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Effects of household wastes and poultry manures on growth and yield performance of okra

Rafiqul Alam Khan[1], A. J. M. Sirajul Karim[2], Md. Rafiqul Islam[1], Md. Abdul Aziz[1], Sayed Nasir Uddin[1]

[1]Department of Agricultural Extension, Ministry of Agriculture, Dhaka, Bangladesh
[2]Department of Soil Science, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur-1706, Bangladesh

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***Corresponding Author**

RA Khan

dr.rafiquedae@gmail.com

ABSTRACT

A series of field and lab experiments were conducted to study the effect of different aged poultry manures and household wastes on growth parameters of okra in a Shallow Red-Brown Terrace Soil under Modhupur Tract (AEZ-28). The experiment was laid out in a randomized complete block design having three replications with thirteen treatments viz. T_1: Recommended dose of chemical fertilizers T_2: 30 days aged HWN_{25} + urea N_{75}, T_3: 30 days aged HWN_{50} + urea N_{50}, T_4: 30 days aged HWN_{75} + urea N_{25}, T_5: 60 days aged HWN_{25} + urea N_{75}, T_6: 60 days aged HWN_{50} + urea N_{50}, T_7: 60 days aged HWN_{75} + urea N_{25}, T_8: 30 days aged PMN_{25} + urea N_{75}, T_9: 30 days aged PMN_{50} + urea N_{50}, T_{10}: 30 days aged PMN_{75} + urea N_{25}, T_{11}: 60 days aged PMN_{25} + urea N_{75}, T_{12}: 60 days aged PMN_{50} + urea N_{50} and T_{13}: 60 days aged PMN_{75} + urea N_{25}. Results showed that best performance were obtained with 60 PMN_{50} + urea N_{50} treatment i.e. 50% N amendment from poultry manure of recommended dose in plant height at initial and final harvesting, average root length and weight, dry matter production, green fruit size and weight, individual green fruit weight, number of fruits plant^{-1}, fruit yield plant^{-1} and fruit yield. The treatments which received poultry manure decomposed for 60 days as supplementation of recipral amount of urea performed better than those of the treatments receiving household wastes along with urea N in proportion. The plants grew to the maximum of 30.25 cm, 42.87 cm and 54.5 cm at 30, 45 and 60 days after transplanting, respectively from the treatment of 60 PMN_{50} + urea N_{50} and the shortest plant appeared to be of 23.8 cm, 33.71 cm and 42.61 recorded at the same periods of 30, 45 and 60 days after transplanting, respectively under the treatment of recommended dose of nitrogen as urea only (control treatment). Plant height at final harvest ranged from 70.75 cm to 91.45 cm where the maximum height was recorded from 60 PMN_{50} + urea N_{50}. The shortest plants were noted from recommended dose of urea nitrogen treatment. Among the treatments of organic manures decomposed for different durations and in supplement with differential amount of recommended dose of nitrogen as urea 60 PMN_{50} + urea N_{50} produced the maximum branches of okra (3.63). The same result was also found from 60 PMN_{75} + urea N_{25} and these were followed by the treatment of 60 HWN_{50} + urea N_{50}.The average root length and root weight of all the treatments were higher than those in control treatment. The longest root (21.36 cm) was noted in the treatment of 60 PMN_{50} + urea N_{50}. The highest fruit length and fruit weight were 12.84 cm and 13.65 g respectively in the same treatment of 60 PMN_{50} + urea N_{50} which were identical to the treatment of 60 PMN_{75} + urea N_{25} (12.75 cm and 13.65 g). Maximum number of fruits plant^{-1} of okra (26.88), the highest yield plant^{-1} (367.1 g) and the maximum yield of okra (14.71 t ha^{-1}) were also recorded from the same (60 PMN_{50} + urea N_{50}). The minimum number of fruits plant^{-1} (17.66), the lowest yield plant^{-1} and the lowest yield (155.01 g and 10.45 t ha^{-1}) were found from control treatment. It was revealed from the results that poultry manure was superior to household wastes in terms of growth and yield of okra plant.

INTRODUCTION

Okra (*Abelmoschus esculentus* L. Moench) is a popular vegetable grown round the year in Bangladesh. It is a nutritious vegetable and plays an important role to meet the demand of vegetables in the country during the crisis period in early summer (Ahmed, 1995). The green fruits of okra are rich sources of vitamins, calcium, potassium and other minerals. Its every 100 g pod contains 1.8 g protein, 6.4 g carbohydrate, 1.2 g fibre, 18 mg vitamin C and 90 mg calcium

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(Rashid, 1999). Calcium, phosphorus and iron are the important minerals which are lacking in cereals but are available in abundant quantities in vegetable like okra (Bose and Som, 1990). The fruits also have some medicinal value and a mucilaginous preparation from the fruit can be used as plasma replacement or blood volume expander (Savello et al., 1980).

Vegetables are considered as a cheaper source of natural supplementary food. In Bangladesh vegetable production and supply is not uniform round the year. Of the total vegetable production in Bangladesh around 30% is produced during kharif season and around 70% is produced in rabi season (Anonymous, 1983). So, there is always scarce of vegetables during the summer season. Okra is grown here both in kharif and in rabi seasons. Although the yield of okra duirng kharif season is less than that in the rabi season due to the pest infestation influenced by the climate (Chattapadhyay, 1983), it creates positive impact on total vegetable supply in the market round the year.

About 26,180 metric tons of okra is produced from 7595 hectare of land with an average yield of 3.94 t/ha in Bangladesh, which is very poor, (BBS, 2009)) compared to that of our neighbouring country like India (6.12 t/ha) and other developing countries (7.12t/ha) of the world (Yamaguchi, 1998). Due to low yield per unit area, the total production of vegetables in our country is low which lead to the poor consumption, only 30 g/day/person as against 42 g in Nepal, 69 g in Pakistan, 120 g in Srilanka and 135 g in India. Daily requirement of vegetables for an adult person is 285 g (Rampal and Gill, 1990). So, to meet up our daily vegetable requirements as well as the shortage of vegetable production, okra has the potentiality to meet crisis to some extent. There are various reasons behind the low yield of okra of which imbalanced fertilizer application is of prime importance. Okra requires proper and sufficient fertilizations to provide regular fruiting and subsequent pickings (Mitra et al., 1990).

In the recent years poultry farms of the different sizes have been established all over the country. Poultry farm holders use concentrated feeds to feed their poultry birds suggesting that poultry excreta are rich in nutrients. As the poultry excreta are not used as fuel, these can be the good source of nutrients for field crops. Many reports showed that poultry manure is the source of N, P and K that can improve soil fertility (Reddy et al., 2005, Sreelatha et al., 2006). Govindasamy et al. (1994) observed that the use of poultry litter was more economical at high target yields of rice than at low target yields. Tanahashi and Yano (2004) reported that the requirement of phosphorus and potassium fertilizers is lower than recommended dose, when the crop fields were examined with poultry litter. Miah et al. (2006) stated that an application of poultry manure with soil test basis (STB), IPNS and AEZ based fertilizer gave higher grain yield compared to other organic materials. In Ghana, Ofosu-Anim and Leitch (2009) reported an increase in total dry weight of leaf, stem, root and head of barley by applying chicken manure. To our knowledge, little information is available on use of poultry manure as a potential source of organic fertilizer for okra production in Bangladesh.

Household wastes are the products of homestead, which is not widely practiced in crop production due to lack of sufficient information regarding this. Mixture of wastes materials especially kitchen wastes, dining wastes, domestic refuses, residues from food processing are used as components of compost. The compost from domestic wastes possesses a high nutritional value, with high concentration of nitrogen, potassium and phosphorus; improve soil physical and biological properties, while the contamination by heavy metals and other toxic substances is negligible (Hogland et al., 2003).

Household wastes and poultry manure are considered as rich source of organic matter and plant nutrients. It represents a management strategy that could counteract depletion of organic matter in soils. Besides, organic residues recycling and further use in soils represents an attempt to alleviate the serious environmental problems caused by residue accumulation (Marcotea et al., 2001; Tejada and Gonzalez, 2003). These materials if processed for recycling can generate a substantial amount of organic manure especially for horticultural soil fertility replenishment. Sustainable production of crops cannot be maintained by using chemical fertilizers alone or only by organic manures. It is necessary to use fertilizer and manure in an integrated way in order to obtain sustainable crop yield without affecting soil fertility. Sufficient research has not yet been carried out in the country regarding the available macronutrient release from household wastes and poultry manure and its effect on okra yield. The use of household wastes and poultry litter and their proper management can help to reduce the need for chemical fertilizer use. Therefore, keeping all these facts in mind the present study was undertaken to evaluate the growth and yield of okra as influenced by household wastes and poultry manure

MATERIALS AND METHODS

Experimental site

The experimental site was located at the research farm of Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur. It is situated at the center of the Agro-ecologocal Zone (AEZ) of Madhupur Tract (AEZ-28), about 24.23° north latitude and 90.08° east longitude having a mean elevation of 8.4 meter above the mean sea level (Anonymous, 1989).

Climate and weather conditions

The experimental plot belongs to the climatic condition which is tropical monsoon and characterized by three distinct seasons: early *Kharif*, *Kharif* and *Rabi* (Ahsan and Karim, 1988). The early Kharif season (the end of March to May) is essentially the hot spring or pre-monsoon season with moderate humidity, highest temperature and evaporation rate. About 20% of the annual rainfall (1100 mm per year) occurs with the maximum average temperature of 30^0C in early *Kharif*. The *Kharif* season covering the period from June to September, characterized by low solar radiation and high humidity. About 80% of the total rainfall occurs in this season. The third one is the Rabi season (mid-October to early March) have cool dry winter with low humidity and minimum or no rainfall. This season is favourable for growing a wide variety of crops (Anonymous, 2010).

Soil

The soil of the experimental field belongs to Salna series representing the Shallow Red Brown Terrace soil in Bangladesh soil classification system which falls under Inceptisols in Soil Taxonomy (Brammer, 1980 and FAO, 1988). The soil is characterized by heavy clays within 50 cm from the surface and is acidic in nature. The soil is silty clay loam in texture and has poor physical properties.

Collection and preparation of household waste and poultry litter compost

Fresh poultry litter and fresh household wastes (one day after dropping) were collected from two selected days and allowed for natural decomposition. Household wastes were collected from BSMRAU campus and poultry litter from a commercial poultry farm, which was situated at Salna near BSMRAU campus. After collecting the household wastes, the raw materials viz. non-edible food, vegetables and fruit parts, after-meal wastes, after sweep wastes, ash etc. were separated from the remaining part of non-decomposable wastes like polyethylene bags or sheets, rubbers, plastics, sponges, glass and ceramic pots and their broken parts, aluminium sheets, iron, tins etc. Then the raw materials of household wastes were mixed well.

The poultry litter was also mixed thoroughly in order to prepare compost following the "Pit method" of composting (Rao, 1999). In BSMRAU farm four 1 cubic meter earthen pits were dug under shade condition. The shade was made by bamboo and polythene sheet to protect the pits material from rainfall and heavy sunshine. The collected household wastes and poultry litter were first hipped into two pits for 60 days decomposition. After 30 days the rest two pits were hipped by fresh poultry litter and household waste for 30 days decomposition.

The pits were opened and turned thoroughly after two weeks to facilitate uniform decomposition. After decomposition samples were collected from every pit for determination of the moisture content and nutrient status in the laboratory (Table 1).

Table 1
Nutrient status of household wastes and poultry manure after 30 and 60 days of decomposition.

Sample	Nutrient content (oven dry basis)				
	Moisture (%)	N (%)	P (%)	K (%)	S (%)
Household waste (30 days)	65.00	1.21	0.21	0.48	0.18
Household waste (60 days)	40.00	1.40	0.6	1.25	0.20
Poultry litter (30 days)	52.70	1.56	0.79	0.25	0.44
Poultry litter (60 days)	35.58	1.61	1.09	0.9	0.58

The experiment was laid out in a Randomized Complete Block Design (RCBD) with 3 replications having 13 treatments. The experimental area was divided into 3 blocks representing replications to reduce heterogeneous effects of soil. Each block consisted of 13 plots and the unit plot size was 2.8 m x 2.0 m (5.6 m^2) having plot to plot and block to block distances 0.75 m and 1.0 m, respectively. The treatments were randomly allotted in each block. Okra seeds were sown in lines having row to row and plant to plant spacing of 50 cm and 35 cm, respectively (Anonymous, 1992) accommodating 28 plants in each plot.

Design and layout of the experiment

Treatment combination and fertilizer rate

The treatments comprised of organic and inorganic sources of nutrients to supply 100% of recommended dose of N, P, K and S as per BARC Fertilizer Recommendation Guide, 2005. The organic sources included the household wastes and poultry manures decomposed during 30 and 60 days. The treatments used in the experiments were as follows:

Treatments			Description
T_1	:	Control	100% of recommended dose of N applied from urea (Urea N_{100})
T_2	:	30 HWN_{25} + Urea N_{75}	25% of recommended dose of N from 30 days aged household wastes + the rest of 75% of N from urea
T_3	:	30 HWN_{50} + Urea N_{50}	50% of recommended dose of N from 30 days aged household wastes + the remaining 50% of N from urea
T_4	:	30 HWN_{75} + Urea N_{25}	75% of recommended dose of N from 30 days aged household wastes + the rest 25% of N from urea
T_5	:	60 HWN_{25} + Urea N_{75}	25% of recommended dose of N from 60 days aged household wastes + the remaining 75% of N from urea
T_6	:	60 HWN_{50} + Urea N_{50}	50% of recommended dose of N from 60 days aged household wastes + the rest 50% of N from urea
T_7	:	60 HWN_{75} + Urea N_{25}	75% of recommended dose of N from 60 days aged household wastes + the rest 25% of N from urea
T_8	:	30 PMN_{25} + Urea N_{75}	25% of recommended dose of N from 30 days aged poultry manure + the rest 75% of N from urea
T_9	:	30 PMN_{50} + Urea N_{50}	50% of recommended dose of N as 30 days aged poultry manure + the rest 50% of N from urea
T_{10}	:	30 PMN_{75} + Urea N_{25}	75% of recommended dose of N from 30 days aged poultry manure + the rest 25% of N from urea
T_{11}	:	60 PMN_{25} + Urea N_{75}	25% of recommended dose of N from 60 days aged poultry manure + the rest 75% of N from urea
T_{12}	:	60 PMN_{50} + Urea N_{50}	50% of recommended dose of N from 60 days aged poultry manure + the rest 50% of N from urea
T_{13}	:	60 PMN_{75} + Urea N_{25}	75% of recommended dose of N from 60 days aged poultry manure + the rest 25% of N from urea

A blanket dose of P (30) +K (50) +S (13) kg/ha was applied to each plot at final land preparation.

The recommended fertilizer dose (RD) was calculated on soil test basis (STB). The calculated recommended dose of NPKS used in the experiment was 75 kg N, 30 kg P, 50 kg K and 13 kg S per hectare. These nutrients were applied as urea, triple super phosphate (TSP), muriate of potash (MoP) and gypsum, respectively. To supply 100% recommended N for the crop in the combined treatments fertilizer and manure were calculated from both the sources. In case of other nutrients (P, K and S) the insufficient supply from organic manures were adjusted by chemical fertilizers to meet the recommended dose of each of the nutrients (Table 2).

Table 2
Treatments, sources and doses of the nutrients used for the experiment.

Treatments			Fertilizers (kg/ha)				Organic manures	
			N	P	K	S	Household wastes (t/ha)	Poultry manure t/ha)
T_1	:	Control - Recommended dose of N applied as urea	75	30	50	13	-	-
T_2	:	30 HWN_{25} + Urea N_{75}	56.25	23.5	35.15	7.65	3.15	-
T_3	:	30 HWN_{50} + Urea N_{50}	37.5	17.0	21.0	2.0	6.25	-
T_4	:	30 HWN_{75} + Urea N_{25}	18.75	7.5	-	-	11.25	-
T_5	:	60 HWN_{25} + Urea N_{75}	56.25	13.90	17.5	7.45	2.70	-
T_6	:	60 HWN_{50} + Urea N_{50}	37.5	-	-	2.3	5.35	-
T_7	:	60 HWN_{75} + Urea N_{25}	18.75	-	-	-	8.0	-
T_8	:	30 PMN_{25} + Urea N_{75}	56.25	11.0	44.0	3.0	-	2.50
T_9	:	30 PMN_{50} + Urea N_{50}	37.5	-	38.0	-	-	4.80
T_{10}	:	30 PMN_{75} + Urea N_{25}	18.75	-	32.0	-	-	7.25
T_{11}	:	60 PMN_{25} + Urea N_{75}	56.25	-	20.0	-	-	3.5
T_{12}	:	60 PMN_{50} + Urea N_{50}	37.5	-	9.15	-	-	4.65
T_{13}	:	60 PMN_{75} + Urea N_{25}	18.75	-	-	-	-	7.0

Note: Each treatment received 1.5 kg Zn/ha. The amount of phosphorus, potassium and sulphur were adjusted where manures were applied.

Test crop

The crop used in the experiment was a high yielding variety of okra (BARI dherosh-1) developed by Bangladesh Agricultural Research Institute (BARI), Gazipur, Bangladesh in the year 1996. Seeds were collected from Horticultural Research center of BARI. The yield potential of this okra variety is 14-16 t/ha (BARI, 1999) and requires 130-150 days to complete its life cycle (from seeding to harvest).

Land preparation

The land was prepared by deep and cross ploughing with a tractor drawn disk followed by harrowing and laddering up to a good tilth. Weeds and stubbles were removed and the plots were laid out as per design. The individual plots were made by making ridges (20 cm height) from the soil surface. The dimension of each plot was 2.8 m x 2.0 (5.6 m^2). The plot to plot and block to block distances were 0.75 m and 1.00 m, respectively. Duties (20 cm height) were made around each plot to restrict the lateral run off of irrigation water. Finally, required manures and fertilizers were applied in the individual plot as per assigned treatments.

Manuring and fertilization

Fertilizer Recommendtion Guide (BARC, 2005) was used for determining the fertilizer dose. Poultry manure and household waste were spread uniformly in the plots and incorporated into the soil by spade. Urea, TSP, MoP, and gypsum were used as the source of N, P, K and S, respectively. Entire quantity of P, K, S, HW and PM and half of N were applied as per treatment at the time of final land preparation. The remaining N was applied into two equal splits around the plant at 3rd and 5th week after seeding followed by irrigation.

Sowing of seeds

Healthy okra seeds were sown in lines on November 15, 2008 maintaining a row to row and plant to plant spacing of 50 cm and 35 cm, respectively (Anonymous, 1992). Previously soaked (for 24 hours), two seeds were pressed gently at a depth of 3 to 4 cm beneath the soil surface and then covered by very friable soil. Sowing was delayed due to cyclone 'Reshmi' and intermittent raining from 24 to 28 October, 2008 hampering the tilth condition of the experimental plot.

Intercultural operations

Necessary intercultural operations were done throughout the cropping season for proper growth and development of the plant. Weaker seedlings were removed six days after germination keeping the healthier one to grow. Surface soil crust was broken and the soil was loosen as well as the plots were made weed free. Each plot was watered uniformly at every alternate day by watering can to bring the soil moisture at desired level at the early stage of growth. Irrigation water was applied as and when necessary. Experimental plots were carefully observed regularly to record any change of plant growth.

Plant protection measures

Malathion @ 0.2 mL/L was sprayed thrice at an interval of 7 days starting a fewdays after the pest appeared. Admire @ 0.5 mL/L was also sprayed three times at an interval of 7 days when hopper and jassid was found in the experimental field.

Harvesting

Edible fruits were harvested at every alternate day at edible stage starting from January 14, 2008 and continued till March 8, 2008. The harvested fruits of each plot were weighed and the yield data were recorded.

Data collection

Ten plants were selected at random from each plot and tagged for collecting data. The following yield and yield contributing characters were considered in this study.

01. Days to anthesis: Number of days required from sowing to first flower opening.
02. Plant height (cm): Average height of 10 plants at final fruit harvest.
03. Number of branches per plant: Average number of branches of 10 plants.
04. Fruit length (cm): The length of fruits excluding peduncle
05. Fruit diameter (cm): The diameter of fruits at mid position measured by a digital slide calipers.
06. Single fruit weight (g): Mean weight of 20 randomly selected edible fruits from each plot.
07. Number of fruits per plant: Total number of fruits produced by a plant.
08. Fruit yield per plant (g): Edible fruit yield per plant.
09. Fruit yield (t): It was calculated from yield per plot.
10. Dry matter production (t): The plant and fruit dry matter was calculated from selected plant and fruit.
11. Root length (cm): Average length of 10 plants root after final fruit harvest.
12. Root weight (g): Average weight of 10 plants root after final fruit harvest.

Plant sampling

The ten-tagged plants selected earlier in each plot were cut at the bottom, chopped with a sharp knife, air-dried in the laboratory and finally oven-dried, grounded and stored in small bags into desiccators for chemical analyses.

Economic evaluation

Economic evaluation of different fertilizer combinations was done through partial budgeting and dominance analysis followed by marginal analysis of the cost undominated treatments as suggested by Perrin et al., (1979). Gross return and variable costs were calculated considering the following rate of costs of the materials: Urea @ 6 Tk./kg, TSP @ 30 Tk./kg, MP @ 25 Tk./kg, Gypsum @ 6 Tk./kg, Household wastes @ 1500 Tk./ton, Poultry manure @ 2000 Tk./ton and okra @ 25 Tk./kg (according to market rate during the year 2008-2009).

Benefit cost ratio (BCR) was calculated using the following formula:

$$BCR = \frac{\text{Gross return (Tk./ha)}}{\text{Total cost of cultivation (Tk./ha)}}$$

Statistical analysis

The collected data were compiled and tabulated in proper form and were subjected to statistical analysis by using the computer package IRRISTAT 5.0 program for Windows Version. Computation and preparation of graphs were done by the use of Microsoft Excel 2003 program.

RESULTS AND DISCUSSION

Days to first flowering of okra

The time required to first flowering of okra varied insignificantly due to different treatments of household wastes and poultry manures. The period required to first flowering of okra ranged from 51.00 days to 57.00 days (Table 3). Among the treatments, 30 HWN_{75} + urea N_{25} treatment required maximum period (57 days) for first flowering of okra. This was followed by the treatment of 30 PMN_{75} + urea N_{25}. Soil organic matter is a key factor for sustainable soil fertility and crop productivity. Organic matter undergoes mineralization with the release of substantial quantities of N, P and S and small amount of micronutrients. The differential aged composted and un-composted poultry manures and municipal wastes showed different nutrient release pattern and thereby resulted in difference in yield and yield contributing characters (Chanyasak et al. 1983). The results indicated that, generally lower readily available nutrient containing soil led to delayed flowering initiation. These results are in good agreement with the findings of Hoque et al. (2002). The treatment of 60 PMN_{50} + urea N_{50} required minimum days (51 days) for flowering initiation by the crop (Table 3).

Plant height before harvest of okra

The plant height of okra was recorded three times at 15 days interval from 30 days to 60 days after sowing (DAS). Plant height depends on available nutrients especially the nitrogen in soil which is responsible for rapid growth of a plant. Among the treatments plant height of okra at 30 DAS ranged from 23.8 cm to 30.25 cm. The mean effect of treatment on plant height of okra was statistically significant at all the three sampling time (Figure 1). The highest plant height (30.25 cm) was recorded from the treatment T_{12} (60 PMN_{50} + urea N_{50}) at 30 DAS which was 27.11 % higher over the control treatment. The second highest plant height (29.73 cm) was found in the treatment T_{13} (60 PMN_{75} + urea N_{25}). The minimum plant height (23.8 cm) at 30 DAS was recorded from the treatment T_1 (control). The maximum plant height of 30.25 cm, 42.87 cm and 54.5 cm at 30, 45 and 60 DAS, respectively was recorded from the treatment T_{12} (60 PMN_{50} + urea N_{50}). The shortest plants were 23.8 cm, 33.71 cm and 42.61 cm in height at 30, 45 and 60 DAS, respectively under the treatment T_1 (recommended dose of chemical fertilizer alone).

The highest plant height (54.5 cm) at 45 DAS was also recorded from the treatment T_{12} (60 PMN_{50} + urea N_{50}) which was 27.14 % increase over recommended dose of chemical fertilizer. The second highest plant height (53.46 cm) was found in the treatment T_{13} (60 PMN_{75} + urea N_{25}). Among the household wastes treated plots the taller plant (40.36 cm) at 45 DAS was registered from the treatment T_6 (60 HWN_{50} + urea N_{50}) which was followed by the treatment T_7 (60 HWN_{75} + urea N_{25}). The lowest plant height (33.71 cm) at 45 days was found in the control treatment.

Whereas the highest plant height (54.5 cm) at 60 DAS was also recorded from the treatment of 60 PMN_{50} + urea N_{50} which were 27.96 % increase over the recommended dose of chemical fertilizer for okra. The following plant height (53.46 cm) was found in the treatment of 60 PMN_{75} + urea N_{25} (Figure. 1).

From the results it can be concluded that okra plants treated with poultry manure of different aged at different ratios with recommended urea nitrogen fertilizer performed better than okra plants treated with household wastes of different aged at different ratios with recommended urea nitrogen fertilizer. This might be due to the slow releasing poultry manure provided substantial amount of nutrients consistently to okra. Noor et al. (2007) showed that recommended dose of fertilizer and organic manure influenced growth characteristics and fruit yield when they were applied in an integrating manner because the slow releasing poultry manure provided substantial amount of nutrients consistently to okra. The results are also in agreement with the works of Cutcliffe et al. (1968). Akande et al. (2010) found that plants treated only with NPK were shorter than plants treated with any of the organic materials mixed with NPK that were comparable with each other. Plants from the control had significantly shorter plants than from any of the fertilizer types.

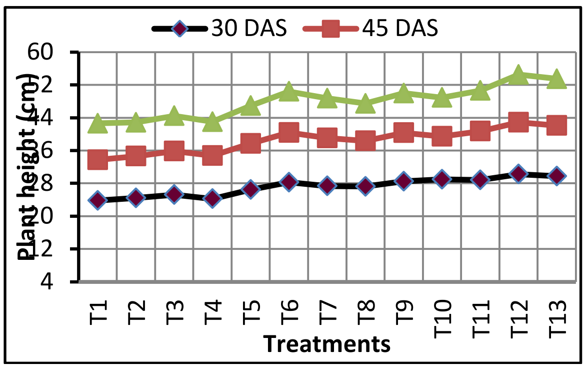

Figure 1
Effects of household wastes and poultry manures on plant height of okra.

Plant height at final harvest

Plant height at final harvest (118 DAS) significantly varied among the different treatments of household wastes and poultry manures decomposed for different duration along with recommended dose of urea nitrogen fertilizers. Plant height at final harvest ranged from 70.75 cm to 91.45 cm where the maximum value (91.45 cm) was recorded from the treatment T_{12} (60 PMN_{50}+ urea N_{50}) and the lowest one from the recommended dose of chemical fertilizer. The following plant height (89.40 cm) next to height was found in the treatment of 60 PMN_{75} + urea N_{25} (Table 3). Though the two types of treatment component produced different results from each other to some extent, the poultry manure treated plants showed superiority over household wastes treatment.

Number of branches per plant

The influence of household wastes and poultry manures on number of branches plant^{-1} of okra was found to vary significantly (Table 3). Number of branches plant^{-1} of okra ranged from 2.17 to 3.63. The maximum branches (3.63) were recorded from 60 HWN_{50} + urea N_{50} (T_6) which was statistically similar to T_{12} (60 PMN_{50} + urea N_{50}). The lowest number of branches plant^{-1} of okra was found from the plants treated with only recommended dose of chemical fertilizer.

Single root length and single root weight of okra

It was found that the application of household wastes and poultry manures along with chemical fertilizers significantly affected average root length and average root weight of okra (Table 4). All the treatments produced higher average root length and average root weight in comparison to the application of only recommended dose of chemical fertilizer. The longest root (21.36 cm) was recorded in the treatment of 60 PMN_{50}+ urea N_{50} which was followed by the treatment of 30 PMN_{75} + urea N_{25} and 30 PMN_{50} + urea N_{50} and 60 HWN_{50} + urea N_{50}. The average root weight showed similar trend as average root length. The heaviest root (9.64 g) was recorded from the 60 PMN_{50} + urea N_{50} treatment and the lightest one (6.05 g) was in control treatment (Table 4). Nutrients contained in manures were probably released more slowly and stored for a longer period in the soil ensuring longer residual effects and ultimately improved root development (Sharma and Mittra, 1991; Abou El Magd et al., 2005).

Dry matter production of okra

Total dry matter production of okra was found significantly affected by application of household wastes and poultry manures as compared to control (Table 5). The total dry matter production ranged from 3.97 to 6.09 t ha^{-1}, the highest value being noted in the treatment T_{12} (60 PMN_{50}+ urea N_{50}) which was statistically superior to all the other treatments except T_{11} and T_{13}. The second highest amount (5.98 t ha^{-1}) was recorded in treatments T_{13} (60 PMN_{75} + urea N_{25}). The minimum amount of dry matter (3.97 t ha^{-1}) was obtained from the treatment T_1 having sole recommended dose of chemical fertilizer (Table 5). The treatments of differential amount from poultry manure along with chemical fertilizers have shown superiority in dry matter production over the application of household wastes. The poultry manure being the slow releasing organic manures discharged nutrients slowly to the plants as found in the trial carried by Noor et al., 2008.

Table 3
Effects of household wastes and poultry manures on growth parameters of okra plant.

Treatments	Days to first flowering	Plant height (cm) at final harvest (118 DAS)	Number of branches $plant^{-1}$
T_1 : Control - Recommended dose of N applied as urea	52.00	70.75	2.17
T_2 : 30 HWN_{25} + Urea N_{75}	55.00	72.45	2.70
T_3 : 30 HWN_{50} + Urea N_{50}	55.00	75.65	2.80
T_4 : 30 HWN_{75} + Urea N_{25}	57.00	72.75	2.50
T_5 : 60 HWN_{25} + Urea N_{75}	54.00	80.50	3.03
T_6 : 60 HWN_{50} + Urea N_{50}	52.00	87.47	3.63
T_7 : 60 HWN_{75} + Urea N_{25}	55.00	84.03	3.17
T_8 : 30 PMN_{25} + Urea N_{75}	54.00	79.55	3.05
T_9 : 30 PMN_{50} + Urea N_{50}	53.00	84.50	3.27
T_{10} : 30 PMN_{75} + Urea N_{25}	56.00	82.45	3.20
T_{11} : 60 PMN_{25} + Urea N_{75}	53.00	85.80	3.35
T_{12} : 60 PMN_{50} + Urea N_{50}	51.00	91.45	3.55
T_{13} : 60 PMN_{75} + Urea N_{25}	52.00	89.40	3.53
SE(±)	0.414	0.89	0.009
CV (%)	4.00	5.07	1.50

Table 4
Effects of household wastes and poultry manures on average root length and average root weight of okra plant.

Treatments	Average root length (cm)	Average root weight (g)
T_1 : Control - Recommended dose of N applied as urea	16.73	6.05
T_2 : 30 HWN_{25} + Urea N_{75}	17.32	6.69
T_3 : 30 HWN_{50} + Urea N_{50}	18.61	7.35
T_4 : 30 HWN_{75} + Urea N_{25}	17.66	7.12
T_5 : 60 HWN_{25} + Urea N_{75}	17.29	7.75
T_6 : 60 HWN_{50} + Urea N_{50}	19.78	8.39
T_7 : 60 HWN_{75} + Urea N_{25}	18.11	8.20
T_8 : 30 PMN_{25} + Urea N_{75}	19.01	8.22
T_9 : 30 PMN_{50} + Urea N_{50}	19.78	8.95
T_{10} : 30 PMN_{75} + Urea N_{25}	20.21	8.52
T_{11} : 60 PMN_{25} + Urea N_{75}	18.73	8.13
T_{12} : 60 PMN_{50} + Urea N_{50}	21.36	9.64
T_{13} : 60 PMN_{75} + Urea N_{25}	19.19	8.55
SE(±)	0.203	0.024
CV (%)	5.60	1.60

Table 5
Effects of household wastes and poultry manures on dry matter production of okra plant.

Treatments			Dry matter production (t ha^{-1})		
			Plant	Fruit	Total
T_1	:	Control - Recommended dose of N applied as urea	2.05	1.92	3.97
T_2	:	30 HWN_{25} + Urea N_{75}	2.35	1.95	4.30
T_3	:	30 HWN_{50} + Urea N_{50}	2.55	2.12	4.67
T_4	:	30 HWN_{75} + Urea N_{25}	2.56	1.93	4.49
T_5	:	60 HWN_{25} + Urea N_{75}	3.10	2.05	5.15
T_6	:	60 HWN_{50} + Urea N_{50}	3.15	2.04	5.19
T_7	:	60 HWN_{75} + Urea N_{25}	3.12	2.17	5.29
T_8	:	30 PMN_{25} + Urea N_{75}	3.15	2.00	5.15
T_9	:	30 PMN_{50} + Urea N_{50}	3.20	2.03	5.23
T_{10}	:	30 PMN_{75} + Urea N_{25}	3.25	2.01	5.26
T_{11}	:	60 PMN_{25} + Urea N_{75}	4.05	1.89	5.94
T_{12}	:	60 PMN_{50} + Urea N_{50}	4.11	1.98	6.09
T_{13}	:	60 PMN_{75} + Urea N_{25}	4.07	1.91	5.98
SE(±)			0.010	0.079	0.083
CV (%)			1.6	6.90	7.10

Effect on fruit size and fruit weight of okra

Fruit size

The data presented in Table 6 show the effect of application of household wastes and poultry manures along with chemical fertilizers on fruit size being assessed by the length and diameter of the fruit. The maximum fruit length (12.84 cm) was recorded in the treatment T_{12} (60 PMN_{50} + urea N_{50}) which was closest (12.75) to the treatment T_{13} (60 PMN_{75} + urea N_{25}). The shortest length was found in application of 30 HWN_{25} + urea $N_{75.}$ The fruit diameter varied from 1.46 cm to 1.85 cm, the highest being noted in the treatment of T_{12} (60 PMN_{50}+ urea N_{50}) closely followed by treatment T_{11} (60 PMN_{25} + urea N_{75}) and treatment T_{13} (60 PMN_{75} + urea N_{25}). The lowest value was recorded from 30 HWN_{50} + urea N_{50} treatment (Table 6). Singh et al. (2004) found increased dry matter weight and fruit size of pea by integrated application of organic manures and chemical fertilizer which was in agreement with the present findings.

Fruit weight

The single green fruit weight of okra was found to vary significantly with the differential amount of organic manures and chemical nitrogen fertilizer (Figure 2). The highest individual fruit weight (13.65 g) in green condition was recorded from the treatment T_{12} (60 PMN_{50} + urea N_{50}) followed by T_{13} having 60 PMN_{75} + urea N_{25} treatment (Figure 2). Among the household wastes treated plots of growing okra, 60 HWN_{50} + urea N_{50} in T_6 performed the best in case of individual green fruit weight (11.79). The poultry manure based treatments showed superiority over the household based treatments. The lowest individual green fruit weight of okra (8.62 g) was found in the treatment T_1 having recommended dose of chemical fertilizer only. It was also observed that the application of PM along with chemical fertilizers could give satisfactory result which could not be possible in case of lone organic manure or lone chemical fertilizers. Noor et al. (2007) reported that integrated application of organic manures and chemical fertilizer favoured the yield characteristics and fruit yield of okra because the slow releasing poultry manure provided substantial amount of nutrients consistently to okra. The results were also in agreement with the works of Cutcliffe et al. (1968).

Effects on yield contributing characters of okra

Number of fruits plant^{-1} of okra

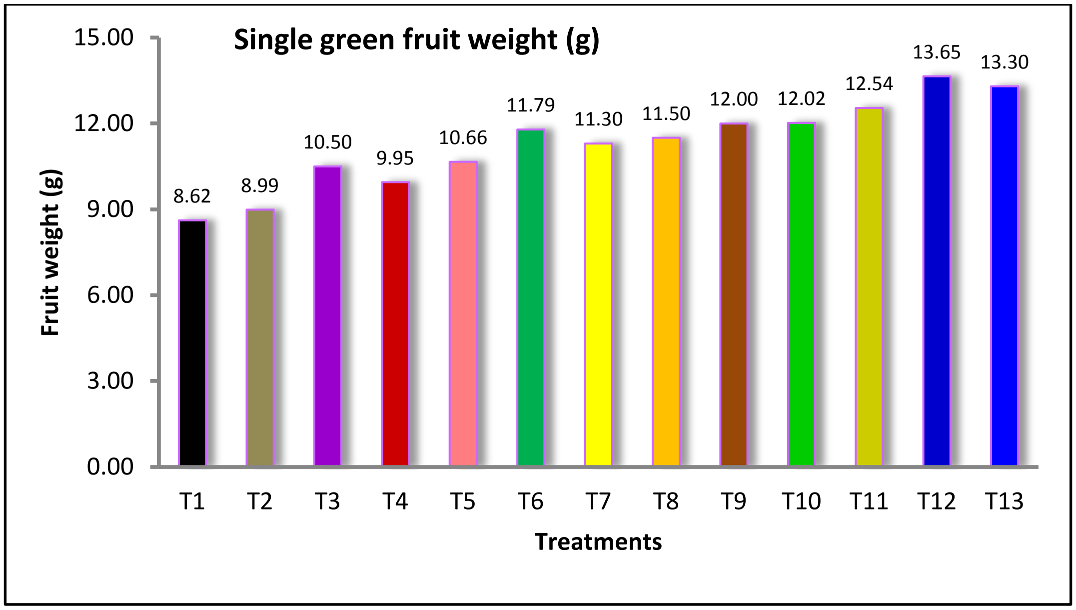

Figure 2
Effects of household wastes and poultry manures on fruit weight of okra.

Table 6
Effects of household wastes and poultry manures on fruit size of okra.

Treatments		Green fruit size (cm)	
		Length	Diameter
T_1 :	Control - Recommended dose of N applied as urea	10.17	1.55
T_2 :	30 HWN_{25} + Urea N_{75}	10.12	1.59
T_3 :	30 HWN_{50} + Urea N_{50}	11.90	1.46
T_4 :	30 HWN_{75} + Urea N_{25}	11.02	1.52
T_5 :	60 HWN_{25} + Urea N_{75}	10.85	1.54
T_6 :	60 HWN_{50} + Urea N_{50}	12.34	1.72
T_7 :	60 HWN_{75} + Urea N_{25}	11.46	1.61
T_8 :	30 PMN_{25} + Urea N_{75}	11.50	1.65
T_9 :	30 PMN_{50} + Urea N_{50}	12.12	1.52
T_{10} :	30 PMN_{75} + Urea N_{25}	11.95	1.60
T_{11} :	60 PMN_{25} + Urea N_{75}	12.32	1.74
T_{12} :	60 PMN_{50} + Urea N_{50}	12.84	1.85
T_{13} :	60 PMN_{75} + Urea N_{25}	12.75	1.69
SE(±)		0.049	0.019
CV (%)		2.2	6.2

Household wastes and poultry manures decomposed for different duration with the combinations of differential amount of chemical nitrogen fertilizer have significantly influenced the number of fruits plant^{-1} of okra (Table 7). The maximum number of fruits (26.88) plant^{-1} of okra was recorded in the treatment provided with 50% of recommended nitrogen as urea and the rest as poultry manure decomposed for a period of 60 days (PMN_{50} + urea N_{50}), which closely followed by the treatment of 30PMN_{50}+ urea N_{50} (26.79). Treatment T_2 - T_7 where household wastes amendments decomposed for different duration and reduced rate of chemical fertilizer were applied produced significantly lower number of fruits plant^{-1}, this indicates significant and superiority of poultry manure over the household wastes. The minimum number of fruits plant^{-1} (17.66) was noted in control. Better performance under judicious application of organic manures and chemical nitrogen might be due to the improvement of soil physical, chemical and biological properties which have facilitated nutrient availability resulting in better growth and yield of okra plant. Ray et al, 2005, opined that better growth and fruiting under the balanced application of organic manure and chemical fertilizer might be due to the secretion of some growth promoting substances.

Fruit yield plant^{-1} of okra

Fruit yield plant^{-1} of okra varied significantly among the treatments of household wastes and poultry manures decomposed for different duration along with the chemical nitrogen (Figure 3). The highest yield plant^{-1} (367.1 g) was recorded from the treatment T_{12} (60PMN$_{50}$+ urea N$_{50}$) which was statistically higher than all other treatments. The second highest yield plant^{-1} (321.3 g) was noted in the treatment T_9 (30PMN$_{50}$+ urea N$_{50}$) whereas the lowest yield plant^{-1} (155.01 g) was found in the control treatment. The data indicates that the yield plant^{-1} of okra was always higher under application of poultry manure as compared to household wastes. Edmond et al. (1977) showed that when recommended dose of fertilizer and organic manure applied in a combined approach influenced yield characteristics and yield because the slow releasing poultry manure provided substantial amount of nutrients consistently to okra. The results were also in agreement with the works of Cutcliffe et al. (1968) and Noor et al. (2007).

Fruit yield of okra ha^{-1}

Integrated application of differential amounts of poultry manure and household wastes along with urea to maintain the recommended dose of N have created significant interaction on the yield of okra (Table 7). The maximum yield of okra (14.71 t ha^{-1}) was recorded in the treatment T_{12} (60 PMN$_{50}$ + urea N$_{50}$) which was statistically higher than all other treatments. The second highest yield (13.57 t ha^{-1}) was observed in the treatment T_{13} (60 HWN$_{75}$ + urea N$_{25}$). The results exhibited that okra yield was always higher under application of poultry manure at different age and different proportions with urea nitrogen. The lowest yield (10.45 t ha^{-1}) was found in the treatment with recommended dose chemical nitrogen. This might be due to the slow releasing of nutrients from poultry manure which provided substantial amount of nutrients consistently to okra. Soil organic matter is a key factor for sustainable soil fertility and crop productivity. Organic matter undergoes mineralization with the release of substantial quantities of N, P and S and small amount of micronutrients (Jahiruddin et al. 1995). The differential aged composted and uncomposted poultry manures and municipal wastes showed different nutrient release pattern and thereby resulted in difference in yield and yield contributing characters (Chanyasak et al. 1983). Smith (1950) reported that uric acid, which constituted 60 percent of the nitrogen in the poultry manure changes rapidly to ammoniacal form and then to nitrate, which is utilized by plants. Brown (1958) observed that poultry manure contained growth promoting hormones which might produce better root growth. This fact might work in the present study. Noor et al. (2007) showed that recommended dose of fertilizer and organic manure influenced fruit characteristics and fruit yield when these were applied in an integrating manner because the slow releasing poultry manure provided substantial amount of nutrients consistently to okra. The results are also in agreement with the works of Cutcliffe et al. (1968), Singh et al. (2004), Yadav et al. (2006). They explained that integrated nutrient management might have improved the physical, biological and chemical properties of the soil instead of only chemical environment which might have facilitated for better root growth of plants as well as nutrient availability and uptake by plants which led to better vegetative growth and higher yield of okra. It was also observed that household waste (HW) along with the chemical fertilizer failed to produce the higher yield. This might be due to the plot receiving poultry manure received higher amount of phosphorus and sulphur that might have led to higher fruit setting and yield of okra.

Table 7
Effects of household wastes and poultry manures on number of fruits per plant and fruit yield per hectare of okra.

Treatments			Number of fruits plant^{-1}	Fruit yield (t ha^{-1})
T_1	:	Control - Recommended dose of N applied as urea	17.66	10.45
T_2	:	30 HWN_{25} + Urea N_{75}	18.34	11.63
T_3	:	30 HWN_{50} + Urea N_{50}	23.36	12.53
T_4	:	30 HWN_{75} + Urea N_{25}	22.90	12.82
T_5	:	60 HWN_{25} + Urea N_{75}	22.19	13.32
T_6	:	60 HWN_{50} + Urea N_{50}	24.28	13.28
T_7	:	60 HWN_{75} + Urea N_{25}	24.36	13.57
T_8	:	30 PMN_{25} + Urea N_{75}	22.47	12.81
T_9	:	30 PMN_{50} + Urea N_{50}	26.79	13.48
T_{10}	:	30 PMN_{75} + Urea N_{25}	21.31	13.05
T_{11}	:	60 PMN_{25} + Urea N_{75}	24.40	12.42
T_{12}	:	60 PMN_{50} + Urea N_{50}	26.88	14.71
T_{13}	:	60 PMN_{75} + Urea N_{25}	23.13	13.15
SE(±)			0.084	0.535
CV (%)			6.34	7.19

Effects of household wastes and poultry manure decomposed for different durations on yield contributing characters and yield of okra along with their nutritional aspects and post soil status were assessed by experiment. Results showed that best performance were obtained with 60 PMN_{50} + urea N_{50} treatment i.e. 50% N amendment from poultry manure of recommended dose in plant height at initial and final harvesting, average root length and weight, dry matter production, green fruit size and weight, individual green fruit weight, number of fruits plant^{-1}, fruit yield plant^{-1} and fruit yield. The treatments which received poultry manure decomposed for 60 days as supplementation of recipral amount of urea performed better than those of the treatments receiving household wastes along with urea N in proportion. The plants grew to the maximum of 30.25 cm, 42.87 cm and 54.5 cm at 30, 45 and 60 days after transplanting, respectively from the treatment of 60 PMN_{50} + urea N_{50} and the shortest plant appeared to be of 23.8 cm, 33.71 cm and 42.61 recorded at the same periods of 30, 45 and 60 days after transplanting, respectively under the treatment of recommended dose of nitrogen as urea only (control treatment). Plant height at final harvest ranged from 70.75 cm to 91.45 cm where the maximum height was recorded from 60 PMN_{50} + urea N_{50}. The shortest plants were noted from recommended dose of urea nitrogen treatment. Among the treatments of organic manures decomposed for different durations and in supplement with differential amount of recommended dose of nitrogen as urea 60 PMN_{50} + urea N_{50} produced the maximum branches of okra (3.63). The same result was also found from 60 PMN_{75} + urea N_{25} and these were followed by the treatment of 60 HWN_{50} + urea N_{50}.The average root length and root weight of all the treatments were higher than those in control treatment. The longest root (21.36 cm) was noted in the treatment of 60 PMN_{50} + urea N_{50}. The highest fruit length and fruit weight were 12.84 cm and 13.65 g respectively in the same treatment of 60 PMN_{50} + urea N_{50} which were identical to the treatment of 60 PMN_{75} + urea N_{25} (12.75 cm and 13.65 g). Maximum number of fruits plant^{-1} of okra (26.88), the highest yield plant^{-1} (367.1 g) and the maximum yield of okra (14.71 t ha^{-1}) were also recorded from the same (60 PMN_{50} + urea N_{50}). The minimum number of fruits plant^{-1} (17.66), the lowest yield plant^{-1} and the lowest yield (155.01 g and 10.45 t ha^{-1}) were found from control treatment. It was revealed from the results that poultry manure was superior to household wastes in terms of growth and yield of okra plant.

CONCLUSIONS

Okra plants treated with poultry manure along with differential amount of N from urea performed better than household wastes for okra cultivation. The findings of the experiment revealed that 50% of the recommended dose of nitrogen as urea and the rest of nitrogen as poultry manure the amount being 4.65 ton per hectare performed better for okra production. Poultry manure was found superiority in most cases over household wastes. The treatment of PMN_{50} decomposed for a period of 60 days was best in terms of growth, yield parameters and nutrient status in plant and soil whereas the residual effect was found highest in the treatment of 30 days aged PMN_{50} decomposed for a period of 30 days.

REFERENCES

Abou El-Magd, Hoda MM, Mohammed A and Fawzy ZF (2005). Relationship, growth and yield of broccoli with increasing N, P or K ratio in a mixture of NPK fertilizers. Annals Agriculture Science Moshtohor, 43 (2): 791-805.

Ahmed KU (1995). Phal-Phul O Shak-Shabji (In Bangla) 5th ed. Mrs. Mumtaj Kamal, Mirpur, Dhaka, Bangladesh: 400.

Ahsan S and Karim Z (1988). Soil fertility management research on upland soils of Bangladesh. Proceedings of the International Conference on the Management of Fertilization of Upland Soils in the Tropics and Subtropics. Journal of Rabenandrasena (ed.). Nanjing, China: 247-251.

Akande MO, Oluwatoyinbo FI, Makinde EA, Adepoju AS and Adepoju IS (2010). Response of Okra to Organic and Inorganic Fertilization. Nature and Science, 8 (11): 95-98.

Anonymous (1989). Annual Weather Report. Meteorological Station, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur.

Anonymous (1992). Crop production through irrigation manual. Deep Tubewel Project-2, Department of Agricultural Extension, Khamarbari, Farmgate, Dhaka: Scha-10.

Anonymous (2010). Annual Report July 2007-June 2008. Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur. Meteorological Station, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur.

BARC (Bangladesh Agricultural Research Council) (2005). Fertilizer recommendation guide 2005. BARC, Soils Pub. No. 14. 2007. Farmgate, Dhaka: 25-128.

BARI (1999). KRISHI PROJUKTI HATBOI (Hand book on Agrotechnology). Bangladesh Agricultural Research Institute, Gazipur. 1701: 369.

BBS (2009). The Year Book of Agricultural Statistics of Bangladesh. Bangladesh Bureau of Statistics, Statistics Division, Ministry of Planning, Govt. of the Peoples Republic of Bangladesh: 138.

Bose TK and M.G. Som (1990). Importance of vegetable production. Naya Prokash, Calcutta, India: 04-661.

Brammer H (1980). Ploughpan and tillage problems in Bangladesh. BARC S & I Pub. No. 5: 5.

Chanyasak V, Katayama A, Hirai M, Mori S, and Kubota H (1983). Effects of compost maturity on growth of Komatsuna (*Brassicarapa*, var. *pervidis*) in Neubauer'spot. I. Comparison of growth in compost treatments with that in inorganic nutrient treatments as controls. Soil Science and Plant Nutrition, 29: 239–250.

Chattapadhyay SB (1983). Principles and procedures of plant protection. Oxford and IBH Publishing Co. Pvt. Ltd. Delhi: 63.

Cutcliffe JA, Munro DC and MacKay DC (1968). Effect of nitrogen, phosphorus, potassium and manure on terminal, lateral and total yields and maturity of broccoli. Canadian Journal of Plant Science, 48: 439-446.

Edmond JB, Sen TL, Andrews FS and Hall Facre RG (1977). Fundamentals of Horticulture. Tata Mcgraw-Hill Publishing Co. Ltd, New Delhi: 237-257.

FAO (Food and Agriculture Organization) (1997). Production Year Book No. 47. FAO, Rome, Italy: 97.

Govindasamy R, Cochran MJ, Miller DM and Norman RJ (1994). Economics of trade-off between urea nitrogen and poultry litter for rice production. Journal of Agricultural and Applied Economics, 26(2): 552-564.

Hogland W, Bbanrye T, Marques M and Nimmermark S (2003). Physical, chemical and biological processes for optimizing decentralized composting. Compost Sci. Util. 11(4): 330- 336.

Hoque MO, Farooque AM, Hoque MS, Salam MA and Rahman MH (2002). Effect of combined use of manure and fertilizer on the yield of main and ratoon crop of cabbage. Bangladesh Journal of Agricultural Research, 27(4): 649-655.

Jahiruddin M, Ali MS, Hossain MA, Ahmed MU and Haque MM (1995). Effect of boron on grain set, yield and some other parameters of wheat cultivars. Bangladesh Journal of Agricultural Science, 22: 179.

Marcotea I, Hernandez T, Garcia C and Polo A (2001). Influence of one or two successive annual applications of organic fertilizers on the enzyme activity of a soil under barley cultivation. Bioresearch Technology, 79: 147-154.

Miah MAM, Ishaque M and Saha PK (2006). Integrated nutrient management for improving soil health and rice production. Proc. of twenty first BRRI-DAE joint workshops on bridging the rice yield gap for food Security. BRRI, Gazipur, Bangladesh, 19-21 September, Paper 11: 1-15.

Mitra SK, Sadhu MK and Bose TK (1990). Nutrition of vegetable crops. Naya Prokash, Calcutta: 327-363.

Noor S, Mahiuddin M, Shil NC and Talukder MR (2008). Integrated nutrient management for tomato-okra-Indian spinach cropping pattern. Annual Research report (2007-2008). Soil Science Division, Bangladesh Agriculture Research Institute, Gazipur: 108-114.

Noor S, Shil NC, Haque MA and Farid ATM (2007). Integrated nutrient management for broccoli-okra cropping sequence. Journal of the Asiatic Society of Bangladesh, Science, 33(1): 85-94.

Ofosu-Anim and Leitch (2009). Relative efficiency of organic manures in spring barly (*Hordeum vulgare* L.) production. Australian Journal of Crop Science, 3(1): 13-19.

Perrin PK, Winkelman DL, Moseardi ER and Anderson JR (1979). Farm agronomic data for farmer's recommendation. Information bulletin 27. CIMMYT, Mexico.

Rampal and Gill HS (1990). Demand and supply of vegetables and pulses in South Asia. *In:* vegetable research and development in South Asia: Proceeding of a workshop held at Islamabad, Pakistan, 24-29 September, 1990. S. Shanmugasundaram (ed.) AVRDC publication no. 90-331. AVRDC, Taiwan.

Rao DN and Mikkelsen DS (1977). Effects of acetic, propionic, and butyric acid acids on rice seedling growth and nutrition. Plant and Soil, 47: 551-557.

Rashid MM (1999). Shabji Biggan (Vegetable science). 2nd Edition. Rashid Publishing House, 94, Puraton DOHS, Dhaka, Bangladesh: 243-385.

Ray R, Patra SK, Ghosh KK and Sahoo SK (2005). Integrated nutrient management in okra (*Abelmoschus esculentus* L., Moench) in a river basin. Indian Journal of Horticulture, 62(3): 260-264.

Reddy BGM, Pattar PS and Kuchanur PH (2005). Response of rice to poultry manure and graded levels of NPK under irrigated conditions. Oryza-. 2005; 42(2): 109-111.Cuttack, India: Association of Rice Research Workers, Central Rice Research Institute.

Savello PA, Mortin FW and Hill JM (1980). Nutritional composition of okra seed meal. Agriculture and Food Chemistry, 28: 1163-1166.

Sharma AR and Mittra BN (1991). Effect of different rates of application of organic and nitrogen fertilizers in a rice-based cropping system. Journal of Agricultural Science, (Cambridge). 117: 313-318.

Singh TR, Singh S, Singh SK, Singh MP and Srivastava BK (2004). Effect of integrated nutrient management on crop nutrient uptake and yield under okra-pea-tomato cropping system in a Mollisol. Indian Journal of Horticulture, 61(4): 312-314.

Sreelatha T, Raju AS and Raju AP (2006). Effect of different doses of farm yard manure and poultry manure and their interaction with fertilizer nitrogen on yield and nutrient uptake in mesta-rice cropping system. Journal of Research ANGRAU, 34(1): 41-47.

Tanahashi T and Yano H (2004). The method of presuming the effect of nitrogen based on the nitrogen content of poultry manure compost. Japanese Journal of Soil Science and Plant Nutrition, 75(2): 257-260.

Tejada M and Gonzalez JL (2003). Effects of the application of a compost originating from crushed cotton gin residues on wheat yield under dryland conditions. European Journal of Agronomy, 19: 357- 368.

Yadav P, Singh P and Yadav RL (2006). Effect of organic manures and nitrogen levels on growth, yield and quality of okra. Indian Journal of Horticulture, 63(2): 215-217.

Yamaguchi M (1998). World vegetables principles, production and nutritive values. Van Nostrand Reinhold. New York, USA: 415.