EFFECTS OF NPKS AND COWDUNG ON THE PERFORMANCE OF OKRA (*Abelmaschus esculentus* L.)

A Thesis

By

SATHI SARKER

Student No. 1705221

MASTER OF SCIENCE
IN
CROP PHYSIOLOGY AND ECOLOGY

DEPARTMENT OF CROP PHYSIOLOGY AND ECOLOGY
HAJEE MOHAMMAD DANESH SCIENCE AND TECHNOLOGY UNIVERSITY
DINAJPUR-5200

DECEMBER 2018

EFFECTS OF NPKS AND COWDUNG ON THE PERFORMANCE OF OKRA (*Abelmaschus esculentus* L.)

A Thesis

By

SATHI SARKER

Student No. 1705221

Submitted to the

Department of Crop Physiology and Ecology

Hajee Mohammad Danesh Science and Technology University, Dinajpur

in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

IN

CROP PHYSIOLOGY AND ECOLOGY

DEPARTMENT OF CROP PHYSIOLOGY AND ECOLOGY

HAJEE MOHAMMAD DANESH SCIENCE AND TECHNOLOGY UNIVERSITY

DINAJPUR-5200

DECEMBER 2018

EFFECTS OF NPKS AND COWDUNG ON THE PERFORMANCE OF OKRA (*Abelmaschus esculentus* L.)

A Thesis

By

SATHI SARKER

Student No. 1705221

Approved as to the style and content by

_____

Professor Dr. Md. Maniruzzaman Bahadur
(Supervisor)

_____

Professor Dr. Sripati Sikder
(Co-supervisor)

_____

Professor Dr. Sripati Sikder
Chairman
Examination Committee

DEPARTMENT OF CROP PHYSIOLOGY AND ECOLOGY
HAJEE MOHAMMAD DANESH SCIENCE AND TECHNOLOGY UNIVERSITY
DINAJPUR-5200

DECEMBER 2018

Dedicated to my

beloved parents

ACKNOWLEDGEMENTS

The Author express her deepest sense of gratefulness to the Almighty Allah who has enabled her to complete the present research work and to prepare this capacious thesis for the degree of Master of science (MS) in Crop Physiology and Ecology.

The Author expresses her heartiest respect, sincere appreciation and immense indebtedness to her respectable teacher research Supervisor Professor Dr. Md. Maniruzzaman Bahadur, for his scholastic guidance during planning and execution of the research, valuable suggestions, continuous support and all hint of support and help throughout the period of research work and preparation of manuscript of the thesis.

The Author fells proud to express her hearted sense of respect anti gratefulness to her co-supervisor Professor Dr. Sripati Sikder, Chairman, Department of Crop Physiology and Ecology, Hajee Mohammad Danesh Science and Technology University, Dinajpur for his valuable suggestions, sincere helps, scholar instructions and careful corrections of the manuscript of the thesis.

The Author recognize a profound thanks to Professor Dr. Abu Hasan, Professor Dr. Abu Khayer Md. Muktadirul Bari Chowdhury, Department of Crop Physiology and Ecology, Hajee Mohammad Danesh Science and Technology University, Dinajpur for their important suggestions, all round help and kindly support for successful completion of the manuscript of the thesis.

The author also extend gratitude to all the friends, staffs of the Department of Crop Physiology and Ecology, Hajee Mohammad Danesh Science and Technology University, Dinajpur for their help assistance during the period the research.

The Author is very thankful anti gratitude to all friends anti existing colleagues as well wisher for their eagerness, direct and indirect helps during the period of research work.

At last, from the core of heart, the Author feels duty bound to acknowledge the blessing anti incentives of beloved parents Md. Tara Sarker and Sufia Begum and other family members for their blessing, inspirations, sacrifices anti moral supports and financial assistance, which encouraged anti paved the way for higher studies.

December 2018 *The Author*

ABSTRACT

An experiment was conducted at the research farm and laboratory of Crop Physiology and Ecology Department, Hajee Mohammad Danesh Science and Technology University, Dinajpur, during March to August 2018 to evaluate the effect of different level of NPKS and cowdung fertilizers on growth and yield of okra. The experiment was laid out in two factors and Randomized Complete Block Design (RCBD) with three replications. Two okra varieties, such as Arka Anamica, BARI Dherosh-1 and five fertilizer treatments, such as T_1 = control (no. fertilizer and no. cowdung), T_2 = (N 100 + P 35 + K 70 + S 20) Kg ha^{-1} (recommended dose of fertilizer for okra), T_3 = ½ of T_2 + cowdung (CD) 5 t ha^{-1}, T_4 = ½ of T_2 + cowdung 10 t ha^{-1}, T_5 = ½ of T_2 + cowdung 15 t ha^{-1} were tested. Combination of Arka Anamica (V_1) and fertilizer treatment, T_5 (T_5 = ½ of T_2 + cowdung 15 t ha^{-1}) had higher plant height (cm), leaf number $plant^{-1}$, branch number $plant^{-1}$, leaf length (cm), leaf breadth (cm), nodal distance (cm), number of green fruit per plant, green fruit length per plant (cm), edible fruits weight per plant (g), edible fruits weight per plot (g) and edible fruits weight (t ha^{-1}), higher seed number per fruits after maturity, seed weight per fruits (g), seed yield per plant (g), seed yield per plot (g), 1000-seed weight (g) and seed yield (t ha^{-1}). Between two varieties Akra Anamika showed higher values in case of most of the parameter studied while BARI Dherosh-1 had minimum values in most of the parameters. BARI Dherosh-1 took minimum days to flower initiation and first flower initiation while Akra Anamika need some higher days for flowering. The seed yield (t ha^{-1}) of okra was significantly affected by the interaction of variety and fertilizer. The highest (4.01 t ha^{-1}) seed yield was observed at V_1T_5 combination and V_2T_1 combination gave the lowest (2.56 t ha^{-1}) seed yield.

CONTENTS

CONTENTS (Contd.)

CONTENTS (Contd.)

LIST OF TABLES

CHAPTER 1

INTRODUCTION

Okra (*Abelmoschus esculentus* L. Moench) known in English speaking countries as ladies's fingers, bhindi, bamia, ochro or gumbo is the flowering plant belongs to family Malvaceae. Okra is one of the most popular vegetable crops grown throughout the tropics of the world during spring and summer seasons. It is valued for its edible green seed pods. The plant is cultivated in tropical, subtropical and warm temperate regions around the world. Okra is an important fruit vegetable of high commercial and food values. It is primarily valued for its tender, immature green pods in fresh form; however its curry, soups and edible young leaves are also popular. To a limited extent it finds use in canned, dehydrated or frozen forms for off-season consumption by the army at high altitudes and export (Sharma *et al.* 2015).

Okra is an important vegetable crop which supplies higher nutrition. The green pods (per 100 g edible portion) of okra contains moisture 89.6 g, carbohydrates 6.4 g, protein 1.9 g, fat 0.2 g, fibre 1.2 g, minerals 0.7 g, calcium 66 mg, magnesium 43 mg, phosphorus 56 mg, potassium 103 mg, Vitamin-A 88 IU, Vitamin-C 13 mg etc. (Bose *et al.* 2003).

The green tender fruits of okra are highly nutritious vegetable containing 1107 mg of calcium and 8.9 mg of iron for every 1000 g edible protein and fair amount of vitamins viz. A, B and C. It is also rich in protein and crude fibre (Sonathampi and Indira 2000). Recently an attention has been given to the use of okra seeds as

a source of proteins (about 20% of dry mater) and vegetable oil (about 14% of dry mater) seeds contain mainly saturated fatty acids (oleic) and palmitic acid and their high lysine level (Al-Wandawi 1983).

In Bangladesh vegetable production is not uniform round the year. Vegetables are plenty in winter, but are low in summer. Of the total vegetable production, around 38% is produced during Kharif season (Anonymous, 2010). Total production of okra was produced 42,366 mt. from 10,204 ha of land in the year 2009-2010 and the average yield was 3.92t/h and1 (BBS, 2010), which is very low compared to that of other developed countries where the yield was as high as 14.0-15.0 t/h (Jamaguch 2009).

Among the various factors affecting successful cultivation of okra, the judicious fertilizer application is one of those. The requirements of fertilizers in okra are important for the early growth and total yield of fruit. Integrated use of organic and inorganic fertilizers can improve crop productivity. The soil enriched with cowdung provides additional substances that are not found in chemical fertilizers (Mal *et al.* 2013).

Okra cultivation requires nutrients such as nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), sodium (Na) and sulphur (S) for fertility maintenance and crop production. These nutrients are specific in function and must be supplied to plants at the right time and at the right quantity. Lack of sufficient amounts of these nutrients result in poor performance of the okra with growth been affected resulting to low yield (Chauhan 1972). Organic manure

helps to improve the physical condition of soil and provide adequate amount of necessary nutrients for the soil productivity (Qhureshi 2007).

Nitrogen is an essential element and important determinant in growth and development of crop plants. It plays an important role in chlorophyll, protein, nucleic acid, hormone and vitamin synthesis and also helps in cell division, cell elongation. Phosphorus fertilization can influence fruiting and development of okra. Phosphorus is called the "key to life" because it is directly involved in most living processes (Firoz 2009).

Phosphorus can influence fruiting and fruit developments of crops and regarded as key of life because it is directly involved in most living process. Phosphorus is a key constituent of ATP which transforms energy to the plant. Phosphorus take part in various physiological process and helps in nutrients uptake by promoting root growth and their by ensuring a good pod yield (Das *et al.* 2014)

Potassium plays a unique role in osmotic regulation, opening and closing of stomata and improves the colour, flavours and size of fruits (Bhende *et al.* 2015).

Sulfur is identified as a low acute toxic element in plant disease control (Singh *et al.* 2012). Basically, it prevents fungal infections including powdery mildew, black spots, and rusts. Since sulfur has the ability to prevent spore germination, it would be advantageous in the application at seedling stage sulfur is available in the market in the form of powder, liquid and wettable powder (Bilal 2008).

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 although the organic manures contain plant nutrients in small quantities as compared to the fertilizers, the presence of growth promoting principles like enzymes and hormones, besides plant nutrients make them essential for improvement of soil fertility and productivity (Premsekhar and Rajshree 2009)

Being a short duration crop, its growth and yield parameters are largely influenced by appropriate nutrient management practice. Sole application of chemical fertilizers to meet the crop nutrient demand is deleterious for both soil and environment (Thiruna and Balaji 2015). Hence, organic manure from different sources could be an effective substitute of chemical fertilizers which improves the crop yield and soil properties (physical and chemical). It has also been proved that organic sources contribute a lot in organic matter percentage in the soil.

In Bangladesh there is a great possibility of increasing okra yield per unit area with proper use of fertilizers. Fertilizer application in okra production is the most important management variable. Evidences reveal that appropriate combination of fertilizers play an important role for okra production. The yield of okra may be increased through judicious combination of fertilizers.

Considering above factors, the present piece of study was undertaken with the following objectives.

1. To determine the effect of fertilizer levels on growth and yield of okra.
2. To determine the effect of cowdung on growth and yield of okra.
3. To assess the optimum combination of NPKS and cowdung for different varieties of okra under local ecological conditions.

CHAPTER 2

REVIEW OF LITERATURE

Okra is a popular vegetable crop grown from seed which can grow on a wide range of soils. It is mainly cultivated in Kharif season in Bangladesh. Bangladesh is a poor yielder compared to other neighboring countries like India and other developing countries of the world. The low yield of okra in Bangladesh may be due to improper use of fertilizers and poor management practices. Some workers use NPKS fertilizers and cow-dung for the increase of growth, yield and yield attributes of okra. A number of experiments have been conducted to observe the, effect of different NPKS fertilizer levels and cow-dung on the growth, yield components and yield of different varieties of okra. In this chapter review of some of the available information related to the present study are given.

2.1. Effect of inorganic fertilizers

Dehigaspitiya *et al.* (2016) investigated that the effect of sulfur solutions as foliar spray with different concentrations on some selected growth parameters of ladies fingers plants. Result showed that the highest significant values in number of leaves (26), leaf length (21cm) and leaf width (24cm) were observed that in 10g/L solution of sulfur applied as foliar spray. Pest and disease incidence was significantly higher in control experiment while all the other treated plants don't showed any physiological damage or symptom. The results revealed that the application of sulfur as a foliar spray can be effectively use in increase the net photosynthetic area and to reduce the pest and disease incidence.

Mohsen and Abdel-Fatteh (2015) was conducted an field experiment to evaluate the response of nitrogen and phosphorus fertilizer rates with or without botanical compost regarding growth and yield of okra (*Abelmoschus esculentus* L.) as well as other attributes. The results showed that application of different levels of nitrogen plus phosphorus fertilizer combined with or without compost; significantly ($p<0.05$) influenced the growth, yield and other attributes of okra plants. Application of 100 kg N fedG1+75 kg P fedG1 with or without compost to okra plants gave the highest values of plant growth, yield and quality in the two studied seasons.

Bhende *et al.* (2015) evaluated the effect of phosphorus and potassium on quality attributes of okra with 4 levels of phosphorus and 4 levels of potassium. The result showed that the effect of phosphorus and potassium were found significantly increased with application of 75 kg P ha^{-1} and 75 kg k/ha. Seed quality characters like test weight and germination percentage were found significantly maximum with application of 75 N kg ha^{-1} and 75 kg S ha^{-1}. Overall assessment indicated that 75 kg P ha^{-1} and 75 kg N ha^{-1} was optimum dose for enhancing qualities of okra.

Singh *et al.* (2008) assessed the effect of nitrogen and plant spacing on the yield attributes, yield and nitrogen content of okra. The experiment comprised four levels of nitrogen (0, 60, 90 and 120 kg ha^{-1}) and three levels of plant spacing (40 x 20, 40 x 30 and 40 x 40 cm). Application of 120 kg nitrogen ha^{-1} caused to produce highest length, diameter, number of fruits, and fresh weight of fruit, yield ha^{-1} and nitrogen content in pods. Low plant density (40 x 40 cm) promoted all the

above fruiting attributes and nitrogen content in pods significantly as compared to high plant density barring the yield ha^{-1} however, it was recorded highest (118.46 q) under 40x30 cm spacing.

2.2. Effect of organic manure

Khandaker *et al.* (2017) an experiment was carried out to study the effect of different types of organic manures on yield performances of *Albemoschus esculentus* L. Moench (okra). The result showed that the application of poultry manure increased significantly the growth and yields performances on okra compared to other types of organic manures. Poultry manure significantly increased the plant height with 52.64 cm, while the lowest of 35.98 cm was from control plot. Okra yield of poultry manure plot had the highest number of pods with 9.67, while control plot had the lowest number of pods with 2.00. So, it can be concluded that application of poultry manure significantly increased the growth and yields performances on okra compared to other types of organic fertilizers.

A field experiment was conducted to evaluate the effect of nitrogen and bio-organics on growth and yield of okra under loamy sand soils during kharif season 2013 (Yadav *et al.* (2017). The results showed that the application of 100 kg N ha^{-1} (T_3) produced significantly highest both growth attributes viz. plant height at 30, 60 DAS and at harvest, number of branches per plant, leaf area, chlorophyll content and yield attributes. The results also showed that application of vermin-compost @ 5 t ha^{-1} + Azotobacter significantly increased the above growth and yield attributes as compared to rest of treatments. Application of 100 kg N ha^{-1}

with vermicompost @ 5 t ha^{-1} + Azoctobacter proved the best treatment combination in terms of fruit yield per plot, fruits yield ha^{-1} in comparison to other treatment combinations.

Anisa *et al.* (2016) investigated the effect of biofertilizers on rhizosphere microbial population of okra (*Abelmoschus esculentus* L. Moench). Biofertilizer application along with FYM had a positive influence on the inoculated microbes.

Kumar *et al.* (2013) studied the impact of integrated nutrient management (INM) on growth and economic yield of okra. The result showed that treatment T_5 (75 kg N + 40 kg P2O5 + 40 Kg K_2O + 5 tones VC) gave maximum plant height (84.70 cm), number of nodes (18.94) per plant, number of pods per plant (15.07), length of pod (14.31 cm), diameter of pod (1.69 cm), fresh weight of the plant (352.24 g), dry weight of the plant (286.14 g) and yield of green pods (72 g per plant). The treatment, T_5 (75 kg N + 40 kg P2O5 + 40 KG K2O + 5 tones VC) showed a comparatively better result of growth and yield than other treatments. So, it can be concluded that vermin-compost manure which contains the micronutrients with minimum inorganic manure may be a potential source for better growth and high yield in okra.

Sharma *et al.* (2010) recorded that application of 5 t ha^{-1} vermin-compost recorded significantly higher values of yield attributes, fruit yield (69.2 ha^{-1}) and protein content (18.0%) as well as B:C ratio (2.11) with net returns of Rupees 35614 ha^{-1} in okra crop.

Yadav and Yadav (2010) conducted an experiment on okra and observed that the integrated application of 75 percent RDF with vermicompost @ 6.5 t ha^{-1} gave significantly higher marketable fruit yield (86.40 g ha^{-1}), which was at par with the treatments namely 50 per cent RDF with vermin-compost @ 6.5 t ha^{-1} and 75 per cent RDF + Neem cake @ 3.5 t ha^{-1}.

Premsekhar and Rajshree (2009) investigated the influence of different organic manures on the growth, yield and quality of okra var. Arka Anamika. The results showed that FYM 20 t ha^{-1} recorded the highest yield of 10.39 t ha^{-1} with the B:C ratio of 3.56. The crude fibre content of fruits under this treatment was also less when compared to control.

2.3. Effect of organic manure and inorganic fertilizers

Zainab *et al. (*2016) a field experiment was conducted to evaluates the effects of organic and inorganic fertilizers on the growth of okra. Organic fertilizers (Cowdung and poultry droppings) and inorganic (NPK 15:15:15 and Urea 64:0) fertilizers were used for the experiment. The results obtained from the experiment showed that plants treated with poultry litters have best performance by recording the highest fresh and dry weight (0.39g) at 4 weeks after planting (WAP); highest stem height 29.33cm for all the concentrations applied. Similarly, it has highest leaf area and stem girth (64.67cm and 2.23cm respectively) at 8 weeks after planting.

Fagwalawa and Yahaya (2016) conducted a field experiment to investigate the effect of different sources organic manure on growth and yield of okra. Results

indicated that Poultry manure positively increased okra plant height by 30.40 % and SPC manure increased number of fruit of okra by 9.00 % compared to control treatments. Fresh fruit weight was significantly increased by 125.66 % with poultry manure compared to control treatments. Basal on the findings on the experiments it could be deduced that poultry manure seems to promote higher growth and yield of okra.

Sharma *et al.* (2015) studied the effect of organic manures and inorganic fertilizers on the growth and seed yield of okra. Application of 60:30:30 kg NPK/ ha significantly increased plant height (55.29 cm), stem diameter (5.7 cm), branches per plant (5.77), average fruit weight (15.55 g), marketable yield per plant (1.73 kg) and seed yield (12.78 q/ha) except than internodal length as compared to other treatments. The interaction between organic and inorganic fertilizers had significant beneficial effect on internodal length and yield of okra. Among fertilizer doses, 75 % RDF NPK gave maximum net returns and B:C ratio (2.26) and minimum in control.

Singh *et al.* (2015) investigated the response of different organic and inorganic fertilizers on growth & yield of okra. The results indicated that the vegetative growth characters plant height, diameter of stem, number of leaves per plant, days required for initiation of first flower as well as yield contributing characters viz. number of pods per plant, length of pod, fresh weight per pod, weight of pods per plant and yield of pods were found to be maximum in the application of treatments T_4 (50 kg N 25 kg P_2O_5 and 25 kg K_2O + 6 tons of vermicompost per ha as compared to control treatment and other treatments.

Sidhya *et al.* (2015) was conducted a field experiment to evaluate the influence of biofertilizer, organic manure and inorganic fertilizers individually and in combination on okra cv. VRO-6 with 8 treatments and 3 replications during summer- rainy season of 2009-2010. Results revealed that the combined application of mycorrhiza + 50 % organic manure + 50 % inorganic fertilizers or mycorrhiza + 75 % organic manure + 25 % inorganic fertilizer produced the highest fruit yield (13.67 t ha^{-1}) and other morphological characters under study all the treatments. Sole mycorrhizal application did not produce any better results unless it was combined with organic manure and inorganic fertilizer.

Sylvester *et al.* (2014) carried out an experiment to observe the performance of okra (*Abelmoschus esculentus* L. Moench*)* by using inorganic and organic fertilizer. Application of poultry manure at the rate of 10 t ha^{-1} had the highest yield and reduced number of insect pests, although mean plant height, mean leaf number and mean leaf number were highest with 500 kg ha^{-1} NPK treatment at 10 week after planting. Stem girth was highest in 10 t ha^{-1} poultry manure and was not significantly different from 500 kg ha^{-1} NPK treatment. Complementary application of 10 t ha^{-1} poultry manure and 300 kg ha^{-1} NPK favoured okra growth and yield most in terms of quality and quality (market value) and decreased insect pest infestations. Poultry manure at 10 t ha^{-1} turned out to be the most beneficial application compared with the other treatments.

Uka *et al.* (2013) compared the relative effect of organic and inorganic fertilizers on the growth of okra (*Abelmoschus esculentus* L). Cowdung and poultry droppings were applied at the rates of 2.5 kg per 10 kg of soil one week before

sowing, while NPK fertilizer (15:15:15) was applied at the rate of 6 g per 10 kg of soil three weeks after sowing. The application of Cowdung, poultry droppings and NPK fertilizer had significant effects on all the parameters assessed. The result shows that the use of organic manure in the production of vegetables like okra should be encouraged.

Attigah *et al.* (2013) a study on the effect of poultry and cattle manures on the growth and yield of okra (*Abelmoschus esculentus* L.*)* was carried out in 2008 and 2009. The treatments were; 350 kg ha^{-1} NPK, 8 t ha^{-1}Poultry Manure, 12 t ha^{-1} Cowdung Manure, 175 kg NPK + 4 t ha^{-1}Poultry Manure, 175 kg NPK + 6 t ha^{-1} Cowdung Manure and No treatment of manure (control). The combined treatments of 175 kg NPK + 4 t ha^{-1} Poultry Manure and 175 kg NPK + 6 t ha^{-1} Cowdung Manure produced higher levels of the growth and yield parameters than the rest of the treatments in both seasons. The treatment combination of 175 kg NPK + 4 t ha^{-1} Poultry Manure was more superior in the areas assessed.

Rahman and Akter (2012) investigated five different doses of NPK fertilizers, viz. T_0 (0N0P0K) – two kg Cowdung, T_1 (1N1P1K) (a) 2 kg cow-dung, 65 g urea, 150 g TSP and 105 g MP were applied during land preparation, (b) 65 g urea were applied after 25 days of sowing, T_2 (0N1P1K) – 2 kg cow-dung, 150 g TSP and 105 g MP were applied during land preparation, T_3 (1N0P1K) – (a) 2 kg cow-dung, 65 g urea and 105 g MP were applied during land preparation, (b) 65 g urea were applied after 25 days of sowing and T_4 (1N1P0K) – (a) 2 kg cow-dung, 65 g urea and 150 g TSP were applied during land preparation, (b) 65 g urea were applied after 25 days of sowing on the growth, yield and yield attributes of okra.

Gupta *et al.* (2011) a field experiment carried out to indicated that chemical fertilizers in form of nitrogen, phosphorus, potassium sulpher had a positive effect on plant in bringing morphological as well as biochemical changes. The biofertilizer and cowdung also showed positive effect in improving quality and quantity of the crop and the best results were obtained in the plot with combination of chemical fertilizers, biofertilizer and cowdung. the maximum root length, shoot length, dry weight of plant, number of fruits and total fruits production was found to be 13.20 cm, 37.56 cm, 12.64 and 4864 kg ha^{-1}, respectively in case of T7 (combination treatment).

Bairwa *et al.* (2009) reported that okra produced highest number of fruits (18.36), fruit yield (182.50 g plant-1 and 135.18 q ha^{-1}), fruit weight (17.65 g), length of fruits (12.26 cm) and thickness of fruits (1.898 cm) with the application of Neem cake 6 q ha^{-1} + cow-dung 10 q ha^{-1} + Azotobacter + PSB + 60 % recommended dose of NPK through inorganic fertilizers. The fruit yield was increased 29.30 per cent over control along with highest benefit cost ratio (3.19) in this treatment. Similarly, total chlorophyll content of leaves at 30 and 60 DAS (0.311 and 0.390 mg g^{-1} fresh weight) respectively, nitrogen (2.275 %), phosphorus (1.060 %) and potassium contents of leaves (1.443 %) and protein content of fruit (1.86 g 100 g^{-1}) were also highest with the same integrated nutrient management treatment.

Sharma *et al.* (2009) recorded highest yield of okra in the treatment comprising 100 % recommended NPK + vermicompost @ 10 t ha^{-1}, 11.10 and 11.63 t ha^{-1} during 2003 and 2004, respectively. Similarly, maximum yield of onion was observed in plots receiving 100 % recommended NPK plus 25 t vermicompost

ha^{-1} during both the years i.e. 9.83 and 14.67 t ha^{-1} during 2003-04 and 2004-05, respectively. After completion of the experiment, the highest available NPK content (303, 28.1, 345 kg ha^{-1}, respectively) were recorded in case of the treatment consisting of 10 t vermicompost ha^{-1} to okra and 25 t vermicompost ha^{-1} to onion along with 100 % NPK to these crops. Furthermore, yield of okra obtained at 5 t vermicompost ha^{-1} plus 100 % NPK (9.73 and 10.83 t ha^{-1} during 2003 and 2004) was at par with that under 10 t farmyard manure plus 100 % NPK (10.03 and 10.46 t ha^{-1} during 2003 and 2004). Similarly, yield of onion obtained at 12.5 t vermicompost ha^{-1} plus 100% NPK (8.38 and 12.56 t ha^{-1} during 2003-04 and 2004-05) was at par with that under 25 t farmyard manure ha^{-1} plus 100 % NPK (8.86 and 12.08 t ha^{-1} during 2003-04 and 2004-05).

Osmotoso and Shittu (2007) determined the effect of NPK fertilizers application rates and method of application on growth and yield of okra. Okra seed variety LD88 were treated to three levels of NPK fertilizers rates (0, 150 and 300 kg NPK/ha) and two methods of fertilizer application (ring and band method). The result indicated that the fertilizer NPK significantly increase growth parameters (plant height, leaf area, root length, number of leaves), yield and yield components with optimum yield of okra obtained at 150 NPK kg ha^{-1} and ring method of application seems appropriate of okra production.

Ray *et al.* (2005) investigated the feasibility of two biofertilizers either alone or in combination with cow-dung and different levels of NPK fertilisers in okra. Application of Azospirillum or Azotobacter supplemented with 15 cowdung t ha^{-1} and 25-12.5-12.5 kg N, P2O5, K2O/ha to okra was found to be more beneficial

for sustaining higher growth and yield of crop and promoting inherent fertility status of soil in medium land of Dankuni basin.

Dademal and Dongale (2004) conducted an experiment effect of application of organic manure (FYM @ 7.5 t ha^{-1}) with four levels of chemical fertilizer (0:0:0, 50:25:25, 100:50:50 and 150: 75: 75 kg NPK/ha) on content and uptake of nutrients (N, P and K) in okra. They observed that the effect of organic manure @ 7.5 t ha^{-1} FYM and higher chemical fertilizer (150: 75: 50 kg ha^{-1}) gave maximum uptake of N (63.28 kg ha^{-1}), P (9.97 kg ha^{-1}) and K (45.01 kg ha^{-1}) on lateritic soils.

Prabhu *et al.* (2002) studied the effect of integrated nutrient management on content and uptake of nutrient in okra cv. 'Parbhani Kranti'. They observed that maximum N, P, K contents were found in fruit at highest level of fertilizer doses i.e. at RDF (100: 50: 50 kg NPK/ha). Application of FYM and biofertilizer resulted in increase in NPK content in fruit. Combination of 2/3 RDF + FYM @ 10 t ha^{-1} + Azospirillum + VAM showed a higher content with maximum yield.

Abusaleha and Shanmugavelu (1988) carried out an experiment to observe the effect of organic sources of nitrogen with ammonium sulphate on growth and yield of okra cv. Pusa Sawani. The result showed that the organic sources application of 40 kg N through poultry manure stimulated better response than FYM, horse manure and even through ammonium sulphate. In later study,

2.4. Interactive effect of varieties and organic manures and inorganic fertilizers

Solangi *et al.* (2015) investigated the nutrient uptake of some okra varieties (i.e. Bemisal, Sabzpari and Reshum) as affected by different levels of applied N, P and K. On average, the maximum uptake of N (76.62 kg/ ha^{-1}), P (38.54 kg/ ha^{-1}) and K (48.68 kg/ ha^{-1}) was observed at the highest levels of NPK 140-75-75 kg/ ha^{-1}. The lowest N, P and K uptake was recorded in control, where no NPK fertilizers were applied. It was also observed that K uptake increased with the increase in P levels. Among the tested okra varieties, Sabz Pari got maximum uptake of NPK (56.73, 25.01 and 32.67 kg/ ha^{-1}) compared to Bemisal and Reshum.

Singh *et al.* (2014) examined the response of two okra (*Abelmoschus esculentus* L. Moench) varieties (Mahyco-12 and Parbhani Kranti) to fertilizer application using four levels of fertilizers (60-40-20, 90-60-40, 120-80-60 and 150-100-80 of NPK kg / ha). Mahyco-12 recorded significantly higher plant height, LAI, internode length and number of branches per plant, as compared to variety Parbhani Kranti and showed earlier 50 % flowering and first picking stages. The yield attributes and fruit yield of Mahyco-12 was significantly higher than Parbhani Kranti. Application of 150:100:80 kg NPK ha significantly increased growth, yield attributes and fruit yield of okra.

Singh *et al.* (2013) concluded that at lower levels of fertilizers the variety Mahyco-12 and Parbhani Kranti behaved equally well. However, at higher fertilizer doses the yield of variety Mahyco-12 was higher. The hybrid Mahyco12

showed better resistance to yellow vein mosaic virus (YVMV) and the incidence increased with increasing doses of fertilizer.

Achebe *et al.* (2013) investigated the effect of different levels of NPK fertilizers on six cultivars of okra *(Abelmoschus esculentus* L.*)*. The application of NPK 20:10:10 fertilizer level was significantly different from others in growth and yield parameters. Higher mean values were observed with 250 kg ha^{-1} level followed by 150 kg ha^{-1}. Cultivar LD — 88 performed better in number of pods and fresh pod weight. The application of 250 kg ha^{-1} level of NPK 20:10:10 fertilizer is appropriate in attaining high pod yield in Asaba and cultivar LD-88 showed the best performance in Asaba soil.

Gudugi (2013) a field experiment was conducted to investigate the effect of Cowdung and inorganic fertilizer on the growth and yield of Okra (*Abelmoschus esculentus* L.) during the 2011 and 2012 cropping seasons. The inorganic fertilizer was applied at rate of 200kg ha^{-1} Cowdung applied at 20 t ha^{-1} and inorganic fertilizer significantly produced taller plants, more leaves and more fruits. Non application of fertilizer significantly delayed flowering. In 2011, Cowdung at 20 t ha^{-1} and inorganic fertilizer statistically gave similar fruit weight which was significantly higher than other treatments. The highest fruit weight in 2012 was obtained with Cowdung at 20 t ha^{-1}.

Sajid *et al.* (2012) observed the impact of nitrogen and phosphorus on seed yield and yield components of okra cultivars. It is concluded that okra variety Green

Star and application of N and P (at rates of 100 kg N/ha +60 kg P/ha) in combination resulted in higher seed yield of okra.

Bodamwal and Rajput (2006) tried various organic manure (vermicompost @ 5 t ha^{-1}, neem cake @ 200 kg ha^{-1}) and inorganic source is chemical fertilizer (100% RDF 100:50: 50, 50% RDF and control) on Parbhani Kranti variety of okra at Parbhani. They observed that application of 50% RDF + 50% neem cake was found superior for length of fruit, diameter of fruit, number of fruit and dry weight of fruit.

Singh *et al.* (2005) studied the effect of various levels of nitrogen (50, 100 and 150 kg ha^{-1}) and phosphorous (30, 60 and 90 kg ha^{-1}) with gibberellic acid (0, 75 and 150 ppm) vegetative growth attributes and yield on Pusa Sawani variety of okra during rainy season. They observed that highest level of nitrogen (150 kg ha^{-1}) phosphorous (90 kg ha^{-1}) and gibbrellic acid (150 ppm) showed significantly highest values of plant height (137.75 cm) number of branches per plant (3.60), plant spared (998.41 cm^2), stem girth (2.41 cm), leaf area (128.69 cm^2) and yield (167.61 q/ha).

Paliwal *et al.* (1999) tried three levels of nitrogen (40, 80 and 120 kg ha^{-1}) and four levels of sulphur (40, 80, 120 and 160 kg ha^{-1}) on Pusa Sawani variety of okra at Coimbatore for finding out the growth and yield response. They found that application of N @ 120 kg ha^{-1} and sulphur @ 160 kg ha^{-1} showed highest yield as well as values of yield attributing characters viz., number of fruits per plant, length of fruit, diameter of fruit, mean fruit weight per plant and yield.

CHAPTER 3

MATERIALS AND METHODS

This chapter describes the experimental aspects of the study. The field experiment was conducted to study the effect of different levels of fertilizers and cowdung on yield of BARI Darosh-1 and Arka Anamica. The experiment was conducted research field, Hajee Mohammad Danesh Science and Technology University, Dinajpur during March to August 2018. The details of the materials used and techniques adopted during the course of investigation are furnished under the following headings and subheadings.

3.1. Experimental Site and Soil

The experimental site was located at 25° 38′ and 88°41′ E longitude and at the elevation of 34.5 m above the sea level. The experimental field was medium high land, sandy loam textured soil belonging to agro ecological zone 1 (AEZ 1) named old Himalayan piedmont plain (FAQ and UNDP 1988).

3.2. Climate and weather

The experiment field was under subtropical climate characterized by winter during the month of March to August 2018. The means of Meteorological information like regularly precipitation, relative humidity, maximum temperature and average temperature, day length and sunshine hours of the experimental site during the crop growing period are presented.

3.3. Experimental treatments

The two factors of experiment consisted of Nitrogen (N), Phosphorous (P), Potassium (K), Sulphur (S), Cowdung treatments and 2 cultivars.

a) Factor A (variety)

V_1 = Akra Anamica

V_2 = BARI Dherosh- 1

b) Factor B (cowdung)

T_1 = control (No fertilizer and No cowdung) kg ha^{-1}

T_2 = (N 100 + P 35 + K 70 + S 20) kg ha^{-1} (recommended dose of fertilizer for okra)

T_3 = ½ of T_2 + Cowdung (CD) 5 t ha^{-1}

T_4 = ½ of T_2 + Cowdung 10 t ha^{-1}

T_5 = ½ of T_2 + Cowdung 15 t ha^{-1}

3.4. Experimental design and Lay out

The field experiment was laid out in two factors Randomized Complete Block Design (RCBD) with three replications. The treatments were randomly allowed in each block. The experimental plot was first divided into blocks each representing a replication. Each block then divided into 10 unit plot of 1.5 × 2 m^2 sizes. The distance between block to block was 1 m and plot to plot was 0.50 m.

3.5. Preparation of the experimental field

The selected field for growing okra was first opened on March, 2018 by a tractor and was exposed to the sun for a week. Then the land was prepared to obtain good tilt by several ploughing, cross ploughing by a power tiller followed by laddering subsequent operations were done with harrow, spade and hammer. Weeds and stubbles were removed; large clods were broken into small particles and finally taken into a desirable tilt to ensure proper growing condition. The plot was partitioned into the unit plots as per the experimental design mentioned earlier different levels of fertilizer (chemical fertilizer) doses were applied in different plots according to lay out. Fertilizers were mixed well with the soil of each plot. Proper irrigation and drainage channels were also prepared around the plots. Each unit plot was prepared keeping 5 cm height from the drain. The bed soil was made friable and the surface of the bed was leveled.

3.6. Manuring and fertilization

Manures and fertilizers were applied as the methods of application described by Haque (1993). The entire quantity of Cowdung was applied just after opening the land. After laid out Urea, TSP, MP and gypsum were applied as the sources of nitrogen, phosphorous, potassium and sulphur respectively as per treatment of experiment.

The total quantity of TSP, MP, Gypsum and half of urea were applied as basal dose after preparing the plots. The half of urea of each treatment were applied 45 days after sowing seeds.

3.7. Collection and sowing of seeds

Seeds of the designated okra variety BARI Dharosh- 1 (released by Bangladesh Agricultural Research Institute in 1996) and Arka Anamica (Indian variety) were collected from local market of Siddik bazar, Dhaka and from dealer of Lal Teer Seed Ltd., Dhaka. The seeds were sown on 06/03/2018 in rows of raised beds. Row to row and plant to plant spacing were maintained 50 cm and 40 cm respectively. Three seeds were sown in each pit. Then the seeds were covered with fine soil by hand. Some seedlings were raised in poly bags (9 x 15 cm^2) for gap filling. The growth medium used in poly bags was prepared by mixing different doses (T_1, T_2, T_3, T_4, T_5) of fertilizers in different bags. The poly bags were watered just after sowing the seeds.

3.8. Intercultural operations

Necessary intercultural operations were done throughout the cropping season for proper growth and development of the plant. The growing seedlings were always kept under careful observation. After sowing the seeds, the following intercultural operations were accomplished for their better growth and development.

a) Thinning

Five to six days after germination only one healthy seedling was kept to grow in each location and other seedlings were removed.

b) Gap filling

Plots with growing seedlings were regularly observed to find out any damage and dead seedlings for its replacement. Gap filling was done as and when required.

c) Weeding

Weeding was done manually to keep the plot free from weeds when necessary.

d) Drainage

Stagnant water was effectively drained out at the time of heavy rain. Irrigation was applied when necessary.

3.9. Plant protection

The okra plants were infested by shoot and pod borer and Jassid. Hand picking of shoot and pod borer larvae, Shobicron 425 EC and Aktara 25 WG were sprayed as control measures.

3.10. Sampling and data collection

The first sampling was done at 25 DAS and it was continued at an interval of 25 DAS, viz. 50, 75, 100, and 125 DAS. At each harvest from 3 selected plants leaf number, plants height and branch number were collected and plant height was measured with a graduated scale placed on the ground level to top of the leaves. The number of leaves per plant, plant height (cm) and branch number per plant were recorded separately at each harvest. The sampling was done at 25 DAS interval until maturity and the following characters were studied. Data of days to 50% seed emergence, leaf area (cm^2), nodal distance (cm), days to first flowering, number of branches $plant^{-1}$ were collected.

In case of edible fruit , fruits were collected at 2 days interval and after final collection total no of edible fruit $plant^{-1}$, fruit length $plant^{-1}$ (cm) and fruits weight

plant^{-1} (g) fruits weight (t ha^{-1}), seed number fruit^{-1}, seed weight fruit^{-1} (g), seed yield plant^{-1} (g), 1000 seed weight (g), seed yield (g plot^{-1}) and seed yield (t ha^{-1}) were calculated.

3.11. Morphological parameters

a) Leaf number

Three plants were tagged for data collection. From these tagged plant data on leaf no/plant was counted with an interval of 25 DAS, viz. 50, 75, 100 and 125 DAS.

b) Plant height (cm)

Three plants were tagged for data collection. From these tagged plant data on plant height per plant (cm) was recorded from ground levels to top of the leaves and it was continued from each plot starting for 25 DAS, viz. 50, 75, 100 and 125 DAS.

c) Branch number

Three plants were tagged for data collection. From these tagged plant data on branch number per plant was counted at an interval of 25 DAS, viz. 50, 75, 100 and 125 DAS.

d) 50% seed emergence

The date of 50% seed germination of each plot was recorded and days were counted from the day of seed sowing.

e) Days to first flowering

The days to first flowering of each plot was recorded, days were counted from the day of seed sowing.

f) Leaf area (cm^2)

Leaf area per plant (cm^2) was measured by a digital leaf area meter (Model: Cl 202, USA). For data collection 5th leaf from the top of plant was selected. Data were collected at 75 DAS and after final collection, average leaf area $plant^{-1}$ (cm^2) was calculated.

g) Nodal distance $plant^{-1}$ (cm)

In case of nodal distance, data were collected at 75 DAS and after final collection, average nodal distance $plant^{-1}$ was calculated.

3.12. Yield and yield contributing characters

a) Number of Fruit $plant^{-1}$

In case of number of edible fruits $plant^{-1}$ were collected at 2 days interval and after final collection total number of edible fruit $plant^{-1}$was calculated.

b) Fruit length $plant^{-1}$ (cm)

In case of fruit length plant-1, data were collected at 2 days interval and after final collection average fruit length plant' was calculated.

c) Fruit weight $plant^{-1}$ (g)

In case of fruit weight $plant^{-1}$ (g), fruits were collected at 2 days interval and after final collection average fruit weight (g) $plant^{-1}$ were calculated.

d) Fruit weight (t ha^{-1})

In case of fruit weight (t ha^{-1}), weight plant^{-1} was collected into t ha^{-1}.

e) Number of Seed fruit^{-1}

Ten fruits from each plot were taken and seed number was counted and average seed number was calculated.

f) Seed weight fruit^{-1} (g)

Ten fruits from each plot were taken and seed weight was measured and from this seed weight fruit^{-1} (g) was calculated.

g) Seed yield plant^{-1} (g)

All seeds from tagged three plants were collected and weight of seed was taken by sun drying.

h) 1000- seed weight (g)

1000- seed weight (g) was measured by an electric balance.

i) Seed yield (g plot^{-1})

Seed yield (g plot') was calculated from seed weight plant^{-1}.

j) Seed yield (t ha^{-1})

Seed yield (t ha^{-1}) was calculated from seed yield (g plot^{-1}).

3.13. Statistical analysis

The collected data were analyzed using the computer package program MSTAT and the significance of the mean differences were adjudged by the "Duncan's Multiple Range Test" (Gomez and Gomez, 1984).

CHAPTER 4

RESULTS AND DISCUSSION

Phenological Parameters

4.1. Emergence (%)

Emergence percentage was significantly influenced by the variety. The highest days was observed in BARI Dherash-1 (6.27) and the lowest days was observed in Arka Anamica (5.8). Emergence percentage was also influence by the fertilizer application methods. The highest days was observed in T_1 (6.67) treatment and the lowest days was T_5 (5.33) treatment.

Interaction effect of variety and fertilizer was significantly influenced in emergence days. The highest days required for germination in V_1T_1 (6.67), V_2T_1 (6.67) and V_2T_3 (6.67) treatment combination and the lowest days was V_1T_4 (5.33) treatment combination.

4.2. Days to first flower initiation

Days to first flower initiation was significantly influenced by the variety. The highest days was required in Arka Anamica (23.00) and the lowest days was required in BARI Dherash-1 (21.2). Days to first flower initiation was also significantly influenced by the fertilizer application methods. The highest days was required in T_1 (23.84) treatment and the lowest was T_5 (21.00) treatment.

Interaction effect of variety and fertilizer was not significantly influenced in days to first flower initiation. The highest days required for first flower initiation in

V_1T_1 (24.67) treatment combination and the lowest was V_2T_5 (20.33) treatment combination.

4.3. Days to first flowering

Days to first flower was significantly influenced by the variety. The highest days was required in Arka Anamica (30.94) and the lowest days was required in BARI Dherash-1 (28.6). Days to first flower initiation was also significantly influenced by the fertilizer application methods. The highest days required in T_1 (32.0) treatment and the lowest was T_5 (28.5) treatment.

Interaction effect of variety and fertilizer was significantly influenced in days to first flower. The height days require for days to first flower was in V_1T_1 (32.67) treatment combination and the lowest was V_2T_5 (27.67) treatment combination which was similar to V_2T_2 (27.67).

Table 1: Effect of NPKS and cowdung on the emergence %, days to first flower initiation and days to first flowering of okra verities

Variety	Days to germination % (DAS)	Days to first flower initiations	Days to first flowering
Arka Anamica (V_1)	5.80 b	23.00 a	30.94 a
BARI Dherash-1(V_2)	6.27 a	21.20 b	28.60 b
Sig. level	*	*	*
Fertilizer			
T_1	6.67 a	23.84 a	32.00 a
T_2	5.83 c	21.50 d	28.67 d
T_3	6.50 b	22.50 b	30.00 b
T_4	5.83 c	21.67 c	29.67 c
T_5	5.33 d	21.00 e	28.5 e
Sig. level	**	*	*
Interaction			
V_1T_1	6.67 a	24.67 a	32.67 a
V_1T_2	5.67 d	22.33 e	29.67 d
V_1T_3	6.33 b	23.67 b	31.67 b
V_1T_4	5.33 e	22.67 d	31.33 c
V_1T_5	5.34 e	21.67 f	29.33 d
V_2T_1	6.67 a	23.00 c	31.33 c
V_2T_2	6.00 c	20.67 h	27.67 g
V_2T_3	6.67 a	21.33 g	28.33 e
V_2T_4	6.33 b	20.67 h	28.00 f
V_2T_5	5.67 d	20.33 i	27.67 g
CV(%)	11.12	3.93	4.26
SE	0.547	0.707	1.036
Sig. level	*	*	*

T_1= control (No fertilizer and No Cowdung)

T_2 = (N 100 kg ha^{-1}) + (P 35 kg ha^{-1}) + (K 70 kg ha^{-1}) + (S 20 kg ha^{-1}) (recommended dose of fertilizer for okra)

T_3 = 1/2 of T_2 + Cowdung 5 t ha^{-1}

T_4 = 1/2 of T_2 + Cowdung 10 t ha^{-1}

T_5 = 1/2 of T_2 + Cowdung 15 t ha^{-1}

* = significant 5% level of probability

4.4. Morphological parameters

4.4.1. Plant height (cm)

4.4.1.1. Plant height at 25 DAS

Plant height at 25 days was significantly influenced by the variety. The highest value was observed in Arka Anamica (11.66) and the lowest value was observed in BARI Dherash-1 (10.71). Plant height was significantly influenced by the application method of fertilizer. The highest value was observed in T_5 (12.65) treatment and the lowest was T_1 (9.57) treatment.

Interaction effect of variety and fertilizer was also significantly influenced in plant height of okra. The height value was observed in V_1T_5 (13.01) treatment combination and the lowest was V_2T_1 (9.15) treatment combination.

4.4.1.2. Plant height at 50 DAS

Plant height at 50 days was significantly influenced by the variety. The highest value was observed in Arka Anamica (36.60) and the lowest value was observed in BARI Dherash-1(35.92). Plant height was significantly influenced by the application method of fertilizer. The highest value was observed in T_5 (39.84) treatment and the lowest was T_1 (33.11) treatment.

Interaction effect of variety and fertilizer was also significantly influenced in plant height of okra. The height value was observed in V_2T_5 (40.11) which was followed by V_1T_5 (39.56) and the lowest value was in V_2T_1 (32.22) treatment combination.

4.4.1.3. Plant height at 75 DAS

Plant height at 75 days was significantly influenced by the variety. The highest value was observed in Arka Anamica (83.79) and the lowest value was observed in BARI Dherash-1(81.22). Plant height was significantly influenced by the application method of fertilizer. The highest value observed in T_5 (99.95) treatment and the lowest was T_1 (70.29) treatment. Khan *et al.* (2002) and Rahman and Akter (2012) also reported significant influence of varieties on plant height.

Interaction effect of variety and fertilizer was significantly influenced in plant height of okra. The height value was observed in V_1T_5 (100.56) treatment combination and the lowest was V_2T_1 (68.15) treatment combination.

It might be due to higher amount of nitrogen, having greater availability of salt like nitrate, phosphate potash and sulphur which significantly increase the plant height (Kumar *et al.* 2013). Observations regarding plant height were in close conformity with the Das *et al.* (2014), Sidhya *et al.* (2015) and Singh *et al.* (2015). Combined effect of varieties and nutrient levels showed non-significant effect of plant height of okra.

4.4.1.4. Plant height at 100 DAS

Plant height at 100 days was significantly influenced by the variety. The highest value was observed in BARI Dherash-1 (134.98) and the lowest value was observed in Arka Anamica (134.93). Plant height was significantly influenced by

the application rate of fertilizer. The highest value observed in T_5 (149.44) treatment and the lowest in T_1 (119.44) treatment.

Interaction effect of variety and fertilizer was significantly influenced in plant height of okra. The height value was observed in V_2T_5 (150.11) treatment combination and the lowest in V_2T_1 (119.33) treatment combination.

4.4.1.5. Plant height at 125 DAS

Plant height at 125 days was significantly influenced by the variety. The highest value was observed in Arka Anamica (157.62) and the lowest value was observed in BARI Dherash-1(156.19). Plant height was significantly influenced by the application rate of fertilizer. The highest value observed in T_5 (171.89) treatment and the lowest in T_1 (142.84) treatment.

Interaction effect of variety and fertilizer was significantly influenced in plant height. The height value was observed in V_1T_5 (173.67) treatment combination and the lowest in V_2T_1 (140.78) treatment combination.

Table 2: Effect of NPKS and cowdung on the plant height of okra varieties at different DAS

Variety	Plant height at 25 DAS	Plant height at 50 DAS	Plant height at 75 DAS	Plant height at 100 DAS	Plant height at 125 DAS
Arka Anamica (V_1)	11.66 a	36.60 a	83.79 a	134.93 b	157.62 b
BARI Dherash-1(V_2)	10.71 b	35.92 b	81.22 b	134.98 a	156.19 a
Sig. level	*	*	*	**	*
Fertilizer					
T_1	9.57 e	33.11 e	70.29 e	119.44 e	142.84 e
T_2	11.55 b	37.17 b	88.27 b	142.36 b	163,73 b
T_3	10.70 d	35.11 d	75.52 d	129.89 d	151.81 d
T_4	11.43 c	36.05 c	78.50 c	133.61 c	154.27 c
T_5	12.65 a	39.84 a	99.95 a	149.44 a	171.89 a
Sig. level	*	*	**	*	*
Interaction					
V_1T_1	9.97 i	33.99 h	72.43 i	119.56 i	144.89 i
V_1T_2	12.11 c	37.33 c	88.49 c	141.95 d	165.22 c
V_1T_3	11.16 e	35.11 f	76.03 f	130.89 g	149.62 h
V_1T_4	11.99 d	37.00 e	81.41 e	133.44 f	154.67 e
V_1T_5	13.01 a	39.56 b	100.56 a	148.78 b	173.67 a
V_2T_1	9.15 j	32.22 i	68.15 j	119.33 j	140.78 j
V_2T_2	10.99 f	37.01 d	88.06 d	142.78 c	162.22 d
V_2T_3	10.22 h	35.11 g	74.99 h	128.89 h	154.00 f
V_2T_4	10.87 g	35.11 g	75.58 g	133.77 e	153.89 g
V_2T_5	12.28 b	40.11 a	99.33 b	150.11 a	170.11 b
CV(%)	7.29	8.42	10.27	9.45	7.49
SE	0.483	0.717	2.70	2.68	0.547
Sig. level	*	*	**	*	*

T_1= control (No fertilizer and No Cowdung)

T_2 = (N 100 kg ha^{-1}) + (P 35 kg ha^{-1}) + (K 70 kg ha^{-1}) + (S 20 kg ha^{-1}) (recommended dose of fertilizer for okra)

T_3 = 1/2 of T_2 + Cowdung 5 t ha^{-1}

T_4 = 1/2 of T_2 + Cowdung 10 t ha^{-1}

T_5 = 1/2 of T_2 + Cowdung 15 t ha^{-1}

* = significant 5% level of probability, ** = significant 1% level of probability

4.4.2. Number of leaves per plant

4.4.2.1. Number of leaves at 25 DAS

Number of leaves at 25 days after sowing (DAS) was significantly influenced by variety. The highest leaf number per plant was observed in Arka Anamica (5.33) and the lowest leaf number per plant was observed in BARI Dherash-1 (4.88). Number of leaves per plant was significantly influenced by fertilizer application methods. The highest value was observed in T_5 (5.89) treatment and the lowest in T_1 (3.89) treatment.

Number of leaves per plant at 25 DAS was also significantly influenced by the interaction effect of variety and fertilizer application methods. The highest value was observed in V_1T_5 (6.33) treatment combination and the lowest in V_2T_1 (3.44) treatment combination.

4.4.2.2. Number of leaves at 50 DAS

Number of leaves at 50 days after sowing (DAS) was significantly influenced by variety. The highest leaf number per plant was observed in Arka Anamica (16.06) and the lowest leaf number per plant was observed in BARI Dherash-1 (15.56). Number of leaves per plant was significantly influenced by fertilizer application methods. The highest value was observed in T_5 (19.27) treatment and the lowest in T_1 (11.33) treatment. The number of leaves per plant was influenced significantly due to different treatments of varieties and nutrient levels. These findings are in line with findings of Singh *et al.* (2014).

Number of leaves per plant at 50 DAS was also significantly influenced by the interaction effect of variety and fertilizer application methods. The highest value was observed in V_1T_5 (19.56) treatment combination and the lowest in V_2T_1 (10.90) treatment combination.

Nutrient levels had exhibited significant effect on number of leaves per plant. Highest number of leaves per plant were reported for the reason is to the effect of plant nutrients by addition of fertilizer leading to increased uptake of NPKS (Singh *et al.,* 2015). Similar findings have been reported by Yadav *et al.* (2006), Prasad and Naik (2013) and Sharma *et al.* (2015). Combined effect of varieties and nutrient levels had non-significant effect on number of leaves per plant at all the stages of crop under study (Singh *et al.,* 2015).

4.4.2.3. Number of leaves at 75 days

Number of leaves at 75 days after sowing (DAS) was significantly influenced by the variety. The highest leaf number per plant was observed in Arka Anamica (26.04) and the lowest leaf number per plant was observed in BARI Dherash-1(25.67). Number of leaves per plant was significantly influenced by fertilizer application methods. The highest leaf number per plant observed in T_5 (32.67) treatment and the lowest in T_1 (18.73) treatment.

Number of leaves per plant at 75 DAS was also significantly influenced by the interaction effect of variety and fertilizer application methods. The highest leaf number per plant was observed in V_1T_5 (33.67) treatment combination and the lowest in V_2T_1 (18.11) treatment combination.

4.4.2.4. Number of leaves at 100 DAS

Number of leaves at 100 days after sowing (DAS) was significantly influenced by variety. The highest leaf number per plant was observed in Arka Anamica (36.67) and the lowest leaf number per plant was observed in BARI Dherash^{-1} (34.31). Number of leaves per plant was significantly influenced by fertilizer application methods. The highest leaf number per plant was observed in T_5 (43.05) treatment and the lowest was T_1 (24.49) treatment.

Number of leaves per plant at 100 DAS was also significantly influenced by the interaction effect of variety and fertilizer application methods. The highest leaf number per plant was observed in V_1T_5 (43.79) treatment combination and the lowest was V_2T_1 (24.33) treatment combination.

4.4.2.5. Number of leaves at 125 DAS

Number of leaves at 125 days after sowing (DAS) was significantly influenced by variety. The highest leaf number per plant was observed in Arka Anamica (9.48) and the lowest leaf number per plant was observed in BARI Dherash-1(9.22). Number of leaves per plant was significantly influenced by fertilizer application methods. The highest leaf number per plant observed in T_5 (12.22) treatment and the lowest in T_1 (6.27) treatment.

Number of leaves per plant at 125 DAS was also significantly influenced by the interaction effect of variety and fertilizer application methods. The highest leaf number per plant was observed in V_1T_5 (12.67) treatment combination) and the lowest was V_2T_1 (6.22) treatment combination.

Table 3: Effect of NPKS and cowdung on the number of leaves per plant of okra varieties

Variety	Number of leaves at 25 DAS	Number of leaves at 50 DAS	Number of leaves at 75 DAS	Number of leaves at 100 DAS	Number of leaves at 125 DAS
Arka Anamica (V_1)	5.33 a	16.06 a	26.04 a	36.67 a	9.48 a
BARI Dherash-1(V_2)	4.88 b	15.56 b	25.67 b	34.31 b	9.22 b
Sig. level	*	**	*	*	*
Fertilizer					
T_1	3.89 e	11.33 e	18.73 e	24.49 e	6.27 e
T_2	5.59 b	17.33 b	28.56 b	38.95 b	9.99 b
T_3	4.92 d	14.56 d	21.33 d	32.10 d	8.89 d
T_4	5.25 c	16.62 c	27.99 c	38.84 c	9.38 c
T_5	5.89 a	19.27 a	32.67 a	43.05 a	12.22 a
Sig. level	*	*	*	*	*
Interaction					
V_1T_1	4.33 i	11.78 i	19.33 i	24.67 i	6.33 i
V_1T_2	5.67 b	17.00 e	29.11 d	41.00 c	9.99 d
V_1T_3	5.00 g	15.90 g	21.56 g	33.22 g	9.00 g
V_1T_4	5.33 f	16.11 f	26.56 f	40.67 d	9.44 e
V_1T_5	6.33 a	19.56 a	33.67 a	43.79 a	12.67 a
V_2T_1	3.44 j	10.90 j	18.11 j	24.33 j	6.22 j
V_2T_2	5.50 c	17.68 c	28.00 e	36.90 f	10.00 c
V_2T_3	4.84 h	13.22 h	21.11 h	30.99 h	8.78 h
V_2T_4	5.16 e	17.11 d	29.44 c	37.00 e	9.33 f
V_2T_5	5.44 d	19.00 b	31.67 b	42.33 b	11.79 b
CV(%)	13.15	11.00	10.93	4.62	8.48
SE	0.547	1.42	2.30	1.34	0.648
Sig. level	*	*	*	*	*

T_1= control (No fertilizer and No Cowdung)

T_2 = (N 100 kg ha^{-1}) + (P 35 kg ha^{-1}) + (K 70 kg ha^{-1}) + (S 20 kg ha^{-1}) (recommended dose of fertilizer for okra)

T_3 = 1/2 of T_2 + Cowdung 5 t ha^{-1}

T_4 = 1/2 of T_2 + Cowdung 10 t ha^{-1}

T_5 = 1/2 of T_2 + Cowdung 15 t ha^{-1}

* = significant 5% level of probability

4.4.3. Number of branches plant^{-1}

4.4.3.1. Number of branches at 50 DAS

Number of branches per plant at 50 DAS was significantly influenced by the variety. The highest number of branches per plant was observed in Arka Anamica (1.92) and the lowest number of branches per plant was observed in BARI Dherash-1 (1.67). Number of branches per plant was significantly influenced by fertilizer application methods. The highest number of branches per plant was observed in T_5 (2.44) treatment and the lowest number of branches per plant was in T_1 (1.05) treatment.

Number of branches per plant in okra was significantly influenced by the interaction effect of variety and fertilizer application methods. The highest number of branches per plant was observed in V_1T_5 (2.56) treatment combination and the lowest number of branches per plant was observed V_2T_1 (0.78) treatment combination.

4.4.3.2. Number of branches at 75 DAS

Number of branches per plant at 75 DAS was significantly influenced by the variety. The highest number of branches per plant was observed in Arka Anamica (2.44) and the lowest was observed in BARI Dherash-1(2.08). Number of branches per plant was significantly influenced by fertilizer application methods. The highest number of branches per plant was observed in T_5 (3.00) treatment and the lowest number of branches was in T_1 (1.67) treatment.

The number of branches per plant was influenced significantly due to different treatments of varieties and nutrient levels. Minimum number of branches per plant was observed in variety V_2 (BARI Dherash-1). These findings are in line with findings of Singh *et al.* (2014).

Number of branches per plant was significantly influenced by the interaction effect of variety and fertilizer application methods. The highest number of branches per plant was observed in V_1T_5 (3.11) treatment combination and the lowest in V_2T_1 (1.56) treatment combination.

Nutrient levels had exhibited significant effect on number of branches per plant. Highest number of leaves per plant were reported for the reason is to the effect of plant nutrients by addition of fertilizer leading to increased uptake of NPK (Singh *et al.*, 2015). Similar findings have been reported by Yadav *et al.* (2006), Prasad and Naik (2013) and Sharma *et al.* (2015). Combined effect of varieties and nutrient levels had non-significant effect on number of branches per plant at all the stages of crop under study.

4.4.3.3. Number of branches at 100 DAS

Number of branches per plant at 100 DAS was significantly influenced by the variety. The highest number of branches per plant was observed in Arka Anamica (3.74) and the lowest number of branches per plant was observed in BARI Dherash-1(3.06). Number of branches per plant was significantly influenced by the fertilizer application methods. The highest number of branches per plant

observed in T_5 (4.24) treatment and the lowest number of branches per plant in T_1 (2.84) treatment.

Number of branches per plant was significantly influenced by the interaction effected of variety and fertilizer application methods. The highest number of branches per plant was observed in V_1T_5 (4.11) treatment combination and the lowest number of branches per plant was V_2T_1 (2.44) treatment combination.

4.4.3.4. Number of branches at 125 DAS

Number of branches per plant at 125 DAS was significantly influenced by the variety. The highest number of branches per plant was observed in Arka Anamica (3.80) and the lowest number of branches per plant was observed in BARI Dherash-1(3.37). Number of branches per plant was significantly influenced by the fertilizer application methods. The highest number of branches per plant was observed in T_5 (4.16) treatment and the lowest number of branches per plant was T_1 (2.95) treatment.

Number of branches per plant was significantly influenced by the interaction effected of variety and fertilizer application methods. The highest number of branches per plant was observed in V_1T_5 (4.33) treatment combination and the lowest number of branches per plant V_2T_1 (2.56) treatment combination.

Table 4: Effect of NPKS and cowdung on the number of branches of okra varieties

Variety	Number of branches at 50 DAS	Number of branches at 75 DAS	Number of branches at 100 DAS	Number of branches at 125 DAS
Arka Anamica (V_1)	1.92 a	2.44 a	3.74 a	3.80 a
BARI Dherash-1(V_2)	1.67 b	2.08 b	3.06 b	3.37 b
Sig. level	*	**	*	*
Fertilizer				
T_1	1.05 e	1.67 e	2.84 e	2.95 e
T_2	2.05 b	2.44 b	3.67 b	3.78 b
T_3	1.44 d	1.95 d	3.05 d	3.39 d
T_4	1.95 c	2.27 c	3.44 c	3.67 c
T_5	2.44 a	3.00 a	4.24 a	4.16 a
Sig. level	*	*	*	*
Interaction				
V_1T_1	1.33 h	1.78 h	3.22 g	3.33 g
V_1T_2	2.11 c	2.67 c	4.00 b	3.89 c
V_1T_3	1.56 i	2.11 g	3.56 e	3.67 e
V_1T_4	2.00 d	2.56 d	3.78 d	3.78 d
V_1T_5	2.56 a	3.11 a	4.11 a	4.33 a
V_2T_1	0.78 j	1.56 i	2.44 j	2.56 i
V_2T_2	1.99 e	2.22 e	3.33 f	3.67 e
V_2T_3	1.33 g	1.78 h	2.56 i	3.11 h
V_2T_4	1.89 f	2.21 f	3.11 h	3.56 f
V_2T_5	2.33 b	2.89 b	3.89 c	3.99 b
CV(%)	23.70	17.62	16.06	12.45
SE	0.346	0.326	0.447	0.366
Sig. level	*	**	*	*

T_1= control (No fertilizer and No Cowdung)

T_2 = (N 100 kg ha^{-1}) + (P 35 kg ha^{-1}) + (K 70 kg ha^{-1}) + (S 20 kg ha^{-1}) (recommended dose of fertilizer for okra)

T_3 = 1/2 of T_2 + Cowdung 5 t ha^{-1}

T_4 = 1/2 of T_2 + Cowdung 10 t ha^{-1}

T_5 = 1/2 of T_2 + Cowdung 15 t ha^{-1}

* = significant 5% level of probability, ** = significant 1% level of probability

4.4.4. Leaf length (cm)

4.4.4.1. Leaf length (cm) at 75 DAS

Leaf length (cm) per plant at 75 DAS was significantly influenced by the variety. The highest leaf length (cm) was observed was Arka Anamica (16.04) and the lowest leaf length (cm) was observed in BARI Dherash-1 (14.63). Leaf length (cm) was significantly influenced by the fertilizer application methods. The highest leaf length (cm) observed was T_5 (17.02) treatment and the lowest leaf length (cm) was T_1 (13.70) treatment. These findings are in line with findings of Singh *et al*. (2014). Leaf length (cm) per plant in okra was significantly influenced by the interaction effect of variety and fertilizer application methods. The highest leaf length (cm) was observed in V_1T_5 (18.11) treatment combination and the lowest leaf length (cm) was observed V_2T_1 (13.21) treatment combination.

Nutrient levels had exhibited significant effect on leaf length. Highest leaf length (cm) per plant were reported for the reason is to the effect of plant nutrients by addition of compost leading to increased uptake of NPK (Singh *et al*., 2015). Similar findings have been reported by Yadav *et al*. (2006), Prasad and Naik (2013) and Sharma *et al*. (2015). Combined effect of varieties and nutrient levels had non-significant effect on number of branches per plant at all the stages of crop under study.

4.4.5. Leaf breath (cm)

4.4.5. 1. Leaf breadth (cm) at 75 DAS

Leaf breadth (cm) at 75 DAS was significantly influenced by the variety. The highest leaf breadth (cm) was observed in Arka Anamica (14.16) and the lowest leaf breadth (cm) was observed in BARI Dherash-1(13.77). Leaf breadth was significantly influenced by the fertilizer application methods. The highest leaf breadth (cm) was observed in T_5 (15.38) treatment and the lowest leaf breadth (cm) was T_1 (12.30) treatment. The leaf breath per plant in okra was significantly influenced by the interaction effect of variety and fertilizer application methods. The highest leaf breadth was observed in V_1T_5 (15.78) treatment combination and the lowest was V_2T_1 (11.84) treatment combination.

4.4.6. Nodal distance (cm)

4.4.6.1. Nodal distance (cm) at 75 DAS

Nodal distance (cm) at 75 DAS was significantly influenced by the variety. The highest value was observed in Arka Anamica (7.08 cm) and the lowest value was observed in BARI Dherash-1 (6.57 cm). Nodal distance was significantly influenced by the fertilizer application methods. The highest value observed in T_5 (7.88cm) treatment and the lowest was T_1 (5.52 cm) treatment. These results are in close conformity with the findings of Singh *et al.* (2014). The nodal distance per plant in okra was significantly influenced by the interaction effect of variety and fertilizer application methods. The highest value was observed in V_1T_5 (8.16

cm) treatment combination and the lowest in V_2T_1 (5.25 cm) treatment combination.

The beneficial effect of application of organic manures along with inorganic fertilizers reflected in enhanced vegetative growth of plant. This may be attributed to the synergistic effect of organic manure in making available more plant nutrient by improving the soil physical and chemical condition and solubilizing the nutrients. Moreover, the organic manures are also significant sources of major and micronutrients much needed by plants (Tyagi *et al.*, 2016). Similar results have been reported by Das *et al.* (2014) and Sharma *et al.* (2015) in okra. Combined effect of varieties and nutrient levels had non-significant effect on internodal length (cm) at all the stages of crop under study.

Table 5: Effect of NPKS and cowdung on the plant leaf length (cm), leaf breath (cm) and nodal distance (cm) of okra varieties

Variety	Leaf length (cm) at 75 DAS	Leaf breadth (cm) at 75 DAS	Nodal distance (cm) at 75 DAS
Arka Anamica (V_1)	16.04 a	14.16 a	7.08 a
BARI Dherash-1(V_2)	14.63 b	13.77 b	6.57 b
Sig. level	*	*	*
Fertilizer			
T_1	13.70 e	12.30 e	5.52 e
T_2	16.04 b	14.58 b	7.34 b
T_3	14.99 c	13.70 d	6.57 d
T_4	14.94 d	13.89 c	6.81 c
T_5	17.02 a	15.38 a	7.88 a
Sig. level	*	**	*
Interaction			
V_1T_1	14.16 j	12.78 i	5.80 i
V_1T_2	16.73 b	14.80 c	7.50 c
V_1T_3	15.46 e	13.64 h	6.90 g
V_1T_4	15.74 d	13.87 f	7.03 e
V_1T_5	18.11 a	15.78 a	8.16 a
V_2T_1	13.21 i	11.84 j	5.25 j
V_2T_2	15.35 f	14.36 d	7.18 d
V_2T_3	14.52 g	13.75 g	6.22 h
V_2T_4	14.13 h	13.90 e	6.59 f
V_2T_5	15.93 c	14.99 b	7.60 b
CV(%)	5.00	3.20	15.79
SE	0.627	0.366	0.880
Sig. level	*	*	*

T_1= control (No fertilizer and No Cowdung)
T_2 = (N 100 kg ha^{-1}) + (P 35 kg ha^{-1}) + (K 70 kg ha^{-1}) + (S 20 kg ha^{-1}) (recommended dose of fertilizer for okra)
T_3 = 1/2 of T_2 + Cowdung 5 t ha^{-1}
T_4 = 1/2 of T_2 + Cowdung 10 t ha^{-1}
T_5 = 1/2 of T_2 + Cowdung 15 t ha^{-1}
* = significant 5% level of probability

4.5. Yield and yield components

4.5.1. Number of green fruits per plant

Number of green fruit per plant was significantly influenced by the variety. The highest number of green fruits per plant was observed in Arka Anamica (23.86) and the lowest was observed in BARI Dherash-1 (21.14). Number of green fruit per plant was significantly influenced by fertilizer application methods. The highest value was observed in T_5 (26.67) treatment followed by recommended dose of fertilizer application T_2 (23.33) and the lowest number of green fruit per plant was found in T_1 (20.26). These findings are in resemblances with the results obtained by Khan *et al.* (2002) and Jamala *et al.* (2011). Interaction effect of variety and fertilizer was significantly influenced in green fruit per plant. The highest value was observed in V_1T_5 (28.22) treatment combination and the lowest in V_2T_1 (19.05) treatment combination.

Similar findings of significantly higher number of fruits/plant by the use of organic manure & inorganic fertilizers have also been reported by Prasad and Naik (2013), Singh *et al.* (2015) and Tyagi *et al.* (2016) in okra. Combined effect of varieties and nutrient levels showed non-significant influence on number of fruits per plant.

4.5.2. Green fruit length per plant (cm)

Green fruit length per plant (cm) was significantly influenced by the variety. The highest green fruit length per plant (cm) was observed in Arka Anamica (10.42) and the lowest value was observed in BARI Dherash-1(9.35). Green fruit length

per plant was significantly influenced by fertilizer application methods. The highest value was observed in T_5 (12.01) treatment followed by recommended dose of fertilizer application T_2 (10.19) and the lowest value was observed in T_1 (8.84) treatment. Similar findings have been reported by Jamala *et al.* (2011) and Singh *et al.* (2014) in okra.

Interaction effect of variety and fertilizer was significantly influenced in edible fruit length per plant. The highest value was observed in V_1T_5 (12.33) treatment combination and the lowest in V_2T_1 (8.30) treatment combination.

Application of nutrient levels caused significant influence on fruit length and fruit diameter and fruit weight. Combined application of organic manures and inorganic fertilizers which might have acted complementary and supplementary to each other and resulted into adequate slow but steady supply of nutrients (Bairwa *et al.,* 2009). The availability of nutrients at the critical stages of the crop growth resulted early establishment, vigorous growth and development of plants leading to longer and wider fruits (Mal *et al.,* 2013). High value in fruit length and fruit diameter was observed due to integrated nutrients application by Kumar *et al.* (2013) in okra.

4.5.3. Edible fruits weight per plant (g)

Edible fruits weight per plant was significantly influenced by the variety. The highest edible fruits weight per plant (g) was observed in Arka Anamica (263.80) and the lowest was observed in BARI Dherash-1 (232.77). Edible fruit weight was significantly influenced by fertilizer application methods. The highest value was

observed in T_5 (294.74) treatment which was followed by recommended dose of fertilizer application T_2 (258.02) and the lowest in T_1 (223.34) treatment.

Interaction effect of variety and fertilizer was significantly influenced in edible fruits weight. The highest value was observed in V_1T_5 (311.9) treatment combination and the lowest in V_2T_1 (209.08) treatment combination.

4.5.4. Edible fruits weight per plot (g)

Edible fruits weight per plot was significantly influenced by the variety. The highest edible fruits weight per plot (g) was observed in Arka Anamica (3955.14) and the lowest was observed in BARI Dherash-1(3491.51). Edible fruit weight per plot was significantly influenced by fertilizer application methods. The highest value observed in T_5 (4421.20) treatment which was followed by recommended dose of fertilizer application T_2 (3870.38) and the lowest in T_1 (3345.61) treatment.

Interaction effect of variety and fertilizer was significantly influenced in edible fruits weight per plot. The highest value was observed in V_1T_5 (4678.57) treatment combination and the lowest in V_2T_1 (3136.28) treatment combination.

Table 6: Effect of NPKS and cowdung on the number of green fruits per plant, edible fruits length/plant, edible fruits weight per plant and edible fruits weight per plot of okra varieties

Variety	Number of green fruit per plant	Green/fruits length/ plant(cm)	Edible fruits weight/ plant (g)	Edible fruits weight/ plot (g)
Arka Anamica (V_1)	23.86 a	10.42 a	263.80 a	3955.14 a
BARI Dherash-1(V_2)	21.14 b	9.35 b	232.77 b	3491.51 b
Sig. level	*	*	*	*
Fertilizer				
T_1	20.26 e	8.84 e	223.34 e	3345.61 e
T_2	23.33 b	10.19 b	258.02 b	3870.38 b
T_3	20.88 d	9.05 d	229.41 d	3441.13 d
T_4	21.36 c	9.32 c	235.89 c	3538.3 c
T_5	26.67 a	12.01 a	294.74 a	4421.20 a
Sig. level	*	*	*	*
Interaction				
V_1T_1	21.48 g	9.38 g	237.60 g	3554.95 g
V_1T_2	24.83 c	10.85 c	274.47 c	4117.16 c
V_1T_3	21.92 e	9.58 e	242.45 e	3636.75 e
V_1T_4	22.84 d	9.98 d	252.55 d	3788.3 d
V_1T_5	28.22 a	12.33 a	311.9 a	4678.57 a
V_2T_1	19.05 j	8.30 j	209.08 j	3136.28 j
V_2T_2	21.84 f	9.54 f	241.57 f	3623.6 f
V_2T_3	19.83 i	8.53 i	216.37 i	3245.51 i
V_2T_4	19.90 h	8.67 h	219.22 h	3288.3 h
V_2T_5	25.11 b	11.70 b	277.59 b	4163.85 b
CV (%)	1.08	2.47	1.06	1.06
SE	0.20	0.20	2.17	32.37
Sig. level	*	**	*	*

T_1= control (No fertilizer and No Cowdung)

T_2 = (N 100 kg ha^{-1}) + (P 35 kg ha^{-1}) + (K 70 kg ha^{-1}) + (S 20 kg ha^{-1}) (recommended dose of fertilizer for okra)

T_3 = 1/2 of T_2 + Cowdung 5 t ha^{-1}

T_4 = 1/2 of T_2 + Cowdung 10 t ha^{-1}

T_5 = 1/2 of T_2 + Cowdung 15 t ha^{-1}

* = significant 5% level of probability, ** = significant 1% level of probability

4.5.5. Edible fruits weight (t ha^{-1})

Edible fruits weight (t ha^{-1}) was significantly influenced by the variety. The highest edible fruits weight (t ha^{-1}) was observed in Arka Anamica (13.18) and the lowest was observed in BARI Dherash-1 (11.59). Edible fruit weight per plot was significantly influenced by fertilizer application methods. The highest value was observed in T_5 (14.73) treatment which was followed by recommended dose of fertilizer application T_2 (12.80) and the lowest value was observed in T_1 (11.16) treatment.

Findings revealed that significant effect of varieties and nutrient levels on fruit weight (g) in okra. Such variability in fruit weight in okra is also conformity with the earlier findings reported by and Khan *et al.* (2002), Jamala *et al.* (2011), Singh *et al.* (2013), Mal *et al.* (2014) and Singh *et al.* (2014).

Interaction effect of variety and fertilizer was significantly influenced in edible fruits weight (t ha^{-1}). The highest value was observed in V_1T_5 (15.59) treatment combination and the lowest value was observed in V_2T_1 (10.45) treatment combination.

Application of nutrient levels caused significant influence on fruit weight (g). Maximum fruit weight (g) were taken with application of V_1T_5 (½ of T_2 + CD 15 t ha^{-1}) nutrient level which was significantly higher over other nutrient levels. Similar findings have been reported by Yadav *et al.* (2006), Bairwa *et al.* (2009) and Singh *et al*. (2015), in okra. Interactive effect of varieties and nutrient levels had exerted non-significant influence on fruit weight (g) in okra.

4.5.6. Seed number per fruits after maturity

Number of seed per fruits after maturity was significantly influenced by the variety. The highest Seed number per fruits after maturity was observed in Arka Anamica (44.58) and the lowest was observed in BARI Dherash-1(39.33). Number of seed per fruits after maturity was significantly influenced by fertilizer application methods. The highest value observed in T_5 (48.69) treatment which was followed by recommended dose of fertilizer application T_2 (43.84) and the lowest was observed in T_1 (38.21) treatment.

Interaction effect of variety and fertilizer was significantly influenced in number of seed per fruits after maturity. The highest value was observed in V_1T_5 (51.82) treatment combination and the lowest value was observed in V_2T_1 (36.07) treatment combination.

4.5.7. Seed weight per fruits (g)

Seed weight per fruits (g) was significantly influenced by the variety. The highest seed weight per fruits (g) was observed in Arka Anamica (2.73) and the lowest value was observed in BARI Dherash-1 (2.40). Seed weight per plant was significantly influenced by fertilizer application methods. The highest value observed in T_5 (3.09) treatment which was followed by recommended dose of fertilizer application T_2 (2.71) and the lowest value was observed in T_1 (2.31) treatment.

Interaction effect of variety and fertilizer was significantly influenced in seed weight per fruit. The highest value was observed in V_1T_2 (2.90) treatment combination and the lowest in V_2T_1 (2.17) treatment combination.

Table 7: Effect of NPKS and cowdung on the edible fruits weight (t ha^{-1}), seed number per fruits after maturity and seed weight per fruits of okra varieties

Variety	Edible fruits weight (t ha^{-1})	Seed number per fruits after maturity	Seed weight per fruits (g)
Arka Anamica (V_1)	13.18 a	44.58 a	2.73 a
BARI Dherash-1(V_2)	11.59 b	39.33 b	2.40 b
Sig. level	*	*	*
Fertilizer			
T_1	11.16 e	38.21 e	2.31 e
T_2	12.80 b	43.84 b	2.71 b
T_3	11.46 d	38.96 d	2.38 d
T_4	11.79 c	40.09 c	2.44 c
T_5	14.73 a	48.69 a	3.09 a
Sig. level	*	*	*
Interaction			
V_1T_1	11.88 f	40.36 g	2.46 f
V_1T_2	13.72 c	46.64 b	2.90 a
V_1T_3	12.11 e	41.18 e	2.52 e
V_1T_4	12.62 d	42.91 d	2.62 c
V_1T_5	15.59 a	51.82 a	2.83 b
V_2T_1	10.45 j	36.07 j	2.17 i
V_2T_2	11.86 g	41.04 f	2.54 d
V_2T_3	10.81 i	36.73 i	2.23 h
V_2T_4	10.95 h	37.28 h	2.28 g
V_2T_5	13.87 b	45.55 c	2.83 b
CV(%)	4.42	1.34	2.75
SE	0.447	0.461	0.058
Sig. level	*	*	*

T_1= control (No fertilizer and No Cowdung)
T_2 = (N 100 kg ha^{-1}) + (P 35 kg ha^{-1}) + (K 70 kg ha^{-1}) + (S 20 kg ha^{-1}) (recommended dose of fertilizer for okra)
T_3 = 1/2 of T_2 + Cowdung 5 t ha^{-1}
T_4 = 1/2 of T_2 + Cowdung 10 t ha^{-1}
T_5 = 1/2 of T_2 + Cowdung 15 t ha^{-1}
* = significant 5% level of probability

4.5.8. Seed yield per plant (g)

Seed yield per plant (g) was significantly influenced by the variety. The highest seed yield per plant (g) was observed in Arka Anamica (67.89) and the lowest was observed in BARI Dherash-1 (59.58). Seed yield per plant was significantly influenced by fertilizer application. The highest value was observed in T_5 (75.98) treatment followed by T_2 (66.66) and the lowest value was observed in T_1 (55.96) treatment.

Interaction effect of variety and fertilizer was significantly influenced in seed yield. The highest value was observed in V_1T_5 (80.4) treatment combination and the lowest in V_2T_1 (51.54) treatment combination.

4.5.9. Seed yield per plot (g)

Seed yield per plot (g) was significantly influenced by the variety. The highest seed yield per plot (g) was observed in Arka Anamica (1018.28) and the lowest value was observed in BARI Dherash-1 (893.7). Seed yield per plot was significantly influenced by fertilizer application methods. The highest value was observed in T_5 (1139.62) treatment which was followed by T_2 (999.78) and the lowest was found in T_1 (839.38) treatment.

Interaction effect of variety and fertilizer was significantly influenced in seed yield per plot. The highest value was observed in V_1T_5 (1206) treatment combination and the lowest in V_2T_1 (773.1) treatment combination.

4.5.10. Seed yield (t ha^{-1})

Seed yield (t ha^{-1}) was significantly influenced by the variety. The highest seed yield (t ha^{-1}) was observed in Arka Anamica (3.39) and the lowest value was observed in BARI Dherash-1(2.98). Seed yield (t ha^{-1}) was significantly influenced by fertilizer application methods. The highest value observed in T_5 (3.79) treatment which was followed by recommended dose of fertilizer application T_2 (3.32) and the lowest value was observed in T_1 (2.80) treatment.

Interaction effect of variety and fertilizer was significantly influenced in seed yield (t ha^{-1}). The highest value was observed in V_1T_5 (4.01) treatment combination and the lowest value was observed in V_2T_1 (2.56) treatment combination.

4.5.11. 1000 seed weight (g)

1000 seed weight (g) was significantly influenced by the variety. The highest 1000 seed weight (g) was observed in Arka Anamica (51.10 g) and the lowest value was observed in BARI Dherash-1 (44.56g). 1000 seed weight (g) was significantly influenced by the fertilizer application methods. The highest value was observed in T_5 (54.23g) treatment which was followed by recommended dose of fertilizer application T_2 (49.90g) and the lowest was in T_1 (43.20g) treatment.

1000 seed weight was significantly influence by the interaction effect of variety and fertilizer application methods. The highest 1000 seed weight was observed in V_1T_5 (57.70g) treatment combination and the lowest was found in V_2T_1 (40.43g) treatment combination.

Table 8: Effect of NPKS and cowdung on the seed yield per plant (g), seed yield per plot (g), seed yield (t ha^{-1}) and 1000 seed weight (g) of okra varieties

Variety	1000-seed weight (g)	Seed yield per plant (g)	Seed yield per plot (g)	Seed yield (t ha^{-1})
Arka Anamica (V_1)	51.10 a	67.89 a	1018.28 a	3.39 a
BARI Dherash-1(V_2)	44.56 b	59.58 b	893.70 b	2.98 b
Sig. level	*	*	*	*
Fertilizer				
T_1	43.20 e	55.96 e	839.38 e	2.80 e
T_2	49.90 b	66.66 b	999.78 b	3.32 b
T_3	45.52 d	59.28 d	889.25 d	2.96 d
T_4	46.3 c	60.80 c	911.92 c	3.03 c
T_5	54.23 a	75.98 a	1139.62 a	3.79 a
Sig. level	*	*	*	*
Interaction				
V_1T_1	46.71 f	60.38 g	905.65 g	3.01 g
V_1T_2	53.07 b	70.75 c	1061.25 c	3.54 c
V_1T_3	49.21 e	62.81 e	942.20 e	3.13 e
V_1T_4	49.56 d	65.08 d	976.30 d	3.25 d
V_1T_5	57.70 a	80.40 a	1206.00 a	4.01 a
V_2T_1	40.43 i	51.54 j	773.10 j	2.56 j
V_2T_2	46.71 f	62.56 f	938.30 f	3.12 f
V_2T_3	41.83 h	55.75 i	836.30 i	2.79 i
V_2T_4	43.04 g	56.50 h	847.55 h	2.82 h
V_2T_5	50.77 c	71.55 b	1073.25 b	3.57 b
CV(%)	2.74	1.74	1.76	0.19
SE	1.07	0.909	13.69	0.044
Sig. level	*	*	*	*

T_1= control (No fertilizer and No Cowdung)

T_2 = (N 100 kg ha^{-1}) + (P 35 kg ha^{-1}) + (K 70 kg ha^{-1}) + (S 20 kg ha^{-1}) (recommended dose of fertilizer for okra)

T_3 = 1/2 of T_2 + Cowdung 5 t ha^{-1}

T_4 = 1/2 of T_2 + Cowdung 10 t ha^{-1}

T_5 = 1/2 of T_2 + Cowdung 15 t ha^{-1}

* = significant 5% level of probability

CHAPTER 5

SUMMARY AND CONCLUSION

The experiment was conducted at the research from and laboratory of Crop Physiology and Ecology Department, Hajee Mohammad Danesh Science and Technology University, Dinajpur, during March to August 2018 to evaluate the effect of different level of NPKS and cowdung on the performance of okra. The experiment was laid out in two factors Randomized Complete Block Design (RCBD) with three replications. Two okra varieties, such as Arka Anamica, BARI Dherosh-1 and five fertilizer treatments, such as T_1 = control (No fertilizer and No cowdung) kg ha^{-1}, T_2 = (N 100 + P 35 + K 70 + S 20) kg ha^{-1}, T_3 = ½ of T_2 + cowdung (CD) 5 t ha^{-1}, T_4 = ½ of T_2 + cowdung (CD) 10 t ha^{-1}, T_5 = ½ of T_2 + cowdung 15 t ha^{-1} were tested.

Data were recorded on plants height (cm), leave number $plant^{-1}$, branch number $plant^{-1}$, leaf length (cm), leaf breadth (cm), nodal distance (cm) at different growth stages. Other yield and yield contributing character like number of green fruit per plant, green fruit length per plant (cm), edible fruits weight per plant (g), edible fruits weight per plot (g), edible fruits weight (t ha^{-1}) and seed number per fruits after maturity, seed weight per fruits (g), seed yield per plant (g), seed yield per plot (g), seed yield (t ha^{-1}), 1000-seed weight (g) were recorded. The collected data were analyzed using the computer package program MSTAT and the significance of the mean differences were adjudged by the "Duncan's Multiple Range Test" (DMRT).

From results it was observed that two varieties of okra and fertilizers had significant difference. Arka Anamica and fertilizer treatment, T_5 (1/2 of T_5 + Cowdung 15 t ha^{-1}) had higher plant height (cm), leaf number per plant, branch number per plant, leaf length (cm), leaf breadth (cm), nodal distance (cm), number of green fruit per plant, green fruit length per plant (cm), edible fruits weight per plant (g), edible fruits weight per plot (g), edible fruits weight (t ha^{-1}), seed number per fruits after maturity, seed weight per fruits (g), seed yield per plant (g), seed yield per plot (g), seed yield (t ha^{-1}), 1000-seed weight (g). On the other hand, variety BARI Dherosh-1 had minimum values in case of above characteristics; mentioned. Although BARI Dherosh-1 and fertilizer treatment, T_5 (1/2 of T_5 + cowdung 15 t ha^{-1}) had also highest plant height. Variety Arka Anamica took more time for first flowering (30.94 days). The interaction of variety and fertilizer doses significantly affects days to first flowering (32.67). The interaction of variety and fertilizer doses significantly affects the seed yield (t ha^{-1}) of okra. The highest (4.01 t ha^{-1}) seed yield was observed at V_1T_5 combination and V_2T_1 combination gave the lowest seed yield (2.56 t ha^{-1}).

CHAPTER 6

REFERENCES

Abusaleha P. S. and K. G. Shanmugavelu. 1988. Studies on effects of organic v/s inorganic source of nitrogen on growth, yield and quality of okra (*Abelmoschus esculents* L. Moench). Indian J. Hort., 49(2): 312-315.

Achebe U A., E A. Obidiebube, S O. Akparobi and E F. Nwachuckwu. 2013. Effect of different le'els of (NPK 20:10:1 O kg ha^{-1}) fertilizer on the growth and yield of six okra cUltivars in asaba soils. J.Agri. Sci. 3(9): 689-698.

Al-Wandawi. 1983. Chemical composition of seeds of two okra cultivers. J. Agro Food Chem. 3 1:1355-1358.

Anisa N. A., B. L. Markose and K. S. Gopal. 2016. Effect of integrated nutrient management on population of biofertilizers in rhizosphere of okra (*Abelmoschus esculentus* L. Moench). Int. J. of Innovative Res. In Sci. Engineering and Tech. 5(4): 5628-5632.

Anonymous. 2010. Research and development of vegetable crops. Paper presented in the workshop on March 7-9, 2010 at IPSA, Gazipur. 1- 5

Attigah A.S., E. K. Asiedu, K. Agyarko and H. Kwame. 2013. Growth and yield of okra (*Abelmoschus esculentus* L.) as affected by organic and inorganic fertilizers. 8(12).

Bairwa H. L., A. K. Shukla, L. N.Mahawer, R. A.Kaushik, K. B. Shukla and K. D. Ameta. 2009. Response of integrated nutrient management on yield, quality and physico-chemical characteristics of okra cv. Arka Anamika. Ind. J. Hort. 66(3): 310-314.

BBS. 2010. Bangladesh Bureau of Statistics. Planning Division, Ministry of Planning. Government of People's Republic of Bangladesh, Dhaka. pp.66-74.

Bhende S. K., H. K. Deshmukh, P. K. Nimbolkar, R. K. Dewangan, and A. H. Nagone. 2015. Effect of phosphorus and potassium on quality attributes of okra cv. 'Arka Anamika'. Int. J. Environ. Sci. 6(2): 225-231.

Bilal A. 2008. The role of copper and sulfur based fungicides in organic vegetable production: 8 -105.

Bodamwal S.G. and S. G. Rajput 2006. Influence of organic and inorganic fertilizer on seed quality and seed yield of okra Parbhani Kranti. J. Maharashtra. Agric. Univ. 31 (1): 130-131.

Bose, T. K., J. Kabir, T.K. Maity, V.A. Parthasarathyand M.G. Som. 2003. Vegetables Crops volume-3. Naya Prokash, Calcutta (India). pp. 209-240.

Chauhan D. V. S. 1972. Vegetable Production in India (3rd edition). Ram Prasad and Sons, Agra.

Dademal A.A. and J. H. Dongale. 2004. Effect of manures and fertilizers on growth and yield of okra and nutrient availability in lateric soil of Kokan. J. Soils and Crops 14 (2): 262-268.

Das A. K., B. Prasad and R. Singh. 2014. Response of chemical fertilizer and vermin-compost on okra (*Abelmoschus esculentus* L.) cv. Pravani Kranti. The Asian J. of Horti. 9(2): 372-376.

Dehigaspitiya D.P.B., A.G.M. Dhananjanie, N. Dahanayake, A. Atapattu and P.C.D. Perer. 2016. Identification of the Effect of Sulfur Spray on Okra (*Abelmoschus esculentus* L. var. MI 5) Seedlings. Journal of Agri Search., 3(4).

Fagwalawa L. D. and S.M Yahaya. 2016. Effect of organic manure on the growth and yield of okra. Imperial J. of Interdisciplinary Res. 2(3): 130-133.

FAO (Food and Agriculture Organization) and UNDP (United Nations Development Progamme). 1988. Land resource appraisal of Bangladesh for agricultural development. Agro-cological regions of Bangladesh. FAO. Rom. Italy.pp. 2 12-22 1.

Firoz Z.A. 2009. Impact of nitrogen and phosphorus on the growth and yield of okra (*Abelmoschus esculentus* L. Moench) in hill slope condition. Bangladesh J. Agril. Res. 34(4): 713-722.

Gomez, H.C. and A. A. Gomez. 1984. Statistical Procedures for Agric. Res., John Wiley and Sons. New York, p. 680.

Gudugi I.A.S. 2013. Effect of Cowdung and in organic fertilizers on the growth and yield of Okra (*Abelmoschus esculentus (L.)* Euro. J. Exp. Bio., 3(2):495-498.

Gupta A.K., B. Ray M.P. Singh and V. Upadhyaya. 2011. Effect of fertilizers and vermicompsot and growth, yield and biochemical changes in *Abelmoschus esculentus*. Plant Archives, 11 (1): 285-287.

Haque M. M. 1993.Tomato, Brinjal and Okra. In: K. Ahmed and M. Sahajan (eds.).Homestead vegetable production,BARI, Joydevpur, ajipur. p. 61.

Jamaguch M. 2009. World Vegetables Principles, Production and Nutritive Values. 6th edition. Van NostrandReiduction. Newyork, USA. 312.

Jamala G. Y., P.G. Bonil, P. Abrahami and A.M. Musa. 2011. Soil status and yield response of different varieties of okra (*Abelmoschusesculentus* L. Moench) grown at Mubi floodplain, North Eastern, Nigeria. J. Agric. Biotech. Sustainable Dev. 3(7): 120-125.

Khan F. A., Jalal-ud-din, A. Ghaffoor and K. W. Khan. 2002. Evaluation of different cultivars of okra (*Abelmoschus esculentus* L.) under the Agro-climatic Conditions of Dera Ismail Khan. Asian J. of Plant Sci. 1(6): 663-664.

Khandaker M. M., N. Jusoh, N. H. Al, A. Ralmi and S. Z. Ismail. 2017. The effect of different types of organic fertilizers on growth and yield of *Abelmoschus esculentus L.* Moench (okra). Bulg. J. Agric. Sci., 23 (1): 119–125.

Kumar T., M. Kumar, M.K. Singh, A. Kumar, S. Kumar and B. Singh. 2013. Impact of integrated nutrient management (INM) on growth and economic yield of okra. Ann. Hort. 6(1): 107-114.

Mal B., P. Mahapatra, S. Mohantyand, H.N. Mishra. 2013. Growth and yield parameters of okra (*Abelmoschus esculentus*) influenced by diazotrophs and chemical fertilizers. J. Crop and Weed 9(2): 109-112.

Mohsen A. A. M. and Abdel-Fatteh. 2015. Effect of different levels of nitrogen and phosphorus fertilizer in combination with botanical compost on growth and yield of okra (*Abelmoschus esculentus* L.) under sandy soil condition in Egypt. Asian J. Agric. Res. 9(5): 249-258.

Osmotoso S. O. and O. S. Shittu. 2007. Effect of NPK fertilizer rates and method of application on growth and yield of okra (*Abelmoschus esculentus* L. Moench) at Ado-Ekiti, Nigeria. Int. J. Agric. Res. 2(7): 614-619.

Paliwal R.; I. S. Naruka and J. K. Yadav. 1999. Effect of nitrogen and sulphur on growth and yield of okra (*Abelmoschus esculentus* L. Moench) cv. Pusa Sawani. South Ind. Hort., 47 (1-6): 250- 251.

Prabhu T., P.R. Narwadkar, A. K. Sajindranath and M.R. Bhore. 2002. Effect of integrated nutrient management on yield and quality of okra (*Alelmeschus esculentus* L. Moench) Cv. Parbhani Kranti. Gujarat J. Applied Hort., 2 (2): 28-33.

Prasad P. H. and A. Naik. 2013. Effect of varying NPK levels and bio-fertilizers on growth and yield of okra (*Abelmoschus esculentus* L. Moench) under sustainable condition. Trends Biosci. 6(2): 167169.

Premsekhar M. and V. Rajshree. 2009. Influence of organic manures on growth, yield and quality of okra. Am. Eurasian J. Sustan. Agric. 3(1): 6-8.

Qhureshi Z. 2007. Breeding Investigation in Bhendi (*Abelmoschus esculentus* L. Moench). Master Thesis, University of Agriculture Sciences, GKVK, Bangalore.

Rahman M. A. and F. Akter. 2012. Effect of NPK fertilizers on growth, yield and yield attributes of okra (*Abelmoschus esculentus* L. Moench.) Bangladesh J. Bot. 41(2): 131-134.

Ray R., S. K. Patra, K. K. Ghosh and S. K. Sahoo. 2005. Integrated nutrient management in okra (*Abelmoschus esculentus* L. Moench) in a river basin. Ind. J. Hort. 62(3): 260-264.

Sajid M., M.A. Khan, A. Rab, B. Arif, I. Jan, Z. Hussain and M. Mukhtiar. 2012. Impact of nitrogen and phosphorus on seed yield and yield components of okra cultivars. The J. Animal & Plant Sci. 22(3): 704-707.

Sharma I. J., R.K. Samnotra, V. Kumar, A.P. Rai and B. Dhotra. 2015. Effect of organic and inorganic fertilizers on the growth and yield of okra under sub-tropical region. Ann. Plant and Soil Res. 17(2): 215-218.

Sharma R. P., N. Datt and G. Chander. 2009. Effect of vermicompost, farmyard manure and chemical fertilizers on yield, nutrient uptake and soil fertility in okra (*Abelmoschus esculentus*) - onion (Allium cepa) sequence in Wet Temperate Zone of Himachal Pradesh. J. Indian Society Soil Sci. 57(3): 357-361.

Sharma T. R., A. K. Pandey, S. D. Updhyaya and S. B. Agrawal. 2010. Effect of vermicompost on yield and quality of kharif season okra (*Abelmoschus esculentus* L. Moench). Vegetable Science, 37 (1-2) : 181-183.

Sidhya P., M. K. Pandit, S. Bairagi and M. M. Shyamal. 2015. Effect of mycorrhizal inoculation, organic manure and inorganic fertilizers on growth and yield of okra (*Abelmoschus esculentus* L. Moench). J. Crop and Weed 11(special issue): 10-13

Singh A. K., Manibhushan, M. K. Meena and A. Upadhyaya. 2012. Effect of sulphur and zinc on rice performance and nutrients dynamics in plant and soils of Indo Gangetic plains. Journal of Agril. Sci. 4 (11): 162-170.

Singh J. P., I. N. Shukla, R. K. Singh Gautam, B. Singh and S. Kumar. 2008. Effect of different levels of nitrogen and phosphorus under varying plant geometry on growth and yield of okra (*Abelmoschus esculentus* L.) Prog. Agric. 8(1): 21-24.

Singh K. V., K. Anuj, M. Kumar, S. Soni, A. Kumar and M.K. Singh. 2015. Response of different organic and inorganic fertilizers on growth and yield of okra (*Abelmoschus esculentus* L. Moench). Ann. Hort. 8(1): 107-109.

Singh U. K., N. Kumawat and R. Kumar. 2014. Response of okra (*Abelmoschus esculentus* L. Moench) to levels of fertilizers. *BIOINFOLET* 11 (1 B): 165-167.

Singh U. K., R. Kumar, U. N. Shukla and N. Kumawat. 2013. Response of okra (*Abelmoschus esculentus* L. Moench) to fertilizer levels. BIOINFOLET 10(3 B): 952-953.

Singh, Laxman, R. S. Dhaka and S. Mukharjee. 2005. Effect of nitrogen, phosphorous and gibberellic acid on vegetative growth and yield of okra (*Alelmeschus esculentus* L. Moench) under semi-arid conditions. Haryana. J. Hort. Sci. 34 (1-2): 166-167.

Solangi M., A. A. Tagar, A. M. Solangi, A. G. Siyal, K. S. Soothar and A. R. Shah. 2015. Nutrient uptake of some okra varieties as influenced by different levels of applied N, P and K. Sci. Int. (Lahore), 27(5): 4327-4331.

Sonathampi K. and V. Indita. 2000. Nutritive value and organoleptic evaluation of thamaravenda genotypes (*Abelmoschus caillei L.)*.J. Trop. agric. pp. 38-40.

Sylvester R., B. O. Nuga, N. E. S. Lale and R. N. Osayi. 2014. Effect of organic and inorganic fertilizers on okra (*Abelmoschus esculentus* L. Moench) production and incidence of insect pests in the Humid Toropics. IORS J. Agric. and Veterinary Sci. 7(4): 25-30.

Thiruna V. M. and T. Balaji. 2015. Effect of integrated nutrient management (INM) on growth attributes, biomass yield, secondary nutrient uptake and quality parameters of bhendi (*Abelmoschus esculentus* L.). J. Applied and Nat. Sci. 7(1): 165-169.

Tyagi S. K., A. Shukla,V. K. Mittoliya, M. L. Sharma, A. R. Khire and Y. K. Jain. 2016. Effect of integrated nutrient management on growth yield and economics of okra under nimar valley condition of Madhya Pradesh. Int. J. Tropical Agri. 34(2): 415-419.

Uka U. N., K. S. Chukwaka and M. Iwuagwu. 2013. Relative effect of organic and inorganic fertilizers on the growth of okra (*Abelmoschus esculentus* L. Moench) J. Agric. Sci. 58(3): 159-166.

Yadav G. L., S. P. Singh, O. P. Jitarwal, V. K. Yadav and R. Choudhary. 2017. Effect of Nitrogen and Bio-organics on Growth and Yield of Okra (*Abelmoschus esculentus* L. Moench). ChemSci Rev Lett. 6(23): 1515-1519.

Yadav P., P. Singh and R. L. Yadav. 2006. Effect of organic manures and nitrogen levels on growth, yield and quality of okra. Indian J. Hort. 63(2): 215-217.

Yadav S. S. and N. Yadav. 2010. Effect of integrated nutrient management on yield of okra in Zaid crop. Bhartiya Krishi Anusandhan Patrika, 25: 2-4.

Zainab M. A., C. Eluwa, C. Vincent, O. S. Ayodele, G. Y. Lakwannum and O. S. Kehinde. 2016. Effects of Organic and Inorganic Fertilizers on the Growth of NH-Ae 47-4 Variety of Okra. J. Appl. Sci. Environ. Manage. 20(1). 201-206.