EFFECT OF CULTIVARS AND POTASSIUM ON THE GROWTH, YIELD AND NUTRIENT CONTENT OF OKRA

BY

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CERTIFICATE

This is to certify that the thesis entitled **"Effect of Potassium and Cultivars on the Growth, Yield and Nutrient Content of Okra"** submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **Master of Science** in **Agricultural Chemistry**, embodies the result of a piece of bonafide research work carried out by **Md. Asaduzzaman**, Registration number: **06-02055** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

I further certify that any help or source of information, received during the course of this investigation has duly been acknowledged.

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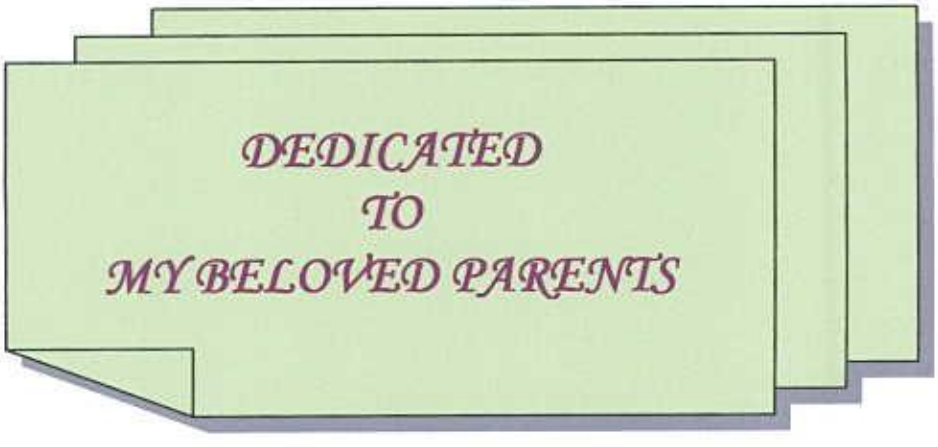
DEDICATED
TO
MY BELOVED PARENTS

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The Author

EFFECT OF CULTIVARS AND POTASSIUM ON THE GROWTH, YIELD AND NUTRIENT CONTENT OF OKRA

ABSTRACT

The experiment was carried out at the experimental Farm of Sher-e-Bangla Agricultural University (SAU), Dhaka during the period from April to July 2012 to study the effect of cultivars and potassium on the growth, yield and nutrient content of okra. The test crop used in the experiment was Dherosh cultivar. The experiment consisted of two factors: Factor A: Dherosh cultivars (2 cultivars) as- C_1: Arka Anamica; C_2: Dherosh F_1 Green Lady and Factor B: Potassium fertilizer (4 levels) as-K_0: 0 kg K_2O/ha (control); K_1: 50 kg K_2O/ha; K_2: 100 kg K_2O/ha and K_3: 150 kg K_2O/ha. The two factors-experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. In case of okra cultivar, at 20, 40, 60 and, 80 DAS, the tallest plant (24.58 cm, 52.20 cm, 74.92 cm and 89.95 cm, respectively) was recorded in C_1, whereas the shortest plant (22.70 cm, 48.91 cm, 69.48 cm and 84.18 cm, respectively) was observed in C_2. The maximum number of pods per plant (24.57) was observed in C_1 and the minimum number (23.80) was recorded in C_2. The highest yield per hectare (8.91 ton) was recorded in C_1 and the lowest yield per hectare (8.03 ton) was found in C_2. The highest potassium content in pod (1.17%) was recorded in C_1 and the lowest potassium (1.08%) in C_2. For potassium fertilizer, at 20, 40, 60 and 80 DAS, the tallest plant (25.23 cm, 53.50 cm, 81.30 cm and 84.70 cm, respectively) was observed in K_2, while the shortest plant (21.48 cm, 46.54 cm, 63.40 cm and 78.03 cm, respectively) was recorded in K_0. The maximum number of pods per plant (25.07) was observed in K_2, again the minimum number (23.30) was recorded in K_0. The highest yield per hectare (9.28 ton) was recorded in K_2, whereas the lowest yield per hectare (7.22 ton) was recorded in K_0. The highest potassium content in pod (1.34%) was recorded in K_3, whereas the lowest (0.82%) potassium in K_0. Due to the combined effect of okra cultivars and different levels of potassium, at 20, 40, 60 and 80 DAS, the tallest plant (25.57 cm, 54.13 cm, 78.80 cm and 94.20 cm, respectively) was found in C_1K_2 and the shortest plant (20.06 cm, 41.78 cm, 51.00 cm and 70.80 cm, respectively) in C_2K_0. The maximum number of pods per plant (25.60) was found in C_1K_2 and the minimum number (22.67) in C_2K_0. The highest yield per hectare (9.75 ton) was found in C_1K_2, while the lowest yield per hectare (6.91 ton) in C_2K_0. The highest potassium content in pod (1.43%) was found in C_1K_3, while the lowest potassium (0.75%) in C_2K_0. Form the findings it was revealed that Arka Anamica okra cultivar with 100 kg K_2O/ha was the best combination for attaining highest yield contributing characters and yield of okra.

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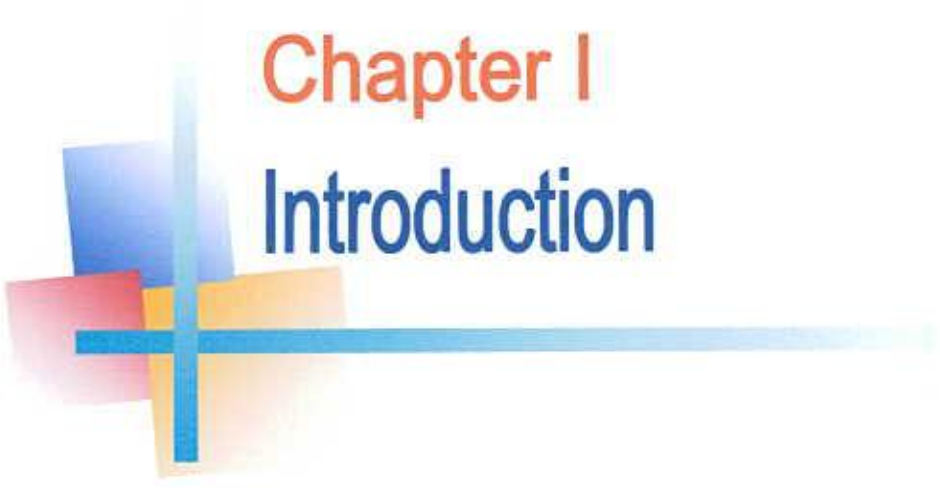


Chapter I

Introduction

CHAPTER I

INTRODUCTION

Okra [*Abelmoschus esculentus* (L.) Moench] is a popular vegetable that belongs to the family Malvaceae and locally known as "Dherosh" or "Bhindi". It is an annual vegetable crop grown from seed in tropical and sub-tropical parts of the world (Tahkur and Arora, 1986). It is well distributed throughout the Indian sub continent and East Asia (Rashid, 1990). Okra is specially valued for its tender and delicious edible pods which are rich sources of vitamins and minerals. Tender green pods of okra contains approximately 86.1% water, 2.2% protein, 0.2% fat, 9.7% carbohydrate, 1.0% fibre and 0.8% ash (Purseglove, 1987). The pods have some medicinal value with mucilaginous preparation which may be used as plasma replacement or blood volume expander (Savello *et al.,* 1980). In Bangladesh the total production of okra is about 246 thousand tons which was produced from 7287.5 hectare of land in the year 2010 with average yield about 3.38 t/ha which is very low (BBS, 2011) compared to that of other developed countries where the yield is as high as 7.0-12.0 t/ha (Yamaguchi, 1998). On the other hand, the yield of okra varied from 11 to 15 t/ha from region to region (Hossain, 2000).

In Bangladesh, vegetable production is not uniform round the year and it is plenty in winter but less in quantity in the summer season. Around 30% of total vegetables are produced during *kharif* season and around 70% in the *rabi* season

(Anon., 1993). Therefore, as vegetable okra can get an importance in *kharif* season as well as summer season in our country context. The per capita consumption of vegetables in SAARC countries have variation and it was in Pakistan (69 g), in Srilanka (120 g), and in India (135 g) and all are higher than that of Bangladesh. Many dietitians prescribed that the daily requirements of vegetables for an adult person is approximately 285 g (Rampal and Gill, 1990). Therefore, there is a big gap between the requirement and consumption of per capita vegetable in Bangladesh. As a result, malnutrition is very much evident in our country. Successful okra production may contribute partially in solving vegetable scarcity of summer season for the Bangladeshi people.

There are many genotype(s)/cultivars of okra having diverse characters in different parts of the country. Those genotypes are available in the market without any uniformity and standard nomenclature. The low yield of okra in Bangladesh however is not an indication of low yielding potentiality of this crop, but may be attributed to a number of reasons viz. unavailability of quality seeds of high yielding varieties in appropriate time, fertilizer miss-management, disease & insect infestation, improper or limited irrigation facilities and other in appropriate agronomic practices. Among the different reasons fertilizer management is the important factor that greatly affects the growth, development and yield of this crop. The application of fertilizers influences the physical and chemical properties of soil and enhances the biological activities. To attain considerable production and quality yield for any crop it is necessary ensuring proper management for the availability of essential nutrient in proper doses. Farmers of our country generally

use a large amount of nitrogenous fertilizer in vegetable crop production without application of other essential micro and macro nutrients.

Deficiency of soil nutrient is now considered as one of the major constraints to successful upland crop production in Bangladesh (Islam and Noor, 1982). The cultivation of vegeatble crops requires proper supply of plant nutrient. Okra responds greatly to major essential elements like N, P and K for its growth and yield (Thompson and Kelly, 1988). Potassium as an inorganic fertilizer and plays a vital role for proper growth and development of okra. Application of potassium in appropriate time, dose and proper method is prerequisite for any crop cultivation. Generally, a large amount of potassium is required for the growth of leafy vegetable (Opena *et al.*, 1988). For that the management of fertilizers especially potassium is the important factor that greatly affects the growth, development and yield of okra.

Considering the background stated above, the present study was undertaken to investigate the response of okra variety and potassium fertilizer with the following objectives-

- To find out the optimum level of potassium for better growth and yield of different cultivar of okra;
- To find out the suitable cultivar of okra in response to potassium fertilizer;
- To determine the content of potassium in pod from plant sample through chemical analysis.

Chapter II

Review of Literature

CHAPTER II

REVIEW OF LITERATURE

Okra is specially valued for its tender and delicious edible pods and is an important summer vegetable crop in Bangladesh. There are many genotype(s)/ cultivars of okra having diverse characters in different parts of the country. Management of fertilizer especially potassium is an important factor that greatly affects the growth, development and yield of okra. So it is important to assess the effect of potassium for the optimum growth and yield of okra variety. However, very limited research reports on the performance of okra variety in response to potassium have been done in various part of the world including Bangladesh and the work so far done in Bangladesh is not adequate and conclusive. However, some of the important and informative works conducted at home and abroad in this aspect re reviewed under the following headings:

2.1 Response of okra cultivars on growth and yield

Perdosa *et al.* (1983) observed wide variation among 100 okra introductions at the University of Viscosa, Brasileia. They observed that the days from sowing to the end of the juvenile period varied from 43 to 63 days, first anthesis from 52 to 85 days and for the cultural cycle from 131 to 227 days. Plant height at the end of the cultural cycle varied from 73 to 240 cm. Percentage of fruit set varied from 57.4 to 92.9%. Fruit length varied from 12 to 28 cm, fruit diameter from 1.9 to 2.6 cm and mean number of seeds per fruit from 54 to 130. The weight of 100 seeds varied from 5.53 to 7.43.

Martin and Rhodes (1983) studied variability of 95 accessions of *A. esculentus* and *A. tetraphylous*. They found significant differences among the accessions for all the characters studied, viz. plant height, plant spread, number of primary branches per plant, days to flowering, nodes where the first flower appear, number of leaf per plant, leaf length, leaf breadth, petiole length, number of pod per plant, pod weight and total yield.

Geneif (1984) evaluated okra lines under irrigation for yield, quality, disease resistance and general adaptation and found wide variation. Some of the lines showed high yielding capacity and superior attributes especially pod colour, surface and cooking qualities. Two lines namely 'OL-6' and 'OL-8' were tested over three seasons. The dark green colour and smooth surface of their pods had advantage in export markets. Other lines showed average performance but good cooking qualities.

A survey on okra (*A. esculentus* L.) in India was undertaken by National Bureaus for Plant Genetic Resource (NBPGR) under the International Board for plant Genetic Resources (IBPGR) supported project by Verma (1993). He showed that okra accessions had variability for morphology, viz. plant height (60-250 cm) and fruit length (5-25 cm).

Hussein *et al.* (1994) evaluated six local ecotypes and six exotic cultivars of okra for yield and yield components. Significant difference was observed among the accessions for the studied traits. The highest yielding genotype was 'Balady'. Green and the highest yielding cultivar was 'Clemon Spineless'.

Dash and Mishra (1995) worked on variation and character association of fruit yield and its component characters in 27 okra genotypes. They reported that all genotypes differed significantly for fruit yield per plant, fruit length, fruit girth fruit weight, number of seeds per fruit and seed weight per fruit.

Sannigrani and Chaudhury (1998) conducted an experiment at Tezpur, Assam, India during the Kharif seasion to evaluate the performance of 7 okra cultivars (Arka Abhay, Arka Anamika, BD-1, BD-2, Prabhani Kranti, Punjab 7 and Pusa Swani). The cultivars differed significantly for growth and yield contributing characters. Arka Anamika and Arka Abhay were found to be the most suitable okra cultivars for commercial cultivation in Assam, compared to Pusa Sawani.

Sonia (1999) investigated the variability of 48 okra genotypes in the mid hills, Himachal Prasesh, India during the Kharif season. Marketable fruit yield per plant varied from 154-467 g and the yield was higher in genotypes 'IC-39135', 'IC-9856' and 'Punjab Padmini'. The genotype 'IC-39135' had the highest number of nodes per plant. The genotype 'LC-12' had the highest fruit weight followed by Perfect 'Long Green', 'LG-26', 'LG-11' and 'LG-16'. Days to 50% flowering varied from 44.33 to 71.00 and 'IC-45791' was the earliest to flowering among the genotypes. The genotypes 'IC-14026' and 'IC-45796' had the highest duration of availability of edible pods.

Hazra and Basu (2000) studied the genetic variability of 22 okra cultivars from West Bengal, India during the summer. They reported wide range of variations for plant height, leaves per plant, nodes per plant, days to first flowering, fruit weight,

fruits per plant, seeds per fruit, yield plant; moderate variations for primary branches per plant and fruit length, and lesser variations for node to first flowering, ridges per fruit and dry weight of fruit among the 22 cultivars of okra.

Upon examining 30 okra genotypes by Bendale *et al.* (2003) observed a wide range of variability for yield and yield-contributing characters (first flowering node, days to first harvest, pod length, pod weight, plant height, nodes per plant, internode length, number of branches per plant, moisture content in pod, fruiting period, seeds per pod, 100-seed weight, number of pods per plant and yield per plant).

Subrata *et al.* (2004) conducted an experiment with twenty-five genotypes of okra grown in Nadia, West Bengal, India, during kharif 2001 to study the genetic variability of important growth and fruit characters and their relationships. All the 12 characters (days to first flower, days to 50% flowering, plant height at first flower, number of leaves at first flower, node at first flower, number of ridges per fruit, fruit length, fruit width, fruit weight, fruit dry weight, number of fruits per plant and fruit yield per plant) varied significantly among the genotypes.

The present investigation was conducted by Akotkar *et al.* (2010) to evaluate the variability of some yield contributing characters, and the genetic diversity in fifty genotypes of okra collected from the NBPGR New Delhi, India. Analysis of variance indicated significant difference among the genotypes for different morphological characters.

The study was carried out by Saifullah and Rabbani (2010) at the Regional Agricultural Research Station, Bangladesh Agricultural Research Institute, Jamalpur, Bangladesh. The materials of the study were consisted of 121 okra genotypes collected from different parts of Bangladesh and recorded significant variation in internodes per plant, length and diameter of fruit, fruits per plant, average weight of fruit, seeds per fruit and fruit yield.

2.2 Response of potassium fertilizer on growth and yield of okra

Mani and Ramanathan (1980) carried out an experiment to study the effect of nitrogen and potassium on the yield of okra. There were 5 levels of N (0, 20, 40, 60 and 80 kg/ha) and 5 levels of K_2O (0, 15, 30, 45 and 60 kg/ha). Nitrogen fertilization significantly increased yield. The highest K level (60 kg/ha) increased yield by 149.2% over the control and combined application of 80 kg N/ha with either 30 kg or 60 kg K_2O/ha produced maximum yields (17.2 t/ha and 17.5 t/ha respectively).

Adelana (1985) reported that significant responses were obtained to 20-40 kg N, 20 kg P and 20-30 kg K/ha at two sites in the derived savanna and at one site in the forest zone.

Abdul and Aarf (1986) carried out subsequently two trails with okra cv. Batrra and it was grown with 5 levels of fertilizers i.e. 100, 250, 300, 350 and 400 kg NPK/ donum (1338 m^2). The maximum okra yield (12.23 t/donum) was obtained with 400 kg NPK. The numbers of pods/plant was increased slightly by increasing

fertilizers levels and to a maximum of 400 kg, but there was no significant effect on average pod weight.

Mishra and Pandey (1987) conducted trails with okra CV. Pusa Sawani, with N and K_2O which were each applied at 0, 40, 80 and120 kg/ha. N at 80 kg/ha significantly increased the number of fruits/plant, 1000 seed weight and the seed yield of okra. Application of K above 120 kg/ha adversely affected, plant height, number of branches per plant, pod length, yield per plant as well as fruit yield. Interaction effect was significant with 80 kg/ha N and 40 kg K_2O/ha giving the highest seed yield and it was 15.47 q/ha.

Lenka *et al.* (1989) investigated a field trail with three replicates with N (as urea) applied at 4 levels (0, 50, 75, 100 kg/ha), P_2O_5 at 2 levels (30 and 60 kg/ha) and K_2O at a constant 40 kg/ha. They stated that N and P significantly increased plant height, yield and its attributes. Application of 100 kg N/ha and 30 kg P_2O_5/ha gave a satisfactory seed yield (7.60 q/ha).

Rain and Lal (1990) conducted a field experiment in Bapalta, Andhra Pradesh, India and studied the growth and development of okra cultivars (Parbhani Kranti, Arka Anamika and Pussa Sawani) in response to 4 fertilizer levels(0-0-0, 50-25-25, 100-50-50 and 150-75-75 kg N, P_2O_5, K_2O/ha respectively). Results showed that leaf area, index (LAI) and leaf area duration (LAD) were significantly influenced at all stages by cultivers, fertilizer levels and their interaction effects. Among cultivars, Pusa Sawani showed the maximum leaf area, LAI and LAD. However, Arka Anamika showed significantly superior performance with respect

to plant height, number of leaves, and number of nodes and yield per plant. The highest fertilizer level resulted in maximum leaf area, LAI and LAD, which gradually increased up to 60 days after sowing (DAS). Dry matter increased and also influenced significantly by cultivars, fertilizer levels and their combination. Harvest index (HI) was also influenced by cultivars, fertilizer levels and their interaction. Arka Anamicka, with a moderate vegetative growth and high Net Assimilation Rate (NAR), had the highest Harvest Index (HI) values. Among the fertilizer levels, maximum HI was recorded by 100-50-50 kg NPK/ha.

Naik and Srinivas (1992) conducted field experiments with cv. Pusa Sawani in the rainy seasons of 1985 and 1986 on a sandy loam with low available P in soil, applying P at 30, 60 or 90 kg P_2O_5/ha. All the P and 40 kg K_2O/ha were applied before sowing of okra seeds. The highest seed yields were obtained with 90 kg P_2O_5/ha and 40 kg K_2O/ha (11.89 and 10.71 q/ha in 1985 and 1986, respectively). Other parameters (fruit length, fruit diameter, number of fruits/plant, number of seeds/fruit and 1000-seed weight) were also generally highest with the highest rate of fertilizer application.

An experiment was conducted by Bhai and Sing (1998) at Palampur, India to investigate the effect of K application rate (50, 70 or 90 kg/ha). They reported that K application significantly increased the plant height, number of nodes per plant yield of okra.

Rani *et al.* (1999) conducted a field experiment in Bapatla, Andra Pradesh, India, during 20 March – 8 July 1997 studied the growth and development of 3 okra

cultivars (Parbhani Kranti, Arka Anamika and Pusa Sawani) in response to 4 fertilizer levels (0-0-0, 50-25-25,100-50-50 and 150-75-75 kg N, P_2O_5 and K_2O/ha respectively). Results showed that leaf area, leaf area index (LAI) and leaf area duration (LAD) were significantly influenced at all stages by cultivars, fertilizer levels and their interaction effects. Among the cultivars, Pusa Sawani showed the maximum leaf area, LAI and LAD. However, Arka Anamika showed significantly superior performance with respect to plant height, number of leaves, number of nodes and yield per plant. Harvest index (HI) was also influenced by cultivars fertilizer levels and their interactions. Arka Anamika, with a moderate vegetable growth and high NAR, bad the highest HI values. Among the fertilizer levels, maximum HI was recorded by 100-50-50 kg NPK/ha.

Gowda *et al.* (2001) conducted a field experiment in Bangalore, Karnataka, India during summer season to determine the response of okra cultivars Arka Anamika, Varsha and Vishal to 3 NPK fertilizer rates (125:75:60 kg/ha, 150:100:75 kg/ha and 175:125:100 kg/ha). The highest dry matter production in leaves (20.40 g), stems (35.17 g), roots (18.03 g), fruits (31.11g) and whole plants (104.71 g) was recorded with 175:125:100 kg NPK/ha treatments. Varsha recorded significantly higher dry matter production in leaves (17.48g), stems (31.44 g), roots (17.61 g), fruits (29.98 g) and whole plants (96.51 g) compared to the other cultivars. In the interaction effect, the highest total dry matter production (1111.48 g/plant) was recorded in Varsha supplemented with 175:125:100 kg NPK/ha, which was at per with Arka Anamika supplemented with 175:125:100 kg NPK/ha. Comparative

data on the effect of varying fertilizer rates, cultivars and their interaction on the length, diameter and yield of fruits are tabulated.

Prabu and Pramanik (2002) conducted an experiment in Parbhani, Maharashtra, India, during the summer season of 2001 to investigate the effects of organic fertilizers at 0, 1/3, 2/3 and full rate (N: P: K at 100: 50: 50 kg/ha), in the presence or absence of farmyard manure (FYM at 10 t/ha), and bio-fertilizers (un inoculated; *Azospirillum* + phosphate sollubilizing bacteria, and *Azospirillum* + vesicular arbuscular mycorrhiza) on the performance of okra cultivar Parbhani Kranti. Result showed that the treatment 2/3 recommended NPK dose + FYM + *Azospirillum* vesicular arbuscular mycorrhiza produced the highest yield.

Gowda *et al.* (2002) conducted a study in the summer season oin Bangalore, Karnataka, India to investigate the effects of different fertilizer levels (N:P:K at 125:75:60, 150:100:75 and 175:125:100 kg/ha) on okra cultivers Arka Anamica, Varsha and Vishal. Dry matter accumulation and nutrient (N, P and K) accumulation increased with increasing fertilizer levels. The highest fertilizer level resulted in the highest nutrient uptake. Varsha showed the highest nutrient uptake and accumulation in leaves and fruits at the highest level of fertilizer.

Aslam and Bose (2003) reported that excessive use of nitrogen fertilizers is a factor of nitrate accumulation in vegetable, which cause health problems to the consumers. A study was conducted to assess the effect of NPK fertilizers on NO_3 accumulation in okra (*Abelmoschus esculentus*) and carrot (*Daucus carota*) at Ayub Agricultural Research Instute, Faisalabad, Pakistan. For okra five (0, 100,

150, 175 and 200 kg N/ha) and two P_2O_5 rates (0, 75 kg/ha) were tested with 60 kg K_2O/ha as basal dose. Increasing fertilizer rates increased NO_3 concentration over the control in okra. Additionally, the doses of NPK fertilizers applied in this study did not pose health hazards to the consumers.

Bamel and Sing (2003) conducted a plot experiment to study the effect of different fertilizer sources on *M. incognita* in okra under greenhouse condition. Better plant growth and reduced nematode damage when a combination of N, P, K and Zn fertilizers was applied at recommended dose. Individually, murate of potash and potassium sulfate at higher doses recorded maximum plant growth. Ammonium sulfate and gypsum reduced nematode reproduction significantly compared to other treatments. All the fertilizers except calcium nitrate, murate of potash and potassium sulfate, showed reduction in nematode damage with a corresponding increase in their dose.

Two field experiments were conducted by El-Shaikh (2005) at the Experimental Farm of Sohag, South Valley University, Egypt, during 2003 and 2004 to investigate the effects of phosphorus (22.5, 30.0, 37.5 and 45 kg P_2O_5/fed) and potassium fertilizers on the growth, yield and quality of two okra cultivars (El-Balady and Golden Coast). Applying high levels, i.e. 37.5 and 45 kg K_2O/fed, of phosphorus significantly improved the most studied characters.

Field experiments were conducted by Sunita *et al.* (2006) for two consecutive years at the Feirsa Agricultural University, Ranchi, Jharkhand, India, to determine the effects of intercrop and NPK fertilizer application on the performance of okra

(cv. Arka Anamika). Treatments comprised: two intercrops (cowpea and French bean) and five fertilizer rates (0, 25, 50, 75 and 100% recommended dose of NPK). The results revealed that treatment with 100% recommended dose of fertilizers recorded higher okra equivalent yield (153.16 q/ha) and net returns (Rs. 30,709.91/ha) than the rest of the fertilizer rates. The best performance of okra in terms of yield, number of fruits per plant, fruit weight and plant height were observed with 100% recommended dose of fertilizer.

A field experiment was conducted by Khan *et al.* (2007) in 1999 in Medziphema, Nagaland, India, on a sandy loam soil having 5.3 pH, 4.5% organic carbon, 208.0 kg/ha available N, 12.3 kg P_2O_5/ha and 189.6 kg K_2O/ha to study the response of okra to biofertilizers and K application in terms of growth, yield and leaf nutrient (N, P and K) status. The treatments consisted of five levels of K (0, 30, 60, 90 and 120 kg/ha) and four levels of biofertilizers. The application of K and biofertilizers significantly increased the growth and yield. The optimum K requirement was found to be 60 kg/ha, along with Azotobacter in foothills of Nagaland.

A study was conducted by Omotoso and Shittu (2007) to determine the effect of NPK fertilizer application rates and method of application on growth and yield of okra (*Abelmoschus esculentus* (L.) Moench) at the Teaching and Research Farm, University of Ado-Ekiti. Okra seed variety LD88 were treated to three levels of NPK fertilizer rates (0, 150 and 300 kg NPK ha^{-1}) and two methods of fertilizer application. Treatments were arranged in a split-plot design with fertilizer application method as main plot factor and NPK rates as sub-plot factor. The

treatments were replicated three times to give a total of eighteen experimental field plots. 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 from NPK @ 150 kg ha^{-1}.

The influence of NPK 20-10-10 on the fresh pod yield and root growth of okra variety, V 35 grown in the lowland humid tropics was investigated by Awe *et al.* (2009) during the 2002 and 2003 cropping seasons. Four rates (0, 150, 300 and 450 kg/ha) of the fertilizer were applied to the crop. The treatments were replicated three times in a Randomized Complete Block design. The results suggest that the optimum NPK 20-10-10 level for okra variety, V 35 in the study area lies between 300-450 kg NPK 20-10-10/ha. Therefore, application rates above 450 kg NPK 20-10-10/ha for okra production in the study area will not be economical.

Chapter III

Materials and Methods

CHAPTER III

MATERIALS AND METHODS

The experiment was carried out during the period from April to July 2012 to study effect of cultivars and potassium on the growth, yield and nutrient content of okra. A short description of the location of experimental site, climate and soil condition of the experimental plot, materials used for the experiment, design of the experiment, data collection procedure and procedure of data analysis have been presented in this chapter under the following headings-

3.1 Location of the experimental site

The experiment was carried out at the experimental Farm of Sher-e-Bangla Agricultural University (SAU), Dhaka. The experimental site is situated between $23^0 74^/N$ latitude and $90^0 35^/E$ longitude.

3.2 Climatic condition of the experimental site

Experimental location situated in the sub-tropical climate zone, which is characterized by heavy rainfall during the months of April to September and scanty rainfall during the rest of the period of the year. Details of the meteorological data during the period of experiment collected from Bangladesh Meteorological Department, Agargoan, Dhaka and presented in Appendix I.

3.3 Soil characteristics of the experimental site

The soil of the experimental field belongs to the Tejgaon series under the Agroecological Zone, Madhupur Tract (AEZ- 28) and the General Soil Type is

Deep Red Brown Terrace Soils. A composite sample was made by collecting soil from several spots of the field at a depth of 0-15 cm before the initiation of the experiment. The collected soil was air-dried, ground and passed through 2 mm sieve and analyzed for some important physical and chemical properties. The analytical data of the soil sample collected from the experimental area were determined in the SRDI, Soil Testing Laboratory, Khamarbari, Dhaka and presented in Appendix II.

3.4 Planting materials

The test crop used in the experiment was Dherosh cultivar.

3.5 Treatment of the experiment

The experiment consisted of two factors:

Factor A: Dherosh cultivars (2 cultivars) as

i C_1: Arka Anamica

ii. C_2: Dherosh F_1 Green Lady

Factor B: Potassium fertilizer (4 levels) as

i. K_0: 0 kg K_2O/ha (control)

ii. K_1: 50 kg K_2O/ha

iii. K_2: 100 kg K_2O/ha

iv. K_3: 150 kg K_2O/ha

There were 3 (2 × 4) treatments combination such as C_1K_0, C_1K_1, C_1K_2, C_1K_3, C_2K_0, C_2K_1, C_2K_2 and C_2K_3.

3.6 Collection of seeds

The seeds of okra were collected from Siddique Bazar, Dhaka.

3.7 Land preparation

The plot selected for conducting the experiment was opened in the third week of March, 2012 with a power tiller, and left exposed to the sun for a week. After one week the land was harrowed, ploughed and cross-ploughed several times followed by laddering to obtain good tilth. Weeds and stubbles were removed and finally obtained a desirable tilth of soil was obtained for sowing okra seeds. All weeds, stubbles and residues were eliminated from the field. Finally, a good tilth was achieved. The soil was treated with insecticides (cinocarb 3G @ 4 kg/ha) at the time of final land preparation to protect young plants from the attack of soil inhibiting insects such as cutworm and mole cricket.

3.8 Application of manure and fertilizers

Urea, Triple Super Phosphate (TSP) and Muriate of Potash (MP) were used as a source of nitrogen, phosphorous, and potassium, respectively. Manures and fertilizers that were applied to the experimental plot presented in Table 1. The total amount of cowdung, TSP and MP (as per treatment) was applied as basal dose at the time of final land preparation dated at 31 March, 2012. Urea was applied at 15, 30 and 45 days after sowing (DAS). Application of manures and fertilizer in details are presented in Table 1.

Table 1. Dose and method of application of fertilizers in okra field as per Fertilizer Recommendation Guide (BARC, 2005)

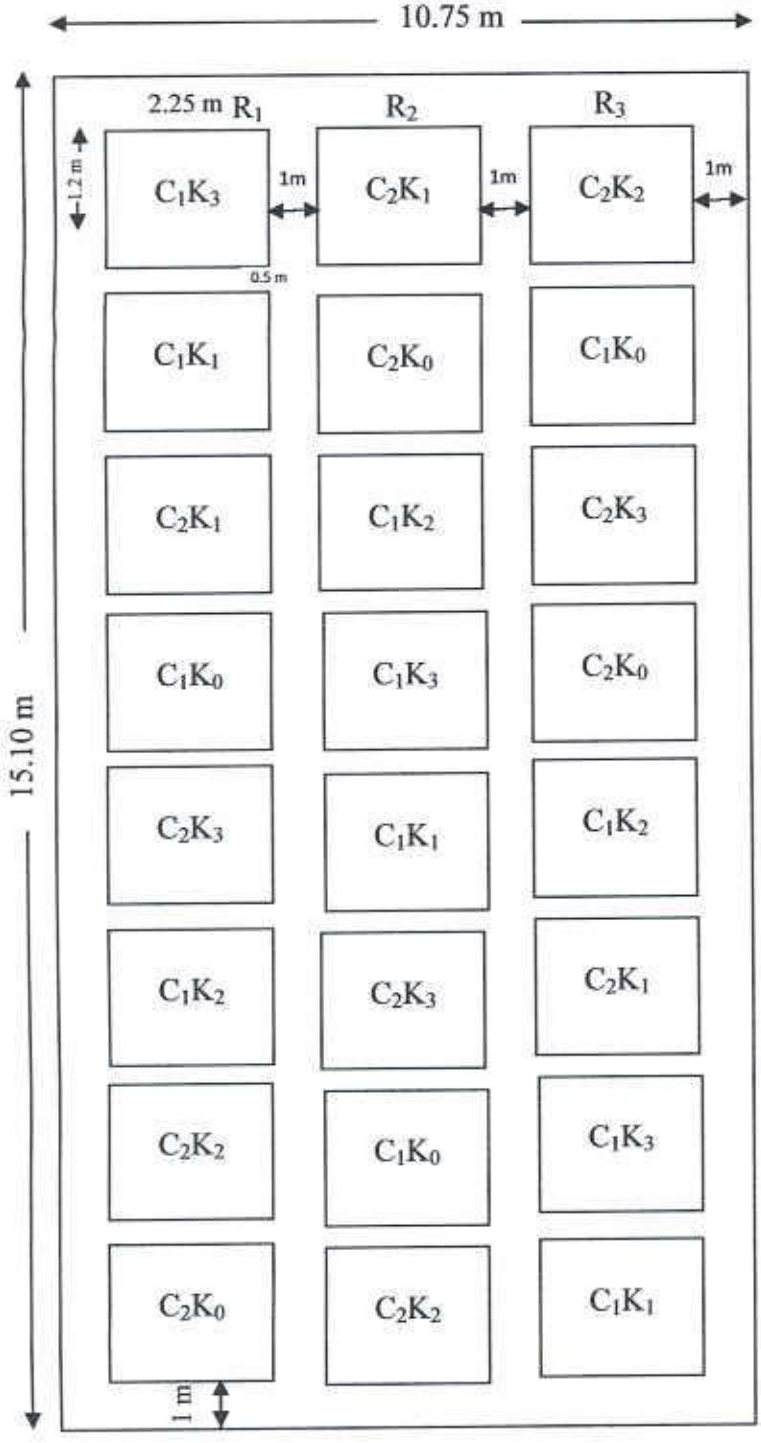
Fertilizers	Dose/ha	Application (%)			
		Basal	15 DAS	30 DAS	45 DAS
Cowdung	10 tons	100	--	--	--
Nitrogen (as urea)	120 kg	--	33.33	33.33	33.33
P_2O_5 (as TSP)	50 kg	100	--	--	--
K_2O (as MP)	As per treatment	100	--	--	--

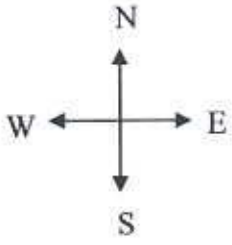
3.9 Design and layout of the experiment

The two factors experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. The total area of the experimental plot was 162.33 m^2 with length 15.10 m and width 10.75 m. The total area was divided into three equal blocks. Each block was divided into 8 plots where 8 treatments combination were allotted at random. There were 24 unit plots altogether in the experiment. The size of the each plot was 2.25 m × 1.2 m. The distance maintained between two blocks and two plots were 1.0 m and 0.5 m, respectively. The spacing was at 50 cm × 40 cm. The layout of the experimental plot is shown in Figure 1.

3.10 Seeds sowing

The okra seeds were sown in the main field at 04 April in 2012. Seeds were treated with Bavistin before sowing the seeds to control the seed borne diseases. The seeds were sown in rows having a depth of 2-3 cm with maintaining distance from 60 cm and 40 cm from row to row and plant to plant, respectively.





Plot size: 2.25 m × 1.2 m

Plant to plant: 50 cm

Row to row distance: 40 cm

Between replication: 1.0 m

Factors A:

C_1: Arka Anamica

C_2: Dherosh F_1 Green Lady

Factors B:

K_0: 0 kg K_2O/ha (control)

K_1: 50 kg K_2O/ha

K_2: 100 kg K_2O/ha

K_3: 150 kg K_2O/ha

Figure 1. Layout of the experimental plot

3.11 Intercultural operation

After raising seedlings, various intercultural operations such as gap filling, weeding, earthing up, irrigation pest and disease control etc. were accomplished for better growth and development of the okra seedlings.

3.11.1 Gap filling

The seedlings in the experimental plot were kept under careful observation. Very few seedlings were damaged after germination and such seedling were replaced by new seedlings Replacement was done with healthy seedling in the afternoon having a boll of earth which was also planted on the same date by the side of the unit plot. The seedlings were given watering for 7 days starting from germination for their proper establishment.

3.11.2 Weeding

The weeding was done by nirani with roots at 15, 30 and 45 days after sowing to keep the plots free from weeds.

3.11.3 Irrigation

Light watering was given by a watering cane at every morning and afternoon and it was continued for a week for rapid and well establishment of the germinated seedlings.

3.11.4 Pest and disease control

Insect infestation was a serious problem during the period of establishment of seedings in the field. In spite of Cirocarb 3G applications during final land

preparation few young plants were damaged due to attack of mole cricket and cut worm. Cut worms were controlled both mechanically and spraying Darsban 29 EC @ 3%. Some discolored and yellowish diseased leaves were also collected from the plant and removed from the field.

3.12 Harvesting

Fruits were harvested at 3 days interval based on eating quality at soft and green condition. Harvesting was started from 22 May, 2012 and was continued up to July 2012.

3.13 Data collection

Five plants were randomly selected from each unit plot for avoiding border effect, except yields of plots, which was recorded plot wise. Data were collected in respect of the following parameters to assess plant growth; yield attributes and yields as affected by different treatments of the experiment. Data on plant height, number of leaves, length of petiole, diameter of stem, length of leaf, number of branches per plant, were collected at 20, 40, 60 and 80 days after sowing (DAS). Fresh weight per plant and dry weight per plant was recorded at 80 DAS at maximum growth stages. All other yield contributing characters and yield parameters such as days to flowering, number of flower buds/plant, number of pods per plant, weight of individual pods, length of pod, diameter of pod, yield per plot was also recorded as per the suitable time of optimum performance of okra plants.

3.13.1 Plant height

Plant height was measured from sample plants in centimeter from the ground level to the tip of the longest stem of five plants and mean value was calculated. Plant height was also recorded at 20 days interval starting from 20 days after sowing (DAS) upto 80 days to observe the growth rate of plants.

3.13.2 Number of leaves per plant

The total number of leaves per plant was counted from each selected plant. Data were recorded as the average of 5 plants selected at random from the inner rows of each plot from 20 DAS to 80 DAS at 20 days interval.

3.13.3 Length of petiole

Length of petiole was measured from the longest petiole of 5 sample plants in centimeter and mean value was calculated. Length of petiole was also recorded at 20 days interval starting from 20 days after sowing (DAS) upto 80 days to observe the growth rate of the plants.

3.13.4 Diameter of stem

Stem diameter was measured from sample plants with a digital calipers-515 (DC-515) from the three different parts of five plants and mean value was calculated. Stem diameter was recorded at 20 days interval starting from 20 days after sowing (DAS) upto 80 days to observe the growth rate of plants.

3.13.5 Length of leaf

Length of leaf was measured from sample plants in centimeter from the one side to another side of leaf of the longest five leaves and mean value was calculated.

3.13.6 Number of branches per plant

The total number of branches per plant was counted from each selected plant. Data were recorded as the average of 5 plants selected at random from the inner rows of each plot from 20 DAS to 80 DAS at 20 days interval.

3.13.7 Fresh weight of leaves per plant

At 80 DAS leaves of three okra plants from inner rows selected and pulled out then the plant was taken, clean and weighted by a digital weighing machine and average was calculated for measuring fresh weight of plant.

3.13.8 Dry matter content of leaves

After taking fresh weight the sample it was sliced into very thin pieces and put into envelop then placed in oven maintained at 70^0C for 72 hours. It was then transferred into desiccators and allowed to cool down at room temperature. The final dry content was taken by following formula:

$$\text{Dry matter content of leaves} = \frac{\text{Dry weight of leaves (g)}}{\text{Fresh weight of leaves (g)}} \times 100$$

3.13.9 Days required to staring of flowering

Days required to starting of flowering was recorded from the date of sowing to the initiation of 1st flower bud.

3.13.10 Number of flower buds per plant

The number of flower buds per plant was counted from the sample plants and the average numbers of flower buds produced per plant were recorded.

3.13.11 Number of pods per plant

The number of pods per plant was counted from the sample plants for the whole growing period and the average number of pods produced per plant was recorded and expressed in pods per plant.

3.13.12 Pod length

The length of pod was measured with a meter scale from the neck of the pod to the bottom of 10 selected marketable pods from each plot and there average was taken and expressed in cm.

3.13.13 Pod diameter

Diameter of pod was measured at the middle portion of 10 selected marketable pod from each plot with a digital calipers-515 (DC-515) and average was taken and expressed in cm.

3.13.14 Weight of individual pods

The weight of individual pod was measured with a digital weighing machine from 10 selected marketable pods from each selected plots and there average was taken and expressed in gram.

3.13.15 Yield per plant

Yield of okra per plant was recorded by the weighing of whole pod per plant by a digital weighing machine for the whole growing period and was expressed in gram.

3.13.16 Yield per hectare

Yield per hectare of okra pods was estimated by converting the weight of plot yield into hectare and was expressed in ton.

3.13.17 Potassium content in pod

Preparation of pod samples

The pod plant samples were dried in an oven at 70^0C for 72 hours and then ground by a grinding machine to pass through a 20-mesh sieve. The pod samples were analyzed for determination of K content. The methods were as follows:

Digestion of pod samples with nitric-perchloric acid for K estimation

A sub sample weighing 0.5 g was transferred into a dry, clean 100 mL digestion vessel. Ten ml of di-acid (HNO_3: $HClO_4$ in the ratio 2:1) mixture was added to the flask. After leaving for a while, the flasks were heated at a temperature slowly raised to 200^0C. Heating were stopped when the dense white fumes of $HClO_4$ occurred. The contents of the flask were boiled until they became clean and colorless. After cooling, the content was taken into a 100 mL volumetric flask and the volume was made up to the mark with de-ionized water. K were determined from this digest.

3.17.3 Potassium estimation

Five milli-liter of digested sample from the pod was taken and diluted to 50 ml volume to bring it to the desired concentration so that the absorbance of the sample were measured within the range of standard solutions. The absorbances were measured by atomic absorption flame photometer.

3.18 Statistical analysis

The data obtained for different characters were statistically analyzed to find out the significance of the difference for cultivars and potassium fertilizer on the growth, yield and nutrient content of okra. The mean values of all the recorded characters were evaluated and analysis of variance was performed by the 'F' (variance ratio) test. The significance of the difference among the means of treatment combinations was estimated by Duncan's Multiple Range Test (DMRT) at 5% level of probability (Gomez and Gomez, 1984).

Chapter IV

Results and Discussion

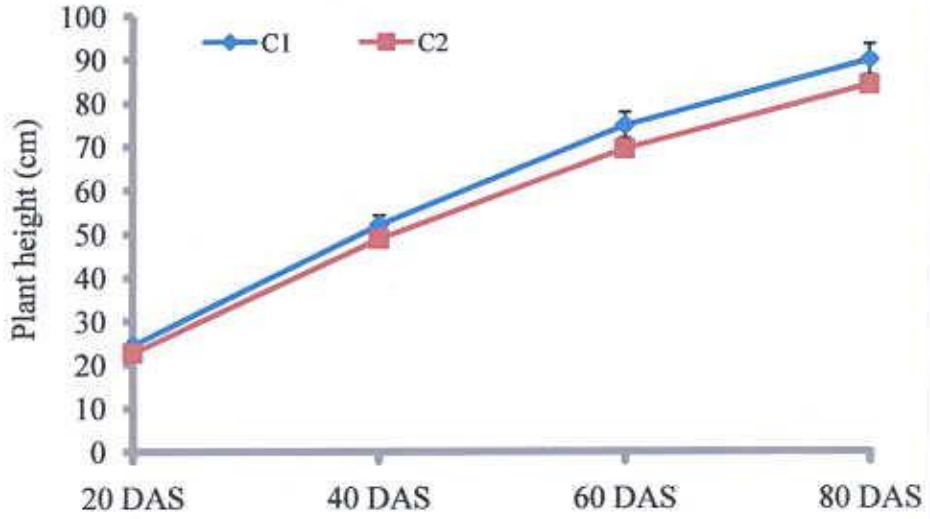
CHAPTER IV

RESULTS AND DISCUSSION

The experiment was conducted to find the growth and yield of okra as influenced by cultivars and different levels of potassium fertilizer. The analyses of variance (ANOVA) of the data on different growth and yield parameters are presented in Appendix III-X. The results have been presented and discusses with the help of table and graphs and possible interpretations given under the following headings:

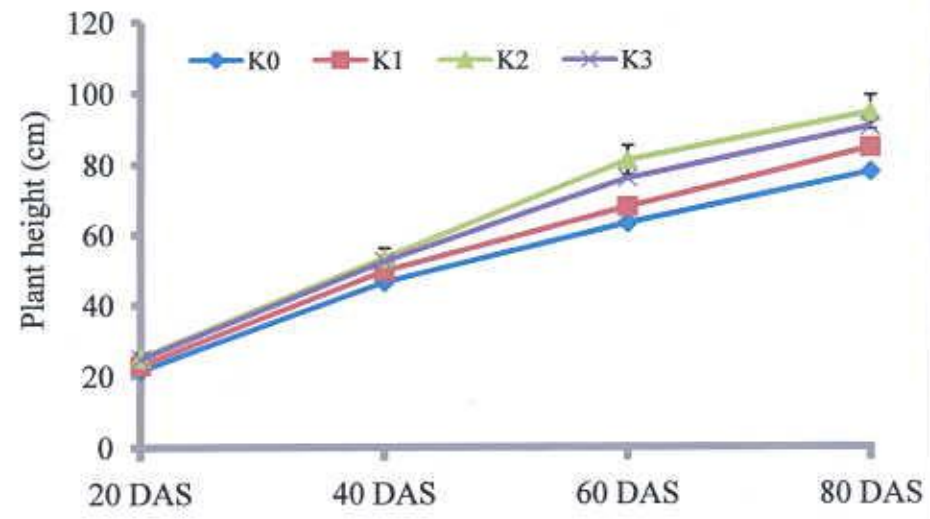
4.1 Plant height

Plant height varied significantly at 20, 40, 60 and 80 DAS for different cultivars of okra under the present study (Figure 2; Appendix III). At 20, 40, 60 and, 80 DAS, the tallest plant (24.58 cm, 52.20 cm, 74.92 cm and 89.95 cm, respectively) was recorded from C_1 (Arka Anamica), whereas the shortest plant (22.70 cm, 48.91 cm, 69.48 cm and 84.18 cm, respectively) was observed from C_2 (Dherosh F_1 Green Lady). Different okra cultivars produced different plant height on the basis of their varietal characters and crop variety is one of the important factors for highest growth, yield and benefit of any crop. Subrata *et al.* (2004) reported that plant height varied significantly among the genotypes. Perdosa *et al.* (1983) reported that plant height at the end of the cultural cycle varied from 73 to 240 cm. Rain and Lal (1990) reported that Arka Anamika showed significantly superior performance with respect to plant height than the okra cultivars of Parbhani Kranti, and Pussa Sawani.



C_1: Arka Anamica C_2: Dherosh F_1 Green Lady

Figure 2. Effect of cultivars on plant height of okra



K_0: 0 kg K_2O/ha (control) K_1: 50 kg K_2O/ha

K_2: 100 kg K_2O/ha K_3: 150 kg K_2O/ha

Figure 3. Effect of different levels of potassium on plant height of okra

Significant difference was recorded for different levels of potassium fertilizer on plant height at 20, 40, 60 and 80 DAS (Figure 3; Appendix III). At 20, 40, 60 and 80 DAS, the tallest plant (25.23 cm, 53.50 cm, 81.30 cm and 84.70 cm, respectively) was observed from K_2 (100 kg K_2O/ha), which was statistically similar (24.85 cm, 52.47 cm, 76.10 cm and 90.70 cm, respectively) with K_3 (150 kg K_2O/ha) and followed (23.00 cm, 49.71 cm, 68.00 cm and 84.83 cm, respectively) by K_1 (50 kg K_2O/ha), while the shortest plant (21.48 cm, 46.54 cm, 63.40 cm and 78.03 cm, respectively) was recorded from K_0 (0 kg K_2O/ha) i.e. control condition. Mishra and Pandey (1987) reported that application of K above 120 kg/ha adversely affected plant height.

Combined effect of okra cultivars and different levels of potassium fertilizer showed significant differences on plant height at 20, 40, 60 and 80 DAS (Table 2; Appendix III). At 20, 40, 60 and 80 DAS, the tallest plant (25.57 cm, 54.13 cm, 78.80 cm and 94.20 cm, respectively) was found from C_1K_2 and the shortest plant (20.06 cm, 41.78 cm, 51.00 cm and 70.80 cm, respectively) from C_2K_0.

4.2 Number of leaves per plant

Different cultivars of okra showed statistically significant variation on number of leaves per plant at 20, 40, 60 and 80 DAS (Figure 4; Appendix IV). At 20, 40, 60 and, 80 DAS, the maximum number of leaves per plant (7.02, 14.58, 28.82 and 35.69, respectively) was observed from C_1, while the minimum number (6.62, 13.63, 26.40 and 32.85, respectively) was found from C_2. Rain and Lal (1990) reported that Arka Anamika showed significantly superior performance for number of leaves than the okra cultivars of Parbhani Kranti, and Pussa Sawani.

Table 2. Combined effect of cultivars and different levels of potassium on plant height of okra

Treatments	Plant height (cm) at			
	20 DAS	40 DAS	60 DAS	80 DAS
C_1K_0	22.89 bc	51.30 ab	75.80 abc	85.27 cd
C_1K_1	24.50 ab	52.13 a	70.73 bc	88.47 bc
C_1K_2	25.57 a	54.18 a	78.80 ab	94.20 ab
C_1K_3	25.37 ab	52.56 a	74.33 abc	91.87 ab
C_2K_0	20.06 d	41.78 c	51.00 d	70.80 e
C_2K_1	21.51 cd	47.29 b	65.27 c	81.20 d
C_2K_2	24.88 ab	52.81 a	83.80 a	95.20 a
C_2K_3	24.34 ab	52.38 a	77.87 ab	89.53 abc
$LSD_{(0.05)}$	2.373	4.382	9.798	5.592
Significance level	0.05	0.01	0.01	0.01
CV(%)	5.73	4.95	7.75	5.67

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

C_1: Arka Anamica

C_2: Dherosh F_1 Green Lady

K_0: 0 kg K_2O /ha (Control)

K_1: 50 kg K_2O /ha

K_2: 100 kg K_2O /ha

K_3: 150 kg K_2O /ha

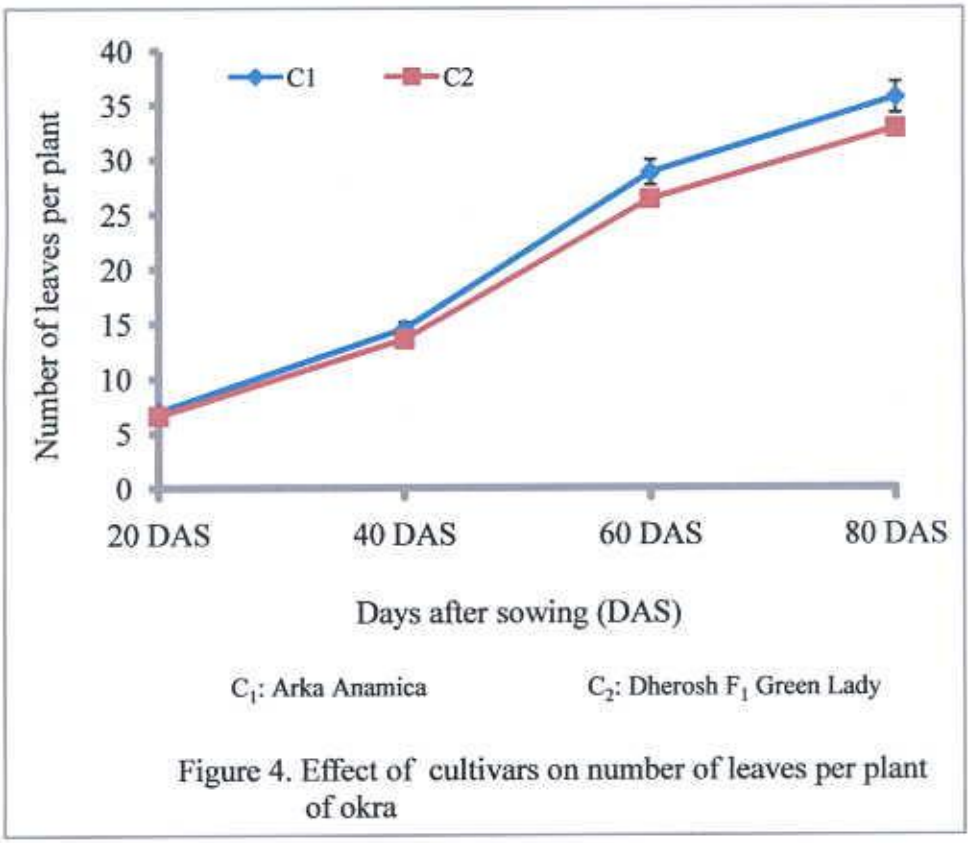


Figure 4. Effect of cultivars on number of leaves per plant of okra

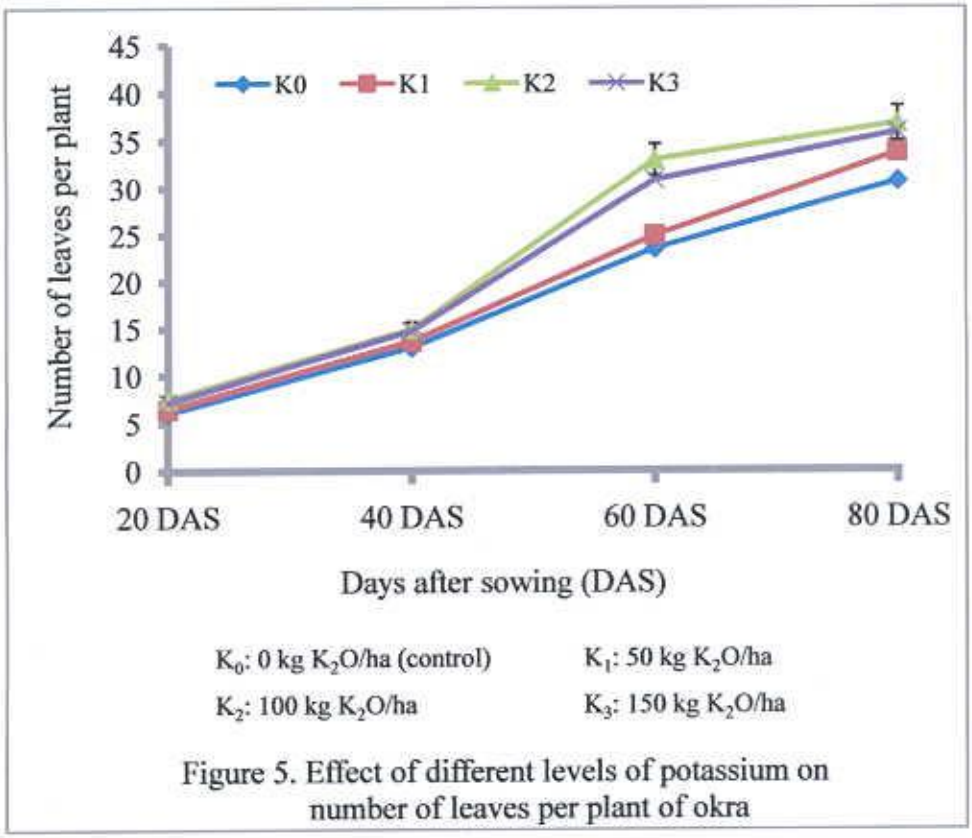


Figure 5. Effect of different levels of potassium on number of leaves per plant of okra

Number of leaves per plant showed significant difference for different levels of potassium fertilizer at 20, 40, 60 and 80 DAS (Figure 5; Appendix IV). At 20, 40, 60 and 80 DAS, the maximum number of leaves per plant (7.53, 14.96, 33.00 and 36.77, respectively) was found from K_2, which was statistically identical (7.20, 14.77, 30.87 and 35.85, respectively) with K_3 and followed (6.47, 13.65, 24.93 and 33.73, respectively) by K_1, whereas the minimum number (6.07, 13.03, 23.53 and 30.73, respectively) was obtained from K_0. It revealed that with the increase of potassium number of leaves per plant showed increasing trend then decreased.

Okra cultivars and different levels of potassium fertilizer showed significant differences on number of leaves per plant at 20, 40, 60 and 80 DAS due to their combined effect (Table 3; Appendix IV). At 20, 40, 60 and 80 DAS, the maximum number of leaves per plant (7.60, 14.96, 33.33 and 37.01, respectively) was recorded from C_1K_2, while the minimum number (5.33, 12.57, 21.27 and 25.68, respectively) was observed from C_2K_0.

4.3 Length of petiole

Statistically significant variation was recorded for length of petiole at 20, 40, 60 and 80 DAS for different cultivars of okra under the present study (Table 4; Appendix V). At 20, 40, 60 and, 80 DAS, the highest length of petiole (6.86 cm, 10.70 cm, 13.67 cm and 13.41 cm, respectively) was found from C_1 and the lowest length of petiole (6.20 c,. 9.78 cm, 12.38 cm and 15.32 cm, respectively) was found from C_2. Subrata *et al.* (2004) reported that length of petiole varied significantly among the genotypes.

Table 3. Combined effect of cultivars and different levels of potassium on number of leaves per plant of okra

Treatments	Number of leaves per plant at			
	20 DAS	40 DAS	60 DAS	80 DAS
C_1K_0	6.81 abc	13.50 ab	25.80 ab	35.79 a
C_1K_1	6.60 bc	14.92 a	26.80 bc	34.51 a
C_1K_2	7.60 a	14.96 a	33.33 a	37.01 a
C_1K_3	7.20 abc	14.93 a	29.33 ab	35.46 a
C_2K_0	5.33 d	12.57 b	21.27 d	25.68 b
C_2K_1	6.33 c	12.39 b	23.07 c	32.95 a
C_2K_2	7.47 ab	14.95 a	32.67 a	36.53 a
C_2K_3	7.20 abc	14.61 a	32.40 a	36.25 a
$LSD_{(0.05)}$	0.797	1.353	4.749	5.325
Significance level	0.05	0.05	0.01	0.05
CV(%)	6.67	5.48	9.66	8.87

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

C_1: Arka Anamica

C_2: Dherosh F_1 Green Lady

K_0: 0 kg K_2O /ha (Control)

K_1: 50 kg K_2O /ha

K_2: 100 kg K_2O /ha

K_3: 150 kg K_2O /ha

Table 4. Effect of cultivars and different levels of potassium on length of petiole of okra

Treatments	Length of petiole (cm) at			
	20 DAS	40 DAS	60 DAS	80 DAS
Cultivars				
C_1	6.86 a	10.70 a	13.67 a	16.41 a
C_2	6.20 b	9.78 b	12.38 b	15.32 b
$LSD_{(0.05)}$	0.393	0.822	0.600	0.859
Significance level	0.01	0.05	0.01	0.05
Level of potassium				
K_0	5.77 b	8.41 c	11.15 c	13.36 c
K_1	5.99 b	9.66 b	12.70 b	15.77 b
K_2	7.36 a	11.88 a	14.42 a	17.42 a
K_3	6.99 a	11.01 a	13.84 a	16.93 ab
$LSD_{(0.05)}$	0.555	1.163	0.849	1.215
Significance level	0.01	0.01	0.01	0.01
CV(%)	6.87	9.17	5.26	6.18

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

C_1: Arka Anamica

C_2: Dherosh F_1 Green Lady

K_0: 0 kg K_2O /ha (Control)

K_1: 50 kg K_2O /ha

K_2: 100 kg K_2O /ha

K_3: 150 kg K_2O /ha

Different levels of potassium fertilizer varied significantly in terms of length of petiole at 20, 40, 60 and 80 DAS (Table 4; Appendix V). At 20, 40, 60 and 80 DAS, the highest length of petiole (7.36 cm, 11.88 cm, 14.42 cm and 17.42 cm, respectively) was observed from K_2, which was statistically identical (6.99 cm, 11.01 cm, 13.84 cm and 13.93 cm, respectively) with K_3 and followed (5.99 cm, 9.66 cm, 12.70 cm and 15.77 cm, respectively) by K_1, while the lowest number (5.77 cm, 8.41 cm, 11.15 cm and 13.36 cm, respectively) was recorded from K_0 i.e. control condition.

Length of petiole showed significant differences at 20, 40, 60 and 80 DAS due to the combined effect of okra cultivars and different levels of potassium fertilizer (Table 5; Appendix V). At 20, 40, 60 and 80 DAS, the highest length of petiole (7.42 cm, 12.29 cm, 14.43 cm and 18.08 cm, respectively) was recorded from C_1K_2, whereas the lowest length (5.69, 9.20, 11.82 and 14.76 cm, respectively) from C_2K_0.

4.4 Diameter of stem

Diameter of stem showed statistically significant variation at 20, 40, 60 and 80 DAS due to different cultivars of okra under the present study (Figure 6; Appendix VI). At 20, 40, 60 and, 80 DAS, the highest diameter of stem (1.58 cm, 2.41 cm, 3.48 cm and 4.65 cm, respectively) was observed from C_1, while the lowest diameter (1.40 cm, 1.88 cm, 3.10 cm and 4.27 cm, respectively) was found from C_2. Genotypes responses differently in terms of diameter of stem due to their genetical characters (Subrata *et al.*, 2004).

Table 5. Combined effect of cultivars and different levels of potassium on length of petiole of okra

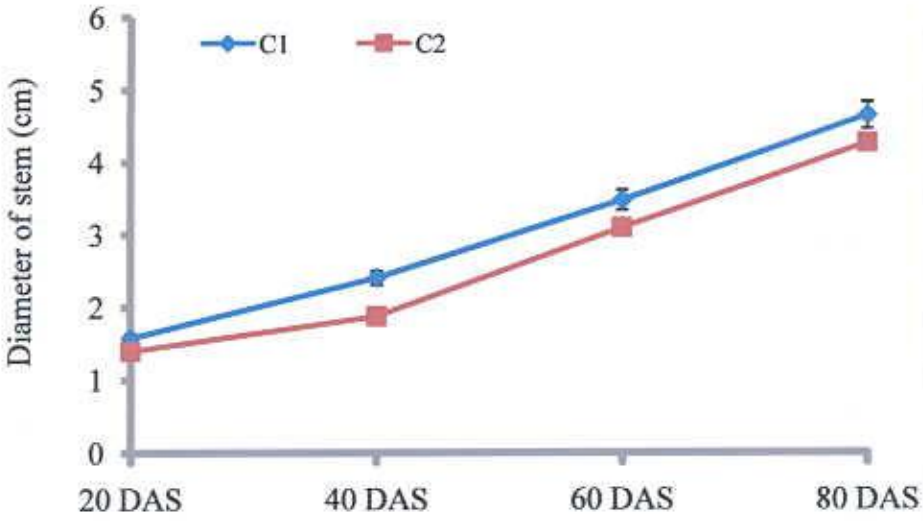
Treatments	Length of petiole (cm) at			
	20 DAS	40 DAS	60 DAS	80 DAS
C_1K_0	6.97 ab	10.47 bc	12.70 bc	15.70 bc
C_1K_1	6.30 bc	10.12 bc	13.57 ab	16.78 ab
C_1K_2	7.42 a	12.29 a	14.43 a	18.08 a
C_1K_3	6.75 ab	10.72 abc	13.99 ab	16.43 abc
C_2K_0	4.58 d	6.35 d	9.60 d	11.02 d
C_2K_1	5.69 c	9.20 c	11.82 c	14.76 c
C_2K_2	7.30 a	11.48 ab	14.40 a	16.75 ab
C_2K_3	7.24 a	11.30 ab	13.69 ab	17.43 ab
$LSD_{(0.05)}$	0.785	1.645	1.201	1.719
Significance level	0.01	0.01	0.01	0.01
CV(%)	6.87	9.17	5.26	6.18

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

C_1: Arka Anamica C_2: Dherosh F_1 Green Lady

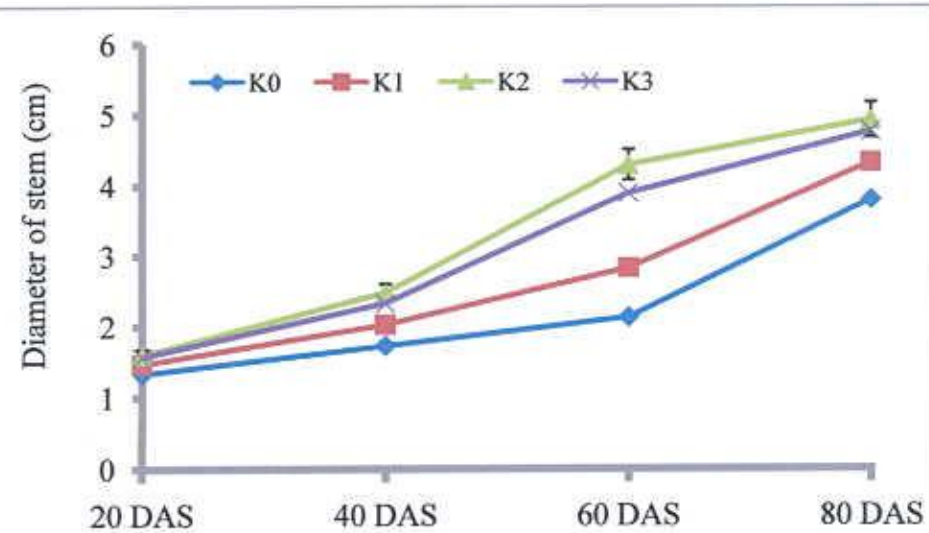
K_0: 0 kg K_2O /ha (Control) K_1: 50 kg K_2O /ha

K_2: 100 kg K_2O /ha K_3: 150 kg K_2O /ha



C_1: Arka Anamica C_2: Dherosh F_1 Green Lady

Figure 6. Effect of cultivars on diameter of stem of okra



K_0: 0 kg K_2O/ha (control) K_1: 50 kg K_2O/ha

K_2: 100 kg K_2O/ha K_3: 150 kg K_2O/ha

Figure 7. Effect of different levels of potassium on diameter of stem of okra

Significant difference was recorded for different levels of potassium fertilizer on diameter of stem at 20, 40, 60 and 80 DAS (Figure 7; Appendix VI). At 20, 40, 60 and 80 DAS, the highest diameter of stem (1.60 cm, 2.48 cm, 4.30 cm and 4.93 cm, respectively) was found from K_2, which was statistically identical (1.57 cm, 2.33 cm, 3.90 cm and 4.77 cm, respectively) with K_3 and followed (1.47 cm, 2.03 cm, 2.83 cm and 4.33 cm, respectively) by K_1. On the other hand, the lowest diameter stem (1.33 m, 1.73 cm, 2.13 cm and 3.80 cm, respectively) was recorded from K_0.

Combined effect of okra cultivars and different levels of potassium fertilizer showed significant differences on diameter of stem at 20, 40, 60 and 80 DAS (Table 6; Appendix VI). At 20, 40, 60 and 80 DAS, the highest diameter of stem (1.67 cm, 2.63 cm, 4.13 cm and 5.00 cm, respectively) was attained from C_1K_2 and the lowest diameter 1.13 m, 1.27 cm, 1.73 cm and 3.13 cm, respectively) was observed from C_2K_0.

4.5 Length of leaf

Length of leaf differed significantly at 20, 40, 60 and 80 DAS for different cultivars of okra under the present study (Table 7; Appendix VII). At 20, 40, 60 and, 80 DAS, the highest length of leaf (7.23 cm, 13.67 cm, 16.41 cm and 19.92 cm, respectively) was found from C_1, while the lowest length of leaf (6.72 cm, 12.38 cm, 15.32 cm and 18.28 cm, respectively) was observed from C_2. Subrata *et al.* (2004) reported that length of leaf varied significantly among the genotypes.

Table 6. Combined effect of cultivars and different levels of potassium on diameter of stem of okra

Treatments	Diameter of stem (cm) at			
	20 DAS	40 DAS	60 DAS	80 DAS
C_1K_0	1.53 ab	2.20 c	2.53 d	4.47 bcd
C_1K_1	1.53 ab	2.27 bc	3.47 c	4.40 cd
C_1K_2	1.67 a	2.63 a	4.13 ab	5.00 a
C_1K_3	1.60 a	2.53 ab	3.80 bc	4.73 abc
C_2K_0	1.13 c	1.27 e	1.73 e	3.13 e
C_2K_1	1.40 b	1.80 d	2.20 d	4.27 d
C_2K_2	1.53 ab	2.33 abc	4.47 a	4.87 a
C_2K_3	1.53 ab	2.13 c	4.00 ab	4.80 ab
$LSD_{(0.05)}$	0.175	0.298	0.450	0.363
Significance level	0.05	0.05	0.01	0.01
CV(%)	6.62	7.87	7.79	4.64

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

C_1: Arka Anamica

C_2: Dherosh F_1 Green Lady

K_0: 0 kg K_2O /ha (Control)

K_1: 50 kg K_2O /ha

K_2: 100 kg K_2O /ha

K_3: 150 kg K_2O /ha

Table 7. Effect of cultivars and different levels of potassium on leaf length of okra

Treatments	Length of leaf (cm) at			
	20 DAS	40 DAS	60 DAS	80 DAS
Cultivars				
C_1	7.23 a	13.67 a	16.41 a	19.92 a
C_2	6.72 b	12.38 b	15.32 b	18.28 b
$LSD_{(0.05)}$	0.363	0.600	0.859	0.523
Significance level	0.01	0.01	0.05	0.01
Levels of potassium				
K_0	6.24 b	11.15 c	13.36 c	15.40 c
K_1	6.53 b	12.70 b	15.77 b	18.77 b
K_2	7.62 a	14.42 a	17.42 a	21.48 a
K_3	7.50 a	13.84 a	16.93 ab	20.74 a
$LSD_{(0.05)}$	0.514	0.849	1.215	0.740
Significance level	0.01	0.01	0.01	0.01
CV(%)	5.94	5.26	6.18	8.13

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

C_1: Arka Anamica

C_2: Dherosh F_1 Green Lady

K_0: 0 kg K_2O /ha (Control)

K_1: 50 kg K_2O /ha

K_2: 100 kg K_2O /ha

K_3: 150 kg K_2O /ha

Statistically significant difference was recorded for different levels of potassium fertilizer on length of leaf at 20, 40, 60 and 80 DAS (Table 7; Appendix VII). At 20, 40, 60 and 80 DAS, the highest length of leaf (7.62 cm, 14.42 cm, 17.42 cm and 21.48 cm, respectively) was observed from K_2, which was statistically identical (7.50 cm, 13.84 cm, 16.93 cm and 20.74 cm, respectively) with K_3 and followed (6.53 cm, 12.70 cm, 15.77 cm and 18.77 cm, respectively) by K_1, again the lowest length (6.24 cm, 11.15 cm, 13.36 cm and 15.40 cm, respectively) was found from K_0.

Okra cultivars and different levels of potassium fertilizer showed significant variation for length of leaf at 20, 40, 60 and 80 DAS due to combined effect (Table 8; Appendix VII). At 20, 40, 60 and 80 DAS, the highest length of leaf (7.89 cm, 14.43 cm, 18.08 cm and 21.63 cm, respectively) was recorded from C_1K_2, while the lowest length (6.02 cm, 11.82 cm, 14.76 cm and 17.40 cm, respectively) was recorded from C_2K_0.

4.6 Number of branches per plant

Number of branches per plant varied significantly at 20, 40, 60 and 80 DAS for different cultivars of okra (Table 9; Appendix VIII). At 20, 40, 60 and, 80 DAS, the maximum number of branches per plant (1.65, 2.42, 3.47 and 3.88, respectively) was recorded from C_1 and the minimum number (1.41, 1.88, 3.10 and 3.45, respectively) was observed from C_2. Management practices influence the number of branches per plant but cultivars itself manipulated the number of branches per plant. Subrata *et al.* (2004) reported that number of branches/plant

Table 8. Combined effect of cultivars and different levels of potassium on leaf length of okra

Treatments	Length of leaf (cm) at			
	20 DAS	40 DAS	60 DAS	80 DAS
C_1K_0	6.79 c	12.70 bc	15.70 bc	16.96 c
C_1K_1	7.03 bc	13.57 ab	16.78 ab	20.13 b
C_1K_2	7.89 a	14.43 a	18.08 a	21.63 a
C_1K_3	7.20 abc	13.99 ab	16.43 abc	20.93 ab
C_2K_0	5.69 d	9.60 d	11.02 d	13.83 d
C_2K_1	6.02 d	11.82 c	14.76 c	17.40 c
C_2K_2	7.35 abc	14.40 a	16.75 ab	21.33 a
C_2K_3	7.80 ab	13.69 ab	17.43 ab	20.55 ab
$LSD_{(0.05)}$	0.726	1.201	1.719	1.046
Significance level	0.01	0.01	0.01	0.01
CV(%)	5.94	5.26	6.18	8.13

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

C_1: Arka Anamica

C_2: Dherosh F_1 Green Lady

K_0: 0 kg K_2O /ha (Control)

K_1: 50 kg K_2O /ha

K_2: 100 kg K_2O /ha

K_3: 150 kg K_2O /ha

Table 9. Effect of cultivars and different levels of potassium on number of branches per plant of okra

Treatments	Number of branches per plant at			
	20 DAS	40 DAS	60 DAS	80 DAS
Cultivars				
C_1	1.65 a	2.42 a	3.47 a	3.88 a
C_2	1.41 b	1.88 b	3.10 b	3.45 b
$LSD_{(0.05)}$	0.068	0.149	0.225	0.251
Significance level	0.01	0.01	0.01	0.01
Levels of potassium				
K_0	1.23 b	1.73 c	2.13 d	2.82 c
K_1	1.58 a	2.03 b	2.83 c	3.53 b
K_2	1.68 a	2.48 a	4.30 a	4.28 a
K_3	1.65 a	2.33 a	3.90 b	4.00 a
$LSD_{(0.05)}$	0.096	0.211	0.318	0.355
Significance level	0.01	0.01	0.01	0.01
CV(%)	5.02	7.87	7.79	7.84

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

C_1: Arka Anamica

C_2: Dherosh F_1 Green Lady

K_0: 0 kg K_2O /ha (Control)

K_1: 50 kg K_2O /ha

K_2: 100 kg K_2O /ha

K_3: 150 kg K_2O /ha

varied significantly among the genotypes. Martin and Rhodes (1983) found significant differences among the accessions for number of primary branches/plant.

Significant difference was recorded for different levels of potassium fertilizer on number of branches per plant at 20, 40, 60 and 80 DAS (Table 9; Appendix VIII). At 20, 40, 60 and 80 DAS, the maximum number of branches per plant (1.68, 2.48, 4.30 and 4.28, respectively) was observed from K_2, which was statistically identical (1.65, 2.33, 3.90 and 4.00, respectively) with K_3 and followed (1.58, 2.03, 2.83 and 3.53, respectively) by K_1, again the minimum number (1.23, 1.73, 2.13 and 2.82, respectively) was recorded from K_0 i.e. control condition. Mishra and Pandey (1987) reported that application of K above 120 kg/ha adversely affected number of branches per plant.

Statistically significant variation was recorded due to the combined effect of okra cultivars and different levels of potassium fertilizer on number of branches per plant at 20, 40, 60 and 80 DAS (Table 10; Appendix VIII). At 20, 40, 60 and 80 DAS, the maximum number of branches per plant (1.87, 2.63, 4.13, and 4.43, respectively) was found from C_1K_2, while the minimum number (1.07, 1.27, 1.73 and 2.33, respectively) from C_2K_0.

4.7 Fresh weight of leaves per plant

Fresh weight of leaves per plant varied for different cultivars of okra (Table 11; Appendix IX). The highest fresh weight of leaves per plant (253.32 g) was found from C_1 and the lowest fresh weight (217.18 g) from C_2.

Table 10. Combined effect of cultivars and different levels of potassium on number of branches per plant of okra

Treatments	Number of branches per plant at			
	20 DAS	40 DAS	60 DAS	80 DAS
C_1K_0	1.40 d	2.20 c	2.53 d	3.30 c
C_1K_1	1.67 b	2.27 bc	3.47 c	3.83 b
C_1K_2	1.87 a	2.63 a	4.13 ab	4.43 a
C_1K_3	1.67 b	2.53 ab	3.80 bc	3.90 ab
C_2K_0	1.07 e	1.27 e	1.73 e	2.33 de
C_2K_1	1.50 cd	1.80 d	2.20 d	3.23 c
C_2K_2	1.50 cd	2.33 abc	4.47 a	4.13 ab
C_2K_3	1.63 bc	2.13 c	4.00 ab	4.10 ab
$LSD_{(0.05)}$	0.136	0.298	0.450	0.502
Significance level	0.01	0.05	0.01	0.05
CV(%)	5.02	7.87	7.79	7.84

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

C_1: Arka Anamica C_2: Dherosh F_1 Green Lady

K_0: 0 kg K_2O /ha (Control) K_1: 50 kg K_2O /ha

K_2: 100 kg K_2O /ha K_3: 150 kg K_2O /ha

Table 11. Effect of cultivars and different levels of potassium on yield contributing characters of okra

Treatments	Fresh weight /plant (g)	Dry matter content of leaves (g)	Days to starting of flowesting	Number of pods/plant
Cultivars				
C_1	253.32 a	12.27 a	41.08 b	24.57 a
C_2	217.18 b	10.40 b	42.33 a	23.80 b
$LSD_{(0.05)}$	7.902	0.866	1.070	0.739
Significance level	0.01	0.01	0.05	0.05
Levels of potassium				
K_0	213.17 d	9.90 b	43.17 a	23.30 b
K_1	225.20 c	11.42 a	41.00 b	23.60 b
K_2	261.85 a	12.05 a	40.83 b	25.07 a
K_3	240.77 b	11.97 a	41.83 ab	24.77 a
$LSD_{(0.05)}$	11.17	1.225	1.514	1.045
Significance level	0.01	0.01	0.05	0.01
CV(%)	7.84	8.73	9.93	4.50

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

C_1: Arka Anamica C_2: Dherosh F_1 Green Lady

K_0: 0 kg K_2O /ha (Control) K_1: 50 kg K_2O /ha

K_2: 100 kg K_2O /ha K_3: 150 kg K_2O /ha

Significant difference was recorded for different levels of potassium fertilizer on fresh weight of leaves per plant (Table 11; Appendix IX). Data revealed that the highest fresh weight of leaves per plant (261.85 g) was attained from K_2, which was closely followed (240.77 g) by K_3, whereas the lowest weight (213.17 g) was recorded from K_0 i.e. control condition which was followed (225.20 g) by K_1.

Fresh weight of leaves per plant showed significant differences due to the combined effect of okra cultivars and different levels of potassium fertilizer (Table 12; Appendix IX). The highest fresh weight of leaves per plant (294.90 g) was observed from C_1K_2 and the lowest weight (195.53) from C_2K_0.

4.8 Dry matter content of leaves

Different cultivars of okra showed significant differences in terms of dry matter content of leaves under the present study (Table 11; Appendix IX). The highest dry matter content of leaves (12.27 g) was recorded from C_1, whereas the lowest weight (217.18 g) was observed from C_2.

Significant variation was observed due to different levels of potassium fertilizer on dry matter content of leaves (Table 11; Appendix IX). The highest dry matter content of leaves (12.05 g) was observed from K_2, which was statistically similar (11.97 g and 11.42 g) with K_3 and K_1, whereas the lowest (9.90 g) from K_0.

Okra cultivars and different levels of potassium fertilizer showed significant differences on dry matter content of leaves for their combined effect (Table 12; Appendix IX). The highest dry matter content of leaves (14.63 g) was found from C_1K_2 and the lowest dry matter (9.57 g) from C_1K_0.

Table 12. Combined effect of cultivars and different levels of potassium on yield contributing characters of okra

Treatments	Fresh weight /plant (g)	Dry matter content of leaves (g)	Days to starting of flowesting	Number of pods/plant
C_1K_0	230.80 c	9.57 bc	42.67 ab	23.53 bc
C_1K_1	236.93 bc	11.37 bc	41.67 bc	24.53 ab
C_1K_2	294.90 a	14.63 a	39.67 c	25.60 a
C_1K_3	250.63 b	13.50 a	40.00 c	25.27 ab
C_2K_0	195.53 e	10.23 bc	43.67 ab	22.67 c
C_2K_1	213.47 d	11.47 b	40.33 c	22.66 c
C_2K_2	228.80 cd	9.47 c	41.67 bc	24.53 ab
C_2K_3	230.90 c	10.43 bc	44.00 a	24.27 ab
$LSD_{(0.05)}$	15.80	1.733	2.140	1.478
Significance level	0.01	0.01	0.01	0.05
CV(%)	7.84	8.73	9.93	4.50

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

C_1: Arka Anamica C_2: Dherosh F_1 Green Lady

K_0: 0 kg K_2O /ha (Control) K_1: 50 kg K_2O /ha

K_2: 100 kg K_2O /ha K_3: 150 kg K_2O /ha

4.9 Days to starting of flowering

Days to starting of flowering varied for different cultivars of okra under the present study (Table 11; Appendix IX). The maximum days required to starting of flowering (42.33) was observed from C_2, whereas the minimum days (41.08) was found from C_1. Days to starting of flowering varied for different varieties might be due to genetical influences. Subrata *et al.* (2004) reported that days to first flower varied significantly among the genotypes. Sonia (1999) days to flowering varied from 44.33 to 71.00.

Significant difference was recorded for different levels of potassium fertilizer on days to starting of flowering (Table 11; Appendix IX). Data revealed that the maximum days to starting of flowering (43.17) was observed from K_0, which was statistically similar (41.83) with K_3, while the minimum days (40.83) was observed from K_2 which was statistically similar (41.00 days) with K_1.

Combined effect of okra cultivars and different levels of potassium fertilizer showed significant differences on days to starting of flowering (Table 12; Appendix IX). The maximum days to starting of flowering (44.00) was recorded from C_2K_3 and the minimum days (39.67) from C_1K_2.

4.10 Number of flowering buds per plant

Statistically significant variations was recorded in terms of number of flowering buds per for different cultivars of okra under the present trial (Figure 8; Appendix IX). The maximum number of flowering buds per plant (31.29) was recorded from C_1, while the minimum number (28.23) was observed from C_2.

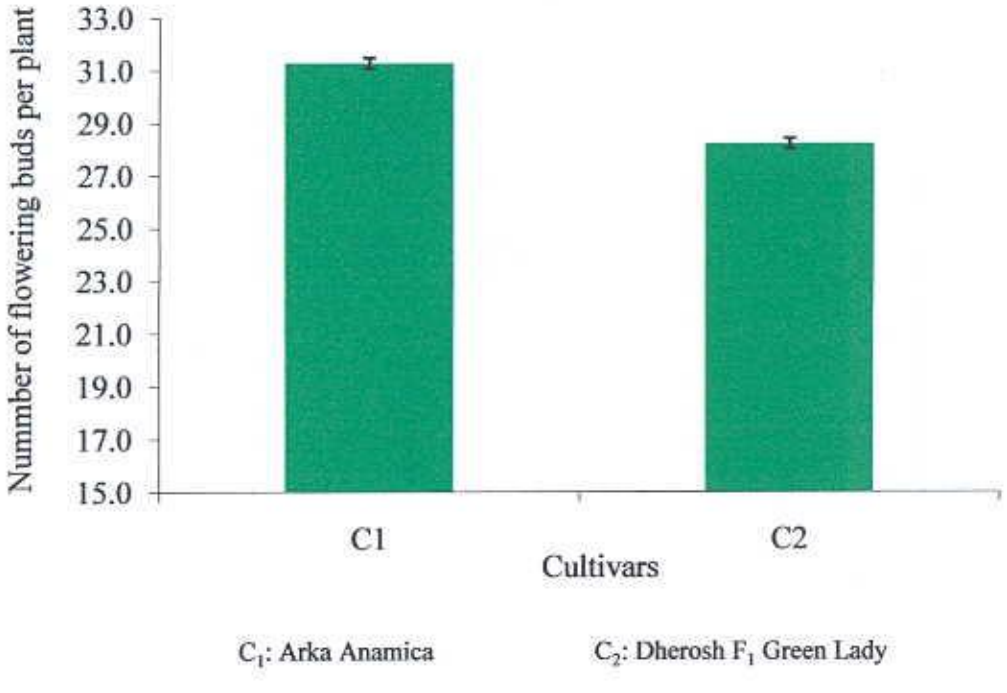


Figure 8. Effect of cultivars on number of flowering buds per plant of okra

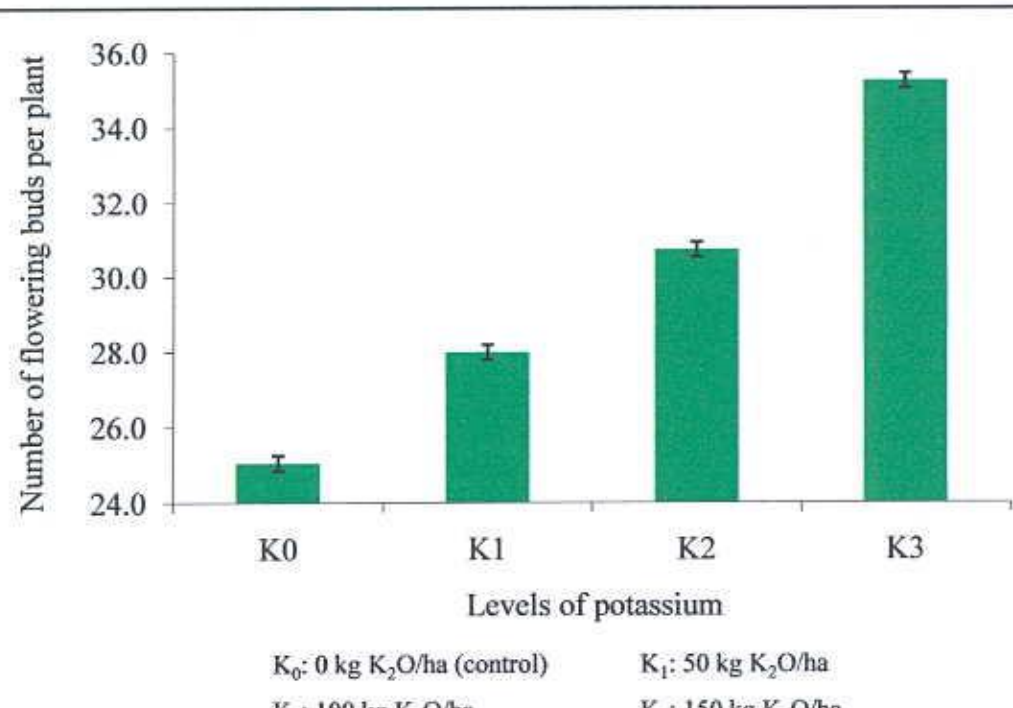


Figure 9. Effect of different levels of potassium on number of flowering buds per plant of okra

Different levels of potassium fertilizer varied significantly in terms of number of flowering buds per plant (Figure 9; Appendix IX). The maximum number of flowering buds per plant (35.26) was observed from K_3, which was closely followed (30.74) by K_2, whereas the minimum number (25.05) was recorded from K_0 which was closely followed (27.99) by K_1.

Number of flowering buds per plant showed significant differences due to the combined effect of okra cultivars and different levels of potassium fertilizer (Figure 10; Appendix IX). The maximum number of flowering buds per plant (35.78) was found from C_1K_2, while the minimum number (23.07) from C_2K_0.

4.11 Number of pods per plant

Number of pods per plant varied for different cultivars of okra under the present study (Table 11; Appendix IX). The maximum number of pods per plant (24.57) was observed from C_1 and the minimum number (23.80) was recorded from C_2. Different varieties responded differently for number of pods to input supply, method of cultivation and the prevailing environment during the growing season. Subrata *et al.* (2004) reported that number of pods/plant varied significantly among the genotypes.

Significant difference was recorded for different levels of potassium fertilizer on number of pods per plant (Table 11; Appendix IX). The maximum number of pods per plant (25.07) was observed from K_2, which was statistically identical (24.77) with K_3 and followed (23.60) by K_1, again the minimum number (23.30) was recorded from K_0 i.e. control condition.

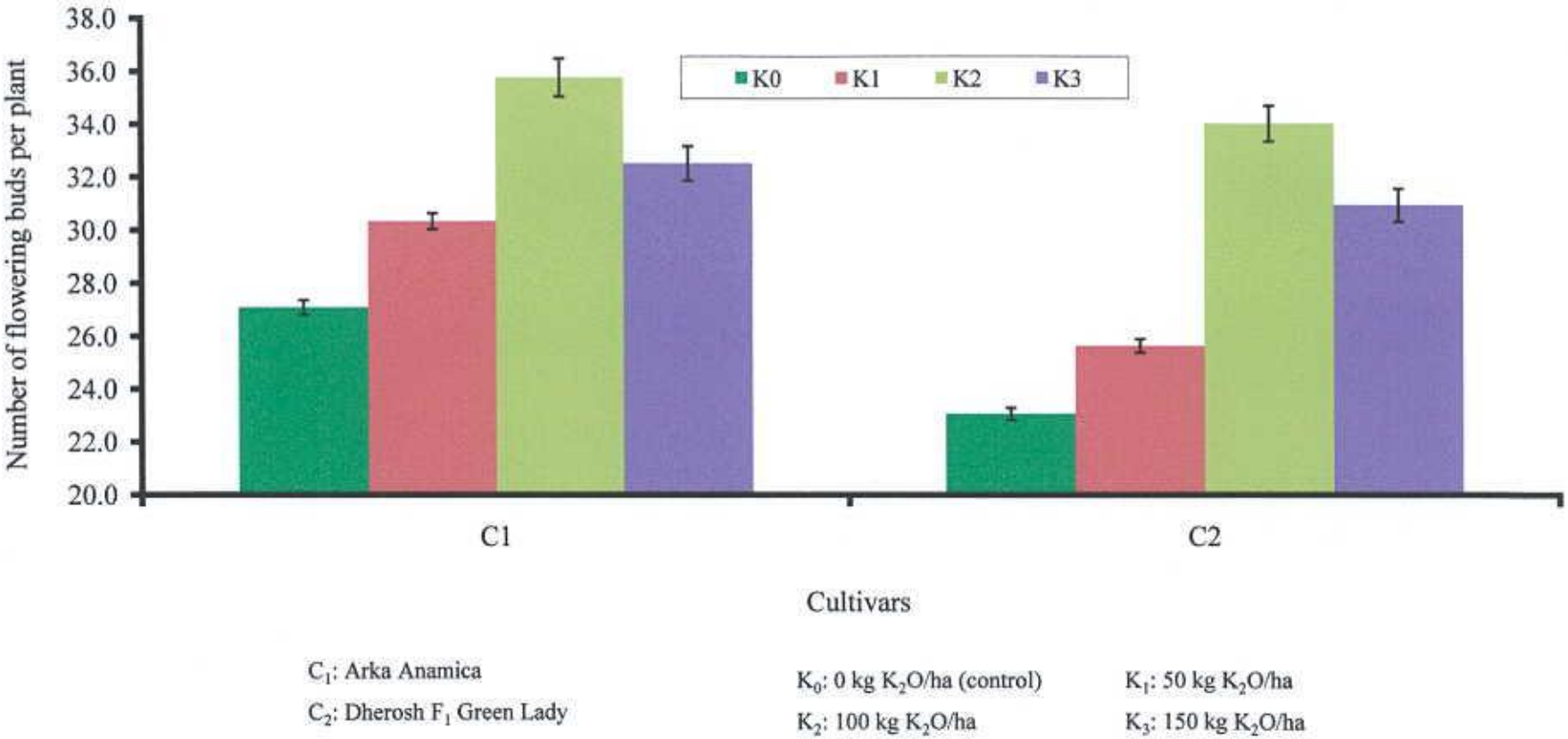


Figure 10. Combined effect of different cultivars and levels of potassium on number of flowering buds per plant of okra

Combined effect of okra cultivars and different levels of potassium fertilizer showed significant differences on number of pods per plant (Table 12; Appendix IX). The maximum number of pods per plant (25.60) was found from C_1K_2 and the minimum number (22.67) from C_2K_0.

4.12 Pod length

Different cultivars of okra varied significantly in terms of pod length under the present trial (Table 13; Appendix X). The tallest pod (17.98 cm) was recorded from C_1, while the shortest pod (15.84 cm) was observed from C_2. Dash and Mishra (1995) reported that genotypes differed significantly pod length. Subrata *et al.* (2004) reported that pod length varied significantly among the genotypes.

Pod length varied significantly due to different levels of potassium fertilizer (Table 13; Appendix X). The tallest pod (19.15 cm) was found from K_2, which was statistically identical (18.60 cm) with K_3 and followed (16.55 cm) by K_1, again the shortest pod (13.55 cm) was attained from K_0. Mishra and Pandey (1987) reported that application of K above 120 kg/ha adversely affected pod length.

Statistically significant variation was recorded due to the combined effect of okra cultivars and different levels of potassium fertilizer in terms of pod length (Table 14; Appendix X). The tallest pod (19.53 cm) was observed from C_1K_2 and the shortest pod (10.80 cm) from C_2K_0.

Table 13. Effect of cultivars and different levels of potassium on yield contributing characters and yield of okra

Treatments	Pod length (cm)	Pod diameter (cm)	Individual fruit weight (g)	Yield/hectare (ton)
Cultivars				
C_1	17.98 a	1.31 a	16.23 a	8.91 a
C_2	15.84 b	1.23 b	14.98 b	8.03 b
$LSD_{(0.05)}$	0.783	0.072	1.038	0.687
Significance level	0.01	0.05	0.01	0.01
Levels of potassium				
K_0	13.55 c	1.17	13.52 c	7.22 b
K_1	16.35 b	1.23 bc	14.57 bc	8.65 a
K_2	19.15 a	1.36 a	16.60 a	9.28 a
K_3	18.60 a	1.32 ab	15.73 ab	8.74 a
$LSD_{(0.05)}$	1.108	0.094	1.467	0.971
Significance level	0.01	0.01	0.01	0.01
CV(%)	5.29	6.31	8.85	7.24

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

C_1: Arka Anamica C_2: Dherosh F_1 Green Lady

K_0: 0 kg K_2O /ha (Control) K_1: 50 kg K_2O /ha

K_2: 100 kg K_2O /ha K_3: 150 kg K_2O /ha

Table 14. Combined effect of cultivars and different levels of potassium on yield contributing characters and yield of okra

Treatments	Pod length (cm)	Pod diameter (cm)	Individual fruit weight (g)	Yield/hectare (ton)
C_1K_0	16.30 c	1.25ab	15.93 ab	7.52 cd
C_1K_1	17.00 bc	1.34 a	15.50 ab	9.27 ab
C_1K_2	19.53 a	1.35 a	17.67 a	9.75 a
C_1K_3	19.10 a	1.31 a	15.83 ab	9.12 ab
C_2K_0	10.80 d	1.09 c	12.10 c	6.91 d
C_2K_1	15.70 c	1.12 bc	14.63 b	8.02 bcd
C_2K_2	18.77 a	1.39 a	16.53 ab	8.82 abc
C_2K_3	18.10 ab	1.33 a	16.63 ab	8.36 abcd
$LSD_{(0.05)}$	1.566	0.141	2.075	1.373
Significance level	0.01	0.05	0.05	0.05
CV(%)	5.29	6.31		7.24

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

C_1: Arka Anamica

C_2: Dherosh F_1 Green Lady

K_0: 0 kg K_2O /ha (Control)

K_1: 50 kg K_2O /ha

K_2: 100 kg K_2O /ha

K_3: 150 kg K_2O /ha

4.13 Pod diameter

Pod diameter varied for different cultivars of okra under the present study (Table 13; Appendix X). The highest pod diameter (1.31 cm) was recorded from C_1 and the lowest pod diameter (1.23 cm) was observed from C_2.

Significant difference was recorded for different levels of potassium fertilizer on pod diameter (Table 13; Appendix X). Data revealed that the highest pod diameter (1.36 cm) was observed from K_2, which was statistically identical (1.32 cm) with K_3 and followed (1.23 cm) by K_1, whereas the lowest pod diameter (1.17 cm) was recorded from K_0 i.e. control condition.

Okra cultivars and different levels of potassium fertilizer showed significant differences in terms of pod diameter due to combined effect (Table 14; Appendix X). The highest pod diameter (1.35 cm) was recorded from C_1K_2, while the lowest pod diameter (1.09 cm) was recorded from C_2K_0.

4.14 Weight of individual pod

Weight of individual pod varied for different cultivars of okra (Table 13; Appendix X). The highest weight of individual pod (16.23 g) was found from C_1, whereas the lowest weight (14.98 g) was observed from C_2. Dash and Mishra (1995) reported that genotypes differed significantly for fruit weight.

Significant difference was recorded for different levels of potassium fertilizer on weight of individual pod (Table 13; Appendix X). The highest weight of individual pod (16.60 g) was observed from K_2, which was statistically identical

(15.73 cm) with K_3 and followed (14.57 g) by K_1, while the lowest weight (13.52 g) was recorded from K_0. Mishra and Pandey (1987) reported that application of K above 120 kg/ha adversely affected weight of individual fruit.

Combined effect of okra cultivars and different levels of potassium fertilizer showed significant differences on weight of individual pod (Table 14; Appendix X). The highest weight of individual pod (17.67 g) was found from C_1K_2 and the lowest weight of individual pod (12.10 g) from C_2K_0.

4.15 Yield per plant

Statistically significant variation was recorded in terms of yield per plant due to different cultivars of okra under the present study (Figure 11; Appendix X). The highest yield per plant (253.48 g) was found from C_1, whereas the lowest yield per plant (242.75 g) was recorded from C_2. Dash and Mishra (1995) reported that genotypes differed significantly for fruit yield/plant. Rain and Lal (1990) reported that Arka Anamika showed significantly superior performance with respect to and yield per plant than the okra cultivars of Parbhani Kranti, and Pussa Sawani.

Significant difference was recorded for different levels of potassium fertilizer on yield per plant (Figure 12; Appendix X). The highest yield per plant (260.40 g) was recorded from K_2, which was statistically identical (255.13 g) with K_3 and followed (242.97 g) by K_1. On the other hand, the lowest yield per plant (233.97 g) was found from K_0. Mishra and Pandey (1987) reported that application of K above 120 kg/ha adversely affected yield per plant. Bhai and Sing (1998) reported that K application significantly increased the yield per plant.

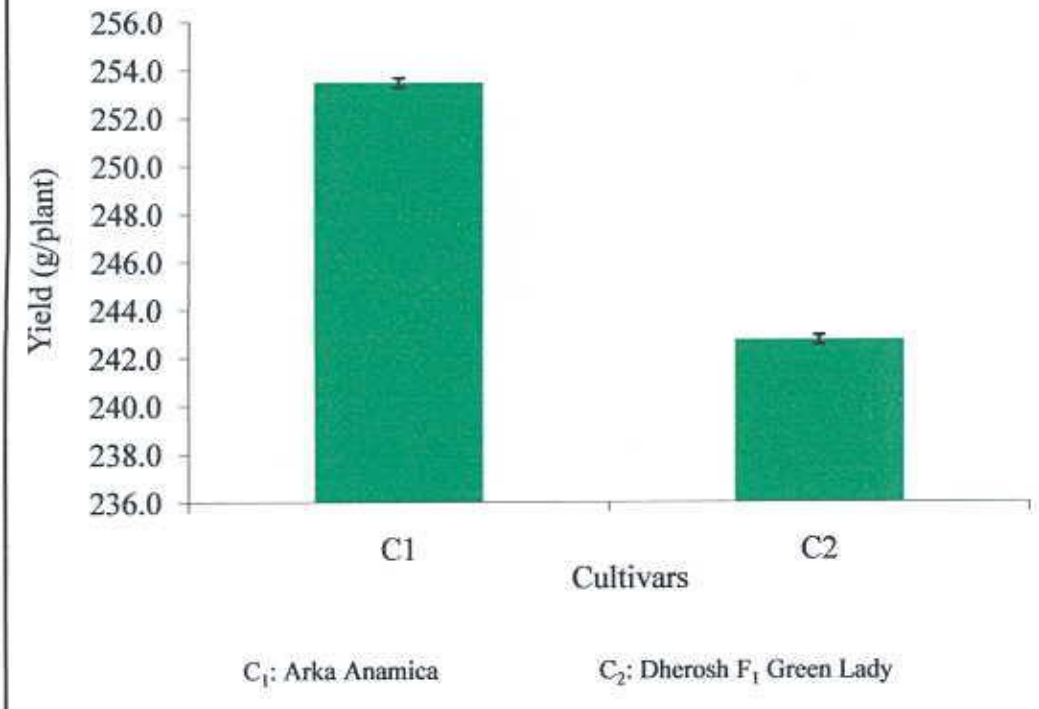


Figure 11. Effect of cultivars on yield per plant of okra

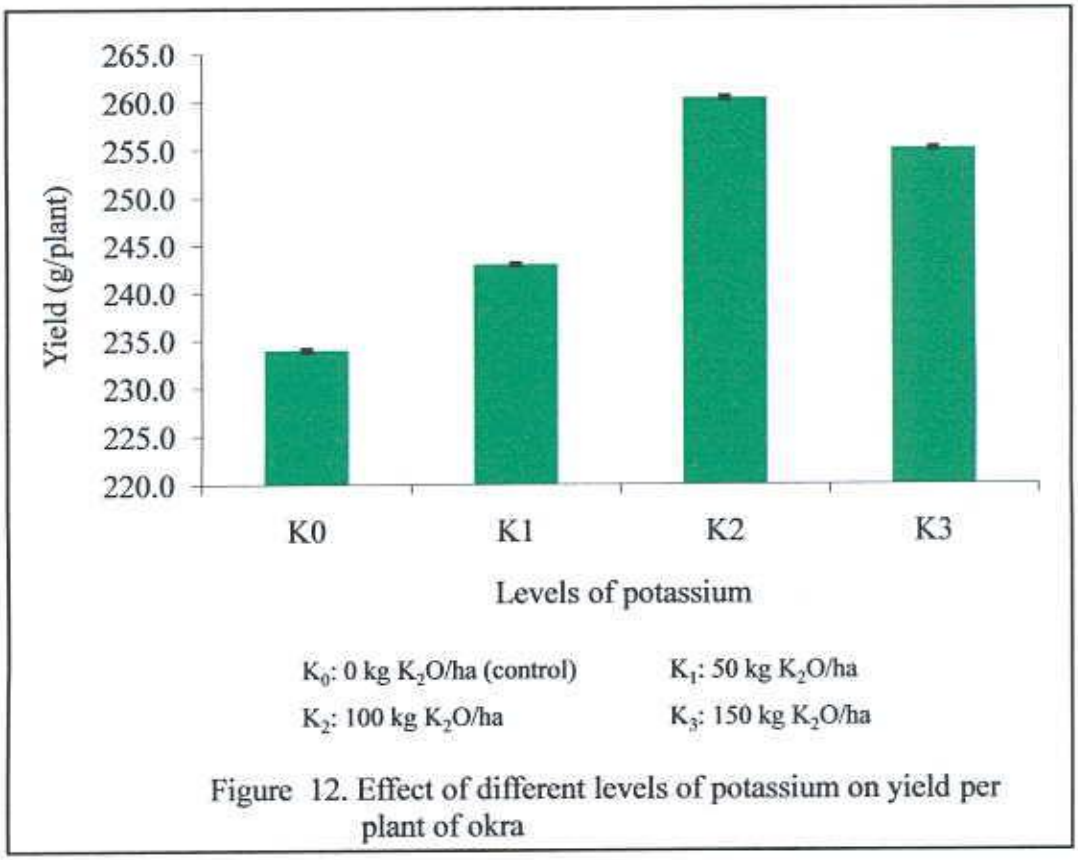


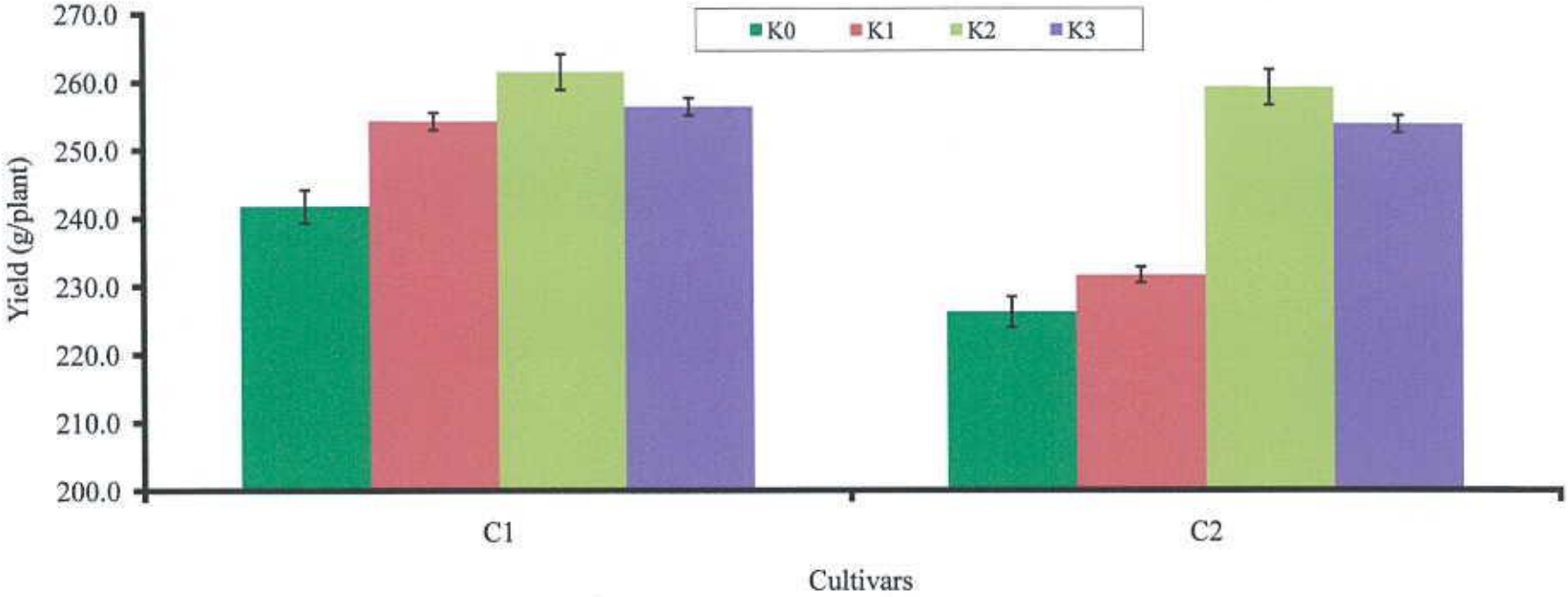
Figure 12. Effect of different levels of potassium on yield per plant of okra

Yield per plant showed significant differences due to the combined effect of okra cultivars and different levels of potassium fertilizer (Figure 13; Appendix X). The highest yield per plant (261.53 g) was observed from C_1K_2, while the lowest yield per plant (226.20 g) from C_2K_0.

4.16 Yield per hectare

Yield per hectare varied for different cultivars of okra under the present study (Table 13; Appendix X). The highest yield per hectare (8.91 ton) was recorded from C_1 and the lowest yield per hectare (8.03 ton) was found from C_2. Subrata *et al.* (2004) reported that fruit yield/hectare varied significantly among the genotypes. Mani and Ramanathan (1980) reported that highest K level (60 kg/ha) increased yield by 149.2% over the control and combined application of 80 kg N/ha with either 30 kg or 60 kg K_2O/ha produced maximum yields (17.2 t/ha and 17.5 t/ha respectively). Mishra and Pandey (1987) reported that application of K above 120 kg/ha adversely affected seed yield.

Significant difference was recorded for different levels of potassium fertilizer on yield per hectare (Table 13; Appendix X). Data revealed that the highest yield per hectare (9.28 ton) was recorded from K_2, which was statistically identical (8.74 ton and 8.65 ton) with K_3 and K_1, whereas the lowest yield per hectare (7.22 ton) was recorded from K_0 i.e. control condition. Mishra and Pandey (1987) reported that application of K above 120 kg/ha adversely affected yield contributing characters as well as fruit yield.



C_1: Arka Anamica

C_2: Dherosh F_1 Green Lady

K_0: 0 kg K_2O/ha (control)

K_1: 50 kg K_2O/ha

K_2: 100 kg K_2O/ha

K_3: 150 kg K_2O/ha

Figure 13. Combined effect of different cultivars and levels of potassium on yield per plant of okra

Combined effect of okra cultivars and different levels of potassium fertilizer showed significant differences on yield per hectare under the present trial (Table 14; Appendix X). The highest yield per hectare (9.75 ton) was found from C_1K_2, while the lowest yield per hectare (6.91 ton) from C_2K_0.

4.17 Potassium content in pod

Potassium content in pod varied for different cultivars of okra under the present study (Figure 14; Appendix X). The highest potassium content (1.17%) was recorded from C_1 and the lowest potassium (1.08%) was found from C_2.

Significant difference was recorded for different levels of potassium fertilizer on potassium content in pod (Figure 15; Appendix X). Data revealed that the highest potassium content in pod (1.34%) was recorded from K_3, which was followed (1.22%) with K_2, whereas the lowest (0.82%) potassium was recorded from K_0 i.e. control condition.

Combined effect of okra cultivars and different levels of potassium fertilizer showed significant differences on potassium content in pod of okra (Figure 16; Appendix X). The highest potassium content (1.43%) was found from C_1K_3, while the lowest potassium (0.75%) from C_2K_0.

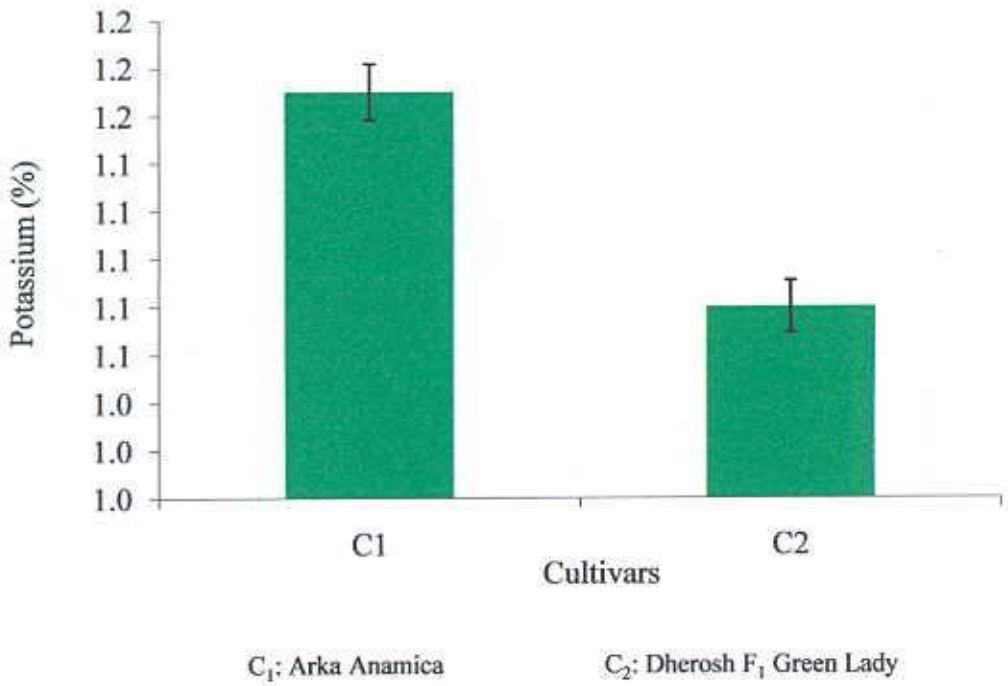


Figure 14. Effect of cultivars on potassium content on pod of okra

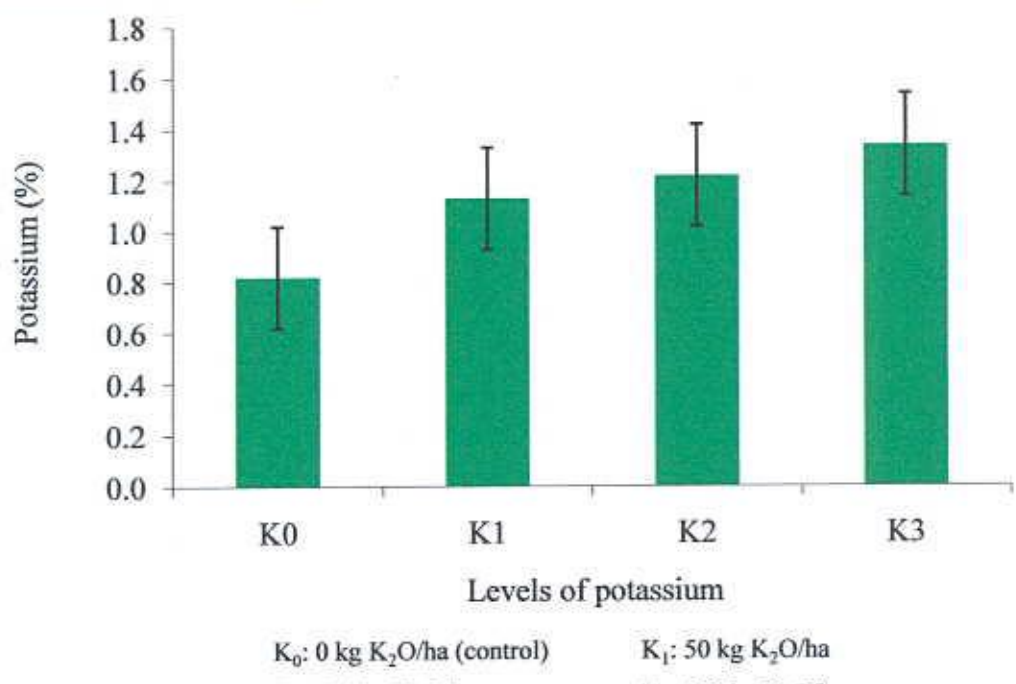
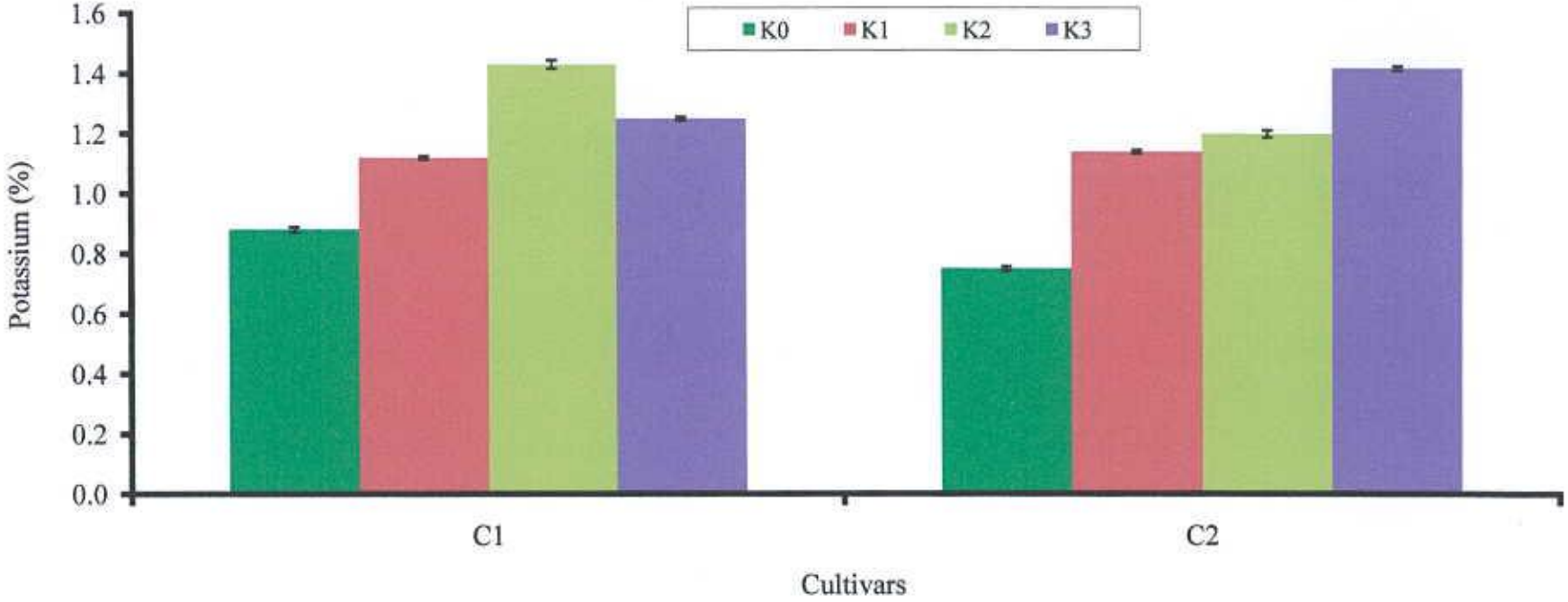


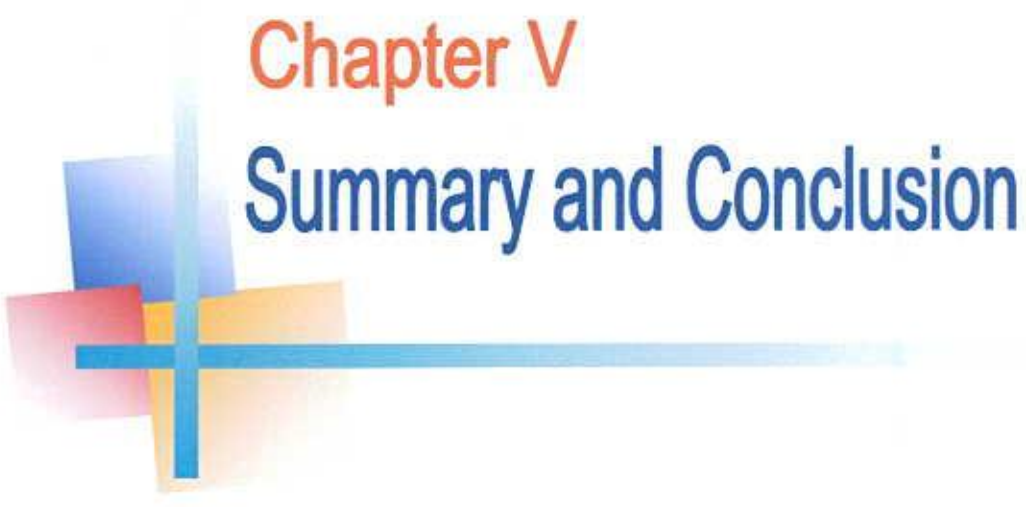
Figure 15. Effect of different levels of potassium on potassium content in pod of okra



C_1: Arka Anamica
C_2: Dherosh F_1 Green Lady

K_0: 0 kg K_2O/ha (control)
K_1: 50 kg K_2O/ha
K_2: 100 kg K_2O/ha
K_3: 150 kg K_2O/ha

Figure 16. Combined effect of different cultivars and levels of potassium on potassium content in pod of okra



Chapter V

Summary and Conclusion

CHAPTER V

SUMMARY AND CONCLUSION

The experiment was carried out at the experimental Farm of Sher-e-Bangla Agricultural University (SAU), Dhaka during the period from April to July 2012 to study effect of potassium and cultivars on the growth, yield and nutrient content of okra. The test crop used in the experiment was Dherosh cultivar. The experiment consisted of two factors: Factor A: Dherosh cultivars (2 cultivars) as- C_1: Arka Anamica; C_2: Dherosh F_1 Green Lady and Factor B: Potassium fertilizer (4 levels) as-K_0: 0 kg K_2O/ha (control); K_1: 50 kg K_2O/ha; K_2: 100 kg K_2O/ha and K_3: 150 kg K_2O/ha. The two factors experiment was laid out in Randomized Complete Block Design (RCBD) with three replications.

In case of okra cultivar, the tallest plant, maximum number of leaves per plant, longest petiole, highest diameter of stem, highest length of leaf, maximum number of branches per plant, highest fresh weight of leaves per plant, highest dry matter content of leaves, minimum days to starting of flowering, maximum number of flower buds per plant, maximum number of pods per plant, tallest pod, highest pod diameter, highest weight of individual pod, highest yield per plant, highest yield per hectare and highest potassium content was recorded from C_1, while the shortest plant, minimum number of leaves per plant, shortest petiole, lowest diameter of stem, lowest length of leaf, minimum number of branches per plant, lowest fresh weight of leaves per plant, lowest dry matter content of leaves, maximum days to starting of flowering, minimum number of flower buds per

plant, minimum number of pods per plant, shortest pod, lowest pod diameter, lowest weight of individual pod, lowest yield per plant, lowest yield per hectare and lowest potassium content was observed from C_2.

For potassium fertilizer, the tallest plant, maximum number of leaves per plant, longest petiole, highest diameter of stem, highest length of leaf, maximum number of branches per plant, highest fresh weight of leaves per plant, highest dry matter content of leaves, minimum days to starting of flowering, minimum number of flower buds per plant, maximum number of pods per plant, longest pod, highest pod diameter, highest weight of individual pod, highest yield per plant, highest yield per hectare and highest potassium content was recorded from K_2, whereas the shortest plant, minimum number of leaves per plant, shortest petiole, lowest diameter of stem, lowest length of leaf, minimum number of branches per plant, lowest fresh weight of leaves per plant, lowest dry matter content of leaves, maximum days to starting of flowering, minimum number of flower buds per plant, minimum number of pods per plant, shortest pod, lowest pod diameter, lowest weight of individual pod, lowest yield per plant, lowest yield per hectare and lowest potassium content was found in K_0.

Due to the combined effect of okra cultivars and different levels of potassium, the tallest plant, maximum number of leaves per plant, longest petiole, highest diameter of stem, highest length of leaf, maximum number of branches per plant, highest fresh weight of leaves per plant, highest dry matter content of leaves, minimum days to starting of flowering, maximum number of flower buds per

plant, maximum number of pods per plant, longest pod, highest pod diameter, highest weight of individual pod, highest yield per plant, highest yield per hectare and highest potassium content was found from C_1K_2, while the shortest plant, minimum number of leaves per plant, shortest petiole, lowest diameter of stem, lowest length of leaf, minimum number of branches per plant, lowest fresh weight of leaves per plant, lowest dry matter content of leaves, maximum days to starting of flowering, minimum number of flower buds per plant, minimum number of pods per plant, shortest pod, lowest pod diameter, lowest weight of individual pod, lowest yield per plant, lowest yield per hectare and lowest potassium content was recorded from C_2K_0.

Form the findings it was revealed that Arka Anamica okra cultivar with 100 kg K_2O/ha was the best combination for attaining highest yield contributing characters and yield of okra.

Considering the situation of the present experiment, further studies in the following areas may be suggested:

1. Such study is needed in different agro-ecological zones (AEZ) of Bangladesh
2. Farmers may use Arka Anamika variety to increase okra production in Bangladesh.
3. Such study is needed to find out the effect of potassium on mineral contents other than potassium or alternative used of organic fertilizer.

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Appendices

APPENDICES

Appendix I. Monthly record of air temperature, rainfall, relative humidity, rainfall and sunshine of the experimental site

Month (2012)	Air temperature (°C)		*Relative humidity (%)	*Rainfall (mm)	*Sunshine (hr)
	Maximum	Minimum			
April	33.6	23.6	69	163	6.4
May	34.7	25.9	70	185	7.8
June	32.4	25.5	81	228	5.7
July	35.1	22.4	67	298	5.9

* Monthly average; Source: Bangladesh Meteorological Department, Agargoan, Dhaka-1212

Appendix II. Soil characteristics of experimental field analyzed by Soil Resources Development Institute (SRDI), Khamarbari, Farmgate, Dhaka

A. Morphological characteristics of the soil of experimental field

Morphological features	Characteristics
Location	Laboratory field , SAU, Dhaka
AEZ	Madhupur Tract (28)
General Soil Type	Shallow red brown terrace soil
Soil series	Tejgaon
Topography	High land and fairly leveled

B. Physical and chemical properties of the initial soil

Characteristics	Value
Sand, silt and clay (%)	27, 43 and 30
Textural class	Silty-clay
pH	5.6
Organic matter (%)	0.78
Total N (%)	0.03
Available P (ppm)	20.00
Exchangeable K (me/100 g soil)	0.10

Appendix III. Analysis of variance of the data on plant height at days after sowing (DAS) as influenced by cultivars and different levels of potassium

Source of variation	Degrees of freedom	Mean square			
		Plant height (cm) at			
		20 DAS	40 DAS	60 DAS	80 DAS
Replication	2	0.580	0.919	16.740	16.562
Cultivars (A)	1	21.258**	65.021**	177.127*	199.526**
Potassium (B)	3	18.135**	58.319**	386.200**	316.116**
Interaction (A×B)	3	3.145*	36.372**	282.162**	67.758**
Error	14	1.836	6.260	31.302	10.196

**: Significant at 0.01 level of significance; *: Significant at 0.05 level of significance

Appendix IV. Analysis of variance of the data on number of leaves per plant at days after sowing (DAS) as influenced by cultivars and different levels of potassium

Source of variation	Degrees of freedom	Mean square			
		Number of leaves per plant at			
		20 DAS	40 DAS	60 DAS	80 DAS
Replication	2	0.040	0.513	4.502	1.246
Cultivars (A)	1	0.973*	5.368**	94.407**	48.476*
Potassium (B)	3	2.674**	5.048**	125.091**	43.105**
Interaction (A×B)	3	0.812*	1.905*	86.033**	36.595*
Error	14	0.207	0.597	7.355	9.246

**: Significant at 0.01 level of significance; *: Significant at 0.05 level of significance

Appendix V. Analysis of variance of the data on petiole length at days after sowing (DAS) as influenced by cultivars and different levels of potassium

Source of variation	Degrees of freedom	Mean square			
		Petiole length (cm) at			
		20 DAS	40 DAS	60 DAS	80 DAS
Replication	2	0.144	0.646	1.099	0.853
Cultivars (A)	1	2.587**	4.982*	10.045**	7.155*
Potassium (B)	3	3.519**	13.941**	12.461**	19.635**
Interaction (A×B)	3	2.301**	7.741**	3.024**	11.972**
Error	14	0.201	0.882	0.470	0.963

**: Significant at 0.01 level of significance; *: Significant at 0.05 level of significance

Appendix VI. Analysis of variance of the data on stem diameter at days after sowing (DAS) as influenced cultivars and different levels of potassium

Source of variation	Degrees of freedom	Mean square			
		Stem diameter (cm) at			
		20 DAS	40 DAS	60 DAS	80 DAS
Replication	2	0.012	0.030	0.127	0.007
Cultivars (A)	1	0.202**	1.654**	0.882**	0.882**
Potassium (B)	3	0.086**	0.664**	5.877**	1.539**
Interaction (A×B)	3	0.033*	0.118*	0.904**	0.615**
Error	14	0.010	0.029	0.066	0.043

**: Significant at 0.01 level of significance; *: Significant at 0.05 level of significance

Appendix VII. Analysis of variance of the data on leaf length at days after sowing (DAS) as influenced by cultivars and different levels of potassium

Source of variation	Degrees of freedom	Mean square			
		Leaf length (cm) at			
		20 DAS	40 DAS	60 DAS	80 DAS
Replication	2	0.455	1.099	0.853	0.207
Cultivars (A)	1	1.576**	10.045**	7.155*	16.078**
Potassium (B)	3	2.863**	12.461**	19.635**	44.342**
Interaction (A×B)	3	0.913**	3.024**	11.972**	3.383**
Error	14	0.172	0.470	0.963	0.357

**: Significant at 0.01 level of significance; *: Significant at 0.05 level of significance

Appendix VIII. Analysis of variance of the data on number of branches per plant at days after sowing (DAS) as influenced by cultivars and different levels of potassium

Source of variation	Degrees of freedom	Mean square			
		Number of branches per plant at			
		20 DAS	40 DAS	60 DAS	80 DAS
Replication	2	0.015	0.030	0.127	0.010
Cultivars (A)	1	0.304**	1.654**	0.882**	1.042**
Potassium (B)	3	0.257**	0.664**	5.877**	2.463**
Interaction (A×B)	3	0.036**	0.118*	0.904**	0.365*
Error	14	0.006	0.029	0.066	0.082

**: Significant at 0.01 level of significance; *: Significant at 0.05 level of significance

Appendix IX. Analysis of variance of the data on yield contributing characters as influenced by cultivars and different levels of potassium

Source of variation	Degrees of freedom	Mean square				
		Fresh weight /plant (g)	Dry matter content /plant (g)	Days to starting of flowering	Number of flowers/ plant	Number of pods/ plant
Replication	2	168.540	0.478	0.542	0.716	0.662
Cultivars (A)	1	7837.32**	20.907**	9.375*	55.940**	17.019**
Potassium (B)	3	2653.34**	5.952**	6.819**	113.157**	3.692*
Interaction (A×B)	3	664.078**	11.308**	9.042**	6.652*	2.116*
Error	14	81.439	0.979	1.494	2.322	0.838

**: Significant at 0.01 level of significance; *: Significant at 0.05 level of significance

Appendix X. Analysis of variance of the data on yield contributing characters and yield of okra as influenced by cultivars and different levels of potassium

Source of variation	Degrees of freedom	Mean square				
		Pod length (cm)	Pod diameter (cm)	Individual fruit weight (g)	Yield/ pant (kg)	Yield/ hectare (ton)
Replication	2	0.635	0.441	1.322	26.262	0.364
Cultivars (A)	1	27.520**	3.784*	30.600**	691.227**	4.726**
Potassium (B)	3	38.954**	4.711**	10.885**	853.718**	4.670**
Interaction (A×B)	3	7.590**	2.656*	5.518*	151.391**	2.109*
Error	14	0.800	0.644	1.404	26.065	0.615

**: Significant at 0.01 level of significance; *: Significant at 0.05 level of significance