EFFECT OF NITROGEN AND CULTIVARS ON THE YIELD AND YIELD CONTRIBUTING CHARACTERS OF OKRA [*Abelmoschus esculentus* (L) Moench]

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DHAKA-1207

JUNE 2006

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By

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REGISTRATION NO. 25174/00307

A thesis

Submitted to the Department of Horticulture & Postharvest Technology Sher-e-Bangla Agricultural University, Dhaka in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE (MS)

IN

HORTICULTURE

SEMESTER: JANUARY – JUNE 2006

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This is to certify that the thesis entitled, "EFFECT OF NITROGEN AND CULTIVARS ON THE YIELD AND YIELD CONTRIBUTING CHARACTERS OF OKRA [*Abelmoschus esculentus* (L) Moench]" 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 HORTICULTURE, embodies the result of a piece of bona fide research work carried out by MD. FARUQ BIN HOSSAIN REGISTRATION NO. 25174/00307 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 been duly acknowledged.

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ABSTRACT

EFFECT OF NITROGEN AND CULTIVARS ON THE YIELD AND YIELD CONTRIBUTING CHARACTERS OF OKRA

[*Abelmoschus esculentus* L. Moench]

By

MD. FARUQ BIN HOSSAIN

Detail information about optimum level of N fertilizers application and superior okra cultivar is limited. The response of three cultivars of okra [*Abelmoschus esculentus* (L.) Moench] viz. BARI Dherosh 1, Arka anamica and Shatdari to nitrogen (N) levels (0, 59.8, 64.4, 69.0 and 73.6 kg N/ha) were examined by using Randomized Complete Block Design (RCBD) with three replications at the Horticultural Farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka–1207, during the period from March to June, 2005. Yield increased with increasing the N levels. The three cultivars performed best in both yield and yield contributing characters at the highest N level 73.6 kg N/ha. The highest yield was recorded from Arka anamica (17.3 t/ha) followed by BARI Dherosh 1 (15.3 t/ha) and Shatdari (9.4 t/ha) at 73.6 kg N/ha. The cultivar Arka anamica and N level 73.6 kg/ha is the suitable combination for successful okra cultivation.

DEDICATED

TO

MY DEPARTMENT

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ACKNOWLEDGEMENTS

All praises, gratitudes and thanks are due to the omniscient, omnipresent and omnipotent Allah who enabled the author to complete this thesis successfully.

The author expresses his deepest sense of gratitude, sincere appreciation and immense indebtedness to his supervisor Md. Hasanuzzaman Akand, Assistant Professor Dept. of Horticulture & Postharvest Technology, Sher-e-Bangla Agricultural University, Dhaka for his guidance, constructive criticism and valuable suggestion in successful completion of the research work and preparation of this thesis. Profound gratitude is expressed to his honorable co-supervisor Dr. Md. Nazrul Islam, chairman, Dept. of Horticulture & Postharvest Technology Sher-e-Bangla Agricultural University, Dhaka for the scholastic guidance and constant inspiration throughout the research work and preparation of this thesis.

The author is highly grateful to Prof. A. K. M. Mahtabuddin and Prof. Md. Ruhul Amin, teachers of the Dept. of Horticulture and Postharvest Technology, SAU, for valuable suggestions and cooperation they extended during the study period.

The author also expresses his heartfelt thanks to all the teachers of the Dept. of Horticulture and Postharvest Technology, SAU, for their help, valuable suggestions and encouragement during the period of the study.

The author expresses his heartfelt thanks to Mr, Noor Md. Rahmatullah Assistant Professor Dept. of Agricultural Statistics, SAU for his help in analyzing and interpreting the data.

He wants to express thanks to all the stuff, Department of Horticulture and Horticultural Farm, SAU for their generous help in various aspects during the entire period of the research.

Thanks are extended to his brother, sisters, relatives, well wishers and friends for their inspiration, help and encouragement throughout the study.

The Author

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CHAPTER 1

INTRODUCTION

Okra (*Abelmoschus esculentus* L. Moench) is a popular vegetable in Bangladesh which originated in tropical Africa (Purseglove, 1987). It belongs to the family Malvaceae and locally known as "Dherosh" or "Bhindi". It plays an important role in vegetable market during summer season when the supply of vegetables is limited. It is an annual vegetable crop in tropical and sub-tropical parts of the world but it grows year round in our country and commercially cultivated mainly in summer.

In Bangladesh, vegetable production is not uniform round the year. Vegetables are plenty in winter but are in short in summer.The total vegetable production around 30 % is produced during Kharif season and around 70% is produced in Rabi season (Anon, 1993). So, as a vegetable okra can get an importance in summer season production. On the other hand, due to low production of vegetables the present consumption is only about 50g/day/person; with potato and sweet potato, it is 70g/day/person, which is the lowest among the countries of South Asia and South- East Asia (Rekhi, 1997). The per capita consumption of vegetables in the South Asian Association for Regional Co-operation(SAARC) countries, mainly Pakistan (69 g), Srilanka (120 g) and India (135 g) are higher then that of Bangladesh but many dietitians prescribed a daily requirements of 285g of vegetable for an adult person (Ramphal and Gill, 1990). Therefore, there is a big gap between the requirement and supply of vegetables in Bangladesh. As a result, malnutrition is very much evident in the country. Successful okra production may contribute partially in solving vegetable scarcity of summer season for the increasing population.

Vegetable deficiency is a chronic problem of Bangladesh. At present vegetable are grown 429 thousand hectares of land which is only 3% of the total cropped area, and total annual production of vegetable is estimated to be 2 million metric tons with an average productivity of 5 tons (t) per hectare (ha) (Rekhi, 1997).

So, to meet up our daily vegetable requirements as well as the shortage of vegetable production, okra can partially improve the vegetable production in the country. Total production of okra is about 240 thousand tons, produced from 7287.5 ha of land in the year 2005 and the average yield was about 33.8 t/ha which is very low (Monthly Bulletin, BBS, February, 2005).

Tender green pods of okra generally marketed as fresh condition. The tender fruit 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). Tender pods content high mucilage and are used in soups and gravies; seeds are also a good source of protein. The pods also have some medicinal value and a mucilaginous preparation from the pod can be used as a plasma replacement or blood volume expander (Savello *et al.*, 1980).

Use of fertilizers to augment the yield of any crop is the unanimous recommendation. However, what, when and how much fertilizer should be used to get the maximum benefit, varies with the crop, soil and climatic condition of the tract. Although the vegetable grower in Bangladesh are using various fertilizers for the production of okra, yet no definite recommendation is available through research for okra. The crop produces only low yield in Bangladesh because farmers do not use optimum dose of fertilizers, due to lack of fertilizer recommendation (Hossain, 1997).

Considering the above mentioned facts and based on the prior observation, an investigation was undertaken to find out the suitable cultivar and its optimum dose of N. The three okra cultivars and their interactions with the following objectives:

1.To determine the optimum dose of nitrogen to obtain the optimum yield in okra.

2.To find out the suitable cultivar of okra in response of nitrogen.


CHAPTER 2

REVIEW OF LITERATURE

Growth, yield performance and production capability of okra at different fertilizer doses have been extensively studied in various part of the world. But very little studies have been done on this crop under the agroecological condition of Bangladesh particularly in respect of cultivar and different levels of nitrogen. However, available information partioning to this study are reviewed under the following paragraphs:

Fertilizers are indispensable for the production system of modern agriculture and play a vital role to increase the yield, providing other factors are not limiting. Chemical fertilizers today hold the key to success of the crop production system of Bangladesh Agriculture, being contributed 50% of the total production (Rekhi, 1997). The chemical fertilizer supplies sufficient available nutrients readily for proper growth and yield of plant. Among the macronutrients, NPK are used largely by plants. Physio- morphological and biological development of plants depends on the judicious application of NPK. An excess or deficiency of NPK causes remarkable effect on growth and yield of plant. Some available information about the effect of inorganic fertilizers on growth and yield of okra are reviewed here.

Gowda *et al.* (2002) was conducted a study in the summer season of 1999 in Bangalore, Karnataka, India to investigate the effects of different fertilizer levels (N:P:K at 125:75:60, 150:100:75 and 75:125: 100 kg/ha) on okra cultivars Arka Anamika, 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.

Prabu *et al.* (2002) was conducted an experiment in Parbhani, Maharashtra, India, during the summer season of 2001 to investigate tile effects of inorganic fertilizers at 0, 1/3, 2/3 and full rate (N:P:K at 1.00:50:50 kg/ha), in the presence or absence of farmyard manure (FYM at 10 t/ha), and biofertilizers (uninoculated; Azospirillum + phosphate solubilizing

bacteria and Azospirillum + vesicular arbuscular mycorrhiza) on the performance of okra cultivar Parbhani Kranti. Results showed that the treatment 2/3 recommended NPK dose + FYM + Azospirillum + vesicular arbuscular mycorrhiza produced in the highest yield.

Gowda *et al.* (2001) was conducted a field experiment in Bangalore, Karnataka, India during the 1999 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 (31.11 g) 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 (17.48 g), stems (31.44 g), roots (17.61 g), fruits (29.98 g), and whole plants (96.51 g) compared with 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 par 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.

Yogesh *et al.*(2001) was conducted a field experiment in Nagina, India, during the kharif seasons of 1998 and 1999 to study the effect of N (80, 100, and 120 kg/ha), P (60 and 80 kg/ha), and sowing date (25 June and 15 July) on okra (cv. Parbhani Kranti) seed yield. One-third of N and 100% of P were applied during sowing; the remaining N was applied as a top dressing at 30 days after sowing and at the flowering stage. Seed yield, which increased with the increase in N rate, was not significantly affected by P rate. The highest number of Seeds per pod (57.0) and seed yield per plot (2.94 kg) were obtained with the application of 120 kg N/ha and 80 kg P/ha, along with sowing on 25 June.

Rani *et al.* (1999) were conducted a field experiment in Bapatla, Andhra 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_20_5, K_20/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 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. 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 between stages and was influenced significantly by cultivars, fertilizer levels and their combinations. Crop growth (CGR) and relative growth rates were influenced by cultivars and fertilizers. Pusa Sawani supplied with the highest fertilizer level recorded the maximum CGR 60 DAS. Net assimilation rate (NAR) declined 60 DAS. Harvest index (HI) was also influenced by cultivars, fertilizer levels and their interactions. Arka Anamika,with a moderate vegetative growth and high NAR, bad the highest HI values. Among the fertilizer levels, maximum HI was recorded by 100-50-50 kg NPK/ha.

Kurup *et al.* (1997) reported that N rate upto 100 kg could increase the setting. percentage, length and diameter of fruits, fruit number and weight per plant and the total pod yield of okra cv. Kiran.

An experiment was conducted by Somkuwar *et al.* (1997) in India to determine the effect of 3 levels of N (25, 50 and 75 kg/ha) on the growth of okra varieties punjab 7, Parbha ni Kranti and sel 2-2. The results showed that fruit yield per plant and yield per ha were increased with an increase in nitrogen concentration. Parbhani Kranti produced the fruit highest fruit yield (171.11g) per plant and yield per ha (7770 kg) at 75 kg N/ha.

Singh (1995) studied the effect of various doses of nitrogen on seed yield and quality of okra in India. There were 6 levels of N (0, 30, 60, 901, 120 and 150 kg/ha). He found that application of N at 90, 150 kg/ha gave the highest number of pods/plant (12.2-14.0), pod length (16.7-17.6 cm), seed yield (17.5-19.0 q/ ha) and 1000 seed weight (67.2- 68g).
Arora *et al.* (1991) compared growth and yield of a new okra. cultivar, Punjab Padmini, with that of cv. Pusa Sawaili grown under variable N (0, 30, 60 and 90 kg/ha) and P (0,

30 and 60 kg/ha) fertilizer applications. They stated that plant height , number of fruits, fruit size and total green fruit yield were significantly improved by the application of 90 kg N/ha and 60 kg /ha.Punjab Padmini gave a higher mean fruit yield (124.6 q/ha) than Pussa Sawani (121.6 kg/ha).A significant increase in mean marketable yield for both cultivars was obtained with an increase in N application from 0 to 90 kg/ha (100.9 to 156.0 q/ ha) and an increase in P application from 0 to 60 kg/ha (116.0 to 136.5 q/ha). Optimum treatment was 90 kg N + 60 kg P/ha, giving a yield of 192.1 q/ha.

Lenka *et al.* (1989) investigated a field trial with three replicates with N (as urea) applied at 4 levels (0, 50, 75 and 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 1.00 kg N/ha and 30 kg P_2O_5 /ha gave a satisfactory seed yield (7.60 q/ha).

In trails with okra cv. Pusa Sawani, N and K were each applied at 0-120 g/ha (Mishre and Pandey, 1987). N at 80 kg /ha. and K at 40 kg/ha significantly increased the number of fruits per plant, 1000 seed weight and the seed yield. Application of N above 80 kg/ha and K above 40 kg/ha adversely affected seed yield. Interaction effect was significant with 80 kg N and 40 kg K/ha giving the highest seed yield of 15.47 q/ha.

Majanbu *et al.* (1986) observed that nitrogen application generally increased fruit and shoot dry weights markedly, whereas phosphorus increased them only moderately. Leaf apd primary branch production and plant height were also enhanced by nitrogen fertilization upto 100 kg N/ha, but were influenced by P application.

Abdul and Aarf (1986) stated that in two trails, cv. Batraa was grown at spacing of 20, 30, 40, 50 and 60 cm with 5 levels of 100, 250, 300, 350 and 400 kg NPK/donum (1338 m^2). The maximum yield (12.23 t/donum) was obtained with 400 kg NPK at 20 cm spacing. The number of pods/plant was increased slightly by increasing fertilizers levels and wider spacing to a maximum of 59, but there was no significant effects on average pod weight.

Majanbu *et al.* (1986) stated that the growth response and nutrient concentration in okra as influenced by four nitrogen rates (0, 25, 50, and 100 kg/ha) and three phosphorus raies (0, 13 and 26 kg/ha) were examined using two varieties (White Velvet and NHAE 47-4). They found that nitrogen application generally increased pod and shoot dry weights markedly. Leaf and primary branch production and plant height were also enhanced by nitrogen fertilization up to 100 kg N/ha.The application of nitrogen enhanced the concentration of N, P and K in pods and N and Mg in leaves while P and K concentrations in leaves were depressed. Nutrient concentrations in plant tissue were also partly a function of plant age and variety.

The response of okra (*Abelmoschus esculentus*), cultivars white velvet and NHAE 47-4 to fertilization in Northern Nigeria was examined using 0, 25, 50 and 100 kg N/ha and 0,13 and 26 kg P/ha (Majanbu *et al.,* 1985). Nitrogen application significantly increased green pod yield, pod diameter, number of fruits/plant, number of seed/pod and pod weight. Application of P al.so significantly, increased green pod yield, pod number and number of seeds/pod. For optimum green pod,yield of white velvet 35 kg N/ha was suggested while NHAE 47-4, N fertilization could be increased to 70 kg/ha. There was no differential response of cultivars to P fertilization for green pod yield; however, the application of 13 kg/ha enhanced the performance of both cultivars.

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.

In an experiment of okra cultivars White Velvet and NHAE 47-4 to fertilization in Northern Nigeria was examined using 0, 25, 50 and 100 kg N/ha and 0, 13 and 26 kg P/ha (Majanbu *et al.*, 1985). Nitrogen application significantly increased green pod yield, pod diameter, number of pods per plant, number of seeds/pod and pod weight. For optimum green pod yield of White Velvet 35 kg N/ha is suggested while for NHAE 47-4, N fertilization can be increased to 70 kg/ha.

In a field trail with the cv. Pusa Sawni the plant received N at 40-120 and/or P_2O_5 at 30 or 60 kg/ha (Reddy *et al.*, 1984). Nitrogen alone increased the yields frorn 58.9 q/ha in the control to 97.5 q/ha at 120 kg N/ha, however, the highest yield (101.46 q/ha) was obtained with N+P at highest rates.

Response of okra to varying levels of plant spacing (60 x 20, 60 x 30 and 60 x 40 cm) and graded levels of nitrogen (0, 50, 100 and 150 kg N/ha) and phosphorus (0, 30 and 60 kg P/ha) was studied on sandy loam soil poor in organic carbon, medium in available phosphorus and rich in available potassium during kharif season of 1972,. 1974 and 1977 at the Indian Institute of Horticultural Research, Bangalore (Gupta *et al.*, 1981). They stated that the closest spacing (60 x 20 cm) gave consistently higher yields in all the years of study. Nitrogen phosphorus fertilization, increased plant height, number of nodes per plant and pod size which finally contributed in increasing the pod yield. Application of 100 kg nitrogen and 60 kg phosphorus per hectare gave the highest yield as compared to other levels.

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, 203, 140, 60 and 80 kg/ha) and 5 levels of K_20 (0, 15, 30, 45 and 60 kg/ha). Nitrogen fertilization significantly increased yield. The highest N level (80 kg/ha) increased yield by 149.2 % over the control. Combined application of 80 kg N/ha with either 30 kg or 60 kg K_20/ha produced maximum yields (17.2 t/ha and 17.5 t/ha respectively). Different K levels had no significant effect on yield in the absence of N.

In a trail with okra, cv. Pussa Sawani, the effects were compared applying N at 0.75 or 150 kg/ ha and P_{20_5} and K_20, each at 0,60 or 120 kg /ha , in all possible combinations by Singh (1979). He found that the highest yield was given by a combination of N 75, P 60, K O.

Planting density of okra, cv. Clemson Spinless, was 16, 32, 64 plants/ m^2 using 1 or 2 rows/bed and 2.5 or 5 cm spacing in the rows (Albregts and Howard, 1974). Yield/unit

area increased linearly with plant density on a double logarithmic scale. The percentage of marketable pods was not affected by the treatments but pod size decreased with increasing density, i.e. 9.6, 9.2 and 8.6 g/pod for 16, 32 and 64 plants/m^2, respectively. Two fertilizer levels, NPK at 224-98-196 and 448-196-372 kg/ha, did not affects yield differently.

An experiment was conducted by Chauhan and Gupta (1973) to find out the effect of NPK on the growth and yield of okra *(Abelmoschus esculentus).* They found that plant height and girth, number of leaves and yield of green pod were increased by increasing applictfion of N (22.5,45.0 or 67.5 kg/ ha). P at 22.5 or 45.0 kg/ ha and K at 22.5 Kg / ha had no effect on growth and yield. NPK applications, however, generally increased yields.

In a 2 year trails with okra the effects were assessed of N (as urea) at 40-120 kg/ha, P_20_5 (as suoerphosphate) at 17.44-52.32 kg/ha and 1C (as muriate) at 24.9-74.7 kg/ ha (Shama and Shukla, 1973). The highest yields were obtained with N at 120 at 34.88 and K at 49.8 kg/ ha.

An experiment was conducted during 1966-67 at race course farm area of agricultural college, Gwalior to find out the optimum requirement of okra crop for nitrogen, phosphorus and potash on sandy loam soil (Chauhan and Gupta, 1973). It was found that height, girth of plant and yield of green pods were increased as the level of nitrogen increased from 22.5 kg to 67 kg/ha in the soil. However the application of NPK increases the yield in general. Number of pods and height of plants is positively correlated with the yield of crop.

In two years trails, on okra the response was assessed to N, P and K applied at 60, 30 and 30 kg/ha, respectively (Bid *et al.,* 1971). The best growth was obtained when all three elements were applied,of the 2-nutrient combinations NK was the most effective, followed by NP and PK.

Ahmad and Tullock (1968) studied the response of okra to nitrogen, phosphorus, potassium and magnesium fertilization at Trinidad on loamy soil and best yields were obtained with 112 kg N, 168 kg P, 280 kg K and 112 kg Mg per hectare.

In an investigation at the Punjab Agricultural University, Ludhiana, Singh *et al.* (1967) observed 113 kg N/ha to be an economic dose. It was also recornmended that 62.5 kg. N/ha is sufficient on soils of good fertility for both spring and rainy season crop (Anon., 1983). In Himachal Pradesh, NPK at the rate of 60,50 and 30 kg per hectare, respectively, were recommended for getting the best yield (Anon., 1978).


CHAPTER 3

MATERIALS AND METHODS

This chapter deals with the materials and methods that were used in executinon of the experiment.

3.1 Experimental Site

The experiment was conducted at the horticultural farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka–1207, during the period from March to June, 2005. The location of the site in 23.774° N latitude and 90.335° E longitude with an elevation of 8.2 meter from sea level (Anon 1989).

3.2 Climate

The experimental site is situasted in subtropical zone, characterized by heavy rainfall during the months from April to September (Kharif season) and scantly rainfall during the rest of the year (Rabi season). Information regarding average monthly the maximum and the minimum temperature, rainfall and relative humidity, soil temperature as recorded by the weather yard, Bangladesh Meterological Department (Climate division), during the period of study have been preasented in Appendix II.

3.3 Soil

The soil of the experimental area belongs to the Modhupur Tract in Agroecological Zone (AEZ) 28 (UNDP, 1988). The analytical data of the soil sample collected from the experimental area were determined in the SRDI, Soil Testing Laboratory, Khamarbari, Dhaka have been presented in Appendix I.

3.4 Plant materials

Three cultivars of okra:

1. BARI Dherosh 1
2. Arka Anamica
3. Shatdari

3.5 Design and layout of the experiment

The experiment was laid out in Randomized Complete Block Design (RCBD) having two factors with three replications. An area of 37.4 m x 15.5 m was divided into three equal blocks. Each block contained 15 plots where 15 treatments were allotted randomly. Thus, there were 45 unit plots altogether in the experiment. The unit plot size was 4.0 m x 1.8 m. The unit plots and blocks were separated by 0.60 m and 0.75 m respectively. Plant to plant distance 60 cm and row to row distance 80 cm. Each unit plot had three rows and each with five plants. Therefore, there were fifteen plants per unit plot.

3.6 Treatments of the experiment

The experiment was designed to study the effect of cultivars and different levels of nitrogen on yield and yield contributing characters of okra. The experiment consisted of two factors, which are as follows:

3.6.1 Factor A

Cultivars

1. V_1 : BARI Dherosh- I
2. V_2 : Arka Anamica
3. V_3 : Shatdari

3.6.2 Factor B

Nitrogen levels (in the form of urea)

N_0: No application of N fertilizer (control)

N_1: Application of N, at the rate of 60 kg/ha

N_2: Application of N, at the rate of 64 kg/ha

N_3: Application of N, at the rate of 69 kg/ha

N_4: Application of N, at the rate of 74 kg/ha

3.6.3 Treatment combination:

There were altogether fifteen treatment combinations such as:

$V_1 N_0$, $V_1 N_1$, $V_1 N_2$, $V_1 N_3$, $V_1 N_4$

$V_2 N_0$, $V_2 N_1$, $V_2 N_2$, $V_2 N_3$, $V_2 N_4$

$V_3 N_0$, $V_3 N_1$, $V_3 N_2$, $V_3 N_3$, $V_3 N_4$

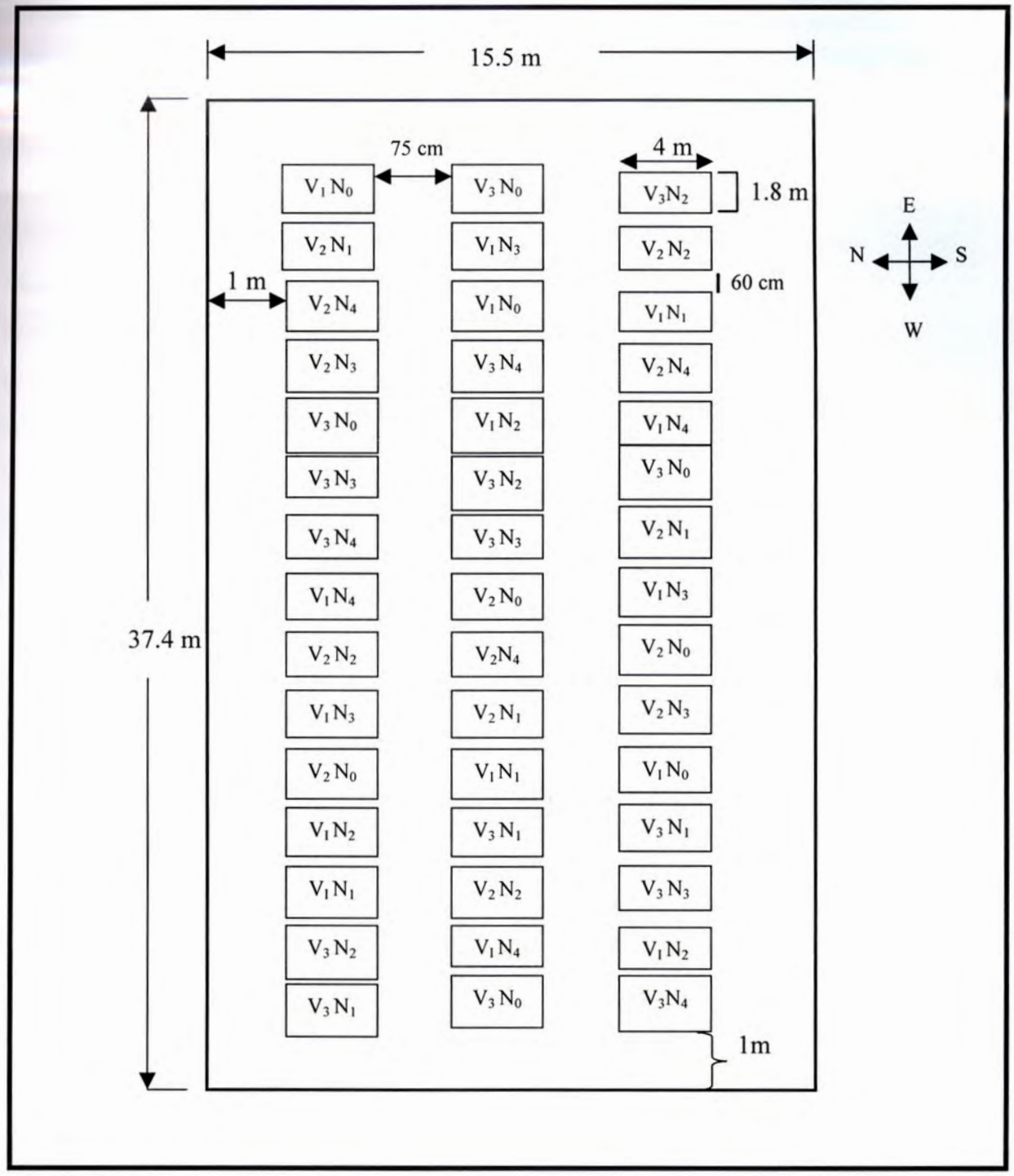

Fig.1. Field layout

3.7 Soil Analysis

The analytical data of the soil sample collected from the experimental area were determined in the SRDI, Soil Testing Laboratory, Khamarbari, Dhaka. The analytical results of the collected soil before treatment are presented in Table 1.

Table 1. Physical and chemical properties of the soil before starting the experiment

Characters	**Value**
Partical size analysis	
% Sand	27
% Silt	43
% clay	30
Textural class	silty-clay
pH	6.5
Organic carbon (%)	0.45
Organic matter (%)	0.78
Total N (%)	0.03
Available P (ppm)	20.00
Exchangeable K (me/ 100 g soil)	0.10
Available S (ppm)	45

3.8 Land preparation

The land, which was selected to conduct the experiment, was opened on 06 March 2005 with the help of a power tiller and then it was kept open to sun for seven days prior to further ploughing. Afterwards it was prepared by ploughing and cross ploughing followed by laddering. Deep ploughing was done to have a good tilth, which necessary for getting better yield of the crop. The weeds and stubbles were removed after each laddering. Simultaneously the clods were broken and the soil was made into good tilth.

The basal dose of manures, cowdung 10 tons/ha and fertilizers were mixed into the soil during final land preparation. Finally, the plot was raised 10 cm from the soil surface to keeping the drain around the plot.

3.9 Manures, fertilizers and their methods of application

Manures, fertilizer doses and their methods of application described by Rashid (1999) are shown in table 2.The entire quantities of P_2O_5 were applied before sowing.

Table 2. Doses of manures, fertilizers, and their methods of application used for this experiment

Manures/ fertilizers	Dose per ha (kg)	Basal dose (kg)	Top dressing (kg)
Cowdung	10 tons/ha	Entire	----
P_2O_5	48	Entire	----
K_2O	90	Half (50%)	Rest half (50%) was applied into two equal splits at 40 and 60 days after sowing (DAS)
N_2	-	-	Total N was applied into three equal splits at 20, 40 and 60 DAS

3.10 Collection and sowing of seeds

The seeds of okra cv. BARI Dherosh 1, Arka Anamica and Shatdari were used in the experiment. The seeds were collected from Kushtia Seed Store, Dhaka. The seeds were soaked in water for 24 hours and then wrapped with a piece of thin cloth. The soaked seeds were then spreaded over polythene sheet for 2 hours to dry out the surface water. This treatment was given to help quick germination of seeds. The seeds were sown in the rows of the raised bed on 15 March 2005. Row to row and plant to plant distance were maintained 80 cm and 60 cm, respectively. Two to three seeds were sown in each pit. Then the seeds were covered with fine soil by hand.

3.11 Intercultural operations

Necessary intercultural, operations were done throughout the cropping season for proper growth and development of the plant. Stagnant water was effectively drained out at the time of heavy rain. Irrigation was applied as and when necessary.

3.11.1 Thinning out

Seedlings emergence were completed within 7 days and then they attained a height of about 10 cm. They were thinned out and only one healthy seedling was kept to grow in each hill.

3.11.2 Weeding

Weeding was done four times in order to get free from weeds in the plot.

3.11.3 Plant protection measures

For controlling shoot and pod borer before pod setting sprayed Diaginon 60 EC @ 3.5 ml/L water in thrice in an interval of 10 days started soon after the appearance of infestation. After fruit setting Nogos @ 0.02 % was sprayed 4 times in an interval of 7 days for controlling Jassid.

3.11.4 Diseases management

The crop was healthy and disease free and fungicide was used.

3.12 Data collection

Data were recorded on the following parameters from sample plants during the course of experiment. Ten (10) plants were sampled randomly from each unit plot for the collection of data. The plants in the outer rows and at the extreme end of the middle rows were excluded from the random selection to avoid the border effect. The data were collected at 30, 50 and 70 DAS. The following yield and yield contributing characters were considered in this study.

3.12.1 Days to anthesis

Days required from sowing to first flower opening.

3.12.2 Time to harvest

Days required to reach the edible maturity from anthesis.

3.12.3 Duration of picking period

Days in between first harvest to the last harvest of edible pods.

3.12.4 Plant height (cm)

The height was measured in centimeter (cm) by a meter scale at 30, 50, 70 DAS from the soil surface of steam up to the tip of the longest leaf. Average height of 10 plants were taken very carefully from the randomly selected plants.

3.12.5 Plant girth (cm)

The plant girth (diameter) measured by a slide calipers. The girth of the plants was measured in centimeter (cm) at 30, 50 and 70 DAS at thickened portion of the plant.

3.12.6 Leaf length

Length of leaves were measured in centimeter (cm) with the help of a meter scale from the base of leaf which attached with petiole up to tip point of leaves and average leaf length of 10 leaves per plant were recorded from randomly selected sample plants.

3.12.7 Leaf breadth

Breadth of leaves were measured in centimeter (cm) with the help of a meter scale from the middle of the leaves. Average leaf breadth of 10 leaves per plant were recorded from randomly selected sample plants.

3.12.8 Number of leaves per plant

Number of leaves per plant of 10 randomly selected plants was counted at 30, 50 and 70 DAS. All the leaves of each plant were counted separately. Only the smallest young leaves at the growing point of the plant were excluded from counting. Calculation the average number of leaves, then average number was recorded.

3.12.9 Number of branches per plant

Number of branches per plant of 10 randomly selected plants ware counted at 30, 50 and 70 DAS. All the branches of each plant were counted separately. Only the smallest young

branches at the growing point of the plant were excluded from counting. Calculation the average number of branches, then average number was recorded.

3.12.10 Pod length (cm)

The length of pods excluding peduncle (mean length of 20 randomly selected pods from each unit plot).

3.12.11 Pod breadth (cm)

The diameter of pods at mid position measured by a slide calipers (mean diameter of 20 randomly selected fruits from each unit plot)

3.12.12 Individual pod weight (g)

Mean weight of 20 randomly selected pods at edible stage from each plots.

3.12.13 Number of pods per plant

Total number of pods produced by a plant.

3.12.14 Pod yield per plant (g)

Edible pod yield per plant (mean of 10 randomly selected plants from each plot).

3.12.15 Pod yield (t/ha)

The pod yield per hectare as calculated in ton by converting the total yield of pod per plot.

3.13 Statistical analysis

The recorded data on different parameters were statistically analyzed by using MSTAT software to find out the significance of variation resulting from the experimental treatments. The mean values for all the treatments was calculated and the analysis of variance for most of the characters was accomplihsed by 'F'variance test. The significance of difference between pair of means was tested at 5% and 1% level of probabilty (Gomez and Gomez, 1984).


CHAPTER 4

RESULTS AND DISCUSSION

An experiment was carried out to investigate the influence of nitrogen on the edible pod against three cultivars of okra during the experimental period from March to July 2005. The results are presented in table 3, 4, 5, 6 and 7 figure 2, 3, plate1, 2 and 3 discussions are given in the following headings.

4.1 EFFECT OF NITROGEN ON YIELD CONTRIBUTING CHARACTERS OF OKRA

4.1.1 Plant height

The five levels of nitrogen showed significant variation in respect of plant height at 30 DAS (Figure 2). The different levels of nitrogen in plant height which ranging from 7.8 to 14.8 cm. The maximum plant height (21.2 cm) was recorded in plots where highest level of N (74 kg/ha) was applied while the minimum plant height (9.1 cm) was found in control treatment.

The five levels of nitrogen showed significant variation in respect of plant height at 50 DAS (Figure 2). The maximum plant height (44.8 cm) was recorded in plots where highest level of N (74 kg/ha) was applied while the minimum plant height (28.8 cm) was found in control treatment.

Significant variation in plant height was observed at 70 DAS due to application of different levels of N to the soil (Figure 2). The maximum plant height (116.8 cm) was obtained from highest level of N (74 kg/ha), while the minimum plant height (82.5 cm) was found in control treatment.

Chauhan and Gupta (1973) reported that variation in plant height in okra due to nitrogen level at 22.5 kg N /ha (105.3 cm) and 45 kg N/ha (104.3 cm). While Gupta *et al.* (1981) observed that plant height of okra were increased with the increase of nitrogen level from 0 kg N/ha (87.8 crn), 30 kg N/ha (96.6 cm) and 60 kg N/ha (100.4 cm).

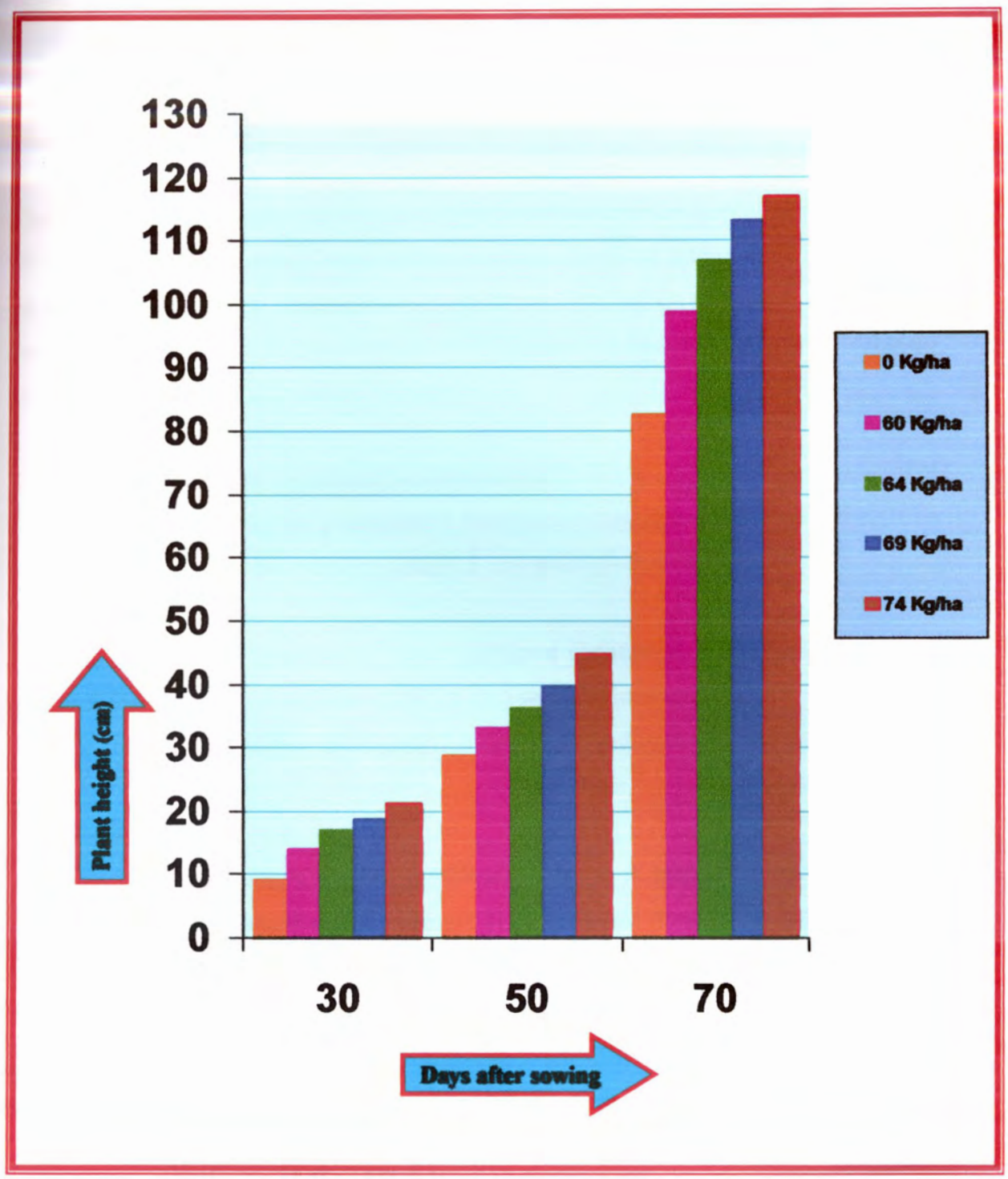

Figure 2. Effect of different levels of N on plant height at different days after sowing (DAS)

The present findings a little bit higher (116.8 cm) than the reported yield. This may be due to increasing N levels, differences in the genetic make up of the cultivar or ecological variation or all.

4.1.2 Plant girth

The five levels of nitrogen did not show significant variation in respect of plant girth at 30 DAS (Table 3). However, some differences were observed among the different levels of nitrogen in plant girth ranging from 0.5 to 0.8 cm. The highest plant girth (0.8 cm) was recorded in plots where highest level of N (74 kg/ha) was applied while the lowest plant girth (0.5 cm) was found in control treatment

Plant girth did not show significant variation at 50 DAS due to increasing the rates of N to the soil (Table 3). Highest plant girth (1.8 cm) was obtained in plots where 74 kg N/ha were applied while the lowest plant girth (1.5 cm) was found in control treatment

The five levels of nitrogen did not show significant variation in respect of plant girth at 70 DAS (Table 3). Highest Plant girth(3.6 cm) was obtained in plots where 74 kg N/ha was applied while the lowest plant girth (2.8 cm) was found in control treatment

4.1.3 Leaf length

The five levels of nitrogen showed significant variation in respect of leaf length at 30 DAS (Table 3). The maximum leaf length (10.8 cm) was obtained in plots where the highest level of N (74 kg/ha) was applied while the minimum leaf length (7.8 cm) was found in control treatment.

The five levels of nitrogen showed significant variation in respect of leaf length at 50 DAS (Table 3). The maximum leaf length (18.0 cm) was recorded in plots where the highest level of N (74 kg/ha) was applied while the minimum leaf length (13.2 cm) was found in control treatment.

Significant variation in leaf length was observed at 70 DAS due to application of different levels of N to the soil (Table 3). The maximum leaf length (18.2 cm) was obtained from the highest level of N (74 kg/ha), while the minimum leaf length (13.4 cm) was found in control treatment.

4.1.4 Leaf breadth

The five levels of nitrogen showed significant variation in respect of leaf breadth at 30 DAS (Table 3). The maximum leaf breadth (13.3 cm) was obtained in plots where the highest level of N (74 kg/ha) was applied while the minimum leaf breadth (9.3 cm) was found in control treatment.

The five levels of nitrogen showed significant variation in respect of leaf breadth at 50 DAS (Table 3). The maximum leaf breadth (25.4 cm) was recorded in plots where the highest level of N (74 kg/ha) was applied while the minimum leaf breadth (21.6 cm) was found in control treatment.

Significant variation in leaf breadth was observed at 70 DAS due to application of different levels of N to the soil (Table 3). The maximum leaf breadth (25.5 cm) was obtained from the highest level of N (74 kg/ha), while the minimum leaf breadth (21.6 cm) was found in control treatment.

4.1.5 Number of leaves per plant

The five levels of nitrogen showed significant variation in respect of number of leaves per plant at 30 DAS (Table 3). The maximum number of leaves per plant (14.5) were obtained in plots where the highest level of N (74 kg/ha) was applied while the minimum number of leaves per plant (7.2) were found in control treatment.

The five levels of nitrogen showed significant variation in respect of number of leaves per plant at 50 DAS (Table 3). The maximum number of leaves per plant (24.8) were recorded in plots where the highest level of N (74 kg/ha) was applied while the minimum number of leaves per plant (17.2) were found in control treatment.

Significant variation in number of leaves per plant were observed at 70 DAS due to application of different levels of N to the soil (Table 3). The maximum number of leaves per plant (50.3) were obtained from the highest level of N (74 kg/ha), while the minimum number of leaves per plant (35.5) were found in control treatment.

4.1.6 Number of branches per plant

The five levels of nitrogen showed significant variation in respect of number of branches per plant at 30 DAS (Table 3). The maximum number of branches per plant (1.1) were obtained in plots where the highest level of N (74 kg/ha) was applied while the minimum number of branches per plant (0.1) were found in control treatment.

The five levels of nitrogen showed significant variation in respect of number of branches per plant at 50 DAS (Table 3). The maximum number of branches per plant (4.2) were recorded in plots where the highest level of N (74 kg/ha) was applied while the minimum number of branches per plant (2.4) were found in control treatment.

Significant variation in number of branches per plant was observed at 70 DAS due to application of different levels of N to the soil (Table 3). The maximum number of branches per plant (4.3) were obtained from the highest level of N (74 kg/ha), while the minimum number of branches per plant (2.5) were found in control treatment.

The result indicated that the number of branches per plant increased has a positive relation with the nitrogen levels and ultimately increased the total yield. It may be mentioned that lateral branches give some pods which influenced per plant yield.

Chauhan and Gupta (1973) reported that no significant effect on number of branches per plant due to nitrogen application (22.5 kg and 45.0 kg N/ha). In the present study significant effect was observed due to nitrogen application (0, 60, 64, 69 and 74 kg N/ha). The present findings is different then the reported results. This might be due to the lower level of nitrogen application than the present study.

Table 3. Effect of nitrogen on yield contributing characters of Okra

DAS	Nitrogen levels	Characters				
		Plant girth (cm)	Leaf length (cm)	Leaf breadth (cm)	Number of leaves per plant	Number of branches per plant
30	N_0	0.5	7.8	9.3	7.2	0.1
	N_1	0.6	9.5	11.4	10.3	0.3
	N_2	0.7	9.8	12.1	12.1	0.6
	N_3	0.7	10.2	12.7	13.2	0.7
	N_4	0.8	10.8	13.3	14.5	1.1
50	N_0	1.5	13.2	21.6	17.2	2.4
	N_1	1.6	14.8	23.1	20.2	2.7
	N_2	1.6	16.3	24.1	22.1	3.1
	N_3	1.7	17.0	25.0	23.3	3.7
	N_4	1.8	18.0	25.4	24.8	4.2
70	N_0	2.8	13.4	21.6	35.5	2.5
	N_1	3.1	15.0	23.4	39.0	3.1
	N_2	3.1	16.5	24.2	40.6	3.3
	N_3	3.3	17.2	25.1	44.5	3.8
	N_4	3.6	18.2	25.5	50.3	4.3
Level of significance		NS	**	*	**	**
F Value		0.98	2.77	1.39	8.80	1.94

** Significant at 1% level, * Significant at 5% level, NS– Non Significant

N_0= Control, N_1= 60 kg/ha, N_2= 64 kg/ha, N_3= 69 kg/ha and N_4= 74 kg/ha

DAS - Days after sowing

4.2 EFFECT OF CULTIVAR ON YIELD CONTRIBUTING CHARACTERS OF OKRA

4.2.1 Plant height

Significant variation was observed among the cultivars in respect of plant height at 30 DAS (Table 4). The maximum plant height was recorded from Arka Anamica (17.3 cm). The minimum plant height was recorded from Shatdari (13.4 cm).

Significant variation was observed among the cultivars in respect of plant height at 50 DAS (Table 4). The maximum plant height was recorded from Arka Anamica (37.0 cm). The minimum plant height was recorded from Shatdari (35.9 cm).

Among the three cultivars significant variation was observed in plant height at 70 DAS (Table 4). The maximum plant height was recorded from BARI Dherosh 1 (113.8 cm) which was significantly superior than the others. The plants of Arka Anamica showed the minimum (96.7 cm) plant height.

4.2.2 Plant girth

Non significant variation was observed among the cultivars in respect of plant girth at 30, 50 and 70 DAS (Table 4) which ranging from 0.6 - 3.3 cm

4.2.3 Leaf length

Significant variation was observed among the cultivars in respect of leaf length at 30 DAS (Table 4). The maximum leaf length was recorded from Arka Anamica (9.9 cm). The minimum leaf length was recorded from Shatdari (9.4 cm).

Significant variation was observed among the cultivars in respect of leaf length at 50 DAS (Table 4). The maximum leaf length was recorded from Shatdari (16.9 cm). The minimum leaf length was recorded from Arka Anamica (13.7 cm).

Among the three cultivars significant variation was observed in leaf length at 70 DAS (Table 4). The maximum leaf length was recorded from Shatdari (17.1 cm) which was significantly superior than the others. The plants of Arka Anamica showed the minimum (13.9 cm) leaf length.

4.2.4 Leaf breadth

Significant variation was observed among the cultivars in respect of leaf breadth at 30 DAS (Table 4). The maximum leaf breadth was recorded from BARI Dherosh 1 Arka (12.2 cm). The minimum leaf breadth was recorded from Shatdari (11.0 cm).

Significant variation was observed among the cultivars in respect of leaf breadth at 50 DAS (Table 4). The maximum leaf breadth was recorded from Arka Anamica (24.9 cm). The minimum leaf breadth was recorded from BARI Dherosh 1 (22.6 cm).

Among the three cultivars, significant variation was observed in leaf breadth at 70 DAS (Table 4). The maximum leaf breadth was recorded from Arka Anamica (25.1 cm) which was significantly superior than the others. The plants of BARI Dherosh 1 showed the minimum (22.7 cm) leaf breadth.

4.2.5 Number of leaves per plant

Significant variation was observed among the cultivars in respect of number of leaves per plant at 30 DAS (Figure 3). The maximum number of leaves per plant were recorded from Shatdari (12.3). The minimum number of leaves per plant were recorded from BARI Dherosh 1 (10.4).

Significant variation was observed among the cultivars in respect of number of leaves per plant at 50 DAS (Figure 3). The maximum number of leaves per plant were recorded from Shatdari (22.3). The minimum number of leaves per plant were recorded from BARI Dherosh 1 (20.2).

Among the three cultivars significant variation was observed in number of leaves per plant at 70 DAS (Figure 3). The maximum number of leaves per plant were recorded from Shatdari (45.3) which was significantly superior than the others. The plants of Arka Anamica showed the minimum (39.9) number of leaves per plant.

4.2.6 Number of branches per plant

Significant variation was observed among the cultivars in respect of number of branches per plant at 30 DAS (Table 4). The maximum number of branches per plant were recorded from Arka Anamica (0.9). The minimum number of branches per plant was recorded from BARI Dherosh 1 (0.3).

Significant variation was observed among the cultivars in respect of number of branches per plant at 50 DAS (Table 4). The maximum number of branches per plant were recorded from Shatdari (3.6). The minimum leaf breadth was recorded from BARI Dherosh 1 (3.0).

Among the three cultivars significant variation was observed in number of branches per plant at 70 DAS (Table 4). The maximum number of branches per plant were recorded from Shatdari (3.8) which was significantly superior than the others. The plants of Arka Anamica showed the minimum (3.1) number of branches per plant.

The result indicated that more lateral branches produced more fruits which ultimately influenced fruit yield per plant.

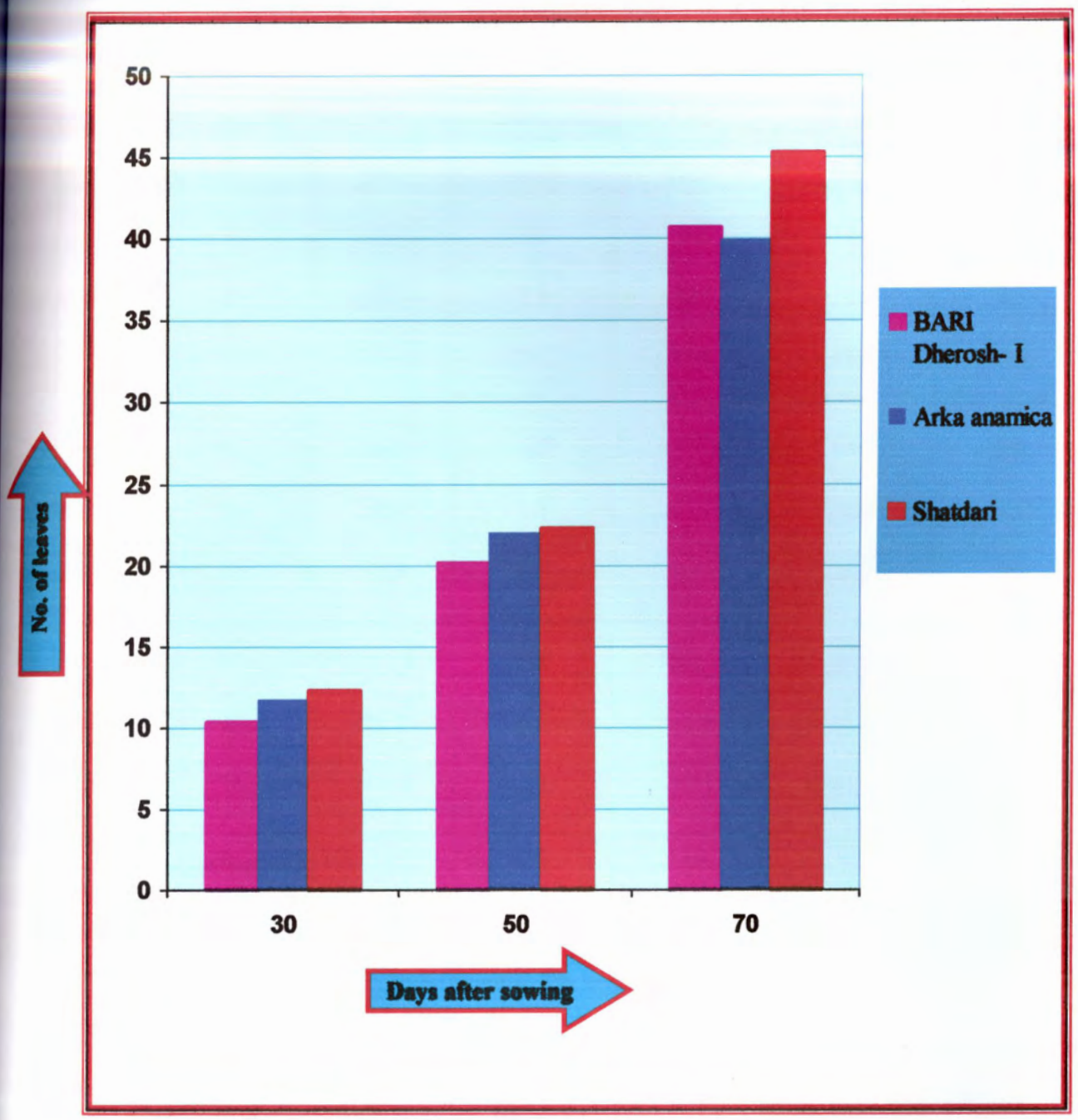

Figure 3. Effect of cultivars on number of leaves at different days after sowing (DAS)

Table 4. Effect of cultivars on yield contributing characters of okra

DAS	Cultivers	Characters				
		Plant height (cm)	Plant girth (cm)	Leaf length (cm)	Leaf breadth (cm)	Number of branches per plant
30	V_1	17.1	0.6	9.5	12.2	0.3
	V_2	17.3	0.6	9.9	12.1	0.9
	V_3	13.4	0.7	9.4	11.0	0.5
50	V_1	36.5	1.7	15.0	22.6	3.0
	V_2	37.0	1.7	13.7	24.9	3.1
	V_3	35.9	1.7	16.9	24.1	3.6
70	V_1	113.8	3.1	15.2	22.7	3.2
	V_2	96.7	3.3	13.9	25.1	3.1
	V_3	100.9	3.1	17.1	24.2	3.8
Level of significance		**	NS	**	**	*
F Value		11.33	0.50	4.35	6.18	2.79

** Significant at 1% level, * Significant at 5% level, NS– Non Significant

V_1 = BARI Dherosh- I

V_2 = Arka Anamica

V_3 = Shatdari

DAS - Days after sowing.

4.3 COMBINED EFFECT OF CULTIVAR AND NITROGEN ON THE YIELD AND YIELD CONTRIBUTING CHARACTERS

The combined effect of cultivars and nitrogen on the yield and yield components of okra is presented in Table 5, 6 and plate 1, 2, and 3.

4.3.1 Plant height

Plant height was significantly increased with increasing the nitrogen level at 30 DAS (Table 5). The maximum plant height (23.8 cm) was recorded from Arka Anamica at the highest level of N (74 kg/ha) while the minimum plant height (9.3 cm) was recorded from Arka Anamica at control treatment.

Significant variation was observed in plant height at 50 DAS (Table 5). The maximum plant height (45.2 cm) was recorded from BARI Dherosh 1 at the highest level of N (74 kg/ha) while the minimum plant height (27.1 cm) was recorded from Shatdari at control treatment.

Significant variation was observed in plant height at 70 DAS (Table 5). The maximum plant height (127.0 cm) was recorded from BARI Dherosh 1 at the highest level of N (74 kg/ha) while the minimum plant height (77.9 cm) was recorded from Arka Anamica at control treatment.

4.3.2 Plant girth

Plant girth was non significantly increased with increasing the nitrogen level at 30 DAS (Table 5). The maximum plant girth (0.80 cm) was recorded from BARI Dherosh 1 at the highest level of N (74 kg/ha) while the minimum plant girth (0.53 cm) was recorded from Shatdari at control treatment.

Non significant variation was observed in plant girth at 50 DAS (Table 5). BARI Dherosh 1 and Arka Anamica showed the maximum plant girth (1.83 cm) at the highest level of N (74 kg/ha) while the minimum plant girth (1.43 cm) was recorded from BARI Dherosh 1 at control treatment.

At 70 DAS (Table 5) the maximum plant girth (3.67 cm) was recorded from Shatdari at 74 kg N/ha and the minimum plant girth (2.63 cm) was recorded from Shatdari at control treatment.

Chauhan and Gupta (1973) stated that plant height and girth, number of leaves and yield of green pod were increased by increasing applictfion of N (22.5,45.0 or 67.5 kg/ ha). P at 22.5 or 45.0 kg/ ha and K at 22.5 Kg / ha had no effect on growth and yield. NPK applications, however, generally increased yields.

4.3.3 Leaf length

Leaf length was significantly increased with increasing the nitrogen level at 30 DAS (Table 5). The maximum leaf length (11.3 cm) was recorded from Arka Anamica at the highest level of N (74 kg/ha) while the minimum leaf length (7.6 cm) was recorded from Shatdari at control treatment.

Significant variation was observed in leaf length at 50 DAS (Table 5). The maximum leaf length (19.1 cm) was recorded from Shatdari at the highest level of N (74 kg/ha) while the minimum leaf length (12.2 cm) was recorded from BARI Dherosh 1 at control treatment.

Significant variation was observed in leaf length at 70 DAS (Table 5). The maximum leaf length (19.1 cm) was recorded from Shatdari at the highest level of N (74 kg/ha) while the minimum leaf length (12.4 cm) was recorded from BARI Dherosh 1 at control treatment.

4.3.4 Leaf breadth

Leaf breadth was significantly increased with increasing the nitrogen level at 30 DAS (Table 6). The maximum leaf breadth (14.1 cm) was recorded from Arka Anamica at the highest level of N (74 kg/ha) while the minimum leaf breadth (8.1 cm) was recorded from Shatdari at control treatment.

Significant variation was observed in leaf breadth at 50 DAS (Table 6). The maximum leaf breadth (26.1 cm) was recorded from Arka Anamica at the highest level of N (74 kg/ha) while the minimum leaf breadth (20.5 cm) was recorded from BARI Dherosh 1 at control treatment.

Significant variation was observed in leaf breadth at 70 DAS (Table 6). The maximum leaf breadth (26.3 cm) was recorded from Arka Anamica at the highest level of N (74 kg/ha) while the minimum leaf breadth (20.5 cm) was recorded from BARI Dherosh 1 at control treatment.

4.3.5 Number of branches per plant

Number of branches per plant were significantly increased with increasing the nitrogen level at 30 DAS (Table 6). The maximum number of branches per plant (1.8) were recorded from Arka Anamica at the highest level of N (74 kg/ha) while the minimum number of branches per plant (0.1) were recorded from BARI Dherosh 1 at control treatment.

Significant variation was observed in number of branches per plant at 50 DAS (Table 6). The maximum number of branches per plant (4.6) were recorded from Shatdari at the highest level of N (74 kg/ha) while the minimum number of branches per plant (2.2) were recorded from Arka Anamica at control treatment.

Significant variation was observed in number of branches per plant at 70 DAS (Table 6). The maximum number of branches per plant (4.7) were recorded from Shatdari at the highest level of N (74 kg/ha) while the minimum number of branches per plant (2.3) were recorded from BARI Dherosh 1 at control treatment.

4.3.6 Number of leaves per plant

Number of leaves per plant were significantly increased with increasing the nitrogen level at 30 DAS (Table 6). The maximum number of leaves per plant (15.4) were recorded

from Arka Anamica at the highest level of N (74 kg/ha) while the minimum number of leaves per plant (6.2) were recorded from Arka Anamica at control treatment.

Significant variation was observed in number of leaves per plant at 50 DAS (Table 6). The maximum number of leaves per plant (25.1) were recorded from Arka Anamica at the highest level of N (74 kg/ha) while the minimum number of leaves per plant (14.9) were recorded from BARI Dherosh 1 at control treatment.

Significant variation was observed in number of leaves per plant at 70 DAS (Table 6). The maximum number of leaves per plant (61.1) were recorded from Shatdari at the highest level of N (74 kg/ha) while the minimum number of leaves per plant (32.7) were recorded from Arka Anamica at control treatment.

Lenka *et al.* (1989) investigated a field trial with three replicates with N (as urea) applied at 4 levels (0, 50, 75 and 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.

4.3.7 Days to first anthesis

The five levels of nitrogen did not show any significant variation in respect of days to anthesis (Table 7). They required around 41 days to anthesis. Singh *et al.* (1998) reported that the application of 90 kg N/ha produced advanced flowering by 4.08 days compared with the control. The present findings is different then the reported results.

4.3.8 Time to harvest

Significant variation was observed for anthesis to edible maturity (Table 7). The variation among the combinations were 5.97 to 7.00 days.

4.3.9 Duration of picking

Significant variation was observed in respect of picking duration (Table 7). They required around 45 days to harvesting periods. Arka Anamica was harvested significantly at longer period (45.6 days) followed by BARI Dherosh 1 (34.3 days) while the lowest (35.00 days) in Shatdari.

4.3.10 Pod length

The pod length was significantly differed among the combinations (Table 7, plate 1, 2 and 3). The maximum pod length was recorded at the highest N level (74 kg/ha) in the selected cultivers. Arka Anamica (13.86 cm), BARI Dherosh 1 (13.22 cm) and Shatdari (12.90 cm) pod length were obtained. The minimum pod length (11.0 cm) was recorded from Shatdari at control treatment .

4.3.11 Pod diameter

Significant variation was observed in respect of pod diameter (Table 7, plate 1, 2 and 3). The maximurn pod diameter was obtained from the highest N level (74 kg/ha), BARI Dherosh 1 (1.85 cm), Shatdari (1.81 cm) and Arka Anamica (1.78 cm). But the minimum pod diameter was (1.46 cm) from Arka Anamica compared to those of other two cultivars.

4.3.12 Number of pods per plant

Number of pods per plant differed significantly among the tested cultivers and different N levels (Table 7). The maximurn pods were obtained from the highest N level (74 kg/ha). Arka Anamica (56), BARI Dherosh 1 (48) and Shatdari (34). The minimum pods (15) from Shatdari at control treatment compared to those of other two cultivars.

Kurup *et al.* (1997) reported that N rate upto 100 kg could increase the setting. percentage, length and diameter of fruits, fruit number and weight per plant and the total pod yield of okra.

4.3.13 Individual pod weight

Significant variation was observed in respect of individual pod weight (Table 7). The maximum individual pod weight was observed in BARI Dherosh 1 (15.28 g), Arka Anamica (14.98 g) and Shatdari (13.32 g) at the highest N level (74 kg/ha).

Majanbu *et al.* (1985) stated that nitrogen application significantly increased green pod yield, pod diameter, number of fruits/plant, number of seed/pod and pod weight.

4.3.14 Edible pod yield

The combined effect of cultivar and nitrogen on pod of okra was significant (Table 7). The maximum yield per plant (831.6 g) was recorded from Arka Anamica with application of the highest N level (74 kg/ha), thus giving the maximum yield of 17.3 t/ha. The second highest yield (734.02 g/plant or 15.3 t/ha) was produced by Arka Anamica by using 69.0 kg N/ha which was followed by the treatment combination of BARI Dherosh 1 and 74 kg N/ha (733.44 g or 15.2 t/ha). Shatdari was produced the minimum yield compared to those of other two cultivers which varies from 165.6 to 452.88 g/plant (3.5 to 9.4 t/ha). Shatdari was produced its highest yield 452.88 g/plant or 9.4 t/ha at the highest level of N (74 kg /ha).

Shama and Shukla (1973) stated that the highest yields were obtained with N at 120 at 34.88 and K at 49.8 kg/ ha.

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, 203, 140, 60 and 80 kg/ha) and 5 levels of K_20 (0, 15, 30, 45 and 60 kg/ha). Nitrogen fertilization significantly increased yield. The highest N level (80 kg/ha) increased yield by 149.2 % over the control. Combined application of 80 kg N/ha with either 30 kg or 60 kg K_20/ha produced maximum yields (17.2 t/ha and 17.5 t/ha respectively). Different K levels had no significant effect on yield in the absence of N.

Reddy *et al.* 1984 reported that nitrogen alone increased the yields frorn 58.9 q/ha in the control to 97.5 q/ha at 120 kg N/ha, however, the highest yield (101.46 q/ha) was obtained with N+P at highest rates.

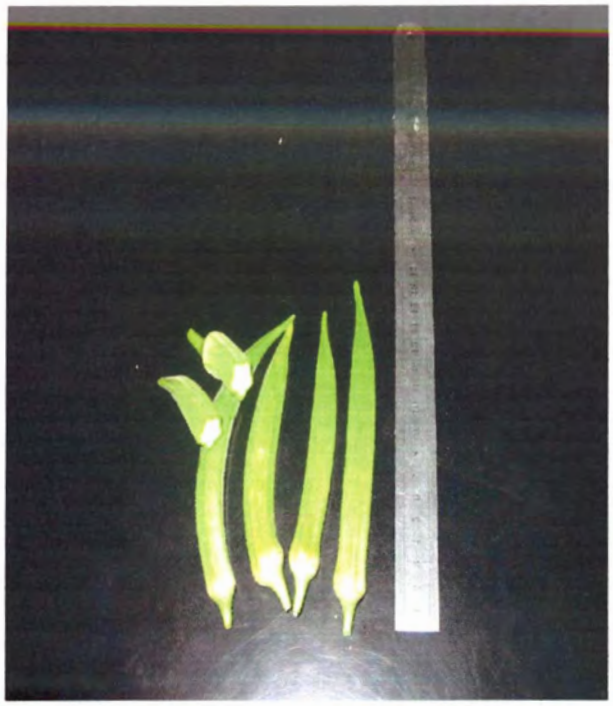

Plate 1. Fruits of BARI dherosh 1

Plate 2. Fruits of Shatdari

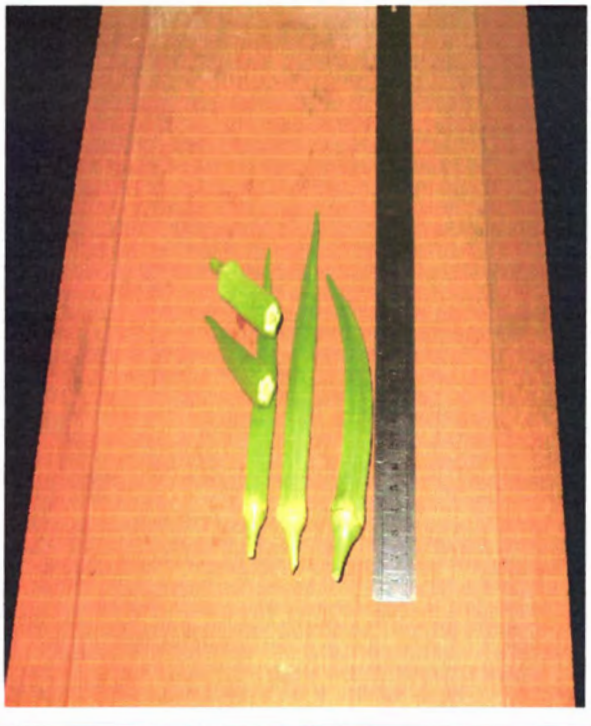

Plate 3. Fruits of Arka Anamica

Plate 4. Experimental field

Table 5. Combined effect of cultivar and nitrogen on plant height, plant girth and leaf length of Okra

Treatment combination	Plant height (cm)			Plant girth (cm)			Leaf length (cm)		
	30 DAS	50 DAS	70 DAS	30 DAS	50 DAS	70 DAS	30 DAS	50 DAS	70 DAS
$V_1 N_0$	9.3	30.1	89.7	0.57	1.43	2.67	7.7	12.2	12.4
$V_1 N_1$	14.5	33.4	110.3	0.60	1.65	2.97	9.7	14.5	14.7
$V_1 N_2$	18.2	36.1	117.7	0.63	1.63	3.02	9.9	15.6	15.9
$V_1 N_3$	20.1	37.9	124.3	0.63	1.77	3.47	10.0	16.1	16.4
$V_1 N_4$	23.4	45.2	127.0	0.80	1.83	3.62	10.2	16.6	16.9
$V_2 N_0$	8.3	29.2	77.9	0.57	1.50	3.13	8.2	13.4	13.5
$V_2 N_1$	14.6	33.7	92.7	0.58	1.58	3.20	9.7	14.1	14.6
$V_2 N_2$	19.2	35.9	98.1	0.62	1.62	3.23	9.9	15.9	15.9
$V_2 N_3$	20.9	41.3	104.6	0.74	1.77	3.30	10.8	16.8	16.9
$V_2 N_4$	23.8	45.1	110.4	0.76	1.83	3.43	11.3	18.5	18.8
$V_3 N_0$	9.9	27.1	80.1	0.53	1.60	2.63	7.6	14.2	14.4
$V_3 N_1$	12.4	32.3	92.8	0.60	1.61	2.97	9.2	15.8	15.9
$V_3 N_2$	13.7	36.1	105.0	0.68	1.67	2.97	9.6	17.4	17.8
$V_3 N_3$	14.9	39.9	110.6	0.73	1.72	3.17	9.9	18.3	18.5
$V_3 N_4$	16.4	44.3	113.2	0.79	1.80	3.67	11.1	19.1	19.1
Level of significance	**	**	**	NS	NS	NS	**	**	**
F Value	8.92	11.32	3.37	0.50	0.53	0.98	4.34	2.76	5.51

** Significant at 1% level, * Significant at 5% level, NS– Non Significant and DAS – Days after sowing.
V_1 = BARI Dherosh- I, V_2 = Arka Anamica, V_3 = Shatdari
N_0= Control , N_1= 60 kg/ha, N_2= 64 kg/ha, N_3= 69 kg/ha, N_4= 74 kg/ha

Table 6. Combined effect of cultivar and nitrogen on Leaf breadth, number of leaves per plant and number of branches per plant of Okra

Treatment combination	Leaf breadth (cm)			Number of leaves per plant			Number of branches per plant		
	30 DAS	50 DAS	70 DAS	30 DAS	50 DAS	70 DAS	30 DAS	50 DAS	70 DAS
$V_1 N_0$	10.9	20.5	20.5	7.4	14.9	37.3	0.1	2.3	2.3
$V_1 N_1$	12.0	21.6	21.9	9.9	18.9	39.6	0.2	2.4	3.0
$V_1 N_2$	12.4	22.7	22.8	10.5	20.1	40.0	0.3	2.9	3.1
$V_1 N_3$	12.9	23.9	23.9	11.2	22.8	43.3	0.3	3.4	3.4
$V_1 N_4$	13.2	24.3	24.4	13.1	24.6	43.7	0.5	4.1	4.2
$V_2 N_0$	9.0	23.6	23.7	6.2	18.2	32.7	0.1	2.2	2.4
$V_2 N_1$	11.6	24.3	24.6	10.8	20.6	38.2	0.4	2.6	2.7
$V_2 N_2$	12.5	24.9	25.0	12.6	22.8	39.2	0.9	2.9	3.0
$V_2 N_3$	13.2	25.8	25.8	13.8	23.3	43.6	1.4	3.5	3.7
$V_2 N_4$	14.1	26.1	26.3	15.4	25.1	46.1	1.8	3.9	4.1
$V_3 N_0$	8.1	20.8	20.8	8.1	18.6	36.7	0.2	2.8	2.9
$V_3 N_1$	10.7	23.6	23.7	10.2	21.2	39.3	0.4	3.3	3.6
$V_3 N_2$	11.4	24.8	24.9	13.4	23.5	42.7	0.6	3.5	3.9
$V_3 N_3$	12.1	25.3	25.6	14.6	23.9	46.7	0.6	4.2	4.3
$V_3 N_4$	12.8	25.9	25.9	15.2	24.7	61.1	1.1	4.6	4.7
Level of significance	**	**	**	**	**	**	*	*	**
F Value	2.64	2.59	6.18	2.79	1.02	1.94	3.36	2.20	2.21

** Significant at 1% level, * Significant at 5% level, NS– Non Significant and DAS - Days after sowing

V_1 = BARI Dherosh- I, V_2 = Arka Anamica, V_3 = Shatdari

N_0= Control, N_1= 60 kg/ha, N_2= 64 kg/ha, N_3= 69 kg/ha, N_4= 74 kg/ha

Table 7. Combined effect of cultivars and nitrogen on yield contributing characters of okra

Treatment combination	Characters								
	Days to first anthesis	Days to edible maturity	Duration of picking	Pod length (cm)	Pod diameter (cm)	Number of pods per plant	Individual pod weight (g)	Edible pod yield (g/plant)	Edible pod Yield (t/ha)
$V_1 N_0$	41	6.30	43.35	11.50	1.71	17	12.20	207.4	4.3
$V_1 N_1$	41	6.37	43.33	11.95	1.78	26	12.80	332.8	6.9
$V_1 N_2$	40	6.10	43.34	12.74	1.80	34	13.50	459.0	9.6
$V_1 N_3$	41	6.00	43.30	13.02	1.81	39	14.84	578.8	12.1
$V_1 N_4$	40	5.97	43.32	13.22	1.85	48	15.28	733.4	15.3
$V_2 N_0$	42	6.56	45.67	12.10	1.46	30	12.20	366.0	7.6
$V_2 N_1$	40	6.45	45.64	12.70	1.65	37	13.90	514.3	10.7
$V_2 N_2$	41	6.57	46.67	13.20	1.70	42	14.20	596.4	12.4
$V_2 N_3$	41	6.33	45.63	13.80	1.73	49	14.85	733.1	15.2
$V_2 N_4$	41	6.31	45.69	13.86	1.78	56	14.98	831.6	17.3
$V_3 N_0$	40	7.00	34.90	11.00	1.70	15	11.04	165.6	3.5
$V_3 N_1$	42	6.75	35.00	11.40	1.76	22	11.86	260.9	5.4
$V_3 N_2$	41	6.71	35.10	11.86	1.78	26	12.62	328.1	6.8
$V_3 N_3$	41	6.63	35.20	12.60	1.79	29	13.20	382.8	7.9
$V_3 N_4$	41	6.42	34.80	12.90	1.81	34	13.32	452.9	9.4
Level of significance	NS	*	**	**	**	**	**	**	**
F Value	2.34	4.90	2.99	3.78	3.49	43.30	5.66	62.89	2.90

** Significant at 1% level, * Significant at 5% level, NS– Non Significant and DAS - Days after sowing. V_1 = BARI Dherosh- I , V_2 = Arka Anamica, V_3 = Shatdari . N_0= Control, N_1= 60 kg/ha, N_2= 64 kg/ha, N_3= 69 kg/ha, N_4= 74 kg/h


CHAPTER 5

SUMMARY

A study was conducted to evaluate the performance of three caltivars of okra in respect of yield and yield contributing characters at the Horticultural Farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka–1207, during the period from March to June, 2005.

Yield and yield contributing characters like plant height, plant girth, leaf length, leaf breadth, number of leaves per plant, number of branches per plant were studied at 30 DAS, 50 DAS and 70 DAS. Days to anthesis, time to harvest, duration of picking period, pod length, pod breadth, individual pod weight, number of pods per plant, pod yield per plant and pod yield per ha were studied by applying 0, 60, 64, 69.0 and 74 kg N/ha to evaluate the best combination of cultivars and N level.

The maximum plant height (127.0 cm), pod diameter (1.85 cm), individual pod weight (15.28 g) was observed in BARI Dherosh 1 at the highest level of N (74 kg /ha). Among the three cultivars, the maximum plant girth (3.67 cm), leaf length (19.1 cm), number of branches per plant (4.7), number of leaves per plant (61.1) was recorded from Shatdari at the highest level of N (74 kg/ha). Arka Anamica performed the best in leaf breadth (26.3 cm), pod length (13.86 cm), number of pods per plant (56), yield per plant (831.6 g) and yield (17.3 t/ha) at the highest level of N (74 kg/ha).

The three cultivars required around 41 days to anthesis and time to harvest varying among the combinations were 5.97 to 7.00 days, in respect of picking duration they required around 45 days to harvest. Arka Anamica was harvested significantly at longer period (45.6 days) followed by BARI Dherosh 1 (44.3 days) while the lowest (35.00 days) in Shatdari.

CONCLUSION AND RECOMMENDATION

The results of present study generated some information, which may help on effective vegetable production. These as follows:

The three cultivars BARI Dherosh 1, Arka Anamica and Shatdari showed best performance at highest N level 74 kg N/ha in presence of recommended doses of P_2O_5 48 kg, K_2O 90 kg /ha and cow dung 10 t/ha.

Though the cultivar BARI Dherosh 1 produced the maximum individual pod weight (15.28 g) but the maximum pods per plant were obtained from Arka Anamica (56) at the highest N level 74 kg N/ha. For that reason, the maximum production (17.3 t/ha) was recorded from Arka Anamica followed by BARI Dherosh 1 (15.3 t/ha) and Shatdari (9.4 t/ha).

The results of present study indicated that the number of branches increased has a positive relation with the nitrogen levels and ultimately increased the total yield. It may be mentioned that lateral branches give some pods which influenced per plant yield.

As such, long term research program should be initiated to generate useful detail information about optimum level of fertilizers application and superior selection of okra cultivars. However, further investigation is suggested to confirm the result of this study since the cultivers were grown in one year only and incorporating desirable traits to improve.

Okra yield and yield contributing characters like green pod yield per plant and per hectare, pod length and diameter, number of pods per plant and individual pod weight significantly increased with increasing rate of nitrogen application. Therefore further investigation is suggested by applying more N/ha.

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APPENDIX

Appendix I. Characters of Horticultural farm soil as analyzed by Soil Resources Development Institute (SRDI), Khamar Bari, Farmgate, Dhaka.

Morphological characters of the experimental field

Morphological features	Characters
Location	Horticulture Garden,SAU, Dhaka
AEZ	Madhupur Tract (28)
General Soil Type	Shallow red brown terrace soils
Land type	High land
Soil series	Tejgaon
Topography	Fairly leveled
Flood level	Above flood level
Drainage	Well drained
Cropping pattern	Lettuce - Okra

Appendix II. Monthly records of temperature, relative humidity, rainfall, soil temperature, sunshine of the experimental site during the period from February to July, 2005

Year	Month	Air temperature (^{0}C)			Relative Humidity (%)	Rainfall (mm)	Soil temperature (^{0}C)			Sunshine (hrs)
		Max	Min	Av			5 cm depth	10 cm depth	20 cm depth	
2005	February	28.88	17.98	23.43	61.04	03	12.9	12.9	13.8	221.5
	March	32.22	21.78	27.00	66.69	155	16.2	16.2	17.2	210.2
	April	30.01	21.79	25.10	82.00	245.5	28.0	28.4	28.0	177.0
	May	33.01	25.39	29.20	81.58	146.0	30.8	31.2	30.6	222.9
	June	31.18	25.51	28.34	88.23	332.7	30.5	30.8	30.4	101.0
	July	30.74	25.88	28.31	87.00	787.2	30.4	30.6	30.3	119.9