EFFECTS OF NITROGEN, SOWING DATE, POPULATION AND VARIETY ON GROWTH, YIELD COMPONENTS AND YIELD OF OKRA *(Abelmoschus esculentus* (L.) Moench).

v

BY

MOSES ASHOLA AMADU

A THESIS SUBMITTED TO THE POST-GRADUATE SCHOOL OF AHMADU BELLO UNIVERSITY, IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN AGRONOMY

DEPARTMENT OF AGRONOMY
FACULTY OF AGRICULTURE
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DECLARATION

I hereby declare that this thesis has been written by me and that it is a record of my own research work. It has not been presented in any previous publication for a degree.

(Candidate)

The above declaration is confirmed.

8-5-2000

Prof. M. K. Ahmed
(Major Supervisor)

Date: 8-5-2000

CERTIFICATION

This thesis entitled "EFFECTS OF NITROGEN, SOWING DATE, POPULATION AND VARIETY ON GROWTH, YIELD COMPONENTS AND YIELD OF OKRA (*Abelmoschus esculentus* (L.) Moench) by MOSES ASHOLA AMADU meets the regulations governing the degree of Doctor of Philosophy of Ahmadu Bello University, Zaria, and is approved for its contribution to Scientific knowledge and literary presentation.

8-5-2000

Prof M.K. Ahmed
Chairman,
Supervisory Committee

(On-Sabbatical)

Prof. V.B. Ogunlela
Member,
Supervisory Committee

Represented
24/5/00

Dr. E.B. Amans
Head,
Dept. of Agronomy

Dean,
Postgraduate School

Date: 12/03/01

Ahmadu Bello University, Zaria.

DEDICATION

The work is dedicated to my wife, FLORENCE and our children, OYINLOLA, OLUSOLA, JUWON and TOSIN for their prayers throughout the period of this study.

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ABSTRACT

The responses of two okra (Abelmoschus esculentus (L.) Moench) varieties (Local-1 and V-35) sown at two sowing dates (early and late, depending on establishment of rains) with 3 levels each of nitrogen, (0, 45, and 90kgN/ha) and 3 populations (22,000, 44,000 and 88,000 plants/ha) were investigated during 1992 to 1994 rainy seasons. The experiments were conducted in a split plot design, replicated 3 times at the Institute for Agricultural Research Farm, Samaru. The main plot treatments were factorial combinations of nitrogen and sowing date, while sub-plot treatments consisted of a combinations of 3 populations and two varieties (variety Local-1 and variety v-35). Date of sowing and nitrogen were found to influence the growth parameters. An increase in nitrogen levels increased the growth parameters including number of leaves, fresh weights of stem and roots, leaf area, leaf area index, and plant height. It also increased yield components and yield in all experiments. Populations and varieties were not consistent in their effects during the period of study. A delay in sowing reduced most of the growth parameters as well as yield components and yield. Correlation coefficient of growth parameters and yield components were found to be consistently close and positively correlated with the yield. Among factors studied, date of sowing is the most crucial factor affecting both vegetative characters and yield components, followed by nitrogen, population and variety. The adapted Local-1 cultivar, with a population of 22,000 plants/ha and at 90kgN/ha is optimum for production under Samaru conditions.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Okra Production and its economic importance

Okra (Abelmoschus esculentus (L.) Moench) is a member of the Malvaceae family. The crop is a tropical and sub-tropical annual and a native to Africa (Woodroof, 1927). It was grown by the Egyptians in the 13th century and probably from there spread to the Mediterranean region (Corley 1965). The total world production was estimated at 4 million tonnes out of which developing countries produced about 3.1 million tonnes (Grubben 1977). Although no production figures are available for Nigeria because most of the produce is consumed locally, a yield range of 6 to 12t/ha was recorded under local conditions where it is cultivated alone or in mixture with other crops such as pepper over a total area of about 1.5 million hectares (Anon, 1980).

In Nigeria, okra is normally produced throughout the year. It is produced in abundance under rainfed conditions, but on limited hectarage in the dry season with irrigation. The fresh immature fruits (pods) and leaves are valued for their mucilagenous properties. Eka, (1978) observed that mucilagenous property, that is sliminess or ability to draw, is an important determinant of acceptability of okra cultivars in most African countries.

Okra is a good source of vitamins, minerals and proteins. The pod has an ascorbic acid content of 203mg/100g in fresh fruit (Keshinro and Ketiku 1979) and high levels of calcium, iron, fibre and ash (Oyenuga, 1968; Oyolu, 1983). The plants is also useful for its fibre, oil and medicinal properties. There is a lot of cash value attached to this crop, depending on the market situation, time of production in the year and relative demand. Although the volume of internal trade in okra is not actually known, this is likely to be substantial among states, while also varying from state to state.

Research work on native vegetables in Nigeria has received relatively little attention. Until recently, there was virtually no research information on the basis of agronomic requirements of the okra crop. The yield response of okra varieties to nitrogen fertilizer has been reported in the forest zone of Nigeria (Fatokun and Chheda, 1983) and northern Guinea savannah zone as well (Majanbu et al., 1985). However, most of the reports on the effect of nitrogen application on green pod yield of okra have been conflicting (Majanbu, 1983; Majanbu et al.1985; Adejonwo, 1988).

Unfavourable soil conditions such as high soil temperature and inadequate soil moisture can be detrimental to the production of okra (Daniel-Kalio, 1982). However under favourable conditions, it develops so rapidly that it requires only about two-three months from sowing to harvesting first fruits (Ukwueze, 1987). The plant may continue to produce fruits for over a period of seven or more weeks, especially if the fruits are picked promptly and not allowed to mature (Boswell and Reed, 1962). There is evidence which shows that frequent harvesting or picking of fresh fruits (pods) promotes fruiting of the crop,(Khalid and Hamid, 1964; Perkins et al. 1972). The cultivation of okra is mostly done by peasant farmers or part time farmers. Okra is sometimes grown as a sole crop or as an intercrop with other crops. This depends upon the grower's decision. Okra fruits (pods) tend to become fibrous with age, thus declining in quality. If the fruits (pods) are to be sun dried and stored for future use, they are allowed to reach maximum tender growth before harvesting and later sliced into pieces (Van-Epenhuijsen, 1974).

In Nigeria, little research work on the nutritional requirements of okra has been reported. It has been generally observed that the crop gives poor yields, a situation which is often associated with its stunted growth. One of the reasons to which this calamity can be associated may be improper nutrition and poor choice of sources of nutrients used, coupled with inappropriate date of sowing and plant population. Although various sources of fertilizer are being used by farmers growing okra, information derived through research work

is very scanty. The various reported results to investigate the effect of variety on okra performance have largely been inconsistent at best. With this background, the aspects of nitrogen nutrition, sowing date and plant population were investigated on okra varieties with the following objectives:-

1. To determine the effect of nitrogen, sowing date, population on growth, yield and yield components of two okra varieties.

2. To determine the interactions between nitrogen, sowing date, population and varieties of okra (*Abelmoschus esculentus* (L.) Moench).

3. To identify suitable plant population, variety and sowing date for okra production.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Nitrogen Status of Savannah Soils

Savannah soils are inherently low in organic matter content and there is no available nitrogen to sustain crop growth for even one season (Ologunde, 1981). According to Jones and Wild, (1975), the total nitrogen contents of savannah soils ranges from 0.008 to 0.29 percent. These reports of low values were closely linked to the generally low levels of organic matter in those soils. Jones (1973) found carbon content of the savannah soils had a mean value of 0.60 percent. Although the total nitrogen content of savannah soil is low, it is important to note that these values fluctuate from year to year in a particular soil. There is however also a build up of mineralized nitrogen during the dry season and this declines rapidly after the onset of rains (Jones and Wild, 1975).

The effect of rainfall and symbiotic fixations on the nitrogen status of savannah soils are worthy to note (Jones and Wild, 1975). The annual contribution of nitrogen by rainfall is small. At Samaru, the amount ranges from 4 to 5kg/ha annum (Jones and Bromfield, 1970). Most accounts of non-symbiotic nitrogen fixation in savannah soils are mainly of qualitative rather than of quantitative importance (Jones and Wild, 1975), hence no reliable estimate can be given on the significance of non-symbiotic fixation in savannah soils. Weinhard et al. (1971) concluded that non-symbiotic fixation in the rhizosphere makes significant contribution to the nitrogen economy of the soil plant system in fallow as well as under arable cropping.

Of equal importance to the nitrogen status of savannah soils is the amount lost yearly through burning and cultivation. Jones and Wild (1975) observed that bush burning was the

main agent of nitrogen loss from natural savannah. Cultivation increases soil aeration and this enhances mineralization and also increases the risk of nitrogen loss through leaching and denitrification.

Ologunde (1981) reported that the principal pathway of organic nitrogen loss from soil of savannah is through leaching. Nitrogen is also lost through burning of crop residues. Native vegetation and rhizosphere population of grasses are also destroyed from cultivated soils and there is a declining return of plant residue to the soil; consequently, the potential for biological fixation is reduced. An annual decline in total nitrogen of more than 4% percent from soils under continuous cultivation at Samaru was reported (Jones, 1971).

2.2 Varieties of okra

Studies on the growth of two okra varieties in the humid tropics or rain forest zone in Nigeria, have shown that the number of fruits produced significantly influenced the yield of variety (Adelana 1981; Fotokun and Chheda, 1981). The variety with the highest number of fruits per plant, therefore produced the higher yield. However, additional factors to the yield in variety was the time of sowing, amount of rainfall, plant population, diseases and weed control.

In an experiment using two varieties of okra namely V-35 and Jokoso, Adelana (1983), observed that the growth pattern in the varieties were similar, but different in leaf area and dry matter accumulation. The variety (Jokoso) with higher dry matter content and leaf area was relatively more vigorous. Majanbu (1983) and Majanbu et al. (1985) observed higher fruit number from NIIAE 47-4 than from white velvet, though the two varieties attained similar height. They reported that variety NIIAE 47-4 was more responsive to nitrogen than white velvet.

Mani and Ramanathan (1980) reported that optimum nitrogen requirement of variety of okra would depend on genetic, climatic and edaphic factors. Their observations were informed by the amount of rainfall, nutrient status of the soil and the response of the crop to nitrogen. Kuwada (1964) after studying three to four okra varieties with respect to their plant height, number of nodes, stem diameter and leaf shape, concluded that variation in okra could be attributed to geographical origin.

The two okra varieties used in these studies namely, Local-1 and V-35, have similar growth patterns, but they differ morphologically. The leaves of variety Local-1 are spherical, thin, glabrous with serrated margins. The stems are glabrous and about 110 cm in height. The fruits are longer, glabrous and cylindrical. The flowers which are bright yellow in colour are carried singly in the leaf axis on peduncles rarely more than 3cm in length . Duration of variety Local-1 is 150 days and the total green pod yield is 3 t/ha.

Variety V-35 has large alternate cordate and thicker leaves with three of five smooth edged lobes. The stems are shorter and about 95cm in height. The fruits are shorter and roundish. The flowers which are bright in yellow in colour are carried singly in the leaf axis on peduncles rarely more than 3cm in length. The duration is also 150 days. Its total pod yield is 2.5 to 3t/ha.

2.3 Effect of nitrogen application on nitrogen content of okra

Plant mineral nutrition is considered as the supply and absorption of nutrients by a plant for the manufacture of organic substances. Jacob and Uexkull (1958) concluded that nutrients absorbed by plants promote development at any stage and consequently improve the plant yield. The supply of nutrients operates as a mean of increasing yield with certainty, and at the same time improving the quality of the crop. The traditionally grown okra however,

appears to be a less efficient utilizer of added mineral nutrients than tomato, pepper and maize (Thompson and Kelly 1957; Albregts and Howard, 1973).

Asif and Greg (1972) observed that nitrogen application increased N-content in okra fruit and stem than other parts in okra plant as nutrients contents also vary within the same plant and from one part to another. Adedipe (1975) also reported that when higher nitrogen is applied to okra, higher N-content is accumulated in okra leaf, fruit and stem because nutrient is usually accumulated in plant tissue. The effect of nitrogen application on nitrogen content of tissue is also believed to be affected by climatic factors. Csizinszky (1996) reported that nitrogen concentrations in leaves and stem were higher with nitrogen fertilization. Millar (1955) reported that nitrogen content of fruits increased with increasing nitrogen rates when determined at 8, 10 and 12 WAS. He observed that during most of the crop growth cycle, it is those plant parts that are undergoing the most active growth that have the highest concentrations of nutrient.

Taber and Peterson (1979) reported that the ear leaves from plants provided with urea were higher in nitrogen than those from Ca $(NO_3)_2$ because of the favourable soil conditions that prevailed during the application. George and Likey (1980) reported that nitrogen in the fruit of blueberry fruit was increased linearly with nitrogen rate during their experiments. They attributed their findings to minimal rainfall which reduced leaching of the nitrogen applied.

Nitrogen has been found by Rennie (1956), Pennosini, (1959) and Trogdon and Volk (1950) to have little effect on protein contents of okra. On the other hand, Warder et al. (1973) reported that added nitrogen increased protein contents in okra. They observed that young plants are generally richer in nutrient than older ones. Nitrogen of course is a major factor in leafy vegetables where a dark green colour is required to satisfy the consumers.

Growers have known for many years that fruits, that are nitrogen starved are not easily sold. Fertilizers can cause changes in some of the colours of leafy vegetables and fruits. Hunter and Stanford (1977); Oslon, et al. (1976); Black and Siddoway, (1977); Robert, (1988); Savello,et al (1980); Csizinsky, (1996) reported that nitrogen application increased nitrogen content in okra and that the nutrient content may also differ from one year to the other.

2.4 Effects of Sowing dates and growth of okra

Some factors like sowing date, spacing and picking of green fruits which directly affect yield are the main concern of the growers. The effects of three dates of sowings, (20th June, 10th and July 30th) with three spacing between rows (30, 45 and 60cm) were investigated by Grewal et al. (1972). Sowing on 20th June gave the highest yield over the other two sowing dates (10th July and 30th July). Yield in the case of 45cm row spaciang was also significantly higher when compared to that of 60cm. However, total number of harvest fruits weight increased with increased row-spacing which can be attributed to more feeding area available to the plants in terms of nutrients and light in comparison to the closer spaced plants. This also supports the findings of Randhawa and Parmum (1969) who reported that total number of fruits and fresh weight of okra increased with row-spacing.

Singh and Sikka (1955), Lal and Singh (1969) reported that late-sown okra is usually affected by yellow vein mosaic virus, consequently reducing the yield, a development which they attributed the fact that late-sown okra was not well established due to the way the rain was usually distributed. Early sowing and good rainfall favour good growth and yield of okra (Bisaria and Shamshery 1979) and Shrestha (1983) reported that favourable climatic conditions or environment, mineral nutrient supply is inevitable for maximum crop growth. Singh et al. (1988) reported that okra sown on June 20th at 40 x 30cm produced a higher

maximum yield than okra sown in July at the same spacing, while Lal and Pundrick (1979) observed that sowing of okra in Mid-June (i.e. before the onset of heavy rains) rather than at various dates in July significantly reduced the percentage of plants affected by yellow vein mosaic virus and thus increased the yield. Rao and Suryanarayan (1977) observed that okra sown early with 112kgN/ha at a spacing of 45 x 60cm yielded higher than late-sown okra with the same spacing. Robert (1988) also reported that earliness in sowing coupled with increased nitrogen application rate (80kgN/ha) increased plant vigour and size, leaf number and leaf area, plant height and stem diameter. Kamalanathan et al. (1970) reported that a closer spacing of 60 x 20cm significantly and consequently recorded highest yield per hectare both in terms of number of fruits and weight, but the yield per plant was higher in the wider spacing (60 x 40cm). The production in yield per plant in closely spaced plants was as a result to a decrease in the number of lateral branches as suggested by McFerran et al. (1963). The requirements of okra for growth and development are related to temperature and day length, Majanbu (1983).

2.5 Effect of plant population on growth and yield of okra

Albregts and Howard (1974) reported that population was not consistent in its effect on growth. In 1971, the lower plant population (16,000 plants/ha) initiated production a few days earlier than those seeded more densely (32,000 and 64,000 plants/ha) but in 1972, the reverse was the case. During both years (1971 and 1972) they found that the increase in nitrogen (80kgN/ha) to the more densely seeded or densely sowing (64,000 plants/ha) gave the higher yield from 2nd week of production through the end of the harvest seasons. Kamalanathan et al. (1970) recorded the highest yield when the plant population was 83,000 plants/ha. This was due to the fact that the number of plants accommodated in one hectare

was higher than that of the widest spacing which can only accommodate fewer plants (i.e. 33,000 and 22,000 plants/ha).

Verma et al. (1970) revealed that increasing nitrogen under a population of 33,000 plants/ha, gave highest yield and when the nitrogen was increased from 90kgN/ha to 120kgN/ha with a population of 44,000 plants/ha, the yield was seriously affected as the excessive nitrogen resulted in increased vegetative development. Kamalanathan et al. (1970) reported that closer spacing of 60 x 20cm significantly and consistently recorded highest yield per hectare both in terms of number of fruits and weight, but the yield per plant was more under the wider spacing (60 x 40cm). The production in yield per plant in closely spaced plants was due to a decrease in the number of lateral branches as suggested by McFerran et al. (1963).

According to NAERLS (1989) spacing of okra may be varied according to the varieties, i.e. for tall or large varieties, spacing should be 45cm and dwarf or sparsely branching types should be 30cm apart on 75cm ridge. Khan and Joiswal (1988) reported that okra spaced at 30 x 15cm with 150kgN/ha application produced a higher pod yield than either 30 x 30 or 45 x 30cm. Kamalanathan el al (1970) reported that sowing density (population) on okra yield from an increase in stand from one to 2 or 3 plants per hill reduced individual plant yield and vigour but increased in overall yields. They also recommended that two plants per hill, spaced at 60 x 20cm were recommended for optimum economic returns and higher yield.

2.6 Effect of Nitrogen on okra

Nitrogen is a major constituent of chlorophyll, plant protein and amino acids. Increasing the supply of nitrogen in the soil solution will enhance the synthesis of these compounds, thereby promoting plant growth. The growth of a plant will be at optimum when the nutrient requirements of the crop are met. Liberal applications of nitrogen stimulate root activity (Burris, 1959). It determines the rooting pattern of a crop (Bruetsch and Estes, 1976) and promotes plant growth but too much of it leads to luxuriant development of the vegetative parts at the expense of reproductive growth. Plant growth is retarded when nitrogen supply is deficient (Chhonkar and Singh, 1963); Watanabe and Inayama, 1977). These workers have found that nitrogen deficiency symptoms in okra include stunted growth thin shoot and small leaves. Under extreme conditions of nitrogen deficiency, there could be premature leaf abscission and can therefore result in small pods formation.

2.7 Effect of Nitrogen on okra growth and development

The effect of nitrogen on plant growth in general is surprising. Nitrogen fertilization of okra significantly increased plant height, number of leaves, stem diameter and number of branches (Chhonkar and Singh, 1963; Adejonwo, 1988; Singh et al 1967, 1965; Verma et al. 1970; Chauhan and Gupta, 1973) reported that dry matter yield of okra was significantly increased by nitrogen application.

The effect of nitrogen on flower development in okra has also been reported. Kamalanathan et al. (1970) found that flowering was delayed by excessive nitrogen supply. On the contrary, however, Chauhan and Gupta, (1973) did not observe any influence of nitrogen on the number of days to flowering Sanchez et al. (1986) Joel and Mack (1979) reported that increased in nitrogen fertilization (112kgN/ha significantly increased plant height than other two levels (0 and 56kgN/ha).

2.8 Nitrogen effect on plant branching

The limit to the number of fruits per plant on the main stem is set by the number of internodes and hence plant height. Increasing number of branches per plant will result in increase in the number of nodes per plant. In an experiment to study the relationship of yield to different growth characters in okra, Roy and Chhonkar (1976) established that a positive correlation exists between number of branches and fruits yield. The effect of nitrogen on number of branches per plant as reported by Chauhan and Gupta (1973) was positive. This result was further confirmed by Hooda et al. (1980). They reported that with each progressive increase in nitrogen level, the number of branches produced per plant also increased.

2.9 Effect of Nitrogen on Fruit size

In an experiment conducted by Verma, et al. (1970) revealed that fruit size increased as a result of nitrogen fertilization. They found that at 90kgN/ha rate of application, okra fruit yield was at maximum, yield having decreased when nitrogen rate was increased to 120kgN/ha. Although there was a decrease in fruit yield at this excessive nitrogen rate probably due to the reduction in the number of fruits per plant at 120kgN/ha. Size of the fruit may limit the number of fruits that could be formed on a given plant. It is when fruits are harvested early that flower bud initiation is allowed to form. It is therefore, not advantageous to encourage large fruits formation by delaying harvesting if such fruits are to be used fresh.

2.10 Nitrogen effect on fruit number/plant

A major yield component in okra is the number of fruits per plant (Chauhan and Gupta,1973; Fatokun et al. 1979). Studies on the growth of two cultivars and the effect of nitrogen on

these in the humid tropics or rainforest zone have shown that the number of fruits produced significantly influenced the yields of cultivars (Adelana 1981; Fatokun and Chheda, 1981). The variety with the highest number of fruits per plant, therefore, produced the highest yield. Increasing the supply of nitrogen to plants increased fruit number, however, there are other factors, such as time of sowing and seasonal rainfall variation, that could affect number of fruits per plant.

2.11 Nitrogen effect on fresh pod yield

Increase in fresh pod yield resulting from nitrogen application were reported by several workers to have a linear relationship with rates of application ranging from 56 to 134.8kgN/ha (Singh et al. 1967; Sharma and Shukla, 1973; Albregts and Howard, 1974; Hooda et al. 1980; Mani and Ramanathan, 1980). The optimum nitrogen requirement for the crop varied with the environment. Verma et al. (1970), reported a decrease in fresh okra pod yield when nitrogen application was increased upto 120kgN/ha and yield continued to decline at even higher nitrogen application rates. However, Ahmed and Tullock-Reid (1968) did not observe a decrease in yield until when nitrogen rate was increased beyond 112kgN/ha. The optimum nitrogen requirement of a given crop is strongly a function of both the genotype and environment and the interaction of these two factors. Ahmed and Tullock-Reid (1968) and Hooda et al. (1980) recommended nitrogen levels of 112kgN/ha and 120kgN/ha, respectively at their respective environments for maximum okra fruit yields. The rate of increase in fresh pod yield resulting from a given level will of course depend also on the time of application.

A major yield component in okra is the number of fruits per plant (Khalid and Hamid, 1964; Perkins et al 1972; Fatokun et al. 1979). Significant increase in the number of fruits per plant as the level of nitrogen was increased have been reported (Asif and Greg, 1977; Fatokun and Chheda, 1983; Majanbu et. al. 1985). The higher rate of nitrogen produced more fruits per plant. Fruit quality increase with age (Tindall, 1968; Chavan and Bhandari 1971; Singh et al. 1972), therefore, fruits should be harvested when they are still young and tender. Brown (1943) reported that one of the objectives of nitrogen fertilization is to maintain vegetative growth and colour. He fruther stated that growth responds to the interaction of soil nutrients and reserve food materials in the plants. Increased in nitrogen fertilization, increased okra yield significantly. This observation was made by several workers such as Singh et al. (1967); Sharma and Shukla (1973), Albregts and Howard (1974), Hooda et al. (1980), Mani and Ramanathan (1980) who reported that increased in fruit yield of okra resulting from increase from nitrogen fertilization. Mani and Ramanathan (1980) observed that nitrogen fertilization significantly increased okra yield. The highest N-fertilization (80kgN/ha) increased the yield by 149.2% over the control, Ramu and Muthuswamy (1964) also reported that the yield of okra was doubled (98.7%) that of control when sprayed with 2% urea.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Experimental sites

Three field experiments were conducted on the research farm of the Institute for Agricultural Research, Samaru (11°11'N 07°38'E and 680m above sea level) during the 1992 to 1994 wet seasons, located in the northern guinea savannah zone of Nigeria. The soils of the experimental site is sandy loam in texture which is highly weathered. The experiments were conducted during 1992, 1993 and 1994 wet seasons respectively.

3.2 Land preparation, sowing and other cultural operations

The experimental fields were ploughed once, harrowed twice and ridged 75cm apart. Soil samples were taken from two depths (0-20 and 20-40cm) prior to fertilizer application and analysed for their physico chemical - properties (Table 1).

Table 1: Physical and chemical properties of the soils of the experimental sites at Samaru.

Composition	1992		1993		1994	
	Depth (cm)					
	0-20	20-40cm	0-20	20-40cm	0-20	20-40cm
Chemical Characteristics						
pH(H_2O)1:2:5	4.8	4.8	4.3	4.4	5.6	1.6
Organic g/kg	0.5	0.4	0.5	0.4	0.4	0.5
Total N g/kg(%)	0.05	0.04	0.06	0.07	0.04	0.03
Total P g/kg	117	97	108	107	93	122
Exchangeable Bases						
K cmol/kg	104	97	61	73	97	104
Mg cmol/kg	105	190	108	59	158	108
Ca cmol/kg	409	615	377	409	845	742
CEC cmol/kg	6.0	8.4	12	4.5	7.9	7.8
Clay cmol/kg	10	18	8	24	8	22
Silt cmol/kg	46	42	48	34	45	46
Sand cmol/kg	42	44	40	48	42	44
Textural class	SL	SL	SL	SL	SL	SL

SL = Sandy Loam

Nitrogen was supplied as per treatment using calcium ammonium nitrate (26%N) in two equal split applications, 3 weeks after sowing (WAS) and at the stage of flowering. Single superphosphate and muriate of potash were applied uniformly to supply 45kgP_2O_5/ha and 40kg K_2O/ha before land preparation. Three to four okra seeds were hand sown at an intra-row spacing of 15, 30 and 45cm on the ridges to obtain desired populations. Uniform stand of two seedlings per hill was maintained by carefully thinning at 3 WAS. Weeds were controlled by spraying with contact herbicide (gramoxone) 1L/ha. Supplementary hand weeding was used to keep the plots free of weeds when necessary. Vetox 85 at 1L/ha was applied to control insect/pests.

3.3 Soil Analysis

Soil samples were collected at two depth (0-20 and 20-40cm). The samples were air dried for several days, mixed thoroughly and grounded to pass through a 2mm sieve. The texture was determined by the hydrometer method using calgon as a dispersing agent (Day, 1965). Total nitrogen was determined by the macro-Kjeldahl procedure (Bremner, 1965). Exchangeable cations were determined using the 1N NH_4OAC. Extracted K and Na were determined by flame emission photometry, while Ca and Mg were determined by atomic absorption spectrometry (Heald, 1965).

3.4 Treatments and Experimental Design

The experiment was laid out in a split plot design, replicated three times. The main treatment consisted of 3 levels of nitrogen (0, 45 and 90kgN/ha) and two sowing dates, (early and late) while the sub-plot treatments were made up of three plant population levels (22,000, 44,000 and 88,000 plants/ha) and two okra varieties (Local-1 and V-35.

3.4.1 Observations and Data Collection

Observations were recorded at 4, 6, 8 and 10 WAS for all growth characters, except for number of branches which was recorded at 10 WAS only.

3.4.2 Sampling

Five plants were taken at random and tagged for ancillary observations. In addition, five plants were randomly taken for each destructive sampling, like total dry matter, leaf area and leaf area index, longest root length at different stages as shown in 3.4.1.

3.4.3 Number of leaves, fresh and dry weights

Number of leaves were counted at 4 stages as stated above. They were carefully plucked along with petiole, weighed for fresh weight, while dried in an oven at 60°C until they attained constant weight which was recorded as dry weight.

3.4.4 Leaf area and leaf area index

Leaf area (LA) was determined by modified Watson (1952) method. Two plants were randomly selected, the leaves were detached and traced on a graph sheet and its area determined by counting the number of complete squares. The traced leaves together with remaining leaves in the samples were dried in the oven at a constant temperature at 60°C. Measurement of weights were taken from the dried traced leaves and the remaining leaves in the sample separately. The leaf area (LA) of the sample was calculated using the formula:

$$\text{Leaf area (LA)} = \frac{W \times M}{Y \times Z}$$

Where W = Weight of traced leaves in grams
M = Weight of remaining leaves in the sample in grams.
Y = Mean traced area in weight in grams
Z = Traced leaf area in cm^2

Leaf area index (LAI) the assimilatory surface per unit of land area was calculated as determined by Watson (1952).

$$LAI = \frac{\text{Total leaf area/plant (cm}^2\text{)}}{\text{Area of ground/plant (cm}^2\text{)}}$$

3.4.5 Plant height (cm)

This was determined by measuring the height with a ruler from the base of the plant to the tip of the main stem of the sampled plants, cut from the ground level at 4 stages (4, 6, 8 and 10 WAS).

3.4.6 Fresh and dry weights of stem (g)

Five randomly sampled plants were weighed immediately after removal of leaves for fresh weight and recorded as fresh weight. The stems were later dried in an oven at 60°C until they attained a constant weight which was recorded as dry weight.

3.4.7 Length of longest root, fresh and dry weights of roots

Roots were carefully lifted by loosening the soil all round the sampled plants. They were carefully lifted by holding at their base and cleaned off the soil by washing. The length of the longest root was measured with the help of a string and a ruler and weighed immediately to record fresh weight. They were dried in an oven at 60°C until they attained a constant weight which was recorded as dry weight of root. It is likely that some root end will break and will not give the actual length of the root, yet for the purpose of statistical analysis to study the effect of factors on the root, it is valid as it is assumed that more or less similar rootlet will cut at the end in all the samples, as deletion of a constant value will not affect the validity of the results.

3.4.8 Relative growth rate (RGR)

This is the cumulative dry matter increment per unit time. This was computed as per the procedure described by Blackman (1919), Briggs et al. (1920) by the equation:

$$RGR = g/g/wk \text{ or } mg/g/day = 2.303 \frac{(Log_{10} W_2 - Log_{10} W_1}{t_2 - t_1}$$

Where = W_1 and W_2 represent total dry matter of plants at times t_1 and t_2, respectively/week.

3.4.9 Crop growth rate (CGR)

This parameter was calculated at 8 and 10 WAS. It is the dry weight increment per unit area of land per unit time. This was computed as described by Watson (1952).

$$CGR\ (g/m^2/Wk) = \frac{W_2 - W_1}{t_2 - t_1}$$

Where = W_1 and W_2 represent total dry matter of plants at times t_1 and t_2, respectively/week.

3.4.10 Nitrogen content

Five plants were sampled starting at 8, 10 and 12 WAS in 1992 to 1994 for the purpose to determine nitrogen content. The nitrogen content in different plant parts (leaves, stem and fruit) was determined. The samples were oven-dried at 60°C to a constant weight before grinding with a mill for analysis. The determination of total N-was done using Micro Kjeldahl method (Bremner 1965).

One gram of plant sample was placed in 50ml Kjeldahl flask or in a digestion tube. Some few drops of water was added, and allowed to stand for about 30 minutes. Catalyst mixture 5 gram was added to sample along 20ml of concentrated sulphuric acid. The flask was put on low

heat on a digestion stand until frothing ceases. The heat was increased until digest was cleared and was further digested for 2 hours.

The flask was cooled and little water was added before washing the content into a 100ml volumetrics flash and allowed to cool. Ten ml of the digest was taken into a distillation flask. Twenty ml of 2% Boric Acid was measured into 100ml conical flask, and added 10N HOH to the 10ml pipettee digest of which 50ml distillate was collected after and titrated the distillate with 0.01N H_2SO_4 to a pink end point. Percent N in the sample was calculated. To calculate total N%, this formula is followed.

$$\%N = \frac{0.014 \text{ x Titrate x Vol. of digest x Normality of acid x100}}{\text{Weight of sample x Vol. Of aliquot used}}$$

3.4.11 Statistical analysis

The data obtained were analysed using analysis of variance as suggested by Snedecor and Cochran (1967) and the means were separated by Duncan's Multiple Range Test (Duncan 1955). Coefficient of correlation (r) among parameters recorded were determined. Path-coefficient analysis was carried out to determine the direct, indirect and total contributions as well as percentage contributions of some crop parameters to seed yield as described by Ahmed (1997).

3.4.12 Meteorological data

Meteorological data of rainfall, temperature, relative humidity and sunshine hours during the period of experimentations were obtained from the Meteorological Unit of the Institute for Agricultural Research, Samaru and details of these are shown in Appendix I.

CHAPTER FOUR

4.0 RESULTS

4.1 Number of leaves per plant

The mean number of leaves as affected by nitrogen, sowing date, population, variety and their interactions at 4, 6, 8 and 10 WAS during 1992 to1994 seasons is given in Table 2.

. Nitrogen application increased number of leaves at 6 WAS in 1992 season. The date of sowing significantly affected the number of leaves produced at all the stages of growth. Early sowing increased number of leaves only at 90kgN/ha, but in late sowing there was increased in number of leaves when the nitrogen was increased from 0-45kgN/ha and a further increase from 45 - 90kgN/ha significantly decreased number of leaves. When the two sowing dates were compared at the same level of nitrogen, early sowing resulted in higher number of leaves than late sown crop because of the favourable conditions that early crop gets such as rainfall and better temperature for growth.

Table 2: Number of leaves/plant as affected by nitrogen, sowing date, population, variety of okra and their interactions during 1992 to1994 seasons.

Treatment	WEEKS AFTER SOWING											
	1992				1993				1994			
	4	6	8	10	4	6	8	10	4	6	8	10
Nitrogen (N) (Kg/ha)												
0	4.1	4.3b	6.0	5.1	4.3c	4.1b	4.2b	4.1b	4.2c	3.1b	5.1b	4.2b
45	4.1	5.2a	6.0	6.1	5.2b	6.5a	4.2b	4.2b	5.1b	4.1a	5.2b	4.2b
90	4.1	5.1a	6.0	6.1	6.5a	6.6a	6.4a	5.5a	6.3a	4.5a	6.4a	5.6a
SE ±	0.2	0.2	0.2	0.3	0.3	0.5	0.4	0.3	0.2	0.2	0.2	0.1
Sowing date (D)												
Early		25-6-92				18-7-93				9-7-94		
	6.7a	6.8a	7.4a	7.4a	4.6a	5.7a	5.6a	6.4a	7.1a	4.4a	6.4a	5.4a
Late		24-7-92				16-8-93				8-7-94		
	2.2b	4.3b	4.3b	4.2b	3.3b	3.2b	3.4b	3.5b	3.4b	3.0b	4.2b	3.3b
SE ±	0.41	0.41	0.31	0.41	0.41	0.41	0.30	0.30	0.20	0.20	0.20	0.10
Population /ha (P)												
22,000	3.1	4.1	5.0	5.1	3.0	4.2	4.3	4.2	5.0	3.1	5.0	4.1
44,000	3.0	4.2	5.2	5.2	3.2	4.1	4.3	4.2	5.1	3.2	5.0	4.1
88,000	3.1	5.0	5.3	5.3	4.3	4.3	4.3	4.3	5.1	3.1	5.0	4.0
SE ±	0.10	0.30	0.20	0.21	0.41	0.31	0.32	0.42	0.22	0.23	0.21	0.10
Variety (V)												
Local-1	4.3	4.0	5.3	5.3	4.0	4.3	4.1	4.1	5.1	3.0	5.1	4.1
V-35	3.1	5.1	5.3	5.3	4.1	5.1	4.2	4.2	5.1	3.0	5.2	4.1
SE ±	1.21	1.21	0.20	0.11	0.30	0.40	0.31	0.23	0.24	0.22	0.23	0.10
Interactions												
NxD	NS	NS	NS	*	NS	NS	NS	*	**	NS	NS	NS
NxP	NS	NS	NS	NS	NS	NS	NS	NS	*	NS	NS	NS
DxP	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	*	NS
NxV	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
DxV	NS	NS	NS	NS	NS	NS	NS	NS	NS	**	NS	*
PxV	NS	NS	NS	NS	NS	NS	*	NS	NS	NS	NS	*

Means followed by the same letter within a treatment group of a column are not significantly different using Duncan's Multiple Range Test (DMRT, 05).
* and ** Significant at 5 and 1 percent levels, respectively.
NS = Not significant.

In 1993, effect of nitrogen was found to be significant at 4, 6, 8 and 10 WAS. Both at 4 and 6 WAS, control treatment produced significantly lower number of leaves when compared with other two nitrogen levels which was with each other at par. At 8 WAS, when nitrogen was increased from 0 to 45kgN/ha, it did not increase the number of leaves. However, a further increase in nitrogen from 45 to 0kgN/ha significantly increased the number of leaves. The date of sowing significantly affected the number of leaves at all the stages of growth. Early sown okra produced higher number of leaves than late sown okra. Plant Population and variety did not affect the number of leaves in all the stages of growth.

The effect of nitrogen and sowing dates, were found to be highly significant at all the stages of growth during 1994 season. Nitrogen affected the number of leaves significantly at 4, 6 and 8 and 10 WAS, while the control produced significantly lower number of leaves than the two applied nitrogen levels. At 10 WAS increasing nitrogen level to 45kgN/ha did not affect number of leaves, however at the highest nitrogen level (90kgN/ha) a higher number of leaves were produced than the 0 and 45kgN/ha rates. Both, the population and variety tested did not affect the number of leaves produced at all the growth stages.

Interactions between nitrogen x date of sowing were found to be significant at 10 WAS in 1992 and 1993 and at 4 WAS in 1994 seasons (Table 3).

Table 3: Number of leaves/plant as affected by nitrogen x date of sowing interactions at 10 WAS both in 1992 and 1993 and at 4 WAS in 1994 rainy seasons at Samaru.

	1992(10 WAS)		1993(10 WAS)		1994(4WAS)	
Nitrogen	Sowing date		Sowing date		Sowing date	
	Early	Late	Early	Late	Early	Late
(NKg/ha)	25-6-92	24-7-92	18-7-93	16-8-93	9-7-94	8-8-94
0	5.3b	3.1d	2.3c	2.0c	6.2b	2.2d
45	5.2b	4.2c	5.2b	2.0c	6.2b	3.3c
90	6.1a	3.3d	6.1a	2.1c	7.4a	3.4c
SE ±	0.50		0.52		0	0.31

Means followed by the same letter within an interaction table are not significantly different using Duncan's Multiple Range Test (DMRT.05).

A close examination of results revealed that both in 1992 and 1994 seasons, 90kgN/ha produced significantly higher number of leaves than the other two nitrogen levels. In 1993, however each increment in nitrogen level, significantly increased the number of leaves. In late sown crop, 45kgN/ha produced significantly higher number of leaves than control (0kgN/ha) in 1992 and 1994 seasons. In the case of 1993, no such difference was observed. When the number of leaves per plant was observed for different sowing dates, at each level of nitrogen, early sowing resulted in significantly higher number of leaves in all the years.

Nitrogen x population interaction was significant only in 1994 at 4 WAS.(Table 4).

Table 4: Number of leaves/plant as affected by nitrogen x population interactions at 4 WAS in 1994 seasons.

Treatment	1994 (4 WAS)		
Nitrogen	Plant population/ha		
(Nkg/ha)	22,000	44,000	88,000
0	4.0c	4.3c	4.2c
45	5.0b	5.3b	6.4a
90	6.0a	6.2a	5.1b
SE ±		0.31	

Means followed by the same letter within an interaction table are not significantly different using Duncan's Multiple Range Test (DMRT. 05).

Increased nitrogen level from 0-90kgN/ha increased the number of leaves/plant, both at 22,000 and 44,000p/ha. In the case of 88,000 plants/ha, such increase was observed at a maximum of 45kgN/ha, followed by 90 and 0kgN/ha. At 45kgN/ha, 88,000 plants/ha, produced significantly higher number of leaves than the other two populations. At 90kgN/ha, 22,000 and 44,000 plants/ha produced in higher number of leaves than 88,000 plants/ha.

Date of sowing x population interaction was significant at 8 WAS. (Table 5).

Table 5: Number of leaves/plant as affected by date of sowing x population interaction at 8 WAS in 1994 season.

Treatment		1994 (8 WAS)		
Sowing date		Plant population/ha		
		22,000	44,000	88,000
Early	9-7-94	6.2a	6.3a	5.2b
Late	8-8-94	4.3c	4.4c	4.3c
S.E ±			0.30	

Early sown okra produced significantly higher number of leaves than late sown. In early sown okra, both at 22,000 and 44,000 plants/ha there were no significant difference with number of leaves produced.

Sowing date x variety interaction was significant at 6 and 10 WAS in 1994 season (Table 6).

Table 6: Number of leaves/plant as affected by date of sowing x variety interaction at 6 and 10 WAS in 1994 season at Samaru

	1994 (6 WAS)	1994 (10 WAS)		
Sowing date	Variety		Variety	
	Local-1	V-35	Local-1	V-35
Early 9-7-94	4.4a	3.2b	5.3a	5.4a
Late 8-8-94	2.2b	3.3b	3.3c	4.3b
SE ±	0.20		0.20	

Means followed by the same letter within an interaction table are not significantly different using Duncan's Multiple Range Test (DMRT.05).

number of leaves than Local-1. When the two varieties were considered under the same population level at 8 WAS, 88,000 plants/ha produced higher number of leaves than other two population levels in 1993, whereas in 1994 at 10 WAS, 22,000 plants/ha produced higher number of leaves in variety Local-1, whereas in case of V-35, each increase in population levels significantly increased the number of leaves per plant.

4.2 Fresh weight of leaves (g/plant)

The mean fresh leaves weight as affected by nitrogen, sowing date, population and variety at 4, 6, 8 and 10 WAS during 1992 to 1994 rainy seasons at Samaru is given in Table 8.

Table 8: Leaves fresh weight (g/plant) as affected by nitrogen, sowing date, population variety and their interactions during 1992 to 1994 rainy seasons at Samaru.

Treatment	WEEKS AFTER SOWING 1992				1993				1994			
	4	6	8	10	4	6	8	10	4	6	8	10
Nitrogen (N) (Kg/ha)												
0	144.4c	171.2c	239.5b	298.4	99.3b	162.5b	139.2b	164.4c	98.2c	84.0c	117.2c	13.3c
45	200.3b	192.5	271.3c	298.3	129.6a	228.4a	137.4b	217.5b	155.4b	115.3b	146.3b	217.4
90	214.6a	177.7b	284.4a	295.1	98.4b	229.3a	181.7a	300.7a	183.5a	142.4a	163.6a	242.7
SE ±	1.21	2.30	3.20	2.70	2.20	6.20	7.00	4.20	3.01	5.00	5.00	1.71
Sowing date (D)												
Early		25-6-92				18-7-93				9-7-94		
	302.6a	301.3a	410.7a	432.6a	160.5a	365.8a	268.7a	381.4a	203.3a	172.0a	214.1a	301.4
Late		24-7-92				16-8-93				8-7-94		
	70.0b	58.4b	118.4b	163.4b	58.8b	47.3b	38.2b	72.3b	88.6b	56.3b	69.6b	80.4b
SE ±	5.10	3.80	3.50	2.10	1.20	1.80	1.80	2.11	3.00	3.00	4.00	2.10
Population (P/ha)												
22,000	178.3	178.4	246.1b	290.3c	105.3	211.4	158.3	234.1	141.4a	122.3a	147.5a	218.4a
44,000	166.4	185.3	271.4a	299.2b	107.3	215.6	141.0	223.4	148.3b	110.1b	144.0a	190.3b
88,000	214.0	178.2	271.3a	302.1a	115.5	194.4	160.3	224.4	127.2c	109.3b	135.4b	170.1c
SE ±	15.51	10.51	2.20	1.50	8.11	15.91	10.00	4.00	3.00	4.01	5.00	2.61
Variety (V)												
Local-1	168.2	168.3	249.3	277.3b	106.3b	198.2b	166.3a	211.2b	100.4b	124.3a	140.4	223.4a
V-35	205.5	192.4	280.5	317.4a	113.4a	215.1a	140.4b	242.3a	190.1a	104.1b	143.3	158.2b
SE ±	10.20	11.20	11.90	12.01	1.81	5.11	2.70	3.50	3.00	3.01	4.01	2.10
Interactions												
NxD	**	**	*	*	NS	NS	NS	NS	**	**	**	**
NxP	NS	NS	NS	NS	NS	NS	NS	NS	*	*	NS	NS
DxP	NS	NS	NS	NS	NS	NS	NS	*	*	*	NS	NS
NxV	NS	NS	NS	*	NS	NS	NS	NS	*	*	NS	NS
DxV	*	NS	NS	*	NS	NS	NS	*	*	NS	*	*
PxV	*	NS	NS	NS	NS	NS	NS	*	*	*	NS	*

Means followed by the same letter within a treatment group of a column are not significantly different using Duncan's Multiple Range Test (DMRT 05).
* and ** Significant at 5 and 1 percent levels, respectively.
NS = Not significant.

In 1992, effect of nitrogen was significant at all the stages of growth, except at 10 WAS. At initial stages of growth at 6 WAS, 45kgN/ha gave the highest fresh leaf weight, but at 8 WAS, 90kgN/ha produced higher leaves fresh weight than other levels of nitrogen. The differences in sowing dates were highly significant at all the stages of growth. Early sown okra produced significantly higher fresh leaf weight than the late sowing okra due to the favourable conditions during the growth period. The differences due to population were found to be significant at 8 and 10 WAS. The highest population plants/ha (88,000) produced higher fresh leaf weight at 10 WAS, however at 8 WAS the fresh leaf weight was similar to 44,000 plants/ha. When the varieties means were considered they were found to be significant at 10 WAS. The variety V-35 produced higher fresh leaf weight than Local-1.

In 1993 rainy season, fresh leaves weight was significantly affected by nitrogen, sowing date and variety in all the stages of growth and not significantly affected by population levels. At 4 and 6 WAS, 45kgN/ha resulted significantly in higher fresh leaf weight than that of the control and further increase of nitrogen level upto 90kgN/ha reduced fresh leaf weight at 4 WAS and was found to be similar at 6 WAS. At 8 WAS, fresh leaf weight was similar in 0, and 45kgN/ha, however at 90kgN/ha there was higher fresh leaf weight. At 10 WAS, however, each increase in nitrogen level, significantly increased fresh leaf weight. When the sowing dates were compared, it was observed that the early sown crop produced higher fresh leaf weight than late sown crop in all the four stages of growth. The V-35 produced higher leaf fresh weight than Local-1 in all the stages of growth, except at 8 WAS when variety Local-1 produced significantly higher fresh leaf weight than variety V-35.

In 1994 rainy season, nitrogen and sowing dates effects were found to be highly significant in all the stages of growth. Population effect were significant at 5% level and the variety effect were higily significant at all the stages of growth. Each increase in nitrogen level significantly increased the fresh leaf weight at all the stages of growth. Early sown okra produced higher fresh leaf weight when compared with late sown okra at all the stages of growth. Each increase in population, increased the fresh leaf weight in all the stages, except at 6 WAS when 44,000 plants/ha produced significantly lower fresh leaf weight than 22,000 plants/ha. Further increase in population level to 88,000 plants/ha did not increase leaf fresh weight. The variety Local-1 produced a higher fresh leaf weight at 6 and 10 WAS than V-35, while V-35 produced higher leaf fresh weight at 4 WAS than Local-1.

Interactions between nitrogen x date of sowing during 1992 and 1994 seasons were found to be significant in all the stages of observations (4 to10WAS) (Tables 9 and 10).

Table 9: Fresh leaves weight (g/plant) as affected by nitrogen x date of sowing interactions at 4 to 10 WAS in 1992 season.

	1992(4WAS)		1992(6WAS)		1992(8WAS)		1992 (10 WAS)	
Nitrogen	Sowing date							
(Nkg/ha)	25-6-92	24-7-92	25-6-92	24-6-92	25-6-92	24-7-92	25-6-92	24-7-92
0	158.2d	99.2f	117.3c	80.3d	297.0c	140.2d	349.1c	158.3e
45	288.4b	146.3e	179.3b	67.1e	396.1b	143.3d	413.3b	170.2d
90	353.6a	176.1c	249.5a	86.3d	463.4a	44.3d	523.5a	170.2d
SE ±	5.0		6.00		4.30		2.60	

Means followed by the same letter within an interaction table are not significantly different using Duncan's Multiple Range Test (DMRT. 05).

Table 10: Fresh leaves weight (g/plant) as affected by Nitrogen x date of sowing interactions at 4 to10 WAS in 1994 rainy season.

	1994(4WAS)		1994(4WAS)		1994(8WAS)		1994 (10 WAS)	
Nitrogen	Sowing date							
(Nksg/ha)	9-7-94	8-8-94	9-7-94	8-8-94	9-7-94	8-8-94	9-7-94	8-8-94
0	128.4d	140.3c	128.3c	140.2d	7s5.1c	58.3d	152.1c	73.4f
45	217.3b	143.2c	217.5b	143.1d	221.3b	71.2e	354.3b	19.2e
90	295.3a	144.1c	265.5a	144.1d	248.5a	78.2e	396.5a	87.3d
SE ±	5.00		5.00		6.00		3.00	

Means followed by the same letter within an interaction table are not significantly different using Duncan's Multiple Range Test (DMRT. 05).

Early sown crop at all the stages both in 1992 and 1994 seasons produced significantly higher fresh leaf weight with each increase in nitrogen level. However, in the late sown crop, there was no significant difference at 10 WAS in 1992 and at 4 and 6 WAS in 1994. The Control produced lower fresh leaf weight than the two applied nitrogen levels. The applied rate of nitrogen produced significantly higher fresh leaf weight at 4 WAS in 1992 and at 8 WAS in 1994 season. In the case of 6 WAS in 1992, 45kgN/ha produced better fresh leaf weight than other two nitrogen levels, and in the case of 10 WAS in 1994, each increase in nitrogen level significantly increased fresh leaf weight when the same nitrogen levels, were examined for the different sowing dates, in all cases, late sown crop produced significantly lower fresh leaf weight than in early sown crop, both in 1992 and 1994 seasons.

Nitrogen x population was found to be significant at 4 and 6 WAS in 1994 season (Table 11).

Table 11: Fresh leaves weight (g/plant) as affected nitrogen x population interactions at 4 and 6 WAS in 1994 rainy season.

	1994 (4WAS)			1994 (6 WAS)		
Nitrogen	Plant population/ha			Plant population/ha		
(Nkg/ha)	22,000	44,000	88,000	22,000	44,000	88,000
0	115.3e	102.3f	76.2g	108.3d	70.0f	74.4e
45	164.2c	163.2c	138.1d	116.4c	123.2c	106.2d
90	204.6a	178.4b	168.2c	142.7a	138.5b	147.6a
SE ±		6.00			7.00	

Means followed by the same letter within an interaction table are not significantly different using Duncan's Multiple Range Test (DMRT, 05).

When each population level was examined for the different nitrogen levels, an increase in nitrogen level significantly increased fresh leaf weight in all the populations and at both stages studied. At 0kgN/ha, fresh leaf weight decreased with increase in population level at 4 WAS, but at 6 WAS, the fresh leaf weight decreased when the population level was increased from 22,000 to 44,000 plants/ha. When 44,000 and 88,000 plants/ha was considered, 44,000 plants/ha was lower than 88,000 plants/ha. When the population level was increased from 22,000 to 44,000 plants/ha the fresh leaf weight was similar, but increase in population to 88,000 plants/ha, fresh leaf weight was decreased. At 90kgN/ha, fresh leaf weight was decreased with increase in populations. However, at 6 WAS such decreased was observed upto 44,000 plants/ha; a further increase in populations increased the fresh leaf weight, which was at par with 22,000 plants/ha

Date of sowing x population was significant at 10 WAS in 1993 and at 4 and 6 WAS in 1994 (Table 12).

Table 12: Fresh leaf weight (g/plant) as affected by date of sowing x population interactions at10, 4 and 6 WAS in 1993 and 1994 rainy seasons.

		1993 (10WAS)				1994 (4WAS)			1994 (6 WAS)		
Sowing date		Plant population/ha				Plant population/ha			Plant population/ha		
		22,000	44,000	88,000		22,000	44,000	88,000	22,000	44,000	88,000
Early	18-7-93	186.6a	174.3b	162.4c	9-7-94	241.5a	194.4b	175.4c	184.6a	174.3b	162.4c
Late	16-8-93	69.4e	88.6d	90.4d	8.8.94	81.4e	101.6d	80.3e	61.3d	59.3d	48.3e
SE ±			5.30				5.00			6.00	

Means followed by the same letter within an interaction table are not significantly different using Duncan's Multiple Range Test (DMRT, 05).

In all the interactions, early sown okra produced higher fresh leaf weight when compared with late sown okra. When the sowing dates were examined across the different populations in 1993 at 10 WAS and at 4 WAS in 1994, early sown crop, each increase in population significantly decreased fresh leaf weight. However, at 6 WAS in 1994, 88,000 plants/ha, produced higher fresh leaf weight which was significant at par at 10 WAS in 1993 with 88,000 plants/ha and 22,000 plants/ha at 6 WAS in 1994 season. However, at 6 WAS in 1994, fresh leaf weight at 44,000 plants/ha was lower than other two populations .

Nitrogen x variety interactions were found to be significant at 10 WAS in 1992 and at 4 and 6 WAS in 1994 season (Table 13).

Table 13: Leaves fresh weight (g/plant) as affected nitrogen x variety interactions at 10 WAS at 10,4 and 6 WAS during 1992 and 1994 seasons.

	1992 (10 WAS)		1994 (4 WAS)		1994(6WAS)	
Nitrogen Variety (kg/ha)	Variety Local-1	V-35	Variety Local-1	V-35	Local-1	V-35
0	164.6d	133.6e	70.6e	126.4c	85.4d	84.3d
45	188.3c	252.3a	104.5d	206.7b	122.3b	108.5c
90	204.5b	251.4a	127.3c	240.5a	164.5a	120.4b
SE ±	3.60		5.00		6.00	

Means followed by the same letter within an interaction table are not significantly different using Duncan's Multiple Range Test (DMRT, 05).

Incase of variety, Local-1 and in early sown crop, each level of nitrogen, increased fresh leaf weight. Both varieties produced significantly higher fresh leaf weight with each increase in nitrogen level at all the stages of growth and in two seasons, except the variety V-35 at 10 WAS in 1992 whereas fresh leaf weight increased when nitrogen level was increased from 0 to 45kgN/ha. A further increase in nitrogen to 90kgN/ha did not increase fresh leaf weight.

Date of sowing x variety interaction was significant at 4 and 10 WAS in 1992; at 10 WAS in 1993 and at 4, 8 and 10 WAS in 1994. (Tables 14 and 15)

Table 14: Leaf fresh weight (g/plant) as affected by date of sowing x variety interactions at 4 and 10 WAS at 10 WAS during 1992 and 1993 seasons.

		1992 (4 WAS)		1992 (10 WAS)		1993 (4 WAS)		
		Variety		Variety			Variety	
		Local-1	V-35	Local-1	V-35		Local-1	V-35
Early	25-6-92	140.7b	264.6a	209.4b	219.4a	18-7-93	364.7a	238.6b
Late	24-7-92	60.3d	115.3c	71.3e	67.6e	16-8-93	81.4e	78.7d
SE ±		4.00		6.00			2.90	

Table 15: Leaves fresh weight (g/plant) as affected nitrogen x variety interactions at 4,8 and 10 WAS in 1994 seasons.

	1994 (4 WAS)		1994 (8 WAS)		1994(10WAS)	
Nitrogen	Variety					
(Nkg/ha)	Local-1	V-35	Local-1	V-35	Local-1	V-35
9-7-94	140.4b	264.6a	299.4be	450.6a	325.4b	371.5a
8-8-94	60.4d	114.4e	151.3d	155.4e	248.3e	243.4d
SE ±	4.01		3.50		2.10	

Means followed by the same letter within an interaction table are not significantly different using Duncan's Multiple Range Test (DMRT. 05).

Both varieties produced higher fresh leaf weight when sown early in all the interactions tables stated above. When the same dates were examined across the two varieties the variety V-35 produced higher fresh leaf weight than variety Local-1 in 1992, but in 1993, leaf fresh weight of variety Local-1 was found to be higher than V-35 in early sown crop. When examined the two varieties, V-35 produced higher fresh leaf weight than Local-1 at 4 and 10 WAS in 1992.

Table 17: Leaves fresh weight (g/plant) as affected population x variety interactions at 4, 6, and 10 WAS in 1994 season.

	1994 (4 WAS)		1994 (6 WAS)		1994(10WAS)	
Plant population/h	Variety		Variety		Variety	
	Local-1	V-35	Local-1	V-35	Local-1	V-35
22,000	99.2e	235.6a	140.4a	104.3c	261.6a	162.1d
44,000	115.1d	180.5b	121.1b	99.4d	249.4b	131.3e
88,000	87.0f	168.4c	110.0c	108.3c	159.3d	182.4c
SE ±	5.00		6.00		4.00	

Means followed by the same letter within an interaction table are not significantly different using Duncan's Multiple Range Test (DMRT. 05).

There was differential response of different varieties. At 22,000 plants/ha, the variety V-35 produced higher leaf fresh weight than variety Local-1. When the population was increased from 44,000 to 88,000 plant/ha, Local-1 produced higher leaf fresh weight than V-35. At 10 WAS in 1993 season, variety Local-1 produced higher leaf fresh weight than variety V-35 at 22,000 to 44,000 plants/ha. There was no significant difference between the two varieties at 88,000 plants/ha. Within variety, each population level decreased fresh leaf weight as the population was increased in Local-1 variety. However, no such difference was observed in variety V-35. In 1994 season, V-35 at 4,6 and 10 WAS both varieties produced significantly higher leaf fresh weight at 22,000 plants/ha. At the same population level both varieties produced a lower fresh leaf weight as the population increases at 4, 6 and 10 WAS. When the same populations was considered against the same variety at 22,000 plants/ha Local-1 produced higher leaf fresh weight at 6 and 10 WAS. At 44,000 plants/ha, the Local-1 produced lower leaf fresh weight than V-35, but at 88,000 plants/ha, V-35 produced a higher leaf fresh weight than Local-1 except at 6 WAS.

4.3 Leaf dry weight (g/plant)

The mean dry weight of leaves for 1992 to 1994 seasons is given in Table 18.

Table18: Leaves dry weight (g/plant) as affected by nitrogen, sowing date, population, variety and their interactions during 1992 to 1994 rainy seasons at Samaru.

	WEEKS AFTER SOWING											
Treatment	1992				1993				1994			
	4	6	8	10	4	6	8	10	4	6	8	10
Nitrogen (N) (Kg/ha)												
0	35.3	39.3	30.3	42.4b	8.0	16.1a	12.3	13.1	14.2b	24.1b	41.3b	26.2c
45	36.4	41.1	38.2	52.3a	11.0	12.4b	15.2	15.2	18.1a	29.2a	48.1a	37.1a
90	37.2	43.3	41.5	40.0b	11.0	12.2b	18.00	16.0	17.2a	31.3a	51.2a	34.4b
SE ±	8.00	4.00	8.00	3.00	4.00	1.21	6.00	3.00	2.00	2.300	3.00	2.00
Sowing date (D)												
Early		25-6-92				18-7-93				9-7-94		
	56.4a	62.4a	56.3a	68.6a	14.3a	22.4a	28.4a	27.6a	30.6a	38.3a	74.7a	47.6a
Late		24-7-92				16-8-93				8-7-94		
	18.2b	19.1b	18.3b	29.3b	6.4b	4.4b	12.3b	13.4b	13.3b	18.3b	18.4b	17.3b
SE ±	4.00	3.00	8.00	5.00	3.00	8.00	4.11	8.00	2.00	2.00	4.00	3.00
Population (P/ha)												
22,000	36.1	38.0	38.3	46.3c	9.1	12.8	14.1	16.3	19.1a	26.2b	51.3a	38.7a
44,000	36.8	41.0	35.0	49.0b	10..3	13.6	16.1	16.1	15.0b	27.2b	48.1a	27.9c
88,000	37.6	46.0	37.1	51.3a	11.2	13.7	15.4	15.2	16.6b	31.0a	41.0b	30.5b
SE ±	4.00	3.00	8.00	3.00	3.00	8.00	4.11	8.00	2.00	2.00	4.00	3.01
Variety (V)												
Local-1	32.3b	39.0	38.8	48.6	11.3	16.0a	16.1	17.3	18.1a	30.1a	46.9	30.4b
V-35	42.4a	41.0	34.7	48.7	9.1	11.0b	14.1	15.3	15.7b	26.2b	46.7	34.3a
SE ±	1.00	7.00	5.00	3.00	2.00	3.00	5.00	5.00	1.00	2.10	3.01	2.00
Interactions												
NxD	NS	NS	*	NS	NS	NS	NS	NS	NS	NS	NS	*
NxP	NS	NS	NS	NS	NS	NS	*	NS	NS	NS	NS	*
DxP	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	*
NxV	NS	NS	NS	NS	NS	*	NS	NS	NS	NS	NS	NS
DxV	NS	NS	NS	*	NS	NS	NS	NS	NS	*	NS	NS
PxV	NS	NS	NS	NS	NS	*	NS	NS	NS	NS	*	NS

Means followed by the same letter within a treatment group of a column are not significantly different using Duncan's Multiple Range Test (DMRT. 05).

* and ** Significant at 5 and 1 percent levels respectively.

NS = Not significant.

In 1992 rainy season, dry weight of leaf was found to be significant at 10 WAS only. The dry weight of leaf increased when nitrogen level was increased either to 45 or 90kgN/ha. The differences due to sowing dates were found to be highly significant at all the 4 stages of growth. Early sown crop resulted in significantly higher leaf dry weight than the late sown crop. The effect of population was found to be significant at 10 WAS only. Each population level significantly increased the dry weight of leaf. Differences in varieties were significant at 4 WAS only. The variety V-35 produced higher leaf dry weight than Local-1.

In 1993, the differences oweing to nitrogen levels were significant at 6 WAS only. The control treatment produced a higher leaf dry weight than other two nitrogen treatments. The effect of sowing date was found to be highly significant in all the four stages of growth. The early sown crop produced higher dry leaf weight when compared to late sown crop. The effects of population levels were found to be none significant in all the four stages of growth. The effect of varieties were significant at 6WAS only. Local-1 produced higher leaf dry weight when compared with V-35 variety.

In 1994, nitrogen, sowing date and population levels were found to be significant at all the four stages of leaf dry weight. At 4, 6 and 8 WAS control resulted in lower leaves dry weight than other two levels of nitrogen which were at par. At 10 WAS, 45kgN/ha produced the highest leaf dry weight followed by 90 and 0kgN/ha. Early sown crop produced a higher leaf dry weight than the late sown in all the four stages of growth. Leaf dry weight has a significant effect on population levels during the four stages of growth. The differences due to varieties were found to be significant, except at 8 WAS. Both at 4 and 6 WAS Local-1 produced higher leaf dry weight than V-35. However, at 10 WAS the V-35 variety produced higher leaf dry weight than the Local-1 variety.

Interaction between nitrogen x date of sowing was significant at 8 WAS in 1992 and at 10 WAS in 1994 (Table 19)

Table 19: Leaf dry weight (g/plant) as affected by nitrogen x date interaction at 8 and 10 WAS during 1992 and 1994 rainy seasons.

1992(8WAS)			1994(10WAS)	
Nitrogen (NKg/ha)	Early Sowing date 25-6-92	Late 24-7-92	Early Sowing date 9-7-94	Late 8-8-94
Nitrogen				
0	38.3b	27.1c	50.2b	18.3d
45	47.2a	28.3c	57.4a	34.3c
90	48.4a	28.3c	50.3b	18.4d
SE ±	6.00		4 .00	

Means follow by the same letter within an interaction table are not significantly different using the Duncan's Multiple Range Test (DMRT. 05).

At 8 WAS in 1992, application of nitrogen at both levels increased dry leaf weight in early sown crop, however there was no such difference observed in late sown crop. At 10 WAS, 45kgN/ha resulted in significantly higher leaf dry weight than other two levels. When the two sowing dates were examined at the different levels of nitrogen in both interactions, the early sown crop resulted in higher leaf dry weight than late sown crop.

Nitrogen x population interaction was significant at 8 WAS in 1993 and at 10 WAS in 1994 seasons (Table 20).

Table 20: Leaves dry weight (g/plant) as affected by nitrogen x population interaction at 8, and 10 WAS in 1993 and 1994 seasons.

	1993 (8 WAS)			1994 (10 WAS)		
Nitrogen	Plant population/ha					
(Nkg/ha)	22,000	44,000	88,000	22,000	44,000	88,000
0	10.3b	15.4a	15.4a	15.4a	39.4a	18.2c
45	15.4a	8.3b	10.3b	38.3a	38.4a	34.3a
90	16.3a	15.4a	16.4a	38.2a	27.4a	37.4a
SE ±		3.00			5.00	

Means followed by the same letter within an interaction table are not significantly different using Duncan's Multiple Range Test (DMRT, 05).

When the different population levels were observed for the different nitrogen levels, 22,000 plants/ha at 8 WAS increasing in nitrogen levels at 45 and 90kgN/ha, significantly increased the leaf dry weight . At 44,000 and 88,000 plants/ha, 45kgN/ha produced significantly lower leaf dry weight, than other two nitrogen levels. When each level of nitrogen was considered across the population in control (0kgN/ha) 22,000 plants/ha produced significantly lower leaf dry weight than other two populations. At 45kgN/ha, it was higher than other two populations and at 90kgN/ha, no difference in leaf dry weight was observed in all the three populations tested during the experiments. At 10 WAS in 1994, there was no significant difference in population level at 22,000 plants/ha. At 44,000 and 88,000 plants/ha, 45kgN/ha produced higher leaf dry weight

than other two populations at 44,000 plants/ha which was significant at par at 88,000 plants/ha and both at 45 and 90kgN/ha. When the same nitrogen was observed for the three population levels at control (0kgN/ha) 22,000 plants/ha produced higher leaf dry weight than other two levels. There was no difference at 45 and 90kgN/ha; but 44,000 plants/ha produced lower leaf dry weight than other two treatments. When the same population was examined at the varying nitrogen levels, there was difference at 22,000 plants/ha, but at 44,000 and 88,000 plants/ha, 45kgN/ha produced similar dry leaf weight at 88,000 plants/ha, but it was higher at 44,000 plants/ha than other two populations.

Interaction between date of sowing x population was significant at 10 WAS in 1994 season only. (Table 21).

Table 21: Leaf dry weight (g/plant) as affected by date of sowing x population interaction at 10 WAS in 1994 season.

	1994 (10 WAS)		
Sowing date	**Plant population/ha**		
	22,000	44,000	88,000
9-7-94	60.3a	39.2b	42.3b
8-8-94	17.2c	17.3c	19.3c
SE ±		3.00	

Means followed by the same letter within an interaction table are not significantly different using Duncan's Multiple Range Test (DMRT. 05).

Early sowing of okra produced significantly higher leaf dry weight in all the population levels. When the sowing dates were examined for different populations, 22,000 plants/ha produced higher leaf dry weight than other two population levels. No such difference was observed for the late sown crop.

Nitrogen x variety interaction was found to be significant at 6 WAS in 1993 season, only. (Table 22).

Table 22: Leaf dry weight (g/plant) as affected by nitrogen x variety interaction at 6 WAS in 1993 season.

	1993 (6 WAS)	
Nitrogen	Variety	
(Nkg/ha)	Local-1	V-35
0	13.3b	11.3c
45	12.3b	14.4a
90	14.4a	15.6a
SE ±	1.50	

Means followed by the same letter within an interaction table are not significantly different using Duncan's Multiple Range Test (DMRT, 05).

When the same varieties were considered for different nitrogen levels, Local-1 produced similar leaf dry weight, when the nitrogen was increased from 0 - 45kgN/ha, but a further increase in nitrogen from 45 to 90kgN/ha significantly increased leaf dry weight. The response was reverse in the case of V-35. Control significantly produced lower leaf dry weight than other two nitrogen levels. When the same nitrogen level was considered for the two varieties, V-35 produced lower leaf dry weight than Local-1 at 0kgN/ha, it was also higher than Local-1 at 45kgN/ha and there was no difference at 90kgN/ha

Date of sowing x variety interactions were significant at 10 WAS in 1992 and at 6 WAS in 1994. (Table 23)

Table 23: Leaf dry weight (g/plant) as affected by date of sowing x variety interaction at 10 WAS in 1992 and at 6 WAS in 1994.

1992 (10 WAS)			1994 (6 WAS)		
Sowing date	Variety		Sowing date	Variety	
	Local-1	V-35		Local-1	V-35
Early 25-6-92	60.3a	49.3b	9-7-94	38.4a	35.4a
Late 24-7-94	42.2c	42.1c	8-8-94	23.3b	14.3c
SE ±	5.00			3.00	

Means followed by the same letter within an interaction table are not significantly different using Duncan's Multiple Range Test (DMRT.05).

Late sown okra produced similar leaf dry weight at 10 WAS, whereas at 6 WAS, Local-1 and V-35 produced higher leaf dry weight. When the two varieties were examined across the sowing dates in both interactions, early sowing produced higher leaf dry weight than late sowing.

Interactions between population x variety were found to be significant at 6 WAS in 1993 and at 8 WAS in 1994 seasons. At 6 WAS in 1993, leaf dry weight in Local-1 was similar at different population levels (Table 24).

Table 24: Leaf dry weight (g/plant) as affected by population x variety interactions at 6 WAS and 8 WAS during 1993 and 1994 seasons.

	1993 (6 WAS)		1994 (8 WAS)	
Plant population/ha	Variety		Variety	
	Local-1	V-45	Local-1	V-35
22,000	11.3b	16.4a	10.3b	16.1a
44,000	11.3b	14.4a	17.4a	10.3b
88,000	11.2b	15.3a	17.3a	15.4a
SE ±	2.61		6.00	

Means followed by the same letter within an interaction table are not significantly different using Duncan's Multiple Range Test (DMRT. 05).

At 6 WAS in 1993, leaf dry weight in Local-1 was similar at different population levels. At 22,000 and 44,000 plants/ha, variety V 35 produced higher leaf dry weight at the other two populations. At 8 WAS in 1994, 22,000 plants/ha resulted in lower leaf dry weight with Local-1 than other two populations. When the same population was observed for the two varieties, at 22,000 plants/ha V-35 produced higher leaf dry weight than Local-1 in both interactions. At 44,000 plants/ha V-35 produced higher leaf dry weight at 6 WAS in 1993 but at 8 WAS, Local-1 produced higher leaf dry weight than V-35 at 88,000 plants/ha. The difference between the two varieties were not significant in both interactions tables.

4.4 Fresh weight of stem (g/plant)

The data on fresh weight during 1992 to 1994 seasons is given in Table 25.

Table25: Fresh stem weight (g/plant) as affected by nitrogen, sowing date, population variety and their interactions during 1992, 1993 and 1994 rainy seasons at Samaru.

Treatment	WEEKS AFTER SOWING											
	1992				1993				1994			
	4	6	8	10	4	6	8	10	4	6	8	10
Nitrogen (N) (kg/ha)												
0	34.3c	34.2b	50.3b	46.4b	30.3	36.3c	57.2c	54.3c	67.5c	78.4c	48.3c	56.3c
45	46.4b	49.5a	63.3a	67.2a	29.1	46.9b	69.1b	86.4b	80.4b	84.3b	82.2b	90.4b
90	56.7a	50.4a	69.4a	68.4a	36.4	50.3a	76.6a	96.7a	98.6a	95.7a	98.5a	99.6a
SE ±	7.00	6.01	5.01	5.01	5.01	3.01	9.00	7.70	6.70	0.30	0.60	1.41
Sowing date (D)		25-6-92				18-7-93				9-7-94		
	71.6a	76.6a	101.7a	100.6a	44.5a	73.6a	115.9a	121.4a	160.3a	152.6a	266.3a	340.4a
		24-7-92				16-8-93				8-7-94		
	19.3b	12.5b	22.4b	20.6b	19.4b	20.3b	22.3b	33.2b	17.2b	42.4b	95.3b	64.4b
SE ±	4.00	5.00	4.01	2.01	6.00	1.00	1.51	2.80	9.20	.04	0.60	2.80
Population (P/ha)												
22,000	36.3	45.3	58.4	58.1	29.3	55.2	57.2	73.3	90.3	92.3	97.8	97.3
44,000	45.4	44.4	63.3	62.0	30.1	36.1	69.1	76.1	89.3	97.6	82.4	100.2
88,000	55.3	46.3	60.2	60.2	36.4	46.4	79.4	86.4	86.4	103.5	63.1	103.1
SE ±	8.00	5.00	9.00	6.00	5.01	8.00	10.00.	9.75	6.00	6.00	7.01	6.41
Variety (V)												
Local-1	42.3b	52.4a	60.3	59.3b	35.5a	55.5a	73.4	76.1	80.3	108.6a	88.8a	94.4b
V-35	46.5a	37.3b	60.3	65.4a	28.3b	30.4b	64.3	81.3	87.4	87.4b	73.3b	100.7a
SE ±	0.30	0.50	2.01	2.00	2.30	1.00	8.05	3.44	3.20	0.40	0.60	2.80
Interactions												
NxD	NS	NS	*	*	NS	NS	NS	NS	*	*	*	NS
NxP	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
DxP	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
NxV	NS	NS	NS	NS	NS	NS	NS	NS	*	NS	NS	NS
DxV	NS	*	*	*	NS	*	NS	NS	*	NS	NS	NS
PxV	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	*	NS

Means followed by the same letter within a treatment group of a column are not significantly different using Duncan's Multiple Range Test (DMRT. 05).

* and ** Significant at 5 and 1 percent levels, respectively.

NS= Not significant.

In 1992, the effect of nitrogen was found to be significant at all the 4 stages of growth. At 4 WAS each level of nitrogen significantly increased fresh stem weight. At 6, 8 and 10 WAS, increasing nitrogen levels from 0 to 45kgN/ha significantly increased fresh stem weight. However, further increase from 45 to 90kgN/ha did not increase fresh stem weight significantly. The differences due to sowing dates were highly significant at all the 4 stages of growth. Early sown okra (25-6-92) resulted in higher fresh stem weight. Population was not significant in any stage of growth. Fresh stem weight was affected by variety at the initial growth of stages at 4 and 6 WAS. The variety V-35 produced higher fresh stem weight than Local-1, at 4 WAS, while Local-1 produced higher fresh stem weight than V-35 at 6 WAS.

In 1993, significant differences in the mean was dues to nitrogen levels at 6, 8 and 10 WAS for fresh stem weight. In all the 3 stages of growth, each increment in nitrogen levels significantly increased fresh stem weight. The sowing date differences in the means were highly significant in all the 4 stages of growth. Early sown okra (18-7-93) resulted in higher stem fresh weight when compared with late sown okra (16-8-93). The effect of population on fresh stem weight was not significant in all the 4 stages of growth. The effect of variety for fresh stem weight was significant at 4 and 6 WAS . Variety Local-1 had higher fresh stem weight than V-35 at 4 and 6 WAS.

In 1994, the differences in nitrogen levels and sowing dates effects were significant at all the 4 stages of growth. Each increase in the levels of nitrogen increased the fresh stem weight in all the 4 stages of growth. The early sown okra (9-7-94) produced higher stem fresh weight than sown okra (8-8-94). The population levels effect were not statistically significant at all the

4 stages of growth. The differences which were due to varieties were significant at all the stages of growth, except at 4 WAS. Local-1 variety produced higher fresh stem weight than V-35 at 6 and 8 WAS. However at 10 WAS V-35 produced higher fresh stem weight than Local-1.

Nitrogen x date of sowing interaction was significant at 8 and 10 WAS in 1992 and at 4, 6, and 8 WAS in 1994 (Table 26).

Table 26: Fresh stem weight (g/plant) as affected by nitrogen x date of sowing interaction at 8 and 10 WAS 1992 and at 4, 6 and 8 WAS in 1994.

	1992 (8 WAS)		1992 (10 WAS)		1994 (4 WAS)		1994 (6WAS)		1994 (8 WAS)	
Nitrogen (NkgN/ha)	Early 25-6-92	Late 24-7-92	Early 25-6-92	Late 24-7-92	Early 9-7-94	Late 8-8-94	Early 9-7-94	Late 8-8-94	Early 9-7-94	Late 8-8-94
0	68.2b	39.2d	87.4a	30.2d	119.5c	14.2e	125.2b	41.2e	222.3c	74.3f
45	88.3a	42.3c	86.3a	36.3c	166.3b	16.3d	166.4a	42.3c	267.6b	96.4e
90	90.4a	42.3c	88.4a	42.4b	196.4a	20.2d	166.4a	43.3c	309.8a	115.2d
SE ±	5.30		3.00		4.00		6.00		2.10	

Means followed by the same letter within an interaction table are not significantly different using Duncan s Multiple Range Test (DMRT, 05).

In 1992 season, both in early and late sown the two applied rates of nitrogen produced higher fresh stem weight than control (0kgN/ha). Early sowing of okra at all levels produced significantly higher fresh stem weight than late sown okra. At 10 WAS, however, no difference was observed in early sowing in different rates of nitrogen levels, but in case of late sowing okra, each increase in nitrogen level significantly increased the fresh stem weight. When the two sowing dates were examined at the same level of fertilizer, early sowing produced higher fresh stem weight than late sowing in all levels.

In 1994 season, early sowing both at 4 and 8 WAS produced significantly higher fresh stem weight with each increase in nitrogen, but at 6 WAS such difference was observed when nitrogen levels was increased from 0-45kgN/ha. Further increase in nitrogen to 90kgN/ha, however, did not significantly affected fresh stem weight. In case of late sowing, 45kgN/ha produced higher fresh stem weight than control (0kgN/ha) at 4 WAS and no difference was observed at 6 WAS and at 8 WAS 90kgN/ha produced higher fresh stem weight than other two nitrogen levels. When the two sowing dates were examined at the same nitrogen level in control, early sowing produced higher fresh stem weight at all the stages of growth and in all levels.

The interactions between nitrogen x population and date of sowing x population were not significant in all the stages and seasons. Nitrogen x variety interaction was found to be significant at 4 WAS in 1994 season only. (Table 27)

Table 27: Fresh stem weight (g/plant) as affected by nitrogen x variety interaction at 4 WAS in 1994 season.

	1994 (4 WAS)	
Nitrogen (Nkg/ha)	Local-1	V-35
	Variety	
0	65.4d	69.4d
45	98.3b	84.4c
90	107.8a	108.6a
SE ±	4.0	

Means followed by the same letter within an interaction table are not significantly different using Duncan's Multiple Range Test (DMRT, 05).

The two varieties responded similarly to nitrogen levels for fresh stem weight. Each increment in nitrogen increased fresh stem weight. When each level of nitrogen was examined between the varieties, no significant difference was observed at all the three levels of nitrogen.

Date of sowing x variety interaction was significant at 6, 8 and 10 WAS in 1992; at 6 WAS in 1993 and at 4 WAS in 1994 seasons (Table 28).

Table 28: Fresh stem weight g/plant as affected by date of sowing x variety interactions at 6, 8 and 10 WAS in 1992; at 6 WAS in 1993 and at 4 WAS in 1994 seasons at Samaru.

	1992 (6 WAS)		1992 (8 WAS)		1992 (10 WAS)		1993 (6 WAS)		1994 (4 WAS)	
Sowing date	Local-1	V-35	Local-1	V-35	Local-1	V-35	Local-1	V-35	Local-1	V-35
							18-7-93		9-7-94	
Early 25-6-92	58.8a	54.4a	70.8a	72.6a	68.3a	76.6a	91.8a	55.4b	165.2a	155.6b
							16-8-93		8-8-94	
Late 24-7-92	34.6b	30.3b	52.6b	48.4b	48.4c	48.4c	19.3c	18.3c	15.3d	19.6c
SE ±	5.10		4.30		2.50		1.50		3.00	

Means followed by the same letter within an interaction table are not significantly different using Duncan's Multiple Range Test (DMRT, 05).

The responses of the two varieties were similar to date of sowing for fresh stem weight in 1992 season. There was no significant different within either early and late sown for the two varieties, however, early sown crop, produced significantly higher fresh stem weight than late sown crop. At 6 and 4 WAS in 1993 and 1994 seasons, early sown crop produced higher fresh stem weight than late sown crop when the two varieties were examined at the same sowing dates, Local-1 variety produced higher fresh stem weight than V-35 in early sown crop, but in late sown crop no difference was observed at 6 WAS in 1993, but at 4 WAS in 1994, variety Local-1 produced higher fresh stem weight than variety V-35.

Population x variety interaction was significant at 6 WAS in 1994 season only (Table 29).

Table 29: Fresh stem weight (g/plant) as affected by population x variety interaction at 6 WAS in 1994 season.

	1994 (6 WAS)	
	Variety	
Plant population/ha	Local-1	V-35
22,000	90.6c	94.3c
44,000	104.7b	91.3c
88,000	29.8a	76.4d
SE +	7.00	

Means followed by the same letter within an interaction table are not significantly different using Duncan's Multiple Range Test (DMRT, 05).

The variety Local-1 produced significantly higher fresh stem weight with each increase in population. Incase of V-35 there was no significant difference in the fresh stem weight between 22,000 and 44,000 plants/ha, but the two population levels, produced higher fresh stem weight than 88,000 plants/ha. When the same variety was examined between 22,000 plants/ha, 44,000 and 88,000 plants/ha, Local-1 produced higher fresh stem weight than V-35 variety.

4.5 Stem dry weight (g/plant)

The data on stem dry weight during 1992 to 1994seasons is given in Table 30.

Table 30: Stem dry weight (g/plant) as affected by nitrogen, sowing date, population, variety and their interactions during 1992, 1993 and 1994 rainy seasons at Samaru.

	WEEKS AFTER SOWING											
Treatment	1992				1993				1994			
	4	6	8	10	4	6	8	10	4	6	8	10
Nitrogen (N) (Kg/ha)												
0	34.2	35.1	48.3c	73.3	50.1	90.6a	95.3c	100.0c	16.3	14.1c	45c	41.4
45	50.4	48.5	57.4b	86.2	40.0	60.3b	98.4	125.4b	23.5	19.3b	47b	41.4
90	63.1	53.4	69.6a	85.5	60.4	60.3b	100.6	132.6a	24.4	21.4a	51a	38.3
SE ±	12.40	12.10	7.00	10.21	13.01	5.00	12.00	6.00	6.00	3.00	2.00	3.00
Sowing date (D)												
Early		25-6-92				18-7-93				9-7-94		
	79.6a	74.4a	96.5a	100.4a	70.6a	100.3a	144.4a	200.3a	29.4a	25.3a	75.9a	362.6a
Late		24-7-92				16-8-93				8-7-94		
	19.4b	17.4b	21.3b	62.3b	30.3b	40.3b	80.6b	38.6b	13.4b	11.3b	20.5b	18.6b
SE ±	1.90	1.70	5.00	9.80	1.00	1.00	4.00	5.00	2.00	1.00	3.00	2.00
Population (P/ha)												
22,000	45.3	45.1	58.3	80.2	49.3	62.1	97.3	117.4	13.3	17.2b	53.7a	37.4
44,000	49.0	45.2	57.3	80.2	50.3	70.3	95.4	121.2	25.2	21.3c	47.4b	40.5
88,000	53.3	45.4	58.2	80.2	50.2	80.4	100.2	119.3	25.3	17.5b	42.3c	43.2
SE ±	5.11	7.00	8.00	6.00	3.01	7.21	6.01	4.00	5.00	2.01	4.01	7.01
Variety (V)												
Local-1	45.3	57.1	58.4	81.3	60.3	80.5	100.3a	111.3b	13.3b	129.4	47.3	42.3
V-35	54.2	43.3	59.5	81.3	40.1	60.3	94.4b	124.5a	29.6a	27.5	47.4	39.2
SE ±	8.91	8.11	5.00	9.00	2.01	2.01	3.00	5.00	1.00	2.00	3.00	2.00
Interactions												
NxD	NS	*	NS	NS	NS	NS	NS	NS	*	*	NS	NS
NxP	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
DxP	NS	NS	NS	NS	NS	NS	*	NS	*	*	NS	NS
NxV	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	*	NS
DxV	NS	*	NS	NS	NS	*	NS	NS	*	*	NS	*
PxV	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Means followed by the same letter within a treatment group of a column are not significantl different using Duncan's Multiple Range Test (DMRT, 05).

* and ** Significant at 5 and 1 percent levels, respectively.

NS = Not significant

In 1992 rainy season, stem dry weight was found to be significantly affected by nitrogen level at 8 WAS. Each increase in nitrogen level significantly increased the stem dry weight. The sowing date affected the stem dry weight at all the stages of growth. The early sown date resulted in higher stem dry weight than the late sowing okra. Population levels did not affect stem dry weight, likewise variety also did not affect stem dry weight at any stage of growth in 1992.

In 1993 season, nitrogen levels affected the stem dry weight at 6 and 10 WAS. At 6 WAS, control produced highest stem dry weight than both 45 and 90kgN/ha. But at 10 WAS, each increase in nitrogen level significantly increased stem dry weight. The sowing date affected the stem dry weight at all the stages of growth. The early sown okra produced highest dry stem weight than the late sown okra. The differences due to population levels and variety were not statistically significant at any of the growth stages, except at 8 and 10 WAS when effect of variety on stem dry weight was significant. Local-1 produced higher stem dry weight than V-35 at 8 WAS and V-35 produced higher stem dry weight than Local 1 at 10 WAS.

In 1994, the differences in the mean of nitrogen at 6 and 8 WAS were found to be significant. At 6 WAS control produced lowest stem dry weight than the two applied levels of nitrogen. At 8 WAS 90kgN/ha produced higher stem dry weight than both 45 and 0kgN/ha. The differences oweing to sowing dates were highly significant at all the growth stages. Early sown okra resulted in higher stem dry weight than late sown okra. The significant differences at 6 and 8 WAS after sowing were due to populations. At 6 WAS, early sown okra at 88,000 plants/ha produced a lower stem dry weight than 44,000 plants/ha. In case of 8 WAS, each increase in

population level resulted in a decrease in stem dry weight. The varietal differences due to varieties were not significant at all the stages of growth, except at 4 WAS, when variety V-35 produced higher stem dry weight than variety Local-1.

Interaction between nitrogen x date of sowing was significant at 6 WAS in 1992 and at 4 and 6 WAS in 1994 seasons (Table 31).

Table 31: Stem dry weight (g/plant) as affected nitrogen x date of sowing interactions at 6 WAS; and at 4 and 6 WAS during 1992 and 1994 seasons.

Treatment	1992 (10 WAS)		1994 (4 WAS)		1994(6WAS)	
	Sowing date		Sowing date		Sowing date	
Nitrogen (Nkg/ha)	Early 25-6-92	Late 24-7-92	Early 9-7-94	Late 8-8-94	Early 9-7-94	Late 8-8-94
0	75.3c	50.3d	23.1b	9.3a	17.3b	11.1c
45	96.4b	33.2e	32.4a	13.4c	30.3a	10.4d
90	116.6a	50.3d	33.2a	15.3c	30.4a	12.5b
SE ±	9.00		4.00		6.00	

Means followed by the same letter within an interaction table are not significantly different using Duncan's Multiple Range Test (DMRT, 05)

At 6 WAS in 1992, early sowing of okra resulted in higher stem dry weight with each increase in nitrogen level, but in late sowing both control and 90kgN/ha produced higher stem dry weight than 45kgN/ha. When the sowing dates were examined under the same nitrogen levels, early sown okra produced higher stem dry weight than late sown okra at all levels of nitrogen. When interactions in 1994 at 4 and 6 WAS were examined, the two applied rate of nitrogen produced higher stem dry weight than control. The late sown okra at 6 WAS with each increment in nitrogen increased the stem dry weight.

Nitrogen x population interaction was not significant in all the seasons and years date of sowing x population interaction was found to be significant at 8 WAS in 1993, at 4 and 6 WAS in 1994 seasons (Table 32).

Table 32: Stem dry weight g/plant as affected by date of sowing x population interaction at 8 WAS; at 4 and 6 WAS in 1993 and 1994 seasons.

	1993 (8 WAS)		1994 (4 WAS)		1994 (6 WAS)	
Plant population/ha	Sowing date		Sowing date		Sowing date	
	Early	Late	Early	Late	Early	Late
	18-7-93	16-8-93	9-7-94	8-8-94	9-7-94	8-8-94
22,000	70.3b	65.3c	13.1d	12.0d	21.1c	13.0d
44,000	88.2a	57.3d	35.0b	15.2e	32.1a	10.0e
88,000	78.3b	65.4c	39.4a	11.2f	23. b	10.0e
SE ±	9.00		2.00		3.00	

Means followed by the same letter within an interaction table are not significantly different using Duncan's Multiple Range Test (DMRT. 05)

Higher stem dry weight was produced at 44,000plants/ha than the two other populations, both in early and late sown okra. When the two sowing dates were examined at different population levels, early sown crop recorded higher stem dry weight when compared with late sown crop. In 1994 season, both at 4 and 6 WAS, early sown crop recorded higher stem dry weight than late sown crop at all the population levels, except at 22,000 plants/ha at 4 WAS. When the sowing dates were examined, for different population levels at 4 WAS, each increase in population level, increased the stem dry weight significantly in early sown crop at 4 WAS, but in late sowing both at 4 and 6 WAS, 44,000 plants/ha produced higher stem dry weight than other two population levels. The late sowing at 6 WAS, 22,000 plants/ha produced higher stem dry weight than other two population levels.

Nitrogen x variety interaction was significant at 8 WAS in 1993 season only (Table 33).

Table 33: Stem dry weight (g/plant) as affected by Nitrogen x variety interaction at 8 WAS in 1994.

Treatment	1994 (8 WAS)	
Nitrogen	Variety	
(kNgN/ha)	Local-1	V-35
0	77.0c	97.9c
45	101.3b	86.3d
90	123.3a	86.7d
SE ±	7.00	

Means followed by the same letter within an interaction table are not significantly different using Duncan's Multiple Range Test (DMRT. 05)

In the case of variety Local-1 each level of nitrogen increased significantly stem dry weight, whereas in V-35 the two applied nitrogen levels resulted in significantly lower stem dry weight. When the same nitrogen levels were examined for the two varieties, the control and 45kgN/ha with Local-1 produced significantly higher stem dry weight than V-35 and the reverse was true for the two applied rates of nitrogen.

Date of sowing x variety interaction was found to be significant at 6 WAS both in 1992 and 1993 and at 4 and 6 WAS in 1994 seasons (Table 34).

Table 34: Stem dry weight (g/plant) as affected by date of sowing x variety interaction at 6,6, 4,4 and 10 WAS during 1992, 1993 and 1994 rainy seasons

	1992 (6 WAS)		1993 (6 WAS)			1994 (4 WAS)		1994 (6WAS)		1994 (10 WAS)	
Sowing date											
Early	Local-1	V-35		Local-1	V-35		Local-1	V-35	Local-1	V-35	Local-1	V-35
25-6-92	96.7a	53.4b	18-7-93	140.6a	90.3b	9-7-94	18.4b	40.6a	40.3a	18.3b	70.3a	56.4
Late												
24-7-92	19.2c	12.3d	16-8-93	30.4c	20.5d	8-8-94	7.3c	9.4c	10.3c	4.4d	15.2c	21.3
SE 4	2.40			2.00			2.0			2.00		6.00

Means followed by the same letter within an interaction table are not significantly different using Duncan's Multiple Range Test (DMRT, 05).

At 6 WAS both in 1992 and 1993 seasons, Local-1 variety produced significantly higher stem dry weight than variety V-35. When the same date was examined for the two varieties early sowing produced higher stem dry weight than late sown crop. In 1994 however, V-35 produced higher stem dry weight than Local-1 variety at 4 WAS in early sowing, but the reverse was true at 6 WAS in 1994 in which variety Local-1 produced higher stem dry weight than variety V-35. In the late sown the difference was not significant at 4 WAS; but at 6 WAS, Local-1 produced higher stem dry weight than variety V-35. Early sowing produced higher stem dry weight than late sown at all the stages in 1994 season.

4.6 Fresh weight of root (g/plant)

Results on fresh weight of root for 1992 to 1994 seasons is presented in Table 35

Table35: Fresh weight of root (g/plant) as affected by nitrogen, sowing date, population variety and their interactions during 1992, 1993 and 1994 rainy seasons at Samaru

Treatment	1992				WEEKS AFTER SOWING: 1993				1994			
	4	6	8	10	4	6	8	10	4	6	8	10
Nitrogen (N) (Kg/ha)												
0	59.3	56.2c	66.4c	71.4c	27.1c	61.3	64.3c	72.1c	19.1	31.4b	33.3	35.4c
45	60.1	73.3b	70.2b	89.3b	35.0b	62.2	75.2a	92.0b	20.2	33.3b	36.2	45.3b
90	61.4	75.4a	76.1a	101.0a	37.3a	62.2b	168.4b	102.3a	21.0	40.5a	41.4	51.5a
SE ±	4.26	1.23	1.21	1.42	1.00	1.00	1.91	2.04	2.03	4.04	5.07	2.02
Sowing date (D)		25-6-92				18-7-93				9-7-94		
Early	98.6a	120.0a	98.5a	98.3a	40.4a	100.4a	100.3a	104.8a	28.5a	56.1a	55.6a	372.4a
		24-7-92				16-8-93				8-7-94		
Late	22.5b	16.8b	42.3b	75.6b	26.5b	22.3b	38.4b	72.6b	11.5b	14.3b	16.6b	16.8b
SE ±	3.00	2.03	4.31	6.01	2.04	4.03	6.01	6.02	1.00	3.03	4.04	3.01
Population (P/ha)												
22,000	60.3	65.3	70.3	84.4	34.4	61.3	69.3	85.44	25.4	32.2	29.5c	48.6a
44,000	58.6	69.5	70.3	92.2	33.4	59.5	66.2	93.42	17.5	37.1	36.4b	37.4b
88,000	63.4	70.1	70.4	87.1	32.6	64.7	72.4	87.1	17.3	36.3	43.6a	47.5a
SE ±	5.31	6.13	5.02	4.21	5.04	9.03	6.37	4.66	8.00	4.03	5.01	4.00
Variety (V)												
Local-1	59.4	64.6	58.4	85.4	35.4	59.4	164.5b	81.3a	20.1	25.3	36.6	39.3
V-35	62.3	72.8	70.3	89.5	31.6	62.8	73.6a	95.6ba	20.4	36.4	35.9	49.5
SE ±	6.13	6.01	4.00	9.01	5.03	8.0b	8.0c	1.23	1.06	3.01	3.03	2.15
Interactions												
NxD	NS	NS	NS	NS	NS	NS	NS	**	NS	NS	NS	*
NxP	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
DxP	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	*
NxV	NS	*	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
DxV	NS	*	NS	NS	NS	NS	NS	NS	NS	NS	*	*
PxV	NS	*	NS	NS	NS	NS	NS	NS	NS	*	NS	*

Means followed by the same letter within a treatment group of a column are not significantly different using Duncan's Multiple Range Test (DMRT, 05)

* and ** Significant at 5 and 1 percent levels, respectively.

NS = Not significant

In 1992, except at initial stage (4 WAS) root fresh weight was significantly affected by nitrogen application. At 6 WAS both 45 and 90kgN/ha gave a higher fresh root weight than control (0kgN/ha). At 8 and 10 WAS, each increase in nitrogen levels significantly increased fresh root weight. Sowing date significantly affected fresh root weight at all the 4 stages of growth. Early sown crop was found to give a higher fresh root weight than late sown crop. Differences oweing to population levels and varieties were found to be non significant at all the stages of growth.

During 1993 season, fresh root weight was not significantly affected at 6 WAS by nitrogen levels. At 4 and 10 WAS each increase in nitrogen levels significantly increased the fresh root weight. At 8 WAS, however, the highest fresh root weight was recorded by 45kgN/ha which was followed by 90kgN/ha. The lowest fresh root weight was observed in control (0kgN/ha). The differences due to sowing dates were highly significant at all the growth stages in which the early sown okra recorded a higher fresh root weight than the late sown okra. The differences due to population levels and the varieties were not statistically significant except at 8 WAS, when V-35 recorded higher fresh root weight than Local 1 at 8 WAS and at 10 WAS when Local-1 recorded higher fresh root weight than V-35.

In 1994 rainy season, the differences due to nitrogen levels were significant at 6 and 10 WAS. At 6 WAS the 90kgN/ha resulted in higher fresh root weight than other nitrogen levels, whereas at 10 WAS the two applied nitrogen levels recorded a higher fresh root weight when compared with control (0kgN/ha). Early sown okra produced higher fresh root weight than late sown crop. The differences oweing to population levels were significant at 8 and 10 WAS, while the variety was not significant at all the stages of growth. At 8 and 10 WAS, 88,000 plants/ha produced higher fresh root weight than the other two population levels.

Nitrogen x sowing date interaction was found to be significant both at 10 WAS in 1993 and 1994 seasons (Table 36).

Table 36: Root fresh weight (g/plant) as affected by nitrogen x date of sowing interaction at 10 WAS, during 1993 and 1994 rainy seasons at Samaru.

	1993 (10 WAS)		1994 (10 WAS)	
Nitrogen	Sowing date		Sowing date	
	Early	Late	Early	Late
(Nkg/ha)	18-7-93	16-8-93	9-7-94	8-8-94
0	88.2b	83.3c	56.4c	15.3d
45	95.4a	84.4c	76.7b	15.4d
90	97.4a	84.3c	83.6a	19.2d
SE ±	2.33		5.00	

Means followed by the same letter within an interaction table are not significantly different using Duncan's Multiple Range Test (DMRT. 05).

In 1993, control produced significantly lower fresh root weight than the applied nitrogen, the difference which was not significant. However, in 1994 season, each increase in nitrogen significantly increased fresh root weight. But in late sown crop there was no significant difference with an increase in nitrogen levels in both seasons. When the two sowing dates were compared at each nitrogen level, early sowing resulted in higher fresh root weight than late sowing.

Non of interaction between nitrogen x population was found to be significant in all the years. Date of sowing x population interaction was observed at 10 WAS in 1994 season only (Table 37).

Table 37: Root fresh weight (g/plant) as affected by date of sowing x population interaction at 10 WAS in 1994 season.

	1994 (10 WAS)	
Plant population/ha	Sowing date	
	Early 9-7-94	Late 8-8-94
22,000	81.6a	15.1d
44,000	54.4c	17.3d
88,000	76.2b	18.4d
SE +	6.02	

Means followed by the same letter within an interaction table are not significantly different using Duncan's Multiple Range Test (DMRT 0.5).

In early sowing each increase in population level significantly decreased fresh root weight. However, no such difference was observed in late sown. At each population level, early sowing resulted in a higher root fresh weight than late sown crop.

Nitrogen x variety interaction was observed at 6 WAS in 1992 season only (Table 38).

Table 38: Root fresh weight (g/plant) as affected by nitrogen x variety interaction at 6 WAS in 1992 season.

Treatment	1992 (6 WAS)	
Nitrogen (Nkg/ha)	**Local-1**	**V-35**
0	37.3c	81.4a
45	45.4b	81.4a
90	81.6a	82.3a
SE +	1.21	

In the case of Local-1 variety, each increase in nitrogen level significantly increased the root fresh weight. In variety V-35, no difference was observed with an increase in nitrogen level. When each level of nitrogen was examined for the two varieties, V-35 resulted in higher root fresh weight than Local-1 variety, except at 90kgN/ha in when both varieties produced statistically similar fresh root weight.

Interaction between date of sowing x variety was found to be significant at 6 WAS in 1992 and at 8 and 10 WAS in 1994 (Table 39)

Table 39: Root fresh weight (g/plant) as affected by date of sowing x variety interactions at 6 WAS in 1992; at 8 and 10 WAS in 1994 seasons.

	1992 (6 WAS)			1994 (8 WAS)		1994 (10 WAS)	
Sowing date	**Variety**			**Variety**		**Variety**	
Early	**Local-1**	**V-35**		**Local-1**	**V-35**	**Local-1**	**V-35**
25-6-92	97.6a	77.4b	**9-7-94**	**56.6a**	54.7a	61.4b	83.5a
Late							
24-7-92	56.3c	42.5d	**8-8-94**	**14.7c**	20.4b	17.3c	16.4c
SE +	7.00			2.00		5.00	

Means followed by the same letter within an interaction table are not significantly different using Duncan's Multiple Range Test (DMRT, 05).

In all the stages of samplings, early sowing resulted in higher root fresh weight than late sown. When the two varieties were examined at the same sowing date in 1992 at 6 WAS, the Local-1 variety produced significantly higher root fresh weight than V-35both in early and late sowing. But in 1994 season, there was no difference in fresh root weight of the two varieties at 8 WAS, however, at 10 WAS,V 35 produced higher fresh root weight than variety Local-1. In the late sown at 8 WAS, the root fresh weight of V-35 was higher than Local 1 and no such difference was observed at 10 WAS.

Population x variety interaction was found to be significant both at 6 WAS in 1992 and at 10 WAS in 1994 (Table 40).

Table 40: Fresh root weight (g/plant) as affected by population x variety interaction at 6,6 and 10 WAS during 1992 and 1994 rainy seasons.

	1992 (6 WAS)		1994 (6 WAS)		1994 (10 WAS)	
Plant population/ha	Variety		Variety		Variety	
	Local-1	V-35	Local-1	V-35	Local-1	V-35
22,000	64.3c	68.4b	35.4b	35.4b	45.3c	51.4a
44,000	60.4d	76.7a	46.6a	25.8d	24.5d	51.4a
88,000	77.6a	64.3c	32.4c	35.4b	48.2b	46.3b
SE ±	1.00		2.32		2.00	

Means followed by the same letter within an interaction table are not significantly different using Duncan's Multiple Range Test (DMRT, 05).

When the response of the same population level was examined for different varieties, variety V-35 produced higher root fresh weight than Local-1. At 6 WAS in 1992 and at 10 WAS in 1994 seasons no such difference was observed. At 44,000 plants/ha, V 35 produced higher root fresh weight than Local-1 at 6 WAS in 1992 and at 10 WAS in 1994. However, at 6 WAS in 1994, it was a reverse. At 88,000plants/ha, Local-1 produced higher root fresh weight than V-35. At

6 WAS in 1992, reverse was true at 6 WAS in 1994 and no such difference was observed at 10 WAS in 1994 season. When each variety was examined at different population levels in early sowing, Local-1 produced higher root fresh weight at 6 WAS in 1994 and the reverse was true in other two stages (6 WAS in 1992 and at 10 WAS in 1994). When the variety was compared, V-35 produced higher fresh root weight both at 6 WAS and at 10 WAS in 1992 and 1994 seasons respectively.

4.7 Root dry weight(g/plant)

The mean of root dry weight during 1992 to 1994is given in Table 41.

Table 41: Dry weight of root (g/plant) as affected by nitrogen, sowing date population variety and their interactions during 1992, 1993 and 1994 rainy seasons at Samaru.

Treatment	WEEKS AFTER SOWING											
	1992				1993				1994			
	4	6	8	10	4	6	8	10	4	6	8	10
Nitrogen (N) (Kg/ha)												
0	12.2	17.7	10.0	11.1	13.3	18.5	18.8	18.8	9.2	14.5	20.4	50.9
45	13.3	18.8	18.8	22.2	13.3	13.3	16.6	24.4	9.2	14.5	20.4	50.9
90	13.3	19.9	18.8	16.6	12.2	18.2	17.7	18.8	9.2	16.4	20.6	40.9
SE ±	2.04	2.04	5.06	7.00	2.38	6.00	4.16	6.07	1.04	2.36	4.00	4.00
Sowing date (D)												
Early		25-6-92				18-7-93				9-7-94		
	18.3a	27.3aa	18.3a	21.2a	16.1a	23.1a	22.2a	29.1a	12.3a	20.4a	29.6a	70.5a
Late		24-7-92				16-8-93				8-7-94		
	8.4b	9.3b	12.2b	11.3b	7.4b	8.4b	13.3b	11.3b	5.4b	9.3b	11.2b	23.9b
SE ±	4.00	1.00	2.01	2.01	1.01	1.00	2.00	2.00	1.00	2.00	3.21	2.70
Population (P/ha)												
22,000	11.1	16.6	16.6	14.4	12.2	16.3	17.1	19.1	8.1	14.8	20.3	47.1
44,000	12.2	19.9	11.1	15.5	13.3	15.8	16.7	18.2	9.4	14.3	18.2	47.3
88,000	17.7	18.8	19.9	18.6	12.2	16.6	17.3	21.3	9.3	16.1	22.3	47.7
SE ±	4.06	2.04	5.04	4.00	2.76	3.00	2.00	4.00	1.46	4.00	3.47	3.56
Variety (V)												
Local-1	12.9	16.6	15.0	18.3	13.2	17.1	17.6	17.3b	8.11	16.3	16.2b	76.12
V-35	13.3	21.1	16.6	14.6	12.3	16.3	17.3	23.2a	9.21	14.4	24.3a	19.12
SE ±	2.37	5.35	2.04	4.34	2.34	1.76	2.00	2.00	1.00	3.00	2.00	3.46
Interactions												
NxD	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
NxP	NS	*	NS	NS	NS	NS	*	NS	NS	NS	NS	*
DxP	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	*
NxV	NS	NS	NS	NS	NS	NS	NS	NS	NS	*	NS	NS
DxV	NS	NS	NS	NS	NS	*	*	NS	NS	*	NS	NS
PxV	NS	*	NS	NS	NS	NS	NS	NS	NS	NS	*	NS

Means followed by the same letter within a treatment group of a column are not significantly different using Duncan's Multiple Range (DMRT, 05).

* and ** Significant at 5 and 1 percent levels, respectively.

NS = Not significant

The root dry weight was not significantly affected by nitrogen, population and variety in 1992 season. The differences due to sowing dates were highly significant at all the stages of growth. Early sown okra recorded a higher root dry weight when compared with late sown okra. Population and variety were not affected by root dry weight in all the seasons and years.

In 1993, the differences in the mean due to nitrogen and population were not statistically significant, but the differences due to sowing dates were highly significant at all the stages of growth. Okra sown on (18-7-93) gave a higher root dry weight than okra sown on 16-8-93. The effect of varieties were found to be significant only at 10 WAS and V-35 recorded a higher dry root weight than Local-1 variety. Population did not affect the root dry weight in all the seasons.

In 1994, the differences due to nitrogen and population levels were not significant at any stage of growth. The differences due to sowing dates were highly significant. Early sown okra produced higher root dry weight than late sown okra. The differences in the varieties were significant at 8 and 10 WAS. At 8 WAS, V-35 recorded a higher root dry weight, while at 10 WAS, Local-1 gave a higher root dry weight. Population did not affect the root dry weight in any of the growth stages.

Nitrogen x date of sowing interaction was found not to be significant in all the seasons and years, but nitrogen x population interaction was observed at 6, 8 and 10 WAS in 1992, 1993 and 1994 seasons (Table 42).

Table 42: Root dry weight (g/plant) as affected by nitrogen x population interaction at 6, 8 and 10 WAS during 1992, 1993 and 1994 seasons.

Treatment	1992 (6 WAS)			1993 (8 WAS)			1994 (10 WAS)		
Nitrogen	Plant population/ha								
(Nkg/ha)	22,000	44,000	88,000	22,000	44,000	88,000	22,000	44,000	88,000
0	12.2d	29.4a	14.4e	13.3d	18.8c	23.2b	14.4d	17.1c	22.1b
45	16.6c	17.3c	20.0b	29.9a	19.3c	25.3b	29.3a	18.1c	23.1b
90	23.3b	25.5a	14.4e	18.8c	21.1b	15.3c	17.2c	19.1c	17.4c
SE ±		4.00			2.11			2.00	

Means followed by the same letter within an interaction table are not significantly different using Duncan's Multiple Range Test (DMRT, 05).

When 22,000 plants/ha was examined for different nitrogen levels, it was observed that each increase in nitrogen level significantly increased root dry weight at 6 WAS in 1992 season. But at 8 and 10 WAS in 1993 and 1994 seasons, 45kgN/ha resulted in higher root dry weight than other two nitrogen levels, followed by 90kgN/ha and control in that order. At 6 WAS in 1992 44,000 plants/ha produced significantly lower root dry weight at 45kgN/ha than other two population levels, and the difference between the other two levels were not significant. At 8 WAS in 1993 season, 90kgN/ha produced lower root dry weight than the other two, which was not significant at 10 WAS 1994. No difference was observed at 44,000 plants/ha. At 88,000 plants/ha, 45KgN/ha resulted in higher root dry weight than other two populations at 6 WAS in 1992, but at 8 and 10 WAS in 1993 and 1994 seasons 90kgN/ha resulted in lower root dry

weight than other two nitrogen levels, the difference of which was not significant. When the same nitrogen level was examined, for the different populations, in control, 44,000 plants/ha at 6 WAS and 88,000 plants/ha at 8 and 10 WAS resulted in higher root dry weight. In the case of 45 kgN/ha, 88,000 plants/ha in 1992 produced higher root dry weight than the other two populations, whereas 22,000 plants/ha both in 1992 and 1994 seasons at 6 and 10 WAS produced similar root dry weight. When 90kgN/ha was considered, 44,000 plants/ha produced higher root dry weight in 1992 and 1993 seasons, whereas no such difference was observed in 1994 season.

Interaction between date of sowing x population was found to be significant at 10 WAS in 1994 season only (Table 43).

Table 43: Root dry weight (g/plant) as affected by date of sowing x population interaction at 10 WAS 1994 season.

		1994 (10 WAS)		
Sowing date		Plant population/ha		
		22,000	44,000	88,000
Early	9-7-94	50.0a	49.3a	46.2b
Late	8-8-94	43.3c	42.1c	43.3c
SE +			2.00	

Means followed by the same letter within an interaction table are not significantly different using Duncan's Multiple Range Test (DMRT, 05).

In early sowing both 22,000 and 44,000 plants/ha produced significantly higher root dry weight than 88,000 plants/ha. No such difference was observed at late sowing date. When populations were examined across the date of sowing early sowing produced higher root dry weight than late sown in all the three populations.

Nitrogen x variety interaction was found to be significant at 6 WAS in 1994 season only (Table 44).

Table 44: Root dry weight (g/plant) as affected by nitrogen x variety interaction at 6 WAS in 1994 season

Treatment	1994 (6 WAS)	
Nitrogen (Nkg/ha)	Variety	
	Local-1	V-35
0	13.3b	12.1c
45	14.3b	13.1c
90	16.4a	13.2c
SE +	1.01	

Means followed by the same letter within an interaction table are not significantly different using Duncan's Multiple Range Test (DMRT, 05).

The root dry weight was found to be similar in 0 and 45kgN/ha and lower than 90kgN/ha. In the case of Local 1 variety, no such difference was observed with increase in nitrogen levels for variety V-35. Examination of each nitrogen level, for the two varieties revealed that variety Local-1 produced a higher root dry weight than variety V-35 in all the nitrogen levels.

Interaction between date of sowing x variety was found to be significant at 6 and 8 WAS in 1993 and at 6 Was in 1994 season only (Table 45)

Table 45: Root dry weight (g/plant) as affected by date of sowing x variety interactions at 6 WAS in 1992; at 8 and 6 WAS in 1994 seasons.

		1992 (6 WAS)		1994 (8 WAS)			1994 (6 WAS)	
Sowing date		Variety		Variety			Variety	
		Local-1	V-35	Local-1	V-35		Local-1	V-35
Early	18-7-93	26.1a	24.3b	28.3a	17.1b	9-7-941	6.3a	6.3a
Late	16-8-93	12.2c	12.2c	12.2c	12.2c	8-8-941	4.6b1	4.6b
SE +		1.01		5.00			1.01	

Means followed by the same letter within an interaction table are not significantly different using Duncan's Multiple Range Test (DMRT. 05).

Early sowing resulted in significantly higher root dry weight of variety Local-1 than variety V-35 in 1993 season, but in 1994 season, no difference in root dry weight was observed in early sowing crop. There was not difference in varieties in all the stages in late planting, when the two varieties were examined across the two sowing dates, early sowing resulted in significantly higher root dry weight than late sowing crop in all the stages, where such difference was observed.

Population x variety interaction was found to be significant at 6 and 8 WAS in 1992 and 1994 seasons respectively (Table 46).

Table 46: Root dry weight (g/plant) as affected population x variety interaction at 6 and 8 WAS, in 1992 and 1994 rainy seasons at Samaru.

	1992 (6 WAS)		1994 (8 WAS)	
Plant population/ha	Variety		Variety	
	Local 1	V-35	Local 1	V-35
22,000	14.2c	17.1b	21.3a	22.3a
44,000	28.3a	18.2b	22.3a	16.3c
88,000	17.2b	19.1b	18.2b	21.3a
SE ±	2.01		1.02	

Means followed by the same letter within an interaction table are not significantly different using Duncan's Multiple Range Test (DMRT. 05).

At 44,000 plants/ha, Local 1 variety produced a higher root dry weight at 6 WAS in 1992, which was followed by 88,000 and 22,000 plants/ha. In the case of variety Local 1 also in 1994 at 8 WAS, 44,000 plants/ha produced a higher root dry weight than 88,000 plants/ha, however, the root dry weight of 22,000 and 44,000 plants/ha were similar. When the variety V-35 root dry weight was examined, no difference was observed at 6 WAS, but at 8 WAS the root dry weight was similar at 22,000 and 88,000 plants/ha which were also higher than 44,000 plants/ha. When the same population was examined for the same variety, V-35 produced higher root dry weight at 22,000 plants/ha, lower root dry weight at 44,000 plants/ha and the difference of 88,000 plants/ha was not significant at 6 WAS in 1992 season. The result of 88,000 plants/ha in 1994, indicated that root dry weight was similar at 22,000 plants/ha, when variety Local 1 produced higher root dry weight at 44,000 plants/ha, whereas variety V-35 produced higher root dry weight at 88,000 plants/ha.

4.8 Leaf Area (cm^2)

Leaf area is an important measure of the photosynthetic capacity of the crop. The leaf area as affected by nitrogen, sowing date, population and variety during 1992 to1994 seasons is given in Table 47

Table 47: Leaf area/plant (cm^2) as affected by nitrogen, sowing date, population, variety and their interactions during 1992, 1993 and 1994 rainy seasons at Samaru.

	WEEKS AFTER SOWING											
Treatment	1992				1993				1994			
	4	6	8	10	4	6	8	10	4	6	8	10
Nitrogen (N) (Kg/ha)												
0	61.2	63.6	73.1b	74.3c	61.6	67.6	73.8b	74.0c	66.3c	80.6c	63.2c	70.0c
45	65.3	66.7	92.0a	90.3b	65.2	63.2	92.3a	91.0b	71.3b	93.5b	103.7b	90.3b
90	77.1	65.3	99.3a	109.2a	77.4	71.4	99.5a	109.0a	78.1a	107.8a	129.9a	100.3a
SE ±	11.21	11.22	10.23	11.43	20.76	10.48	17.56	12.00	5.50	4.52	7.63	4.34
Sowing date (D)		25-6-92				18-7-93				9-7-94		
Early	98.3a	93.4a	125.3a	139.3a	98.4a	110.3a	125.1a	139.3a	98.4a	118.5a	130.0a	117.3a
		24-7-92				16-8-93				8-7-94		
Late	38.2b	38.3b	51.3a	43.4b	38.4b	25.5b	51.5b	43.5b	41.3b	69.3b	67.2b	56.0b
SE ±	11.40	11.11	10.61	9.91	10.22	11.51	7.00	9.63	12.34	6.14	6.63	5.00
Population (P/ha)												
22,000	68.2	66.7	87.6	88.4	67.2	68.9	88.6	92.3	70.7	97.1	93.9	76.4c
44,000	68.6	67.2	88.2	92.1	70.3	60.3	89.0	91.3	70.7	95.3	107.5	86.3b
88,000	70.4	62.8	90.2	94.1	67.3	73.3	89.0	92.3	71.4	87.4	95.5	96.2a
SE ±	5.26	4.68	6.24	4.34	9.43	17.14	17.16	8.26	6.67	17.58	18.34	6.73
Variety (V)												
Local-1	82.6a	71.3	78.8b	78.4b	82.4a	66.0	80.4b	79.9b	51.4b	94.73	107.8a	84.9
V-35	53.0b	60.6	97.5a	104.9a	53.9b	68.9	96.1a	103.4a	92.3a	92.3	90.0b	87.9
SE ±	15.32	11.28	11.43	9.92	10.24	11.58	7.00	9.62	6.11	6.18	6.63	6.23
Interactions												
NxD	NS	NS	NS	NS	NS	NS	*	NS	NS	NS	**	NS
NxP	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
DxP	NS	NS	NS	NS	NS	*	*	NS	**	NS	NS	NS
NxV	NS	NS	NS	NS	NS	NS	*	NS	NS	NS	NS	NS
DxV	*	*	NS	NS	**	NS	NS	NS	**	NS	**	NS
PxV	NS	NS	NS	NS	NS	NS	NS	NS	*	*	**	NS

Means followed by the same letter within a treatment group of a column are not significantly different using Duncan's Multiple Range Test (DMRT, 05).
* and ** Significant at 5 and 1 percent levels, respectively.
NS = Not significant

Leaf area was found to be highly affected by nitrogen at 8 and 10 WAS during 1992 season. Each increase in nitrogen level significantly increased leaf area. The differences due to sowing dates were highly significant at all the stages of growth. Early sown okra (25-6-92) produced significantly higher leaf area than the late sown date okra (24-7-92). Differences due to populations were not significant at any stage of growth, however, the differences due to varieties were significant at 4, 8 and 10 WAS and highly significant at 4 and 10 WAS. At 6 WAS, Local-1 produced highest leaf area than V-35, but at 8 and 10 WAS V-35 produced a higher leaf area than Local-1 variety.

The effect of nitrogen was found to be significant at 8 and 10 WAS in 1993. At 90kgN/ha higher leaf area was produced. The differences due to sowing dates were highly significant at all the 4 stages of growth. Early sown okra resulted in higher leaf area than the late sown okra. The differences due to populations were not significant at any stage of growth, but the differences due to varieties were significant at all the stages of growth except at 6 WAS. At 4 WAS, variety Local-1 produced higher leaf area, whereas at 8 and 10 WAS variety V-35 produced a higher leaf area than Local-1.

In 1994, the effect of nitrogen was found to be significant for leaf area at all the 4 stages of growth. Each increase in nitrogen levels, increased leaf area. Early sown okra (18-7-94) produced highest leaf area when compared with late sown okra (18-8-94). Population was significant at 10 WAS only. The highest population plants/ha (88,000) produced highest leaf area. The variety effect was significant at 4 and 8 WAS, while V-35 produced higher leaf area than Local-1 at 4 WAS and Local-1 produced higher leaf area than V-35 at 8 WAS.

Nitrogen x date of sowing interaction was found to be significant at 8 WAS both in 1993 and 1994 seasons (Table 48).

Table 48: Leaf area/plant (g/plant) as affected by nitrogen x date of sowing interactions at 8 WAS, in 1993 and 1994 rainy seasons at Samaru.

	1993 (8 WAS)		1994 (8 WAS)	
Nitrogen	Sowing date		Sowing date	
	Early	Late	Early	Late
(Nkg/ha)	18-7-93	16-8-93	9-7-94	8-8-94
0	102.3b	44.3d	82.1c	44.3d
45	133.4a	52.2c	135.3b	73.2c
90	141.4a	57.1c	177.4a	86.1c
SE ±	10.10		11.14	

Means followed by the same letter within an interaction table are not significantly different using Duncan's Multiple Range Test (DMRT. 05).

Early sowing resulted in high leaf area/plant by both levels of applied nitrogen which was significantly higher than control in 1993. In 1994 however, each increase in nitrogen level significantly increased leaf area. In late sowing, there was no difference both in applied nitrogen levels which resulted in higher leaf area than control. When the same nitrogen levels were examined cross the two sowing dates, early sowing produced higher leaf area/plant than late sown crop in all the nitrogen levels and the two seasons.

Nitrogen x population interactions were found not to be significant in all the seasons and years. Date of sowing x population interaction was observed at 4 WAS in 1994 season only (Table 49).

Table 49: Leaf area /plant (cm^2)as affected by date of sowing x population interaction at 4 WAS in 1994 season.

		1994 (4 WAS)		
Sowing date	Plant population/ha	22,000	44,000	88,000
Early 9-7-94		81.3b	84.2a	87.3a
Late 8-8-94		58.4d	61.3c	55.1d
SE ±			3.57	

Means followed by the same letter within an interaction table are not significantly different using Duncan's Multiple Range Test (DMRT. 05).

In early sowing each increase in population level significantly increased the leaf area/plant. No such difference was observed in late sown. When each population was examined for the two sowing dates, early sowing resulted in higher leaf area/plant than late sowing in all the population levels tested.

Nitrogen x variety interaction was found to be significant at 6 and 8 WAS in 1993 season (Table 50).

Table 50: Leaf area/plant (cm^2)as affected y nitrogen x variety interaction at 6 and 8 WAS in 1993 season.

Treatment	1993 (6 WAS)		1993 (8 WAS)	
Nitrogen	Variety		Variety	
(Nkg/ha)	Local-1	V-35	Local-1	V-35
0	78.4a	51.2b	78.2b	70.4c
45	55.3b	80.4a	79.3b	105.4a
90	82.4a	54.3b	85.4b	112.3a
SE +-	28.87		17.10	

Means followed by the same letter within an interaction table are not significantly different using Duncan's Multiple Range Test (DMRT. 05).

At 6 WAS in 1993, variety V-35 produced higher leaf area/plant than the other two levels of nitrogen, but variety Local-1 on the other hand produced a lower leaf area/plant at 45kgN/ha. At 8 WAS Local-1 variety did not produce significantly higher leaf area/plant in all the three levels of nitrogen, but V-35 produced higher leaf area/plant at the two applied nitrogen levels than the control. When the same levels of nitrogen were considered for same varieties at control Local 1 produced higher leaf area/plant than V-35. At 45kgN/ha, V-35 produced higher leaf area/plant than Local-1. When 90kgN/ha was examined, variety Local 1 produced higher leaf area/plant at 6 WAS, whereas V-35 produced higher leaf area/plant at 8 WAS.

Date of sowing x variety interaction was observed at 4 and 6 WAS in 1992; at 4 and 8 WAS both in 1993 and 1994 seasons (Tables 51 and 52).

Table 51: Leaf area/plant (cm^2) as affected by date of sowing x variety interaction at 4, 6, and at 4 and 8 WAS during 1992 and 1993 seasons.

	1992 (4 WAS)		1992 (6 WAS)		1993 (4 WAS)		1993 (8 WAS)	
Sowing date	Variety		Variety		Sowing date		Variety	
	Local-1	V-35	Local-1	V-35		Local-1	V-35	Local-1	V-35
Early					Early				
25-6-92	130.3a	70.2b	110.3a	54.2b	18-7-93	129.4a	67.3b	154.4a	106.3b
Late					Late				
24-7-92	30.1c	40.3c	36.3c	60.4b	16-8-93	36.3c	40.3c	61.3d	74.4c
SE ±	26.13		16.65			20.84		9.33	

Table 52: Leaf area/plant (cm^2) as affected by date of sowing x variety interaction at 4 and 8 WAS in 1994 season.

	1994 (4 WAS)		1994 (8 WAS)	
	Variety		Variety	
Sowing date	Local-1	V-35	Local-1	V-35
Early				
9-7-94	86.3a	80.0b	154.4a	106.3b
Late				
8-8-94	56.3c	61.3c	61.3d	73.4c
SE ±	5.35		9.31	

Means followed by the same letter within an interaction table are not significantly different using Duncan's Multiple Range Test (DMRT, 05).

In early sowing Local-1 produced significantly higher leaf area/plant than V-35 in all the stages of growth. In late sowing however, no difference was observed at 4 WAS in 1992, 1993 and 1994 seasons. But at the other stages of growth variety V-35 produced significantly higher leaf

area/plant than Local-1. When the same varieties were examined for different sowing dates, early sowing produced higher leaf area/plant than late sown crop in all the stages studied, except at 6 WAS in 1992 in which no significant difference was observed.

Population x variety interaction was observed at 4, 6 and 8 WAS in 1994 season (Table 53)

Table 53: Leaf area/plant (cm^2) as affected by population x variety interaction at 4, 6 and 8 WAS in 1994 rainy season.

	1994 (4 WAS)		1994 (6 WAS)		1994 (8 WAS)	
Plant population/ha						
	Variety		Variety		Variety	
	Local-1	V-35	Local-1	V-35	Local-1	V-35
22,000	58.3c	60.3c	107.3a	93.3b	93.3b	96.3b
44,000	58.2c	78.2b	94.2b	93.3b	114.2a	7.2b
88,000	90.4a	78.5b	81.1c	93.3b	113.3a	78.1c
SE ±	5.25		1.76		11.44	

Means followed by the same letter within an interaction table are not significantly different using Duncan s Multiple Range Test (DMRT. 05).

When the populations were examined across the two sowing dates, there were significant difference in leaf area/plant of the two varieties at 4 and 8 WAS in 22,000 plants/plant. At 6 WAS however, Local-1 produced higher leaf area/plant than V-35. At 44,000 plants/ha V-35 produced higher leaf area/plant at 4 WAS and Local-1 at 8 WAS resulted in higher leaf area/plant and no difference was observed at 6 WAS. At 88,000 plants/ha Local-1 produced significantly higher leaf area/plant at 4 and 8 WAS whereas leaf area/plant for V-35 was higher than Local-1 at 6 WAS. When the same variety was examined across different population

levels, Local-1 produced significantly higher leaf area/plant at 88,000 plants/ha. At 4 WAS, each increase in population level significantly decreased the leaf area/plant at 6 WAS and leaf area/plant increased significantly when population level was increased from 22,000 either to 44,000 or 88,000 plants/ha. When V-35 was examined across the population levels, 44,000 and 88,000 plants resulted in higher leaf area/plant than 22,000 plants/ha at 4 WAS. No such difference was observed at 6 WAS and 22,000 and 44,000 plants/ha produced a higher leaf area than 88,000 plants/ha.

4.9 Leaf area index.

The mean leaf area index as affected by nitrogen, sowing date, population and variety during 1992 to 1994 seasons is shown in Table 54.

Table54: Leaf area index as affected by nitrogen,. sowing date, population, variety and their interactions during 1992, 1993 and 1994 rainy seasons at Samaru.

	WEEKS AFTER SOWING											
Treatment	1992				1993				1994			
	4	6	8	10	4	6	8	10	4	6	8	10
Nitrogen (N) (Kg/ha)												
0	6.1	6.3	7.4b	7.5c	6.1	6.7	7.4b	7.4c	5.6c	6.8a	6.4b	5.7
45	6.5	6.6	9.2a	9.3b	6.5	6.3	9.3a	9.2b	5.8b	7.0b	6.3b	6.2
90	7.7	5.8	9.9a	10.9a	7.7	7.1	9.9a	10.3a	7.5a	8.4a	7.5a	6.5
SE ±	1.31	0.67	0.66	0.38	1.31	0.50	0.44	0.36	0.52	1.04	0.04	0.38
Sowing date (D)												
Early	25-6-92				18-7-93				9-7-94			
	9.4a	9.4a	12.5a	13.9a	9.9a	11.0a	12.6a	13.9a	7.7a	11.8a	13.3a	8.5
Late	24-7-92				16-8-93				8-7-94			
	3.8b	4.8b	5.2b	4.4b	3.8b	2.6b	5.2b	3.9b	4.9b	3.0b	6.7b	3.5b
SE ±	0.32	0.32	0.24	0.38	0.37	0.41	0.35	0.27	0.39	0.48	0.53	5.7
Population (P/ha)												
22,000	6.8	7.1	8.7	8.9	6.7	6.8	8.9	8.4	5.5b	6.7	6.4	6.2
44,000	6.8	7.0	8.8	9.3	7.0	6.0	9.0	9.3	5.5b	7.7	6.4	6.4
88,000	7.0	7.1	9.0	9.6	6.7	7.3	9.0	8.4	7.9a	8.7	6.5	6.0
SE ±	0.36	0.42	0.37	0.69	0.36	0.63	0.16	0.93	0.39	1.31	1.21	0.58
Variety (V)												
Local-1	8.3a	7.1	7.7b	7.9a	8.2a	6.7	8.0b	8.9	6.9a	6.4	9.7a	6.3
V-35	5.3b	7.0	9.8a	10.3a	5.1b	6.8	9.7a	8.3	5.7b	8.3	3.7b	7.1
SE ±	0.12	0.32	0.46	0.38	0.87	0.36	0.31	0.24	0.33	0.33	0.94	0.23
Interactions												
NxD	NS	NS	NS	NS	NS	NS	*	NS	**	NS	NS	NS
NxP	NS	NS	NS	NS	NS	NS	NS	NS	*	NS	NS	NS
DxP	NS	NS	NS	NS	NS	NS	NS	NS	**	NS	NS	NS
NxV	NS	NS	NS	NS	NS	NS	NS	NS	**	NS	NS	NS
DxV	**	NS	NS	NS	*	NS	NS	NS	**	NS	NS	NS
PxV	NS	NS	NS	NS	NS	NS	*	NS	*	NS	NS	NS

Means followed by the same letter within a treatment group of a column are not significantly different using Duncan's Multiple Range Test (DMRT. 05).

* and ** Significant at 5 and 1 percent levels, respectively

NS = Not significant

Leaf area index was found to be significant at 8 and 10 WAS during 1992 to 1993 seasons and at 4 to 8 WAS in 1994 season. Increased in nitrogen levels increased leaf area index. The differences due to sowing dates of leaf area index were highly significant throughout the 3 year of experimentations as early sown crop produced higher leaf area index when compared with late sown crop.

Nitrogen x date of sowing interaction was found to be significant at 8 WAS in 1993 and at 4 WAS in 1994 seasons (Table 55).

Table 55: Leaf area index affected by nitrogen x date interaction at 8 WAS and at 4 WAS during 1993 and 1994 seasons.

Treatment	1993 (8 WAS)		1994 (4 WAS)	
	Sowing date		Sowing date	
Nitrogen	Early	Late	Early	Late
(Nkg/ha)	18-7-93	16-8-93	9-7-94	8-8-94
0	9.7b	6.3c	5.7c	5.5c
45	9.7b	5.9d	6.8b	4.7d
90	14.3a	5.9d	10.1a	4.7d
SE ±	0.33		0.73	

Means followed by the same letter within an interaction table are not significantly different using Duncan's Multiple Range Test (DMRT, 05).

In early sowing increasing nitrogen levels from 0 to 45kgN/ha did not significantly increases leaf area index; however increased nitrogen levels from 45 to 90kgN/ha, there were significantly increased in leaf area index at 8 WAS in 1993. At 4 WAS in 1994 season, however, each increase in nitrogen level significantly increased leaf area index. In the case of late sowing the two rates of applied nitrogen reduced the leaf area index when compared with control. When

the same levels of nitrogen were examined across the two sowing dates, early sowing resulted in higher leaf area index than late sowing in all the rates of nitrogen, except in control at 4 WAS when no such difference was observed.

Interaction between nitrogen x population interaction was significant at 4 WAS in 1994 season only (Table 56).

Table 56 : Leaf area/plant as affected by nitrogen x population interaction at 4 WAS in 1994 season.

	1994 (4 WAS)		
Nitrogen (Nkg/ha)	22,000	44,000	88,000
0	3.5e	4.0d	9.3a
45	4.8d	6.0c	6.4c
90	8.0b	6.3c	8.3b
SE ±		0.77	

Means followed by the same letter within an interaction table are not significantly different using Duncan's Multiple Range Test (DMRT. 05).

At 22,000 plants/ha the leaf area index did not differ when nitrogen was increased from 0 to 45kgN/ha, however, when the rates was increased from 45 to 90kgN/ha there was significantly difference in leaf area index. At 44,000 plants/ha the leaf area index of control was significantly lower than the two applied nitrogen rates. At 88,000 plants/ha control produced higher leaf area index than the other two applied rates. Increased nitrogen levels from 0 to 45kgN/ha decreased leaf area index, but when nitrogen was increased from 45 to 90kgN/ha, there was an increase in leaf area index. When the same level of nitrogen was examined at different population levels, a difference was found between 22,000 and 44,000 plants/ha; however, leaf area index of 88,000

was higher than variety Local-1. When the same varieties were examined across the two sowing dates, early sowing resulted in higher leaf area index than late sowing in both varieties and in all the three seasons.

Population x variety interaction was found to be significant 8 and 4 WAS in 1993 and 1994 seasons (Table 60).

Table 60: Leaf area index as affected by population x variety interaction at 8 WAS and at 4 WAS in 1993 and 1994 seasons.

	1993 (8 WAS)		1994 (4WAS)	
Plant population/ha	Variety		Variety	
	Local-1	V-35	Local-1	V-35
22,000	10.8a	7.5b	6.7b	4.2d
44,000	10.7a	7.7b	5.0c	5.9c
88,000	10.3a	5.8c	8.9a	6.9b
SE ±	0.10		0.56	

Means followed by the same letter within an interaction table are not significantly different using Duncan's Multiple Range Test (DMRT, 05).

At 22,000 and 88,000 plants/ha, variety Local-1 produced significantly higher leaf area index than variety V-35. At 44,000 plants/ha, variety Local-1 produced higher leaf area index than V-35. In 1994 season, however, variety V-35 produced higher leaf area index than Local-1 at 88,000 plants/ha.

4.10 Crop growth rate (g/plant/wk)

Crop growth rate was significantly influenced by nitrogen in 1992 and 1993 seasons at 8 to 10 WAS. (Table 61).

Table 61: Crop growth rate as affected by nitrogen, sowing date, plant population, variety and their interactions at 8 and 10 WAS during 1992,1993 and 1994 seasons at Samaru.

Treatment	1992		1993		1994	
	8	10	8	10	8	10
Nitrogen (N) (KgN/ha)						
0	0.16c	0.17b	0.08c	0.10c	0.11	0.13
45	0.18b	0.20b	0.10b	0.12b	0.14	0.16
90	0.20a	0.29a	0.12a	0.13a	0.16	0.18
SE ±	0.010	0.014	.007	0.026	.038	0.027
Sowing date						
Early	25-6-92		18-7-93		9-7-94	
	.20.0a	0.26a	.17a	0.17a	.24a	0.26a
Late	24-7-93		16-8-93		8-8-94	
	0.10b	0.18b	.03b	0.07b	.04b	0.05b
SE ±	0.024	0.034	.021	0.022	.34	0.22
Population/ha(P)						
22,000	0.16	0.26	0.10	0.13	0.21	0.22
44,000	0.18	0.21	0.09	0.11	0.13	0.16
88,000	0.19	0.18	0.11	0.12	0.08	0.10
SE ±	.032	0.040	.036	0.043	0.024	0.030
Variety(V)						
Local-1	0.16	0.26a	0.11	0.12	0.16	0.19
V-35	0.20	0.18b	0.09	0.11	0.12	0.13
SE ±	.029	0.033	0.47	0.035	.053	0.025
Interactions						
N x D	NS	NS	NS	**	NS	NS
N x P	NS	*	NS	**	NS	NS
D x P	NS	NS	NS	**	NS	NS
N x V	NS	NS	NS	*	NS	NS
D x V	NS	*	NS	*	NS	NS
P x V	NS	NS	NS	**	NS	NS

Means followed by the same letter within a treatment group of a column are not significantly different using Duncan's Multiple Range Test (DMRT. 05).

* and ** Significant at 5 and 1 percent levels, respectively.

NS = Not significant

Increased nitrogen levels from 0 to 90kgN/ha increased crop growth rate. In 1994, crop growth rate was not influenced by nitrogen levels. Early sown okra significantly increased crop growth rate when compared with late sown okra in all the seasons and years. Crop growth rate was not significantly influenced by plant population during the three year period. Variety was significantly influenced by crop growth rte in 1992 season only. Variety Local 1 variety produced higher crop growth rate than variety V-35.

Nitrogen x date of sowing interaction was found to be significant at 10 WAS in 1993 season only (Table 62).

Table 62: Crop growth as affected by nitrogen x date of sowing interaction at 10 WAS in 1993 season.

Treatment	1993 (10 WAS)	
Nitrogen	Early Sowing date	Late
(NKg/ha)	18-7-93	8-8-93
0	0.20c	0.20c
45	0.26b	- 0.01d
90	0.34a	- 0.30e
SE +	0.040	

Means followed by the same letter within an interaction table are not significantly different using Duncan's Multiple Range Test (DMRT. 05).

In early sowing increasing nitrogen rate either from 0 to 45 or 90kgN/ha did not increase crop growth rate significantly. However, in the case of late sowing, each increase in nitrogen level significantly decreased the crop growth rate. When the same nitrogen level was looked across the sowing dates in control, there was no difference in crop growth rate, but in the case of two rates of applied nitrogen, early sowing significantly increased the crop growth rate when compared with late sown crop.

Nitrogen x population interaction was significant at 10 WAS both in 1992 and 1993 seasons (Table 63).

Table 63: Crop growth rate as affected by nitrogen x population interaction at 10 WAS in 1992 and 1993 seasons.

	1992 (10 WAS)			1993 (10 WAS)		
Nitrogen	**Plant population/ha**					
(Nkg/ha)	22,000	44,000	88,000	22,000	44,000	88,000
0	0.17b	0.18b	0.16b	0.34d	-0.08e	-0.1f
45	0.50a	0.22b	0.18b	0.31b	0.05c	0.29b
90	0.15b	0.24b	0.19b	0.49a	0.09c	0.28b
SE ±		0.07			0.07	

Means followed by the same letter within an interaction table are not significantly different using Duncan's Multiple Range Test (DMRT. 05).

Nitrogen rate of control did not significantly, increase crop growth rate both in 1992 and 1993 seasons However, at 45kgN/ha of 22,000plants/ha resulted in higher crop growth rate than 44,000 and 88,000 plants/ha, in 1992 and 44,000, plants/ha in 1993 was significantly higher than the other two population levels. In 1992, crop growth rate did not differ at 90kgN/ha, but in 1993, crop growth rate at 22,000 plants/ha was significantly higher than the other two population levels. When the same population level was examined at different nitrogen rates 22,000 plants/ha of 45kgN/ha in 1992 and 45 and 90kgN/ha in 1993 resulted significantly higher in crop growth rate. At populations of 44,000 and 88,000 plants/ha there was no change in crop growth rate as nitrogen levels was increased from 0 to 90kgN/ha.

Interaction between date of sowing x population was significant at 10 WAS in 1993 season only (Table 64).

Table 64: Crop growth rate as affected by date of sowing x population interaction at 10 WS in 1993.

	1993 (10 WAS)		
Sowing date	Plant population/ha		
	22,000	44,000	88,000
Early 18-7-93	0.28a	0.20b	0.01
Late 16-8-93	0.19b	0.04c	0.02c
SE ±		0.050	

Means followed by the same letter within an interaction table are not significantly different using Duncan's Multiple Range Test (DMRT, 05).

In early sowing, each increase in population level significantly decreased the crop growth rate. In late sown 22,000 plants/ha resulted in a higher crop growth rate than other two population levels, the difference of which was not significant. When the same population was examined across the two sowing dates, crop growth was higher in early sowing at 22,000 plants/ha, but such difference was observed in 88,000 plant/ha.

Nitrogen x variety interaction was significant at 10 WAS in 1993 season only (Table 65).

Table 65: Crop growth as affected by nitrogen x variety interaction at 10 WAS in 1993.

	1993 (10 WAS)	
Nitrogen (Nkg/ha)	Variety	
	Local-1	V-35
0	-0.15c	-0.04e
45	0.36b	0.07d
90	0.02d	0.46a
SE ±	0.050	

Means followed by the same letter within an interaction table are not significantly different using Duncan's Multiple Range Test (DMRT, 05).

The crop growth rate was higher with an increase in nitrogen rate for variety V-35 than variety Local-1, but in variety Local-1 crop growth rate increased when nitrogen level was increased from 0 to 45kgN/ha, but further increase in nitrogen rate did not increase crop growth rate. When the two crop growth rate of the two varieties were examined, with the same varieties, it was not significant at 0 and 45kgN/ha, however, at 90kgN/ha, crop growth rate of V-35 was higher than Local-1 variety.

Date of sowing x variety interaction was significant both at 10 WAS in 1992 and 199 seasons (Table 66).

Table 66: Crop growth rate as affected by date of sowing x variety interaction at 10 WAS bot in 1992 and 1993 seasons.

	1992 (10 WAS)			1993 (10 WAS)		
		Variety			Variety	
Sowing date		Local-1	V-35		Local-1	V-35
Early	25-6-92	0.27a	0.28a	18-7-93	0.19b	0.43a
Late	24-7-92	0.24a	0.08b	16-8-93	0.03b	-0.17c
SE ±		0.040			0.040	

Means followed by the same letter within an interaction table are not significantly different using Duncan's Multiple Range Test (DMRT, 05).

The crop growth rate did not differ significantly in the two sowing dates in the seasons at different sowing dates. However, in the case of variety V-35, early sowing resulted in higher crop growth rate than late sown crop. When the same sowing date was looked at for different varieties, there was no difference in 1992, but in 1993, variety V-35 has a higher crop growth than variety Local-1. In late sowing, Local-1 variety resulted in significantly higher crop growth than variety V-35 in both seasons.

Population x variety interaction was observed at 10 WAS in 1993 season only (Table 67).

Table 67: Crop growth rate as affected by population x variety interaction at 10 WAS in993 season.

	1993 (10 WAS)	
Plant population/ha	Variety	
	Local-1	V-35
22,000	0.30a	-0.03c
44,000	-0.01c	0.30a
88,000	0.12b	0.06b
SE +-	0.060	

Means followed by the same letter within an interaction table are not significantly different using Duncan's Multiple Range Test (DMRT. 05).

A lower crop growth rate was recorder at 44,000 plants/ha than other two populations in variety Local-1. The same population produced similar crop growth rate at 88,000 plants/ha and the two populations were significantly higher than 22,000 plants/ha in variety V-35. When the same population was examined for the two varieties the Local-1 variety produced higher crop growth rate at 22,000 plants/ha a lower crop growth rate at 44,000 plants/ha and a similar crop growth rate at 88,000 plants/ha was recorded in both varieties.

4.11 Relative growth rate(g/g/wk).

Relative growth rate was significantly influenced by nitrogen at 8 and 10 WAS in 1992 to 1994 seasons (Table 68).

Table 68 Relative growth rate (g/g/wk) as affected by nitrogen, sowing date, population, variety and their interactions from 8 to 10 WAS during 1992, 1993 and 994 seasons.

Treatment	1992		1993		1994	
	8	10	8	10	8	10
(KgN/ha) (N)						
0	1.41b	1.49b	1.44b	1.46b	1.40c	1.45b
45	1.43b	1.49b	1.44b	1.46b	1.42b	1.45b
90	1.50a	1.53a	1.47a	1.48a	1.44a	1.49a
SE ±	0.011	0.013	0.008	0.006	0.017	0.007
Sowing date(D)						
Early	25-6-92		18-7-93		9-7-94	
	1.47a	1.47a	1.47a	1.52a	1.49a	1.55a
Late	24-7-92		16-8-93		8-8-94	
	1.43b	1.43b	1.43b	1.41b	1.35b	1.35b
SE ±	0.009	0.009	0.007	0.004	0.014	0.006
Population/ha (P)						
22,000	1.45	1.45	1.44	1.48	1.43	1.46
44,000	1.46	1.46	1.44	1.45	1.40	1.46
88,000	1.43	1.45	1.44	1.44	1.40	1.44
SE ±	0.011	0.11	0.007	0.006	0.018	0.007
Variety (V)						
Local-1	1.45	1.47	1.41	1.42	1.43	1.49a
V-35	1.46	1.46	1.42	1.43	1.42	1.42b
SE ±	0.009	0.009	0.006	0.005	0.014	0.003
Interactions						
N x D	NS	NS	NS	NS	NS	*
N x P	NS	*	NS	NS	NS	NS
D x P	NS	NS	NS	NS	NS	NS
N x V	NS	NS	NS	NS	NS	NS
D x V	NS	NS	NS	*	NS	NS
P x V	NS	NS	NS	**	NS	NS

Means followed by the same letter within a treatment group of a column are not significantly different using (DMRT 05),
* and ** = Significant at 5 and 1 percent levels, respectively.
NS = Not significant

A higher nitrogen level (90kgN/ha) produced higher relative growth rate. Early sown okra significantly influenced relative growth rate when compared with late sown okra. Relative growth rate was not affected by plant population during the 3 year period (1992 - 1994) as this may be attributed to the higher competition for light, space and nutrient among the populations used. Relative growth rate was significantly influenced by variety at 10 WAS in 1994 season as Local-1 produced higher relative growth rate than V-35.

Nitrogen x date of sowing interaction was found to be significant at 10 WAS in 1994 season only (Table 69).

Table 69: Relative growth as affected by nitrogen x date of sowing interaction at 10 WAS in 1994 season at Samaru.

	1994 (10 WAS)		
Nitrogen (Nkg/ha)	Early 9-7-94	Sowing date	Late 8-8-94
0	1.56a		1.35d
45	1.53b		1.38c
90	1.56a		1.38c
SE ±		0.020	

Means followed by the same letter within an interaction table are not significantly different using Duncan's Multiple Range Test (DMRT, 05).

In early sowing crop, each increase in nitrogen level, significantly increased the relative growth rate (RGR), but in late sown crop relative growth of control (0kgN/ha) was significantly lower than the two applied nitrogen, the difference between the two was not significant. When the two sowing dates were examined at the same nitrogen level, early sowing recorded higher relative growth rate than late sown crop.

Interaction between nitrogen x population was found to be significant at 10 WAS in 1992 season only (Table 70).

Table 70: Relative growth rate as affected by nitrogen x population at 10 WAS in 1992 season.

Treatment	1992 (10 WAS)		
Nitrogen (Nkg/ha)	Plant population/ha		
	22,000	44,000	88,000
0	0.09d	0.21b	0.22b
45	0.23b	0.22b	0.22b
90	0.50a	0.14c	0.14c
SE ±		0.060	

Means followed by the same letter within an interaction table are not significantly different using Duncan's Multiple Range Test (DMRT. 05).

When the populations were examined against the nitrogen level 22,000 plants/ha of relative growth rate in control was significantly lower than the two applied nitrogen levels, the difference which was not statistically significant. Both at 44,000 and 88,000plants/ha the difference between control and 44,000 plants/ha was not significant. Further increase in nitrogen to 90kgN/ha decreased the relative growth rate significantly. When the same nitrogen level was examined across the populations, the difference at 0kgN/ha was not significant, however, at 45kgN/ha, 22,000plants/ha recorded lower relative growth significantly. When the same nitrogen level was looked across the population, the difference at 45kgN/ha was not significant,

however at 45kgN/ha, 22,000 plants/ha recorded lower relative growth rate than the other two populations, difference of which was not significant.

At 90kgN/ha, however, 22,000 plants/ha recorded significantly higher relative growth rate than other two populations. Date of sowing x population and nitrogen x variety interactions were found not to be significant, but date of sowing x variety interaction was observed at 10 WAS in 1993 season only (Table 71).

Table 71: Relative growth rate as affected by date of sowing x variety interaction at 10 WAS in 1993 season at Samaru.

1993 (10 WAS)

Sowing date	Variety	
	Local-1	V 35
Early 18-7-93	1.56a	1.48b
Late 16-8-93	1.38c	1.38c
SE ±	0.007	

Means followed by the same letter within an interaction table are not significantly different using Duncan's Multiple Range Test (DMRT. 05).

Both varieties recorded higher relative growth rate in early sowing. The difference between the two varieties either in early sowing or late sowing was not significant.

Population x variety interaction was only significant at 10 WAS in 1993 season (Table 72).

Table 72: Relative growth rate as affected by population x variety interaction at 10 WAS in 1993 season.

	1993 (10 WAS)	
Plant population/ha	Variety	
	Local-1	V-35
22,000	1.48a	1.42b
44,000	1.48a	1.38c
88,000	1.43b	1.43b
SE ±	0.025	

Means followed by the same letter within an interaction table are not significantly different using Duncan's Multiple Range Test (DMRT. 05).

In Local-1 variety the difference in relative growth either at 22,000 or 44,000plants/ha was not significant, but such relative growth was significantly higher than 88,000 plants/ha. In variety V-35 44,000 plants/ha resulted in lower relative growth rate than other two populations. When the two varieties were examined at the same population level, both 22,000 and 44,000 plants/ha in Local-variety produced significantly higher relative growth rate than that of variety V-35. No such difference was observed at 88,000 plants/ha.

4.12 Plant height(cm)

Plant height as affected by nitrogen, population, variety, sowing date and their interaction during 1992 to 1994 is given in Table 73

Table73: Plant height (cm) as affected by nitrogen, sowing date, population, variety and their interactions at Samaru 1992 - 1994 during rainy seasons.

Treatment		WEEKS AFTER SOWING										
		1992			1993				1994			
	4	6	8	10	4	6	8	10	4	6	8	10
Nitrogen (N) (Kg/ha)												
0	24.1	29.4	70.3	78.3c	74.3	75.3c	116.3b	110.2c	34.1c	27.3c	52.2c	96.5c
45	27.4	30.3	86.2	104.4b	74.3	81.2b	117.b	131.3b	47.3b	30.2b	60.1b	104.4b
90	29.5	32.1	84.1	113.6a	68.1	86.4a	122.5a	145.6a	50.6a	32.6a	69.5a	115.7a
SE ±	3.00	1.00	6.00	11.2	4.32	1.52	3.31	3.22	1.00	1.00	3.00	4.00
Sowing date (D)		25-6-92				18-7-93				9-7-94		
Early	38.4a	38.6a	124.5a	142.8a	114.7a	127.6a	188.5a	210.4a	53.5a	33.3a	76.6a	48.7a
		24-7-92				16-8-93				8-7-94		
Late	17.6b	22.4b	42.3b	54.6a	29.5b	34.4b	48.4b	47.5b	35.3b	26.4b	46.3b	62.4b
SE ±	8.00	1.23	1.44	8.00	8.00	8.00	1.00	3.54	2.00	2.34	2.00	4.00
Population (P/ha) (P)												
22,000	28.2	29.1	81.3	96.0	72.1	80.4	118.0	128.3	44.3	29.2	60.2b	120.6a
44,000	29.3	30.1	82.4	100.4	73.2	79.0	108.1	130.2	46.3	30.2	66.7a	98.3b
88,000	27.1	32.2	86.2	98.3	72.4	81.6	128.4	128.4	42.4	30.3	57.3c	98.4b
SE ±	2.00	2.00	4.00	7.00	9.44	2.443	11.23	5.2	3.00	2.00	2.00	4.00
Variety (V)												
Local-1	29.2	30.1	82.3	107.2a	81.3a	85.3a	126.4a	124.3a	38.4b	30.3	62.6a	111.2
V-35	27.4	31.2	84.4	90.4b	63.4b	76.2b	110.3b	134.4a	50.5a	30.2	58.4b	99.3
SE ±	2.00	4.00	4.00	4.00	1.12	2.74	1.24	2.00	3.00	2.33	2.00	4.00
Interactions												
NxD	NS	NS	NS	NS	NS	NS	NS	NS	**	NS	**	NS
NxP	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
DxP	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
NxV	NS	NS	NS	NS	NS	NS	NS	NS	**	NS	NS	NS
DxV	NS	NS	NS	NS	NS	NS	NS	NS	**	NS	**	**
PxV	NS	NS	NS	NS	NS	NS	NS	NS	*	*	**	**

Means followed by the same letter within a treatment group of a column are not significantly different using Duncan's Multiple Rage Test (DMRT. 05).
* and ** Significant at 5 and 1 percent levels, respectively.
NS = Not significant

Plant height was significantly affected by nitrogen at 10 WAS in 1992 only. Each increase in nitrogen levels did not increase plant height at the other 3 stages of growth. The difference in mean of sowing dates were found to be highly significant in all the 4 stages of growth. The height of okra sown on 25/6/92 was taller than okra sown on 24/7/92. The differences in population levels were not significant at any stage of growth. The effect of variety on the height was found to be significant at 10 WAS. The Local-1 variety produced taller plants than variety V-35.

In 1993 season, there was no significant differences in plant height at 4 WAS, however significant differences in the other 3 growth stages were observed. At 6 WAS each increase in nitrogen levels produced taller plants. At 8 WAS 45kgN/ha produced taller plants than both control and 90kgN/ha. In the case of 10 WAS, 90kgN/ha resulted in taller plants than both 0 and 45kgN/ha.

The differences in sowing dates were highly significant at all the 4 stages of growth. Okra sown on 18-7-93 produced taller plants than late sown okra on 16-8-93. The population levels under study did not affect plant height significantly. The differences due to varieties were found to be significant at all the 4 stages of growth, Local-1 variety produced significantly taller plants than V-35 in all the growth stages. In 1993, the 1st order interactions between nitrogen, sowing date, population and variety were found not to be significant .

During rainy season in 1994, plant height was affected by nitrogen at all the growth stages. Each increase in nitrogen level significantly increased plant height. In the case of 6 WAS two applied nitrogen produced taller plants, than control. Plant height was significantly

affected by sowing date at all the stages of growth . Okra sown on 9-7-94 produced taller plants than okra sown on 8-8-94. The plant height mean of population levels were affected at 8 and 10 WAS. At 8 WAS, 44,000 plants/ha produced taller plants than 22,000 plants/ha which was also taller than 88,000 plants/ha. In the case of 10 WAS plant height reduced significantly when population was increased either to 44,000 or 88,000 plants/ha. There was significant differences in the varieties at 4 and 8 WAS. At 4 WAS V-35 produced taller plants than Local-1, but at 8 WAS Local-1 variety was found to produced taller plants than V-35.

Interaction between nitrogen x date of sowing was found to be significant at 4 and 8 WAS in 1994 season (Table 74).

Table 74: Plant height(cm) as affected by nitrogen x date of sowing interaction at 4 and 8 WAS in 1994 season.

Treatment	1994 (4 WAS)		1994 (8 WAS)	
	Early Sowing date	Late	Early Sowing date	Late
Nitrogen (Nkg/ha)	9-7-94	8-8-94	9-7-941	8-8-94
0	37.3c	32.3d	61.5c	43.3e
45	59.3b	37.4c	78.3b	44.2e
90	63.4a	37.4c	90.6a	53.3d
SE ±	3.00		5.00	

Means followed by the same letter within an interaction table are not significantly different using Duncan's Multiple Range Test (DMRT. 05).

In early sowing, each increase in nitrogen level significantly increased the plant height. In late sowing 0kgN/ha produced lower height than two rates of applied nitrogen at 4 WAS. In the case of 8 WAS, both 0 and 45kgN/ha resulted significantly in lower height than 90kgN/ha. When

Date of sowing x variety interaction was found to be significant at 4, 8 and 10 WAS in 1994 season (Table 76).

Table 76: Plant height(cm) as affected by date of sowing x variety interactions at 4, 8 and 10 WAS in 1994 season.

	1994 (4 WAS)		1994 (8 WAS)		1994 (10 WAS)	
Sowing date	Variety					
	Local-1	V-35	Local-1	V-35	Local-1	V-35
Early 9-7-94	40.4b	69.5a	74.4b	82.8a	120.7a	118.6a
Late 8-8-94	36.3c	30.3d	53.3c	39.4d	100.5b	80.4c
SE ±	3.0		3.0		5.0	

Means followed by the same letter within an interaction table are not significantly different using Duncan's Multiple Range Test (DMRT, 05).

Early sowing resulted in taller plants at all the stages of okra growth indicating significant interactions in 1994 season. When the two varieties were examined within the same sowing date, variety V-35 produced taller plants than Local-1 variety both at 4 and 8 WAS however, at 10 WAS no difference was observed. In the case of late sowing variety Local-1 produced taller plants than variety V-35 at 4, 8 and 10 WAS.

As in the case of date sowing x variety interaction, population x variety interaction was also significant at 4, 8 and 10 WAS 1994 (Table 77).

Table 77: Plant height(cm) as affected by population x variety interactions at 4, 8 and 10 WAS in 1994 season.

	1994 (4 WAS)		1994 (8 WAS)		1994 (10 WAS)	
Plant population/ha	Variety		Variety		Variety	
	Local-1	V-35	Local-1	V-35	Local-1	V-35
22,000	35.3c	53.7a	70.8a	54.4c	114.7a	113.4a
44,000	37.4c	55.5a	70.8a	62.3b	101.3b	96.6b
88,000	42.4b	41.4b	57.4c	58.5c	113.4a	90.4c
SE ±	4.00		3.00		5.00	

Means followed by the same letter within an interaction table are non-significantly different using Duncan's Multiple Range Test (DMRT, 05).

The Local 1 variety produced taller plants at 88,000 plants/ha when compared with other two populations. But in case of variety V-35 88,000 plants/ha produced shorter plants than other two populations at 4 WAS. At 8 WAS, 88,000 plants/ha produced shorter plants than other two populations in Local 1 variety. But in case of variety V-35, 44,000 plants/ha produced taller plants than the other two populations. At 10 WAS 44,000 plants/ha produced shorter plants than either 22,000 or 88,000 plants/ha in Local -1 variety, but in case of V-35, each increase in population level significantly decreased the plant height. When the two varieties were examined at the same population level at 4 WAS, V-35 and at 8 WAS, Local 1 produced taller plants and no such difference was observed at 10 WAS. At 44,000, V-35 at 4 WAS and Local 1 at 8 WAS produced taller plants, both at 22,000 and 44,000 plants/ha. At 88,000 plants/ha there was no difference between the two varieties at 8 WAS, but at 10 WAS, Local 1 variety produced taller plants than V-35.

The effect of sowing date was highly significant throughout the three year period. The early sown crop produced higher dry matter than late sown. The effect of dry matter on population was significant at 10 WAS in 1992, at 8 and10 WAS both in 1993 and 1994 seasons, with 22,000 plants/ha produced higher dry matter than other two population levels. Variety effect of dry matter was significant throughout the experimentation period as Local 1 produced higher total dry matter than V-35 due to its adaptability factor to the environment.

Interaction between nitrogen x date of sowing was significant at 10 WAS in 1994 season only (Table 79).

Table 79: Total dry matter (g/plant) as affected by nitrogen x date of sowing interaction at 10 WAS in 1994 season.

	1994 (10 WAS)	
Nitrogen	Sowing date	
(Nkg/ha)	Early	Late
	9-7-94	8-8-94
0	35.0c	23.0e
45	37.1b	24.3d
90	38.1a	23.0e
SE ±	0.81	

Means followed by the same letter within an interaction table are not significantly different using Duncan's Multiple Range Test (DMRT, 05).

Each increase in nitrogen level increased the total dry matter/plant significantly both in early and late sown crop. When the total dry matter/plant of the two sowing dates were examined at the same nitrogen level, early sowing was found to produce higher total dry matter/plant when compared with late sown at all nitrogen levels.

Nitrogen x population interactions were found to be significant both at 8 and 10 WAS in 1993 and 1994 seasons (Table 80).

Table 80: Total dry matter (g/plant) as affected by nitrogen x population interaction at 8 to 10 WAS in 1993 and 1994 seasons.

Treatment	1993 (8 WAS)			1993 (10WAS)			1994 (8 WAS)			1994 (10 WAS)		
Nitrogen	Plant population/ha											
(g/ha)	22,000	44,000	88,000	22,000	44,000	88,000	22,000	44,000	88,000	22,000	44,000	88,000
0	32.5b	26.1d	27.4d	41.6a	27.0e	27.2e	30.5b	22.0e	27.6c	38.2a	23.1f	28.7d
45	27.7a	28.8c	26.5d	29.5a	29.0d	28.5d	29.4b	24.9d	27.2c	33.0e	27.0e	28.9d
90	32.3a	29.3c	25.7d	32.0b	31.0c	25.7e	32.7a	30.6b	23.7d	34.8b	32.9c	24.0f
SE ±		0.84			0.84			1.60			0.98	

Means followed by the same letter within an interaction table are not significantly different using Duncan's Multiple Range Test (DMRT, 05).

At 22,000 plants/ha each increase in nitrogen level significantly increased the total dry matter per plant in all the stages and years. At 44,000 plants/ha at 8 WAS in 1994, the differences at the three nitrogen levels were significant. However, at 10 WAS in 1993 and both at 8 and 10 WAS in 1994, each increase in nitrogen significantly increased the total dry matter per plant.

In 1993, at 88,000 plants/ha and at 8 WAS, control produced similar total dry matter per plant when compared with the two applied nitrogen rates. At 10 WAS, 45kgN/ha produced higher total dry matter than control which in turn was higher than 90kgN/ha. In 1994 season, at 8 WAS both 0 and 45kgN/ha, produced higher total dry matter at 88,000 plants/ha than 90kgN/ha, but at 10 WAS 45kgN/ha resulted in higher total dry matter when compared either with 0 or 90kgN/ha. When the same nitrogen level was examined across the populations in 1993 at 8 WAS each increase in plant

population significantly decreased the total dry matter per plant. At 10 WAS each increase in plant population significantly decreased the total dry matter per plant. At 10 WAS in 1992, 22,000 plants/ha produced higher total dry matter per plant than other two populations.

The treatment of 45kgN/ha and 44,000 plants/ha total dry matter per plant produced was higher than 22,000 and 88,000 plants/ha in that order at 8 WAS. At 10 WAS, the same nitrogen level, produced higher total dry matter/plant at 22,000 plants/ha than the other two populations. At 22,000 plants/ha in 1993, both at 8 and 10 WAS, each increase in plant population significantly reduced the total dry matter per plant. In 1994 at 8 WAS, 44,000 plants/ha produced a lower total dry matter than either at 22,000 plants/ha, but at 10 WAS, 22,000 plants/ha produced a higher total dry matter per plant than both 44,000 and 88,000 plants/ha. When the total dry matter per plant was examined at 45kgN/ha, 44,000 plants/ha produced a lower total dry matter per plant both at 8 and 10 WAS, but at 90kgN ha, each increase in plant population significantly reduced the total dry matter both at 8 and 10 WAS.

Interactions between sowing date x population were found to be significant at 8 and 10 WAS in all the experiments (Tables 81a - 81c).

Table 81a: Total dry matter (g/plant) as influenced by date of sowing x population interactions at 8 and 10 WAS in 1992 season.

	1992 (8 WAS)			1992 (10 WAS)		
Sowing date	**Plant population/ha**					
	22,000	44,000	88,000	22,000	44,000	88,00
Early 25-6-92	30.0a	31.1a	31.0a	32.1b	34.6a	33.9a
Late 24-7-92	27.6b	28.0b	24.6c	31.9b	30.7c	26.7b
SE ±		1.15			1.00	

Means followed by the same letter within an interaction table are not significantly different using Duncan's Multiple Range Test (DMRT. 05).

Table 81b: Total dry matter (g/plant) as influenced by date of sowing x population interactions at 8 and 10 WAS in 1993 season.

	1993 (8 WAS)			1993 (10 WAS)		
Sowing date	**Plant population/ha**					
	22,000	44,000	88,000	22,000	44,000	88,00
Early 8-7-93	31.2b	33.1a	30.6c	38.2a	31.7b	31.5b
Late 16-8-93	29.1d	26.9e	22.3f	30.7c	26.3d	22.6e
SE ±		0.76			0.68	

Table 81c: Total dry matter (g/plant) as influenced by date of sowing x population interactions at 8 and 10 WAS in 1994 season.

	1994 (8 WAS)			1994 (10 WAS)		
Sowing date	**Plant population/ha**					
	22,000	44,000	88,000	22,000	44,000	88,000
Early 9-7-94	36.2a	29.4c	31.2b	44.4a	32.2b	33.0b
Late 8-8-94	25.2d	22.1e	21.0e	26.3c	22.7d	21.3e
SE ±		1.30			0.80	

Means followed by the same letter within an interaction table are not significantly different using the Duncan's Multiple Range Test (DMRT.05).

When the same population level was examined across the sowing date, early sowing produced significantly higher total dry matter/plant than late sown crop in all the cases. When the mean of the same sowing date across the different population levels were examined, no difference was observed

in 8 WAS in 1992, but this difference was infavour of 44,000 plants/ha in most of the cases. In case of late sowing increasing the population levels reduced the total dry matter per plant in most of the cases.

Nitrogen x variety interactions were found to be significant at 8 and 10 WAS in all the three seasons (Table 82a-b).

Table 82a: Total dry matter (g/plant) as affected by nitrogen x variety interaction at 8 and 10 WAS in 1992 season.

Treatment	1992(8 WAS)		1992 (10 WAS)	
Nitrogen	Variety		Variety	
(Nkg/ha)	Local-1	V-35	Local-1	V-35
0	26.9c	25.1c	30.3b	26.6c
45	27.0b	27.7b	30.8b	32.0b
90	28.7b	36.8a	31.0b	38.8a
SE +	1.14		1.18	

Means followed by the same letter within an interaction table are not significantly different using the Duncan's Multiple Range Test (DMRT 05).

Table 82b: Total dry matter (g/plant) as affected by nitrogen x variety interactions both at 8 and 10 WAS during 1993 and 1994 seasons.

	1993(8 WAS)		1993(10 WAS)		1994(8 WAS)		1994(10 WAS)	
	Variety		Variety		Variety		Variety	
Nitrogen (KgN/ha)	Local-1	V-35	Local-1	V-35	Local-1	V-35	Local-1	V-35
0	33.0a	24.3f	36.5a	27.5c	29.2b	23.9d	33.7b	26.5e
45	29.2d	26.1e	31.3b	27.0c	25.5c	28.7b	28.8d	30.4c
90	31.4b	30.2c	31.2b	27.9c	32.6a	25.3e	34.8a	26.3e
SE ±	0.78		0.69		1.30		0.80	

Means followed by the same letter within an interaction table are not significantly different using the Duncan's Multiple Range Test (DMRT).05).

In the case of variety V-35, each increase in nitrogen level significantly increased the total dry matter per plant in 1992, except at 10 WAS in 1993 and 1994 seasons. When the response of Local-1 was observed, control resulted in lower total dry matter per plant than the two applied rates of nitrogen in 1992 at 8 WAS. In 1993 season, control produced higher total dry matter per plant than the two applied rates of nitrogen at 8 and 10 WAS. In 1994 season, both at 8 and 10 WAS, each increase in nitrogen level significantly increase total dry matter per plant in most cases.

Date of sowing x variety interactions were found to be significant both at 8 and 10 WAS in 1992 and 1993 seasons (Table 83).

Table 83 Total dry matter (g/plant) as affected by date of sowing x variety interaction at 4, 6 and 8 WAS during 1992 and 1993 seasons.

	1992 (8 WAS)		1992(10 WAS)		1993(8 WAS)	1993(10 WAS)			
Sowing date	Variety		Variety		Sowing date	Variety		Variety	
	Local-1	V-35	Local-1	V-35		Local-1	V-35	Local-1	V-35
Early 25-6-92	27.4b	32.6a	30.6b	36.5a	18-7-93	34.1a	28.7b	37.3a	30.4b
Late 24-7-92	27.8b	27.3b	31.0b	28.6c	16-8-93	26.7c	27.1c	28.5c	24.7d
SE ±	0.93		0.97			0.63		0.56	

Means followed by the same letter within an interaction table are not significantly different using the Duncan's Multiple Range Test (DMRT).05).

In early sowing, the variety V-35 produced higher total dry matter per plant in 1992, both at 8 and 10 WAS, but the reverse was true in 1993, in which Local-1 variety produced higher total dry matter than V-35 at 8 and 10 WAS. In late sowing the difference was not significant at 8 WAS both in 1992 and 1993 seasons.

Population x variety interactions were found to be significant both at 8 and 10 WAS in 1992 and 1993 seasons and at 10 WAS in 1994 season only (Tables 84a-b).

Table 84a: Total dry matter (g/plant) as affected by population x variety interaction at 8 and 10 WAS in 1992 and at 8 and 10 WAS in 1993 seasons.

	1992 (8 WAS)		1992(10 WAS)		1993(8 WAS)		1993(10 WAS)	
	Variety		Variety		Variety		Variety	
Plant population/ha	Local-1	V-35	Local-1	V-35	Local-1	V-35	Local-1	V-35
22,000	27.6c	30.3b	30.8c	33.1b	34.5a	30.4b	39.0a	30.1c
44,000	26.5c	32.5a	29.8c	35.3a	29.0c	27.1d	28.7d	29.4d
88,000	28.6c	26.9c	31.5b	29.0c	30.1b	22.9e	31.2b	23.1e
SE ±	1.16		0.96		0.71		0.67	

Table 84b: Total dry matter (g/plant) as affected by population x variety interaction at 10 WAS in 1994 season.

	1994 (10 WAS)	
Plant population/ha	Variety	
	Local-1	V-35
22,000	33.9a	30.3b
44,000	29.4c	29.3c
88,000	30.3b	29.2c
SE ±	1.31	

Means followed by the same letter within an interaction table are not significantly different using the Duncan's Multiple Range Test (DMRT.05).

Each increase in population level significantly decreased the total dry matter per plant in both varieties in most of the cases. At 8 and 10 WAS in 1992 season, variety V-35 produced highest total dry matter per plant at 44,000 plants/ha; followed by 22,000 and 88,000 plants/ha. At 8 and 10 WAS in 1993 season, variety Local-1 produced a higher total dry matter per plant than variety V-35 at 22,000 plants/ha. When 44,000 plants/ha was examined, V-35 produced a higher total dry matter per plant at both stages in 1992 and such difference was not significant at 10 WAS in 1993 and 1994 seasons. At 88,000 plants/ha, the two varieties produced similar total dry matter per plant in 1992 at 8 WAS and at 10 WAS in 1994 seasons, however, at 10 WAS in1992; at 8 WAS and at 10 WAS in 1993 total dry matter by Local-1 variety was found to be significant than variety V-35.

4. 14 Length of root (cm/plant)

The mean length of longest root during 1992 to 1994 is given in Table 85

Table 85: Length of root (cm/plant) as affected by nitrogen, sowing date, population, variety of okra with their interactions during 1992 to 1994 rainy seasons at Samaru.

Treatment	WEEKS AFTER SOWING											
	1992				1993				1994			
	4	6	8	10	4	6	8	10	4	6	8	10
Nitrogen (N) (Kg/ha)												
0	33.5	51.6c	75.6b	84.6c	20.0	87.0b	128.1c	143.1	14.4	49.9	67.7c	73.3
45	39.6b	56.1b	95.5a	90.1b	17.7	90.3b	139.1b	152.1	15.5	52.2	80.0b	81.1
90	47.9a	71.1a	101.0a	120.5a	16.7	100.0a	137.1a	146.2	17.7	54.4	88.8a	86.6
SE ±	7.00	2.21	9.00	1.10	4.00	3.00	31.10	5.20	2.00	5.00	2.00	9.00
Sowing Date (D)												
Early 25-6-92						18-7-93				9-7-94		
	64.6a	98.8a	100.2a	112.2a	27.2a	109.9a	199.6a	196.6a	16.8a	79.9a	120.4a	120.0a
Late 24-7-92						16-8-93				8-8-94		
	16.4b	20.0b	79.3b	83.3b	9.6b	75.5b	70.0b	98.9b	13.3b	24.4b	36.6b	40.0b
SE ±	8.00	2.21	3.04	9.03	8.01	1.10	1.91	2.70	2.01	3.01	4.00	3.01
Population(P/ha)												
22,00	39.4	57.3	88.4	97.4	19.1	94.4	130.0	144.4b	17.7	55.5	66.6	79.9
44,000	41.3	61.2	92.2	99.3	18.2	90.1	137.7	139.9c	15.5	51.1	81.1	83.3
88,000	40.0	58.1	90.0	97.1	16.4	94.3	136.8	158.8a	14.4	49.5	87.1	78.8
SE ±	4.00	3.43	9.62	2.41	3.04	6.25	5.61	1.82	2.00	4.00	3.00	4.00
Variety (V)												
Local-1	47.2a	58.1	88.3	96.4	20.0	95.2	133.3	154.4	16.6	51.2	77.7	80.6
V-35	33.3b	59.4	92.2	99.2	15.3	90.3	135.6	140.0	14.5	53.3	79.9	79.9
SE ±	5.00	3.00	3.00	3.00	4.00	4.34	5.63	7.34	2.00	3.00	4.00	3.00
Interactions												
N x D	*	NS	NS	NS	NS	*	NS	*	NS	NS	*	NS
N x P	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
D x P	NS	NS	NS	NS	NS	NS	NS	NS	*	NS	*	NS
N x V	NS	NS	NS	NS	*	*	*	NS	NS	NS	NS	NS
D x V	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
P x V	NS	NS	NS	NS	NS	*	NS	NS	NS	NS	NS	NS

Means followed by the same letter within a treatment group of a column are not significantly different using the Duncan's Multiple Range Test (DMRT.05)

* and ** Significant at 5 and 1 percent levels, respectively.

NS = Not significant.

The length of root significantly affected by nitrogen at all the stages of growth in 1992 season. At 4 to 10 WAS the higher the levels of nitrogen the longer was the length of root. At 6 WAS the longest root was produced by 90kgN/ha. At 8 WAS both 45 and 90kgN/ha produced longer root than control. Sowing dates also affected the length of longest root. Okra sown on 25/6/92 produced longer root than those sown on 24/7/92. The population levels did not affect the root length. The variety affected the root length at 4 WAS in which Local-1 produced longer root than V-35.

In 1993 rainy season, nitrogen affected root length at 6 and 8 WAS. At 6 WAS each increment in nitrogen level significantly increased root length, but at 8 WAS the two applied levels of fertilizer produced longer root than control. Sowing of okra on 18-7-93 produced longer root than those sown on 16-8-93. Population levels affected the root length only at 10 WAS. The population level of 88,000 plants/ha produced longer root than 22,000 plants/ha, which was also longer than 44,000 plants/ha. The effect of varieties were not significant at any stage of growth. The effect of nitrogen was significant at 8 WAS in 1994 season only wherein control produced shorter root length than the two applied nitrogen levels.

Sowing dates significantly affected the root length at all the stages of growth. Early sown crop produced longer root than late sown crop. The effect of varieties were not significant on root length at any stage of growth.

Interaction between nitrogen x date of sowing were found to be significant at 4 WAS in 1992; at 6 and 10 WAS in 1993 and at 8 WAS in 1994 seasons (Table 86).

Table 86: Length of root (cm/plant) as affected by nitrogen x date of sowing interaction at 4, 6 WAS in 1992, at 10 WAS in1993 and at 8 WAS in 1994 seasons at Samaru.

	1992(4 WAS)		1993(6 WAS)		1993(10 WAS)		1994(8 WAS)	
Nitrogen (Ng/ha)	Sowing date		Sowing date		Sowing date		Sowing date	
	Early	Late	Early	Late	Early	Late	Early	Late
	25-6-92	24-7-92	18-7-93	16-8-93	18-7-93	16-8-93	18-7-94	8-8-94
0	13.5c	15.1d	102.4c	62.4d	140.6c	119.3d	111.3c	33.2d
45	62.4b	15.2d	112.3b	65.2d	177.9b	121.2d	111.2b	39.1c
90	90.3a	15.3d	145.2a	65.3d	198.9a	120.2d	128.3a	42.3c
SE ±	0.70		0.81		2.31		5.23	

Means followed by the same letter within an interaction table are not significantly different using the Duncan's Multiple Range Test (DMRT.05).

In early sowing each increase in nitrogen level significantly increased the length of root, but in late sowing there was no significant difference at 4 WAS in 1992, at 6 WAS in 1993 and at 8 WAS in 1994 seasons. In case of 10 WAS in 1993, the two levels of applied nitrogen significantly produced longer root length than control. When the same nitrogen level was considered across the two sowing dates, for the root length, it was observed that, control in early sowing produced significantly longer root than late sown crop at each level of nitrogen at 4 WAS in 1992; at 6 and 10 WAS in 1993 and at 8 WAS in 1994 seasons.

Nitrogen x population interactions were not significant at any stage of growth in all the years, but date of sowing x population interaction were found to be significant at 8 and 10 WAS in 1994 season (Table 87).

Table 87: Length of root (cm/plant) as affected by date of sowing x population interactions at 8 and 10 WAS in 1994 rainy season.

	1994(8 WAS)			1994(10 WAS)		
Sowing date	Plant population/ha					
	22,000	44,000	88,000	22,000	44,000	88,00
Early 9-7-94	96.3e	128.3b	138.3a	123.3b	124.3a	112.3c
Late 8-8-94	37.4d	35.1e	37.2d	34.2f	42.2e	45.2d
SE +		07			0.60	

Means followed by the same letter within an interaction table are not significantly different using the Duncan's Multiple Range Test (DMRT.05).

Early sowing produced significantly longer root than late sown crop in all the populations. When the results were examined for different populations at the same sowing date, it was observed that each increase in population increased the root length in early sowing at 8 WAS. Both 22,000 and 88,000 plants/ha produced longer root than 44,000 plants/ha which was followed by 88,000 plants/ha in that order in early sowing. In late sowing each increase in population increased the root length.

Nitrogen x variety interaction was observed at 4, 6 and 8 WAS in 1993 season (Table 88)

Table 88: Length of root (cm/plant) as affected by nitrogen x variety interactions at 4, 6 and 8 WAS in 1993.

	1993(4 WAS)		1993(6 WAS)		1993(8 WAS)	
Nitrogen (Nkg/ha)	Variety					
	Local-1	V-35	Local-1	V-35	Local-1	V-35
0	26.2a	14.1d	77.3d	97.3b	108.3f	146.4b
45	17.3b	6.3c	90.1b	80.9c	120.3e	157.3a
90	16.1c	16.4c	130.3a	80.9c	140.1c	133.1d
SE +	0.91		3.10		3.60	

Means followed by the same letter within an interaction table are not significantly different using the Duncan's Multiple Range Test (DMRT.05).

Variety V-35 both at 4 and 6 WAS produced shorter root length at 45 and 90kgN/ha when compared with control. At 8 WAS the longer root was produced at 45kgN/ha, followed by 0 and 90kgN/ha. In case of Local-1 each increase in nitrogen level significantly increased the root length at 4 and 6 WAS, but at 6 WAS the root length was decreased as nitrogen level was increased. When the length of the two varieties were examined at the same nitrogen level, V-35 produced longer root at 6 and 8 WAS in control. At 90kgN/ha there was a difference in root length of the two varieties at 4 WAS and Local-1 produced longer root than variety V-35 both at 6 and 8 WAS.

4.15 Number of branches per plant

Number of branches as affected by nitrogen, sowing date, population and variety and their interactions is given in (Table 90).

Table 90: Number of branches per plant as affected by nitrogen, sowing date, plant population and okra varieties and their interactions in 1992 to 1994 rainy seasons at Samaru.

Treatment	1992	1993	1994
Nitrogen (N)			
(KgN/ha)			
0	0.00c	1.3c	0.3b
45	1.5b	2.4b	1.2a
90	2.7a	4.6a	1.8a
SE +	0.31	0.43	0.31
Sowing date(D)			
Early	25-6-92	18-7-93	9-7-94
	2.1a	4.2a	1.7a
Late	24-7-92	16-8-93	8-8-94
	1.2b	1.2b	0.5b
SE +	0.70	0.41	0.22
Population/ha(P)			
22,000	1.4	2.8	1.2
44,000	1.5	2.7	1.2
88,000	1.3	2.7	1.1
SE +	0.30	0.32	0.32
Variety (V)			
Local-1	1.5	2.7	1.3a
V-35	1.3	2.8	0.9b
SE +	0.43	0.24	0.20
Interactions			
N x D	**	NS	**
N x P	NS	NS	NS
D x P	NS	NS	NS
N x V	NS	NS	NS
D x V	NS	NS	NS
P x V	NS	NS	NS

Means followed by the same letter within a treatment group of a column are not significantly different using the Duncan's Multiple Range Test (DMRT.05)
* and ** Significant at 5 and 1 percent levels respectively.
NS = Not significant.

Nitrogen application affected the number of branches significantly in all the three years under study. Each increase in nitrogen level significantly increased the number of branches. In 1994, the two levels of applied nitrogen produced higher number of branches than control. The sowing dates were also found to affect the number of branches. Early sown crop produced more branches than late sown crop in all the years. The effect of population levels was not significant on number of branches. The varieties showed significant effect in 1994 season only, when Local-I variety produced more branches than V-35 variety.

All first order of interactions were not significant, except nitrogen x date of sowing interaction which was found to be significant both in 1992 and 1994 seasons (Table 91).

Table 91: Number of branches per plant as affected by nitrogen x sowing date interaction in 1992 and 1994 seasons.

Treatment	1992		1994	
Nitrogen (Nkg/ha	Sowing date		Sowing date	
	Early 25-6-92	Late 24-7-92	Early 9-7-94	Late 8-8-94
0	0.3d	0.3d	0.4c	0.4c
45	1.8b	0.4c	1.8b	0.5c
90	2.9a	0.6c	3.0a	0.6c
SE ±	0.03		0.20	

Means followed by the same letter within an interaction table are not significantly different using the Duncan's Multiple Range Test (DMRT.05).

Each increased in nitrogen level significantly increased the number of branches/plant both in 1992 and 1994 seasons. In early sowing crop however, the two levels of applied nitrogen resulted in higher number of branches. Early sown crop produced more branches than late sown crop in all the years.

CORRELATION STUDIES

Simple correlation coefficient studies indicated that stem dry weight is closely and consistently correlated with fruit yield. Therefore, the other vegetative parameters which are found to be highly correlated with stem dry weight including leaf area, plant height and number of branches were further investigated to study their direct and indirect association with the stem dry weight.

The direct contribution between leaf area and stem dry weight were found to be positive in 1993 and 1994 seasons, however it was negative in 1992. Among the indirect contribution via plant height was positive in all the experiments. When relationship between plant height and stem dry weight were examined, direct relationship was highly significant. The indirect contribution via plant height and number of branches were small and even negative. When the contribution of number of branches and stem dry weight were examined the direct correlation varied from -.16 to .94. Direct contribution via leaf area and number of branches were negative in 1992 as leaf area was small both in 1993 and 1994 seasons. When these values were examined on the basis of percent contribution, plant height consistently gave a contribution of 27%. The contribution of leaf area was much higher in 1992, when compared with 1993 and 1994. The unaccounted residual effect varied between 23 to 34% during 1992 and 1993, but it was 60% in 1994.

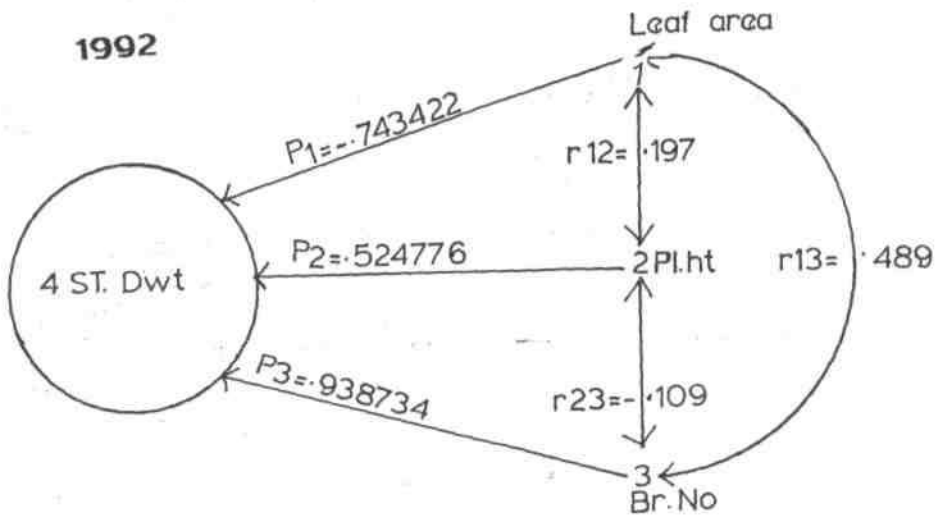


Fig. 1: Path diagram indicating path coefficient (Pi) which measures direct contribution and indicating by singled arrow and correlation coefficient (rij) which measures associations is re[resented by doubled arrow line of No. 1-LA; 2-Pl. ht; 3-No. of br. with st. dry wt. during (a) 1992, (b) 1993 and (c) 1994 wet seasons.

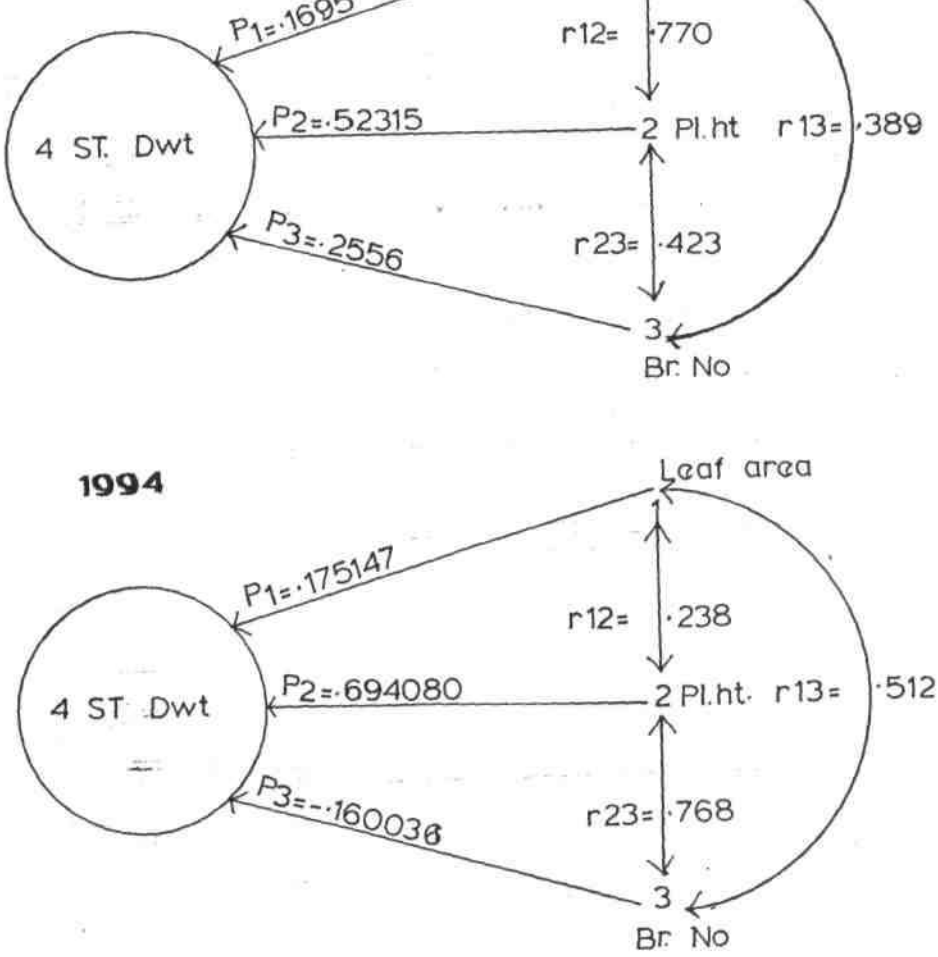


Fig. 1: Path diagram indicating path coefficient (Pi) which measures direct contri
and indicating by singled arrow and correlation coefficient (rij) which me
associations is re[resented by doubled arrow line of No. 1-LA; 2-Pl. ht; 3-No.
with st. dry wt. during (a) 1992, (b) 1993 and (c) 1994 wet seasons.

Nitrogen application affected the number of branches significantly in all the three years under study. Each increase in nitrogen level significantly increased the number of branches. In 1994, the two levels of applied nitrogen produced higher number of branches than control. The sowing dates were also found to affect the number of branches. Early sown crop produced more branches than late sown crop in all the years. The effect of population levels was not significant on number of branches. The varieties showed significant effect in 1994 season only, when Local-1 variety produced more branches than V-35 variety.

All first order of interactions were not significant, except nitrogen x date of sowing interaction which was found to be significant both in 1992 and 1994 seasons (Table 91).

Table 91: Number of branches per plant as affected by nitrogen x sowing date interaction in 1992 and 1994 seasons.

Treatment	1992		1994	
Nitrogen (Nkg/ha	Sowing date		Sowing date	
	Early 25-6-92	Late 24-7-92	Early 9-7-94	Late 8-8-94
0	0.3d	0.3d	0.4c	0.4c
45	1.8b	0.4c	1.8b	0.5c
90	2.9a	0.6c	3.0a	0.6c
SE ±	0.03		0.20	

Means followed by the same letter within an interaction table are not significantly different using the Duncan's Multiple Range Test (DMRT 05).

Table 92: Direct and Indirect contribution of leaf area, plant height and number of branches to stem dry weight.

	Contribution		
1. Leaf area (X_1)and Stem dry wt.(X_4)	1992	1993	1994
Direct contribution (P_1)	-.743422	.1695	.175747
Indirect via plant height ($r_{12}P_2$)	.10338	.3721	.1652
Indirect via number of branches ($r_{13}P_3$)	.4590	.0994	-.08194
Total contribution (Direct and Indirect)	-.181	.641	.259
2. Plant height (X_2) and stem dry wt. (X_4)			
Direct contribution (P_2)	.524776	.5315	.694080
Indirect via leaf area ($r_{12}P_1$)	-.4465	.1305	.04183
Indirect via number of branches ($r_{23}P_3$)	-.1023	.108	-.1229
Total contribution (Direct and Indirect)	.276	.770	.613
3. Number of branches(X_3) and stem dry wt. (X_4)			
Direct contribution (P_3)	.938734	.2556	-.160036
Indirect via leaf area ($r_{13}P_1$)	-.3635	.0659	.08998
Indirect via number of branches ($r_{23}P_2$)	-.05721	.2248	.5331
Total contribution (Direct and Indirect)	.518	.546	.463

Table 93: Direct and combined of growth components expressed as percentage.

Growth Components $(P_i)^2$	% Contribution		
	1992	1993	1994
Direct contribution by LA $(X_1)(P_1)^2$	55.27	2.87	3.089
Indirect contribution by Plant height$(X_2)(P_2)^2$	27.54	28.25	48.18
Indirect Contribution by No. of Branches (X_3) $(P_3)^2$	88.12	6.53	2.56
Combined contribution (2PipJrij)			
LA (X_1) and plant height (X_2)	-15.37	12.6	5.81
LA (X_1) and No. of branches (X_3)	-68.25	3.37	-2.88
Plant height (X_2) and No. of Branches (X_3)	-10.74	11.49	-17.06
Residual	23.4	34.2	60.31
Total	100.00	100.00	100.00

4.16 Number of Fruits/plot

The number of fruits per plant is a major yield component of okra. The higher the number of fruits, the higher is the yield. Nitrogen application significantly increased the number of okra fruits per plot (Table 94).

Table 94: Number of fruits per plot as influenced by nitrogen, population, sowing date, and okra variety and their interactions in 1992 to 1994 rainy seasons at Samaru.

Treatment	1992	1993	1994
Nitrogen (N) (KgN/ha)			
0	90.0c	160.4b	86.3c
45	135.0b	188.3a	111.5b
90	195.0a	162.4b	135.3a
SE ±	1.72	10.50	5.51
Sowing Date(D)			
Early	25-6-92	18-7-93	9-7-94
	210.0a	236.3a	171.8a
Late	24-7-92	16-8-93	8-8-94
	70.2b	103.7b	50.2b
SE ±	1.42	0.93	3.00
Population/ha(P)			
22,000	164.2a	199.2a	118.5a
44,000	149.1b	164.0b	106.8b
88,000	107.3c	147.9c	107.8b
SE ±	3.22	8.23	3.71
Variety(V)			
Local-1	142.1	169.2	109.9
V-35	138.2	171.5	111.4
SE ±	3.10	8.68	6.54
Interactions			
N x D	*	**	**
N x P	NS	NS	NS
D x P	NS	NS	*
N x V	*	*	*
D x V	NS	NS	*
P x V	NS	NS	*

Means followed by the same letter within a treatment, group of a column are not significantly different using the Duncan's Multiple Range Test (DMRT).05)

* and ** = Significant at 5 and 1 percent levels, respectively.

NS = Not significant.

The effect of nitrogen was highly significant in the 3 year period. The highest number of fruits was obtained from the plots with 90kgN/ha. The okra plant is an auxilliary bearer because fruits are borne on auxilliary nodes. The number of fruits per plant is a reflection of the number of flowering nodes that are produced per plant. The number of nodes was in turn determined by the number of internodes after a few basal nodes. However, because of the ability of plants to produce many branches, the number of possible nodes is further increased. The super numery flower nodes on branches also provides another means of increasing the number of fruits. Early sowing resulted in higher number of fruits than late sowing due to the favourable weather conditions, such as good rainfall, optimum temperatures usually associated with early sown crop.

Nitrogen application has a significant effect on population. Widely spaced plants ha (22,000 plants/ha) started bearing fruits early than closely sown plants) (44,000 and 88,000 plants/ha).

The addition of total number of fruits showed that wider spacing (22,000 plants/ha) resulted in the highest total number of fruits due to more feeding space, and light available to the plants than closely spaced crop. The fruits harvested from dense population were smaller compared with those of widely spaced crop (22,000 plants/ha). None of the variety was statistically significant during the experiments.

Nitrogen x date of sowing interactions were observed in all the seasons and years (Table 95).

Table 95: Number of fruits/plot as affected by nitrogen x sowing date interactions in 1992 to 1994 rainy seasons at Samaru.

	1992		1993		1994	
Nitrogen	**Sowing date**		**Sowing date**		**Sowing date**	
	Early	Late	Early	Late	Early	Late
(Nkg/ha)	25-6-92	24-7-92	18-7-93	16-8-93	9-7-94	8-8-94
0	170.3c	80.0e	170.1c	140.2f	137.5c	35.1d
45	188.3b	96.3d	182.2b	150.3e	180.4b	43.6d
90	210.8a	96.0d	218.4a	160.1d	216.8a	53.8d
SE ±	12.31		11.52		13.40	

Means followed by the same letter within an interaction table are not significantly different using the Duncans Multiple Range Test (DMRT.05).

In early sowing each increase in nitrogen level significantly increased the number of fruits/plant, but in late sowing the two applied nitrogen rates resulted in lower number of fruits in 1992 and also in late sowing in 1993 seasons. In 1992 late sowing, the two applied nitrogen rates produced higher number of fruits than control and no such difference was observed in 1994 season. When the two sowing dates were examined at the same nitrogen levels, early sowing produced significantly higher number of fruits/plot at each level of nitrogen in all the seasons.

Nitrogen x population interaction was not significant in all seasons, except date of sowing x population interaction which was significant in 1994 season only (Table 96).

Table 96: Number of fruits/plot as affected by sowing date x population interaction in 1994 rainy season at Samaru.

Sowing date		Plant population/ha		
		22,000	44,000	88,000
Early	9-7-94	176.9a	181.0a	175.8a
Late	8-8-94	60.1b	32.6d	39.8c
SE ±			5.41	

Means followed by the same letter within an interaction table are not significantly different using the Duncan's Multiple Range Test (DMRT.05).

Early sowing produced significantly higher number of fruits/plot at each population level. When the same sowing date was examined across the different populations there were no significant difference in early sowing, but in late sowing 22,000 plants/ha produced higher number of fruits than 88,000 plants/ha which in turn was significantly higher than 44,000 plants/ha.

Nitrogen x variety interaction was found to be significant in all the years (Table 97).

Table 97: Number of fruits/plot as affected by nitrogen x variety interaction in 1992 to 1994 rainy seasons at Samaru.

	1992		1993		1994	
(NKg/ha)	Variety-1		Variety		Variety	
	Local-1	V-35	Local-1	V-35	Local-1	V-35
0	100.2f	110.7e	140.3d	180.4b	83.0e	89.6e
45	130.3c	180.1b	201.7a	180.9b	106.7d	116.3c
90	200.3a	120.4d	160.6c	158.3c	142.2a	128.4b
SE ±	1.21		4.92		6.71	

Means followed by the same letter within an interaction table are not significantly different using the Duncan's Multiple Range Test (DMRT.05).

In Local-1 variety in 1992 and 1994 seasons, each increase in nitrogen level significantly increased the number of fruits/plot. In 1993 season, however, 45kgN/ha produced higher number of fruits/plot, followed by 90 and 0kgN/ha in that order. In case of V-35 also, each increase in nitrogen level significantly increased the number of fruits/plot in 1992 and 1994 seasons. In 1993 season, the difference between control and 45kgN/ha was not significant, but number of fruits in these two treatments were higher than 90kgN/ha. When the two varieties were examined at the same nitrogen level, in control, V-35 produced higher number of fruits/plot in 1992 and 1993 seasons. No such difference was observed in 1994 season. At 45kgN/ha variety Local-1 produced higher number of fruits/plot in 1992 and 1994 seasons. At 90kgN/ha, variety V-35 produced higher number of fruits/plot in 1992 and 1994 seasons, however, such difference was not found in 1993 season.

Date of sowing x variety interaction was significant in 1994 season only (Table 98).

Table 98: Number of fruits/plot as affected by sowing date x variety interaction in 1994 rainy season at Samaru.

	1994	
Date of sowing	Variety	
	Local-1	V-35
Early 9-7-94	180.1a	176.1a
Late 8-8-94	38.1c	50.2b
SE ±	8.80	

Means followed by the same letter within an interaction table are not significantly different using the Duncan's Multiple Range Test (DMRT.05).

The number of fruits of the two varieties were similar in early sowing, but in late sown crop, V-35 produced higher number of fruits than Local-1. When the two dates of sowing were examined for the same variety early sowing produced higher number of fruits/plot than late sowing

Population x variety interaction was found to be significant in 1994 season only (Table 99).

Table 99: Number of fruits/plot as affected by population x variety in 1994 rainy season at Samaru.

	1994	
Plant population/ha	Variety	
	Local-1	V-35
22,000	95.8d	141.2a
44,000	113.8c	99.9d
88,000	122.3b	93.3d
SE ±	5.30	

Means followed by the same letter within an interaction table are not significantly different using the Duncan's Multiple Range Test (DMRT.05).

Each increase in population level significantly increased the number of fruits/plot in Local-1, but in V-35, 22,000 plants/ha produced higher number of fruits than either 44,000 or 88,000 plants/ha. When the two varieties were examined for the same population level, Local-1 at 44,000 plants/ha recorded higher number of fruits than V-35 both at 44,000 and 88,000 plants/ha and the reverse was true at 22,000 plants/ha.

4.17 Yield of Fresh Fruit (ton/ha)

Nitrogen application increased the fresh weight of okra fruits significantly in the three year period (Table 100).

Table 100: Fresh weight of fruits (ton/ha) as affected by nitrogen, sowing date, plant population and okra variety and their interactions in 1992 to 1994 rainy seasons at Samaru.

Treatment	1992	1993	1994
Nitrogen (N)			
(Nkg/ha)			
0	0.90c	1.75c	0.89c
45	1.3b	2.42b	1.60b
90	2.19a	2.75a	2.25a
SE ±	0.80	0.60	0.21
Sowing date(D)			
Early	25-6-92	18-7-93	9-7-94
	2.4a	3.01a	2.3a
Late	24-7-92	16-8-93	8-8-94
	0.5b	1.6b	0.8b
SE ±	0.83	0.62	0.21
Population/ha(P)			
22,000	1.75a	3.0a	1.9a
44,000	1.25b	2.0b	1.5b
88,000	1.49c	1.9c	1.1c
SE ±	0.10	0.51	0.10
Variety(V)			
Local-1	1.4	2.3	1.7a
V-35	1.4	2.3	1.4a
SE ±	0.46	0.93	0.05
Interactions			
N x D	*	**	**
N x P	NS	NS	NS
D x P	NS	NS	NS
N x V	**	**	*
D x V	NS	NS	*
P x V	NS	NS	*

Means followed by the same letter within a treatment, group of a column are not significantly different using the Duncan's Multiple Range Test (DMRT).05)

* and ** = Significant at 5 and 1 percent levels, respectively.

NS = Not significant.

The highest fruit yield was obtained when 90kgN/ha was applied. This represented almost 90% increase in yield over 0kgN/ha. A major yield component in okra is the number of fruits per plant. When fruits were picked before they mature, total number of fruits had increased, and in turn increased the yield. The optimum nitrogen requirement of a crop is a function of both the genotype and environment and the interaction of these two factors. Increase in fresh fruit yield resulting from nitrogen fertilization was observed in these experiment to have a linear relationship with rate of nitrogen application upto 90kgN/ha. There was a significant difference in yield between the two sowing dates. Early sown okra in all the three year resulted in almost 100% increase in fruit yield over late sown okra.

The effect of population on the yield was highly significant in 1992 and 1993 seasons, and was significant in 1994. The significant differences among the population levels in those years were due to early sowing and rainfall during the growth period. Wider row spacing of 45cm produced significantly higher yield than other two spacing (15cm and 30cm). Increased population levels decreased the yield of okra. There was significant difference between the two varieties in 1994 season only. The variety Local-1 resulted in higher fresh fruit weight than V-35.

Interactions between nitrogen x date of sowing were found to be significant in all the seasons and years (Table 101a-b).

Table 101a: Nitrogen x sowing date interactions on fresh okra fruit (ton/ha) in 1992 to 1993 rainy seasons at Samaru.

Treatment	1992		1993	
Nitrogen) (Nkg/ha)	Sowing date		Sowing date	
	Early 26-6-92	Late 24-7-92	Early 18-7-93	Late 16-8-93
0	2.4c	0.3d	2.2c	1.4d
45	2.7b	0.2d	2.3b	1.4d
90	3.0a	0.2d	3.4a	1.5d
SE ±	.09		.07	

Table 101b: Nitrogen x sowing date interaction on fresh weight of okra fruit (ton/ha) in 1994 rainy season at Samaru.

Treatment	1994	
Nitrogen (Nkg/ha)	**Sowing date**	
	Early 9-7-94	Late 8-8-94
0	1.2c	0.3f
45	2.5b	0.6e
90	3.5a	1.0d
SE ±	0.08	

Means followed by the same letter within an interaction table are not significantly different using the Duncan's Multiple Range Test (DMRT).05)

In early sowing each increase in nitrogen level significantly increased the yield in all the seasons. In late sowing the two rates of applied nitrogen produced higher yield than control in 1992 season and 90kgN/ha produced higher yield than either 0 and 45kgN/ha in 1993 season. Each increase in nitrogen significantly increased the yield in 1994 season. When the two sowing dates were examined at the same nitrogen level, early sown crop produced higher yield than late sown crop at all the nitrogen levels and in all the experiments.

Nitrogen x population and date of sowing x population interactions were found not significant in all the years, but nitrogen x variety interactions were significant in 1992, and 1994 seasons (Table 102a-b).

Table 102a: Nitrogen x variety interactions of fresh weight on okra fruit (ton/ha) in 1992 and 1993 rainy seasons at Samaru.

Treatment	1992		1993	
Nitrogen (Nkg/ha)	Variety		Variety	
	Local-1	V-35	Local-1	V-35
0	2.4c	0.3d	1.4c	2.3b
45	2.7b	0.2d	2.6a	2.3b
90	3.0a	0.2d	2.7a	2.5b
SE ±	0.41		0.51	

Means followed by the same letter within an interaction table are not significantly different using Duncan's Multiple Range Test (DMRT).05)

Table 102b: Nitrogen x variety interaction of fresh weight on okra fruit (ton/ha) in 1994 rainy season at Samaru.

Treatment	1994	
Nitrogen (Nkg/ha)	Variety	
	Local-1	V-35
0	1.1d	0.6e
45	1.7b	1.5c
90	2.2a	2.2a
SE ±	0.02	

Means followed by the same letter within an interaction table are not significantly different using Duncan's Multiple Range Test (DMRT).05)

The variety V-35 produced higher yield as the nitrogen level was increased from 0 to 90kgN/ha in 1992 and 1994 seasons. In 1993 season, however, the difference between control and 45kgN/ha was not statistically different, but 90kgN/ha produced higher yield than other two levels of nitrogen. In case of Local-1, the two rates of applied nitrogen produced significantly higher yield than control in 1992 season.

Interaction between sowing date x variety was found to be significant in 1994 season only (Table103).

Table 103: Fresh weight of fruits (ton/ha) as affected by date of sowing x variety interaction in 1994 season.

Treatment		1994	
Date of sowing (Nkg/ha)		Variety Local-1	V-35
Early	9-7-94	2.7a	2.1b
Late	8-8-94	0.8c	0.8c
SE ±		02	

Means followed by the same letter within an interaction table are not significantly different using Duncan's Multiple Range Test (DMRT).05)

In early sowing variety Local-1 produced higher yield than variety V 35. However the reverse was true in late sown crop in which variety V-35 produced higher yield than Local-1.

Population x variety interaction was observed in 1994 season only (Table 104).

Table 104: Population x variety interaction on fresh weight (ton/ha) of okra fruits in 1994 rainy season at Samaru.

Treatment	1994		
	Plant population/ha)		
Variety	22,000	44,000	88,000
Local-1	1.7b	1.9a	1.7b
V-35	1.4c	1.4c	1.4c
SE ±		0.02	

Means followed by the same letter within an interaction table are not significantly different using the Duncan's Multiple Range Test (DMRT).05)

The Local-1 variety produced higher yield at 44,000 plants/ha when compared either with 22,000 or 88,000 plants/ha. No significant difference was observed for variety V-35 at the same population levels. When the two varieties were compared at the same population levels, the variety Local-1 out yielded variety V-35 at all the population levels.

4.18: Dry pod weight of okra (kg/plot)

Data on dry pod weight of okra is given in Table 105.

Table 105: Pod dry weight of okra (kg/plot) as affected by nitrogen, sowing date, plant population and okra variety and their interactions in 1992 to 1994 rainy seasons at Samaru.

Treatment	1992	1993	1994
Nitrogen (N)			
(KgN/ha)			
0	26.4b	21.4b	10.4b
45	32.6a	36.5a	30.5a
90	32.7a	36.7a	30.4a
SE ±	0.31	0.25	0.31
Sowing Date(D)			
Early	25-6-92	18-7-93	9-7-94
	39.1a	43.1a	33.1a
Late	24-7-92	16-8-93	8-8-94
	20.9b	20.0b	13.5b
SE ±	0.24	0.24	0.30
Population/ha(P)			
22,000	29.4	30.3	30.3
44,000	29.5	29.5	20.2
88,000	33.3	33.4	20.2
SE ±	9.61	8.52	8.52
Variety(V)			
Local-1	30.6	30.4	23.2
V-35	29.7	32.3	24.1
SE ±	3.31	3.31	3.31
Interactions			
N x D	*	**NS**	*
N x P	**NS**	**NS**	NS
D x P	**NS**	**NS**	NS
N x V	**NS**	**NS**	NS
D x V	**NS**	**NS**	*
P x V	NS	NS	NS

Means followed by the same letter within a treatment, group of a column are not significantly different using the Duncan's Multiple Range Test (DMRT.05)

* and ** = Significant at 5 and 1 percent levels, respectively.

NS = Not significant

Nitrogen application increased dry pod weight in all the experiments. There was no significant difference between the two applied nitrogen doses (45 and 90kgN/ha) in all the experiments. Differences due to sowing dates were highly significant in all seasons. Early sown okra produced higher dry pod weight when compared with late sown okra.

Population and variety did not influence dry pod weight in any of the experiment. A low or no respond of population may be due to inter-plant competition for light, space and nutrient, while that of variety may be due to its dryness.

Interaction between nitrogen x date of sowing was observed both in 1992 and 1994 seasons (Table 106).

Table 106: Dry weight of okra pod (kg/plot) as affected by nitrogen x sowing date interactions in 1992 and 1994 rainy seasons at Samaru.

Treatment	1992		1994	
Nitrogen (NKg/ha)	Sowing date		Sowing date	
	Early 25-6-92	Late 24-7-92	Early 9-7-94	Late 8-8-94
0	36.1c	20.2e	20.3c	10.3d
45	40.2b	11.1f	36.2b	10.2d
90	45.2a	28.1d	56.1a	10.1d
SE ±	0.03		0.50	

Means followed by the same letter within an interaction table are not significantly different using the Duncan's Multiple Range Test (DMRT).05)

Each increase in nitrogen level significantly increased the dry pod weight in early sown crop in both seasons, but in late sown crop, the dry pod weight with 90kgN/ha was higher than control which was also higher than 45kgN/ha in 1992 season. There was no significant difference observed in late sown crop in 1994 season.

All first order of interactions were not found to be significant, except date of sowing x variety interaction which was found to be significant in 1994 season (Table 107).

Table 107: Dry weight of okra pod (kg/plot) as affected by sowing date x variety interaction in 1994 rainy seasons at Samaru.

Treatment		1994	
Nitrogen (NKg/ha)		Variety	
		Local-1	V-35
Early	9-7-94	33.3a	30.3b
Late	8-8-94	20.2c	10.4d
SE ±		0.40	

Means followed by the same letter within an interaction table are not significantly different using Duncan's Multiple Range Test (DMRT.05).

Early sown crop produced higher pod dry weight than late sown crop and the variety Local-1 produced higher dry pod weight than variety V-35.

4.19: Nitrogen content in okra fruits (%N)

Application of nitrogen increased nitrogen content in okra fruits in all the years at various stages of growth at 8, 10 and 12 WAS in 1992 to 1994 respectively (Table 108).

Table 108: Effect of nitrogen application on nitrogen content(%N) in okra fruits at 8, 10 and 12 WAS in 1992 to 1994 rainy seasons at Samaru.

Treatment	1992	1993	1994
	8WAS	10WAS	12WAS
Nitrogen (NKg/ha)			
0	1.3c	1.4c	1.3c
45	2.0b	2.1b	2.2b
90	2.9a	2.4a	2.9a

Increased nitrogen level (90kgN/ha) resulted in higher nitrogen content than the other two nitrogen levels.

Nitrogen content in okra leaves (%N)

Effect of nitrogen application in okra leaves at 8, 10 and 12 WAS in 1992 to 1994 is shown in Table 109.

Table 109: Effect of nitrogen application on nitrogen content (%N)in okra leaves at 8, 10 and 12 WAS in 1992 to 1994 rainy seasons at Samaru.

Treatment	1992	1993	1994
	8WAS	10WAS	12WAS
Nitrogen (NKg/ha)			
0	1.6c	1.4c	2.4c
45	2.7b	2.9b	2.8b
90	3.2a	3.9a	3.0a

Nitrogen application increased nitrogen content in leaves significantly. There were reductions in nitrogen content in okra leaves in the control plots at 8, 10 and 12 WAS in 1992 to 1994 rainy seasons. The nitrogen content in leaves increased with increasing nitrogen rates from 45 to 90kgN/ha.

Nitrogen content in okra stem (%N)

The nitrogen content in okra stem as influenced by nitrogen is shown in Table 110.

Table 110: Effect of nitrogen application on nitrogen content (%N) in okra stem at 8, 10 and 12 WAS in 1992 to 1994 rainy seasons.

Treatment	1992	1993	1994
	8WAS	10WAS	12WAS
Nitrogen (NKg/ha)			
0	1.1c	1.3c	1.2c
45	1.3b	2.1a	2.0b
90	3.7a	2.1a	2.8a

Nitrogen increased nitrogen content in okra stem at 8, 10 and 12 WAS in 1992 to 1994 rainy seasons. The age of the plant did not have any effect in nitrogen content in okra stem at various stages of sampling. Increase nitrogen to 90kg/ha increased the nitrogen concentration in the stem of okra plant.

Correlation between yield and other yield components

Simple correlation coefficient studied indicated that the number of fruits is closely and consistently correlated with the yield, followed by pod dry weight, leaf dry weight and number of branches. These components were further investigated to study their correlations. A close examination of coefficient revealed that number of fruits were found to be closely associated with other yield components. Therefore, their coefficient correlations were worked out. Among the yield components studied the fruit number were found to be highly correlated with the yield in 1992, 1993 and 1994 seasons. In 1993 and 1994, dry pod weight

was closely associated with the yield, followed by leaf dry weight and number of branches in that order.

Direct and Indirect contribution of fruit number, pod dry weight, leaf dry weight and number of branches on yeild.

The direct contribution between number of fruits with the yield were found to be 4.31 in 1992 and 0.51 and 0.22 in 1993 to 1994. Among the indirect contribution via pod dry weight was positive in all the experiments. Both leaf dry weight and number of branches were negative and varied from -4.04 to 1.39 (pod dry weight) -.16 to 1.9 (leaf dry weight) and number of branches -0.6 to 30. When these values were examined on the basis of percent, number of branches consistently gave contribution of 3.1%. The unaccounted residual effect varied between -26.6 to -561.0% in 1992 and 1994 but 31.4% in 1993.

Table111: Matrix of correlation between various growth parameters as affected by nitrogen, sowing date, population and okra varieties at Samaru during 1992 to 1994.

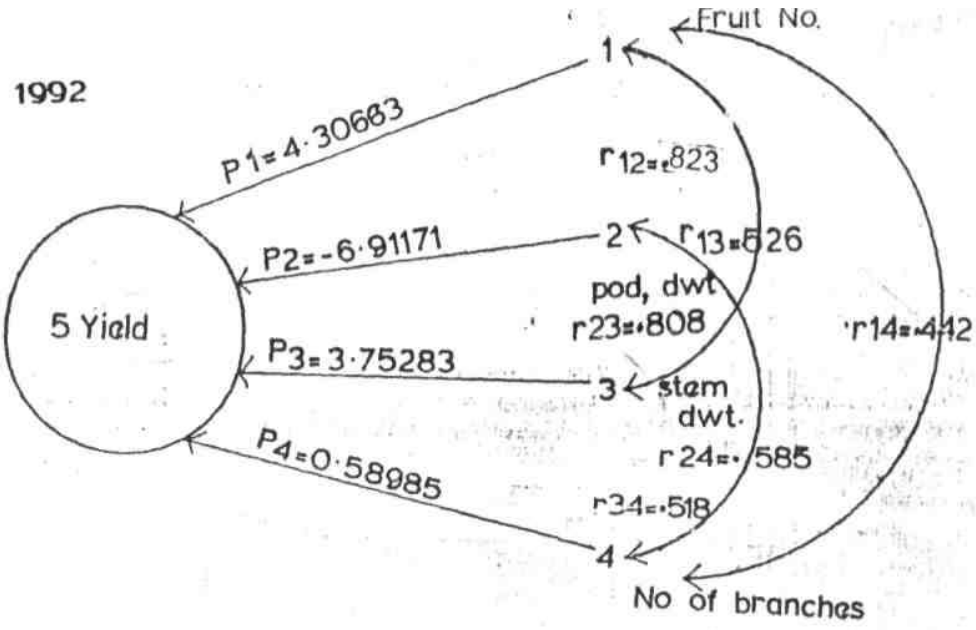
			1 Yield	2 Dry pod wt	3 Leaf No.	4 Leaf dry wt.	5 Stem dry wt.	6 Plant ht.	7 Leaf Area	8 No.of fruits	9 No.of branches
1	Yield	1992	1.00								
		1993	1.00								
		1994	1.00								
2	Dry pod wt.										
		1992	.010	1.00							
		1993	.768**	1.00							
		1994	.617**	1.00							
3	Leaf No.										
		1992	-.302*	-.359*	1.00						
		1993	.639**	-.861**	1.00						
		1994	.300**	-.080*	1.00						
4	Leaf dry wt.										
		1992	.739**	.808**	-.350**	1.00					
		1993	.529**	.872**	.780**	1.00					
		1994	.877**	.923**	.003	1.00					
5	Dry stem wt.										
		1992	-.603**	.803**	-.287**	.822**	1.00				
		1993	.409**	-.421**	.413**	.351**	1.00				
		1994	.878**	.827**	.048	.848**	1.00				
6	Plant ht.										
		1992	-.010	-.054	.159*	-.104**	.276**	1.00			
		1993	-.178*	-.338**	.243**	-.352**	.770**	1.00			
		1994	.799**	.773**	.699**	.602**	.613**	1.00			
7	Leaf area										
		1992	-.248*	-.253*	.260**	-.304**	-.181*	.197*	1.00		
		1993	-.501**	.842**	.647**	.762**	-.641**	-.470**	1.00		
		1994	.369**	.198*	.238*	.207*	.259**	.238*	1.00		
8	Fruit No.										
		1992	.853**	.823**	.714**	.526**	.877**	.401**	.497**	1.00	
		1993	.823**	.873**	.741**	.506**	.807**	.479**	.407**	1.00	
		1994	.444**	.673**	.781**	.532**	.496**	.804**	.662**	1.00	
9	No. of branches										
		1992	.394**	.585**	.465**	.518**	.253*	-.109	.489**	.442**	1.00
		1993	.217*	.502**	.628**	.546**	.416**	.423**	.389**	.240**	1.00
		1994	.492**	.574**	.347**	.463**	.626**	.768**	.512**	.349**	1.00

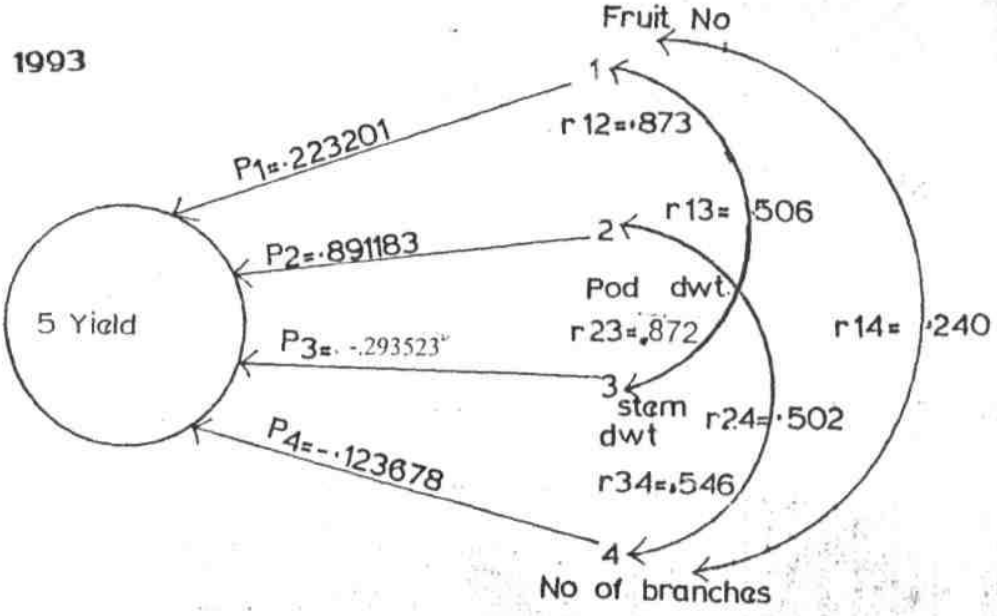
Table 112: Direct and Indirect contribution of fruits number, pod dry wt., leaf dry wt., branches number to yield.

1. Fruit number (X_1) and yield (X_5)	Contribution		
	1992	1993	1994
Direct contribution (P_1)	4.30663	.223201	.51129
Indirect via pod dry wt.($r_{12}P_2$)	-5.688	.7780	-1.6268
Indirect via leaf dry wt. ($r_{13}P_3$)	1.9740	-.1485	1.3872
Indirect via number of branches ($r_{14}P_4$)	.2607	-.0297	.1723
Total contribution (Direct and Indirect)	.853	.823	.444
2 Pod dry wt. (X_2) and yield (X_5)			
Direct contribution (P_2)	-6.91171	.891183	-2.41723
Indirect via pod dry wt. ($r_{12}P_1$)	3.544	.1949	.3441
Indirect via leaf dry wt. ($r_{23}P_3$)	3.0323	-.2560	2.4067
Indirect via number of branches ($r_{24}P_4$)	.3451	-.0619	.2834
Total contribution (Direct and Indirect)	.010	.768	.617
3 Leaf dry wt. (X_3) and yield (X_5)			
Direct contribution (P_3)	3.75283	-.293523	2.60747
Indirect via fruit number ($r_{13}P_1$)	2.2653	.11294	.2720
Indirect via leaf dry wt. ($r_{23}P_2$)	-5.585	.7771	-2.2311
Indirect via number of branches ($r_{34}P_4$)	.3055	-.06753	.2286
Total contribution (Direct and Indirect)	.739	.529	.877
4 Branches number (X_4) and yield (X_5)			
Direct contribution (P_4)	.58985	-.123678	.49379
Indirect via fruit number ($r_{14}P_1$)	1.9035	.05357	.1784
Indirect via pod dry wt. ($r_{24}P_2$)	-4.0434	-.4474	-1.3875
Indirect via leaf dry wt. ($r_{34}P_3$)	1.9440	-.16026	1.2073
Total contribution (Direct and Indirect)	.394	.217	.492

Table 113: Direct and combined of yield components expressed as percentage.

Yield Components $(P_1)^2$	% Contribution		
	1992	1993	1994
Direct contribution by fruit No.(X_1) P_1^2	1854.71	4.98	26.14
Direct contribution by Pod dry wt. $(X_2)P_2^2$	4777.17	79.42	584.30
Direct contribution by leaf dry wt. $(X_3)P_3^2$	1408.37	8.62	679.89
Direct Contribution by NO. of Branches $(X_4)P_4^2$	34.79	1.53	24.38
Combined contribution (2Pipirij)			
Fruit No. (X_1) and pod dry wt.(X_2)	-4899.51	34.73	-166.35
Fruit No. (X_1) and leaf dry wt.(X_3)	1700.25	-6.63	141.85
Fruit No. (X_1) and No. of Branches (X_4)	224.56	-1.33	17.62
Pod dry wt.(X_2) and leaf dry wt.(X_3)	-4191.66	-45.62	-1163.51
Pod dry wt.(X_2) and No. of branches (X_4)	- 476.99	-11.07	-137.03
Leaf dry wt. (X_3) and No. of Branches (X_4)	229.33	3.96	119.23
Residual	-561.0	31.4	- 26.6
Total	100.00	100.00	100.00


1992
Fruit No.
1
P1=4·30683
r12=·823
2
P2=-6·91171
r13=·526
pod, dwt
r23=·808
5 Yield
r14=·412
P3=3·75283
3
stem
dwt.
r24=·585
P4=0·58985
r34=·518
4
No of branches


1993
Fruit No
1
P1=·223201
r12=·873
r13= ·506
2
P2=·891183
Pod dwt.
5 Yield
r23=·872
r14= ·240
P3=-·293523
3
stem
dwt
r24=·502
P4=-·123678
r34=·546
4
No of branches

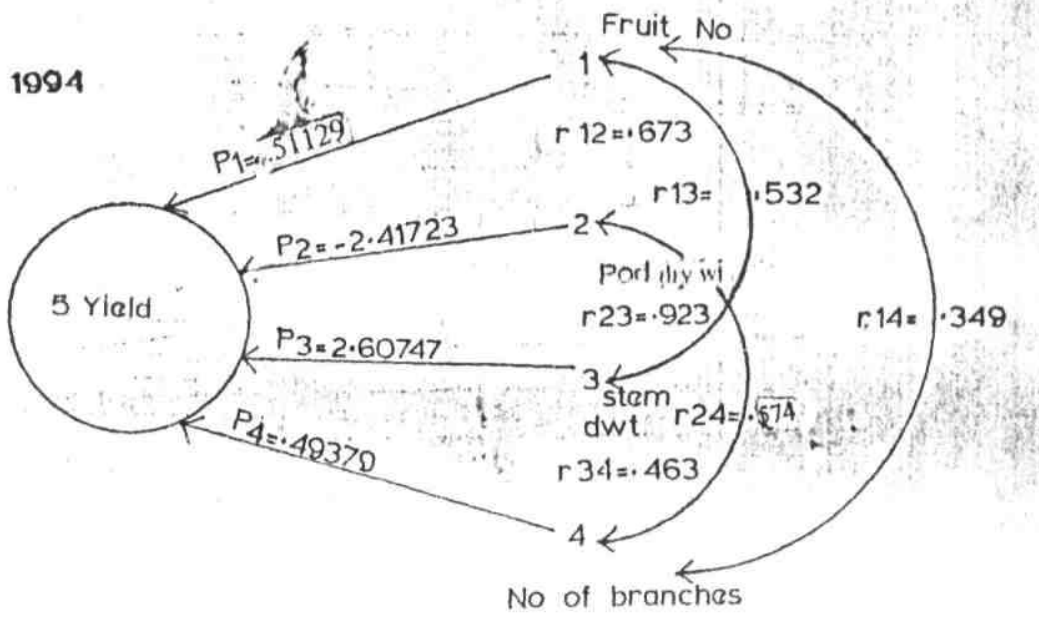

1994
Fruit No
1
P1=·51129
r12=·673
r13= ·532
2
P2=-2·41723
Pod dry wt
5 Yield
r23=·923
r14= ·349
P3=2·60747
3
stem
dwt
r24=·574
P4=·49370
r34=·463
4
No of branches



Fig. 3: Local – 1 Cultivar showing the leaves and pods (fruits)

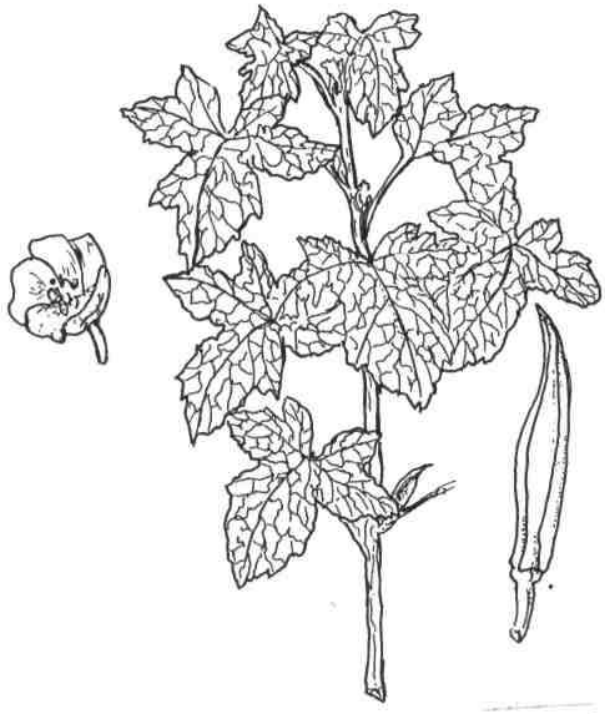


Fig. 4: V-35 Cultivar showing the flower, leaves and the pod (fruit).

CHAPTER FIVE

DISCUSSION

Number of leaves per plant were affected by nitrogen in 1993 and 1994 seasons, as nitrogen was found to promote crop growth. The effect of nitrogen was not significant in 1992 season as the crop was sown in June and it was followed by dry spells which affected the crop growth. When the two sowing dates were compared the number of leaves produced per plant were higher in early sowing due to more conducive conditions for early sown crop. This was in agreement with earlier reports by Verma et al. (1970) and Grewal et al. (1972) who observed that early sown crop produced higher number of leaves per plant than late sown crop. Nitrogen increased fresh weight of leaf in all the stages and in all the experiments. Increase nitrogen, increased fresh leaf weight, which is logical because nitrogen was found to increase vegetative growth. Similar results of increased in fresh leaf weight were observed by Chhonkar and Singh (1963), Mangual Gespo and Martins (1980). Like wise, leaf dry weight was found to be increased at 10 WAS in 1992; at 6 WAS in 1993 and at 4 to 10 WAS in 1994 seasons, because leaf dry weight is a reflection of fresh leaf weight. These results were in agreement with Roy and Chhonkar (1976); Randhawa (1960); Chhonkar and Singh (1963) who had reported that application of nitrogen increased the leaf dry weight. When the two dates were examined, early sown okra produced both higher fresh and dry weights of leaf, because early sown crop had benefits of conducive growth season, as earlier reported by Grewal et al. (1972) Watanabe and Inayama (1977).

Nitrogen affected both fresh and dry weights of stem and root fresh weight at various tages of growth during the experiments. The differences due to nitrogen were found in fair erratic rainy season in which the effect of nitrogen was more evident. Burris (1959), Brutesch and Estes (1976) reported that application of nitrogen stimulate root activity and ooting pattern of a crop. The effect of nitrogen on root dry weight was not significant, as itrogen did not add to dry weight of root. Early sowing produced higher weights of both resh and dry weights of stem and higher fresh root weight due to favourable conditions the arly crop gets. These results were in conformity with those of Bisaria and Shamshery 1979) that early crop produced both higher fresh and stem dry weights and higher fresh root veights.

Nitrogen significantly increased leaf area (LA) and leaf area index (LAI), crop rowth rate (CGR) and relative crop growth rate (RGR) and plant height during the xperiments. Nitrogen due to vegetative growth and its beneficial effect could be seen more nder low rainfall conditions. Mertia and Chauhan (1970); Asif and Greg (1972); Bisaria nd Shamshery (1979); Lal and Pundrik (1979) also reported that increase in nitrogen, ncreased leaf area index (LAI), crop growth rate (CGR), relative growth rate (RGR) and lant height than late sown crop because of favourable conditions for the early sown crop. Adelana (1981), Fatokun and Chheda (1981) reported that early sown crop produced higher eaf area (LA) and leaf area index (LAI). Both varieties (Local-1 and V-35) produced higher eaf area (LA) and leaf area index (LAI) at various stages of growth during the experiments. The differential response was due to its adaptability to the area.

The effect of nitrogen was significant on total dry matter, length of root and number of branches per plant in all the years as it was found to enhance the vegetative growth. Hooda et al. (1980) reported that with each progressive increase in nitrogen level, increased total dry matter per plant, root length and number of branches per plant. In an experiment to study the relationship of yield to different growth characters in okra, a positive correlation existed between number of branches/plant with yield. When the two sowing dates were compared, early sowing produced higher total dry matter per plant, longer root and number of branches per plant. Similar observations were made by Aibregts and Howard (1973), Roy and Chhonkar (1976) that early sown crop produced higher number of branches per plant and longer root. Shoemaker and Gamon (1964) observed that unevenly distributing of rain can reduce the total dry matter per plant of a crop, while Yao and Shaw (1972) observed that the effect of total dry matter per plant on population may be caused as a result of minimal competition among the various populations used.

As okra pods are auxillary borne, the number of fruit per plant on the main stem is set by the number of internodes and hence plant height is the limiting factor for fruit production. Increasing the number of branches per plant will therefore shall result in increase in the number of nodes per plant. Application of nitrogen increased the number of fruits per plot in all the years. The higher the nitrogen, the higher is the number of fruits (Chauhan and Gupta 1973; Fatokun et al. 1978 and Adejonwo 1988) who reported that the higher the nitrogen applied, the higher is number of fruits per plot. Early sowing resulted in higher number of fruits than late sowing. This supports earlier reports by Kolhe and Chavan (1967);

Fatokun et al. (1979), Bisaria and Shamshery (1979) that early sowing of okra, produced higher number of fruits than late sowing. Nitrogen application significantly affected population, as widely spaced plants (22,000 plants/ha) started fruiting early than the other two population levels (44,000 and 88,000 plants/ha). The differences in the two varieties were statistically similar for the number of fruits per plot. Nitrogen application significantly increased the total fresh fruit weight. Increased nitrogen level (90kgN/ha) significantly increased the total fresh fruit weight in all the experiments. The higher the number of fruits, the higher is the total fresh fruit weight, Chauhan and Gupta (1973), Fatokun et al. (1978) and Harapiak et al. (1986). Early sown okra resulted in total higher fresh fruit weight than late sown okra in all the experiments, due to favourable longer growing season. Sharma and Shukla (1973); Singh et al. (1967), Mani and Ramanathan (1980) who observed that early sown okra gets more time for growth development and fruiting. Furthermore, early sowing date was associated with higher nitrogen up-take during the early vegetative growth. This meant that when nitrogen was applied to an early sown crop a large portion of it was absorbed and made available to the plant during the growth.

In addition, when nitrogen is applied to a late sown crop nitrogen absorption is much lower during the early vegetative growth and apparently below the plant needs. This may resulted in reduction of vegetative paremeters and hence lower the yield and can therefore explain the diminished response in yield to nitrogen applied to a late sown crop. Some of the factors like sowing date, spacing and picking of green fruits directly affected yield and quality of okra are a cause of great concern to the growers. These experiments revealed that

early sowing of okra resulted in higher yield than late sown crop because early sown okra escaped to a greater extent from the ill effect of rain, insect attack and virus infection.

Effect of population on the total fresh fruit weight was significant in all the years. Wider row spacing of 45cm produced significantly higher fresh fruit weight than the other two spacings (15cm and 30cm). Increased in population levels, decreased the total fresh fruit weight in all the years. This supports earlier findings of Jacob and Uexkull (1958), Ahmed and Tullock-Reid (1968), Kamalanathan et al. (1970) and Grewal et al (1972) who reported that wider spacing consistently produced higher fresh fruit weight per hectare. The main effect of spacing on yield is believed largely due to a change in radiant energy distribution. With closer and more uniform spacing of plant, it could be assumed that more radiant energy would be intercepted by the plant and that less would fall on soil surface to cause evaporation. Higher plant population could have similar effect. The widest spacing (45cm) resulted in highest number as well as weight of mature number of fruits/plant. Bigger fruits(pods) were harvested from widest spacing and this can be attributed to more space, nutrient and light to the plants than closed spaced one (15 and 30cm) where there would be greater competition for the nutrient. In the case of closed spacings (15 and 30cm) the number of plants that can be accommodated in one hectare are more than that of widest spacing (45cm) which supposed to increase the yield. The variety Local-1 produced higher fresh fruit weight than V-35, which was attributed to its adaptation to the area.

Nitrogen increased the dry pod weight in all the experiments. Differences in sowing dates were highly significant in all the seasons for dry pod weight. Early sown okra produced higher dry pod weight when compared with late sown okra. This was due to favourable season the early crop gets. Population and variety did not influence dry pod weight in any of the experiment. The non or no response of population may be due to inter-plant competition for light, space and nutrient, while that of variety may be due to its dryness.

Nitrogen content of various parts of the plant were estimated from the materials sampled at the peak of the growth of the crop. It was discovered that the higher nitrogen level applied had the highest nitrogen content in the stem, leaf and fruit in the experiments. Higher nitrogen content was recorded at 12 weeks after sowing in all the seasons. The results were in conformity with earlier reports by several workers. Frogdon and Volk (1950); Freeman and Harris (1951); Millar (1955); Rennie (1956); Pentrosini (1959); Smith (1962); Warder et al. (1963); Asif and Greg (1972); Hunter and Stanford (1977); Black and Siddowa (1977); Olson et al. (1976); Savello et al (1980); Robert (1988) and Csizinsky (1996) who reported that nitrogen application increased nitrogen content in okra stem, leaf and fruit.

CHAPTER SIX

SUMMARY AND CONCLUSION

Three experiments were conducted at the Institute for Agricultural Research Station of Ahmadu Bello University, Samaru, during 1992 to 1994 rainy seasons to study the effect of nitrogen, sowing date and population on okra varieties.

The soil of experimental plots were sandy loam with good drainage with PH of 5.7, 5.6 and 5.7 in 1992, 1993 and 1994 seasons respectively. The total rainfall and its distribution was good in 1992 fair in 1993 and erratic in 1994.

The main treatments consisted of 3 levels of nitrogen and two sowing dates, while the sub-treatments were made up of 3 levels of population and two varieties of okra.

Observations recorded include number of leaves, fresh and dry weights of leaves, fresh and dry weights of stem, fresh and dry weights of root, plant height, leaf area and leaf area index, crop growth rate and relative crop growth rate. Growth indices such as length of longest root, total dry matter at 4, 6, 8 and 10 WAS. Number of branches were recorded at harvest (10 WAS). Harvesting was done at 4 to 5 days intervals and the fruits were counted, weighed and recorded. Due to variability in water content in okra fruits they were dried in an oven at 60% to a constant weight and recorded as dry pod weight.

Among the vegetative characters studied, stem dry weight was significantly correlated to the yield. Therefore, the vegetative characters which were closely associated with stem dry weight, including leaf area, plant height and number of branches were intensively investigated. Furthermore, the yield components studied, revealed that number of fruits was

correlated with yield and these components, number of fruits, pod dry weight, stem dry weight and number of branches were intensively investigated.

Therefore among the factors studied, sowing date is the most crucial factor affecting both vegetative characters and the yield, followed by nitrogen, variety and population in that order. A comparative study of these factors studied revealed that date of sowing had a pronounced effect on them. Based on the investigations carried out during 1992 to 1994 rainy seasons, sowing date is the key factor that affected the yield of okra, followed by nitrogen and population. As to the rate of nitrogen and population, it was revealed that 90kgN/ha with a population of 22,000 plants/ha resulted in the higher number of fruits and yield. Local-1 variety was found to have more number of fruits and also yielded higher than V-35 cultivar, due to its better adaptation to the environment.

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Appendix I: Mean Total Rainfall, Temperature, Relative Humidity and Sunshine hours during the period of experiments at Samaru in 1992 to 1994 seasons.

Months	1992				1993				19994			
	Rain fall (mm)	Relative hum(%)	Temp. °C	Sun.S. hrs.	Rain-fall (mm)	Rel. hum-(%)	Temp. °C	Sun S hrs.	Rain-fall	Rel hum. (%)	Temp. °C	Sun S hrs.
June	29.3	70.1	30.4	7.11	-	-	-	-	-	-	-	8
July	213.6	68.1	29.5	6.05	193.7	64.1	29.3	7.3	169.2	66.7	28.3	6
August	181.9	74.8	28.1	5.49	258.1	78.0	25.2	8.1	215.9	26.8	26.8	5
Sept	239.7	69.1	29.8	7.01	159.1	75.0	26.2	6.4	82.5	69.8	31.0	6
Oct.	39.9	35.2	31.5	8.11	32.5	65.0	28.2	8.2	69.1	54.6	30.6	8
Total	737.3	317.3	149.6	33.77	643.4	282.1	108.9	30.24	536.8	217.3	116.7	34
Mean	151.83	63.6	29.9	6.8	160.9	70.5	27.2	7.56	134.2	54.3	29.2	6

Source: Meterological Station - IAR, Samaru.