"EFFECT OF FOLIAR APPLICATION OF NITROGEN SOURCE (UREA) ON GROWTH AND YIELD OF EGGPLANT" *(Solenum melongena L.)*

THESIS

SUBMITTED IN PARTIAL FULFILLMENT

OF REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE

IN

AGRONOMY

BY

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DECLARATION

This is submit that this written submission in my thesis entitled **"Effect of foliar application of nitrogen source (urea) on growth and yield of eggplant (** ***Solenum melongena L.*****)"** represents original ideas in my own words and where other ideas or words have been included. I have adequately cited and referenced the original sources. I also declare that I have stuck to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in my submission. I understand that any violation of the above will be cause for disciplinary action by the School and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has been taken when required.

This thesis encompasses the information generated by me based on experimental work carried out in the Institute. I assure and hold full responsibility for its genuineness.

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CERTIFICATE

The work described in thesis entitled **"Effect of foliar application of nitrogen source (urea) on growth and yield of eggplant (*Solenum melongena L.*)"** has been carried out by Mr. Bhanwar Singh under my supervision. I certify that this is his bonafide work. The work described is original and has not been submitted for any degree to this or any other university

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ACKNOWLEDGEMENT

In this highly complex society, no work can be accomplished by a single individual but it needs inspiration and sincere gratitude of intellectuals as well as the grace of that Almighty. Emotions cannot be adequately expressed in words because then emotions are transformed into a mere formality. My acknowledgements are many times more than what I am expressing here.

With unending humility, at the very outset, I would like to thank "The Almighty", who blessed with the limitless internal strength and favorable circumstances, to face and pass through all odds successfully at this juncture.

With an overwhelming sense of legitimate pride and genuine obligation, I seize this rare opportunity to express my deep sense of gratitude, indebtedness and personal regards to my esteemed teacher, ***Dr. Harmeet Singh Janeja, Assistant Professor, Plant Breeding, LPU, Punjab (India)***, for his expert, invaluable, criticism during the entire course of my investigations.

I feel honoured in expressing real appreciation and regards towards **Dr. Harmeet Singh Janeja** for their prompt anticipations, valuable suggestions and constant encouragement.

I am thankful to esteemed **Dr. Balkrishna S Bhople** (HOD, Agronomy), **Dr. Madhu Sharma** (HOD, Horticulture) and other faculty members of School of Agriculture and Food Technology, for their proper guidance during the entire course of present studies.

I am grateful to Dean, **Dr Neeta Raj Sharma**, School of Biosciences, Lovely Professional University for providing their full help and co-operation during the present investigation.

I avail the blessings, affection and moral encouragement of my gracious parents, constant moral encouragement inspired me to search ahead.

I expressed my heartfelt thanks to my friends Ganesh, Gajanan Gurvinder, Harender Auwal,Devinder, F. lalthasanga …….. for their co-operation, encouragement, moral and timely help when demanded.

LIST OF CONTENTS

Statement by the candidate……………………………………………………II

Certificate ……………………………………………………………….…III

Acknowledgement ……………………………………………………..........IV

List of contents ………………………………………………………............V

List of tables ……………………………………………………………….….VI

List of plates ………………………………………………………………......VII

Abstract ……………………………………………………………………..IX

Abbreviations ……………………………………………………………….......VIII

CHAPTER- 1

INTRODUCTION ………………………………………………………………...1-3

AIM AND OBJECTIVE ………………………………………………………….4

CHAPTER-2

REVIEW OF LITERATURE ………………………………………………….…5-14

CHAPTER-3

METHODOLOGY ……………………………………………………………….15-25

CHAPTER-4

RESULTS AND DISCUSSION ………………………………………………..26-38

CHAPTER -5

SUMMARY AND CONCLUSION...……………………………………….……..39-40

CHAPTER-6

REFERENCES …………………………………………………………...........41-45

LIST OF TABLES

Sr. /NO.	Title	Page No.
3.1	Monthly Metrological data (2013-14) near the experimental research station, LPU, Phagwara. (http://www.tutiempo.net/en/Climate/Amritsar)	16
3.2	Soil physic-chemical properties of the experimental field soil.	17
4.1	Influence of nitrogen source (urea) foliar spray on plant height at different growth stages in eggplant	28
4.2	Influence of nitrogen source (urea) foliar spray on number of leaves per plant at different growth stages in eggplant	30
4.3	Influence of nitrogen source (urea) foliar spray on number of branches per plant at different growth stages in eggplant	32
4.4	Effect of nitrogen source (urea) foliar spray on number of fruits per plant and fruit yield per plant in eggplant	34
4.5	Effect of nitrogen source (urea) foliar spray on fruit length and fruit girth in eggplant.	35
4.6	Effect of nitrogen source (urea) foliar spray on marketable fruit yield per plot and marketable fruit yield per hectare in eggplant.	37
4.7	Effect of nitrogen source (urea) foliar spray on gross return, net return and cost benefit ratio in eggplant	38

LIST OF FIGURE

Sr./No	Title	Page No.
3.1	Monthly metrological data *rabi* season 2013	16

LIST OF PLATES

Sr./No.	Title	Page No.
3.1	Picture showing the experimental plot	22
3.2	Fruit varying plant	23
3.3	Variation size and shape of harvested fruit	23
3.4	Plant bearing young fruit	24
3.5	Picture showing marketable and unmarketable fruit	24

ABBREVIATIONS

Cm	Centimeter
%	Percentage
Kg	Kilogram
G	Gram
pH	potential of hydrogen
N	Nitrogen
P	Phosphorus
K	Potassium
DAT	Day After Transplanting
Ha	Hectare
Qtl	Quintal
FYM	Farm Yard Manure
T	Treatment
P	Plot
CD	Critical difference
HI	Harvest index
M	Meter

ABSTRACT

A study on the effect of foliar application of nitrogen source (urea) on growth and yield of eggplant (*Solenum melongena* L.) was conducted in Randomized Complete Block Design experiment on the experimental plot at the Department of Agriculture, Faculty of Agriculture, Lovely Professional University, Punjab. Nitrogen source (urea) foliar spray effects have been studied at three different levels of N with control (four treatments). Data on vegetative and reproductive growth, marketable and unmarketable yields was collected starting. Nitrogen spray (urea) was non-significantly affected plant height even though T4 (2.0%N) produced taller plants. Number of leaves and branches per plant were produced significant effect by nitrogen foliar spray. Plants which received (2.0%N) had more branches and leaves than the control (T1) treatment. Significantly effect on number of fruit per plant, fruit yield per plant, fruit yield per plot and fruit yield per hectare have been observed on yield and yield related characters. Nitrogen foliar spray T4 treatment produced highest number of fruit per plant (15.07**), fruit yield per plant (1.13** kg), fruit yield per plot (10.61** kg) and marketable fruit yield per hectare (181.70** qtl). Nitrogen T4 treatment recorded the highest total weight of marketable and unmarketable fruit. The spray of nitrogen base of nutrient dose not show significant effect on fruit length and girth there by, it does not change the overall fruit shape or weight individually. From the above observed results, we can conclude that the spray of the nitrogen compound did not modifying shape or size of the eggplant fruit. The highest nitrogen spray dose of 2.0% produced more marketable fruit per hectare. In our study the T4 treatment recorded the highest profit margin as compared to control and two other treatments (0.5 and 1.0%).

CHAPTER-1

INTRODUCTION

Eggplant (*Solenum melongena* L.) is second most popular vegetable and native of India. It can be grown throughout the year across India, expect at higher altitudes. Eggplant has also been grown wildly across the world (Anon.2012). World (India) acreage under eggplant has been estimated to be 1.81(0.6) million hectare with production of 46.69(11.89) million tons and productivity of 25.7(17.5) tons per ha. In Punjab, eggplant is grown over an area of 3.82 thousand hectare with an annual production of 81.2 thousand tons (National Horticulture Database-2011).

Along with tomato and onion, eggplant is an important vegetable in India. Being the most affordable vegetable, it is used in different dishes in every household across the country. Egg plant is a rich source of proteins, essential minerals and vitamins. The fruit (as part of the diet) helps to lower blood cholesterol and is also helpful in regulation of blood pressure. The eggplant fruit contains an alkaloid called "Solanine" which is used for treatment of diabetes, asthma, cholera, bronchitis, diarrohea and many more deseases. Contains proteins (1.4g), fats (0.3g), minerals (0.3g), carbohydrates (4.0g), calcium (18.0mg), magnesium (16.0mg), oxalic acid (18.0mg), phosphorus (47.0mg), vitamin A (124I.U.), thiamine (0.04mg), riboflavin (0.11mg), nicotinic acid (0.09mg), vitamin C (12.0mg), sugar (3.53mg), zinc (0.16mg), and niacin (0.65mg) 100g of fresh eggplant.

Plant nutrition plays an important role for improving yield and quality in eggplant. Nitrogen is considered as one of the essential macronutrients required by the plant for their growth, development and yield. It is also one of the major components of nucleic acid, co-enzymes, cell membranes and involved in many metabolic process like, cell division, photosynthesis, protein synthesis, plant growth and development, expansion of shoot and root growth. Eggplant crop is highly responsive to nitrogen (N) fertilizer application where nitrogen availability may be limited and time of the application is critical. Nitrogen plays an important role in nutrition and therefore is the yield limited factor in many areas especially in low fertile soils. So, managing application time, rate and type of nitrogen fertilizer is very important.

Inside the plant, Nitrogen converts to amino acids, the building blocks of proteins. These amino acids are then used in forming protoplasm, which is used in cell division. These are also used in producing necessary enzymes and structural parts of the plant and they also forma part of the stored proteins. Nitrogen serves as the source of dark green leaves as a result of a high concentration of chlorophyll. Nitrogen combined with high concentrations of chlorophyll utilizes sunlight as an energy source to carryout essential plant functions including nutrient uptake. Plant with in sufficient nitrogen is stunted and grows slower due to also results in lower amount of protein in the seed and plant.

Increasing the levels of nitrogen during the vegetative stage can strengthen and support the roots; enabling plants to take in more moisture and nutrients. This allows a plant to grow rapidly and produce succulent, green foliage, which in turn can improve vegetative growth, and produce a healthy crop that is more resistant to pest, diseases, and environmental strees. Understanding the nitrogen requirements for plants makes it easier to meet their supplement needs. Intensive crop cultivation requires use of nitrogen fertilizer at specific growth levels. Supplying the plant with major nutrients (nitrogen, phosphorus, and potassium) is most effective and economical via soil application. However, excessive use of nitrogen fertilizer affects the soil quality and leads to the environmental hazards as well as reduce economic yield of crop.

The rate of nitrogen uptake depends on nitrogen availability in soil and media and the physiological capacity of roots and leaves to acquire nitrogen. Factors that influence the capacity of roots to take up nitrogen include temperature, moisture, soil texture and the plant developmental stage. Factors that influence the capacity of leaves to absorb nitrogen include plant species, plant age, leaf age, temperature and humidity. Leaves of some species have physical and chemical characteristics that allow them to absorb nitrogen better than others.

Therefore the current investigation is to explore the possibility of supplementing nitrogen fertilizer. Among the alternate methods of plant nutrient application, foliar nutrition of macronutrients is one of the possibilities of improving productivity and increasing fertilizer use efficiency and reduces environmental hazards. Foliar application of fertilizer is a convenient and effective method of nutrient application for many crops

Although foliar feeding has not widespread on agronomic crops but widely used and accepted as an essential part of crop production, especially on horticultural crops. Primarily, foliar feeding is intended to delay natural senescence processes shortly after the end of reproductive growth stages. Foliar feeding targets the growth stages where declining rates of photosynthesis and leveling off of root growth and nutrient absorption occur, in attempts to aid translocation of nutrients into seed, fruit, tuber or vegetative production. Early foliar applications can make an already good crop better, either by stimulating more vigorous regrowth or maximizing the yield potential growth stage period.

The recommended dose of NPK has been reported for autumn and spurring crop separately in different research report with a consciences of 200 kg nitrogen 100 kg phosphorus and 100 kg potash been applied to one acre for eggplant where as by using aerial spray of nitrogen the total requirement for the nitrogen source will be reduced drastically that is less than 5 kg per acre. Foliar urea sprays at concentrations up to 10 percent have been reported in the literature, but 3 percent urea sprays prove to be safe for most species. Combining foliar nitrogen fertilization with reduced rates of soil nitrogen during the growing season can reduce the total nitrogen inputs and the amount of nitrogen runoff during production. Reduced rates of soil nitrogen can lessen excessive vegetative growth, resulting in reduced water requirement, lesser disease insect infestation and hardy plants. Reduced nitrogen in the growing medium during the growing season can also increase root growth relative to shoot growth**.** Foliar nitrogen fertilization can reduce plant dependence on frequent soil nitrogen application. In many growing regions, fertilizers applied in soil are inefficiently taken up due to low temperatures and high rainfall. Combining foliar nitrogen fertilization with defoliants can increase stored nitrogen and improve plant quality. Research at Oregon State University showed that applying 3 percent urea after terminal bud set increases nitrogen reserves and improves plant quality. Foliar nitrogen fertilization can improve plant nitrogen status in shallow root crops when a lack of available water in the topsoil limits nutrient uptake. In many regions, lack of available water in the topsoil is commonly associated with a decline in nutrient availability. Under these conditions, soil application of nitrogen is less effective than foliar applications.

Foliar application of macronutrients helps in efficiency utilization of nutrients to plant directly through leaves, within few days we can realize the effect of macronutrient spray. For best response and to nurture and maintain a healthy growth, a consistent schedule of spray should be declarable. Up to four applications have been with incrementally beneficial results.

Keeping all the points in view, the present investigation on "Effect of foliar application of nitrogen source (urea) on growth and yield of eggplant" was undertaken with the following objectives.

1. To determine the effect of nitrogen source/dosage on plant growth.
2. To identify the effect of nitrogen source/dosage on fruit quality in terms of physical parameters.
3. To study cost benefit ratio.

CHAPTER-2

REVIEW OF LITERATURE

The literature on effect of foliar application of nitrogen source (urea) on growth and yield of eggplant are presented in this chapter. Since limited reviews are available on these aspects in eggplant reviews on other related crops are also included.

Nitrogen is an essential macronutrient needed by all plants. It is an important component of many structural, genetic and metabolic compounds in plant cells and basic components of chlorophyll, the compound by which plants use sunlight energy to produce sugars during the process of photosynthesis. Increasing the levels of nitrogen during the vegetative stage can strengthen and support roots, enabling plants to take in more water and nutrients. A nitrogen-deficient plant is generally older leaves become yellow or pale green due to the lack of chlorophyll, beginning in the tips of the lower leaves and eventually spreading throughout the plant. Understanding the nitrogen requirements for plants makes it easier to develop healther biomass to produce greener and vigorous plants.

Hamid Reza Bozorgi (2011) studied fruit yield with number of fruits per plant, number of branches per plant, fruit length and fruit width. The maximum amount of fruit yield (34.6 t/ha) with 4.82 fruit (mean) and plant height (111.5cm) was found from 90 kg/ha nitrogen fertilizer application. Whereas the lowest fruit yield, number of fruits per plant, plant height, number of branches per plant, fruit length and fruit width respectively with 18.43 ton/ha, 3.35 fruits, 82cm, 2.73 branches, 19.38cm and 3.12cm from control treatment (without nitrogen fertilizer application) on eggplant crop.

Prabhu et al. (2003) and Wange and Kale (2004) and Ge et al.(2008) showed that nitrogen fertilization significantly affected eggplant growth and yield. Nitrogen application increased plant height at vegetative growth, flowering and reproductive stages .The level of 50 N kg/ha produced the tallest plant and shortest plants formed in the control (at vegetative and flowering stages). However, no significant differences were found between three treatments: 50, 100 and 150 N kg/ha (at all stage). Also the effect of nitrogen on the lateral stems number of eggplant was significant at flowering stage. The highest number of lateral stems (14.33) was obtained at

50 N kg/ha, but there was no significant difference between three treatments: 50, 100 and 150 N kg/ha.

Ahamed A. Kandil et al. (2013) has been reported increasing nitrogen fertilizer levels up to 214.2 kg N/ha significantly increased growth characters, total and marketable yields, total culls and bulb weight as well as total weight loss percentages at storage period. In addition, fertilization with 71.4 kg N/ha significantly increased TSS and dry matter percentage.

Wange and Kale (2004). Studied effect of nitrogen fertilization level on leaf number was significant at flowering and reproductive stages. The plant height, leaf number were obtained as a results of the plant height rates of N (100 and 150 N kg/ha) with 41.33 and 57.33 leaves at flowering and reproductive stages, reproductively, while the lowest values were observed at the control plants showing the average value of 32.0 leaves (at flowering stage) and 44.33 leaves (at reproductive stage); however, no significant differences were found between treatment at the vegetative stage.

Bowen and Frey (2002) and Ge et al. (2008) reported Leaf chlorophyll content was affected by nitrogen fertilizer at reproductive stage. They also suggested that by increasing the nitrogen fertilizer rate the leaf dry matter content increased at reproductive stage. The highest leaf dry matter content was obtained at 100 kg N ha application (18.67%), while the least leaf dry matter content was obtained in the control (16.33%) in bell pepper crop.

Sat and Saimbhi (2003) and Law and Egharevba (2009) reported that a promotion effect of inorganic fertilizers on chlorophyll content might be attributed to the fact that N in a constituent of chlorophyll molecule. By increasing the nitrogen fertilizer rate the leaf dry matter content increased at reproductive stage. The highest leaf dry matter content was obtained at 100 kg/ha N application (18.67%), while the least leaf dry matter content was obtained in the (16.33%). Similarly, leaf dry matter content increased as N rate increased. Nitrogen deficiency retarded the vegetative as well as reproductive growth, which resulted in more days to flowering and fruit setting. Similarly, more nitrogen led to maximum days to flowering and fruit setting, as in case of. It means nitrogen enhanced vegetative growth and reduced reproductive growth therefore, a fertilizer dose of 100 kg N per hectare proved better for minimum days to flowering.

Rosati et. al., (2002). Reported that increments in the nitrogen rate of the fertilizers increased the yield and number of fruits Nitrogen fertilization significantly increased yield per plant compared to control. The highest yield in plant was obtained as (3713 g) with application of 100 kg/ha. The lowest yield was obtained as (2615 g) in the zero nitrogen application. Increasing the N levels of the fertilizers to 50 kg/ha N significantly increased the yield of eggplant while yield decreased at the highest rate of nitrogen. This decrease in yield might be due to excess levels in the plant. The marked effect of nitrogen on yield might be due to cumulative stimulating effect of nitrogen on the vegetative growth characters which form the base flowering and fruiting.

Shahi et al. (2002) reported that nitrogen levels at 50 to 150 kg per ha, significantly increased fruit yield, while further addition reduced in both brinjal hybrids (Pusa hybrid-5 and Pusa hybrid-6).Increase plant growth, number of fruit per plant, and yield of brinjal.

Khattak et al. (2001) studied the effect of different nitrogen levels (0, 50, 75, 100, 125, 150 kg/ha) on aubergines (Solanum melongena) cultivar Black Bahar, Long Purple, Neelam Long and Black were studied at Agriculture Research Institute Tarnab, Pesawar, Pakistan, in 2000. Different level of nitrogen significantly increased number of branches, leaves and fruit/plant, stem thickness, plant height and yield at 125 kg N/ha, while minimum values for these parameters were observed in different treatments. Maximum number of branches (7.84), leaves (285.380) and fruit/plant (13.67), stem thickness (1.19 cm) and yield (17674.91 kg/ha) were noted for the plant receiving 125 kg N/ha, while minimum number of branches (6.37), leaves (280.77) and fruit/plant (11.08) were obtained in control treatment and minimum stem thickness (1.01 cm) and yield (14062.41 kg/ha) were found when 50 kg N/ha was applied.

Abdou (2000) studied that the fertilizing sugar beet plants with 100 kg N/fad produced highest values of root and foliage fresh weights, root length and diameter, root, top and sugar yields/fad. Meanwhile, the highest means of TSS, sucrose and purity percentages as well as harvest index were obtained from addition of the lowest nitrogen fertilizer level (60 kg N/fad) on sugar beet crop.

Dera Ismail Khan *et al*. (2008). Analyzed that 100 kg N/ha produced significantly maximum survival percentage (95.66), fruit length (16.45 cm), fruit diameter (9.25 cm), fruit volume (601.7 cm^3), fruit weight (257.4 g) and yield/ha (42.6 t). However, 150 kg N/ha excelled in plant height (91.3 cm), number of leaves (16.23) and days to flowering (49.98), increase the yield and plant growth of eggplant crop.

Bobadi S and Van Damme P. (2003) studied the effect of nitrogen application on number of flowers per plant, number of fruits per plant and fruit yield/ha of eggplant was investigated under controlled greenhouse conditions. Nitrogen was supplied at 50, 75, 100, 125, 150, 175 and 200 kg N/ha with one control (no nitrogen) treatment. Nitrogen supplied at 200 kg N/ha gave best results and significantly produced the highest number of flowers per plant, fruits per plant and yield (32.24 ton/ha) over control plants. Nitrogen application at 150 and 175 kg N/ha showed comparable results with nitrogen applied at 200 kg N/ha.

S. Islam *et al*. (2012) investigated increased nitrogen levels increased the fresh leaves yield significantly at all three locations. Among the nitrogen levels, N5 produced significantly higher fresh leaves yield (2872.58 kg/acre) followed by N4 (2557.83 kg/acre) and N3 (2348.08 kg/acre). However, the lowest fresh leaves yield (1808.66 kg/acre) was recorded in control treatment. Among locations, significantly higher fresh leaves yield (2989.33 kg/acre) and tea production significantly at all N levels. Maximum made tea (574.58 kg/acre) was obtained from N5 treatment, followed by N4 (511.33 kg/acre) and N3 (469.58 kg/acre). Minimum tea production (362.66 kg/acre) was recorded from control treatment. Among locations NTRI produced higher tea (597.85 kg/acre) than Battagram (409.25 kg/acre) and Oghi (398.75 kg/acre). However, difference in made tea production between Battagram and Oghi was non-significant (P=0.05).

Maral moraditochaee, (2012) investigated the effect of nitrogen fertilizer management on all measured traits was significant at 1% probability level. With increasing nitrogen levels up to 75 kg/ha, growth was observed in all studied traits. Comparison of mean between nitrogen management treatments showed that the highest seed yield with 1360 kg/ha, number of pods per plant with 56.41 pods and plant height with 77 cm was obtained by 75 kg/ha nitrogen fertilizer management. On the other hand, the minimum amounts of seed yield with 514.6 kg/ha, number of pods per plant with 37.28 pods and plant height with 55.95 cm was recorded from control treatment (without nitrogen fertilizer application) on cowpea crop.

Mohammad Hossein Aminifard *et al.* (2010) studied that nitrogen was applied in four rates (0, 50, 100 and 150 Kg/ha). Average plant height, lateral stem number, leaf chlorophyll content, flower number, fruit weight and plant yield were determined , Increasing rates of Nitrogen significantly affected plant vegetative growth (plant height, lateral stem number, and leaf chlorophyll content).The highest lateral stem number and leaf chlorophyll content were obtained in plants receiving 150 Kg N ha -1. Nitrogen fertilizer affected flower number and the days to first flowering. Nitrogen application decreased the days to first flowering and treated plants flowered early than control. It was observed that fertilization with 100 Kg N ha-1 resulted in the highest average fruit weight and fruit yield. Our results showed that nitrogen fertilization has strongly influenced vegetative and reproductive growth of eggplant plants grown under field conditions.

Ng etich *et. al*.(2013) studied the five levels of nitrogen treatments (0, 40, 80, 120 and 160 kg N/ha) The growth and yield was significantly ($P < 0.05$) affected by nitrogen nutrition. Plants subjected to 160 kg N/ha exhibited increase of about 22.9 - 55.9% in plant height; 28.0 - 29.4% in stem diameter; 26.6 - 39.7% number of leaves; 61.0 - 204.1% leaf area and 103.2 - 235.2% leaf are index compared to the control. Male and female flowers from plants subjected to 120 kg N/ha were more by between 13.9 - 30.8% and 7.5 - 63.5% respectively in contrast to the control. Biomass yield from 120 and 160 kg N/ha was about 99% higher than the control and about 15.9 t/ha. Maximum edible fruit yield was realized from plants subjected to 120 kg N/ha which averaged at 11.3 t/ha and 86.0% higher than the control and hence can be recommended for improving the production of Zucchini.

Devi *et al.* (2002) studied that the better fruit girth, fruit weight and fruit yield level of eggplant with the application of 120 kg/ha. It is a well known that adequate nitrogen is required by eggplant for satisfactory growth, development and high yield. Thus, an adequate level of nitrogen is very vital to increase the production and yield of eggplant. The main aim of this experiment was to determine the influence of nitrogen fertilization on growth and yield of eggplant.

Nemeat Alla and EL-Geddawy (2001) studied the effect of different levels of nitrogen fertilizer (80, 100, 120 and 140 kg N/fad) on yield and quality of sugar beet. They deduced that increasing nitrogen level up to 100 kg N/fad incremented root length and diameter, root and sugar yields/fad, while decreased TSS and sucrose percentages.

Saleh E. Seadh (2004).Increasing nitrogen fertilizer levels from 20 to 40, 60 and 80 kg N/fad tended to increase all growth attributes, yield and its components under study in the three seasons. Concerning TSS % and HI, increasing nitrogen fertilizer levels from 20 to 40 and 60 kg N/fad tended to increase its means, but increasing nitrogen fertilizer levels from 60 to 80 kg

N/fad tended to decrease its means in all seasons. Respecting sucrose and purity percentages, increasing nitrogen fertilizer levels from 20 to 40, 60 and 80 kg N/fad tended to decrease its averages in the three growing seasons on sugarcane crop.

G.Bhuvaneswari et al.,(2013) investigated the results that four levels of N (0, 25, 50 & 75 kg /ha designated as N0 , N 25, N 50, & N75, respectively). Plant height at first flowering and at first harvest, number of branches at first flowering number of fruits per plant increased significantly with increasing nitrogen doses up to 75 kg N/ha. However, plant height at final harvest and number of branches at first and final harvest increased significantly up to 75 kg N/ha (N3 treatment) in chili crop.

Abid Khan *et al*., (2014) studied, different levels of nitrogen (0, 60, 120 and 180 kg/ha) and potassium (0, 30, 40 and 50 kg/ha) were investigated. Nitrogen levels showed significant effect on all growth and yield parameters. Nitrogen application at the rate of 180 kg/ha significantly affected plant height (68.3 cm), number of leaves/plant (294), number of branches/plant (18.3), stem thickness (2.43 cm), fruits/plant (59.4), fruit length (6.83 cm), seeds/fruit (152) and yield (8.803 tons/ha). The maximum number of fruits/plant (47.7), fruit length (5.76 cm), seeds/fruit (109) and higher yield (7.102 tons/ha) were recorded with 50 kg K/ha which was statistically at par with 40 kg K/ha except for fruit length. Application of 180-40 kg N-K2O/ha is recommended for better growth and yield of chili.

Maryam Valinejad *et al*., (2013) studied the effect of different levels of nitrogen was applied at planting time as urea at rate to supply 0, 16, 32, and 64 kg N/ha. Analysis of the experiment showed an average yield increase of 16.4% and 12.2% for the 32 kg N/ha, compared to the control treatment yield increase in the treatment of 64 kg N/ha was low and it was not significant statistically on soybean crop.

Golada *et al.,* (2013). Studied the different levels of nitrogen 60, 90, 120 kg N/ha increase nitrogen levels up to 90 kg N/ha mark ably improved the yield attributes, yield and net returns. Application of 90 and 120 kg N/ha exhibited significant increase in green cob yield over 60 kg N/ha. The results revealed that application of nitrogen up to 90 kg N/ha level significantly increased green cob yield and baby corn yield in tune of 20.5 and 23.6% as compared to 60 kg N/ha.

Hassanin and Sohair Elayan (2000) studied that the increasing nitrogen rate up to 90 kg N/fad improved size and weight of the individual root and increased root yield by 3.4 t/fad, sugar yield by 0.46 t/fad and top yield by 1.41 t/fad as compared with fertilizing with 60 kg N/fad. On the other hand, higher nitrogen rate depressed sugar beet quality.

Zeinab, Moustafa *et al.* (2000) studied the effect of various nitrogen rates *i.e.* 60, 80, 100, 120, 140 and 160 % of the recommended dose (75 kg N/fad) on root quality and yield. They stated that increasing nitrogen dressing up to 90 kg N/fad (20 % over recommended dose) exhibited the highest root quality, root and sugar yields t/fad. On the other side, further nitrogen dressing markedly decreased the most studies traits.

Maral Moraditochaee (2012) studied that the effect of treatment nitrogen fertilizer on fruit yield, number of fruits per plant, fruit length and plant height showed significant differences at 1% probability level. Comparison of mean between nitrogen fertilizer rates showed that the highest amounts of fruit yield, number of fruits per plant, fruit length and plant height respectively with 35.03 t/ha, 6.34 fruits per plant, and 118.2 cm were recorded from N4 (75 kg/ha nitrogen)treatment. The N3 (50 kg/ha nitrogen) treatment with 6.03 fruits per plant statistically was placed in same level with N4 treatment. Also, the minimum amounts of fruit eggplant yield with 19.52 t/ha, number of fruits per plant with 4.34 fruits, fruit length with 21.12 cm and plant height with 98.1 cm were recorded from N1 (no nitrogen fertilizer) treatment on eggplant. Similar results were reported by Pal *et al*. (2002), Sat and Saimbhi (2003), Akanbi *et al*. (2007) and Aujla *et al.* (2007).

S.K.S. Bhadoria et al., (2005) studied the level of nitrogen there was a corresponding increase in fresh weight, dry weight, TSS and cracking percentage of fruit. Maximum values of quality characters were observed under the application of 100 kg N/ha except ascorbic acid content. Maximum ascorbic acid content was observed under the application of 75 kg N/ha which was at par with the application of 100 kg N/ha. This might be due to better availability of nutrients, increased uptake of nutrients and water, resulting in more photosynthesis and enhanced food accumulation in edible part of the fruits. Ultimately, it increased the fruit quality.

Parviz Golpavar *et al.*, (2012) studied, at nitrogen demand from soybean seeds during seed filling is very high and has been proposed as the cause of nitrogen remobilization and leaf senescence. Effect of fertilizer rate on leaf senescence was significant at 5% probability level. Spraying of both cultivars with nitrogen could delay beginning of leaf senescence stage. The addition of 15 kg N/ha caused a small delay of 2 days in the leaf fall. Whereas, in N25 and N35 this delay were 6 and 10 days, respectively. On the other hand higher effective vegetative growth period of soybean happened in full dose of nitrogen.

Sher aman and Abdur rab (2013) studied that the different nitrogen levels (0, 25, 50, 75, 100, 125 and 150 kg/ha) maximum leaf length (6.88 cm) and plant height (89.16 cm) was observed with the application of 125 kg N/ ha which was statistically similar to the leaf length (6.75 cm) and plant heights (88.30 cm & 88.26 cm) obtained with the application of 150 and 100 kg nitrogen per ha. While minimum leaf length (5.65 cm) was observed with control nitrogen which was statistically similar to the leaf length (5.79 cm) obtained at the rate of 25 kg/ ha nitrogen application. Whereas lower plant height (68.50 cm) was noted in control treatment on tomato crop.

Muhammad Ayub et al., (2010) studied that the effect of different nitrogen levels (0, 25, 50 kg/ha) on forage yield and quality of three clusters bean cultivars namely; cluster bean 2/1, BR-90 and BR-99. The application of nitrogen significantly increased the forage yield and maximum yield (63.70 kg/ha) was recorded at 50 kg/ha. The increase in yield was mainly due to greater plant height, no. of leaves and leaf area per plant and no. of branches per plant. The quality parameters like crude protein, crude fiber, total ash and dry matter percentage were also increased significantly by nitrogen application over control. Significant difference was also observed among cultivars regarding green forage and dry matter yield, plant height, no. of leaves and leaf area per plant. The variety BR-99 produced significantly higher forage yield (63.00 t/ha), crude protein contents (16.63 %) and lower ash contents than cultivars cluster bean 2/1 and BR-90. Crude fiber contents were statistically similar in all cultivars. For obtaining higher cluster bean forage yield having higher protein and ash contents, the cultivar BR-99 may be grown and fertilized at 50 kg N/ha under the agro climatic conditions of Faisalabad.

E. Yildirim et al., (2007) studied effect of foliar urea applications on quality, growth, mineral content and yield of broccoli under field conditions in 2003, 2004 and 2005. Broccoli cultivars AG 3317 and AG 3324 were treated with foliar urea applications at different concentrations (0.0, 0.4, 0.8 and 1.0%). Foliar applications of urea, especially 0.8 and 1.0% resulted in larger heads, weightier heads and plants as well as higher plants. Conversely, the greatest head and leaf dry matter contents were obtained with no fertilizer-nitrogen application. SPAD chlorophyll readings that were measured in the third year increased with elevated urea concentrations. In regard to the nutrient content, it can be interfered that soil nitrogen fertilization and foliar urea applications increased the content of almost all nutrients in leaves and heads of both broccoli cultivars in three experiment years. Generally, the greatest values were obtained from 1.0% urea application for both cultivars. It results from the study that for optimum yields 0.61 and 0.96% concentrations of urea sprays could be successfully used to obtain better growth and yield in broccoli cultivars AG 3317 and AG 3324, respectively.

Kolota and Osinska (2001) investigated a multi-component foliar fertilizer containing N significantly increased the yield of cabbage. The high efficiency of foliar urea application found in this study is in agreement with the finding of Zahran and Abdoh (1998) for onion, and Zeidan (2003) for Fababean. The latter recommended that urea might be used as foliar nitrogen source to obtain better growth and yield.

Veselinka Zecevic *et, al.* (2004) investigated two rate of nitrogen (N1-90 kg N/ha, N2-120 kg N/h) were applied. Nitrogen foliar nutrition resulted in increasing grain yield in average for 0.45 t/ha. In average the increasing other investigated parameters were estimated in absolute percents: protein content for 2.5, sedimentation value for 21.0, wet gluten content for 7.2, water absorption for 5.2, farinograph quality number for 25.4, bread weight for 3.0 and bread volume for 37.5 of the absolute percents. Under the influence of foliar N application the B_2 quality group was improved to A_2 quality group in milky stage. After N foliar application in milky stage (Fm N_2), the highest value of analyzed parameters was established, except protein content and bread weight. However, in the case of N foliar application in both stage (flowering and milky stage) protein content and bread weight showed the highest values on wheat crop.

Asit Baran Mondal and Abdullah Al Mamun (2011) studied that different yield components and yield of tomato were influenced by the foliar application of different concentrations of urea. The maximum plant height (132.6 cm), number of leaves (30.73), number of green leaves per plant at harvest (21.08), days to first flowering (28.94), number of flower clusters (11.89), number of flowers (75.18), fruit clusters (5.81), fruits per cluster (4.14), and fruits per plant (21.49); length (4.72 cm), diameter (6.58 cm), and weight of individual fruit (151.0 g) were significantly influenced by the 10000 ppm concentration of foliar application of urea fertilizer. The 10000 ppm application gave the highest yield (63.69 t/h) with the lowest

(28.48 t/h) in the control treatment. The yield per plant as well as per hectare increased with increasing concentrations of foliar application of urea fertilizer.

Laxman Singh et al., (2000) studied the highest concentration of urea (1.5%). However, time taken to 50% flowering was not influenced significantly by urea spray. Maximum fruit weight (4.86 g), maximum fruit set (39.66%), minimum fruit drop (41.23%), ,maximum yield/ha (193.06q) and maximum per cent dry yield (19.80%) were recorded under 1.5% urea spray followed by 1%,0.5% and control (without spray). The high yielding performance of plant sprayed with urea was due to increased chlorophyll content which accelerated the photosynthetic rate and thereby increased the supply of carbohydrate to the plant. The better availability of nitrogen might have also favoured the metabolic and auxin activities in the plant and ultimately resulted in increased fruit weight, fruit set, and yield of chilli.

CHAPTER-3

METHODOLOGY

A field experiment was carried out to study the effect of foliar application of nitrogen source (urea) on growth and productivity of eggplant cv. Navkiran. These studies were initiated in *rabi* season of 2013-14 at the Agriculture Research Station, Department of Agriculture, Lovely Professional University, Punjab. The details of the materials used and techniques adopted during the course of investigation have been described in this chapter.

3.1.LOCATION OF THE EXPERIMENTAL SITE

The trial was planted from September 2013 to February 2014 at research experiment area, agricultural research station, Dept. of agriculture near the Block number 34 near waste water drain (Latitude 31.249819 and longitude 75.708455 as per goggle map coordinates with altitude of 232 m above sea level).

3.2.CLIMATE AND WEATHER

Punjab generally receives rains from both southwest and northeast monsoons. The rainfall is mostly confined to the monsoon period from June to Aug. with highest rainfall during July. Since the crop was planted in sept., these was no effect of normal monsoon however some rains occur during the planting of eggplant with may precipitation in month of Oct. (76 mm) since the experiment was directly affected by rainfall as effect of accial spray will be discounted if there was be rain immediately after the spray of nutrients. The mean day temperature hovered around (Max. 34.7^{o}c and Min. 5.8^{o}c) and during the period of experimentation range between (89.1 to 79.9%) during cropping period Table 3.1.

Table 3.1. Monthly Metrological data (2013-14) near the experimental research station, LPU, Phagwara. (http://www.tutiempo.net/en/Climate/Amritsar)

Month	Rainfall (mm)	Relative humidity	Maximum Temp.(°C)	Minimum Temp. (°C)
September	9.14	81.9	34.7	23.4
October	75.94	83	32.2	19.5
November	23.11	74.8	26.4	9.9
December	3.56	89.1	20.6	6.2
January	18.04	86.7	19.1	4.4
February	8.87	79.9	20.2	5.8
Total	138.7	-	-	-

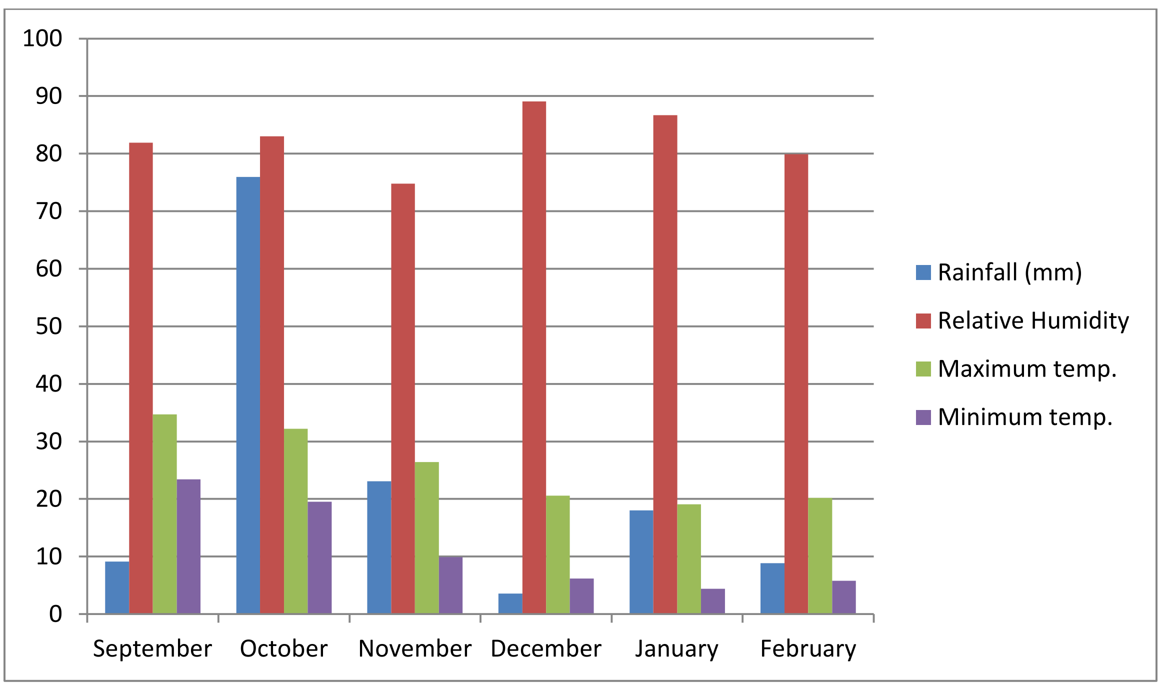

Fig:3.1. Monthly metrological data *rabi* 2013

3.3.SOIL The soil of the experimental site was alluvial soil well fertile and free from perennial weeds. The composite soil sample from experimental site was collected from 0 to 15.0 and 15.0 to 30.0 cm depth before the start of the experiment and was analyzed for different physical and chemical characteristics by following the standard procedure (Jackson, 1967). The results of physical and chemical analysis are presented in Table 3.2.

Table 3. 2. Soil physical and chemical properties of the experimental field soil.

Sr. No	**Particulars**	**Values (0- 30 cm depth)**	**Method employed**
	I. Physical properties		
1	Coarse sand (%)	61%	International pipette method (Piper, 1955)
2	Silt (%)	7%	
3	Clay (%)	32%	
	II. **Chemical properties**		
1	pH	7.7	Buckmoric Hmeter (Piper,1955)
2	Electrical conductivity (dS/m)	0.33	Jackson (1973)
3	Organic carbon (%)	0.56	Wet oxidation method (Jackson, 1957)
	4 Available nutrient status		
A	Available N (kg/ha)	163	Alkaline per magnate method (Subbaiah and Asija,1955)
B	Available P (Kg/ha)	24.4	Olsen's method (Jackson,1957)
C	Available K (kg/ha)	325	Flame photometer method (Tandon, 1993)

3.4.PREVIOUS CROP ON EXPERIMENTAL SITE

The experimental site was left fallow during previous kharif season.

3.5.EXPERIMENTAL DETAILS

The experiment consisted of 4 treatments applied in four levels of nitrogen source (urea) spray as factor. The details of treatments are given below.

Treatments	:	4
Replications	:	3
Total number of plots	:	4×3 = 12

3.5.1. Factor – Levels of nitrogen source (urea)

T1	: N (0%) Control
T2	: N (0.5%)
T3	: N (1%)
T4	: N (2%)

(Note: Nitrogen spray was taken up at 15 days intervals)

N – Nitrogen

T – Treatment

3.6. DESIGN AND LAYOUT

The experiment was laid out in randomized complete block design (RBD) with three replications. The standard cultural practices to raise the crop are followed as per PAU recommendations.

	Water Channel			
R1	T4 P4	T3 P3	T2 P2	T1 P1
R2	T2 P8	T1 P7	T4 P6	T3 P5
	Water Channel			
R3	T1 P12	T2 P11	T3 P10	T4 P9

3.6.1. Plot size:

Gross plot size : 4.7 m X 1.9 m

Net plot size : 4.2 m x 1.4 m

3.7. DESCRIPTION OF EGGPLANT VARIETY – NAVKIRAN

Navkiran eggplant variety was released from the Department of Vegetable Science, University of Agriculture, Pusa New Delhi. It has semi-erect, green leaves, oblong fruit, purple color fruit, purple flowers, solitary bearing habit and occasionally spines are noticed.

3.8. CULTURAL PRACTICES

3.8.1. Preparation of Nursery

The raised seed bed of 7.5 m length, 1.2 m width and 10 cm height were prepared in the agriculture farm soil. Then five baskets of farmyard manure (FYM) and 500g of 15:15:15 (NPK) complex were incorporated thoroughly into the soil. Eggplant seeds were placed one centimeter deep in the rows spaced at 5 cm and covered with thin layer of soil. Insecticide (BHC) 500g was dusted on the seed bed to avoid ants' attack and covered with rice straw. The seed bed was watered daily during evening hours. The thirty days old healthy seedling were transplanting in the main experimental plot.

3.8.2. Main field preparation:

The land was deep ploughed one and the land was brought to fine tilth by twice harrowing and leveling. Then FYM was incorporated at the rate of 15 tons per ha into the soil. The land was leveled with wooden plank to bring the soil to fine tilth. Then layout was done as per the plan given in and general view of the experiment is presented. The ridges and furrows were opened at a distance of 60 cm and one meter wide irrigation channels were opened between the plots.

3.8.3. Application of fertilizers

Furrows were done manually with a row spacing of 60 cm using a marker. In the furrows fertilizers were applied in the form of urea, single super phosphate and muriate of potash as a source of nitrogen, phosphorus and potassium, respectively. The presowing dose of nitrogen and phosphorus and potash fertilizers were applied at the time of transplanting.

3.8.4. Preparation and spray of macronutrient solution

As per the treatment detail 43.4 grams of urea dissolved in one liter of water in a container to make the concentration of 2% T4 solution, 21.7 grams of urea dissolved in one liter water in a separate container to make the concentration of 1% T3 solution, 10.9 grams of urea dissolved in one liter water in a separate container to make the concentration of 0.5% T2 solution and 0% T1 is control treatment. These solutions were sprayed as per the treatment details at 15 days intervals starting with 15 days after transplanting by using knapsack sprayer.

3.8.5. Transplanting

Transplanting was done on 16 September 2013 with 30 days old healthy seedling at the rate of two seedlings per hill with inter and intra row spacing of 60 cm x 50 cm, respectively. After transplanting light irrigation was given to entire plot for proper establishment of plants.

3.8.6. Gap filling

Seven days after transplanting the gap filling was done with fresh seedling in order to maintain cent percent plant population in all treatments.

3.8.7. Thinning

Seven days after transplanting thinning was done manually by removing weaker seedling from each hill and retaining one healthy seedling per hill.

3.8.8. After care

The experimental plots were kept free from weeds by regular hand weeding and inter -cultivation operations. Irrigation was given as and when required. Generally, irrigation was given once in a week depending upon soil and climate.

Plate 3.1

3.8.9. Plant protection

To control the pest and diseases, necessary plant protection measures were taken as and when required. To control fruit and shoot borer (*Leucinodes arbonalis)* carbaryl was sprayed@4 g per liter at 15 days interval for 3 times.

3.8.10. Harvesting

The fruits were harvested when fully matured and attained marketable size and regularly at a 30 days interval accordingly before the application of spray scheduled.

3.9. BIOMETRIC OBSERVATIONS

Five plants from each treatment plot were selected at random and tagged for recording the observations on the following growth and yield parameters.

3.9.1. Vegetative characteristics

3.9.1.1. Plant height (cm)

The tagged plants were used for measuring plant height. It was recorded in centimeters from the base of plant to the terminal growing point of the plant at 30, 60, 90 DAT and at harvest stage.

Plate 3.2

1.9.1.2. Number of leaves per plant

The number of leaves were counted in the tagged plant and recorded. The mean number of leaves were worked out at 30, 60, 90 days after transplanting (DAT) and harvest stage.

3.9.1.3. Total number of branches per plant

The tagged plants were used for counting total number of branches without classifying into primary and secondary branches at 30, 60, 90 DAT and at harvest stage.

3.9.2. Yield and yield components

3.9.2.1. Fruit length (cm)

Length of five mature fruits at fully ripened stage was measured individually in centimeter from base of calyx to tip of fruit using meter scale and thread thereafter average was calculated accordingly.

Plate 3.3

3.9.2.2. Fruit girth (cm)

Fruit girth was measured by using meter scale and thread thereafter average was expressed in centimeters.

3.9.2.3. Fruit yield per plant (kg)

The mean fruit weight per plant was calculated from the fruit harvested over all the pickings.

Plate 3.4

3.9.2.4. Number of fruit per plant

From five randomly selected tagged plants the total number of fruits were counted and recorded per plant. Their average was taken as the number of fruits per plant.

3.9.2.5. Fruit yield per plot (kg)

The total fruit weight for a net plot area was recorded from the fruits harvested from all the pickings.

3.9.2.5. Marketable yield per plot (Kg)

Fruits Round and dark violet color fruits devoid of disease and pest infestation, or malformation and uniform in color having good market acceptability were sorted out as marketable and their weight calculated in Kg/plot basis.

Plate 3.5

3.9.2.6. Fruit yield per hectare (Qtl)

The total fruit weight per hectare was computed based on the fruit weight per net plot.

3.10. Cost benefit ratio

Cost benefit ratio was carried out for all treatments for all culture practices starting from transplanting through to watering, weeding, fertilization and harvesting in order to assess the profitability of the various foliar treatments.

Cost benefit ratio = Net return/Cost of production

3.11. STATISTICAL ANALYSIS

The data of the respective field experiment were subjected to appropriate statistical analysis. The analysis of variance and interpretation of data were as per procedures given by Fisher and Yates (1963),(1984). Levels of significance used in 'F' test was P=0.05(*) and P= 0.01 (**). Critical difference (CD) values were calculated only wherever the 'F'test was found significant.

The data on percentage germination and field emergence were transformed into arcsine root percentage and transformed data was used for the statistical analysis.

CHAPTER-4

RESULTS AND DISCUSSION

A field experiment was carried out to study the effect of foliar application of nitrogen source (urea) on growth and yield of eggplant cv. Navkiran. The studies were initiated in *rabi* season of 2013-14 at the Agriculture Research Station, Department of Agriculture, Lovely Professional University, Punjab are presented in this chapter.

Nitrogen is one of the most important elements supplied for fast growth and development of plants. Nitrogen foliar spray has a pronounced effect on the growth, physiological and chemical characteristics in eggplant. Eggplant require a well-balanced supply of minerals throughout their life cycle for higher productivity as minerals especially nitrogen effect plant growth and development. This effect resulted in improving vigor, net assimilation rate and dry matter accumulation of plant. The soils (in general) suffering from low content of nitrogen leads to drastically reduced yields and may even result into complete failure of crop. Thereby, it is important to determine optimum nitrogen dose, which produces maximum yield, best fruit quality at minimum input in addition to reduced environmental pollution. In order to maximize yields many reports concerned with optimizing application of nitrogen and other nutrients as well as reducing environmental pollution (under varying conditions of soil and climate in this concern)were referred to and it was observed that application of nitrogen fertilizer to eggplant significantly increased number of leaves per plant, number of fruit per plant, fruit yield per plant, number of branches per plant as well as fruit yield per hectare compared to zero nitrogen fertilizer application. The current experiment consists of four variable treatments applied to standing crop of eggplant (four levels of nitrogen source). The effect of variable dosage of macronutrient has been discussed character- wise. The crop was sprayed with variable concentration of nitrogen (T1-control, T2-0.5%, T3-1.0% and T4-2.0%) with a fifteen days interval (and after fruit harvest, if any). The data for different characters was obtained as per schedule i.e. plant height, no. of leaves and branches per plant 30, 60, 90 days interval and harvest stage.

4.1. PLANT GROWTH AND GROWTH PARAMETERS

4.1 .1. Plant height (cm)

The results on plant height at 30, 69, 90 DAT and at harvest as influenced by nitrogen levels are presented in table 4.1.

Difference in plant height due to nitrogen levels at various stages was significant. Application of 0%(T1), 0.5%(T2), 1%(T3), 2%(T4). Nitrogen spray on plant height at 60 DAT was found to be lowest significant but 30and 90 DAT was found to be non – significant. The maximum plant height of 28.36, 48.18 and 68.74 cm at 30, 60 and 90 DAT, respectively was recorded in T4 treatment.

Plant height at harvest stage differed non- significantly due to nitrogen spray. The treatment T4 recorded maximum plant height (73.74 cm) than all T1, T2, and T3 treatment, which is on par with T4 treatment, while the lowest plant height (71.52 cm) was observed in T1control treatment.

Higher plant height with increasing nitrogen possibly may increase nutrients to encourage more vegetative growth. Nitrogen is an element, which is very important for many physiological processes in plants. It helps in producing chlorophyll, nucleotide, phosphotide, alkaloids, enzymes, nucleoproteins and many other necessary substances which play a vital rate in functioning of cell organelles and increase rate of cell division which in turn increase vegetative growth. Different doses of nitrogen showed non- significant effect on plant height at different stages 30, 60, 90 DAT and harvest stage. The maximum plant height (28.36 cm), (48.18 cm), (68.74 cm) and (73.74 cm) was measured with T4 treatment. The minimum plant height (27.19 cm), (46.93 cm), (67.49 cm) and (71.52 cm) was measured in the control treatment. Plant height showed a general trend of gradual increase with the increasing levels of nitrogen (0%, 0.5%, 1%, and 2%). The increase in height may not directly be influence by the foliar spray of macronutrient as non significant in 30, 90 DAT and at the time of harvest. However, at 60 DAT it shows significant (CD at 5% for T4 treatment i.e. 2.0%) in control where as no significant change in 0.5, 1.0, and 2.0% foliar spray treatment. From the above results, it can be safely predicted that the increase/decrease in plant height does not correlate with different foliar spray treatments. (Abid Khan et al., 2014) in chili and E. Yildirim et al., (2007) in broccoli crop.

Table 4.1. Influence of nitrogen source (urea) foliar spray on plant height at different growth stages in eggplant.

Treatments	Plant height (cm) at			
	30 DAT	60 DAT	90 DAT	Harvest
Macronutrient spray (N)				
T-1 (N-0%)	27.19	46.93*	67.49	71.52
T-2 (N-0.5%)	27.68	47.69	68.07	72.28
T-3 (N-1%)	28.32	48.05	68.77	72.81
T-4 (N2%)	28.36	48.18	68.74	73.74
M.S.S				
Replication	0.6811523	0.3525391	0.09570313	0.2773438
Treatment	0.9390191	0.9411892	1.109809	2.618490
Error	0.3221571	0.1124132	0.3246528	0.6276042
F-value(treatment)	2.914786 (N.S.)	8.372586*	3.418449 (N.S.)	4.172199 (N.S.)
S.Em ±	27.88±1.13	47.04±0.67	68.27±1.14	72.59±1.58
C.D. at 5%	(26.75-29.01)	(47.04-48.38)	(67.13-69.41	(71.01-74.17)

4.1.2. Number of leaves per plant

The data on number of leaves per plant at 30, 60, 90 DAT and at harvest as influenced by macronutrient, nitrogen (urea) spray effects are presented in Table 4.2.

Significant results were obtained due to the effect of macronutrient spray on number of leaves per plant at 30, 60 and 90 DAT. However, T4 treatment recorded maximum number of leaves as 29.60, 67.93 and 88.40 per plant at 30, 60 and 90 DAT, respectively, while the lowest number of leaves were 27.33, 61.80 and 81.80 per plant at 30, 60, 90 DAT respectively. But, number of leaves per plant at harvest found to be significant due to macronutrient spray. The T4 treatment recorded maximum number of leaves per plant (94.33) followed by T3 (93.80) and T2 (92.51), which were on par with T4 treatment. The lowest number of leaves per plant (91.67) was recorded with T1 treatment.

Different doses of nitrogen showed highly significant variations in the total number of leaves per plant. Number of leaves per plant showed a gradual increase with the increasing rates of nitrogen (0%, 0.5%, 1%, and 2%). Highest dose of nitrogen T4 treatment recorded the highest number of leaves at different stages 30, 60, 90 DAT and harvest stage. Numbers of leaves recorded per plant were (29.60), (67.93), (88.40) and (94.33) which was statistically identical with T3 treatment. In control treatment lowest number of leaves (27.33), (61.80), (81.80) and (91.67) per plant were recorded as these were raised without fertilizer. With T4 treatment the effect of spray of nutrients has been clearly recorded as expected, as T4 (2.0%) treatment has constantly higher number of leaves as compared to control, T2 and T3 treatment at 30 DAT and at the time of harvest. The above results are on expected lines and will be contributed to better photosynthesis and storage into fruits. Comparatively higher number of leaves with increasing rates of nitrogen may be attributed to vigorous vegetative growth of plant. Similar results were reported by Asit Baran Mondal and Abdullah Al Mamun (2011) and Ng etich et al., (2013) in Zucchini crop.

Table 4.2. Influence of nitrogen source (urea) foliar spray on number of leaves per plant at different growth stages in eggplant.

Treatments	No. of leaves per plant at			
	30 DAT	**60 DAT**	**90 DAT**	**Harvest**
Macronutrient spray (N)				
T-1 (N-0%)	27.33**	61.80**	81.8**	91.67**
T-2 (N-0.5%)	28.13	62.22**	83.13**	92.53
T-3 (N-1%)	29.06	62.53**	86.33**	93.80
T-4 (N2%)	29.60**	67.93**	88.40**	94.33**
M.S.S				
Replication	0.4423828	0.2050781	0.8203125	0.1718750
Treatment	3.021918	23.25347	27.03299	4.384549
Error	0.1192492	0.03862889	0.2816836	0.2491320
F-value(treatment)	25.34121**	601.9709**	95.96934**	17.59930**
S.Em ±	28.53±0.69	63.62±0.39	84.92±1.05	93.08±0.99
C.D. at 5%	(27.84-29.22)	(63.23-64.01)	(83.87-85.97)	(92.09-94.07)

4.1.3. Number of branches per plant

The data on total number of branches per plant at different stage as influenced by levels of nitrogen spray are given in Table 4.3.

Significant results were obtained due to the effect of macronutrient spray on number of branches per plant at 30, 60, 90 DAT, except at harvest stage However, T4 treatment recorded maximum number of branches as 5.47, 11.87 and 15.60 and 17.73 per plant at 30, 60, 90 DAT and harvest stage respectively, while the lowest number of branches were 3.33, 10.40, 13.47 and 15.53 per plant at 30, 60, 90 DAT and harvest stage respectively. The T4 treatment recorded maximum number of branches per plant followed by T3 and T2, which were at par with T4 treatment. The lowest number of branches per plant was recorded in T1 treatment.

Different doses of nitrogen showed significant variation in the number of branches per plant on different days 30, 60, 90 DAT and harvest stage. The maximum number of branches per plant (5.47), (11.87), (15.60) and (17.73) were recorded with T4 treatment. This was statistically significant. Different days after transplanting the minimum number of branches per plant were recorded as (3.33), (10.40), (13.47) and (17.73) by the control T1 treatment. Similar results were reported by Khattak et al., (2001) in aubergines (eggplant) and Hamid Reza Bozorgi (2011) in eggplant crop.

Table 4.3. Influence of nitrogen source (urea) foliar spray on number of branches per plant at different growth stages in eggplant.

Treatments	No. of branches per plant at			
	30 DAT	60 DAT	90 DAT	Harvest
Macronutrient spray (N)				
T-1 (N-0%)	3.33	10.40	13.47**	15.53
T-2 (N-0.5%)	3.67	10.93*	14.07	16.07
T-3 (N-1%)	4.53	11.33	15.33	16.73
T-4 (N2%)	5.47**	11.87*	15.60**	17.73*
M.S.S				
Replication	0.01000214	0.02325439	0.05346680	0.003295898
Treatment	2.741116	1.1555629	3.105577	2.696696
Error	0.1077746	0.1255629	0.1821968	0.3233236
F-value(treatment)	25.43379**	9.202810*	17.04518**	8.340549*
S.Em ±	4.25±0.65	11.13±0.70	14.62±0.85	16.52±1.13
C.D. at 5%	(3.60-4.90)	(10.43-11.83,)	(13.77-15.47)	(15.39-17.65,)

4.2 . FRUIT QUALITY AND YIELD COMPONENTS

4.2.1. Number of fruit per plant

The data on number of fruits per plant as influenced by levels of nitrogen spray are presented in Table 4.4.

Nitrogen spray also influenced significantly the number of fruit per plant. The treatmentT4 significantly produced more number of fruits (15.07/plant) than all other treatments. But, the lowest number of fruits (11.93/plant) was obtained with T1 treatment.

It is evident from the data that average number of fruit per plant was increased with the increasing levels of nitrogen, so highly significant variation was recorded with respect to number of fruits per plant of eggplant. The maximum (15.07) number of fruits per plant was measured with T4 treatment and the minimum (11.93) with the control T1 treatment. G. Bhuvaneswari et al., (2013) and Maral Moraditochaee (2012) also reported similar results i.e. highest level of nitrogen gave highest number of fruits per plant. They measured highest number of fruits per plant by the 2.0% nitrogen foliar spray

4.2.2. Fruit yield pre plant (kg)

Effect of macronutrient spray found was to be significant with respect to fruit yield per plant. The (T4) treatment gave higher fruit yield (1.13 kg) per plant which was followed by (T3) (1.04 kg) and (T2) (1.02 kg) treatments. The lowest fruit yield of (1.0 kg) per plant was obtained with (T1) treatment.

It is evident from the data that average fruit yield per plant was increased with increasing levels of nitrogen. So, highly significant variation was recorded with respect to fruit yield per plant of eggplant. The maximum fruit yield (1.13 kg) per plant was measured with T4 treatment and the minimum fruit yield (1.00 kg) per plant with the control T1 treatment. Shahi et al., (2002) and Maral Moraditochaee (2012) also reported similar resultse.i.highest level of nitrogen gave highest fruit yield per plant. They measured highest fruit yield per plant observed with T4 (2.0%) treatment foliar spray.

Table 4.4. Effect of nitrogen source (urea) foliar spray on number of fruits per plant and fruit yield per plant in eggplant.

Treatments	No. of fruit per plant	Fruit yield per plant (kg)
Macronutrient spray (N)		
T-1 (N-0%) **T-2 (N-0.5%)** **T-3 (N-1%)** **T-4 (N-2%)**	11.93** 12.27** 13.67 15.07**	1.00** 1.02 1.04 1.13**
M.S.S		
Replication **Treatment** **Error** **F-value(treatment)**	0.01343 6.173421 0.08000 77.17091**	0.0006585121 0.01159996 0.0002251733 51.51572**
S.E ± **C.D. at 5%**	13.23±0.56 (12.67-13.79)	1.05±0.0299 (1.02-1.07)

4.2.3. Fruit length (cm) and Fruit girth (cm)

The results on fruit length and fruit girth are presented in Table 4.5.

Nitrogen non - significantly influenced the fruit length. The maximum fruit length of (8.16 cm) was recorded with T4 treatment than T3 (7.87 cm) and T2 (7.74 cm) treatments. The minimum fruit length of (7.58 cm) was recorded with T1 treatment. Nitrogen spray influenced fruit girth non - significantly. Non - significantly highest fruit girth (6.44 cm) was recorded with T4 treatment over (6.11 cm) and (6.01 cm) T3and T2 treatments respectively. Minimum fruit girth (5.88 cm) was recorded with T1 treatment.

There was no significant difference on fruit length (8.16 cm) and fruit girth (6.44 cm) by the use of macronutrient foliar spray. Since in our experiment, shape and size of the fruit did not vary much from control (non-significant at 5% CD), it may be considered as a good sign, as aerial spray of nutrients does not have significant impact on fruit attributes, namely length and width of fruits. The reduction in soil application of fertilizer and aerial spray does not have any negative effect on size and shape of marketable fruits and thereby will be considered as a positive result from consumer preferences, since it reduces soil and environment pollution, as well as, results in lower cost of production.

Table 4.5. Effect of nitrogen source (urea) foliar spray on fruit length and fruit girth in eggplant.

Treatments	**Fruit length (cm)**	**Fruit girth (cm)**
Macronutrient spray (N)		
T-1 (N-0%)	7.58	5.88
T-2 (N-0.5%)	7.74	6.01
T-3 (N-1%)	7.87	6.11
T-4 (N2%)	8.16	6.44
M.S.S		
Replication	0.02557373	0.4049072
Treatment	0.1784736	0.1709425
Error	0.2205980	0.1027662
F-value(treatment)	0.8090443(N.S.)	1.663411(N.S.)
S.Em ±	7.84±0.94	6.11±0.64
C.D. at 5%	(6.90-8.78)	(5.47-6.75)

4.2.4. Marketable Fruit yield/plot (kg) and fruit yield/hectare (qtl)

The data on fruit yield per plot and fruit yield per ha as influenced by macronutrient spray are presented in Table 4.6.

Effect of macronutrient spray was found to be significant. Treatment (T4) recorded maximum fruit yield (10.61 kg/plot and 181.7Qtl/ha), which was followed by (T3) (9.58 kg and 164.0 Qtl/ha) and T2 (8.57 kg and 146.7Qtl/ha) treatment and the lowest fruit yield of 8.27 kg and 141.5Qtl/ha per plot and per ha, respectively was in (T1) treatment.

Different doses of nitrogen showed significant variation in fruit yield per plot and per hectare. The maximum fruit yield (10.71 kg) per plot and fruit yield (181.70 Qtl) per hectare was recorded with T4 treatment which was statistically significant. The minimum fruit yield (8.27 kg) per plot and fruit yield (141.50 Qtl) per hectare was recorded with control treatment. Similar results were reported by Maral Moraditochaee (2012) in (eggplant) and Muhammad Ayub et al., (2010) in eggplant crop.

Table 4.6.. Effect of nitrogen source (urea) foliar spray on fruit yield per plot and fruit yield per hectare in eggplant.

Treatments	Marketable fruit yield/plot (kg)	Marketable fruit yield/hectare (Qtl)
Macronutrient spray (N)		
T-1 (N-0%)	8.27**	141.5**
T-2 (N-0.5%)	8.57**	146.7**
T-3 (N-1%)	9.58	164.0
T-4 (N2%)	10.61**	181.7**
M.S.S		
Replication	0.3657227	107.3906
Treatment	3.401354	996.0486
Error	0.03221305	9.413208
F-value(treatment)	105.5893**	105.8139**
S.Em ±	9.26±0.36	158.49±6.12
C.D. at 5%	(8.90-9.62)	(152.37-164.61)

4.2.5. Cost benefit ratio

The data for total cost of cultivation, gross return, net return and cost benefit ratio due to foliar spray macronutrient on eggplant fruit production is presented in Table 4.7.

The cost of production has been same as cost of spray is negligible as compared to returns in terms of yield. This is quite higher, thereby giving a cost benefit ratio of 1.62, 1.39, 1.1.07 (T4, T3 and T2 treatments respectively) as compared to 1.06 in control. Hence it can be advantageous to the farmer, to adopt new methodology of spraying nitrogen fertilizer. This will improve yield and profit for the farmers without much expenses and efforts.

The foliar spray of nitrogen T4 (2.0%N) treatment has given higher gross and net return of Rs. 150667.90 and 93145.11 respectively B:C ratio of 1.62 followed by foliar spray of T3 (1.0%N) has given net return of Rs. 80017.50.

Table 4.7. Effect of nitrogen source (urea) foliar spray on gross return, net return and cost benefit ratio in eggplant.

Treatment	Fruit yield ($q\ ha^{-1}$)	Gross returns (Rs./ha) A	Total cost of cultivation (Rs./ha) B	Net returns (A-B Rs./ha)	Cost benefit ratio
T_1	145.5	116425.2	56479.5	59945.7	1.06
T_2	149.0	119164.6	57490.38	61674.22	1.07
T_3	171.9	137518.7	57501.2	80017.5	1.39
T_4	188.3	150667.9	57522.79	93145.11	1.62

CHAPTER-5

SUMMARY AND CONCLUSION

The experiment was conducted at the Agriculture Farm, Lovely Professional University, Punjab during the *rabi* season 2013-14 to investigate the effects of different levels of nitrogen on the growth and yield of eggplant.

The treatment consisted of four levels of nitrogen (T1-0%N control, T2-0.5%N, T3-1.0%N, and T4-2.0% N).

The experiment was laid out in the randomized complete block design (RCBD) with three replications. Eggplant seeds of 'Navkiran' variety were collected from the Gupta seed sales center of Jalandhar. Collected seeds were sown in seed bed 7.5 m x 1.2 m on 16 August, 2013. Healthy and uniform sized seedlings of 30 days were transplanted in experimental plots on 16 September, 2013 maintaining a spacing of 60 cm x 50 cm. Five plants were randomly selected from each plot to record growth, quality and yield components. The collected data was statistically analyzed for evaluation of the treatment effect.

The crop was supplemented with protective irrigation as and when required by the crop. Macronutrient (nitrogen) foliar spray 0%, 0.5%, 1.0%, and 2.0% spray were taken 15 DAT initiations.

Fruits were harvested when they were fully mature and attained marketable size regularly at a 30 days interval. The observations were recorded with respect to plant growth and growth parameters, yield and yield attributing character parameters.

The application of nitrogen source (urea) foliar spray (T4) treatment produced significantly higher growth parameters like number of leaves per plant and number of branches per plant. Number of leaves and number of branches per plant were also significantly increased with increase in the levels of nitrogen foliar spray. Treatment T4 (2.0% N) gave higher values of growth parameters.

Treatment T4 recorded significantly higher number of fruit (15.07) per plant, fruit yield (1.13 kg) per plant, fruit yield (10.61 kg) per plot and fruit yield (181.70 qtl) per hectare and recorded non-significantly fruit length (8.16 cm) and fruit girth (6.44 cm).

From the results of present investigation, it is indicated that in order to obtain high quantity and fruit quality in eggplant, it is better to go for application of nitrogen source (urea) foliar spray of (control, 0.5%, 1.0%, and 2.0%) in soil and climatic conditions of Punjab.

Among all nitrogen treatments (T1, T2, T3, and T4), T4 treatment gave highest fruit yield and good quality fruits.

CONCLUSION

The results of present of the experiment revealed that different levels of nitrogen play an important role on the growth and yield of eggplant. In respect of yield and yield contributing characters nitrogen exerted marked effect over the control. From this experiment, it was found that different levels of nitrogen showed a gradual increase of growth and yield of eggplant. Therefore, it could be suggested T4 treatment were the higher dose for the growth and yield of eggplant.

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