N, P, and K required for the growth of vegetable crop such as okra. The result observed that the treatments are capable of improving crop yield and that okra responded well to the Integrated Nutrient Management. Integrated Nutrient Management increased soil organic carbon and available N compared to application of all nutrients through fertilizers (Hegde, 1996).

Furthermore, application of organic manure and sowing date had a significant effect on plant height, number of leaves, number of branches and number of pods of okra plant and there were significant differences in plant height, leaves, fruits, flowers, lengths and weight values obtained from the treatment of Integrated Nutrient Management during the growing period in the study (Figures 2,3,4,5,6 and 7) (Seifu, 2016). The beneficial effect of application of organic manures along with inorganic and bio fertilizer increasing the vegetative growth and yield of plant can be attributed to the joint application of manures, bio-fertilizers and chemical fertilizers that might have acted complementary and supplementary to each other and resulted into adequate slow but steady supply of nutrients (Kumar et al., 2017). Moreover, the organic manures are also significant sources of major and micronutrients much needed by the plants as reported (Rafi et al., 2002).

Nutrients seemed more available to okra plants with the mixes than the organic materials alone. The growth and yield of okra are seem to be highest in Integrated Nutrient Management treatment and lowest in Vermi-coompost application. But when Farm Yard Manure and Vermi-compost used in together the results is far better then used them individually. Similar result found that combine use of inorganic, organic and bio- fertilizers (Integrated Nutrient Management practices) not only improved the quality of fruit and soil health, but it can also produce better vegetative growth and yield of okra (Kumar et al., 2017). Application of a mix of organic materials and inorganic fertilizers can be used to sustain okra in the tropics.

A similar trend of response had been earlier observed with other crops such as: maize; with sorghum- *Sorghum bicolor* L and with rice - *Oryza sativa* L and application of organic materials increased soil pH which is confirmed that application of organic materials could ameliorate slightly acidic tropical soil to improve crop production (Akande *et al.,*2010; Makinde *et al.,* 2001; Bayu *et al.,* 2006; Satyanarayana *et al.,* 2002) Okra fruit production was observed to be more favoured by Integrated Nutrient Management than other organic manures. Several research reported that the combinations of organic and inorganic fertilizer perform better on crop yield than when each of them is solely used. This is indicated that the Integrated Nutrient Management strategy is certainly good substitute for enhancing soil fertility and crop productivity. Moreover the overall weather conditions in the experimental region led to the proper establishment of the okra plant in regards of height, weight and number of fruits. This findings are similar to Sharma, 2011(Sharma, 2011).

5. Conclusion

From the investigation carried out so far and the results obtained from all the parameters, it indicated that Integrated Nutrient Management (Integrated Nutrient Management) gave the highest influence on growth and yield of okra. It was also observed from the study that Integrated Nutrient Management proved to be effective as a good source of fertilizer. A comparable level of productivity can be achieved with a lowered level of inorganic fertilizer combined with manures or Integrated Nutrient Management strategy. Based on the findings of this study, it may be recommended that organic manures can be used to provide nutrition to

okra and attain yields that generally are comparable to that obtained with Integrated Nutrient Management. A comparable level of productivity can be achieved with a lowered level of inorganic fertilizer combined with manures or Integrated Nutrient Management strategy.

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