EFFECT OF FOLIAR APPLICATION OF NITROGENOUS SOURCE ON THE GROWTH, YIELD AND QUALITY OF OKRA.

THESIS

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BY

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2014

CERTIFICATE

This is to certify that the thesis entitled "**Effect of foliar nitrogenous source on the growth, yield and quality of Okra**" submitted in partial fulfilment of the requirements for the degree of Master of Science with major in Agronomy of the Department of Agronomy, School of Agriculture and Food Technology, Lovely Professional University, Phagwara, is a record of bona-fide research carried out by F.Lalthasanga, Registration No. 11201644 under my supervision and on part of the thesis has been submitted for any other degree or diploma.

Place: Phagwara, Punjab .

Date: / /2014

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DECLARATION

I hereby declare that this thesis is a presentation of my own work and has been generated by me as the result of my own research work and efforts. This thesis is submitted by me in partial fulfillment of the requirement for the award of degree M.Sc. in Agronomy from Lovely Professional University, Phagwara, Punjab comprises only my original work and due acknowledgement has been made in the text to all other material used.

This thesis work was done under the guidance of my advisor.

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Abbreviation

N	Nitrogen
P	Phosphorus
K	Potassium
BC	Benefit cost of cultivation
RDF	Recommended dose of fertilizer
CD	Critical difference
DAS	Days after sowing
et al.	et al in (and others)
Fig	Figure
g	gram
ha	hectare
KNO_3	Potassium nitrate
$CaNO_3$	Calcium nitrate
Cm	centimeter
Kg	kilogram
t	tones
RCBD	Randomized complete block design

ABSTRACTS

A field experiment was conducted to study the effect of foliar spray of nitrogen on the plant growth, yield and quality of Okra (*Abelmoschus esculentus*) at the departmental farm, School of Agricultural, LPU, Phagwara, during spring-summer season of 2014. The experiment was laid out in randomized block design(RBD) consisting of 9 treatment combinations with 3 foliar spray of urea, $CaNO_3$ and KNO_3 at 0.5%, 0.75%, 1%, and 2% respectively at 30 DAS and 45 DAS.

Foliar spraying of nitrogen proved to be beneficially effecting the growth and yield traits of okra. The highest yield of okra (42.92t/ha) was obtained from foliar spray of 0.5% urea + 1% KNO_3 (T_8). Maximum plant height(40.07cm), maximum number of leaves per plant(14.92), number of fruits per plant(15.83), fruit length(12.98cm), fruit width(16.27g) and fruit weight(5.30cm) were obtained from a combination spray of 0.5% urea + 1% KNO_3(T_8). A combination spray of 0.5% urea + 1% $CaNO_3$ or 1% KNO3 was reported to be the most effective treatments. In term of economics the treatment T_8 (0.5% urea + 1% KNO_3) recorded highest gross (257520) and net (180068.1) returns and B: C ratio of (2.32).

INTRODUCTION

Okra (*Abelmoschus esculentus* L. Moench), belongs to the family Malvaceae. It is an annual or perennial vegetable crop grown throughout the tropical and subtropical part of the world. Although okra is a rainfed crop, it also comes up well under irrigated condition during kharif and summer seasons. Okra originated in tropical and subtropical areas, in the north-east African center and Asia (Tindall.,1983). It is mainly cultivated for its edible green fruits which are eaten fresh or cooked as a vegetable. It is a good source of vitamin A and B, protein and minerals especially iodine. The stem of the plant is also used for the extraction of fiber. In India it is grown in summer months and during the rainy season.

Okra is a warm season vegetable crop and requires a long warm growing season and is highly sensitive to frost. It is a tropical direct sown vegetable with duration of 90-100 days. Optimum temperature range is 25-30^{0}C. It grows in all types of soil and thrives best in a moist, friable, well drained soil. It is grown commercially in India, Nigeria, Sudan, Egypt, Pakistan, Saudi Arabia, Ghana, Mexico, Benin and Cameroon.

The total area and production under okra in the world is reported to be 1148.0 thousand ha and 7896.3 thousand tons. India ranks first in Okra production; followed by Nigeria and Sudan. In India okra is cultivated in 498.0 thousand ha area with the production of 5784.0 thousand tons and productivity of 11.60mt/ha (Anonymous., 2011) The major okra producing states are Andhra Pradesh, Bihar, Orissa, West Bengal, Uttar Pradesh and Karnataka. Andhra Pradesh is the leading okra producing state which has production of around 1184.2 thousand tons followed by West Bengal 862.1 thousand tons and then Bihar 788.3 thousand tons of okra.

Scientific research on the benefits of certain vegetables has been ongoing and researchers are discovering many interesting things. Research has found that okra has many important health benefits, such as its ability to help reduce cholesterol in the body (particularly the bad kind), its heart disease reducing qualities and even cancer prevention qualities. The fruit of okra contains the following nutrients in 100g edible portion: water 89%, carbohydrates 7.6%, protein 2.4g, fiber 1.2%, vitamin A 520 IU, thiamine 0.17mg, riboflavin 0.21mg and ascorbic acid 31mg. (Oscar *et al.,* 1980). It is also a good source of minerals like calcium and magnesium, potash and iodine.

Fertilizers have been used since ages to improve the production and quality of okra. The fertilizer dose depends upon the fertility of soil and amount of organic manure applied to the crop. About 10-12t/ha of FYM is mixed with the soil at the time of land preparation. Generally application of 150kg N, 60kg P, and 80kg K is recommended for optimum yield. Half dose of N and full dose of P and K are applied at the time of planting. The balance half of N is given 30 days after sowing followed by earthling up operation. Split application of N in soil at every 3rd picking is advantageous for getting high yield, for increasing number of harvest and to maintain size of fruits towards last harvest.

Nitrogen is an essential element and important determinant in growth and development of crop plants. It plays an important role in chlorophyll, protein, nucleic acid, hormone and vitamin synthesis and also help in cell division, cell elongation. Workers have reported linear increase in green pod yield of okra with the application of N from 56 to 150kg/ha (Hooda *et al.,* 1980). Application of N has been reported to significantly increase growth and fruit yield of okra. Significant higher flower and fruit production in okra has also been reported by (Katung *et al*., 1996). This was attributed to the fact that sufficient supply of N will improve cell division and multiplication, foliage production and photosynthetic activity of the plant.

Foliar fertilization is the practice of applying liquid fertilizer to plant leaves. The leaves are green factories where the complex chemical processes of photosynthesis produce the compounds plants needed for growth. Foliar application are absorbed right at the site where they are used as quite fast acting, whereas much of the soil fertilizers may never get used by plants. For instance,80% of phosphorus applied through conventional fertilizer may get fixed up in the soil but up to 80% of foliar-added phosphorus directly absorbed by the plants. Foliar fertilization is widely used practice to correct nutritional deficiencies in plants caused by improper supply of nutrients to roots Silberbush (2002). Two concentrations of urea sprays (1 and 2%) were applied to okra, it was reported that urea application enhanced the growth and fruit yield of okra significantly Naruka and Singh (1998).

A number of studies highlighted the benefits of foliar spray of nitrogen or foliar fertilization in improving plant growth, crop yield, nutrient uptake and product quality. An increase in nitrogen levels increased the growth parameters including

number of leaves, fresh weight of stem and roots and leaf area widen and plant height of Okra (Abassi *et al.,* 2010). It also increased yield components and yield of Okra. The increase in plant growth and development leads to higher marketable yield of okra which increases the gross and net return. Application of nitrogen in the form of foliar spraying can proof beneficial in improving the yield and yield components of okra. Therefore the present study was therefore carried out to evaluate the effect of foliar nitrogen application (urea, $CaNO_3$, KNO_3) on the growth, yield and quality of Okra on the following objectives:

1) To study the effect of nitrogen source on the growth of okra.

2) To observe and study the effect of nitrogen source on the yield and quality of okra.

3) To work out the benefit cost ratio of okra cultivation.

REVIEW OF LITERATURE

The state of knowledge on investigations carried out on the experiment of okra involving the effect of foliar application of different nitrogen sources in relation to the plant growth, flowering and fruiting, yield and quality parameters has been reviewed in this chapter.

2.1 Effect of Nitrogen application on the Growth, Yield and Quality components of okra

A significant improvement in the growth traits and yield of okra plant, viz days to flowering(40.2), plant height(98.4cm), number of branches per plant(4.8), number of fruit/plant and fruit length(9.1cm) was reported by Abbasi *et al*.(2010) in their studies to evaluate the growth and yield response of okra to three newly introduced foliar fertilizer products (Super dawn, Agri-power and Unigrow).

A field experiment was conducted at Mahailluppallama in the Low Country Dry zone of Sri Lanka to determine the fertilizer requirement of okra plant when applied with three fertilizer levels. The result revealed that fertilizer application on a per plant basis and increasing the recommended dosage to one and half more than the recommendation leads to increase in growth and higher yield per hectare (Abeykoon *et al*.2010).

The studies were conducted for determining okra responses to inorganic source of N fertilizer on the growth and yield of okra. The result shows that application of 75kg N/ha results in maximum growth of plants, branches/plant, leaves and nodes/plant and gave the highest yield of okra 11.46 Mg/ha (Akanbi *et al*.2010).

During his studies on response of okra to nitrogen application Alam,(1992) reported that application of Nitrogen at the rate of 125 kg/ha significantly increased plant height, number of branches per plant and number of pods per plant by 55%, 28%, and 71% respectively.

A field experiment was conducted by Amjad *et al*.(2001) on okra cv. Pusa Sawani using three different level of N and P combination to find out the effect on the growth and productivity of okra. They reported that maximum plant height(126.51cm), number of leaves per plant(32.41), number of days to flower(55.30), and number of

pods per plant(26.48) were obtained from the highest application of fertilizer dose at the rate of (150 kg N + 80 kg P /ha).

Spraying of nitrogen was reported to be very effective in increasing the growth and fruit yield of okra. As a result of foliar feeding of 18 kg N/ ha to okra, the yield levels at 50 per cent and 75 per cent of the recommended doses were statistically equal to that recorded with the application of 100 per cent of the recommended dose of fertilizers (Ashish *et al*.2012).

A field experiment was conducted at Adamawa State University, Mubi-Nigeria during 2007-2008 cropping seasons with the aim of assessing the effect of NPK fertilizer on the yield and yield components of okra. The results indicated that application of NPK at 150 kg/ha at the ratio of (22.5N: 22.5P: 22.5K) gave the highest yield of okra. Number of fruits per plant, length and weight of fruits were significantly affected by fertilizer levels (Phillip *et al*.2010).

In their research trial on okra Rahman and Akter, (2012) reported that application of two kg cow-dung and 65 g urea, during land preparation, and application of another 65 g urea after 25 days of sowing resulted in maximum plant height(63.11cm), maximum number of branches per plant(3), number of fruits per plant(6), fresh fruit weight(15.20g), fruit length(15.20cm) and fruit yield per plant (91.20g).

In an experiment to determine the effect of different nitrogen levels (60, 80, 100 and 120kg/ha) on the growth and yield of okra Firoz,(2009) reported that the highest yield(16.73t/ha) and maximum growth of plant was obtained from 100kg N/ha which was almost identical to application of 120kg N/ha.

Nitrogenous and Phosphatic fertilizer applied at the rate of 150 and 120 kg/ha n okra varieties, resulted in maximum plant height (106.51 cm), minimum days to flowering (33.11), and highest pod yield and pod length (17.97 cm) respectively. (Khan *et al*.2013)

A field experiment was conducted by Sajid *et al*.(2010) to evaluate the impact of nitrogen and phosphorous on the seed yield and yield components of okra cultivars. They reported that the maximum number of pods/plant (10.69), maximum seed yield (1374.9 kg/ha) were obtained in plots having received both 150 kg N/ha and 90 kg P/ha.

An experiment was conducted by Moniruzzaman and Quamruzzaman, (2009) on okra variety BARI Dharos-1 with four nitrogen levels (0, 75, 125, and 175 kg/ha) to

find out the effect on the fruit and seed production. The result showed that application of nitrogen at the rate of 125 kg/ha gave the highest fruit yield (2.74t/ha) and seed yield of okra followed by 175 kg of N/ha.

Maximum plant height(106.58cm), maximum no. of leaves/plant(20.56), maximum no. of nodes/plant(12.05), earliest flowering(43.08 days), maximum no. of flowers/plant, maximum length of fruit (15.10cm), maximum no. of fruits/plant (12.51), maximum weight of fruits/plant(209.56g) and highest fruit yield(70.81q/ha) was recorded from treatment receiving highest doses(120:90:60) of NPK fertilizer (Singh *et al*.2012).

Okra plant height increased significantly (70 to 90%) with N(urea) fertilization. Maximum plant height (78.6cm) was recorded when fertilized at 200kg N/ha. Maximum length of okra green pod(12.7cm) and highest green fruit yield per plant(17) was also obtained from the same treatments (Mubashir *et al*.2010).

Plant height and branch or leaf production in okra increased significantly as the rate of N-fertilizer applied increased (90kg N/ha). Additional nitrogen application also had a significant effect on the number of days taken for harvest.Okra plant grown with additional N fertilizer were ready for harvest upto 9 days earlier than the unfertilized plants (Olasantan, 2000).

In an experiment to determine the effect of four Nitrogen levels (0, 150, 300 and 450 mg/l N) application on radish crop during the winter and spring seasons it was reported that the number of leaves per plant and mean leaf area increased with N rates upto 300mg/l in winter and 150mg/l in spring crop. It was concluded that N application upto 300mg/l and 150mg/l during winter and spring increases the growth, root fresh weight and yield of the crop (Akoumianakis *et al*.2011).

Nitrogen level at 90 kg N/ha gave maximum plant height (2.3m), number of branches/plant (12.2), plant weight (178.8g) and root weight/plant(288.3g), number of spears/crown(34.1), spear length (25.1cm), spear weight (32.2g) and total yield(37.9t/ha) in asparagus (Hussain *et al*.2006).

Increasing potassium nitrate rates from 0 to 0.9g/l as a foliar application on Potato plant resulted in a significant increase in plant height(79.1cm), leaf number(70 leaves/plant), leaf area(400cm^2) and also showed increased in total tubers yield(1454g/plant), weight of tuber(154.57g) and diameter(5.13cm) of the tubers (Besma *et al*.2011).

Increasing the nitrogen rates up to 125% of recommended dose resulted in larger curd and higher curd yield of Cauliflower. It also has a positive effect on the quality components and the shelf life of the cauliflower (Kodithuwakku and Kirthisinghe, 2009).

A field experiment was conducted to determine the effect of foliar urea application (0.0, 0.4, 0.8, 1.0%) on the growth, quality and yield components of Broccoli cultivars. It was observed that foliar application of urea, especially 0.8 and 1.0% resulted in larger heads, weightier heads of plants as well as higher plants, it also increased the content of almost all nutrients in leaves and heads of both broccoli cultivars. (Yildirim *et al.* 2007).

Studies were conducted to investigate the effect of urea at the rate of (1% and 2%) on the growth and yield of Squash plant. The foliar spray of urea resulted in vigorous squash plant as expressed by plant length(42.73cm), number of leaves per plant(18.87) and shoots number per plant(2.14) as well as the fresh and dry weight of whole plant and its leaves and shoot compared with the foliar application by other antioxidant materials (Faten *et al.* 2010).

During their field trial on the effect of different levels of N on the growth and yield of radish Jilani *et al*.(2010) reported that application at the rate of 150, 200, 250 kg/ha of N levels gave better results for all the parameters studied viz, maximum number of leaves, root length, leaf length, weight of leaves, root diameter, root weight and yield.

In an experiment to study the response of Onion (*Allium cepa*) to different nitrogen levels(0, 100, 200kg/ha), Arshad Ali Khan *et al*,(2007) reported that maximum leaf length(41.81cm), maximum plant height(56.33cm), bulb weight(136.5g) and highest yield(22280kg/ha) were recorded when the plots were fertilised with 100kg of N per hectare. Maximum plant height (47.36 cm), root length (16.17 cm), fresh weight of leaves (145.1 g), dry matter content (11.66 g) of leaves, fresh weight of root (68.33 g), dry matter content of root (15.90%), gross yield (22.55 t/ha) and marketable yield (20.67 t/ha) were recorded by application of nitrogen at rate of 100 kg N/h (Moniruzzaman *et al*.2013).

Application of nitrogen fertilizer at rates of(150, 200 and 250 kg/ha) on potato significantly promoted vegetative growth and also yield and quality components. Representing the highest number of plant height(88.3cm), leaves number(22.0), shoots number(13.5), dry shoot yield, tuber size, weight(148g) and diameter(8.7cm) as well as

total tuber yield(11.33ten/fed) were recorded when plants were fertilized with 200kg N/ha (Yassen *et al*.2011).

Nitrogen management on maize by the application of 60% N from poultry manure + 38.5% N from urea through fertigation+ 1.5% N from urea through foliar application produced significantly more plant height(207.13cm), cob diameter(4.08cm), number of grains per cob(440.50), grain yield(5.33t/ha), biological yield(15.56t/ha) and also improved the quality components of higher seed protein and seed oil content (Iqbal *et al*.2013).

Application of 5 foliar sprays of water soluble fertilizers 19:09:19 followed by NPK application of 19:19:19 on tomatoes plant resulted in maximum plant height(125.4cm), number of branches(4.2), number of fruits(24.6), average fruit weight(81.6g), fruit length(4.90cm), fruit diameter(4.51cm),total yield(631.66q/ha), net profit along with maximum C:B ratio (Chaurasia *et al*.2005).

An experiment was conducted on tea plant using foliar spray of different nitrogen levels (0, 30, 60, 90, and 120kg/acre). The results showed that application of 30 to 120 kg/acre of nitrogen level increased fresh leaves yield(1808.66 to 2872,58 kg/acre), made tea yield(362.66 to 574.58 kg/acre) and shoot growth (35.502 to 48.58cm) respectively (Shamsul Islam *et al*.2010).

A field experiment was conducted to study the effect of nitrogen and foliar spray of nutrient mixture on growth and yield of wheat (*Triticum aestivum L*). The obtained data showed that both grain and straw yield, and different yield attributing characters viz., number of spikes/ plant, spike weight and grain/spike were significantly maximum with application of 120 kg N/ha and foliar spray of 2% DAP + 1% KCl+ nutrient mixture (Latief *et al*.2012).

An experiment was conducted by Khan *et al*.(2009) on wheat using six concentrations of urea i.e., 0, 2, 4, 6, 8 and 10% as foliar application along with 60 and 120 kg N/ha as a soil application. The foliar spray of 4% urea solution was found to be most effective for enhancing the quantitative and qualitative traits when sprayed at tillering, stem elongation and boot stage. The grain yield was increased by 32% when 4% urea solution was applied as foliar spray.

Application of Nitrogen and Phosphorus fertilizer at the rate of 150kg/ha and 90kg/ha has a positive results on the tiller numbers(27.6), fertile tiller(22.25), 1000-grain weight(26.81) and it also increased the total yield significantly in rice (Yosef Tabar ,2012).

In an experiment to evaluate the effect of different nitrogen levels (0, 112, 168, 224 kg/ha) on the green pod yield of okra Muhammad *et al*.(1993) reported that maximum pod yield(10810kg/ha) was obtained from application of nitrogen fertilizer(urea) at the rate of 168N kg/ha.

Application of nitrogen at the rate of 187.5kg/ha significantly increased average fruit weight (102.60g) as well as number of fruits per plant (14.4) on brinjal plants. Both the marketable yield (441.2q/ha) and also the total yield(508.3q/ha) increased significantly with the increased in nitrogen levels (Pal *et al*. 2002).

Application of recommended dose of NPK(15:15:30) + 5 foliar sprays of 0.5% of water soluble fertilizers gave the highest brinjal fruit yield(36.6t/ha). It also increased the growth and yield parameters, where maximum plant height(62.6cm), plant width(53.5cm), number of main branches(4.6), number of fruits per plant(34.7), fruit weight(57.3g) were recorded from the same treatment (Narayanamma *et al*. 2006).

In an experiment conducted to determine the effect of nitrogen on the seed yield of soybean, Morshed *et al*.(2008) reported that increasing the nitrogen rate upto the levels of 26.45kg/h progressively increased the seed yield of soybean(6.85g/plant). The nutrients uptake and protein content in seeds also increased with the increasing levels of N.

In an experiment to determine the effect of nitrogen fertilizer management on cowpea, Maral *et al*.(2012) reported that with an increased application of nitrogen(urea) fertilizer the growth and yield parameters of cowpea increased significantly. The highest seed yield (1360kg/ha), number of pods per plant (56.41 pods) and maximum plant height (77cm) was obtained with 75kg/ha nitrogen fertilizer management.

Maximum number of pods per plant (95.83), maximum total pod weight per plant (6.83g/plant) were recorded when NPK fertilizer was supplied both through foliar as well as soil application in lentil. Foliar application of nitrogen alone was found to be more effective in producing higher number of seeds per pod (Hamayun *et al*.2011).

In a field experiment conducted to investigate the effect of foliar spray of urea on the growth, yield, nutrients uptake and grain protein content of wheat Maitlo *et al*.(2006) reported that highest plant height(39.77cm), number of tillers(709.26), ear head length(11.11cm), plant dry weight(2651kg/ha) was obtained with 2.5% foliar urea application at different stages of plant growth.

Foliar urea application at the rate of 2 and 4% before flowering resulted in maximum plant height (34.3cm) in chickpea (Aliloo *et al*.2012).

In an experiment conducted on chickpea, Amany A.Bahr, (2007) reported that foliar urea application at the rate of 1% during pod filling stage resulted in tallest plant height(129cm), maximum number of branches per plant(5.8), maximum number of pods per plant(41), seed per plant(66) and the heaviest 100 seed weight(36g).

MATERIALS AND METHODS

A field experiments was conducted to study the effect of foliar spray of nitrogenous source on crop growth, yield and fruit quality of okra cv. Hybrid Rani. The experiment was carried out during spring-summer season of 2014 at the main research field of the Department of Agriculture, Lovely Professional University, Phagwara (Punjab). The details of the materials used and methods adopted during the course of investigation are described below:

3.1 Location of experimental site

The present experiment was conducted at main research field of the department of Agriculture, opposite 34 block of Lovely Professional University Phagwara (Punjab) situated at 31.25°N latitude and 75.70°E longitude and at an altitude of 245 m above mean sea level.

3.2 Soil characteristics of the experimental site

The soil of experimental site at LPU, Phagwara is sandy loam in nature. Soil samples of the experimental sites was collected up to a depth of 0 to 30cm and analyzed for its physio-chemical properties. The detail of the analysis is given in (Fig 3.1)

3.3 Climatic conditions

The Main Agricultural field of Lovely Professional University is situated in the (PB-3) Central Zone of the State. This zone receives rainfall from both South-West and North-East monsoons which is well distributed from June to September with lower coefficient of variation. The monthly meteorological data of rainfall, temperature and relative humidity during the period of experimentation Jan-May 2014 is given in Table 3.2.

The data on weather parameters such as rainfall (mm), mean maximum and minimum temperature (^{0}C) and relative humidity (%) recorded at Meteorological Observatory, Main Agricultural Research Station Amritsar, Punjab.

3.4 Description of okra variety cv. Hybrid Rani

Plants are vigorous, uniform high yielding, short inter nodes. The pods are dark green, glossy slender, and five ridges fruit. The average fruit length is 12-13cm. It has a good shelf life and is less mucilaginous with high tolerance to Yellow Vein Mosaic Virus, and suitable for growing round the years.

Table 3.1: Soil physical and chemical properties in experimental site.

Sr. No	Particulars	Values (0- 30 cm depth)	Method employed
I.	**Physical properties**		
1	Coarse sand (%)	17%	International pipette method (Piper, 1955)
2	Fine sand (%)	44%	
3	Silt (%)	7%	
4	Clay (%)	32%	
II.	**Chemical properties**		
1	pH	7.96	BuckmoricHmeter (Piper,1955)
2	Electrical conductivity (dS/m)	0.33	Jackson (1973)
3	Organic carbon (%)	0.47	Wet oxidation method (Jackson, 1957)
4	**Available nutrient status**		
A	Available N (kg/ha)	167.72	Alkaline per magnate method (Subbaiah and Asija,1955)
B	Available P (Kg/ha)	21.3	Olsen's method (Jackson,1957)
C	Available K (kg/ha)	322.56	Flame photometer method (Tandon, 1993)

Table 3.2: Meteorological data monthly for the experimental year (*Spring* 2014)

Months	Rainfall (mm)	Maximum Temperature (°C)	Minimum Temperature (°C)	Relative Humidity (%)
	2014	2014	2014	2014
January	18.04	19.1	4.4	86.1
February	8.87	20.2	5.8	79.9
March	68.32	25.6	10.5	74.5
April	6.1	34.8	18.8	49.5

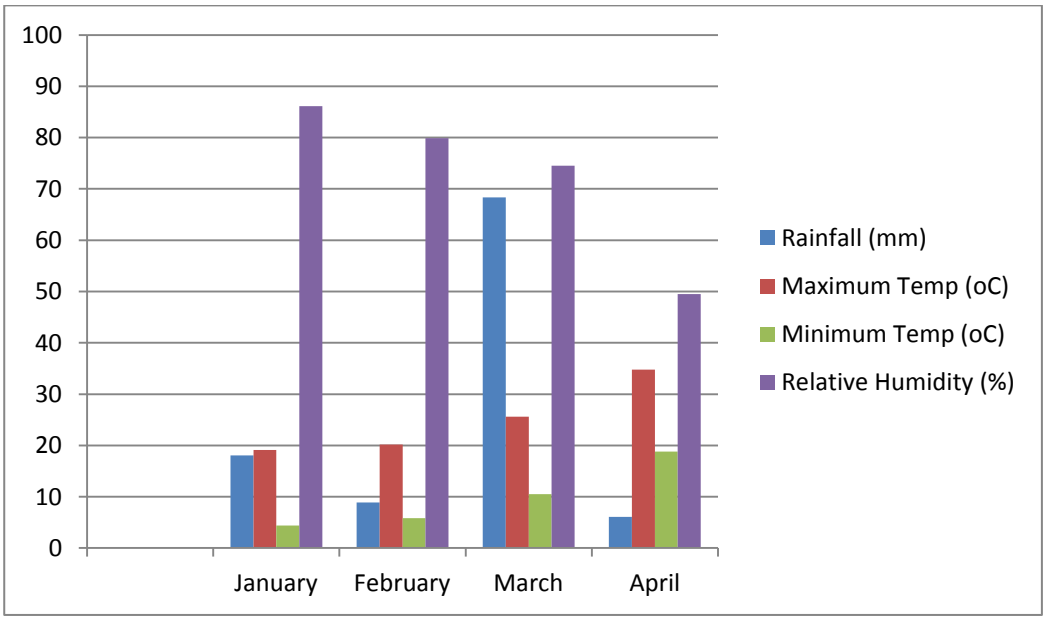

Fig: 3.1 Monthly metrological data *Spring* 2014.

Plate 3.1: Okra at flowering stage (a)

Plate 3.2: Typical okra plant (b)

Plate 3.3: Different sizes of harvested fruits (c)

3.5 Experimental details

The experiment was conducted during spring-summer season of the year 2014. The experiment consists of 9 treatments combination including control, the experiment was laid out in randomized block design. The details of the treatments are given below:

3.5.1 Detail of treatments

T1- 0.5% urea(30 DAS) + 1% urea (45 DAS)
T2- 0.75% urea(30 DAS) + 1% urea (45 DAS)
T3- 1% urea(30 DAS) + 1% urea (45 DAS)
T4- 2% urea(30 DAS) + 1% (45 DAS)
T5- 0.5% urea(30 DAS) + 0.5% $CaNO_3$(45 DAS)
T6- 0.5% urea(30 DAS) + 1% $CaNO_3$(45 DAS)
T7- 0.5% urea(30 DAS) + 0.5% KNO_3(45 DAS)
T8- 0.5% urea(30 DAS) + 1% KNO_3(45 DAS)
T9- Control

3.5.2 Design and Layout

The experiment was laid out in a Randomized Complete Block Design (RCBD), consisting of 9 treatments which were replicated 3 times. The plot was the same for each treatment as follows:

Technical details of the experiment:

Gross plot size : 13.5x7.2= 97.2 m^2

Net plot size : 1.215x27= 32.805 m^2

Spacing : 45x15cm

Design : RCBD

Sowing date : 10^{th}-Feb-2014

3.6 Cultural practices

The cultural practices carried out during the course of study, from the time of land preparation, sowing till harvesting of fruits are listed as follows:

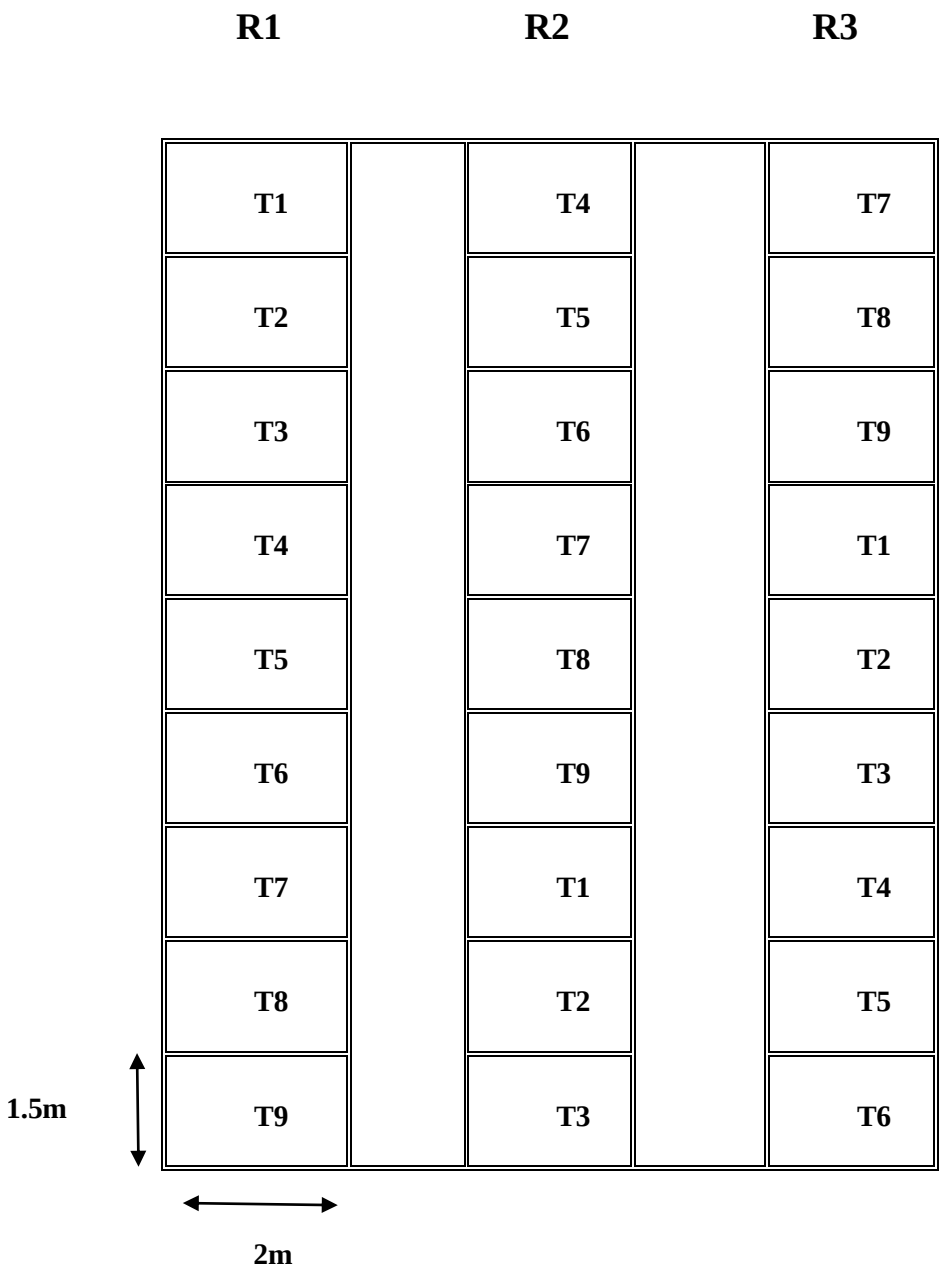

Fig 3.2: Plan layout of experiment

3.6.1 Land Preparation

The land was brought to a fine tilt by ploughing with mould board plough and harrowing twice after the harvest of the previous crops. The plots were laid out as per the plan of the layout.

3.6.2 Manure and Fertilizer application

Farm yard manure(10kg) was incorporated with the soil 1 week before sowing of seeds. The fertilizer requirements (foliar spray) of nitrogen were applied as per treatment per each plot uniformly.

3.6.3 Preparation of spray solution

Urea, calcium nitrate, potassium nitrate were sprayed which is mixed with water. Spray solution were made at the rate of 1%, 0.5%, 0.75% and 2%. To make a 1% spray solution every 10g of fertilizer is weight and mixed in 1 liter of water, 5g in 1 liter for 0.5%, 7g in 1 liter of water for 0.75% and 20g in 1 liter of water and increased accordingly to the requirements.

3.6.4 Sowing

Hybrid variety of okra was used in the study which was sowed on 10^{th} of February, 2014 by hand dibbling of two to three seeds per hill at 2-3cm depth with a spacing of 15x45 cm between plant to plant and row to row respectively.

3.6.5 Gap filling

Gap filling was done two weeks after sowing of the seeds in order to maintain proper plant population.

3.6.6 Irrigation

Irrigation was given once in 8-10 days during the crop growth till harvesting period depending upon the weather condition.

3.6.7 Weeding and inter-cultivation

In order to check weed growth and to maintain the field weed free field, manual weeding with the help of khurpi was done regularly during the early crop growing days.

Hoeing and earthing up was done at an interval of 15 days starting from 30 days after sowing.

3.6.8 Spraying of insecticide

A mixture of Chlorpyriphos 20% E.C and Thiamethoxam 25% WG power was sprayed to prevent caterpillars and green aphids from feeding on the foliage.

3.6.9 Harvesting

The fruit was harvest manually by hand picking at an interval of 2-3 days starting from 16th of April 2014. A total of six pickings were done, and the last picking was done on 8th of May 2014.

3.7 Collection of experimental data

In order to assess the effect of different foliar nitrogen spray on the growth and yield of the crop, periodical observations were recorded from each net plot, five plants were randomly selected and observations on growth was recorded periodically 30,45, 60, DAS and at harvest.

3.8.1.Growth parameters

3.8.1.1. Plant height(cm)

The plant height was measured from ground level to the tip of the main stem on five tagged plants at 30, 45, 60 days after sowing and at harvest. The average height was calculated and expressed in centimeter.

3.8.1.2. Number of leaves per plant

The number of leaves per plant was manually counted at 30, 45 and 60 days after sowing and at harvest from the randomly tagged plants. The average of five plants was calculated and expressed in number.

3.8.1.3. Number of branches per plant

The number of branches per plant was recorded from randomly tagged five plants at harvest. The mean number of branches per plant was computed and expressed in number.

3.8.1.4 Days to flower initiation

In each treatment plants were observed for the first flower initiation starting from the date of sowing.

3.8.1.5 Number of nodes per plant

The number of nodes per plants were counted from the tagged plants at the time of harvest (first picking) and expressed in number.

3.8.2 Yield and quality parameters

3.9.2.1 Number of fruits per plant

The fruits harvested from five tagged plants were counted at every picking day. From 6 pickings the average number of fruits per plant was calculated and expressed in number.

3.8.2.2 Fruit length (cm)

After the harvest from each tagged plants five fruits were selected at random for recording the length of fruit. The length of fruit was measured from the tip of fruit to point of attachment to the pedicel. The mean of five fruits was computed and expressed in centimeter.

3.8.2.3 Fresh fruit weight (g)

Fresh fruits were collected from tagged plants in each treatment and replication was used for recording weight. The mean weight per fruit was worked out and expressed in grams per fruit.

3.8.2.4 Fruit width(cm)

The fruits from the tagged plants were used for measuring the diameter, the mean was worked out and expressed in centimeter.

3.8.2.5 Number of seeds per fruit

Number of seeds/fruit was recorded from the five fruits from each tagged plants. The seeds from each fruit was separated manually by hand and counted. The average number of seeds from five fruits was calculated and expressed in number.

3.8.2.6 Total yield per hectare

The total yield per hectare was calculated by multiplying the average yield per plant and individual fruit weight (g). This is then evaluated and expressed in tones per hectare.

3.9 Economics

The gross monetary returns in rupees per hectare was worked out on the basis of green fruit yield of okra. The prevailing market price of okra was considered.

3.9.1 Gross returns (Rs. ha-1)

The gross returns were calculated by considering the prices of green fruit and prevailing at the time of harvest.

3.9.2 Net returns (Rs. ha-1)

The net returns were calculated by deducting the cost of cultivation from the gross returns.

Net returns (Rs.) = Gross income/ha (Rs.) – Total cost of cultivation/ha (Rs.)

The benefit cost ratio was calculated as follows;

$$\text{B:C ratio} = \frac{\text{Gross returns (Rs. ha-1)}}{\text{Cost of cultivation (Rs. ha-1)}}$$

3.10 Statistical analysis and interpretation of data

The data collected from the experiment at different growth, quality and yield parameters were subjected to statistical analysis as described by Gomez and Gomez (1984). Statistical analysis was carried out by taking the averages of the five plants from each net plot. The level of significance used in 'F' and't' test was P=0.05. Critical difference valves were calculated wherever, the 'F" test was significant.

Results and Discussion.

The experimental results pertaining to the current study entitled ”Effect of foliar spray of nitrogenous source on the growth, yield and quality components in okra” have been presented in this chapter under following headings:

4.1 GROWTH PARAMETERS

4.1.1 Plant height (cm)

Plant height increased as the number of days progressed. The data on plant height at 30, 45, 60 DAS and at the time of first picking as influenced by foliar spray of various nitrogen sources are presented in Table 5.

Plant height differed significantly at all stages of plant growth due to foliar spray of nitrogen. At 30 DAS the maximum plant height(16.63cm) was recorded in T_6 (0.5%urea + 1%$CaNO_3$), while the minimum plant height(14.74cm) was recorded in T_2 (0.75% + 1%urea), however at 45 and 60 DAS the highest plant height(26.73cm and 38.10cm) was recorded from treatment T_8 (0.5% urea + 1%KNO_3)respectively. At the time of harvesting the highest plant height (40.07cm) was recorded from T_8 ((0.5% urea + 1%KNO_3) and lowest plant height was recorded from control (34.23cm) where no fertilizer was applied.

There was a significant difference in plant height among the various treatments. Foliar spraying of plants with the combination of 0.5% urea + 0.5% $CaN0_3$(T5) and 0.5% urea + 1% KNO_3(T8) resulted in more plant height(38.09cm and 40.07 respectively) than the plant height obtained by treatments with urea alone, at the time of harvesting. Moreover higher plant height and growth was obtained by increasing the nitrogen concentration in the treatments. These results are in conformity with Alam, (1992) who reported that highest plant height(92cm) of okra was obtained by nitrogen(125kg/ha) application. Further the results are in accordance with Besma *et al*. (2011) in potato and Faten *et al*. (2012) in squash where the results depict that application of more amount of nitrogen to plant leads to increase in more plant growth. The increase in plant height with increase nitrogen application might be primarily due to enhanced vegetative growth with more nitrogen supply to plants.

Table 4.1: Plant height (cm) as influenced by foliar spray of nitrogen after 30 DAS; 45 DAS; 60 DAS and at Harvest

Treatment	30 DAS	45 DAS	60 DAS	At harvest
T1 (0.5% urea + 1% urea)	15.03	25.20	34.58	36.44
T2 (0.75% urea + 1% urea)	14.74	25.27	35.04	36.90
T3 (1% urea + 1% urea)	15.18	24.31	34.69	37.07
T4 (2% urea + 1% urea)	15.40	25.54	35.03	37.39
T5 (0.5% urea + 0.5% CaNO3)	15.89	26.26	37.31	38.09
T6 (0.5% urea + 1% CaNO3)	16.63	25.73	36.21	37.29
T7 (0.5% urea + 0.5% KNO3)	15.60	25.64	37.65	39.38
T8 (0.5% urea + 1% KNO3)	14.86	26.73	38.10	40.07
T9 (Control)	15.56	23.26	32.51	34.23
S.Em±	0.37	0.43	0.50	0.38
CD @ 5%	1.12	1.29	1.51	1.13

4.1.2 Number of leaves per plant

The data on number of leaves per plant as influenced by foliar spray of various nitrogen sources are presented in Table 6.

Significant increase in the number of leaves per plant was recorded in all the treatments during the growth stages of plant growth.

At 30 DAS maximum leaves number(5.26) was recorded from T_7(0.5% urea + 0.5% KNO_3) and the minimum leaves number(4) was recorded from T_9 (control). Irrespective of the treatments number of leaves increased as the days progressed. At the time of harvesting highest number of leaves (14.92) per plant was recorded from T_8(0.5% urea + 1% KNO_3). Minimum number of leaves per plant was recorded from control (10.64 leaves/ plant).

The increase in number of leaves per plant due to application of nitrogen was also reported by Amjad *et al*.(2001) in okra plants where higher number of leaves(32.41) per plant was obtained by application of 150kg N/ha. The same result was also reported by Singh *et al*.(2012) and Akanbi *et al*.(2010) where application of higher doses of nitrogen leads to increase in plant height and more vegetative growth. This was linked to the positive effect of availability of sufficient amount of nitrogen for the use of plants. The increase in N doses might have enhanced the cell division

and formation of more tissue resulting in excessive vegetative growth and thereby increase the number of leaves per plants.

Table 4.2:Number of leaves per plant as influenced by foliar spray of nitrogen at 30 DAS; 45 DAS; 60 DAS and at Harvest.

Treatment	30 DAS	45 DAS	60 DAS	At harvest
T1 (0.5% urea + 1% urea)	3.74	9.71	10.58	11.84
T2 (0.75% urea + 1% urea)	4.36	11.8	11.77	12.14
T3 (1% urea + 1% urea)	3.77	9.48	10.62	11.80
T4 (2% urea + 1% urea)	4.28	10.79	11.88	12.59
T5 (0.5% urea + 0.5% CaNO3)	4.48	10.39	11.27	13.13
T6 (0.5% urea + 1% CaNO3)	4.55	11.17	13.29	12.45
T7 (0.5% urea + 0.5% KNO3)	5.26	11.86	12.81	13.96
T8 (0.5% urea + 1% KNO3)	5.19	12.07	13.44	14.92
T9 (Control)	4	9.45	9.63	11.64
S.Em±	0.42	0.66	0.46	0.40
CD @ 5%	1.26	1.98	1.37	1.19

4.1.3 Days to flower initiation

The data on days to flower initiation as influenced by foliar spray of nitrogen are presented in Table 7.

Perusal of data indicates that days to flower initiation vary significantly due to foliar spray of nitrogen. T_9(control) recorded minimum number of days to flowering (51.33), while significantly more number of days to flower initiation was recorded (55.67) from T_4(2% urea + 1% urea) and T8(0.5%urea + 1% KNO3)

Nitrogen treatment resulted in late flowering in the plants while control without the application of nitrogen fertilizer resulted in early days of flowering. The same result was also obtained by Abbasi *et al*.(2001) where application of nitrogen resulted in delayed flower formation in okra plants. The same result was also reported by Khan *et al*.(2013) where minimum number of days taken(33.11) for flowering was recorded in plants without any foliar or soil application of nitrogen. Application of higher amount of nitrogen delayed the flowering in plants. This may be due to the fact that excessive supply of N promotes luxuriant vegetative growth of the plants and as a result thereby dominating the reproductive phase.

Table 4.3: Number of branches/plant; Days to flower initiation and Number of nodes per plant as influenced by foliar nitrogen fertilization.

Treatment	No of branches /plant	Days to flower initiation	Number of nodes /plant
T1 (0.5% urea + 1% urea)	1.07	53.67	3.23
T2 (0.75% urea + 1% urea)	1.07	54.00	3.70
T3 (1% urea + 1% urea)	1.07	55.33	3.67
T4 (2% urea + 1% urea)	1.13	55.67	3.50
T5 (0.5% urea + 0.5% CaNO3)	1.07	54.67	3.63
T6 (0.5% urea + 1% CaNO3)	1.13	55.33	3.83
T7 (0.5% urea + 0.5% KNO3)	1.13	54.33	3.90
T8 (0.5% urea + 1% KNO3)	1.17	55.67	3.73
T9 (Control)	1.07	51.33	3.50
S.Em±	0.03	0.44	0.25
CD @ 5%	0.09	1.31	0.74

4.1.4 Number of branches per plant at harvest

The data on number of branches per plant as influenced by foliar spray of nitrogen are presented in Table 7.

All the treatments had a significant effect on the number of branches/plant. However numerically more number of branches per plant (1.17) was recorded from treatment T_8(0.5% urea + 1% KNO_3) and the minimum branches per plant(1.07) was obtained from T_9 (contol). The above findings was reported by Abbasi *et al*.(2010) where foliar nitrogen fertilization leads to more number of branches(4.8) per plant and also Narayanamma *et al*. (2006) in brinjal

4.1.5 Number of nodes per plant at harvest

The data on number of nodes per plant as influenced by foliar spray of nitrogen are presented in Table 7.

An insight into the data clearly indicates that different foliar spray had a non-significant effect on the number of nodes per plant at harvest. However highest number of nodes (3.9) was recorded from T_7(0.5% urea + 0.5%KNO_3) and minimum nodes per plant (3.2) was recorded from T_1(0.5% urea +1% urea) respectively. Akanbi *et al*.(2010) reported that the number of nodes per plant increased when fertilizer rate increased upto 75kg N/ha. It may be due to the non vegetative growth of the plant.

4.2 YIELD AND QUALITY PARAMETERS

4.2.1 Average number of fruits per plant

The data on the average number of fruits per plant as influenced by foliar spray of nitrogen are depicted in Table 8.

An insight into the data clearly indicates that various foliar sprays affected the number of fruits significantly. The foliar application of 0.5% urea and 1 % potassium nitrate (T_8) recorded significantly higher fruit yield per plant (15.8) than other treatments. Minimum fruit yield (10.8) per plant was recorded from control(T9).

In the above research number of fruits per plant increased significantly due to the foliar application of nitrogen source at different growth stages of the plants. A positive effect of nitrogen application on the number of fruits per plant was reported by Mubashir *et al*.(2010) where more number of fruits per plant(17) was obtained by application of nitrogen especially urea. Similarly Sajid *et al*.(2010) and Abeykoon *et al*.(2010) reported that increasing the amount of nitrogen doses results in more number of fruits per plants. The increase in growth and yield parameters by the foliar application of urea was also reported by Maitlo *et al*. (2006) in wheat.

Table 4.4: No. of fruits/plant and No. of seeds/fruit as influenced by foliar nitrogen fertilization.

Treatments	Average number of fruits/plant.	No. of seeds/fruit
T1 (0.5% urea + 1% urea)	14.93	40.17
T2 (0.75% urea + 1% urea)	12.77	39.83
T3 (1% urea + 1% urea)	13.53	40.93
T4 (2% urea + 1% urea)	15.23	40.67
T5 (0.5% urea + 0.5% CaNO3)	14.83	41.37
T6 (0.5% urea + 1% CaNO3)	15.47	40.77
T7 (0.5% urea + 0.5% KNO3)	14.47	41.23
T8 (0.5% urea + 1% KNO3)	15.83	42.43
T9 (Control)	10.80	35.60
S.Em±	0.39	0.48
CD @ 5%	1.18	1.44

4.2.2 Number of seeds per fruit.

The data on the number of seeds per fruits as influenced by foliar spray of nitrogen are presented in Table 8.

A significant difference in number of seeds per fruits was recorded due to foliar spray of nitrogen. Significantly higher number of seeds per fruits (42.43) was recorded due to foliar spray of 0.5%urea +1% potassium nitrate (T_8) which was at par with (T_5) foliar spray of 0.5%urea +0.5% calcium nitrate (41.37). However, lower number of seeds (35.60) per fruits was obtained in control.

The same results were reported by Latief *et al*.(2012) and Khan *et al*.(2009) in wheat where the result shows that foliar application of nitrogen and nutrients mixture increase the yield attributing characters and also increased the grain yield by 32%. Similar findings were also reported by Yosef Tabar, (2012) in rice and Iqabal *et al*.(2013) in maize.

4.2.3 Fresh fruit weight (g)

The data on the fresh fruit weight(g) as influenced by foliar spray of nitrogen are presented in Table 9.

Fruit weight differs significantly due to foliar application of nitrogen. Significantly, higher fruit weight (16.27g) was recorded from treatment with 0.5%urea and 1%potassium nitrate(T_8). Lower fruit weight(12.20g) was obtained from control (T_9).

The findings above are in accordance with the findings of Narayanamma *et al*. (2006) in brinjal who reported that higher doses of N application lead to increase in size and weight. Similar results were also reported by Singh *et al*. (2012) in okra and Yildirim et al.(2007) in broccoli.

4.2.4 Fruit length (cm)

The data on the fruit length (cm) as influenced by foliar spray of nitrogen are presented in Table 9.

The data clearly indicates that fruits length was significantly affected due to foliar application of nitrogen. The treatment with 0.5%urea + 0.5%potassium nitrate (T_8) recorded highest (12.98cm) fruit length. While lowest fruit length (9.69cm) was obtained from control (T_9).

This increase in fruit length may be due to the sufficient supply of nitrogen to the plants for the development of growth and yield characters. The increase in fruit length due to the effect of nitrogen application was reported by Abassi *et al*. (2012) where highest okra fruit length (9.1cm) was obtained with foliar application of

nitrogen source. Similar findings were also reported by Phillip *et al*. (2010) and Khan *et al*. (2013) in okra plant.

Table 4.5: Fruit weight(g); Fruit length(cm) and Fruit width(cm) as influenced by foliar nitrogen fertilization.

Treatment	Fresh fruit weight(gm)	Fruit length(cm)	Fruit width(cm)	Yield (t)
T1 (0.5% urea + 1% urea)	15.27	10.83	4.53	36.57
T2 (0.75% urea + 1% urea)	14.23	10.86	4.40	29.14
T3 (1% urea + 1% urea)	15.07	11.49	4.93	32.70
T4 (2% urea + 1% urea)	14.70	10.70	5.07	36.56
T5 (0.5% urea + 0.5% CaNO3)	15.80	11.48	4.63	37.98
T6 (0.5% urea + 1% CaNO3)	16.13	12.10	5.03	40.62
T7 (0.5% urea + 0.5% KNO3)	15.77	12.81	4.67	37.26
T8 (0.5% urea + 1% KNO3)	16.27	12.98	5.30	41.63
T9 (Control)	12.20	9.69	3.90	20.80
S.Em±	0.33	0.32	0.21	0.61
CD @ 5%	0.98	0.97	0.62	1.81

4.2.5 Fruit width (cm)

The data on the fruit width (cm) as influenced by foliar spray of nitrogen are presented in Table 9.

Perusal of the data indicates that fruit width was significantly affected due to foliar nitrogen application. Among the treatments maximum fruit width (5.30cm) was recorded from the spray of 0.5% urea + 1% KNO_3 (T_8) and minimum fruit width (3.90cm) was recorded from control (T_9).

Almost simililar increase in fruit width due to application of nitrogen source was reported by Yassen *et al*. (2011) in potato and Khan *et al*. (2007) in onion. Increased in fruit size and weight may be due to the adequate supply of nitrogen to the plants. This improved their vegetative growth, synthesis and translocation of photosynthesis from the source to sink, thus resulting in significant increase in number, weight and size of fruits, i.e. the yield and yield components of the plant.

4.2.6 Yield of okra in tones per hectare

The data on plant yield as influenced by the different sources and concentration of okra are presented in Table 4.5. Highest yield 41.6 was obtained from 0.5% urea + 1% KNO_3. The lowest yield was reported from control 20.80.

Table 4.6.Effect of foliar spray of nitrogen on the economics of okra

Treatment	Yield (t/ha)	Gross return Rs./ha A	Total cost of cultivation Rs./ha B	Net returns (A-B) Rs./ha	Cost benefit ratio
T_1	37.99	227940	76335.77	151604.2	1.98
T_2	30.28	181680	76356.74	105323.3	1.37
T_3	33.98	203880	76377.7	127502.3	1.66
T_4	37.31	223860	76461.55	147398.5	1.92
T_5	39.05	234300	76851.92	157448.1	2.04
T_6	41.58	249480	77451.92	172028.1	2.22
T_7	38.03	228180	76851.92	151328.1	1.96
T_8	42.92	257520	77451.92	180068.1	2.32
T_9	21.95	131700	76210	55490	0.72

Legends:

T1- 0.5% urea(30 DAS) + 1% urea

T2- 0.75% urea(30 DAS) + 1% urea (45 DAS)

T3- 1% urea(30 DAS) + 1% urea (45 DAS)

T4- 2% urea(30 DAS) + 1% (45 DAS)

T5- 0.5% urea(30 DAS) + 0.5% CaNO3(45 DAS)

T6- 0.5% urea(30 DAS) + 1% CaNO3(45 DAS)

T7- 0.5% urea(30 DAS) + 0.5% KNO3(45 DAS)

T8- 0.5% urea(30 DAS) + 1% KNO3(45 DAS)

T9- Control

4.3 Economics (Benefit cost ratio)

The data on total cost of cultivation, gross returns, net returns and cost benefit ratio due to foliar spray of nitrogen in okra production are presented in Table 4.3.

The foliar spray of 0.5% urea + 1% KNO3 (T8) recorded the highest gross and net returns of Rs. 257520 and Rs. 180068.1 respectively and B:C ratio of 2.32 followed by foliar spray of 0.5% urea + 1% CaNO3 (T6) which has a net return of Rs. 172028.1.

SUMMARY and CONCLUSION

A field experiments was carried out at the main research field of the Department of Agriculture, Lovely Professional University, Phagwara (Punjab) during spring-summer season of 2014 with the objectives of studying the effect of foliar spray of nitrogenous source at 30 DAS and 45 DAS on the growth, yield and quality of okra cv. F1 Hybrid (Rani). The result of the present study is summarized in this chapter.

Foliar application of nitrogen had a significant influenced on the growth and yield of okra. Highest plant height (40.07cm) was recorded from foliar application of 0.5% urea + 1% KNO_3 (T8) and minimum plant height(34.23cm) was obtained from control(T9). Foliar spraying of urea + KNO3 or CaNO3 had more positive effect on the parameters study than spraying of urea alone. Numbers of leaves per plant(14.92) were also highest in spraying of 0.5% urea + 1% KNO3. However the foliar nitrogen spray does not have a much effect on the number of branches and nodes per plant. Foliar application of nitrogen delayed the flower initiation of plants. In the number of days to flower, the minimum days taken to flower were recorded in control(T9) while maximum days taken to flower were recorded in spraying of 0.5% urea + 1% KNO3(T8). The number of fruits per plant, fruit length(cm), fruit width(cm) and fruit weight(g) were also reported to be effectively influenced by the foliar nitrogen application. Maximum number of fruits per plant(15.83), fruit length(12.98cm), fruit weight(16.27g), and fruit width(5.30cm) were recorded from spraying of 0.5%urea + 1% KNO3. The number of seeds per fruit was also positively affected by the nitrogen spraying, as it leads to more number of seeds per fruits. Highest number of seeds(42.43) per fruit was recorded from spraying of 0.5% urea + 1% KNO3 (T8). The number of fruits(15.83) per plant was also highest at spraying of 0.5% urea + 1% KNO3 (T8).

Conclusion

1. Results of the present trial indicate that application of nitrogen in the form of foliar spraying during the growth stages is beneficial for improving the growth, yield and quality components of okra.

2. Among the various treatments combination of urea and KNO3 at the rate of 0.5% and 1% respectively proved to be the favorite treatment.

3. Further this study can be concluded that, foliar spray of 0.5% urea combined with 1% CaNO3 or 1% KNO3 has much more potential in improving the growth and yield of okra.

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Appendix I: Collection of experimental observations

S/no	Parameters	Frequency	Observation period
1	Growth observation		
	a)Plant height	4	30, 45, 60 DAS and at harvest.
	b)Number of leaves/plant	4	30, 45, 60 DAS and at harvest.
	c)Number of branches/plant	1	At harvest
	d)Days to flower initiation	1	Recorded from date of sowing
	e)Number of nodes/plant	1	At harvest
2	Yield and Quality observation		
	a)No. of fruits/plant	1	After harvest
	b) No. of seeds/fruit	1	After harvest
	c)Fresh fruit weight(gm)	1	After harvest
	d)Fruit length(cm)	1	After harvest
	e)Fruit width(cm)	1	After harvest
	f) Yield of fruits	1	After harvest

Appendix II : Prices of Inputs.

1) Okra seed price:	Rs. 880 per kg.
2) Urea:	Rs. 4.83 per kg.
3) Single super phosphate:	Rs. 9.35 per kg.
4) Murate of potash:	Rs. 4.45 per kg.
5) Labours:	Rs. 150 per day
6) Machinery charges:	Rs. 5000
7) Calcium nitrate:	Rs. 150 per kg.
8) Potassium nitrate:	Rs. 150 per kg
9) Land rent:	Rs. 8000/ha per season
10) Miscellaneous:	Rs. 2500
11) FYM:	Rs. 8 per kg