EFFECTS OF ORGANIC MANURES AND NPK ON GROWTH AND PROTEIN CONTENT OF OKRA (*Abelmoschus esculentus* L. Moench)

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Abstract

Effects of organic manures and NPK fertilizers on okra (*Abelmoschus esculentus* L. Moench) plants were evaluated in the net house of the Department of Soil, Water and Environment, University of Dhaka. The experiment was conducted in a randomized design replicated thrice with eighteen treatments involving eight organic manures along with NPK and without NPK fertilizers. Growth parameters *viz.* plant height, leaf number, leaf area and dry weight of root, stem, leaf and fruits were assessed. The highest height (132.5 cm), leaf number (21.5) and leaf area (412.09 cm^2) were found in T9: Shebok 10 ton ha^{-1} treatment. The highest dry weight of a plant (40.6 g), number of fruits per plant (8) and dry weight of fruit per plant (3.71 g) were found in T_{11}:$N_{30}P_{18}K_{25}$ kg ha^{-1} plus ACI 5 ton ha^{-1} treatment. Maximum protein (25.37%) was achieved in T_{11}, phosphorous (0.481 mg kg^{-1}) in T14 and potassium (4.50 mg kg^{-1}) in T_{13} treatment. Results varied significantly ($p \leq 0.5$). The overall best growth performance and protein content was observed in T_9:Shebok 10 ton ha^{-1} and T_{11}:$N_{30}P_{18}K_{25}$ kg ha^{-1} plus ACI 5 ton ha^{-1} treatment, respectively.

***Key words*:** Growth and yield; Okra; Organic manures; Protein.

INTRODUCTION

Okra (*Abelmoschus esculentus* L. Moench) originated in Asia and Africa (Thomson and Kelly 1979) is an important nutritious most popular vegetable crop in Bangladesh. Green fruits are rich sources of vitamins, calcium, potassium and other minerals (Moniruzzaman *et al*. 2007). It is cultivated all over Bangladesh but its average yield is poor. Growth, yield and quality of okra are largely influenced by the application of fertilizers. It requires proper and sufficient N and K for regular fruiting and subsequent pickings. Recent developments in intensive agriculture, though contributed immensely towards surplus food, caused degradation of fertile land and left residues in food products. Thus, there is increasing awareness throughout the world about the organic, sustainable agricultural practice (Premsekhar and Rajashree 2009). Use of organic manures to meet the nutrient requirement of crop would be an inevitable practice in the years to come for sustainable agriculture since, organic manures generally improve the soil physical, chemical and biological properties along with conserving the moisture holding capacity of soil and thus resulting in enhanced crop productivity along with maintaining the quality of crop produce (Maheswarappa *et al*. 1999).The organic matter content of Bangladesh soils is poor and generally deficient in N. Although P and K deficiencies are not severe, addition of these two nutrients is a must for getting higher yield (Moslemuddin *et al.* 1997). In Bangladesh, a number of organic manure manufacturing company products are available in the market and farmers are using them for sustainable agriculture. But the quality of these organic manures should be assessed in relation to crop production to save our land resources.

The improvement of crop yield and production of this vegetable crop through nutrient management is most desirable and important to mitigate the present and future demand. So, the present study was undertaken to evaluate the effect of organic manures as well as chemical fertilizers (NPK) on the growth, yield and protein content of okra.

METERIAL AND METHODS

Soil sample (0 to 15 cm depth) was collected from Bhulta, Rupganj upazila, Narayanganj under Dhaka division. Soil was air-dried, ground and sieved through 2 mm sieve and kept in polyethylene bags for analysis. The soil had a pH of 6.49 (soil and distilled water ratio 1: 2.5), organic matter 0.56% (Walkley and Black 1934), available N 21 mg kg^{-1} (Marr and Cresser 1983) and available P 5.8 mg kg^{-1} (Murphy and Riley 1962).

A pot experiment was carried out in the net house of the Department of Soil, Water and Environment, University of Dhaka. Five kilograms of soil was taken per earthen pot (22.5 cm diameter × 18 cm depth). Pots were arranged in a completely randomized design. Eighteen treatments with three replicates were:

T_1: Control (-OM & -NPK)
T_2: ACI 10 ton ha^{-1}
T_3: FDAVc10 ton ha^{-1}
T_4: Green life 10 ton ha^{-1}
T_5: Kazi10 ton ha^{-1}
T_6: GTS 10 ton ha^{-1}
T_7: Majim 10 ton ha^{-1}
T_8: Shufola 10 ton ha^{-1}
T_9: Shebok 10 ton ha^{-1}
T_{10}: RD $N_{60}P_{36}K_{50}$ kg ha^{-1}(100%)
T_{11}:$N_{30}P_{18}K_{25}$ kg ha^{-1} (50%) + ACI 5 ton ha^{-1}
T_{12}: $N_{30}P_{18}K_{25}$ kg ha^{-1}(50%) + FDAVc 5 ton ha^{-1}
T_{13}: $N_{30}P_{18}K_{25}$kg ha^{-1}(50%) + Green life 5 ton ha^{-1}
T_{14}: $N_{30}P_{18}K_{25}$ kg ha^{-1}(50%) + Kazi 5 ton ha^{-1}
T_{15}: $N_{30}P_{18}K_{25}$ kg ha^{-1}(50%) + GTS 5 ton ha^{-1}
T_{16}: $N_{30}P_{18}K_{25}$ kg ha^{-1}(50%) + Majim 5 ton ha^{-1}
T_{17}: $N_{30}P_{18}K_{25}$ kg ha^{-1}(50%) + Shufola 5 ton ha^{-1} and
T_{18}:$N_{30}P_{18}K_{25}$kg ha^{-1}(50%) + Shebok 5 ton ha^{-1}

Eight types of organic manures and NPK fertilizers (Urea, TSP and MoP) were collected from the local market. The manures were ACI, FDAVc, Green Life, Kazi, GTS, Majim, Shufola and Shebok. Manures were mixed thoroughly at the rates of 10 and 5 ton ha^{-1}. Recommended dose (RD) of NPK (60:36:50) kg ha^{-1} and half of RD of NPK (30: 18: 25) kg ha^{-1} were applied with half dose of organic manures.

Two seeds were sown per pot and finally a seedling was allowed to grow. Water was applied daily in the morning. The range of temperature, humidity and rainfall were 24° to 33°C, 60 to 73% and 80 to 156 mm, during the experiment, respectively. Height was measured from the soil level to the tip of the leaf and leaf number was counted with the help of a tally counter at 40 days interval but the values are presented in Table 1 at harvest time only. Organic manures and chemical fertilizers were applied to the pots two days before seed sowing. Weeding was done as and when needed. Insecticide was applied two times.

Four months (120d) old plants were harvested as root, stem, leaf and fruit. Samples were washed with tap water and finally with distilled water, wrapped with soft tissue paper, then air-dried in the room temperature for ten days, and finally oven-dried at 65°C for 48 hours. Samples were ground with a mechanical grinder and stored in paper bags for chemical analysis. The concentration of N in fruits was determined by micro- Kjeldahl steam distillation method (Cresser and Parsons 1979). For the

concentration of P and K, 0.5 g fruit sample was digested following the method of Shelton and Harper (1941). Phosphorus was determined by vanadomolybdo phosphoric yellow colour method at 430 nm using spectrophotometer (model DR 5000) and potassium by using JENWAY flame photometer (model PFP 7). Protein content in fruit was determined by the method of Magomya *et al.* (2014).

*Statistical analysis***:** Results were statistically analyzed using Microsoft Excel 2007 and Software Minitab 19.

RESULTS AND DISCUSSION

Growth

The highest plant height (132.5 cm) was observed in T_9: Shebok 10 ton ha^{-1} treatment (Table 1). But a spectacular height was observed in treatments T_{18}: $N_{30}P_{18}K_{25}$ kg ha^{-1} plus Shebok 5 ton ha^{-1} (120cm) and T_3: FDAVc 10 ton ha^{-1} (119 cm). The lowest height was found in treatment T_{17}: $N_{30}P_{18}K_{25}$ kg ha^{-1} plus Shufola 5 ton ha^{-1} (57 cm). The application of different organic manures showed a significant increase in plant height and number of fruits $plant^{-1}$ of chilli (Dileep 2005).

Table 1. Effects of organic manures and NPK fertilizers on height, number of leaf, leaf area and dry weight of okra plants at harvest.

Treatments	Plant height (cm)	Leaf number $plant^{-1}$	Leaf area (Cm^2plant^{-1})	Dry weight of plant (g $plant^{-1}$) (Root+ stem + leaf)
T_1: Control (-OM &-NPK)	81.0^{bcd}	12.0^{cde}	292.13^{g}	22.8^{cde}
T_2: ACI 10 ton ha^{-1}	80.5^{bcde}	10.0^{de}	179.38^{h}	19.1cdefg
T_3: FDAVc 10 ton ha^{-1}	119.0^{hi}	11.0^{cde}	253.50^{a}	15.7^{efg}
T_4: Green life 10 ton ha^{-1}	74.5^{hi}	2.0^{cde}	229.50^{f}	30.2^{abc}
T_5: Kazi 10 ton ha^{-1}	70.5^{fghi}	8.0^{e}	166.50^{ij}	10.7^{fg}
T_6: GTS 10 ton ha^{-1}	57.5^{efgh}	10.5^{de}	128.70^{k}	8.3^{g}
T_7: Majim 10 ton ha^{-1}	93.0^{bcd}	8.5^{e}	248.62^{e}	15.7^{efg}
T_8: Shufola 10 ton ha^{-1}	82.1^{bc}	11.0^{cde}	193.14^{g}	23.1bcde
T_9: Shebok 10 ton ha^{-1}	132.5^{bcde}	21.5^{a}	412.09^{a}	34.9^{ab}
T_{10}: RD $N_{60}P_{36}K_{50}$ kg ha^{-1} (100%)	127.0^{b}	18.0^{ab}	319.69^{b}	28.0^{bcd}
T_{11}: $N_{30}P_{18}K_{25}$ kg ha^{-1} (50%) + ACI 5 ton ha^{-1}	111.5^{b}	18.0^{ab}	282.75^{c}	40.6^{a}
T_{12}: $N_{30}P_{18}K_{25}$ kg ha^{-1} (50%) + FDAVc 5 ton ha^{-1}	92.5^{cdef}	15.0^{bcd}	225.00^{f}	27.9^{bcd}
T_{13}: $N_{30}P_{18}K_{25}$kg ha^{-1} (50%) + Green life 5 ton ha^{-1}	66.5^{defg}	10.0^{de}	161.44^{j}	12.9^{efg}
T_{14}: $N_{30}P_{18}K_{25}$ $kgha^{-1}$(50%)+ Kazi 5 ton ha^{-1}	80.6^{bcde}	12.5^{bcde}	171.10^{f}	9.6^{g}
T_{15}: $N_{30}P_{18}K_{25}$ kg ha^{-1} (50%) +GTS 5 ton ha^{-1}	62.0^{ghi}	12.0^{cde}	98.60^{m}	16.8defg
T_{16}: $N_{30}P_{18}K_{25}$ kg ha^{-1} (50%) +Majim 5 ton ha^{-1}	105.0^{a}	15.5^{bcd}	225.00^{f}	20.0cdefg
T_{17}:$N_{30}P_{18}K_{25}$ kg ha^{-1} (50%) +Shufola 5 ton ha^{-1}	57.0^{i}	9.0^{e}	121.13^{i}	31.3cdef
T_{18}:$N_{30}P_{18}K_{25}$ kg ha^{-1} (50%) + Shebok 5 ton ha^{-1}	120.0^{bc}	16.5^{abc}	275.00^{d}	14.6^{efg}

^{abcdefghi} Data bearing different superscripts within the same column differ significantly at 5% level

The highest value of leaf number (21.5) was recorded in treatment T_9: Shebok 10 tonha^{-1}. Leaf numbers at 40, 80 and 120 days increased significantly ($p \leq 0.5$). The minimum values of leaf numbers were observed in T_5:Kazi 10 ton ha^{-1} (8 no. plant^{-1}) treatment. But a spectacular increase was observed in T_{18}: $N_{30}P_{18}K_{25}$kgha^{-1} plus Shebok 5 tonha^{-1} (18 no. plant^{-1}) and T_{10}: $N_{60}P_{36}K_{50}$ kgha^{-1} (18 no. plant^{-1}) treatments (Table 1).

The leaf area increased up to 120 days. The highest values were recorded in treatment T_9: Shebok 10 ton ha^{-1} (412.09 cm^2 plant^{-1}). Leaf area at 40, 80 and 120 days varied significantly ($p \leq 0.5$). The minimum value of leaf area was observed in the T_{15}:$N_{30}P_{18}K_{25}$ kg ha^{-1} plus GTS 5 ton ha^{-1} (98.6 cm^2 plant^{-1}) treatment. But a spectacular value was observed in T_{10}:$N_{60}P_{36}K_{50}$ kg ha^{-1} (319.69 cm^2 plant^{-1}) and T_{11}:$N_{30}P_{18}K_{25}$ kg ha^{-1} plus ACI 5 ton ha^{-1} (282.75 cm^2 plant^{-1}) treatments (Table 1). Probably higher yield response in organics occurred due to improvement in physical, chemical and biological properties of soil which led to good crop growth and yield in comparison to 100% NPK treatment.

Dry weight of root, stem and leaf per plant is presented in Table 1. The highest total dry weight of a plant was found in T_{11}:$N_{30}P_{18}K_{25}$ kg ha^{-1} plus ACI 5 ton ha^{-1} (40.6 g plant^{-1}) treatment. Akhtar *et al*. (2015) concluded that 30 kgNha^{-1} can be used for better growth of okra.

Table 2. Effects of organic manures and NPK fertilizers on yields, protein, phosphorous and potassium content in okra fruits.

Treatment	No. of Fruits plant^{-1}	Dry weight of fruits (gplant^{-1})	Protein (%)	Phosphorus (mgkg^{-1})	Potassium (mgkg^{-1})
T_1: Control (-OM &-NPK)	3^{abc}	1.02^{efg}	18.56^{def}	0.295^{hi}	4.20^{abc}
T_2: ACI 10 ton ha^{-1}	1^{c}	0.49^{g}	19.68^{cde}	0.369^{g}	3.70^{cdef}
T_3: FDAVc 10 ton ha^{-1}	3^{abc}	1.57^{defg}	21.25^{c}	0.329^{h}	3.00^{hi}
T_4: Green life 10 ton ha^{-1}	1^{c}	0.43^{g}	19.75^{cde}	0.391^{i}	3.00^{hi}
T_5: Kazi 10 ton ha^{-1}	2^{bc}	1.96^{bcdefg}	18.50^{ef}	0.376^{g}	3.30^{efghi}
T_6: GTS 10 ton ha^{-1}	1^{c}	3.71^{ab}	20.25^{cde}	0.317^{hi}	3.10^{ghi}
T_7: Majim 10 ton ha^{-1}	3^{abc}	3.25^{bcd}	20.63^{cd}	0.406^{def}	3.20^{fghi}
T_8: Shufola 10 ton ha^{-1}	1^{c}	1.69^{abcd}	19.81^{cde}	0.426^{c}	3.30^{efghi}
T_9: Shebok 10 ton ha^{-1}	7^{ab}	1.95^{bcdefg}	20.83^{cd}	0.415^{cde}	3.30^{efghi}
T_{10}: RD $N_{60}P_{36}K_{50}$ kg ha^{-1} (100%)	5^{abc}	1.96^{bcdefg}	21.63^{c}	0.403^{def}	3.50^{defgh}
T_{11}: $N_{30}P_{18}K_{25}$ kg ha^{-1} (50%) + ACI 5 ton ha^{-1}	8^{a}	4.06^{a}	25.37^{b}	0.394^{f}	3.60^{defg}
T_{12}: $N_{30}P_{18}K_{25}$ kg ha^{-1} (50%) + FDAVc 5 ton ha^{-1}	3^{abc}	1.88^{bcdefg}	17.50^{f}	0.317^{hi}	3.90^{bcd}
T_{13}: $N_{30}P_{18}K_{25}$kg ha^{-1} (50%) + Green life 5 ton ha^{-1}	3^{abc}	$2.25^{abcdefg}$	21.50c	0.374^{g}	4.50^{a}
T_{14}: $N_{30}P_{18}K_{25}$ kgha^{-1}(50%)+ Kazi 5 ton ha^{-1}	2^{bc}	0.61^{fg}	20.31^{cde}	0.481^{a}	3.40^{defgh}
T_{15}: $N_{30}P_{18}K_{25}$ kg ha^{-1} (50%) + GTS 5 ton ha^{-1}	2^{bc}	3.58^{abc}	24.68^{a}	0.452b	2.80^{i}
T_{16}: $N_{30}P_{18}K_{25}$ kg ha^{-1} (50%) +Majim 5 ton ha^{-1}	2^{bc}	0.99^{efg}	20.56^{cde}	0.406^{def}	3.40^{defgh}
T_{17}:$N_{30}P_{18}K_{25}$ kg ha^{-1} (50%) +Shufola 5 ton ha^{-1}	3^{abc}	2.48^{abcdef}	20.06^{cde}	0.416^{cd}	4.40^{ab}
T_{18}:$N_{30}P_{18}K_{25}$ kg ha^{-1} (50%) + Shebok 5 ton ha^{-1}	6^{abc}	2.73^{abcde}	23.75^{b}	0.401^{ef}	3.80^{cde}

^{abcdefghi} Data bearing different superscripts within the same column differ significantly at 5% level

Protein content in fruits

The highest productivity (8 fruits plant^{-1}, 4.06 g dry weight of fruit plant^{-1}, and protein content 25.37%) was achieved in T_{11}:$N_{30}P_{18}K_{25}$ kg ha^{-1} plus ACI 5 ton ha^{-1} treatment. The highest nutrient value of P (0.481 mg kg^{-1}) and K (4.50 mg kg^{-1}) in fruits was observed in T_{14} and T_{13} treatments, respectively (Table 2). Flowering started at 34 days after sowing. The combined application of NPK and organic manures produced highest number of okra fruits and protein might be due to presence of growth promoting substances like enzymes and hormones in organic manures. Magomya *et al.* (2014) collected ten different plant samples from wild and farm land of Nigeria *viz. Hibiscus canabinus, Haematostaphis barteri, Sesamum indicum, Balanites aegyptiaca, Cassia tora, Celtisin tegrifolia, Anonas En galensiss, Ceiba pentandra, Ficus ingens* and *Solanum melongena* the protein of which ranged from 2.63- 18.59%.

Islam *et al.* (2020) reported that the highest protein content (24.61%) was obtained in spinach in the treatment $VC_{15\ ton\ ha\text{-}1}$ $P_{10kgha\text{-}1}K_{20kgha\text{-}1}$.

Results revealed that among the different organic manures and addition of NPK fertilizers, responded well to T_9:Shebok 10 ton ha–1 and T_{11}:$N_{30}P_{18}K_{25}$ kg ha^{-1} plus ACI 5 ton ha^{-1} treatment on the growth, yield and protein content of okra.

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