EFFECT OF DIFERENT LEVELS OF NITROGEN AND POTASSIUM ON THE GROWTH AND YIELD OF OKRA

(*Abelmoschus esculentus*)

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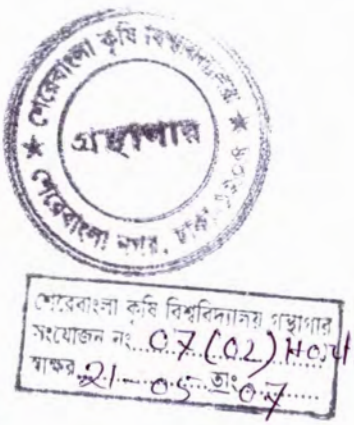

DEPARTMENT OF HORTICULTURE AND POSTHARVEST TECHNOLOGY

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BY

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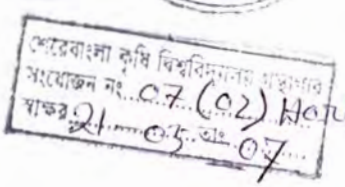

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DECLARATION

This is to certify that the thesis entitled, "Effect of different levels of nitrogen and potassium on the growth and yield 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 HORTICULTURE, embodies the result of a piece of bona fide research work carried out by Muhammad. Monoar Hossain Khan, Roll No. 25193/00320, Registration No. 25193/00320, under my supervision and my guidance. No part of the thesis has been submitted for any other degree in any institutes.

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

Dated:

Dhaka, Bangladesh

Md. Hassanuzzaman Akand

Supervisor

Dedicated to
My
Beloved Parents

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ABSTRACT

An experiment was conducted at the central farm of Sher-e-Bangla Agricultural University Dhaka during the period from April 2005 to July 2005 to study the effect of different levels of nitrogen and potassium on the growth and yield of okra. There were four nitrogen levels (N_0=0, N_1= 70, N_2=110 and N_3=160 kg N/ha) with four potassium levels (K_0=0, K_1 =40, K_2=80 and K_3=120 kg K_2O/ha) in the experiment. The experiment was conducted in the Randomized Complete Block Design (RCBD) with three replications. Nitrogen and potassium levels influenced the growth and yield of okra. The results of the experiment revealed that plant height, plant diameter, petiole length, leaves, breadth, number of leaves, number of branch, green pod length, pod diameter, number of green pod per plant, green pod yield per plant and green pod yield per hectare were significantly influenced by the different levels of nitrogen and potassium except plant diameter at 40 days after sowing (DAS). The highest levels of nitrogen (160 kg/ha) produced the highest green pod yield (9.602 ton/ha) while the lowest (6.278 ton/ha) was recorded from control treatment. The highest green pod yield (8.247 ton/ha) was observed from 80 kg of K_2Oper/ha and the lowest (7.103 ton/ha) was recorded from the control treatment. The combined effect of various levels of nitrogen and potassium were also found significant except plant height, plant diameter,leaf length and leaf breadths at 20 DAS. The use of maximum nitrogen dose 160 kg N/ha and potassium 80 kg K_2O/ha produced the highest yield (9.99ton/ha) and lowest (5.94ton/ha) were recorded from the control treatments. The benefit cost ratio (BCR) was maximum 2.02 in the treatment combination of 160 kg N/ha + 80 kg K_2O/ha whereas the minimum 1.23 was recorded in the control treatment 0 kg N/ha + 0 kg K_2O/ha.

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ACRONOMY

AEZ	=	Agro- Ecological Zone
BBS	=	Bangladesh Bureau of Statistics
BARI	=	Bangladesh Agricultural Research Institute
DAS	=	Days After Sowing
DAE	=	Days After Emergence
et al.	=	And others
etc	=	Etcetera
FAO	=	Food and Agricultural Organization
LSD	=	Least significant difference
NS	=	Non significant
RCBD	=	Randomizer Complete Block design
SAU	=	Sher-e- Bangla Agricultural University
Tk.	=	Taka

CHAPTER I

INTRODUCTION

Okra (*Abelmoschus esculentus*)(L.) Moench is a member under Malvaceae family and is also known as Lady's finger. 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). Its tender green fruits are popular as vegetable among all classes of people in Bangladesh and elsewhere in the world..

Okra is a nutritious and delicious vegetable, fairly rich in vitamins and minerals. Per 100 gm of edible portion of pod has moderate levels of vitamin A (0.01 mg) and C (18 g), calcium (90 mg), phosphorus and potassium. The content of thiamine (0.07 mg), riboflavin (0.08 mg) and niacin (0.08 mg) per 100 g edible portion of pod is higher than that of many vegetables (Rashid, 1990). Tender pods have high mucilage content and are used in soups and gravies. 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.

In Bangladesh vegetable production is not uniform round the year. Vegetables are plenty in winter, but are lower in summer. The total vegetable production, around 30% is produced during kharif season (April to September). and 70% is produced in Rabi season(October to March) (Annon., 1993). Though it is popular in the country, its production is mainly concentrated during summer. So,as vegetable okra can get an importance in summer. Total production of okra is about 19210 metric tones produced from 6210.53 hectare of land in the year 2003, and the average yield is about 3.093 t/ha (BBS, 2004), which is very low, compared to that of other developed countries where the yield is as high as 7.0-12.0 t/ha (Yamaguchi, 1998).

Use of proper doses of fertilizer is one of the most important way of quality green pod yield production of okra and nitrogenous, and potassic fertilizers have a great effect in this respect. Chauhan and Gupta (1973) reported that application of nitrogen (N) and potassium (K) generally increase yield of okra. Similar results were reported by Sharma and Shukla (1973).

Nitrogen plays an important role in building up of protoplasm and protein, which induce cell division and initiate meristematic activities when applied in optimum quantity. Majanbu *et al.* (1985) reported that nitrogen application significantly increased pod weight, diameter, number of fruits/plant and number of seeds/pod in okra..

Potassium also has an important role on balancing physiological activities. Different levels of potassium influence on the growth and yield of okra. Different K levels have no significant effect on yield in the absence of N (Mani and Ramanathan, 1990).

Growth, and yield performance and seed production capability of okra at different fertilizer doses have been studied considerably in various parts of the world. Under the above circumstances, the present research was undertaken to study the effect of nitrogen, and potassium on the growth and yield of okra.

Considering the above facts, the present research was under taken with the following objectives:

- To study the effect of combined and individual effect of nitrogen and potassium on growth of okra.
- To determine the optimum levels of nitrogen and potassium individual or in combination, which would be best for the yield of okra?

CHAPTER - II

REVIEW OF LITERATURE

Okra is an important vegetable crop in Bangladesh. Different levels of nitrogen and potassium application influence the growth and yield of okra. Optimum doses of nitrogen and potassium application are related to best growth, yield of okra. It is important to assess the optimum doses of nitrogen and potassium for the best growth, green pod and yield of okra in Bangladesh. Research reports on the effect of nitrogen and potassium on growth and yield of okra under the soil and climatic condition. Research has been done in various part of the world including Bangladesh. The work so far done in Bangladesh is not adequate and conclusive. Some of the important and informative workers conducted home and abroad in this aspect. However, available this study is reviewed under the following headings:

2.1. Main Effect of Nitrogen and potassium on growth and yield of okra

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 total production (BARC, 1997). The chemical fertilizer success of the crop production system of Bangladesh Agriculture, being contributed 50% of the total production (BARC, 1997). The chemical fertilizer supplies available nutrients readily for proper growth and yield of plant. Among the macronutrients, NPK are used largely by the 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 effects of inorganic fertilizers on growth and yield of okra are reviewed here.

In an investigation at the Punjab Agricultural University, Ludhiana, Singh, and B.N. Korla..(1967) observed 113 kg N/ha to be an economic dose. It was also recommended that 62.5 kg N/ha is sufficient on soils of good fertility for both spring and rainy season crop (Anon, 1993). In Himachal Pradesh, NPK at the rate of 60,50, 30 kg per hectare, respectively, were recommended for getting the best yield (Anon, 1978).

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

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 by increasing application of N (22.5, 45.0 or 67.5kg/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_2O_5 (as superphosphate) at 17.44-52.32 kg/ha and K (as muriate) at 24.9-74.7 kg/ha (Sharma and Shukla, 1973). The highest yields were obtained with N at 120, P_2O_5 at 34.88 and K at 49.8 kg/ha.

In a trail with okra, CV. Pussa Sawani, the effects were compared applying N at 0.75 or 150 kg/ha and P_2O_5 and K_2O, 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 $N_{75}P_{60}K$.

Kuruf *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. Kiron.

In 2-year trails with the okra cv. Pusa Sawani in India Pandey and Singh (1989) found that seed yield (over 11q/ha) was the highest with plants spaced at 45 × 15 cm, receiving 100 kg N/ha and irrigated at 60 mm cumulative pan evaporation (CPE).

Plants of the okra cv. Pusa Sawani, receiving N at 25, 50, 75 or 100 kg/ha were picked at in intervals of 2, 3 or 4 days. Plants receiving 75 kg N/ha gave the highest yield of 152.1 q/ha compared with 88.8 q/ha at 25 kg N/ha and 145.3 q/ha at 100 kg/ha (Tomar and Chauhan, 1982). Picking every 4 days gave higher yield than other 2 (2, 3 days) interval treatments.

In 2-year trails with the okra cv. Pusa Sawani grown for seed production, seed quality was the best in plants spaced at 45 × 30 cm on plots receiving irrigation at 60 mm CPE and N at 100 kg/ha (Pandey and Singh, 1982).

An experiment was conducted by Somkuwar *et al.* (1997) in India to determine the effect of 3 levels of nitrogen (25, 50 and 75 kg/ha) on the growth of okra varieties Punjab 7, Parbhani 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 highest fruit yield (171, 11g) per plant and yield ha^{-1} (7770 kg) at 75 kg N/ha.

A field experiment was conducted on okra cv. Pusa Sawani in India. K rate (50, 70 and 90 kg kg/ha) and GA_3 seed treatment (200 or 300 ppm for 12 h) had no significant effect on yield (Bhat and Singh, 1997).

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

2.2. Combined effect of different levels of nitrogen and potassium on the growth and yield of okra

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 100 N/ha and 30 kg P2O5 / ha gave a satisfactory seed yield (7.60 q/ha).

In trails with okra CV. Pusa Sawani, N and K_2O were each applied at 0-120 kg/ha (Misra and Pandey, 1987). N at 80 kg/ha and K at 40 kg/ha significantly increased the number of fruits/plant, 1000 seed weight and the seed yield. Application of N above 80 ka/ha and K above 40 kg/ha adversely affected seed yield. Interaction effect was significant with 80 kg N 40 kg K/ha giving the highest seed yield of 15.47 q/ha

Arora *et al.* (1991) compared growth and yield of new okra cultivar, Punjab Padmini, with that of cv. Pusa Sawani 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 an 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 (124.6q/ha) than Pussa Sawani (121.6kg/ha). A significant increase in mean marketable yield for both cultivars was 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 1992.1 q/ha.

Sing (1995)[a] studied the effect of various does of nitrogen on seed yield quality of okra in India. There were 6 levels of N (0, 30, 60, 90, 120 and 15 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 (67.2-68.0 g).

Kuruf *et al.* (1997) reported that N rate up to 100 kg could increase the setting percentage, length and diameter of fruits, fruit 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, Parbhani Kranti and sel 2-2. The results showed that fruit yield per plant and yield per ha increased with an increase in nitrogen concentration. Parbhani Kranti produced the fruit highest fruit yield (171.11 g) per plant and yield per ha (7770 kg) at 75 kg N/ha.

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

Rain *and Lal* (1999) were conducted a field experiment in Bapalta, Andhra, Pradesh, India, during 20 March-8 July 1997 studied the growth and development of 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, 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 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 result in maximum leaf area, LAI and LAD, which gradually increased up to 60 days after sowing (DAS). Dry matter increased between and was influenced significantly by cultivars, fertilizer levels and their combination. Crop growth (CGR) and relative growth rates were influenced by cultivars and fertilizers.

Pusa Sawani supplied with the 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 and interaction. Arka Anamika, with a moderate vegetative growth and high

NAR, had the highest HI values. Among the fertilizer levels, maximum HI was recorded by 100-50-50 kg NPK/ha.

Gowda *and Bharma* (2001) was conducted a field a experiment in Bangalore, Karnataka, India, during the 1999 summer season to determine the response of okra cultivars Arka Anamika, Varshal 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 (20.40 g), stems (35.17 g), fruits (31.11 g), and whole plants (104. 71 g) was recorded with 175: 125: 100 kg/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 (111.48 g/plant) was recorded in Varsha supplemented with 175:125:100 kg NPK/ha, which was at par with Akra 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 *and Aora* (2001) was conducted a field experiment in Nagina, Uttar Pradesh, India, during the kharif season of 1998 and 1999 to study the effect of N (80,100, and 120kg/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 effected by P rate. The highest number of seed per pod (57.0) and seed yield per plot (2.94 kg) was obtained with the application of 120 kg/ha and 80 kg P/ha, along with sowing on 25 June.

Gowda *and Bharme* (2002) was conducted a study in the summer season of 1999in 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 cultivars Arka Anamika, Varsha and Vishal. Dry matter accumulation and nutrient (N, P and K) accumulation increased with 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.

In trails with okra CV. Pusa Sawani, N and K_2O were each applied at 0-120 kg/ha (Misra and Pandey, 1987). N at 80 kg/ha and K at 40 kg/ha significantly increased the number of fruits/plant, 1000 seed weight and the seed yield. Application of N above 80 ka/ha and K above 40 kg/ha adversely affected seed yield. Interaction effect was significant with 80 kg N 40 kg K/ha giving the highest seed yield of 15.47 q/ha.

Aslam *and Bose* (2003) reported that excessive use of nitrogen fertilizers is a factor of nitrate accumulation in vegetable, which causes health problems to the consumers. A study was conducted to assess the effect of NPK fertilizers on NO_3 accumulation in okra *(Abelmosclus esculentus)* and carrot *(Daucus carota)* at Ayub Agricultural Research Institute, Faisalabad, Pakistan. For okra five (0, 100, 150, 175, 200 kg ha-1) and two P_2O_5 rates (0, 75 kg ha-1) were tested with 60 kg K_2O/ha as basal dose. On carrot, four N (0, 25, 50, 75 kg ha/1), three P_2O_5 (0, 50, 75 kg ha-1) and two K_2O rates (0, 25 kg ha-1) were applied. Increasing fertilizer rates increased NO_3 concentration over the control in okra and carrot. However, the application of N with P reduced NO_3 concentration in okra. Conversely, the NO_3 concentration in carrot increased significantly over the control either with N applied alone or with P. a balanced use of N and P (2:1) fertilizers reduced the NO_3 accumulation. Additionally, the doses of NPK fertilizers applied in this study did not pose health hazards to the consumers.

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

Mani and Ramanathan (1990) 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

Singh and pande (1982). The highest N levels (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_2O/ha produced maximum yields (17272 t/ha and 17526 t/ha respectively). Different K levels had no significant effect on yield in the absence of N.I

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 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 also 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.

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

Prabu *and pramanik* (2002) was conducted an experiment in Parbhani, Maharashtra, India, during the summer season of 2001 to investigate the effects of inorganic 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 (uninoculated; *Azospirillum* + phosphate sollubilizing bacteria; and *Azospirillum* + vesicular arbuscular mycorrihiza) on the performance of okra cultivar Parbhani Kranti. Result showed that the treatment 2/3 recommended NPK does + FYM + *Azospirillum* +vesicular arbuscular mycorrhiza produced in the highest yield.

Bamel *and Sing* (2003) was observed was conducted a pot experiment to study the effect of different fertilizer sources on *M. incognita* in okra under greenhouse conditions. Better plant growth and reduced nematode damage when a combination of N, P, K and Zn fertilizers was applied at recommended dose. Individually, muriate 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

CHAPTER - III

MATERIELS AND METHOD

This chapter deals with the materials and methods that were used in carrying out the experiment.

3.1 Location of the experimental plot

The experiment was conducted at the Central Farm of the Sher-e-Bangla Agricultural University, Dhaka during the period from April to July 2005. The site is 90.2^{O}N and 23.5^{0}E Latitude and at a altitude of 8.2 m from the sea level. (Anon 1990)

3.2 Characteristics of soil

The soil of the experiment was carried out in a high land belonging to the Modhapur Tract (UNDP, 1998). The soil texture was silty loam with a pH 6.7. Soil samples of the experimental plot was collected from a depth of 0 to 30 cm before conducting the experiment Soil analyzed in the Soil Resources Development Institute (SRDI) Farmgate Dhaka.have been presented in (Appendix 1). The experimental site was a medium high land. The morphological characters of soil of the experimental plots as indicated by FAO (1998) are given below-

AEZ No- 28

Soil series- Tejgaon

General soil- Non- calcareous, dark gray.

3.3 Climate

The experimental area was under the sub-tropical monsoon climate, which is characterized by heavy rainfall during Kharif season (April to September) and scanty in the Rabi season (October to March). There was no rainfall during the month of December, January and February. The average maximum temperature during the period of experiment was 31.82°C and the average minimum temperature was 28.14°C. Details of the meteorological data in respect of temperature, rainfall and relative humidity during the period of the experiment were collected from Weather Station of Agargong, Dhaka and have been presented in (Appendix 2).

3.4 Planting materials used for experiment

The okra variety used in the experiment was "BARI Dherosh 1". This is a high yielding variety and the seeds were collected from the Horticulture Research Center, Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur.

3.5 Experimental Treatment:

Experiment consisted of two factors:

Factor-A:

Four levels of nitrogen

1. N_0: 0 kg N/ha (0 kg Urea/ha)
2. N_1: 70 kg N/ha (152.17 kg Urea/ha)
3. N_2: 110 kg N/ha (239.13 kg Urea/ha)
4. N_3: 160 kg N/ha (347.68 kg Urea/ha)

Factor-B

Four levels of potassium

1. K_0: 0 kg K_2O/ha (0 kg MP/ha)
2. K_1: 40 kg K_2O/ha (66.64 kg MP/ha)
3. K_2: 80 kg K_2O/ha (133.28 kg MP/ha)
4. K_3: 120 kg K_2O/ha (199.92 kg MP/ha)

Total 16 treatment combinations were as follows:

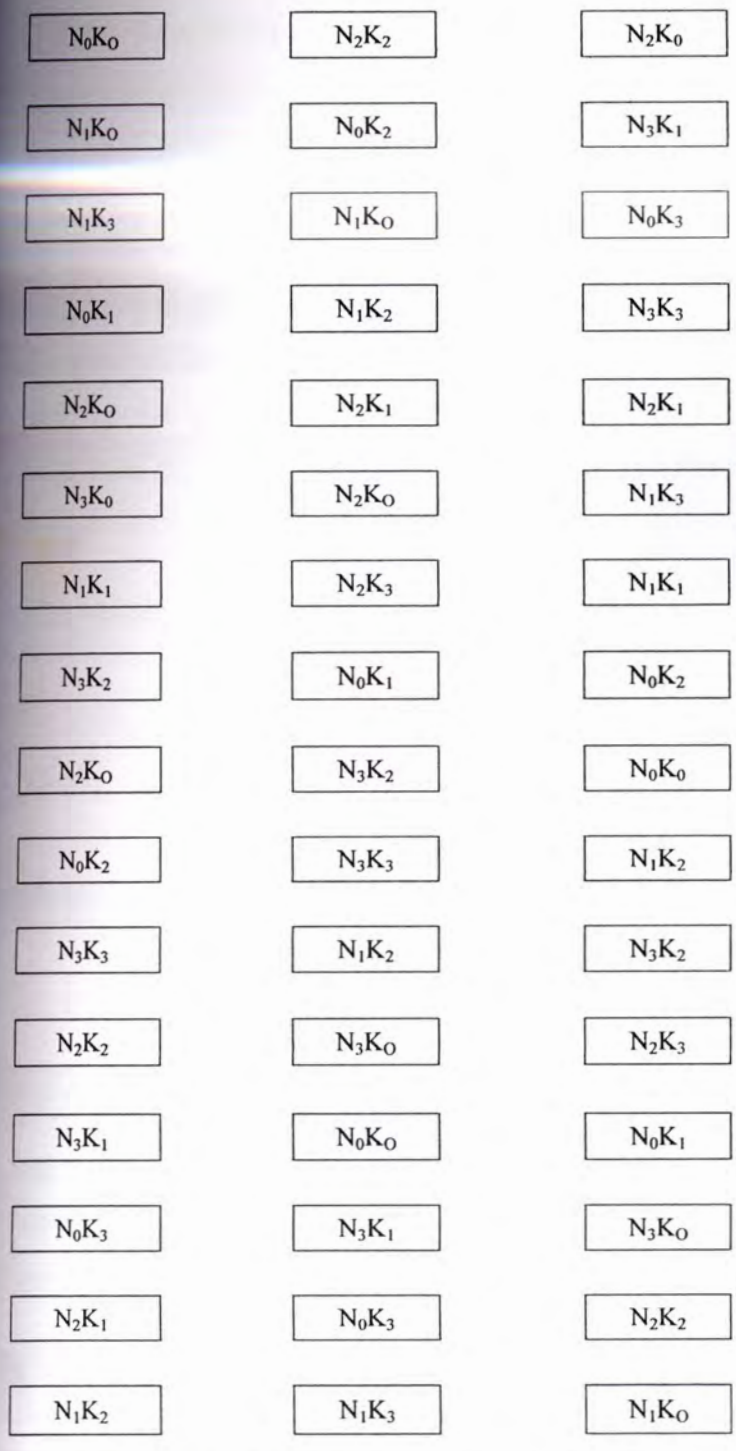
N_0K_0	N_1K_0	N_2K_0	N_3K_0
N_0K_1	N_1K_1	N_2K_1	N_3K_1
N_0K_2	N_1K_2	N_2K_2	N_3K_2
N_0K_3	N_1K_3	N_2K_3	N_3K_3

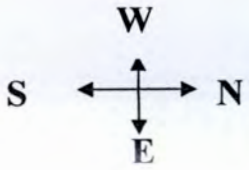
3.6 Layout and design of experiment

The experiment consisting of treatment combination was laid out in RCBD with three replication. The whole field was divided into three blocks and each block consisted of 16 plots. Altogether there were 48 unit plots in each experiment and required 351m^2 land.

Each unit, bed was 2.7 m^2 (1.2m×2.5m) in size. The replication were separated form one another by 1 m. The distance between plots was .75m. The treatment was randomly assigned to each of the block. Each unit plot had 2 rows and each with 5 plants. So there were 10 plants per unit plot. The plants of one row (5 plants) in each unit plot were considered for growth of okra and other one row were considered for yield of okra. Plant to plant distance was 45 cm and raw to raw distance was 60 cm.

A layout of the experiment has been shown in Figure 1.





Plot size : 2.25 m × 1.2 m
Spacing: 60 cm × 45 cm

Plot spacing: 75 cm

Between replication: 1 m

N_0 = Control

N_1 = Nitrogen 70 Kg / ha

N_2 = Nitrogen 110 Kg / ha

N_3 = Nitrogen 160 Kg / ha

K_0 = No fertilizer (control)

K_1 = Potassium 40 Kg / ha

K_2 = Potassium 80 Kg / ha

k_3 = Potassium 120 Kg / ha

Fig. 1. Field layout of the experiment in the Randomized Complete Block Design (RCBD)

3.7Cultivation of okra

3.7.1 Land preparation

The land which was selected to conduct for the experiments was opened on 2 April 2005 by disc plough. After opening the land with a tractor it was ploughed and cross-ploughed six times with a power tiller and each ploughing was followed by laddering to break up the soil clods to obtain unit good tilth and to level the land. After final land preparation the experimental plot was laid out, and the edge around each unit plot was raised to check run out of the nutrients.

3.7.2 Manuring and fertilizer application

The entire quantity of cow dung (10 ton/ha) was applied just after opening the land (Rashid, 1993). Urea, TSP and MP were applied as the source of nitrogen, and potassium respectively as per treatment in each experiment.

In nitrogen and potassium was applied as per treatment and TSP was applied at the rate of 100 kg/ha (Rashid, 1993).

The entire amount of TSP in both the experiments was applied at the time of final land preparation. Urea and MP were applied in two equal installments as top dressing. Urea and MP were applied as top dressing around the plant and incorporate with soil at 3rd and 5th week after seedling emergence.

3.7.3 Sowing of seeds

The okra seeds of cv. BARI Dherosh I were sown on 8, April 2005 in rows of raised beds. Row-to-Row and plant-to-plant spacing were maintained 60 cm and 45 cm, respectively. There seeds were sown in each location. Then the seeds were covered with fine soil by hand.

3.8. Intercultural operations

Necessary intercultural operations were done through the cropping season for proper growth and development of the plant. Five to Six days after germination only one healthy seedling was kept to grow in each location and other seedling were removed. Three weeding were done to keep the plots free from weeds. Stagnant water was effectively drained out at the time of heavy rain. No irrigation was applied.

3.8.1 Gap filing

Dead, injured and weak seedlings were replaced by new vigour seedling from the stock kept on the border line of the experiment.

3.8.2 Weeding

Significant number of weed were found in the control treatment. Weeding was done three times in these plots where it was necessary.

3.8.3 Irrigation

Light irrigation was given just after sowing the seed. A week after Sowing the requrement of irrigation was envisaged through visual estimation. Wherever the plants of a plot had shown the symptoms of wilting the plots were irrigated on the same day with a hosepipe until the entire plot was properly wet.

3.8.4. Plant protection measure

For controlling shoot and pod borer Diazinon 60 EC @ 3.5 ml/L in water was sprayed at an interval of 10 days started soon after the appearance of infestation. After fruit setting No-gos @ 0.02% was sprayed at an interval of 7 days for controlling Jassid.

3.9. Harvesting

Green pods were harvested at 1 day interval when they attained edible stage (i.e. the tender young pods of 8-13 cm long). Green pod harvesting was started from 4, June and was continued up to 20 July.

3.10. Collection of data

Data were recorded on the following parameters from the sample plants during experiment. Ten (10) plants were randomly selected from each unit plot for the collection of per plant data. The plants in the outer rows were selected for data collection of growth of okra and the other rows were selected for data collection of yield of okra.

i) Plant height

Plant height was measured in centimeter (cm) by a meter scale at 20, 40 and 60 days after sowing (DAS) from the point of attachment of the leaf to the ground level up to the tip of the longest leaf.

ii) Plant diameter

Average plant diameter of selected plant from each plot at 20, 40 and 60 days after sowing (DAS) with the slide calipers.

iii) Petiole length

Petiole length was measured in centimeter (cm) by a meter scale at 20, 40 and 60 days after sowing (DAS) from the point of attachment of the leaf.

iv) Leaves length

Leaves of ten (10) randomly selected plants were made detached and measured in centimeter (cm) by a meter scale at 20, 40 and 60 days after sowing (DAS).

vi) Number of leaves per plant

Number of leaf per plant of ten randomly selected plans was counted at 20, 40 and 60 days after sowing (DAS). All the leaves of selected plants were counted separately. Only the

smallest young leaves at the growing point of the plant were excluded from counting. Calculating the average number of leaves, the average number was recorded.

vii) Number of branches per plant

Number of branches per plant of ten randomly selected plans was counted at 20, 40 and 60 days after sowing (DAS). All the branches of selected plants were counted separately.

viii) Green pod length

Ten randomly selected pods from each plot were taken and length was recorded by a meter scale in cm and finally mean was calculated.

ix) Green pod diameter

Mean diameter of 10 randomly selected pods from each plot were measured in cm with the help of slide calipers.

x) Number of green pods per plant

Mean number of green pods of selected plants from each plot was recorded.

xi) Green pod yield per plot

Mean weight of edible green pods of 10 plants from each plot was measured in kilogram (kg).

xii) Green pod yield per hectare

Green pod yield per hectare was calculated in metric ton by converting the mean green pod yield per plot.

3.11. Statistical analysis

The collected data on various parameters were statically analyzed using MSTAT package program. The mean for all the treatment was calculated and analyses of variances of all the characters were performed by F-variance test. The significant of difference between the pairs of treatment means was evaluated by the least significant difference (LSD) test at 5% and at 1% levels of probability (Gomez and Gomez, 1984).

CHAPTER IV

RESULTS AND DISCUSSION

The experiment was considered to investigation of different level of fertilizer Nitrogen as well as potassium on the growth and yield of okra. The analysis variances for different characters have been present in (Appendix 1 to 5). Data of the different parameters analyzed statically and the results have been presented in the (Table1 to14 and figures1 to 21 and appendix 6 to7). The results of the present study have been presented and discussed in this chapter under the following headings:

4.1.1. Plant height

Main effect of nitrogen and potassium on the growth and yield of okra:

The plant height was recorded of different stages of growth i.e.20, 40 and 60 DAS effect sowing. The plant height varied significantly due to the application of different level of nitrogen and potassium. Statistically highly significant result was observed regarding plant by the nitrogen treatment at 60 DAS, 40 DAS, and 20 DAS. (Fig.2 and 3). Nitrogen at the level of 160 Kg/ha gave the highest plant height (20.32 cm) at 20 day While the control (0 Kg/ha) give the lowest (12.7 cm). Application of nitrogen at the rate of 160 Kg/ha and 0 Kg/ha showed the maximum (70.51 cm) and the minimum (50.47 cm) plant height respectively at 40 DAS. (Fig.2) At 60 DAS application of nitrogen at the rate of 160 Kg/ha and 0 Kg/ha showed the maximum (80.39 cm) and minimum (65.91 cm) plant height respectively. Plant height showed a general trend of gradual increase with the increasing levels of nitrogen. Majanbu et al. (1986) observed that plant height was enhanced by nitrogen fertilization up to 100 Kg N/ha. Plant height was increased with increasing rate of nitrogen Singh, (1995)b Singh et, al (1998) stated that the application of 90 Kg N/ha increased plant height by 14.03% compared with the control

It was observed that various level of potassium exhibited significant affect on the plant height at 20 DAS, 40 DAS and 60. (Fig.3).The highest (19.11 cm) and lowest (16.46 cm) plant height were obtained at 80 Kg K_2O/ha and 0 Kg K_2O/ha respectively at 20 DAS (Fig3). The maximum plant height (60.182 cm) was obtained with 80 Kg K_2O/ha and the minimum (54.71 cm) in this respect was obtain from 0 Kg K_2O/ha at 40 DAS. Application of potassium at the rate of 80 Kg K_2O/ha and 0 Kg K_2O/ha showed the maximum (75.97 cm) and the minimum (70.12cm) plant height respectively at 60 DAS.

4.1.2. Combined effect of nitrogen and potassium

Interaction effect between nitrogen and potassium was found significant in this respect of plant height at 20 DAS but 40 DAS and 60 DAS effect between nitrogen and potassium was found highly significant. of plant height. (Appendix 6 and Table-1) But the combined of nitrogen and potassium showed significant effect at 20 DAS (Table 1). The maximum plant height (22.86 cm) was obtained from the combined effect of 160 Kg N/ha and 80 Kg K_2O /ha while the lowest plant height (14.56 cm) was found from the control treatment at 20 DAS (Table-1). Application of nitrogen and potassium at the rate of 160 Kg/ha and 80 Kg K_2O/ha showed the maximum (74.91 cm) and the minimum (45.72 cm) plant height respectively at 40 DAS. At 60 DAS the maximum (82.042 cm) and minimum (63.246 cm) plant height were measured from the treatment combination of 160 Kg N/ha+ 80 Kg K_2O/ha and0 Kg N/ha +0 Kg K_2O/ha respectively (Table 1). Lenka et,al (1989) reported that N and K significantly increased plant height

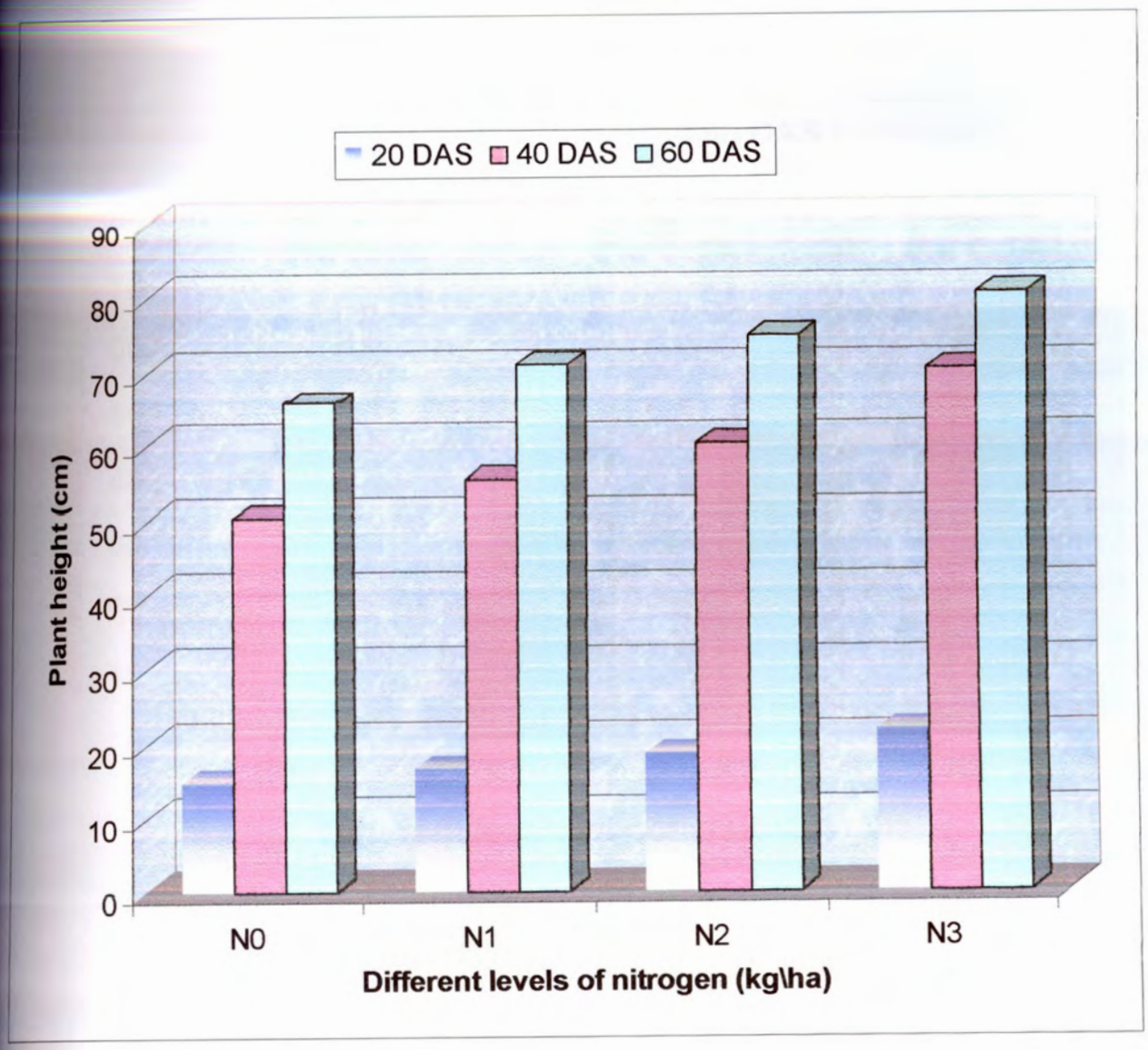


Fig.2: Effect of different levels of nitrogen on plant height of okra at 20, 40 and 60 DAS.

N_o = Control

N_1=Nitrogen 70 Kg / ha

N_2 = Nitrogen 110 Kg / ha

N_3 = Nitrogen 160 Kg / ha

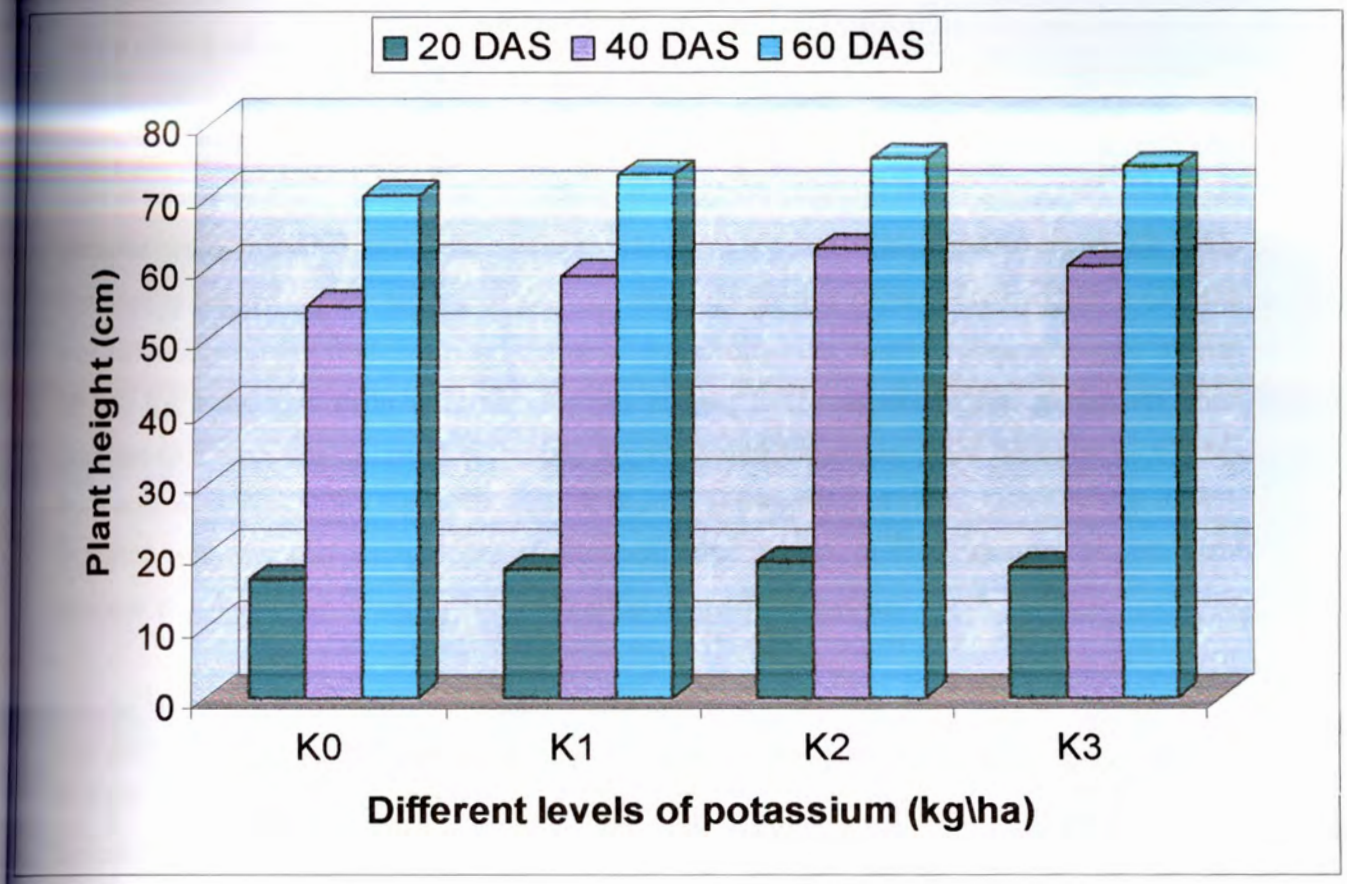


Fig. 3: Effect of different levels of potassium on plant height of okra at 20 , 40 and 60 DAS.

Fig. 2: Effect of different levels of potassium on plant height of okra at 20 DAS, 40 DAS and 60 DAS .

K_0 = Control

K_1 = Potassium 70 Kg / ha

K_2 = Potassium 80 Kg / ha

K_3 = Potassium 120 Kg / ha

4.2.1 PLANT DIAMETER

Main effect of nitrogen and potassium

The present study revealed that there was a highly significant effect of nitrogen on plant diameter of okra. (Fig .4 & 5). The highest (1.94 cm) and the lowest (1.45 cm) plant diameter were recorded from the nitrogen 160kg/ha and control respectively at 20 DAS. Statistically highly significant variation was observed in this respect the maximum (2.3408 cm) and minimum (18.500 cm) plant diameter due to different doses applied nitrogen, at level of 160 Kg N/ha and from control. (Fig .4) at 40 DAS respectly. The maximum plant diameter (3.4 cm) was obtained from 160 Kg N/ha and minimum plant diameter (2.51 cm) from control at 60 DAS. (Fig4). The result clearly showed the plant diameter was gradually increased with the increasing level of nitrogen. Majanbo et, al (1976) observed that plant diameter was enhanced by nitrogen fertilization up to 100 Kg N/ha.

Highly significant results were also observed in the plant diameter by the potassium treatments at 20 DAS, 40 DAS and 60 DAS (Fig. 4&Fig. 5). Application of K_2O at level of 80 Kg/ha gave the highest plant diameter (1.780 cm) while the control (0 Kg K_2O/ha) gave the lowest (1.577 cm) at 20 DAS. Application of potassium at the rate of 80 Kg K_2O/ha and 0 Kg K_2O/ha showed the maximum (2.180 cm) and the minimum (1.977 cm) plant diameter at 40 DAS (Fig 4). The maximum plant diameter (3.1750 cm) was obtained from 80 Kg K_2O/ha and the minimum plant diameter (2.7283cm) from 0 Kg K_2O/ha at 60 DAS. The result clearly showed that the plant diameter was gradually increased with the increasing level of Potassium. Singh et, al (1998) stake that the application of 90 Kg K2O/ha increased plant diameter by 14.03% compared with the control treatment

4.2.2. Combined effect of nitrogen and potassium:

Interaction effect between nitrogen and potassium was found to be insignificant in respect of plant diameter (Table 1 and Appendix 5). At 20 day the maximum plant diameter 2.01cm) was obtained from the combined effect of 160 Kg N/ha and 80 Kg K_2O/ha while the lowest plant diameter was observed with the control treatment. The highest (2.41cm) the plant diameter the plant diameter was observed from the combination of 160 kg N and 80 K_2O/ha while the lowest plant diameter was (1.79cm) observed from the from the control treatment at 40 DAS. The combined effect of different doses of nitrogen and potassium on the plant diameter was non significant at 60 DAS.

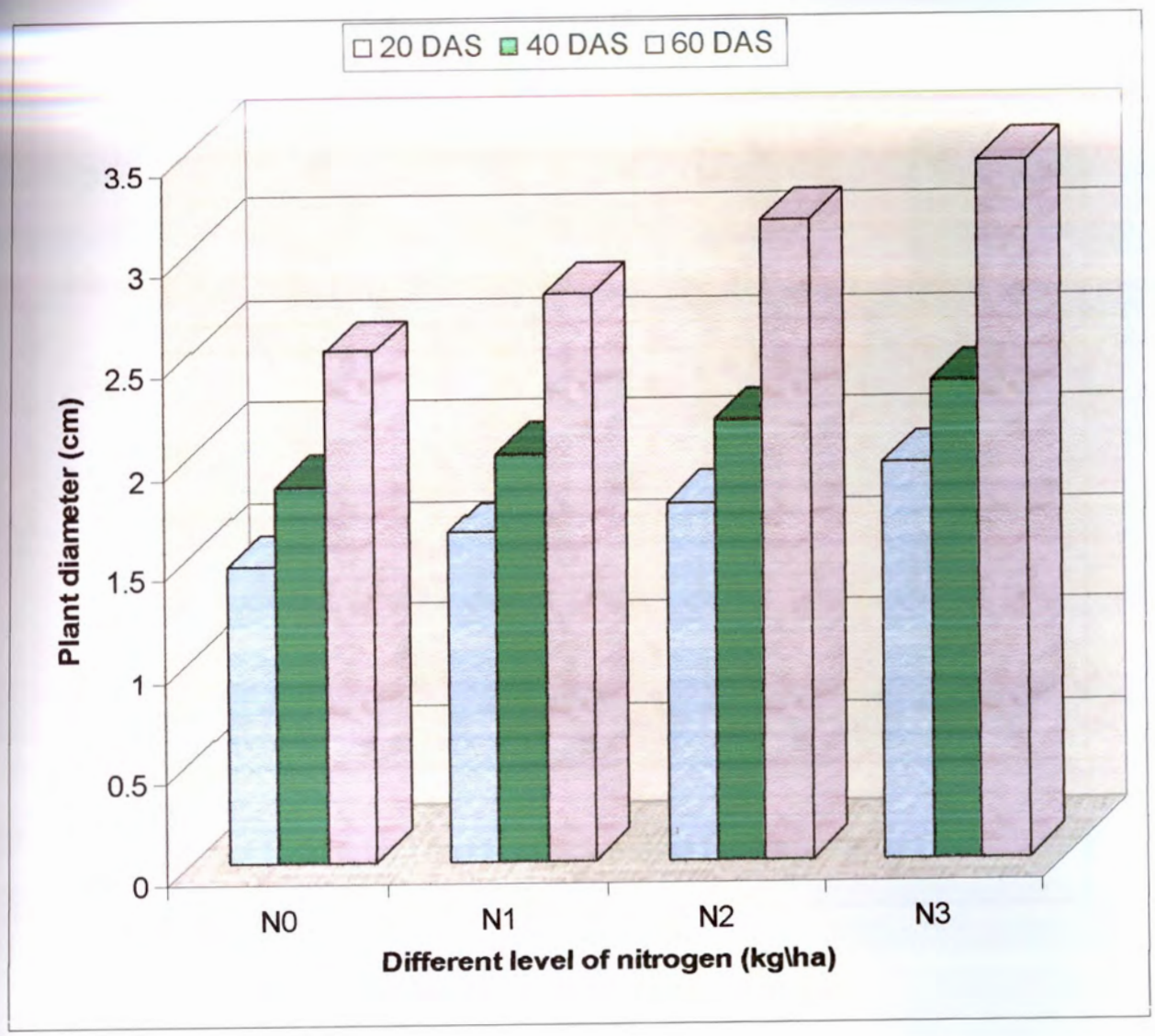


Fig.4. Effect of different levels of potassium on plant height of okra at 20, 40 and 60 days after sowing (DAS).

N_o = Control

N_1 = Nitrogen 70 Kg / ha

N_2 = Nitrogen 110 Kg / ha

N_3 = Nitrogen 160 Kg / ha

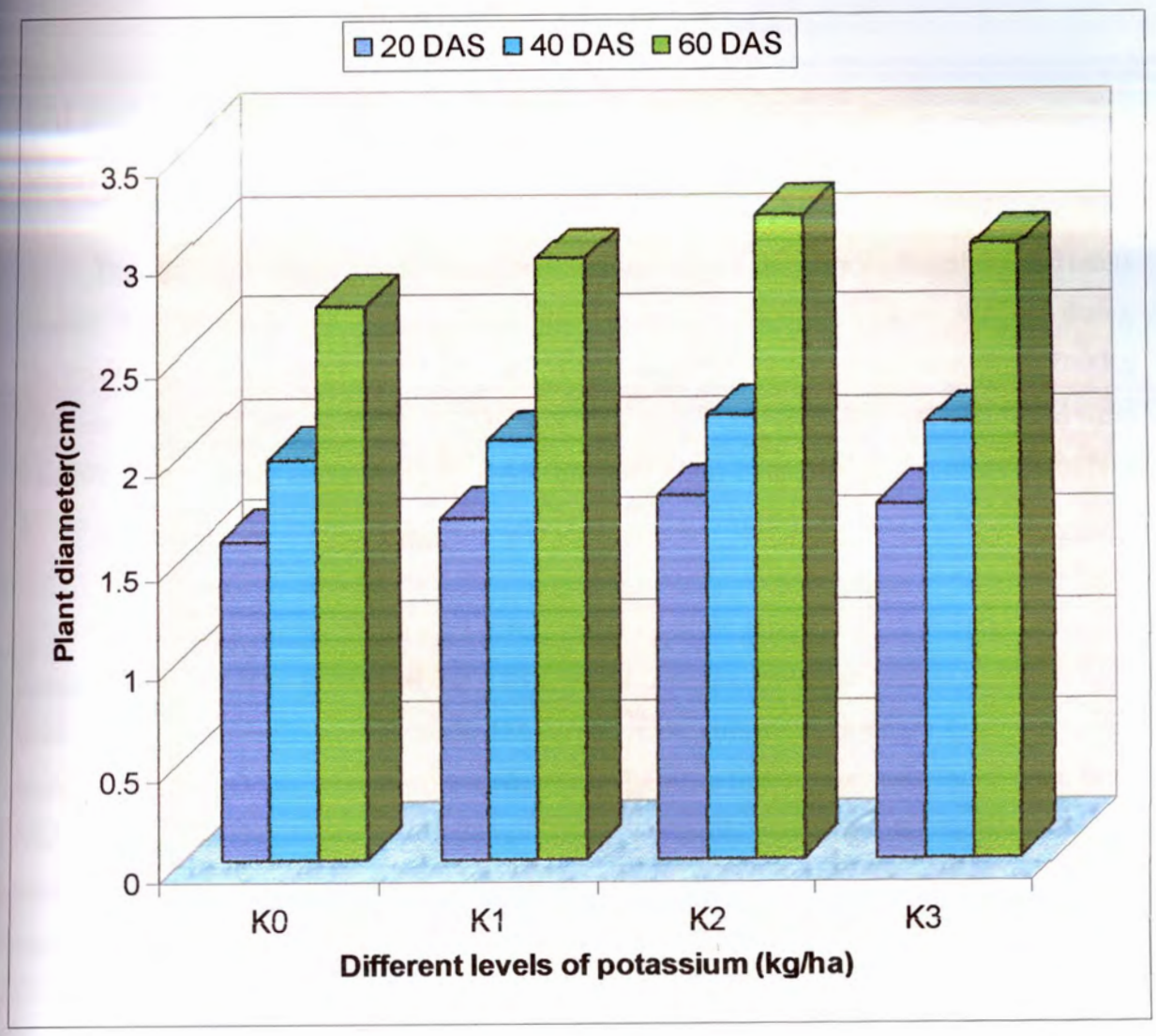


Fig. 5. Effect of different Levels of potassium on plant diameter of okra at 20, 40 and 60 days after sowing (DAS) .

K_o = Control

K_1 = Potassium 70 Kg / ha

K_2 = Potassium 80 Kg / ha

K_3 = Potassium 120 Kg / h

4.3.1 Petiole length

Main effect of nitrogen and potassium

The different levels of nitrogen had significant on the petiole length. The results revealed that petiole length was gradually increased with the increasing in nitrogen doses. The maximum petiole length (4.10 cm) (17.77 cm) and (23.792 cm) was found from, 160 Kg N/ha, and minimum petiole length (1.05 cm),(13.750 cm) and (19.784 cm) was found from 0 Kg N/ha respectively at 20. 4 and 60 DAS. Singh (1995a) a reported that application of N at 90-160 Kg/ha gave the highest petiole length (16.7 –17.6 cm) (Fig. 6)

There was a highly significant effect on the petiole length due to different levels of potassium applied. The K_2O levels of 120 Kg and 0 Kg/ha gave the longest (3.23 cm) and shortest (2.454 cm) respectively at 20 DAS. The maximum petiole length (16.72 cm) was found at 80 Kg K_2O/ha. Whereas the lowest (14.62 cm) in this respect was found from 0 Kg N/ha at 40 DAS. The longer petiole length (22.89) was obtained from the highest doses of nitrogen 160 Kg/ha and smallest petiole length (20.9333 cm) was recorded from the control treatment at 60 DAS. (Fig.7)

4.3.2. Combined effect of nitrogen and potassium

The analysis of variance indicated that a in significant interaction effect at 40 DAS but the combined effect was highly significant at 20 DAS but clearly significant at 60 DAS (Table 1 and appendix 6). However, the maximum (13.50 cm) and the minimum (5.25cm) petiole length was measured from the treatment combination of 100 Kg N/ha with 80 Kg K_2O/ha respectively at 20 DAS. The combined effect of different doses of nitrogen and potassium on petiole length was found insignificant at 40 DAS. The largest petiole length (24.26cm) was measured from the treatment combination of 160 Kg N/ha and 80 Kg K2O/ha. However, the smaller petiole length (18.033 cm) was found from the treatment combination of 0 Kg N and 0 Kg K_2O/ha (Table3) at 60 DAS. This findings in agreement with Naik and Srinivas (1992), reported that petiole length was the highest with the highest rate of fertilizer application 200 Kg N/ha and 120 Kg K_2O/ha

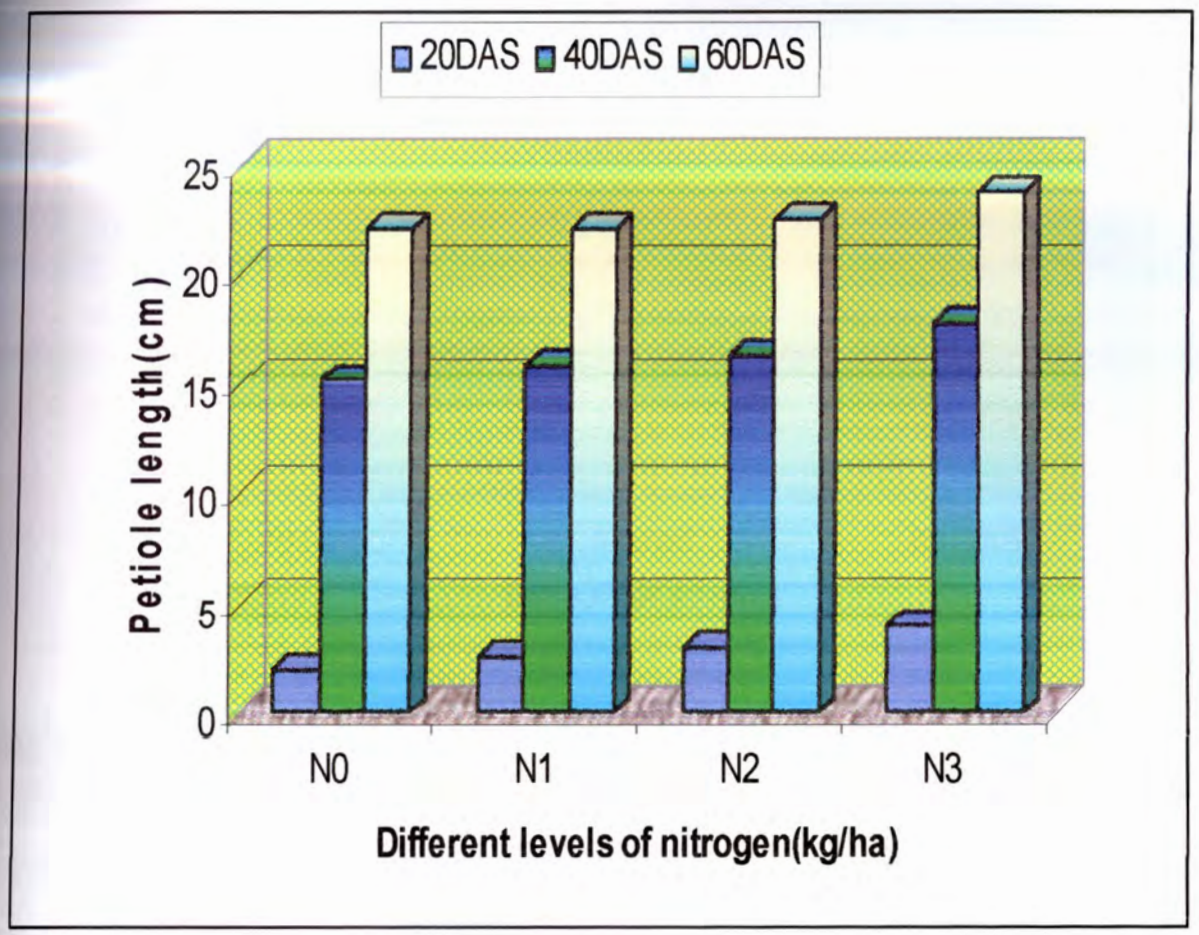


Fig. 6 Effect of different levels of nitrogen on petiole length of okra at 20, 40 and 60 days after sowing (DAS) .

N_o = Control

N_1 = Nitrogen 70 Kg / ha

N_2 = Nitrogen 110 Kg / ha

N_3 = Nitrogen 160 Kg / ha

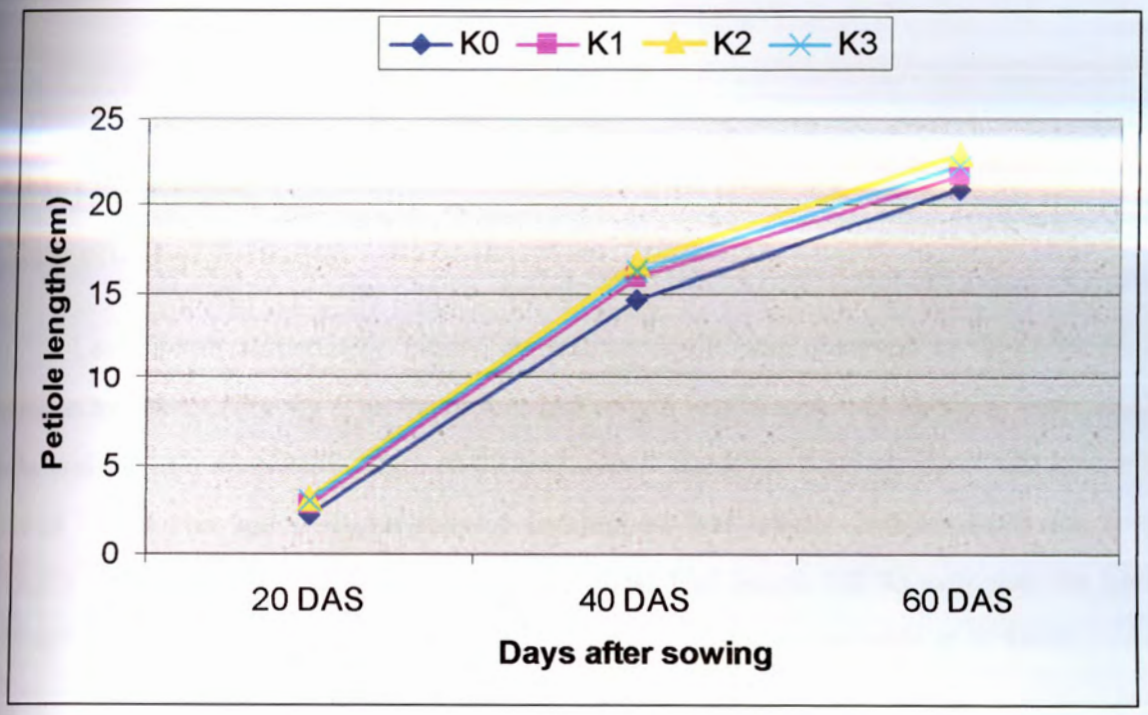


Fig. 7 Effect of different Potassium levels on petiole length of okra at 20, 40 and 60 days after sowing (DAS) .

K_0 = Potassium 0 kg/ha (control)

K_1 = Potassium 70 Kg / ha

K_2 = Potassium 80 Kg / ha

K_3 = Potassium 120 Kg /ha

4.4.1. Leaf length:

Main effect of nitrogen and potassium

Leaf length statistically highly significant result was observed at 20 DAS by the nitrogen treatment (Fig. 8). The maximum leaf length (10.78 cm) was obtained from 160 Kg N/ha and the minimum leaf length (8.07 cm) with 0 Kg N/ha. Application of nitrogen at the rate of 160 Kg/ha and 0 Kg/ha showed the highest leaf length (20.92cm) and the lowest (15.275 cm) respectively at 40 DAS. The highest leaf length (22.83 cm) and the lowest (15.467 cm) observed from 160kgN/ha and control treatment respectively at 60 DAS.

It was observed that different levels of potassium had highly significant effect on the leaf length at 20, 40, and 60 DAS. The maximum (20.35cm) and the minimum (18.00cm)leaf length was performed with the application of 160kgK_2O/ha and control(N0K0)at 60 DAS. This result clearly showed that leaf length was gradually increased with increaseing of potassium doses (Fig.9). Potassium application significantly increased the plant height (Bhai and Singh 1998).

4.4.2. Combined effect of nitrogen and potassium

Leaf length was recorded at 20DAS, 40DAS and 60DAS. It was observed that the combined effect of nitrogen and potassium exhibited non significant at 20DAS, 40DAS but highly significant effect on the petiole .Non-significant interaction effect between nitrogen and potassium on the leaf length at 40day and 20 DAS (Table.2 and Appendix 6). But the combined effect was highly significant at 60 DAS. However the maximum plant leaf length (23.50cm) was measured from the treatment combination of 60 Kg N/ha + 80Kg K2O/ha and the minimum (15.767 cm) from control treatment at DAS. Enka and M.L. Gupta (1989) reported that N and K significantly increased leaf length length at 60DAS.

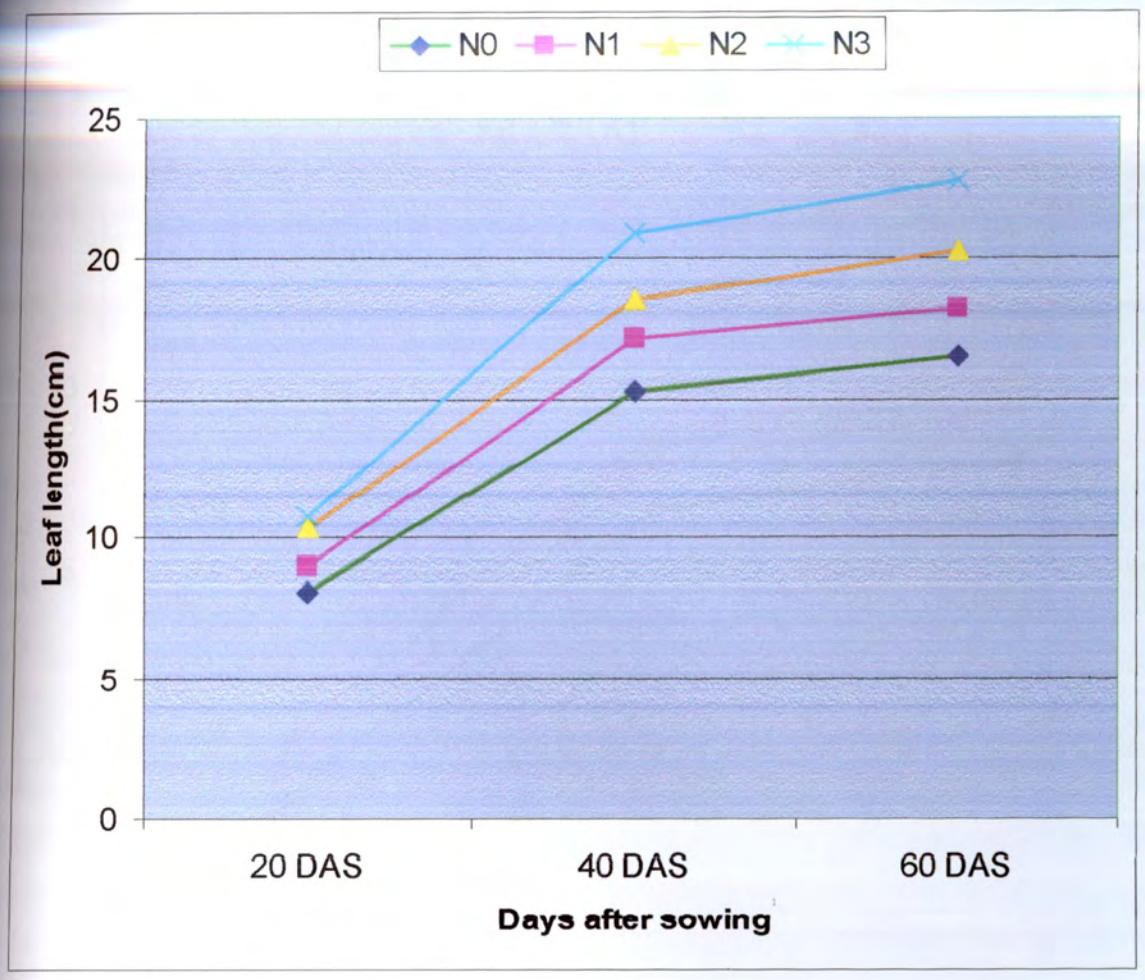


Fig. 8. Effect of different nitrogen levels on leaf length of Okra at 20, 40 and 60 days after sowing (DAS) .

N_o = Control

N_1 = Nitrogen 70 Kg / ha

N_2 = Nitrogen 110 Kg / ha

N_3 = Nitrogen 160 Kg / ha

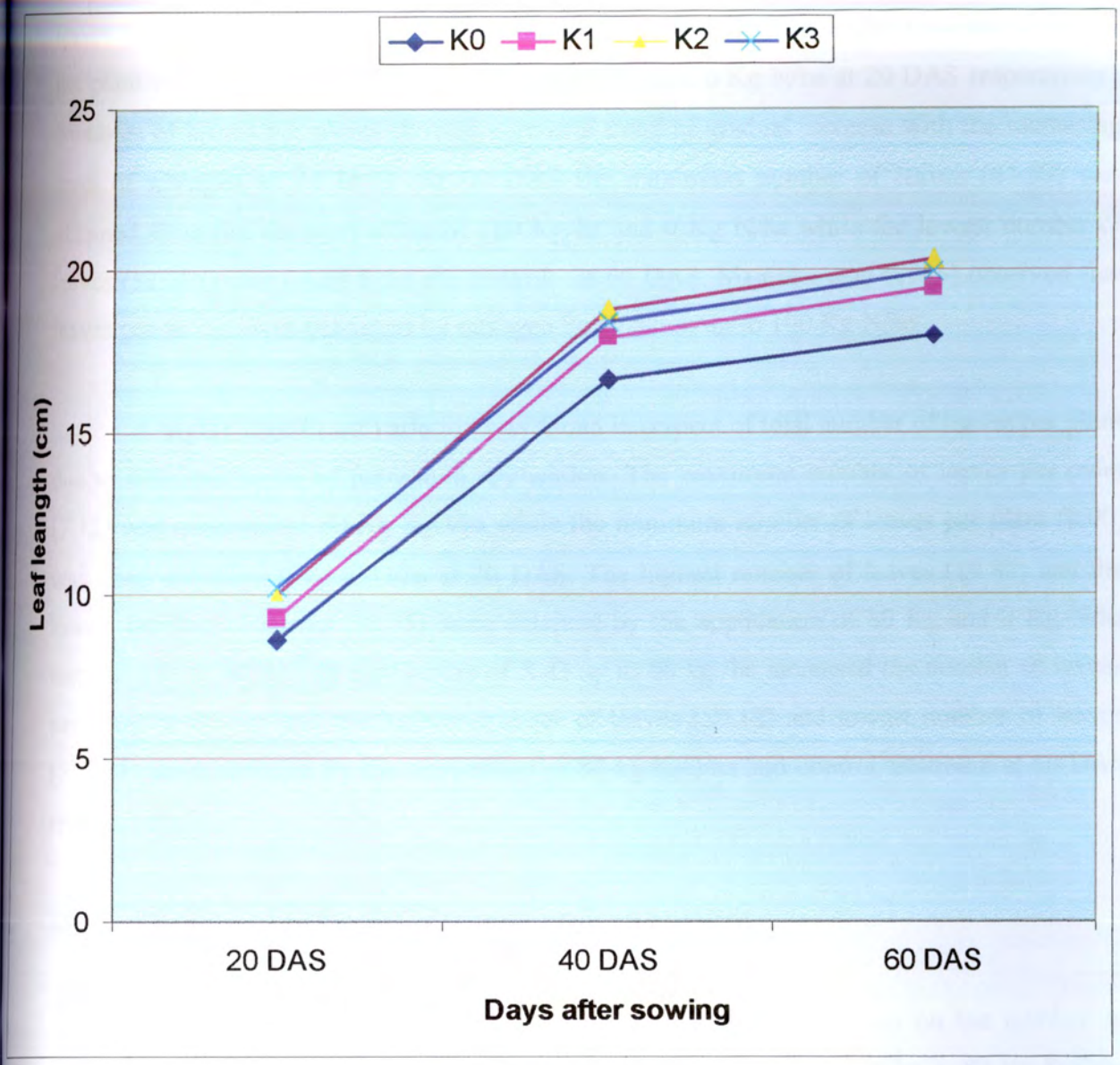


Fig.9. Effect of different potassium levels on leaf length of okra at 20, 40 and 60 days after sowing.

K_0 = Control

K_1 = Potassium 70 Kg / ha

K_2 = Potassium 80 Kg / ha

K_3 = Potassium 120 Kg / ha

4.6.1. Number of leaves per plant:

Main effect of nitrogen and potassium

Application of different levels of nitrogen had significant effect on the total number of leaves per plant (Fig 10 to 11) . The highest (7.25) and the lowest (5.813) number of leaves per plant were found in the treatment of 160 Kg/ha and 0 Kg N/ha at 20 DAS respectively . Numbers of leaves per plants showed a general trend of gradual increase with the increasing level of nitrogen at 40 DAS. At 60 DAS the maximum number of leaves (61.97) was obtained from the nitrogen effect of 160 Kg/ha and 0 Kg N/ha while the lowest number of leaves (52.208) was found from the control at 60 DAS. Majanbu et,al (1986) observed that leaves production was enhanced by nitrogen fertilization up to 100 Kg N/ha.

A highly significant variation was found in respect of total number of leaves per plant due to different levels of potassium application. The maximum number of leaves per plant (7.12) was observed at 80 Kg K_2O/ha while the minimum number of leaves per plant (6.00) was observed from 0 kg K_2O/ha at 20 DAS. The highest number of leaves (19.85) and the lowest number of leaves (18.55) were obtained by the application of 80 Kg and 0 Kg N/ha respectively at 40 day. In application of K_2O up to 80 kg /ha increased the number of leaves per plant at 60 day and the highest number of leaves (59.12) and lowest number of leaves (54.521) were obtained by the application of 80 kg K_2O/ha and control treatment at 60 DAS respectively.

4.6.2. Combined effect of nitrogen and potassium

The combined effect different doses of nitrogen and potassium on the number of leaves were highly significant (Table 2). It was noted that 160 Kg N/ha + 80 kg K_2O/ha produced the highest number of leaves (62.66) and control ($N_0 K_0$) gave the lowest (49.250) number of leaves at 60 DAS. At 40 DAS the plant gave highest number of leaves from the treatment combination of 160 Kg N/ha +80 kg K_2O/ha and gave the lowest leaves (15.03) from the control treatment. The treatment combination of 160 Kg N/ha + 80 Kg K_2O/ha perfumed the maximum number of leaves (8.50) and the treatment combination of 0 Kg N/ha and 0 Kg K_2O/ha gave the number of leaves at 20 DAS. (Appendix 6)

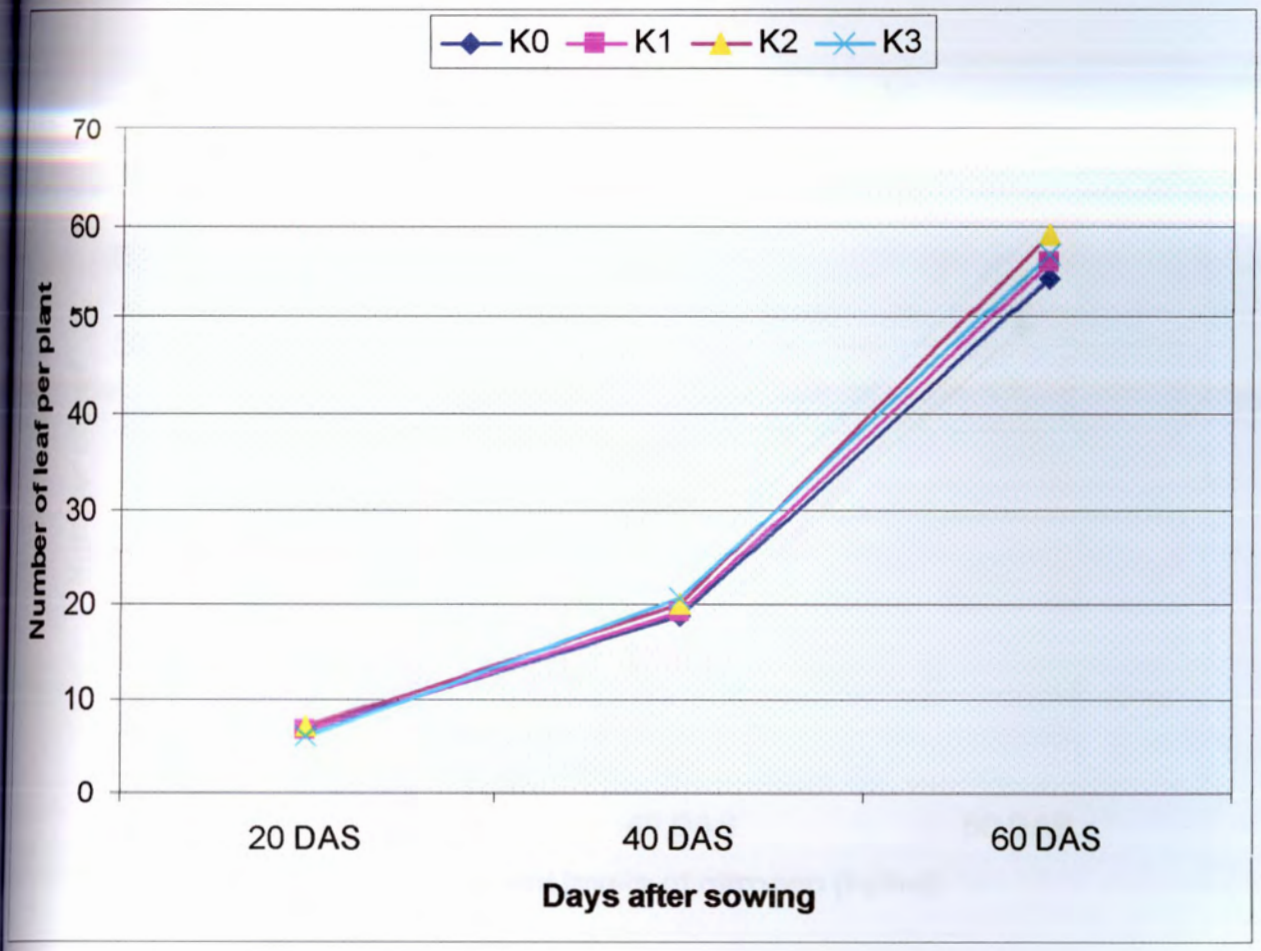


Fig. 10: Effect of different potassium levels on number of leaves per plant of okra at 20, 40 and 60 days after sowing (DAS) .

K_o = Control

K_1 = Potassium 70 Kg / ha

K_2 = Potassium 80 Kg / ha

K_3 = Potassium 120 Kg / ha

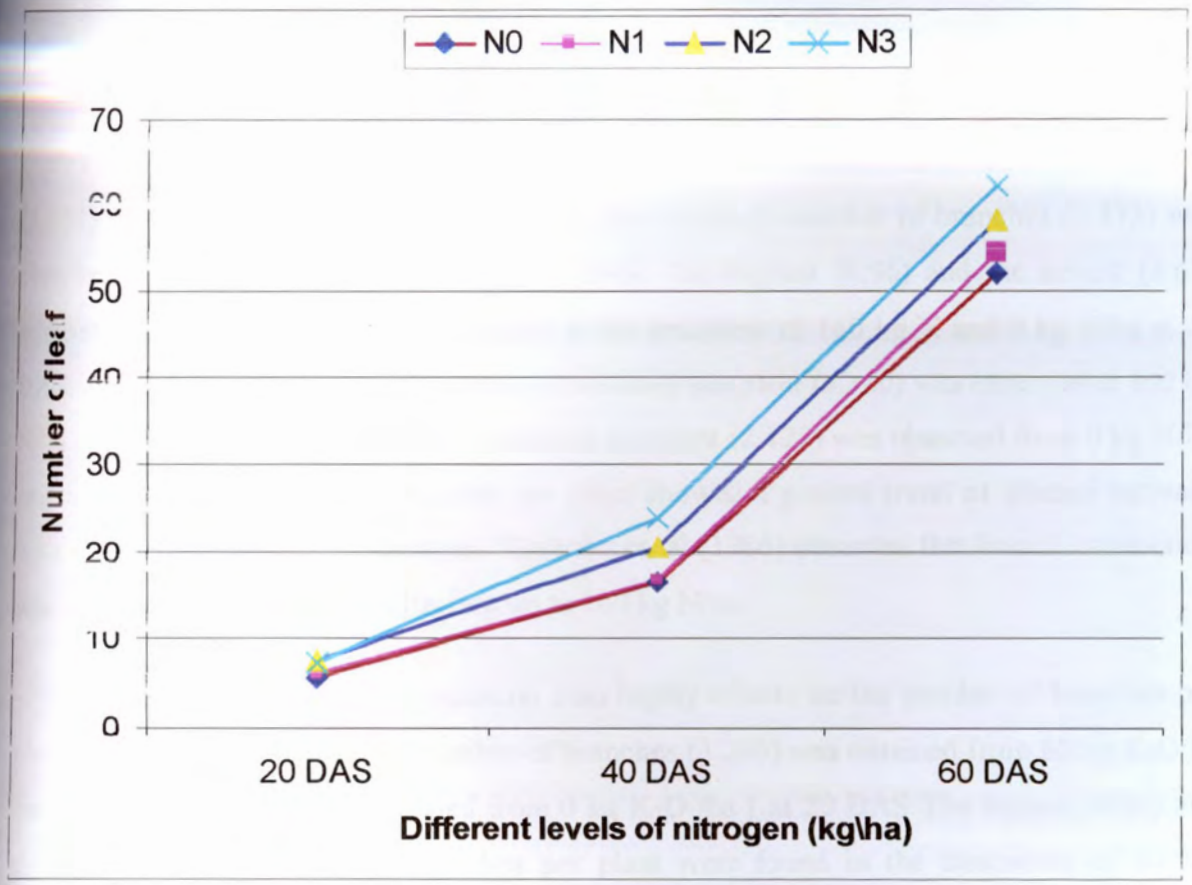


Fig. 11 .Effect of different nitrogen levels on number of leaves per plant of okra at 20, 40 and 60 days after sowing (DAS).

N_o = Control

N_1 = Nitrogen 70 Kg / ha

N_2 = Nitrogen 110 Kg / ha

N_3 = Nitrogen 160 Kg / ha

4.7.1. Number of branch

Main effect of nitrogen and potassium

Highly significant variation was found total number of branches per plant due to application of different levels of nitrogen (Fig;12) . The maximum number of branches (5.254) was observed from 160 kg N/ha and the minimum number of branches (3.875) was observed from 0 kg N/ha (Fig 13) at 60 DAS. The highest (4.96) and the lowest (3.67) number of branches per plant were found in the treatment of 160 kg N and 0 kg N/ha at 40 DAS. At 20 DAS the maximum number of branches per plant (3.380) was observed at 160 kg N/ha while the minimum number of branches per plant (2.125) was observed from 0 kg N/ha respectively. The number of branches per plant showed a general trend of gradual increase with the increasing level of nitrogen. Majanbu et, al (1986) observed that branch production was enhanced by nitrogen fertilization up to 100 kg N/ha.

The different levels of potassium also highly effects on the number of branches per plant (Fig; 13) . The maximum number of branches (3.235) was obtained from 80 kg K_2O/ha and minimum (2.005) was obtained from 0 kg K_2O /ha (at 20 DAS The highest (4.64) and the lowest (3.52) number of branches per plant were found in the treatments of 80 Kg K_2O/ha and 0 kg K_2O/ha respectively at 40 DAS. The highest (5.129) and the lowest (4.188) number of branches per plant found at 80 Kg K2O/ha and 0 kg K_2O/ha at 60 DAS respectively. Number of branch was gradually increased with increased potassium doses, observed by Chauhan and Gupta (1973).

4.7.2. Combined effect of nitrogen and potassium

The combined effect of different levels of nitrogen and potassium was highly significant (Table.2) The maximum number of branches per plant (6.517) was found from the treatment combination of 160 Kg N/ha + 80 Kg K_2O/ha and the minimum number of branches per plant (3.250) was obtained from the treatment combination (N0K0) at 60 DAS. It was noted that (160 Kg N/ha + 80 Kg K2O/ha) produced the highest number of branches per plant (6.16) and the control treatment gave the lowest (3.743) number of branches at 40 DAS. The plant fertilized with the treatment combination of 160 Kg N/ha + 80 Kg K_2O/ha produced the highest number of branches (4.750) and the lowest (1.250) was obtained from the control treatment (N_OK_0) at 20 DAS. (Appendix 6)

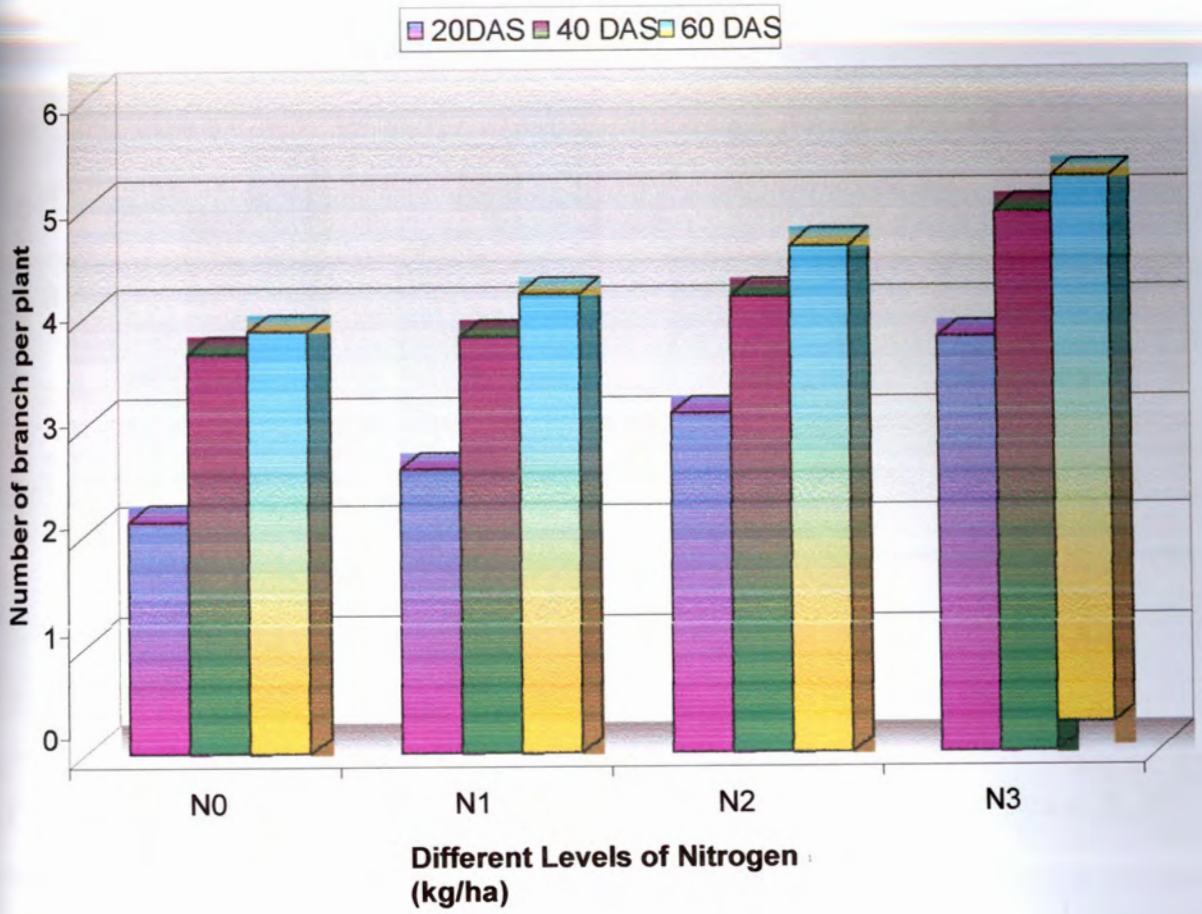


Fig. 12 Effect of different nitrogen levels on number of branch per plant of okra at 20, 40 and 60 days after sowing (DAS).

N_o = Control

N_1 = Nitrogen 70 Kg / ha

N_2 = Nitrogen 110 Kg / ha

N_3 = Nitrogen 160 Kg / ha

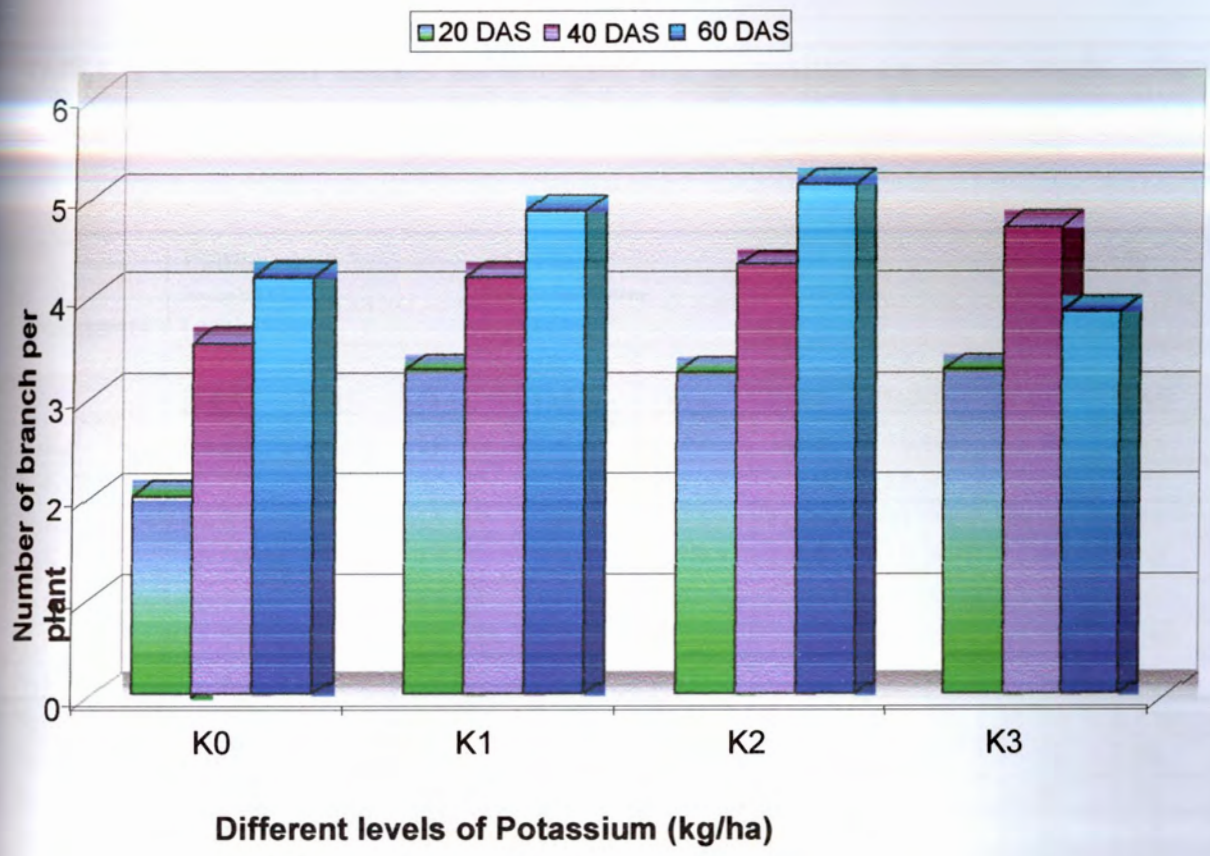


Fig. 13: Effect of different potassium levels on number of branch per plant of okra at 20, 40 and 60 days after sowing (DAS).

K_o = Control

K_1 = Potassium 70 Kg / ha

K_2 = Potassium 80 Kg / ha

K_3 = Potassium 120 Kg / ha

TABLE 1 Combined effects of nitrogen and potassium on plant height, plant diameter and petiole length of okra.

Treatments	Plants height (cm)			Plant diameter (cm)			Petiole length (cm)		
	60 DAS	40 DAS	20 DAS	60 DAS	40 DAS	20 DAS	60 DAS	40 DAS	20 DAS
N_0K_0	63.24	45.72	14.56	2.41	1.79	1.39	18.03	12.50	1.75
N_0K_1	62.27	48.89	15.06	2.4500	1.8100	1.4100	18.90	13.70	1.90
N_0K_2	68.83	54.17	15.49	2.6100	1.9200	1.5200	21.70	14.80	2.05
N_0K_3	66.04	53.11	14.12	2.5700	1.8800	1.4800	19.70	14.00	2.10
N_1K_0	66.97	51.20	14.47	2.5067	1.8400	1.4400	20.70	13.80	2.00
N_1K_1	71.20	57.91	16.76	2.7067	1.9867	1.6200	22.00	15.80	21.50
N_1K_2	73.66	57.55	18.03	3.2100	2.1200	1.7200	22.90	16.50	2.90
N_1K_3	72.64	56.64	17.52	2.7700	2.0800	1.6800	22.30	16.10	2.750
N_2K_0	71.798	54.61	16.25	2.6367	1.9800	1.5800	21.80	15.20	2.26
N_2K_1	58.42	60.50	18.79	3.2700	2.1833	1.7833	22.30	16.50	3.00
N_2K_2	76.2	65.10	20.06	3.3700	2.2733	1.8700	22.70	17.10	3.50
N_2K_3	76.2	60.96	19.05	3.3033	2.2300	1.8300	23.28	18.80	3.25
N_3K_0	78.48	67.31	20.54	3.3600	2.300	1.900	23.20	17.00	3.80
N_3K_1	80.01	69.85	21.33	3.400	2.2833	1.8833	23.70	17.50	4.00
N_3K_2	82.04	74.90	22.86	3.5100	2.4100	2.01	24.36	18.50	4.50
N_3K_3	81.02	70.00	22.09	3.4600	2.3700	1.9700	24.00	18.10	4.10
Lsd 5%	4.495	0.545	1.374	3.773	4.102	4.095	0.96	1.91	0.166
Lsd 1%	4.699	0.77	1.85	5.080	5.522	5.513	1.30	2.57	0.22
Level of Significance	*	**	*	NS	NS	NS	*	NS	**

NS=Non Significant

*Significant at 5% level

**Significant at 1% level

N_0 = Nitrogen 0 kg/ha (Control)

N_1 = Nitrogen 70 kg/ha

N_2 = Nitrogen 110 kg/ha

N_3 = Nitrogen 160 kg/ha

K_0 = Potassium 0 kg/ha (control)

K_1 = Potassium 40 kg/ha

K_2 = Potassium 80 kg/ha

K_3 = Potassium 120 kg /ha

Table 2
Combined effects of nitrogen and potassium on leaf length, number of leaves, number of branch per plant of okra.

Treatments	Growth								
	Leaf length (cm)			Number of leaves			Number of branch		
	60 DAS	40 DAS	20 DAS	60 DAS	40 DAS	20 DAS	60 DAS	40 DAS	20 DAS
N_0K_0	15.76	14.50	7.33	49.25	15.033	5.08	3.25	3.75	1.25
N_0K_1	15.10	14.80	7.82	5.50	16.20	6.50	4.50	3.50	1.50
N_0K_2	17.10	16.10	8.50	57.08	17.10	6.58	4.75	3.31	2.75
N_0K_3	16.90	15.70	8.633	52.00	18.66	5.08	3.00	4.14	3.00
N_1K_0	16.50	15.20	7.93	50.25	17.03	7.50	4.25	3.25	1.25
N_1K_1	18.20	17.20	9.00	54.46	16.06	5.58	5.50	3.29	3.50
N_1K_2	19.10	18.30	9.63	56.253	16.03	6.25	3.75	4.50	2.75
N_1K_3	18.80	17.70	9.40	55.76	18.20	5.43	3.33	4.25	3.00
N_2K_0	17.70	16.60	9.133	56.37	19.10	7.75	4.25	3.75	3.25
N_2K_1	20.80	18.80	16.10	57.08	20.06	8.33	5.16	4.50	4.50
N_2K_2	21.70	19.46	10.43	60.50	21.06	7.16	5.50	3.25	2.69
N_2K_3	21.10	19.40	11.80	58.75	22.03	6.69	3.75	5.25	4.00
N_3K_0	22.03	20.30	10.20	61.25	23.03	7.00	5.00	3.35	2.27
N_3K_1	22.70	20.90	10.33	62.50	24.20	6.25	4.25	5.41	3.50
N_3K_2	23.50	21.50	11.50	62.66	25.20	8.50	6.31	6.16	4.75
N_3K_3	23.10	21.00	11.10	61.25	24.10	7.25	5.25	4.91	3.00
Lsd 5%	0.92	1.57	1.32	2.46	0.85	1.09	0.76	0.61	0.67
Lsd 1%	1.24	2.12	0.178	3.32	1.15	1.48	1.03	0.83	0.91
Level of Significance	**	NS	NS	*	**	**	**	**	**

NS= Non significant
* = Significant at 5% level
** = Significant at 1% level

N_0 = Nitrogen 0 kg/ha (Control)
N_1 = Nitrogen 70 kg/ha
N_2 = Nitrogen 110 kg/ha
N_3 = Nitrogen 160 kg/ha

K_0 = Potassium 0 kg/ha (control)
K_1 = Potassium 40 kg/ha
K_2 = Potassium 80 kg/ha
K_3 = Potassium 120 kg /ha

4.8.1. Green pod length

Main effect of nitrogen and potassium

There was highly significant effect on the green pod length due to the application of different level of nitrogen [Fig 14 and15] .The nitrogen levels of 160 kg and 0 kg/ha gave the longest (13.987cm) and the shortest (11.250 cm) green pod length respectively (Fig.14). The results revealed that green pod length was gradually increased with the increaseing in nitrogen levels Singh (1995) reported that application of nitrogen at 90-160 kg/ha gave the highest pod length (16.7- 17.6 cm) Kurun et,al (1997) also observed that N rates up to 100 kg/ha could increases the fruits length.

The green pod length was recoded at different stages of plucking of okra. The green pod length varied significantly due to the application of different levels of potassium. The different levels of potassium highly significant effects on the green pod length (Appendix-7) The result revealed that green pod length was gradually increased with the increase in potassium dose (Fig-15) The different treatments of potassium had highly significant effect on the green pod length .The highest green pod length (13.200 cm) was obtained from at 80 kg K_2O/ha whereas the lowest (12.088 cm) at 0 kg K_2O/ha.

4.8.2. Combined effect of nitrogen and potassium

Green pod length was significantly influenced by the interaction effect of nitrogen and potassium. The combined effect of nitrogen and potassium at different days after sowing was also significant (Appendix-7, table-3). The result reveled that green pod length was gradually increased with the increased in combined effect of nitrogen and potassium level. The combined effect of different doses of nitrogen and potassium on the green pod length was found to be significant (Table 8). However the maximum (14.30 cm) and the minimum (10.50 cm) green pod length was measured from the treatment combination 160 kg N/ha +80 kg K_2O/ha and control 0kgN/ha+0kgK2o/ha respectively (Appendix 7).

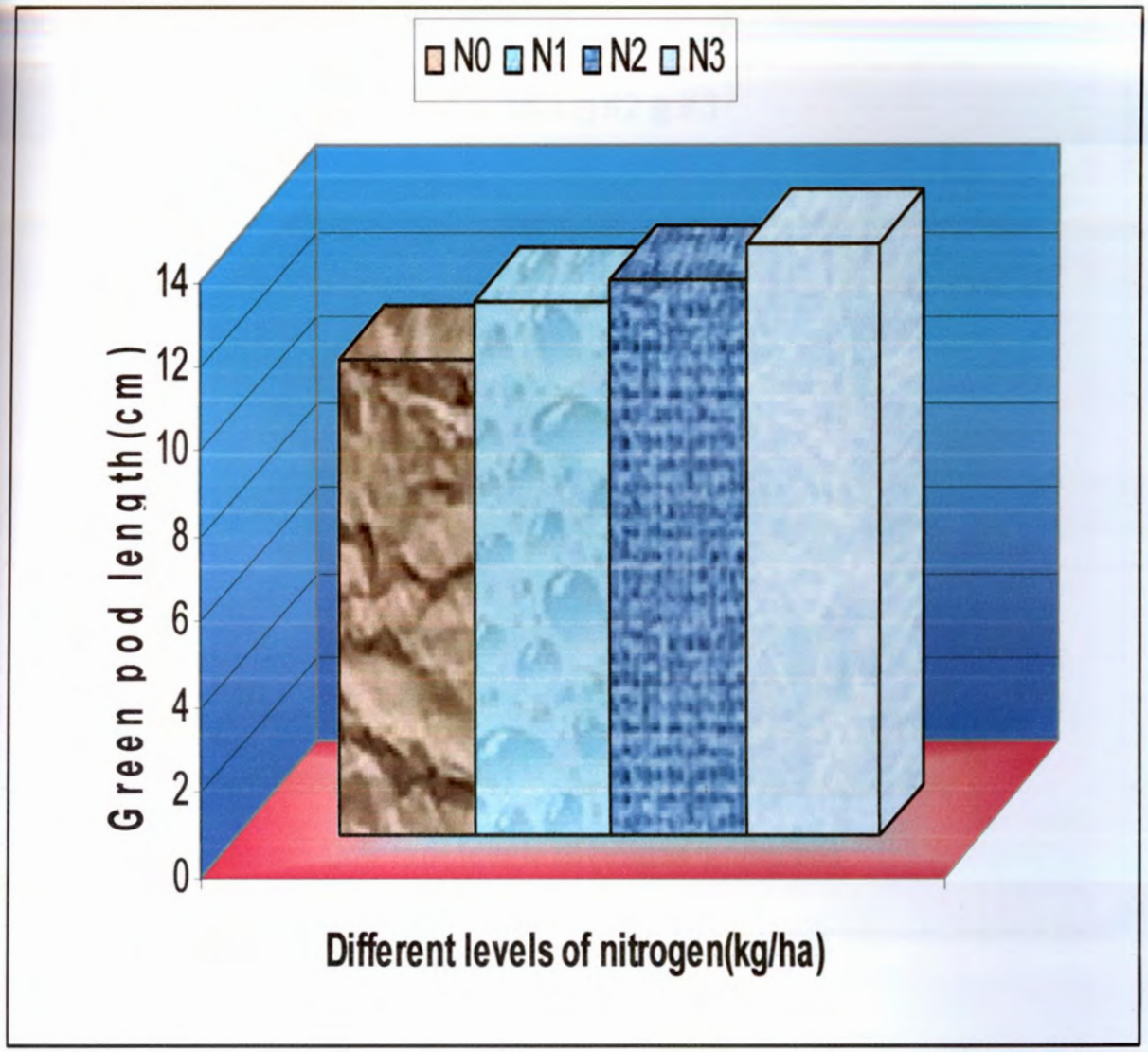


Fig. 14: Effect of different nitrogen levels on green pod length of okra .

N_o = Control

N_1 = Nitrogen 70 Kg / ha

N_2 = Nitrogen 110 Kg / ha

N_3 = Nitrogen 160 Kg / ha

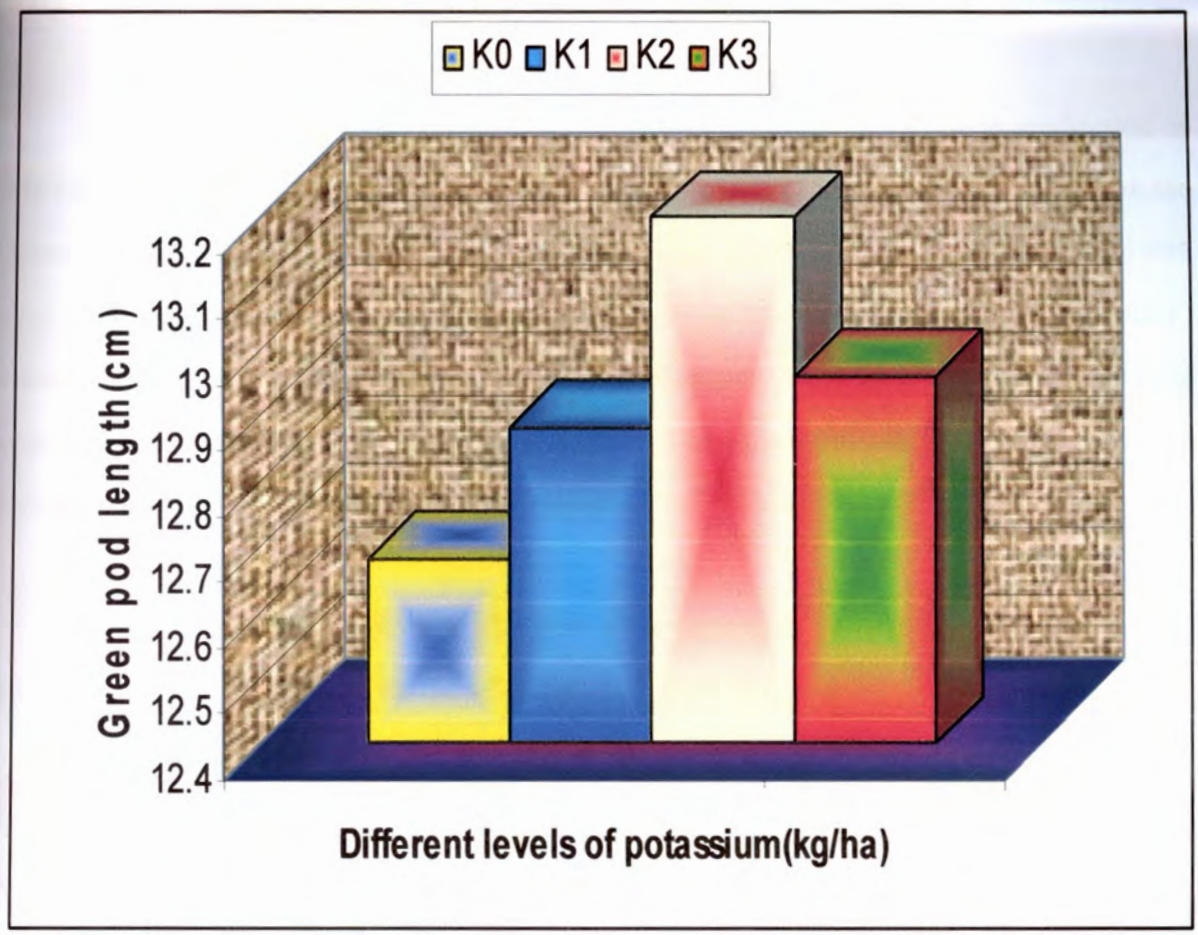


Fig. 15. Effect of different potassium levels on green pod length of okra.

K_o = Control

K_1= Potassium 70 Kg / ha

K_2 = Potassium 80 Kg / ha

K_3 = Potassium 1120 Kg /ha

4.9.1. Green pod diameter

Main effect of nitrogen & potassium

A significant variation was observed on the green pod diameter due to application of different nitrogen levels. The widthest diameter of green pod (1.59cm) was obtained from the highest dose of nitrogen 160 kg/ha whereas the smallest diameter of green pod (1.36cm) was recoded from the control treatment. The nitrogen levels of 160 kg/ha and 110 kg/ha produced statistically identical result interims of green pod diameter. The result of present finding is supported by the findings of Majanbu et, (1985) They obverted that nitrogen application increased the pod diameter (Table 4 and Appendix 7).

Application of different levels of potassium increased the green pod diameter. The effect of different potassium levels of green pod diameter was significant (Table-4). The interaction effect of nitrogen and potassium in these respects was found to be highly significant, but the combined effect was insignificant (Appendix-7). The effect of different potassium levels on diameter of green pod was significant. The maximum (1.55 cm) and the minimum (1.40 cm) diameter of pod was produced by the plants receiving K_2O/ha at the rates of 80 kg K_2O/ha and 0 kg K_2O/ha respectively.

4.9.2. Combined effect of nitrogen and potassium

There was a significant interaction effect between nitrogen and potassium on the green pod diameter but the combined effect was insignificant (Table 3) .The combined effect of nitrogen and potassium in this respect was found to be non significant (Appendix 7). The widthest diameter of pod (1.48 cm) was measured from the combined treatment of 160 kg N/ha + 80 kg K_2O/ha. However the minimum diameter of pod (1.29 cm) was found from the combination of 0 kg N and 0 kg K_2O /ha.

4.10.1. Number of green pod per plant

Main effect of nitrogen and potassium

Number of green pods per plant was highly significant effect by the nitrogen treatment (Fig .16). The maximum (38.750) and the minimum,(29.00) number of green pods per plants was found from the application of nitrogen at the rate of 160 kg N/ha and 0 kg N/ha respectively . This result is similar with the findings of Majanbu et, al (1985 . He reported that nitrogen application significantly increased the number of fruits per plant. Singh (1995b) observed that application of N at 90-160 kg/ha gave the highest of pod/plant (32.7-34.0) Kurup et.al (1997) also stated that N rates up to 100 kg/ha could increase the fruits number of okra .

Analysis of variance revealed that the single effect of potassium was highly significant on the number of green pod per plant (Fig 17). It is evident from that the highest number of green pods per plants (35.750) was produced from the potassium level of 80 kg /ha and the lowest (30.50) from the control treatment (0 kg K_2O/ha).

4.10.2. Combined effect of nitrogen and potassium

The interaction effect of nitrogen and potassium in this respect was found to be significant, but the combined effect was in significant (Table 3 and Appendix 7) This result is conflicting with the finding of Majanbu and *et al* (1985).They reported that nitrogen and potassium combining application increase the number of green pod per plant. Combined effect of nitrogen and potassium was in significant (Table 3). The combined effect of 160 kg N/ha and 80 kg K2O/ha produced maximum number of green pod per plant (42.00) and the plant in control plot produced minimum number of green pod (27.00) . Mishra and Pandey (1987) reported that N at 80 kg/ha and K at 40 kg/ha significantly increased the number of green pod/plant.

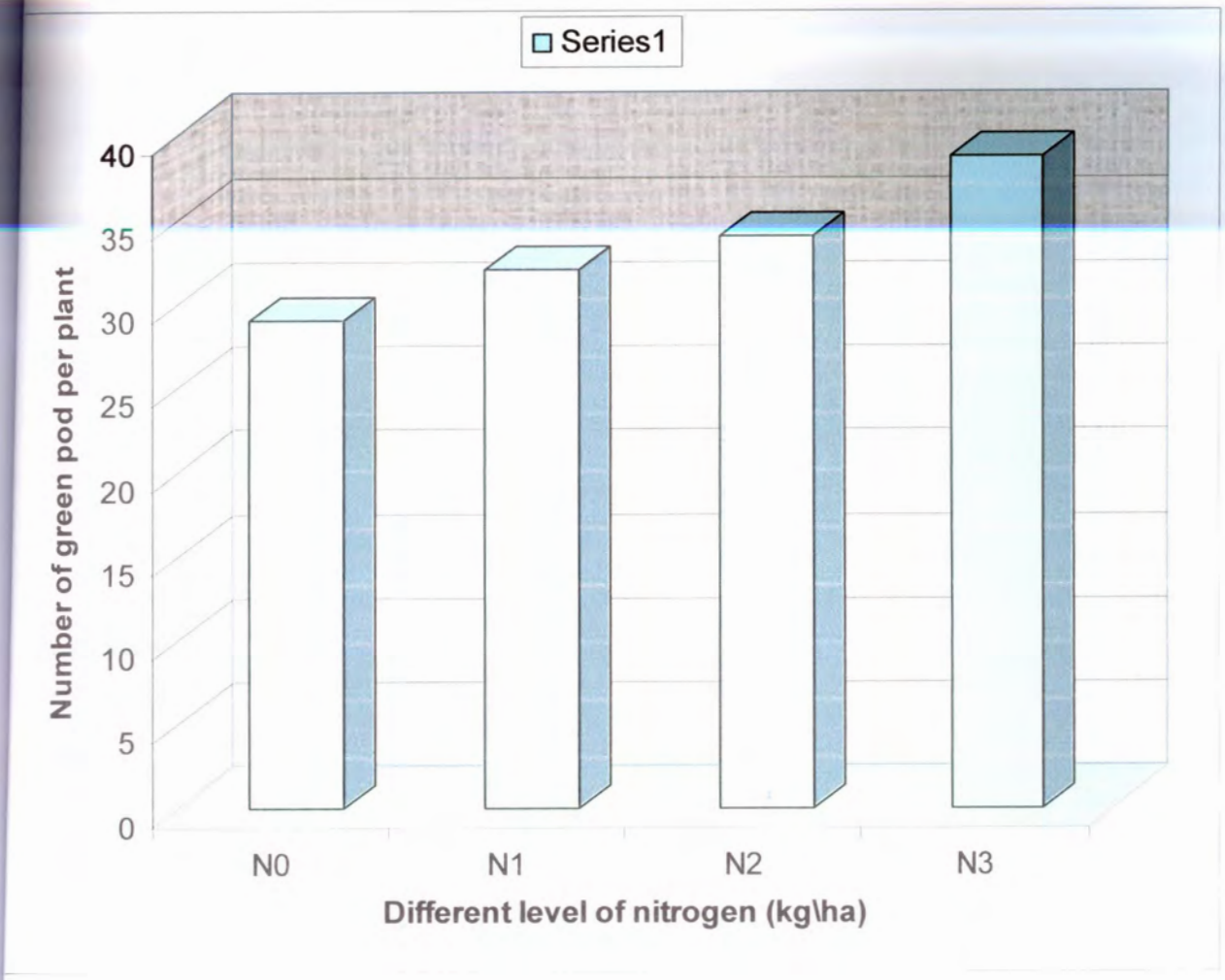


Fig.16. Effect of different nitrogen levels on number of green pod per plant of okra.

N_o = Control

N_1 = Nitrogen 70 Kg / ha

N_2= Nitrogen 110 Kg / ha

N_3 = Nitrogen 160 Kg / ha

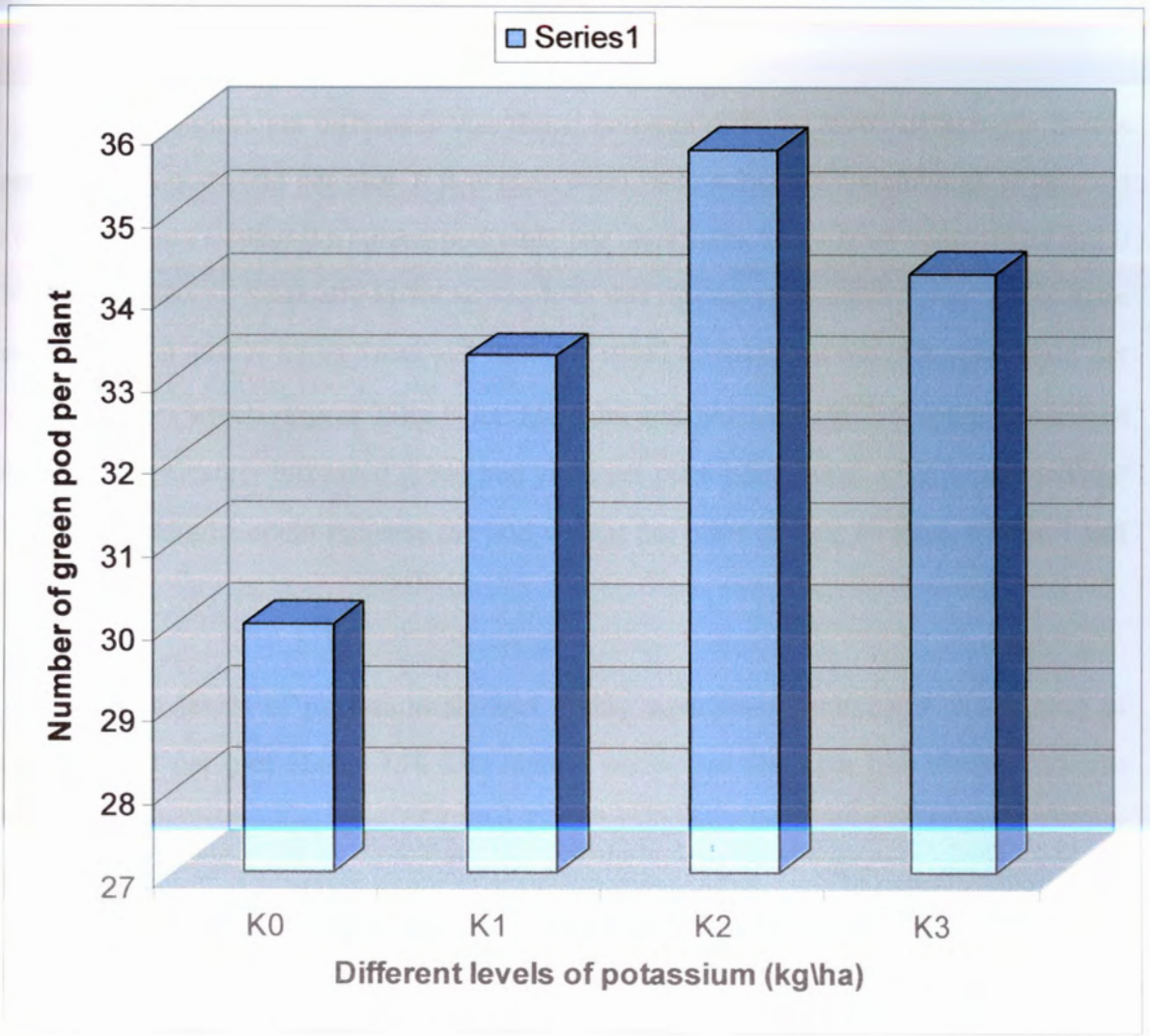


Fig. 17. Effect of different potassium levels on number of green pod per plant of okra.

K_o = Control

K_1 = Potassium 70 Kg / ha

K_2 = Potassium 80 Kg / ha

K_3 = Potassium 120 Kg / ha

4.11.1. Green pod yield kg per plot

Main effect of nitrogen and potassium

A highly significant difference was found between different levels of nitrogen in this respect of green pod yield per plot .It is evident from table 4 that the maximum (2.88kg/plot) and the minimum (1.89kg/plot) green pod yield per plant were found from 160kg N/ha and 0 kg N//ha respectively. Statically identical result in this respect were obtain from the nitrogen levels of 160 and 110 N kg/ha.Tmar and Rathore(1988) obsered that the green pod yield per plant was highest which respect 75kg N/ha. Majanbu and Sokuwa (1997) found that nitrogen application singificantly increased green pod yield per plant.Kurup et al (1997) reported that N rates upto 100kg/ha could increase the pod weight per plant of okra cv kiran. (Table 4 and Appendix 7)

Different levels of potassium showed highly significant variation in this respect of green pod yield per plot (Table 13). The highest green pod yield per plot (2.13kg/ha) was recorded from the potassium dose of 120kg K_2O /ha whereas the lowest green pod yield per plot (2.13kg/plot) was observed from control treatment. Mani and Rhman (1990) reported that that different K levels (K_2O at 0, 15, 30, 45, and 60kg/ha) had no significant effect on yield in absence of N.

4.11.2. Combined effect of nitrogen and potassium

There was no significant interaction effect of N and K on the green pod yield per plot but the combined effect was highly significant effect (Table 3) The combined effect of nitrogen and potassium in this respect was also significant on green pod yields per plot .The highest (3.0kg/plot) and lowest (1.80 kg/plot) green pod yields per plot were recorded from 160 kg N/ha +80 kg K_2O/ha as well 0 kg N/ha +0 kg K_2O/ha respectively (Table11).

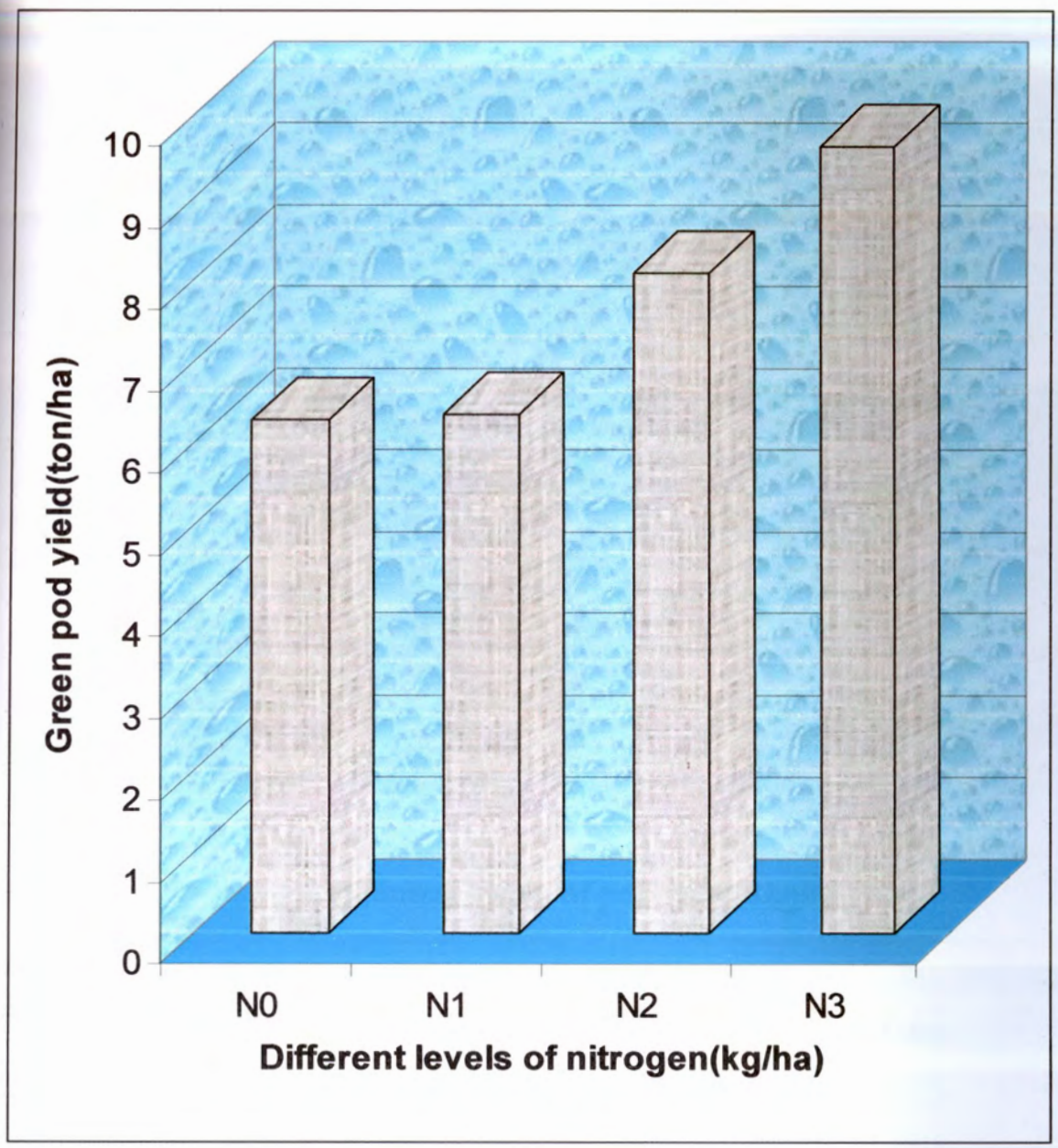


Fig. 18. Effect of different nitrogen levels on green pod yield (ton / ha) of okra

N_o = Control

N_1 = Nitrogen 70 Kg / ha

N_2 = Nitrogen 110 Kg / ha

N_3 = Nitrogen 160 Kg / ha

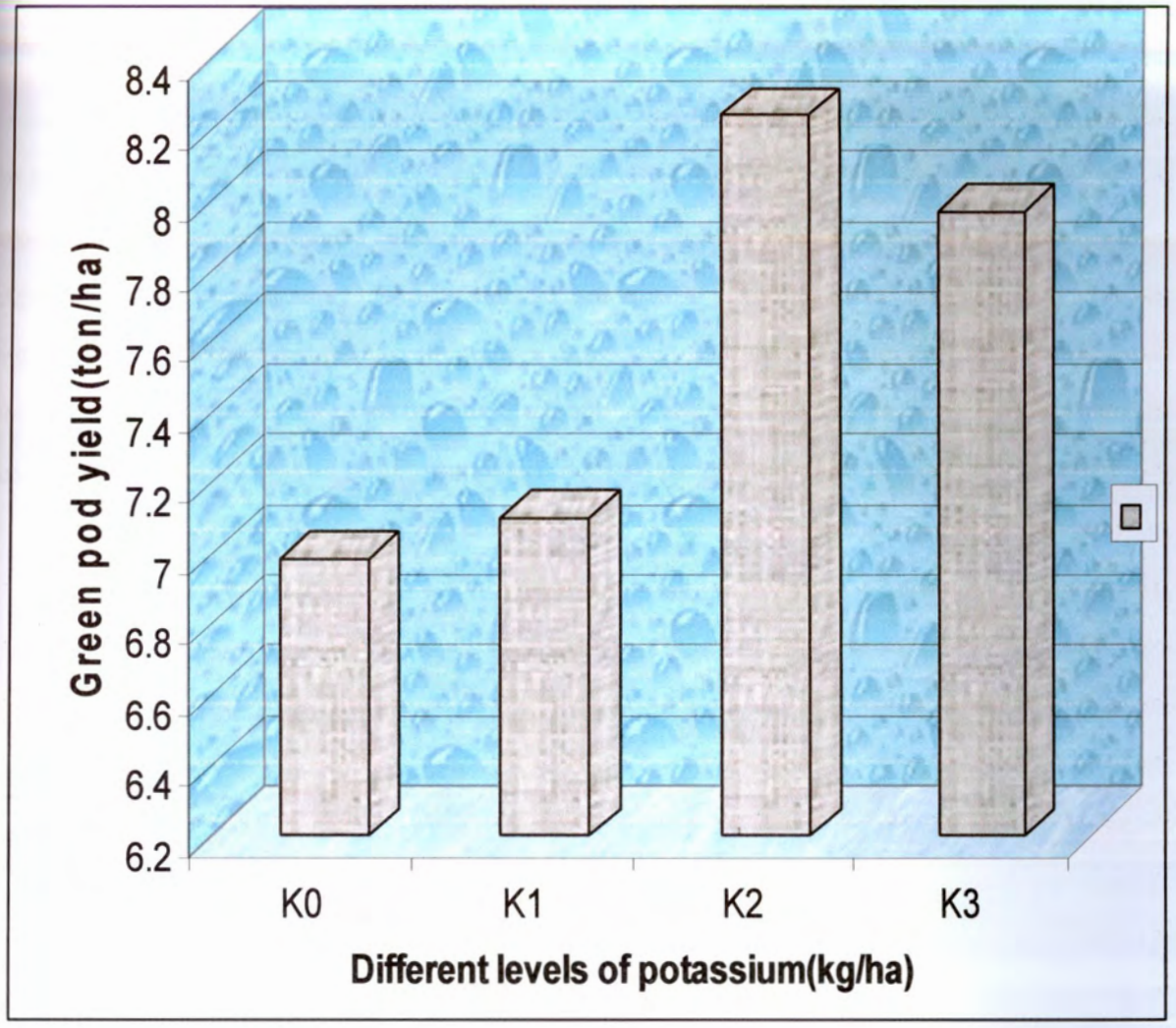


Fig. 19: Effect of different potassium levels on green pod yield (ton / ha) of okra.

K_o = Control

K_1 = Potassium 70 Kg / ha

K_2 = Potassium 80 Kg / ha

K_3 = Potassium 120 Kg / ha

4.12.1. Green pod yield per hectare

Main effect of nitrogen and potassium

The present study was revealed that there was a highly significant effect of nitrogen on green pod yield per hectare (Fig.18). The highest (9.602 ton/ha) and the lowest (6.278 ton/ha) pod yields per hectare were recorded from 160 kg N/ha and 0 kg N/ha respectively . Majanbu et,al (1985) and Somkuwar et, al (1997) found that nitrogen application significantly increased green pod yield . Sing (1995) reported that Nitrogen application improved the productivity of okra plants up to 200 kg/ha. Kurupet et, al (1997) also stated that N rates up to 100 kg/ha could increased the total green pod yield of okra cv. Kiran.

Different level of potassium fertilization exhibited highly significant effect on the green pod yield per hectare. (Fi19). Application of K_2O at the rate of 80 kg /ha, gave the maximum green pod yield per hectare (8.242 ton/ha) , whereas the minimum green pod yield per hectare (6.980 ton/ha) was obtained from the 0 kg K_2O/ha (Fig 19& Appendix 7). Mani and Ramanathan (1990) reported that different K level had no significant effect in the absence of N.

4.12.2. Combined effect of nitrogen and potassium

There was no significant interaction effect between the effect of Nitrogen and Potassium on the green pod yield per hectare (Appendix7). But the combined effect of treatments was highly significant. However, the maximum green pod yield per hectare (9.990 t/ha) was obtained with the treatment combination of 160 kg N/ha +80 kg K_2O/ha and the minimum (5.940 t/ha) with the control treatment (Table 3). Mani and Ramanathan (1990) reported that combined application of 80 kg N/ha with either 30 kg or 60 kg K_2O/ha produced the highest yields 17272 and 17526 kg/ha respectively and different K level had no significant effect on yield in the absence of nitrogen's.

Table-3.Main effect of nitrogen and potassium on the yield characteristics of okra.

Treatments	Yield characteristics		Treatments	Yield characteristics	
Nitrogen levels (Kg/ha)	Pod diameter (cm)	Pod yield per plot (Kg/plot)	Potassium level (Kg/ha)	Pod diameter (cm)	Pod yield per plot (Kg/plot)
N_0	1.36	1.89	K_0	1.40	2.13
N_1	1.47	1.90	K_1	1.41	2.10
N_2	1.59	2.42	K_2	1.53	2.47
N_3	1.41	2.885	K_3	1.46	2.39
LSD (0.05)	0.94	0.20	LSD (0.05)	0.94	0.207
LSD (0.01)	1.275	0.38	LSD (0.01)	1.275	0.38
Level of Significance	**	**	Level of Significance	**	**

NS=Non Significant

*Significant at 5% level

**Significant at 1% level

N_0 = Nitrogen 0 kg/ha (Control)

N_1 = Nitrogen 70 kg/ha

N_2 = Nitrogen 110 kg/ha

N_3 = Nitrogen 160 kg/ha

K_0 = Potassium 0 kg/ha (control)

K_1 = Potassium 40 kg/ha

K_2 = Potassium 80 kg/ha

K_3 = Potassium 120 kg /ha

Table no-4. Combined effect of nitrogen and potassium on the pod length, Pod diameter, green pod per plant, pod yield (kg/plot), pod yield (ton/ha) of okra

Treatment combination	Pod length	Pod diameter	Green pod per plant	Pod yield (kg/plot)	Pod yield(ton/ha)
N_0K_0	10.50	1.29	27.00	1.80	5.94
N_0K_1	10.90	1.31	28.0	1.83	6.09
N_0K_2	12.0	1.50	31.0	2.0	6.66
N_0K_3	11.60	1.35	30.00	1.93	6.42
N_1K_0	11.75	1.33	29.00	1.91	6.36
N_1K_1	12.75	1.48	32.00	1.21	7.03
N_1K_2	13.0	1.58	34.00	2.30	7.65
N_1K_3	12.90	1.50	33.00	2.21	7.35
N_2K_0	12.35	1.62	30.00	2.07	6.89
N_2K_1	13.18	1.49	35.00	2.48	8.22
N_2K_2	13.50	1.64	36.00	2.610	8.69
N_2K_3	13.35	1.61	35.00	2.55	8.49
N_3K_0	13.75	1.37	36.0	2.77	9.22
N_3K_1	13.90	1.39	38.0	2.88	9.58
N_3K_2	14.30	1.48	42.00	3.00	9.99
N_3K_3	14.0	1.40	39.00	2.89	9.62
Lsd 5%	0.459	1.89	3.75	0.41	0.5
Lsd 1%	0.62	2.55	5.05	0.77	0.56
Level of Signific	*	NS	NS	*	**

*Significant at 5% level

**Significant at 1% level

N_0 = Nitrogen 0 kg/ha (Control) K_0 = Potassium 0 kg/ha (control)

N_1 = Nitrogen 70 kg/ha K_1 = Potassium 40 kg/ha

N_2 = Nitrogen 110 kg/ha K_2 = Potassium 80 kg/ha

N_3 = Nitrogen 160 kg/ha K_3 = Potassium 120 kg /ha

4.25. Cost and return analysis

The cost and return analysis were done and have been presented in (Table 5) and appendix 5]. Materials (1A) non- materials (1B) and overhead cost were recorded for all the treatments of units and calculation on per hectare basis (Marketable yield) the prize of okra and the local market was considered.

The total cost of production ranges between TK. 70467 to TK. 75206 per hectare among the different treatments combination. The variation was due to different cost of fertilizer and manure and others. The cost of production Tk. 75,206 per ha was recorded from theof 160kg/ha+120kg K20/ha while the lowest cost of production Tk. 70467 per ha was recorded from the control treatments. Gross return from the different treatment combination range between Tk. 149850 to Tk. 89100 per ha..

Among the different treatments combination of 160kgNkg/ha+80kgK20/ha treatments gave the highest return Tk. 75,692 per ha. While the lowest treatments Tk. 18,633 was obtained from treatment combination of control treatments with no fertilizer. (Table 5)

The benefit cost ratio (BCR) was found to be the highest (2.02) from the combination of 160kg Nkg/ha+80kg K_20/ha treatments and the lowest BCR 1.23 was recorded from the control treatments. Thus it was apparent that although the 160kg Nkg/ha+80kg K_20/ha treatments gave the highest yield (9.99 ton/ha) and the highest net return (Tk. 75,692) and the BCR (2.02)

Table 5- Combined effect of nitrogen and potassium on cost and return of okra.

Treatment combination	Marketable yield (ton/ha)	Gross return (Tk./ha)	Total cost of production (Tk./ha)	Net return (Tk./ha)	Benefit cost ratio (BCR)
N_0K_0	5.94	89100	70467	18633	1.23
N_0K_1	6.09	91350	72017	19333	1.26
N_0K_2	6.66	99900	73065	26835	1.36
N_0K_3	6.42	96300	73777	23235	1.30
N_1K_0	6.36	95400	71928	23472	1.32
N_1K_1	6.03	90450	73690	16760	1.24
N_1K_2	7.65	114750	74403	40347	1.54
N_1K_3	7.35	110250	73400	36850	1.50
N_2K0	6.89	103350	72998	30352	1.41
N_2K_1	8.22	12300	74046	49254	1.66
N_2K_2	8.69	130350	74760	55590	1.74
N_2K_3	8.49	127350	72731	54619	1.75
N_3K_0	9.22	138300	73443	64857	1.88
N_3K_1	9.58	143700	74492	69208	1.92
N_3K_2	9.99	149850	74158	75692	2.02
N_3K_3	9.62	144300	75206	69091	1.91

N_0 = Nitrogen 0 kg/ha (Control) K_0 = Potassium 0 kg/ha (control)

N_1 = Nitrogen 70 kg/ha K_1 = Potassium 40 kg/ha

N_2 = Nitrogen 110 kg/ha K_2 = Potassium 80 kg/ha

N_3 = Nitrogen 160 kg/ha K_3 = Potassium 120 kg /ha

CHAPTER V

SUMMARY AND CONCLUSION

. The experiment was conducted at the center farm of Sher-e- Bangla Agricultural University during the period of April to July 2005. In experiment to evaluate the effects of fertilizer management of different levels of nitrogen and Potassium on the growth and yield of okra. The experiment consists of two factors such as four nitrogen levels viz, 0, 70, 110 and 160 kg N per hectare and four levels of potassium levels viz, 0, 40, 80, and 120 kg/ha, Two factors experiment was laid out in Randomized Complete Block Design (RCBD) with the three replication.There were altogether 16 treatments combination in this experiment. Each between blocks and plots respectively were maintained. Each unit plot had 2 rows and each with ten plants .The plants of two rows in each unit plots were considered vegetable (green pod) production and the plants of other two rows were considered for growth of okra. The okra seeds of ev. BARI- Deherosh 1, was sown on 8 April 2005. Data were recorded on growth and yield contributing parameters and collected data were statistically analyzed for evaluation of the treatments effects. The mean differences were adjusted by least significant different (LSD) test.

Different levels of nitrogen and potassium significantly influenced all parameters. It was observed that nitrogen applied at 160 kg/ha increased the plant height, plant diameter, and petiole length, leaves length, leaves breadth, number of leaves, numbers of branch which were significantly different from at, 20 DAS, 40 DAS and 60 DAS. It was revealed that nitrogen application at 160 kg/ha also influenced the Green pod length, green pod diameter, number of green pod per plants. green pod yield kg/plot, green pod yield t/ha, which are significantly different from all other treatment levels.

The maximum plant height 80.39cm plant diameter 3.43cm petiole length 23.79cm leaves length 22.83cm leaves breadth 19.62cm number of leaves 61.91 and number of branches 5.25 were found from the plants receiving 160 kg N/ha at 60 DAS and the maximum green pod yield, 2.88 kg/plot were found from the plants receiving 160 kg N/ha and maximum green pod yield, 9.602 ton/ha were found from these plants receiving 160 kg N/ha. The minimum plant height, 65.94 cm plant diameter, 2.51 cm petiole length, 19.78 cm, leaves length ,15.46 cm leaves breadth, 15.32 cm number of leaves, 52.20, number of branche.were found from the plant receiving 0 kg N/ha at 60 DAS, respectively and theminimum green pod yield 1.89 kg/plot and minimum green pod yield 6.27 ton/ha were recorded from control treatment (0 kg N/ha)

It was revealed that application of K_2O up to 80 kg/ha significantly influenced by the plant height, diameter, petiole length, leaves length, leaves breadth, number of leaves, number of branch, green pod length diameter, and yield per ha. The highest plant height is 75.97 cm, plant diameter 3.17 cm, petiole length 22.89 cm , leaves length 20.35 cm, leaves breadth 18.04 cm , number of leaves 59.12 , number of branch 5.12 were obtained by the application of 80 kg K_2O/ha at 60 DAS and highest yield 8.24 ton/ha were found from the plant receiving 80 kg K_2O/ha. On the other hand, the lowest plant height 70.10 cm , plant diameter 2.71 cm, petiole length 20.93 cm , leaves length 18.00 cm , leaves breadth 16.25 cm , number of leaves per plant 54.52 , number of branch per plant 4.18 were recorded from the control treatment 0 kg K_2O/ha at 60 DAS and pod length 12.08 cm and green pod diameter 1.40 cm ,number of green 30.50 per plot , green pod yield,6.98 ton/ha were found with the application of 0 kg K_2O/ha.

The treatment combination of (160 kg N/ha and 80 kg K_2O/ha) gave the highest result in respect of plant height, petiole length, leaves length, leaves breadth, number of leaves per plant and number of branch per plant, green pod length, number of green pod per plant, green pod yield per plant, green pod yield ton/ha were statically significant. The maximum plant height 82.04 cm, plant diameter 3.51 cm, petiole length 24.26, leaves length 23.50 cm leaves breadth 20.10 cm, number of leaves per plant 62.66, number of branch per plant 6.51 were recorded by the application of 160 kg N/ha and 80 kg K_2O/ha at 60 DAS and maximum pod length 14.03 cm, green pod diameter 14.80 cm, number of green pod per plant 42.00 and yield 9.99 ton/ha were produced by the same treatment. The plant fertilized with the treatment combination 0 kg N/ha and 0 kg K_2O/ha gave the minimum plant height63.24 cm, plant diameter 2.41 cm, petiole length18.03, leaves length 15.76 cm , leaves breadth 14.50 cm , number of leaves per plant 49.25, number of branch per plant 3.25 at 20 DAS and gave the minimum green pod diameter 12.90 cm, green pod length 10.50 cm , number of green pod per plant 27.00 , green pod yield per plant 1.03 kg/plot and green pod yield per hectare 5.94 ton/ha . The combined effect of Nitrogen and Potassium had insignificant effect of plant height and plant diameter at 60 DAS also Leaf Length, and Leaf breadth.

Therefore it may be suggested that nitrogen level at 160 kg N/ha and potassium levels at 80 kg K_2O/ha can be used successfully for commercial okra production. However, further studies in this relation should be carried out in other region of the country before final recommendation.

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APPENDICES

Appendix i. Characteristics of entire farm soils as analyzed by Soil Resources Development Institute (SRDI) Khamarbari , Farmgate , Dhaka.

A . Morphological Characteristics of the experimental field

Morphological Feature	Characteristics
Location	Center farm SAU Dhaka
AEZ	Madhupur Tract (28)
General Soil Type	Shallow and Brown Terrace Soil
Land Type	High Land
Soil Series	Tejgaon
Topography	Fairly leveled
Flood Level	Above Flood Level
Drainage	Well Drained
Cropping Pattern	Fellow Lettuce

B. Physical and Chemical properties of the initial soil

Characteristics	Value
Particle size analysis (Mechanical analysis)	
% Sand	27
%Silt	43
%Clay	30
Textural class	Silt clay
Chemical analysis	
PH	5.6
Organic Carbon (%)	0.45
Organic Matter (%)	0.78
Total N (%)	0.03
Available P (ppm)	20.00
Exchangeable K (me/100 gm soil)	0.10
Available S ppm	45

Source;SRDI

Appendix ii. Monthly records of year rainfall , relative humidity , soil temperature and sun shine of the experimental site during the period from 2005 January to July

Year	Month	*Air Temperature (0c)`			Relative Humidity (%)	Rainfall (mm)	Soil Temperature			**Sun Shine (hr)
		Maximum	Minimum	Mean			5 cm Depth	10 cm Depth	20 cm depth	
2005	January	24.52	13.86	19.19	68.46	04	11.3	11.3	13.0	194.1
	February	28.88	17.98	23.43	61.04	03	12.9	12.09	13.8	221.5
	March	29.55	18.93	24.24	63.04	155	13.3	13.3	13.9	220.9
	April	30.97	20.45	25.71	65.05	159	14.1	14.1	14.9	215.2
	May	31.57	21.55	26.56	67.2	162.3	14.5	14.5	15.1	212.2
	June	32.3	22.5	27.4	68.9	165.5	14.9	14.9	15.7	208.3
	July	32.5	25.5	29	70.2	170.8	15.3	15.3	16.2	205.5

*Monthly average

** Monthly total

Source; Bangladesh Meteorological Department (Climate division)
Agargoan, Dhaka-1207

Appendix iii: Analysis of variance of the data on the growth of okra

Source of Variation	DF	Mean of Squere																
		Plant Height (cm)			Plant diameter(cm)			Petiole length (cm)			Leaf length (cm)			No of leaves			No of Branch		
		60 DAS	40 DAS	20 DAS	60 DAS	40 DAS	20 DAS	60 DAS	40 DAS	20 DAS	60 DAS	40 DAS	20 DAS	60 DAS	40 DAS	20 DAS	60 DAS	40 DAS	20 DAS
Replication	2	46.07	33.11	7.56	21.87	3.423	3.44	1.07	6.250	0.007	1.156	0.835	0.422	3.85	0.598	0.072	0.98	0.34	0.569
Factor (A) Nitrogen	3	69.865	135.74	16.06	194.23	53.334	52.74	37.181	34.027	9.926	91.21	68.43	18.74	218.78	152.48	7.855	4.28	3.98	5.62
Factor (B) Potassium	3	8.67	22.22	2.24	41.48	9.59	9.38	8.37	9.70	1.355	12.75	10.93	6.20	44.00	9.46	2.167	4.25	2.64	4.61
Interaction N×K	9	0.314	0.767	0.246	7.96	0.752	0.781	1.08	0.255	0.099	1.097	0.774	0.470	6.252	1.94	2.25	1.77	1.85	1.90
Error	30	2.85	4.520	0.679	5.12	6.055	6.03	0.336	1.31	0.010	0.307	0.894	0.628	2.188	0.265	0.434	0.209	0.13	0.163

Appendix iv: Analysis of variance of the data on the yield of okra

Source of variation	Degrees of Freedom (DF)	Green pod length	Mean of sum square			
			Pod Diameter	No. of pod per plant	Pod yield per plot (kg/plot)	Pod yield (ton/ha)
Replication	0.316	2.292	0.663	5.063	0.063	0.250
Factor (A) Nitrogen	15.68	12.058	2.714	201.188	2.714	30.194
Factor (B) Potassium	2.76	5.346	0.420	58.688	0.420	4.742
Interaction N×K	0.186	0.925	0.181	2.012	0.181	1.973
Error	0.076	1.290	0.062	5.063	0.062	0.117

** Significant at 1% level

* Significant at 5% level

Appendix V: Production cost of Okra per Hectare

(A) Material cost (Tk./ha)

Treatment Combination	Seed (4 kg/ha) Tk.	Fertilizer and Manure				Subtotal 1(A)
		Cow dung	Urea	TSP	MP	
N_0K_0	8000	6000	--	1600	--	15600
N_0K_1	8000	6000	--	1600	640	16240
N_0K_2	8000	6000	--	1600	1280	16880
N_0K_3	8000	6000	--	1600	1920	17520
N_1K_0	8000	6000	560	1600	--	16160
N_1K_1	8000	6000	560	1600	1280	17440
N_1K_2	8000	6000	560	1600	1920	18080
N_1K_3	8000	6000	880	1600	--	17480
N_2K0	8000	6000	880	1600	640	17120
N_2K_1	8000	6000	880	1600	1280	17760
N_2K_2	8000	6000	880	1600	1920	18400
N_2K_3	8000	6000	1280	1600	--	16880
N_3K_0	8000	6000	1280	1600	640	17520
N_3K_1	8000	6000	1280	1600	1280	18160
N_3K_2	8000	6000	1280	1600	1280	18160
N_3K_3	8000	6000	1280	1600	1920	18880

Okra Seed @ 8000/kg

Cow dung @ 600/ton

Urea @ Tk.8/kg

TSP @ Tk.16/kg

MP @Tk.16/kg

Appendix V : contd.

(B) Non- material cost (Tk./ha)

Treatment Combination	Land Preparation	Fertilizer and manure application	Seed Sowing	Intercultural Operation	Harvesting	Subtotal 1(B)	Total Input Cost 1(A)+1(B
N_0K_0	10500	--	5250	10000	7500	33250	48850
N_0K_1	10500	750	5250	10000	7500	34000	50240
N_0K_2	10500	1050	5250	10000	7500	34300	51180
N_0K_3	10500	1050	5250	10000	7500	34300	51820
N_1K_0	10500	750	5250	10000	7500	34000	50160
N_1K_1	10500	1050	5250	10000	7500	34300	51740
N_1K_2	10500	1050	5250	10000	7500	34300	52380
N_1K_3	10500	750	5250	10000	7500	34000	51480
N_2K0	10500	750	5250	10000	7500	34000	51120
N_2K_1	10500	1050	5250	10000	7500	34300	52060
N_2K_2	10500	1050	5250	10000	7500	34300	52700
N_2K_3	10500	750	5250	10000	7500	34000	50880
N_3K_0	10500	1050	5250	10000	7500	34000	51520
N_3K_1	10500	1050	5250	10000	7500	34300	52460
N_3K_2	10500	750	5250	10000	7500	34000	52160
N_3K_3	10500	1050	5250	10000	7500	34300	53100

Appendix V : Contd.

(C) Overhead cost and total cost of Production (Tk.)

Treatment Combination	Cost of Lease Land	Miscellaneous Cost (5% of Implementers cost)	Interest on running Capital for 6 Months(13% of total input cost)	Total	Total cost of production(Input cost + Interest on running Capital Tk./ha)
N_0K_0	16000	2442	3175	21617	70467
N_0K_1	16000	2512	3265	21777	72017
N_0K_2	16000	2559	3326	21885	73065
N_0K_3	16000	2591	3368	21959	73779
N_1K_0	16000	2508	3260	21768	71928
N_1K_1	16000	2587	3363	21950	73690
N_1K_2	16000	2619	3404	22023	74403
N_1K_3	16000	2574	3346	21920	73400
N_2K0	16000	2556	3322	21878	72998
N_2K_1	16000	2603	3383	21986	74046
N_2K_2	16000	2635	3425	22060	74760
N_2K_3	16000	2544	3307	21851	72731
N_3K_0	16000	2575	3348	21923	73443
N_3K_1	16000	2623	3409	22032	74492
N_3K_2	16000	2608	3390	21998	74158
N_3K_3	16000	2655	3451	22106	75206

Appendix vi:Combined effects of Nitrogen and Potassium on the growth.

Treatments	Growth																	
	Plants height (cm)			Plant diameter (cm)			Petiole length (cm)			Leaf length (cm)			No. of leaves			No. of branch		
	60 DAS	40 DAS	20 DAS	60 DAS	40 DAS	20 DAS	60 DAS	40 DAS	20 DAS	60 DAS	40 DAS	20 DAS	60 DAS	40 DAS	20 DAS	60 DAS	40 DAS	20 DAS
N_0K_0	63.24	45.72	14.56	2.4100	1.7900	1.3900	18.033	12.50	1.75	15.76	14.50	7.33	49.25	15.033	5.083	3.25	3.75	1.25
N_0K_1	62.27	48.89	15.06	2.4500	1.8100	1.4100	18.90	13.70	1.90	15.10	14.80	7.82	5.50	16.20	6.50	4.50	3.50	1.50
N_0K_2	68.83	54.17	15.49	2.6100	1.9200	1.5200	21.70	14.80	2.05	17.10	16.10	8.50	57.08	17.10	6.58	4.75	3.31	2.75
N_0K_3	66.04	53.11	14.12	2.5700	1.8800	1.4800	19.70	14.00	2.10	16.90	15.70	8.633	52.00	18.66	5.08	3.00	4.14	3.00
N_1K_0	66.97	51.20	14.47	2.5067	1.8400	1.4400	20.70	13.80	2.00	16.50	15.20	7.93	50.25	17.03	7.50	4.25	3.25	1.25
N_1K_1	71.20	57.91	16.76	2.7067	1.9867	1.6200	22.00	15.80	21.50	18.20	17.20	9.00	54.46	16.06	5.58	5.50	3.29	3.50
N_1K_2	73.66	57.55	18.03	3.2100	2.1200	1.7200	22.90	16.50	2.90	19.10	18.30	9.63	56.253	16.03	6.25	3.75	4.50	2.75
N_1K_3	72.64	56.64	17.52	2.7700	2.0800	1.6800	22.30	16.10	2.750	18.80	17.70	9.40	55.76	18.20	5.43	3.33	4.25	3.00
N_2K_0	71.798	54.61	16.25	2.6367	1.9800	1.5800	21.80	15.20	2.26	17.70	16.60	9.133	56.37	19.10	7.75	4.25	3.75	3.25
N_2K_1	58.42	60.50	18.79	3.2700	2.1833	1.7833	22.30	16.50	3.00	20.80	18.80	16.10	57.08	20.06	8.33	5.16	4.50	4.50
N_2K_2	76.2	65.10	20.06	3.3700	2.2733	1.8700	22.70	17.10	3.50	21.70	19.46	10.43	60.50	21.06	7.16	5.50	3.25	2.69
N_2K_3	76.2	60.96	19.05	3.3033	2.2300	1.8300	23.28	18.80	3.25	21.10	19.40	11.80	58.75	22.03	6.69	3.75	5.25	4.00
N_3K_0	78.48	67.31	20.54	3.3600	2.300	1.900	23.20	17.00	3.80	22.03	20.30	10.20	61.25	23.03	7.00	5.00	3.35	2.27
N_3K_1	80.01	69.85	21.33	3.400	2.2833	1.8833	23.70	17.50	4.00	22.70	20.90	10.33	62.50	24.20	6.25	4.25	5.41	3.50
N_3K_2	82.04	74.90	22.86	3.5100	2.4100	2.0100	24.36	18.50	4.50	23.50	21.50	11.50	62.66	25.20	8.50	6.31	6.16	4.75
N_3K_3	81.02	70.00	22.09	3.4600	2.3700	1.9700	24.00	18.10	4.10	23.10	21.00	11.10	61.25	24.10	7.25	5.25	4.91	3.00
Lsd 5%	4.495	0.545	1.374	3.773	4.102	4.095	0.96	1.91	0.166	0.92	1.57	1.32	2.46	0.85	1.09	0.76	0.61	0.67
Lsd 1%	4.699	0.77	1.85	5.080	5.522	5.513	1.30	2.57	0.22	1.24	2.12	0.178	3.32	1.15	1.48	1.03	0.83	0.91
Level of Significance	*	**	*	NS	NS	NS	*	NS	**	**	NS	NS	*	**	**	**	**	**

NS= Non significant
* = Significant at 5% level
** = Significant at 1 % level

Appendix vii: Combined effect of Nitrogen and Potassium on the yield of Okra.

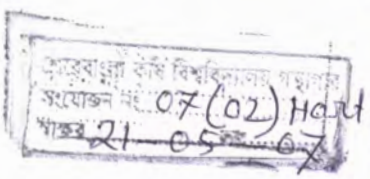
Yield				
Green Pod Length (Cm)	Green Pod Diameter (Cm)	No of Green Pod/plant	Yield /plot (kg/plot)	Yield Ton/ha
Day After Interval				
10.50	1.29	27.00	1.80	5.94
10.90	1.31	28.00	1.83	6.09
12.00	1.51	31.00	2.00	6.66
11.60	1.35	30.00	1.93	6.42
11.75	1.33	29.00	1.91	6.36
12.75	1.48	32.00	1.21	4.03
23.00	1.58	34.00	2.30	7.65
12.90	1.501	33.00	2.21	7.35
12.35	1.623	30.00	2.071	6.89
13.18	1.49	35.00	2.48	8.22
13.50	1.69	36.00	2.61	8.69
13.35	1.61	35.00	2.55	8.49
13.75	1.37	36.00	2.77	9.22
13.90	1.39	38.00	2.88	9.58
14.30	1.48	42.00	3.00	9.99
14.00	1.40	39.00	2.89	9.62
0.43	1.89	3.75	0.415	0.57
0.63	2.55	5.05	0.77	0.56
*	NS	NS	*	**

NS= Non significant
* = Significant at 5 % level
** = Significant at 1 % level

NS=Non Significant

*Significant at 5% level

**Significant at 1% level



N_0 = Nitrogen 0 kg/ha (Control)

N_1 = Nitrogen 70 kg/ha

N_2 = Nitrogen 110 kg/ha

N_3 = Nitrogen 160 kg/ha

K_0 = Potassium 0 kg/ha (control)

K_1 = Potassium 40 kg/ha

K_2 = Potassium 80 kg/ha

K_3 = Potassium 120 kg/hitrogen 160 kg/ha