EFFECT OF NITROGEN AND SULPHUR ON THE GROWTH AND YIELD OF SESAME

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CERTIFICATE

*This is to certify that the thesis entitled "**EFFECT OF NITROGEN AND SULPHUR ON THE GROWTH AND YIELD OF SESAME**" submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfilment of the requirements for the degree of MASTER OF SCIENCE (MS) in AGRONOMY, embodies the results of a piece of bona fide research work carried out by MD. MEHEDI HASAN Registration. No. 09-03425 under my supervision and guidance. No part of this thesis has been submitted for any other degree or diploma.*

I further certify that such help or source of information as has been availed of during the course of this investigation has duly been acknowledged.

Dated:
Dhaka, Bangladesh

(Prof. Dr. Md. Hazrat Ali)
Supervisor

DEDICATED TO

MY

BELOVED PARENTS

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June, 2015. ***The Author***

EFFECT OF NITROGEN AND SULPHUR ON THE GROWTH AND YIELD OF SESAME

ABSTRACT

An experiment was conducted at Sher-e-Bangla Agricultural University farm, Sher-e-Bangla Nagar, Dhaka, Bangladesh during the period from March to July, 2014 to determine the effect of nitrogen and sulphur on growth and yield of sesame. The experiment consisted of two factors having 4 levels each of nitrogen (0, 75, 125, 175 kg N/ha) and sulphur (0, 50, 100 and 150 kg S/ha) laid out in Spilt Plot design with three replications. Plant height, number of leaves, capsule number, capsule length, seed per capsule, 1000 seed weight, seed yield and harvest index were varied significantly with increasing N level upto 75 kg N/ha (N_1). The seed yield and harvest index were 1.38 t/ha and 29.43% respectively when applied 75 kg N/ha. But the highest stover yield (3.81 t/ha) was recorded with 175kg N/ha. On the other hand, plant height, capsule number, capsule length, seed per capsule, 1000 seed weight, seed yield and harvest index were increased significantly with increasing S level upto 50 kg S/ha (S_1). The maximum seed yield (1.31 t/ha) was obtained at 50 kg S/ha and the maximum stover yield (4.70 t/ha) was observed at 100 kg S/ha. The highest seed yield was recorded from the combination of N_1S_1 (75kg N/ha and 50 kg S/ha) and the combination of N_3S_3 (175kg N/ha and 150 kg S/ha) produced the highest stover yield.

LIST OF ABBREVIATED TERMS

ABBREVIATION	FULL NAME
AEZ	Agro-Ecological Zone
et al.	and others
BBS	Bangladesh Bureau of Statistics
cm	Centimeter
^{o}C	Degree Celsius
DAS	Date After Seeding
etc	Etcetera
FAO	Food and Agriculture Organization
g	Gram
ha	Hectare
hr	Hour
kg	Kilogram
m	Meter
mm	Millimeter
Mo	Month
MoP	Muriate of potash
no.	Number
%	Percent
m^2	Square meter
TSP	Triple super phosphate
UNDP	United Nations Development Program

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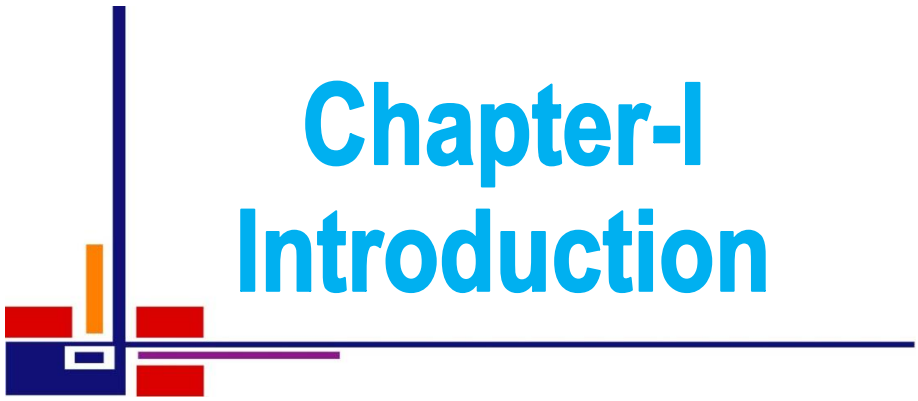


Chapter-I
Introduction

CHAPTER 1

INTRODUCTION

Sesame *(Sesamum indicum L.)* belonging to the family *Pedaliaceae*, is one of the important oil crops, which widely cultivated in different parts of the world. It is grown for seed and oil, both for human consumption and has been grown for thousands of years and today its major production areas are the tropics and the subtropics of Asia, Africa, East and Central America. In Bangladesh, it is locally known as til and is the second important edible oil crop (Mondal *et al.,* 1997). Sesame is a versatile crop having diversified usage and contains 42-45% oil, 20% protein and 14-20% carbohydrate (BARI, 2004).

Sesame oil is generally used mostly for edible purpose in confectionaries and for illumination. It is also used for some other purposes, such as in manufacture of margarine, soap, paint, perfumery products and drugs and as dispersing agent for different kinds of insecticide. Sesameolin, a constituent of the oil, is used for its synergistic effect in pyrethrumj, which increases the toxicity of insecticides (Chaubey *et al.,* 2003). The sesame oilcake is a very good cattle feed since it contains protein of high biological value and appreciable quantities of phosphorus and potassium. The cake is also used as manure (Malik *et al.,* 2003). Sesame seed may be eaten fried mixed with sugar or in the form of sweetmeats. The use of the seeds for decoration on the surface of breads and cookies is most familiar to the Americans.

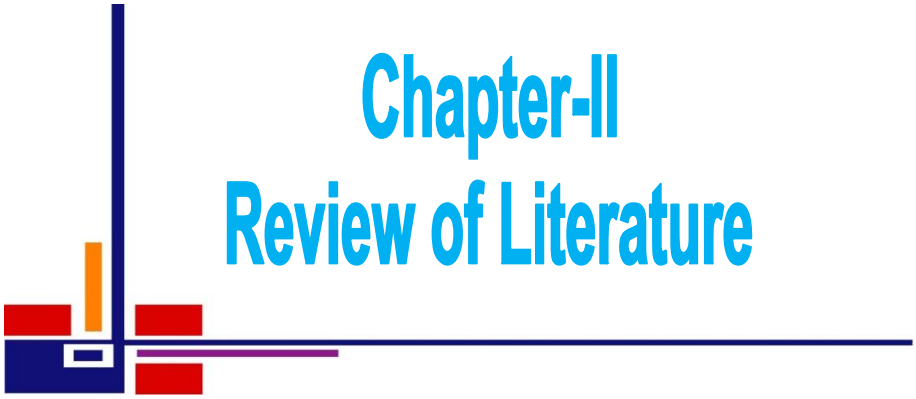
The climate and edaphic conditions of Bangladesh are quite suitable for sesame cultivation. The crop is cultivated either as a pure stand or as a mixed crop with aus rice, jute, groundnut, millets and sugarcane. Among various oil crops grown in Bangladesh, sesame ranks next to mustard in respect of both cultivated area and production. Sesame is grown in almost all regions of Bangladesh. In 2007-2008, the crop covered an area of 78.50 thousand hectares in Bangladesh with the production of 51,000 tons (BBS, 2009). The crop is grown in both rabi and kharif seasons in Bangladesh but the Kharif season covers about two-third of the total sesame area. Khulna, Faridpur, Pabna, Barisal, Rajshahi, Jessore, Comilla, Dhaka, Patuakhali, Rangpur, Sylhet and Mymensingh districts are the leading sesame producing areas of Bangladesh (BARI, 2004).

Yield and quality of seeds of sesame are very poor in Bangladesh. The low yield of sesame in Bangladesh however is not an indication of low yielding potentiality of this crop, but may be attributed to a number of reasons *viz*. unavailability of quality seeds of high yielding varieties, fertilizer management, disease and insect infestation and improper irrigation facilities. Deficiency of soil nutrient is now considered as one of the major constraints to successful upland crop production in Bangladesh (Islam and Noor, 1982). To attain considerable production and quality yield for any crop it is necessary to proper management ensuring the availability of essential nutrient in proper doses. Generally, a large amount of fertilizer is required for the growth and development of vegetable crops (Opena *et al.,* 1988).

Nitrogen plays a vital role as a constituent of protein, nucleic acid and chlorophyll. It is also the most difficult element to manage in a fertilization system such that an adequate, but not excessive amount of nitrogen is available during the entire growing season (Anon., 1972). An adequate supply of nitrogen is essential for vegetative growth and desirable yield (Yoshizawa *et al.,* 1981). On the other hand excessive application of nitrogen is not only uneconomical, but it can prolong the growing period and delay crop maturity. Excessive nitrogen application causes physiological disorder (Obreza and Vavrina, 1993). Sulphur plays a remarkable role in protein metabolism. It is required for the synthesis of proteins, vitamins and chlorophyl and also S containing amino acids such as cystine, cysteine and methionine which are essential components of protein (Tisdale *et al.,* 1999). Lack of S causes retardation of terminal growth and root development. S deficiency induces chlorosis in young leaves and decrease seed yield by 45% (BARI, 2004).

On the basis of the above facts, the present study was undertaken to maximize the seed yield of sesame with nitrogen and sulphur fertilizer with the following objectives:

i. To find out the effects of nitrogen on seed yield of sesame
ii. To see the effect of sulphur fertilization on seed yield of sesame
iii. To see the interaction effect of nitrogen and sulphur fertilization on seed yield of sesame



Chapter-II
Review of Literature

CHAPTER 2
REVIEW OF LITERATURE

In Bangladesh and in many countries of the world sesame is an important and most valuable oil crop. The crop has conventional less attention by the researchers on various aspects because normally it *grows* without care or management practices. Based on this very few research work related to growth, yield and development of sesame have been carried out in our country. Optimum nitrogen and sulphur fertilizers play an important role in improving sesame yield. But research works related to nitrogen and sulphur fertilizer on sesame are limited in Bangladesh. However, some of the important and informative research findings related to the nitrogen and sulphur on sesame have been reviewed in this chapter under the following headings-

2.1 Effect of nitrogen on sesame

Vegetable sesame *(Sesamum radiatum)* was fertilized with N applied as urea (46% N) at 0, 30, and 60 kg/ha and P applied as single super phosphate (SSP) (7.8% P) at 0, 15, and 30 kg/ha in a field experiment conducted by Auwalu *et al.* (2007) in the dry season of 1996 and wet season of 1997. Application of N significantly increased plant height, number of leaves per plant, leaf area index (LAI), leaf fresh and dry weight as well as total marketable yield in both seasons; shoot dry weight was not significantly increased by N application in the 1996 dry weight was not significantly increased by N application in the 1996 dry season.

The effect of nitrogen (N) rates (0, 60 and 90 kg/ha) and plant densities on the yield and yield components of sesame *(Sesatnum indicwn)* cultivars Zarghan local and Darab 14 was evaluated in Iran by Fard and Bahrani (2005). N rates exhibited significant effects on the number of branches per plant, number of capsules per plant, and seed and protein contents. Plant density also had significant effects on the seed yield, biological yield, harvest index, number of branches per plant and number of capsules per plant. Increasing N rates along with plant density

increased the seed yield. Zarghan local recorded the highest yield (1724 kg/ha) and harvest index with the 90 kg N/ha rate and 25.0 plants/m^2 density. Application of 90 kg N/ha increased the protein accumulation by 25% compared to the control (no fertilizer). Seed oil percentage was a stable yield component and was not affected by either N rate or plant density.

A study was conducted by Abdel *et al.* (2003) in the sandy soil of Assiut, Egypt in 2001 and 2002 to investigate the effects of sowing dates, N fertilizer rate (60, 80 and 100 kg/ha) and plant population on the performance of sesame cv. Giza 32. Plants sown on 10 May showed the maximum height (178.99 cm), the height of the first branch and the number of branch per plant were the highest in plants sown on 25 May, while the height of the first capsule was the highest in plants sown on 10 June. The height of the first branch and first capsule, as well as the length of the fruiting zone were the highest at 60 kg N/ ha. The highest seed and oil yields (6.20 kg/ha and 366.39 kg/ha, respectively) were obtained at 80 kg N/ha

A study was conducted by Malik *et al.* (2003) in Faisalabad, Pakistan in 2001 to investigate the effects of different N levels (0, 40 and 80 kg/ha) on the productivity of sesame cv. TS-3 under different plant geometries (flat sowing, paired row planting, ridge sowing and bed sowing). N at 80 kg/ha produced the highest yield (0.79t/ha), 1000-seed weight (3.42 g) and seed oil content (45.88%). Among the plant geometry treatments, bed sowing (50/30 cm) produced the highest seed yield of 0.85 t/ha and seed oil contents (44.06%).

Pathak *et al.* (2002) carried out a field experiment during the kharif seasons of 1997 and 1998, in the Barak Valley Zone of Assam, India, to evaluate the effect of N levels (0, 15, 30 and 45 kg/ha) on the growth and yield of sesame *(S. indicum)*. N at 45 kg/ha recorded the highest mean values for plant height (74.3 cm), number of branches per plant (4.50), number of capsules per plant (39.0) and 1000-grain weight (2.91 g). N at 45 kg/ha also recorded the highest seed yield

(6.95 and 7.25 q/ha), net return (Rs 4450 and 4700/ha) and benefit cost ratio (1.78 and 1.84) during 1997 and 1998, respectively.

A field experiment was carried out by Singh *et al.* (2001) at Agra during rainy (kharif) seasons of 1995 and 1996 to assess the effect of nitrogen levels and different weed control techniques to *Sesamum indicum* on weed density, seed yield, nutrients depletion by weeds and net returns. 60 kg N/ha registered the highest yield (979 kg/ha) and net returns (Rs. 10327/ha) in addition to higher N uptake by crop and N depletion by weeds. However, higher levels of N could not influence P and K removal by weeds significantly

A field experiment was conducted by Ashfaq *et al.* (2001) during the summer seasons of 1996 and 1997, in Pakistan, to study the response of 2 sesame genotypes (92001 and TS3) to different rates of N and P (0, 40, 80 and 120 kg/ha). N at 120 kg/ha and P at 40 kg/ha significantly increased the seed and stalk yield of sesame, as well as the protein content of the oil. This response was higher in TS3 than in 92001.

Six combinations of 2 N (20 and 40 kg N/ha) and 3 K rates (0, 33 and 66 kg K/ha) were applied to soybean and sesame as sole crop or intercropped in a field experiment conducted by Mondal *et al.* (2001) in West Bengal, India during the rainy and summer seasons of 1994 and 1995. Oil yield of sesame and soybean as sole crops were higher compared to the oil yield of both crops as intercrops. Highest oil yield of soybean and sesame was observed with 66 kg K/ha + 40 kg N/ha application. Nutrient uptake by soybean as a sole crop and combined uptake of nutrients by both intercrops were higher during the rainy season than their respective nutrient uptake during summer. However, nutrient uptake of sesame as sole crop was higher in summer than during the rainy season. Maximum uptake of nutrients in both sesame and soybean was observed with 66 kg K/ha + 40 kg N/ha application. Continuous N application resulted in higher N-status in soil.

However, application of K with N resulted in a decreased total N status in soil after the fourth cropping.

The effects of N fertilizer application and weed control measures on sesame were investigated by Prakash *et al.* (2001) in Uttar Pradesh, India, during 1995 and 1996 treatments consisted of 4 N levels (0, 30, 60 and 90 kg/ha) and weed control. N fertilizer rate did not significantly affect the weed population.
Application of 90 kg N/ha resulted in the highest number of capsules per plant, seeds per capsule, 1000-seed weight, seed yield, straw yield and harvest index in both the years.

Two field experiments were conducted by Fayed *et al.* (2000) in Egypt during 1997-98 to study the productivity and performance of sesame under drip irrigation as affected by sowing rate (3.6 kg/ha) and nitrogen fertilizer application (30, 60 and 90 kg/ha) in newly cultivated sandy soil. Increasing nitrogen rates up to 60 kg N/ha significantly increased the values of the yield and all the yield attributes of sesame. Further increase in N rates more than 60 kg/ha had no significant effects on seed yield and yield components except plant height.

A field experiment was conducted by Mitra and Pal (1999) in West Bengal, India, during the summer season (pre-kharif) of 1991 to study the effect of irrigation and nitrogen on growth, yield and water use of summer sesame *(Sesamum indicurri)*. A significant increase in seed yield of sesame was recorded up to three irrigations (0.784 t/ha). The increase in dry matter, number of capsules/plant, seed/capsule and seed yield of sesame was significant up to 100 kg N/ha. Further increase in nitrogen depressed the seed yield and yield attributing characters. For seed yield, the response to applied nitrogen was quadratic in nature and maximum response (0.90 kg seed/kg N) was observed at 100 kg N/ha level.

A field experiment was conducted by Parihar *et al.* (1999) during the summer seasons of 1995 and 1996 on a clay-loam soil at Bilaspur to study the response of summer sesame to irrigation and nitrogen levels. Irrigation scheduled at 0.6 IW/CPE was found to be the optimum, with little further increase in yield from irrigation at 0.8 IW/CPE. Yield increased with increasing N rate (0-80 kg/ha).

A field experiment was conducted by Singh and Singh (1999) in Uttar Pradesh, India, for 2 years (1991 and 1992) during the monsoon season to study the N requirement of the sesame + *V. mungo* intercropping system. The treatments included sole cropping and intercropping of sesame and *V. mungo,* and application of N at 3 rates (10, 20 and 40 kg/ha). Sole crop yields were higher than intercrop yields in both crops. Growth characters of both crops in the intercropping system improved with increasing N rates. The oil content and yield of sesame sole crops, and the grain and protein yields of *V. mungo* sole crops increased with increasing N rates. The best N treatment in intercropping systems was the application of 40 kg N/ha to sesame and 10 kg N/ha to *V. mungo.*

Subrahmaniyan and Arulmozhi (1999) conducted a field study during summer 1996 and 1997 at Vridhachalam, Tamil Nadu, India, sesame cv. VS 9104 and VRJ 1 were grown at densities of 111000 or 166000 plants/ha and given 0, 35,45 or 55 kg N/ha. VS 9104 had a higher number of branches and capsules/plant and higher dry matter production/plant, 1000-seed weight and yield than VRI 1. Yield and yield component values increased with increasing N rate.

In a field experiment conducted by Singaravel and Govindasamy (1998) in 1990 at Neyveli, Tamil Nadu, India, sesame cv. TMV 4 was given 35 kg N/ha and/or Azospirillum, together with 0, 10, 20 or 30 kg humic acid/ha Seed yield and dry matter production were greatest with N fertilizer + 20 kg humic acid.
In a field experiment conducted by Thakur *et al.* (1998) at Raigarh, Madhya Pradesh during the 1994 and 1995 rainy seasons, sesame cv. Gujrat 1 was given

30, 45 or 60 kg N and 20, 30 or 40 kg P_2O_5/ha. Seed, oil and protein yields increased significantly with up to 45 kg N and 30 kg P_2O_5/ha.

A field experiment carried out by Bassiem and Anton (1998) in Ismailia, Egypt, during 1996 and 1997 to investigate the effects of N (at 30, 60 and 90 kg/ha) and K (at 24 and 48 kg K_2O/ha) and foliar spray with ascorbic acid (500 ppm) on yield and its components as well as seed contents of oil and protein of sesame cv. G.32. Seed yield increased significantly by increasing N upto 90 kg/ha, whereas yield attributes increased significantly by adding N upto 60 kg N/ha.

A field experiment was conducted by Dixit *et al.* (1997) during early rabi (winter) season of 1991-92 at Powarkheda, Madhya Pradesh to assess the productivity of sesame cv. TC-25 and Rauss-17 sown at 333 000, 444,000 or 666,000 plants/ha with application of 0-90 kg N/ha. Application of N upto 60 kg/ha increased the seed yield significantly and gave the highest net profit.

In a field experiment in 1990-91 at Tikamgarh, Madhya Pradesh, 4 sesame (*Sesamum indicum)* cultivars were sown at spacing of 30 x 10 or 15 cm and given 0-90 kg N/ha by Tiwari and Namdeo (1997). The application of 90 kg N produced the highest seed yield of 0.81 t/ha. Seed oil contents decreased and protein content increased with increasing N rate.

In field trials in 1993-94 at Cuttaek, Orissa, India, sesame cv. Kalika, Kanak, OMT 10, Uma, Usha and Vinayak sown in rice fallows were compared by Moorthy *et al.* (1997). Seed yield was highest in cv. Kalika, whereas seed oil content was highest in cv. Uma. In a second trial in 1994-95 the same cultivars (except cv. OMT 10) were given 0-90 kg N/ha. Seed yield was not significantly different between cultivars and it increased with rate of N application. Seed oil content was highest in cv. Kalika and it increased with up to 60 kg N/ha.

Mondal *etal.* (1997) carried out a field trial at the University Farm, Kalyani, West Bengal, in summer 1992 in which sesame was not irrigated, irrigated at branching and seed setting growth stages or irrigated at branching, flowering and seed setting growth stages and given 0, 30, 60, 90 or 120 kg N/ha. Plant height, Dry matter accumulation, number of capsules/plant, number of seeds/capsule, 1000-seed weight, seed yield and oil and protein yields were all increased as irrigation frequency and nitrogen fertilizer rate increased. Harvest index was not significantly affected by N application, but increased slightly with irrigation.

Ashok *etal.* (1996) conducted a field experiment in 1990-91 at Pusa, Bihar, where sesame was irrigated at irrigation water: cumulative pan evaporation (IW: CPE) ratios of 0.3, 0.5 or 0.7 or irrigated 30 and 60 d after sowing (DAS), and was given 0-90 kg N/ha. Irrigating at an IW: CPE ratio of 0.7 gave the highest mean seed yield of 0.81 t/ha. Irrigations at 30 and 60 DAS used the same quantity of water as irrigating at an IW: CPE ratio of 0.5, but the seed yield was significantly" higher in the former treatment in 1990. Seed yield was highest with 90 kg N in 1990 (0.91 t/ha) and increased with up to 60 kg N in 1991 (0.92 t/ha). Total N uptake increased with increasing irrigation frequency and increasing N rate. Seed oil content was highest with 30 kg N.

In a field trial conducted by Balasubramaniyan (1996) at Vridhachalam, Tamil Nadu during the 1992-93 summer seasons on sandy-loam soil, 2 sesame genotypes were sown at 3.0, 4.5 or 6.0 \ 105 plants/ha and given 0, 30, 60 or 90 kg N/ha. The pre-release genotype VS 350 yielded more (711 kg/ha) than cv. TMV 3 (636 kg/ha), and matured 10-12 days earlier. Yield was not significantly affected by plant density, but was increased by 30 kg N.

In a field trial conducted by Hooda *et al* (1996) in the rainy season of 1995 at llisar, Haryana, Pennisetum glaucum cv. HHB 67 was intercropped with green gram and sesame cv. Haryana Til No. 1 and was given 0-40 kg N/ha. Grain and straw yields of *P. glaucum* were highest when grown alone with 40 kg N/ha Gross and net returns were highest when *P. glaucum* was intercropped with green gram with application of 40 kg N/ha.

Seed yield of sesame grown at Joydebpur in India by Roy *et al.* (1995) in the early summer seasons of 1991-92 was 0.75 t/ha without N fertilizer and 0.91-0.97 ton/ha with 40-120 kg N. Applied K also increased yield, with no significant difference between application rates of 33.2 and 66.4 kg K/ha.

A field experiment was conducted by Chandrakar *et al.* (1994) during the summer season of 1991 at Raipur, Madhya Pradesh. Sesame cv. Selection 5 irrigated at branching and podding stages, at an irrigation water: cumulative pan evaporation (IW:CPE) ratio of 0.5 upto the podding stage and 0.7 IW:CPE ratio after podding or at IW:CPE ratio of 0.7 throughout plant growth gave seed yields of 1.29, 1.45 and 1.58 t/ha, respectively. Seed yields increased with increasing N (0, 50,100 or 150 kg/ha).

2.2 Effect of Sulphur on sesame

The sulphur (S) dynamics and its availability are less studied than other nutrients, even though S is an essential nutrient for crops production (Rheinheimer *et al*.2007). They carried out a study to evaluate the crop responses to SO_4

application in different soils and to study S recuperation by balancing it in soil and plants. The study composed of a greenhouse experiment with six successive crops (canola, soybean, black bean, sesame, clover and wheat) using four soils and four SO_4 levels (0, 5, 10 and 20 mg/kg) to evaluate immediate and residual effect of SO_4 application. Soil samples were taken from 0-10 cm layer before and after each crop and analysed for SO_4. The dry matter production and SO_4 absorbed by plants were evaluated. The increase of SO_4 availability with fertilizer application was greater in soils with more clay content.

The effects of sulphur in the form of Cochin Refinery sulphur material at 0, 20, 40, 60 and 80 kg/ha, applied alone or in combination with *Thiobacillus* inoculation and/or farmyard manure application on the seed and oil yield, as well as S uptake of sesame cv. Col were determined by Maragatham *et al.* (2006) in a field experiment conducted in Tamil Nadu, India during 2000. Application of Cochin sulphur material at 40 kg/ha resulted in the highest seed yield (0.82 t/ha) as well as S uptake by the plants (5.88 kg/ha).

Amudha *et al.* (2005) carried out an experiment in Tamil Nadu, India, during the summer and kharif seasons in 2001 to study the effects of sulphur at varying rates 0, 15, 30 and 45 kg/ha and different organics (farmyard manure, poultry manure and press mud each applied at 10 t/ha) on the yield and sulphur use efficiency (SUE) of sesame *(Sesamum indicum* cv. TMV 3). The seed and stover yields progressively increased with increasing S levels. While the response ratio, apparent S recovery and agronomic efficiency, but not physiological efficiency, were decreased with increasing S levels. Treatment with 45 kg S/ha registered the maximum seed (870.2 and 898.1 kg/ha) and stover yields (2853.2 and 3155.7 kg/ha) for summer and kharif seasons, respectively, as well as the maximum SUE. Among the organics, poultry manure recorded the highest response ratio, apparent S recovery, agronomic efficiency, physiological efficiency, SUE and seed yield (777.4 and 801.8 kg/ha for summer and kharif seasons, respectively).

To evaluate the efficiency of S sources and optimum S requirement in sesame, studies were carried out by Duhoon *et al.* (2005) during kharif season under rained conditions at four locations in India, i.e. for four years during 1998-2001 at Amreli (Gujarat) on Vertisol, for three years during 1998-2000 at Jalgaon (Maharashtra) on Vertisol and Vriddhachalam (Tamil Nadu) on Alfisol, and for two years during 2000-01 at Tikamgarh (Madhya Pradesh) on Inceptisol. The treatments consisted of three sources (elemental S, gypsum and single super phosphate) and three levels of sulphur (15, 30 and 45 kg/ha) plus the untreated control. Application of 15 kg S/ha through gypsum or single superphosphate gave remarkably higher seed and oil yields with higher benefit cost ratio on Vertisol of Amerli and Jalgaon, and Inceptisol of Tikamgarh. Sulphur had no significant effects on these parameters on Alfisol of Vriddhachalam.

Field experiments were conducted by Vaiyapuri *et al.* (2004) during the 2001 summer and kharif seasons in Tamil Nadu, India, to study the effect of S (0, 15, 30 and 45 kg/ha) and organic amendments (farmyard manure, poultry manure and sulfitation pressmud each at 10 t/ha) on the growth and yield of sesame cv. TMV 3. S at 45 kg/ha and poultry manure gave the maximum plant height, leaf area index at 60 days after sowing, number of branches per plant, total chlorophyll content at 60 days after sowing, number of capsules per plant, number of seeds per capsule, 1000-seed weight, seed yield and stover yield.

A study was conducted by Sharma and Gupta (2003) to determine the effect of sulphur (S) on the growth and yield of selected rainy season crops (cowpea, cluster bean, pearl mille, castor and sesame) in Rajasthan, India, during the rainy season of 1998. Treatments comprised of four S rates (0, 20, 40 and 60 kg/ha). Sulphur increased the height of all tested crops. Increasing S rates also increased the dry_ matter accumulation per plant. Supply of S also promoted floral primordial initiation resulting in higher number of pods (or earheads) per plant and seed number per pod or (earhead), and ultimately enhanced seed yield. Application of S had positive effects on the yields of all crops. The yield increase

as a result of 60 kg S/ha varied greatly, ranging from 27% (sesame) to 45% (cowpea). The average grain yield obtained upon treatment with 40 kg S/ha 13.8 q/ha vs. that obtained upon treatment with the control (10.8 q/ha).

A field experiment was conducted by Sarkar and Banik (2002) during spring oi 1999 and 2000 to study the effects of planting geometry (30x30, 45x15, and 45X 30 cm), row orientation (east-west and north-south), and sulphur rate (0, 25, and 50 kg/ha) on the growth and productivity of sesame cv. B 67. Sowing was conducted on 12 March 1999 and 14 March 2000 after winter rice. Sesame matured in 90 days and was harvested in the first fortnight of June. Despite reductions in yield attributes (capsules per plant, seeds per capsule, and 1000-seed-weight), plants grown at 45x15 cm had the highest seed yield (873 kg/ha), mainly due to high plant density. Planting in north-south direction and applying 50 kg S/ha were more effective in improving leaf area index, crop growth rate, relative growth rate, net assimilation rate, yield attributes, and crop yield than planting in east-west direction and applying 25 kg S/ha.

A field experiment was conducted by Radhamani *et al.* (2001) in Tamil Nadu, India, during summer of 2000 to study the effect of 100 ppm salicylic acid (SA); 100 ppm mepiquat chloride (MC); 0.5% potassium chloride; 100 ppm SA or MC+0.5% potassium chloride; and 20 kg S (gypsum)/ha singly or in combination with 100 ppm SA or MC, 0.5% potassium chloride, and 100 ppm SA or MC+0.05% potassium chloride on sesame cv. TMV 3.. At 30 DAS, 20 kg S/ha singly gave the tallest plants (17.30 cm) and with 100 ppm SA, the highest dry matter production (41.90 kg/ha). At harvest, the tallest plants (108.50 cm) were recorded for 20 kg S+100 ppm SA+0.5% potassium chloride while the highest dry matter production was obtained with 20 kg S/ha singly (3.90 kg/ha) or in combination with 100 ppm SA (3,94 kg/ha) and 100 ppm SA+0.5% potassium chloride (3.87 kg/ha). Treatment with 20 kg S/ha+0.5% potassium chloride and

20 kg S/ha+100 ppm SA+0.5% potassium chloride gave the highest number of capsules per plant (88 and 92), number of seeds per capsule (42 and 47), seed yield (732 and 747 kg/ha), and oil content (44.30%).

Ghosh *et al.* (1997) carried out an experiment with sesame cv. Rama grown on the Gangetic alluvial plains in summer 1994 was given 0-60 kg S/ha and irrigated 1-3 times at different growth stages. Plant height, branch number/plant, dry matter content/plant, 1000-seed weight, and seed and oil yield were highest with 40 kg S. Among irrigation treatments, seed yield was highest (0.76 t/ha) with 3 irrigations at branching, flowering and pod development (30, 50 and 70 days after sowing). The crop responded to higher S rates with 2-3 than with 1 irrigation.

In a greenhouse experiment conducted by Yadav *el al.* (1996) the response of sesame cv. Pratap to different sources of sulphur applied through ammonium sulfate, gypsum, pyrites and elemental sulphur was studied on an alkaline sandy loam soil. Seed and stalk yields, S uptake and oil content of sesame increased significantly with increasing levels of sulphur. Amongst the sources of S tested,.--ammonium sulfate and gypsum were the best followed by pyrites and elemental sulphur in respect of yield, oil content and S uptake.

In a field experiment conducted by Chaplot (1996) in kharif 1986 in Udaipur, Rajasthan, India, sesame was given 20, 40 or 60 kg P_2O_5a /ha as DAP (diammonium phosphate) or SSP (single superphosphate) with or without 50 kg S/ha. Application of 40 or 60 kg P_2O_5/ha gave the best growth and yield. P source was not significant. The highest net return and benefit cost ratio was obtained with the application of S in combination with 40 kg P_2O5/ha as DAP.

2.3 Interaction effect of nitrogen and sulphur on sesame

The effects of N (0, 30, 60 and 90 kg/ha), B (0 and 1 kg/ha) and S (0, 25 and 50 kg/ha) on the growth and productivity of sesame cv. B-67 were investigated by Sarkar and Anita (2005) during the summer seasons of 2001 and 2002 in West Bengal, India. N, S and B improved leaf area index, biomass production, crop growth rate, relative growth rate, net assimilation rate and yield attributes, which resulted in higher seed yield. N at 90 kg/ha, S at 50 kg/ha and B at 1 kg/ha resulted in 94.2, 30.4 and 10.4% higher seed yield, respectively, compared to the control. Increasing N and S levels increased the agronomic and physiological efficiency of the nutrient.

A field experiment was conducted by Naugraiya and Jhapatsingh (2004) in Chhattisgarh, India, during the rainy season to find out the response of oil seed crop, *Sesamum indicum* to nitrogen, sulphur and tree canopy of *Dalbergia sissoo* under agrisilviculture system. Tree canopy of *D. sissoo* had partially adverse effect on plant dry matter production, leaf area index, capsules /plant, length of capsule and seeds/capsule of intercropped sesame, resulting in 6.21% decrease in sesame yield as compared to the crop grown in open field. The role of nitrogen resulted significant increase in the growth and yield attributes, with highest values under N60. Application of sulphur (10 kg S/ha) enhanced the growth and yield attributes significantly than control.

A field experiment was conducted by Chaubey *et al.* (2003) in Uttar Pradesh, India during rainy (kharif) seasons of 1997 and 1998 to study the response of

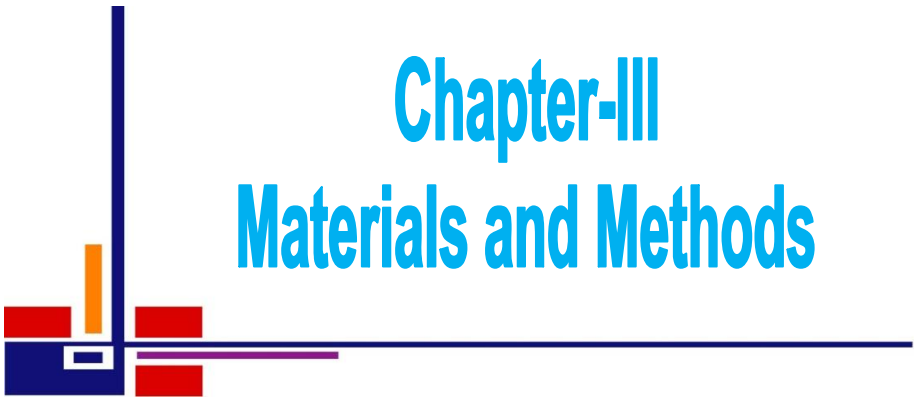
nitrogen and sulphur on growth, yield attributes and yield of sesame *(Sesamum indicum* cv. T-4). The growth, yield attributes and seed yield of sesame were significantly increased with the application of different levels of nitrogen (0, 15, 30, 45 and 60 kg/ha) and sulphur (0, 15, 30 and 45 kg/ha). Interaction of N and S was also significant for capsules/plant and seed yield up to 45 kg N and 30 kg S/ha during both the years. Further increase in the dose of N and S i.e. 60 and 45kg/ha, did not bring significant increase in the seed yield and other attributes. Application of 45 kg N along with 30 kg S/ha was the optimum dose of N and S for getting the highest seed yield of sesame.

The effects of gypsum (0, 500, and 1000 kg/ha) and N (4 5, 60, and 75 kg/ha) rates, and spacing (10, 20 and 30 cm) on sesame cv. Giza 32 were studied by Allam *et al.* (2002) in Assiut, Egypt, in 2000 and 2001. Gypsum was applied during sowing and 55 days after sowing. N as ammonium nitrate was applied after thinning and 3 weeks thereafter. Increasing gypsum and N rates increased plant height, length of fruiting zone, number of branches and capsules per plant, seed yield per plant and per hectare, oil percentage, and oil yield. Seed index and capsule length were highest with 60 and 75 kg N/ha.

A field experiment was conducted by Tiwari *et al.* (2000) during the kharif seasons of 1996 and 1997 in Madhya Pradesh, India. Seeds of sesame cultivars were sown on 21-22 July 1996 and 1997 at 5 kg/ha. In the main plot, N was applied at (15, 30 or 60 kg/ha) partly as diammonium phosphate (basal application at 30 kg P_20_5/ha, supplying 12 kg N/ha). The remaining N was supplied by urea (50% basal and 50% at 30 days after sowing). Crops were harvested on 15-17 October of both years. Subplots were treated with 0, 15 or 30 kg sulphur/ha. Significant improvement in growth and yield (plant height; numbers of primary branches, leaves and capsules/plant; pod length on the stem; number of seeds/capsule; 1000-seed weight and seed and straw weights) were observed for N at 60 kg/ha, compared with N at 15 kg/ha. S at 30 kg/ha resulted in a significant increase only in the numbers of capsules/plant, seeds/capsule,

OSW and SW, compared with S at 0 and 15 kg/ha. SO decreased and SP increased significantly with increasing N, while S application enhanced both SO and SP.

In a field experiment conducted by Nageshwar *et al.* (1995) during the summer season of 1991 at Raipur, Madhya Pradesh, sesame cv. Selection 5 was given 40, 80 or 120 kg N, 0, 30, 60 or 90 kg K_2O and 0 or 10 kg S/ha. Seed yield was the highest with 120 kg N (1.82 t/ha), 60 kg K_2O (1.75 t/ha) and S application (1.68 t/ha). Seed oil content was not affected by fertilizer application. Uptake of P, K and S increased with increasing N rate while N uptake was not affected by N rate. P, K and S uptakes were highest with 90 kg K_2O. S application increased N and K uptakes



Chapter-III
Materials and Methods

CHAPTERS 3
MATERIALS AND METHODS

The experiment was conducted during the period from March to July, 2014 to find out the effect of nitrogen and sulphur on the growth and yield of sesame. This chapter presents a brief description of the experimental site, soil, climate, experimental design, treatments, cultural operations, data collection and analysis of different parameters under the following headings:

3.1 Location

The experiment was conducted at the research field of Sher-e-Bangla Agricultural University farm, Dhaka, Bangladesh. The location of the experimental site is 23°74/N latitude and $90^0$35/E longitude and an elevation of 8.20 m from sea level (Anon., 1989). The following map shows the specific location of the experimental site (Plate 1).

3.2 Characteristics of soil

The soil of the experimental field belongs to the Tejgaon series under the Agroecological Zone, Madhupur Tract (AEZ- 28) and the General Soil Type is Deep Red Brown Terrace Soils. A composite sample was made by collecting soil from several spots of the field at a depth of 0-15 cm before the initiation of the experiment. The collected soil was air-dried, ground and passed through 2 mm sieve and analyzed for important physical and chemical parameters. The initial physical and chemical characteristics of soil are presented in Table 1.

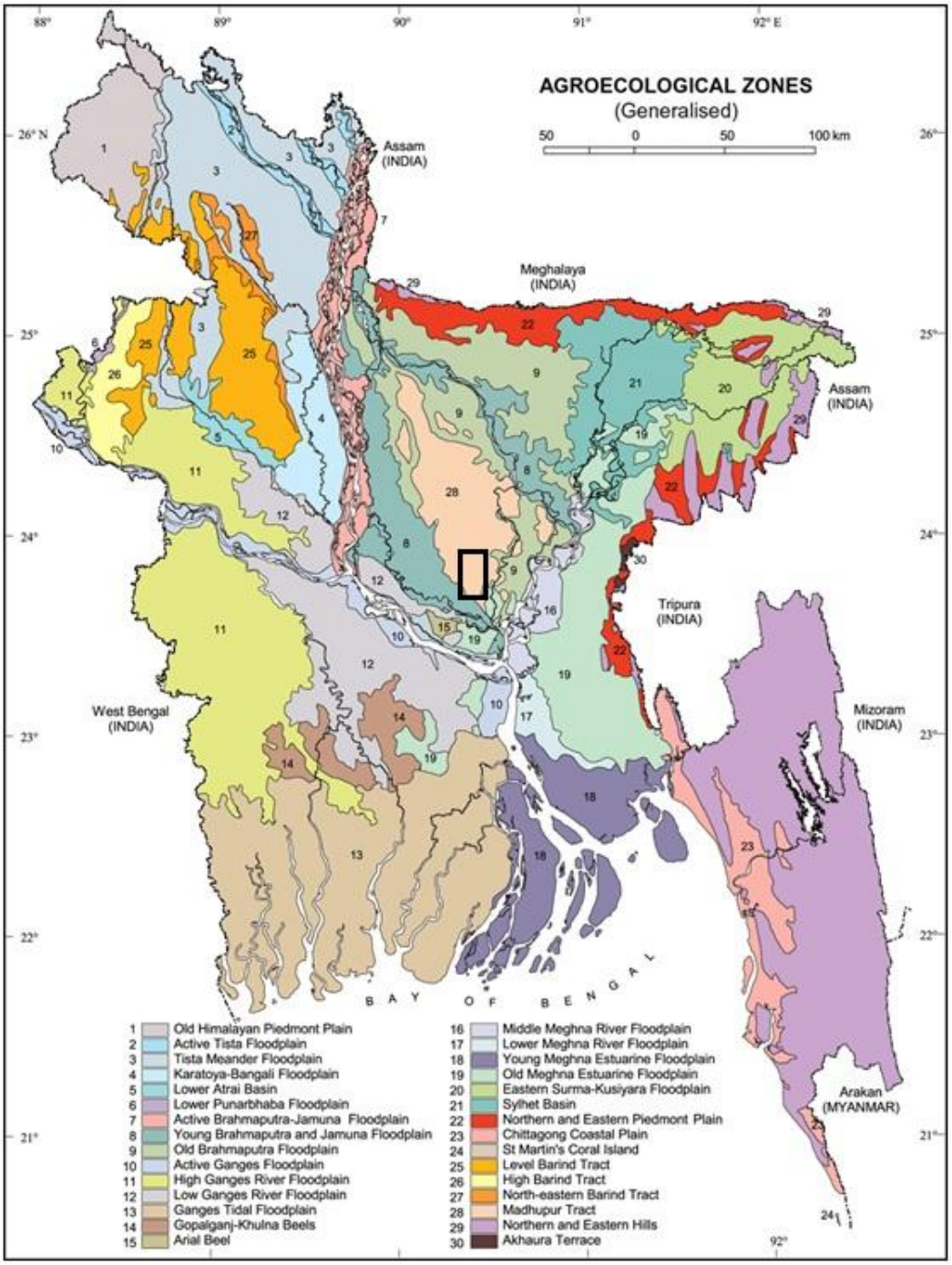


Plate 1. Map showing the experimental site under study

Table 1. Initial characteristics of the soil in experimental field

Characters		Value
l.pH		5.9
2. Particle-size analysi of soil	Sand	29.04
	Silt	41.80
	Clay	29.16
3. Textural Class		Silty Clay Loam
4. Organic carbon (%)		0.98
5, Total N (%)		0.071
6. Phosphorous (ug/g)		14.04
7. Potassium (meq/100 g)		0.31
8. Sulphur (ug/g)		15.16

Source: Soil Resource and Development Institute (SRDI)

3.3 Weather condition of the experimental site

The climate of experimental site was under the subtropical climate, characterized by three distinct seasons, the winter season from November to February and the pro-monsoon period or hot season from March to April and the monsoon period from May to October (Edris *et al.,* 1979). Details of the meteorological data related to the temperature, relative humidity and rainfalls during the period of the experiment was collected from the Bangladesh Meteorological Department, Dhaka and presented in Appendix I.

3.4 Planting material

Seeds of BARI Til-4 used as a crop for the study and collected from Bangladesh Agricultural Research Institute, Gazipur. This variety was developed by BARI and exposed for cultivation in the year of 2009. It is a non-hairy medium sized plant with primary and secondary branches with high potential plant.

BARI Til-4

BARI Til-4 a new high yielding variety of sesame, developed by the Bangladesh Agricultural Research Institute, Joydebpur (Released, 2001). The salient features of this variety are:

1) Plant height is 100-120 cm

2) Leaves are green and broad, upper leaves narrow

3) Seeds are black in color

4) Flowers are light rosy in color

5) Soil salinity tolerance is medium (6-7 dS/m)

6) Life cycle is 90-100 days

7) Capsules plant^{-1} is 60-70 and seeds capsule^{-1} is 60-70

8) Average yield is 1200-1400 kg ha^{-1}

3.5 Treatment of the experiment

The experiment considered of two factors. Details of the treatments are presented below:

Factor A: Levels of Urea as N (4 levels)

i. N_0: 0 kg N/ha (control)

ii. N_1: 75kg N/ha

iii. N_2: 125kg N/ha

iv. N_3:175 kgN/ha

Factor B: Levels of Gypsum as S (4 levels)

i. S_0: 0 kg S/ha (control)

ii. S_1: 50kgS/ha

iii. S_2: 100 kg S/ha

iv S_3: 150kg S/ha

There were 16 (4×4) treatment combinations such as N_0S_0, N_0S_1, N_0S_2, N_0S_3, N_1S_0, N_1S_1, N_1S_2, N_1S_3, N_2S_0, N_2S_1, N_2S_2, N_2S_3, N_3S_0, N_3S_1, N_3S_2 and N_3S_3.

3.6 Layout of the experiment

The experiment was laid out in a two factors split-plot design with three replications. The layout of the experiment was prepared for distributing the treatments in each plot of each block. Each block was divided into16 plots where 16 treatment combinations were allotted randomly. There were 48 unit plots altogether in the experiment. The size of the unit plot was 2.50 m×1.50 m. The distance between two blocks and two plots was 50 cm each.

3.7 Land preparation

The experimental field was first opened on February 25, 2013 with the help of a power tiller and prepared by three successive plowing and cross- plowing. Each plowing was followed by laddering to have a desirable fine tilt. The visible larger clods were hammered to break into small pieces. All kinds of weeds and residues

of previous crop were removed from the field. Individual plots were cleaned and finally leveled with the help of wooden plank.

3.8 Fertilizer application

Manures and fertilizers that were applied to the experimental plot presented in Table 2. The total amount of TSP, half of MP, total zinc oxide, boric acid and sulphur was applied as basal dose at the time of land preparation. The rest amount of MP and total amount of urea (as per treatment) was applied in two installments at 15 and 30 day after seed sowing.

Table 2. Dose and method of application of fertilizers in sesame field

Fertilizers and Manures	Dose/ha	Application (%)		
		Basal	15 DAS	SODAS
Urea	As per treatment	-----	50	50
TSP	150kg	100	-----	-----
MP	50kg	50	25	25
Zinc Oxide	2kg .	100	-----	-----
Sulphur (Gypsum)	As per treatment	100	-----	-----
Boric Acid	1kg	100	-----	-----

Source: BARI, 2008

3.9 Sowing of seeds

The seeds of BARI Til-4 were sown on 11 March 2014 in rows.

3.10 After care

3.10.1 Irrigation

Light over-head irrigation was provided with a watering can to the plots immediately after germination of seedlings. Irrigation also provided at 10 and *25* days after seed sowing.

3.10.2 Thinning

Thinning was done carefully for better growth of the germinated paints and it was done manually after 20 days of sowing, on March 31, 2014. Care was taken to maintain constant plant population per plot.

3.10.3 Gap Filling

Dead, injured and week seedlings were replaced by healthy one from the stock kept on the border line of the experimental plot. Those seedlings were re-transplanted with a big mass of soil with roots to minimize transplanting shock. Replacement was done with healthy seedling having balls of earth those were also sown at same date on border line. The transplanted seedlings were provided shading and watering for three days for the establishment of seedlings.

3.10.4 Weeding

Weeding was done two times at 10 and, 25 days after seed sowing followed by irrigation.

3.10.5 Plant Protection

The crop was protected from the attack of insect-pest by spraying Malathion. The insecticide application were made fortnightly as a matter of routine work from seedling emergence to the end of harvest.

3.11 Harvesting

The pod was harvested depending upon attaining good size and the harvesting was done manually. Enough care was taken during harvesting.

3.12 Data collection

The data were collected from the inner rows of plants of each treatment to avoid the border effect. In each unit plot, 10 plants were selected at random for data collection. Data were collected in respect of the plant growth characters and yield of sesame. Data were recorded on the following parameters-

3.12.1 Plant height

The height of plant was recorded at 30, 45, 60 DAS and at harvest by using a meter scale. The height was measured from the ground level to the tip of the plant of an individual plant. Mean value of ten selected plants was calculated for each unit plot and expressed in centimeter (cm).

3.12.2 Number of branches per plant

Number of branches per plant was counted and the data were recorded from randomly selected 10 plants at 30, 45, 60 DAS and mean value was counted and recorded.

3.12.3 Number of leaves per plant

Number of leaves per plant was counted and the data were recorded from randomly selected 10 plants at 30, 45 and 60 DAS mean value was counted and recorded.

3.12.4 Number of capsule per plant

Numbers of capsule were counted from 10 randomly selected plants as harvested from each unit plot.

3.12.5 Length of capsule (cm)

Length of capsule was measured from 10 randomly selected plants as harvested from each unit plot.

3.12.6 Seeds per capsule

Seeds per capsule were counted from 10 randomly selected capsules as harvested from each unit plot.

3.12.7 Weight of 1000 seeds (g)

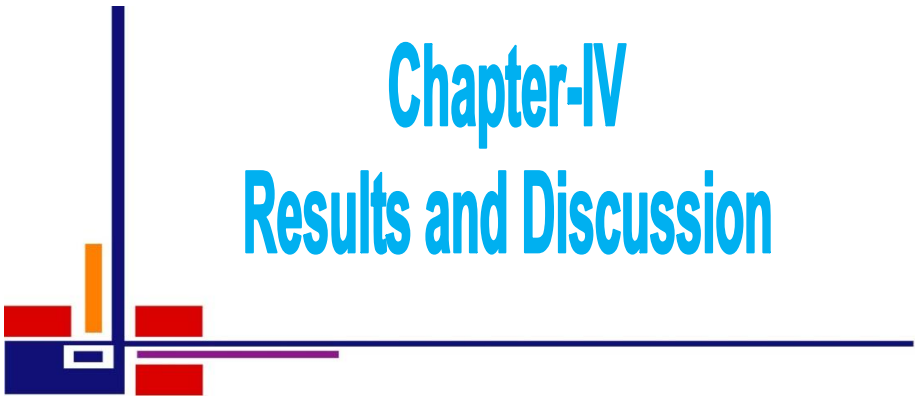
As per treatment, 1000 seeds were counted and weighted accordingly expressing in gram.

3.12.8 Seed yield per hectare

Mature capsules were harvested from each plot and seeds were separated from capsule and weight was recorded. The seed yield per m^2 was finally converted to ton and expressed in ton per hectre(t/ha).

3.12.9 Stover yield per hectare

Mature sesame plants were harvested from each plot and seeds and stover were separated and weight of stover was recorded. The stover yield per $m^2$was finally converted to ton and expressed in ton per hectre(t/ha).



Chapter-IV
Results and Discussion

CHAPTER 4

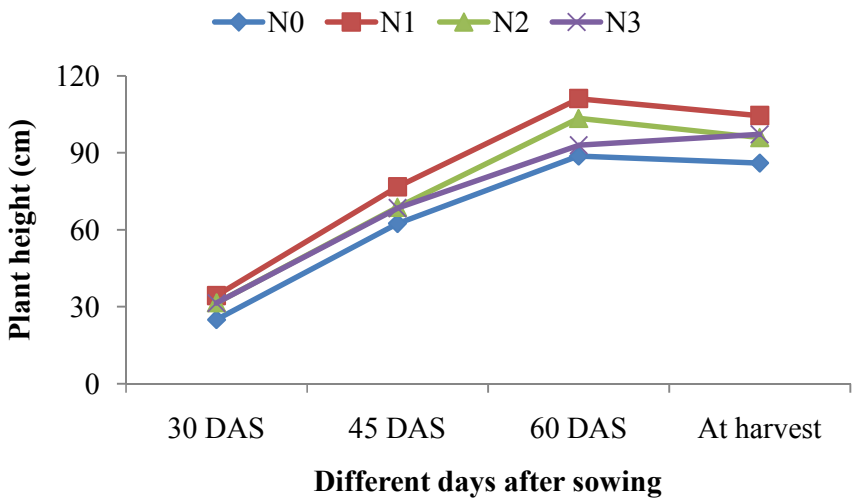
RESULTS AND DISCUSSION

The study was conducted to determine the effect of nitrogen and sulphur on growth and yield of sesame. Data on different growth, yield contributing characters and yield were recorded to find out of the optimum level of nitrogen and sulphur for sesame. The analysis of variance (ANOVA) of the data on different yield contributing characters are given in Appendix 11-IV. Results obtained from the study have been presented and discussed in this chapter.

4.1 Growth, yield contributing characters and yield of sesame

4.1.1 Plant height

Statistically significant variation was recorded for nitrogen on plant height of sesame at 30, 60 DAS and at harvest except 45DAS (Figure 01). The tallest plant (34.36cm, 111.10cm and 104.50cm) was observed from N_1 treatment (75kg N/ha) at 30, 60DAS and at harvest respectively. Meanwhile, at 30DAS tallest plant is recorded from N_1 treatment (34.36cm) which is statistically similar with N_2 (31.56 cm) and N_3(31.42cm). At 60 DAS tallest plant is recorded from N_1 treatment (111.10cm) which is statistically similar with N_2 (103.40 cm) and at harvest tallest plant (104.50cm) is observed from N_1 treatment which is statistically similar with N_3 (97.19 cm) and N_2 (95.94cm). Whereas, the shortest plant (24.98cm, 88.76cm and 86.04cm) was recorded from N_0 treated plots (control) at 30DAS, 60DAS and at harvest respectively. Meanwhile, at 60DAS shortest plant is recorded from N_o(control) which is statistically similar with N_3(92.97cm). At harvest shortest plant (86.04cm) is observed from N_0 (control) which is statistically similar with N_2 (95.94cm) and N_3 (97.19cm). It is found that with the increase of nitrogen fertilizer plant height increased up to a certain level. Fayed *et al.*(2000) and Pathak *et al.(*2002) also found similar results.



N_0: 0 kg N/ha

N_1: 75kg N/ha

N_2: 125kg N/ha

N_3: 175 kg N/ha

Figure 01. Effect of different levels of nitrogen on plant height of sesame at different days after sowing (LSD $_{(0.05)}$ = 5.88, NS, 9.58 and 14.29 at 30, 45, 60 DAS and at harvest respectively)

Plant height of sesame varied significantly at 30, 45, 60 DAS and at harvest due to sulphur application (Figure 02). At 30,45,60DAS and at harvest the tallest plant was recorded 32.49cm,76.23cm,105.0cm and 101.80cm respectively. Meanwhile, at 30 DAS tallest plant (32.49cm) is recorded from S_1 treatment (50 kg S/ha) which is statistically similar with S_3 (32.11 cm) and S_2 (30.40 cm). At 45DAS tallest plant is recorded from S_2 treatment (76.23cm) which is statistically similar with S_1 (71.72 cm). At 60DAS tallest plant is recorded from S_2 treatment (105.0cm) which is statistically similar with S_1 (103.40 cm) and S_3 (97.77cm). At harvest tallest plant (101.80cm) is recorded from S_1 treatment. Whereas the shortest plant (27.31cm, 60.30cm, 90.01cm and 88.83cm) was recorded from S_0 treated plots (control) at 30DAS, 45 DAS, 60DAS and at harvest respectively. At 60DAS shortest plant is recorded from S_0 treatment (90.01cm) which is statistically similar with S_3 (97.77cm) treatment.

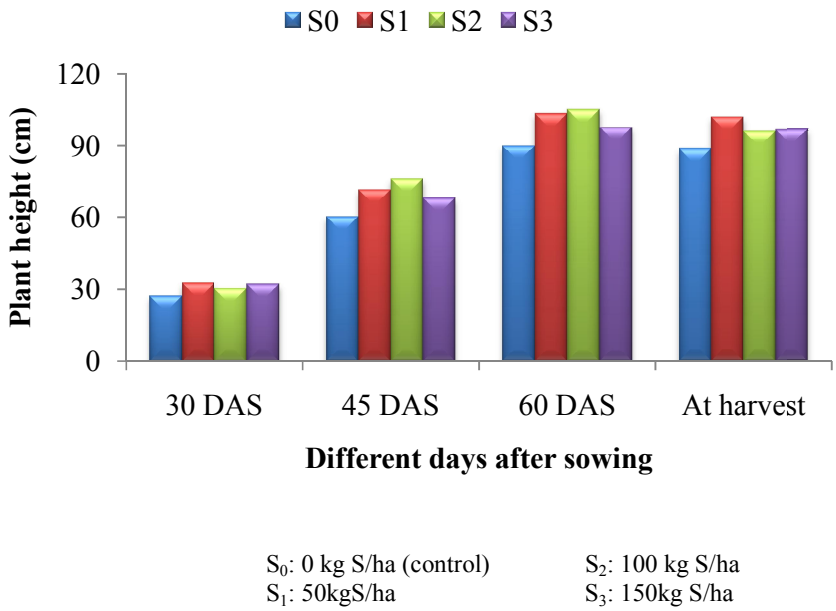


Figure 02. Effect of different levels of sulphur on plant height of sesame at different days after sowing (LSD $_{(0.05)}$ = 2.60, 7.15, 8.12 and 4.54 at 30, 45, 60 DAS and at harvest, respectively)

Significant difference was recorded for the interaction effect of nitrogen and sulphur in terms of plant height at 30, 45,60DAS and harvest (Table 1). At 30DAS the tallest plant (35.78cm)was recorded from N_1S_1 treatment combination (75kg N/ha and 50kg S/ha) which is statistically similar with N_2S_3(34.56cm),N_1S_3(34.11cm),N_1S_0(34.11cm),N_3S_3(33.78cm),N_1S_2(33.44cm),N_3S_1(32.00cm),N_2S_0(31.23cm),N_3S_2(31.11cm),N_2S_1(31.11cm)andN_0S_1(31.07cm)and the shortest plant (15.11cm, 36.33cm,67.90 cm and 75.00cm) was recorded from N_0S_0 treatment combination(control). At 45DAS the tallest plant (83.39cm) was recorded from N_3S_2 treatment combination which is statistically similar with N_1S_1 (83.14cm) treatment combination and the shortest plant (36.33cm) was recorded from N_0S_0 treatment combination (control). At 60DAS the tallest plant (124.7cm) was recorded from N_1S_1 treatment combination the shortest plant (67.90cm) was recorded from N_0S_0 treatment combination (control). At harvest the tallest plant (111cm) was recorded from N_1S_1 treatment the shortest plant (75cm) was recorded from N_0S_0 treatment combination (control).

Table 03. Combined effect of different levels of nitrogen and sulphur on plant height of sesame at different days after sowing

Treatment combination	Different days after sowing (DAS)			
	30	45	60	At harvest
N_0S_0	15.11 f	36.33 d	67.90 e	75.00 h
N_0S_1	31.07 a-e	70.37 a-c	96.10 cd	92.00 e-g
N_0S_2	27.72 de	72.42 a-c	100.7 b-d	85.50 g
N_0S_3	26.00 e	70.81 a-c	90.32 cd	91.67 e-g
N_0S_0	34.11 ab	76.17 ab	91.33 cd	100.0 b-e
N_1S_1	35.78 a	83.14 a	124.7 a	111.0 a
N_1S_2	33.44 a-c	72.97 a-c	114.3 ab	105.2 ab
N_1S_3	34.11 ab	74.71 a-c	114.0 ab	102.0 a-d
N_2S_0	31.23 a-d	67.83 bc	112.7 ab	88.33 fg
N_2S_1	31.11 a-e	69.44 a-c	98.90 b-d	104.7 a-c
N_2S_2	29.34 b-e	76.14 ab	101.8 b-d	94.89 d-f
N_2S_3	34.56 a	61.61 c	100.1 b-d	95.89 c-f
N_3S_0	28.78 c-e	60.88 c	88.11 cd	92.00 e-g
N_3S_1	32.00 a-d	63.92 bc	93.78 cd	99.67 b-e
N_3S_2	31.11 a-e	83.39 a	103.3 bc	99.33 b-e
N_3S_3	33.78 a-c	65.69 bc	86.66 d	97.77 b-e
LSD $_{(0.05)}$	5.19	14.29	16.24	9.07
CV (%)	10.07	12.27	9.73	5.61

No: 0 kg N/ha (control) S_0: 0 kg S/ha (control)

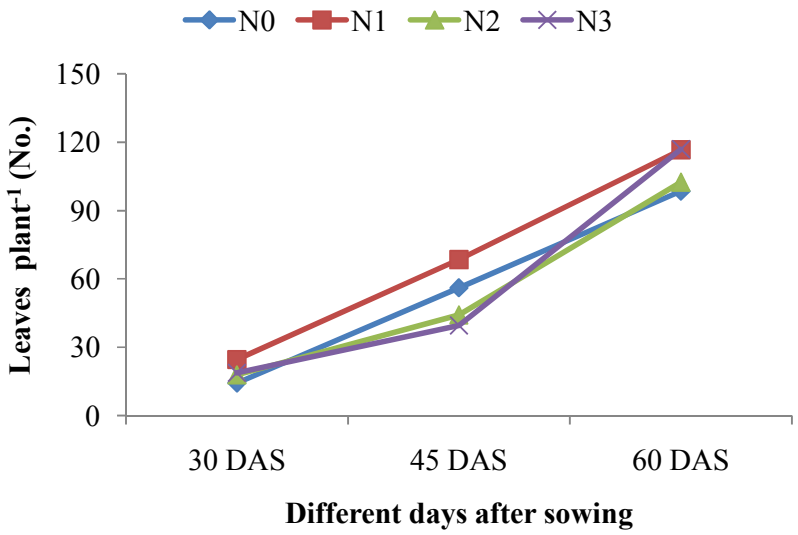
N_1: 75kg N/ha S_1: 50kgS/ha

N_2: 125kg N/ha S_2: 100 kg S/ha

N_3:175 kgN/ha S_3: 150kg S/ha

4.1.2 No. of leaves per plant

Significant difference was recorded for nitrogen on number of leaves per plant at 30DAS and 45 DAS except 60DAS. (Figure 03). Highest number of leaves per plant was recorded 24.69 from N_1 (75kg N/ha) and the minimum number of leaves (14.36) was recorded from N_0(control).). At 45 DAS highest number of leaves per plant (68.47) was recorded from N_1 (75kg N/ha) and the minimum number of leaves (39.56) was recorded from N_0(control). Pathak *et al.(*2002) also found similar results.



No: 0 kg N/ha (control) N_2: 125kg N/ha
N_1: 75kg N/ha N_3:175 kgN/ha

Figure 03. Effect of different levels of nitrogen on leaves plant^{-1} of sesame at different days after sowing (LSD $_{(0.05)}$ = 3.18, 12.99 and NS at 30, 45 and 60 DAS, respectively)

Significant difference was recorded for sulphur on number of leaves per plant at 60DAS only. (Figure 04). Highest number of leaves per plant was recorded 122.3 from S1 (50kg S/ha) which was followed 114.7 from S2(100kg S/ha). The minimum number of leaves (97.67) was recorded from S3(150kg S/ha) which was statistically similar with S0(control) and S2(100kg S/ha). . Vaiyapuri et al.(2004) also found similar results.

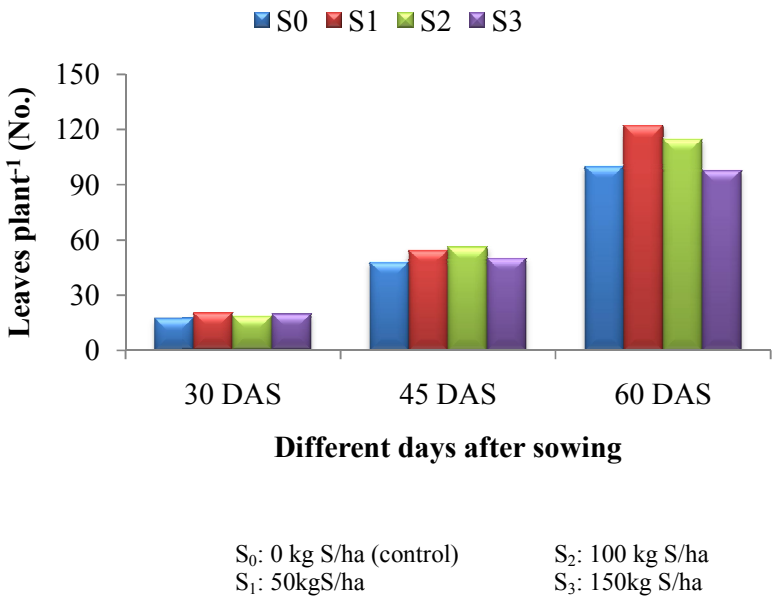


Figure 04. Effect of different levels of sulphur on leaves plant^{-1} of sesame at different days after sowing (LSD (0.05) = NS, NS and 20.13 at 30, 45 and 60 DAS)

Significant difference was recorded for the interaction effect of nitrogen and sulphur in terms of number of leaves per plant at 30,45 and 60DAS (Table 02). The highest number of leaves per plant (26.67, 76.66 and 140.1) was recorded from N_1S_1 treatment combination (75kg N/ha and 50kg S/ha) and the minimum number of leaves per plant (10.67 and 58.00) was recorded from N_0S_0 treatment combination (control) at 30 DAS and 60DAS respectively. At 45 DAS the minimum number of leaves per plant was recorded 34.78 in N_3S_0 (175kg N /ha and Control) which was statistically identical with N_0S_0.

Table 04. Combined effect of different levels of nitrogen and sulphur on leaves plant^{-1} of sesame at different days after sowing

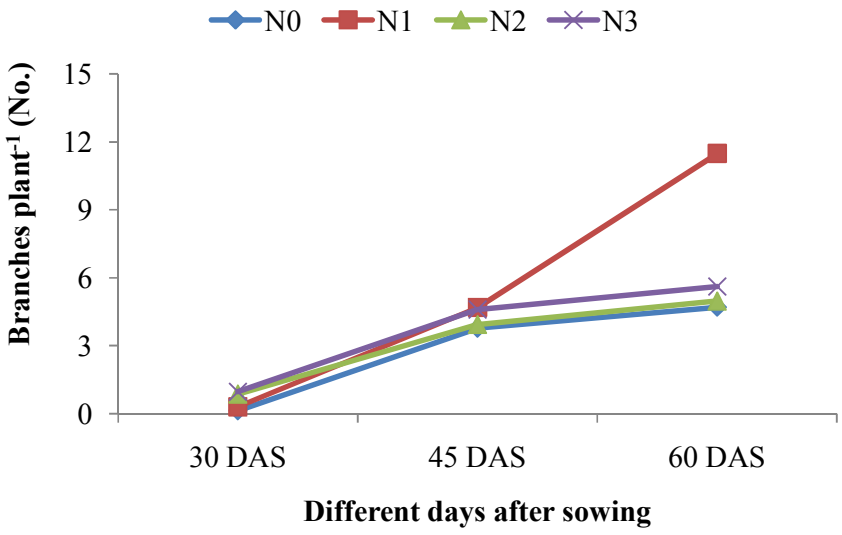
Treatment combination	Different days after sowing (DAS)		
	30	40	60
N_0S_0	10.67 e	42.11 de	58.00 c
N_0S_1	15.11 de	58.67 a-d	141.1 a
N_0S_2	16.11 de	56.55 a-e	108.8 ab
N_0S_3	15.56 de	67.22 a-c	86.44 bc
N_0S_0	24.00 ab	69.44 ab	108.5 ab
N_1S_1	27.67 a	76.66 a	140.1 a
N_1S_2	24.33 ab	69.00 ab	110.1 ab
N_1S_3	22.75 a-c	58.78 a-d	107.8 ab
N_2S_0	15.44 de	45.33 c-e	111.0 ab
N_2S_1	18.89 b-d	45.67 c-e	105.2 ab
N_2S_2	17.11 c-e	50.00 b-e	110.0 ab
N_2S_3	20.11 b-d	35.89 e	83.78 bc
N_3S_0	19.33 b-d	34.78 e	122.2 ab
N_3S_1	19.55 b-d	36.78 de	102.7 ab
N_3S_2	15.89 de	48.67 b-e	130.0 a
N_3S_3	20.56 b-d	38.00 de	112.7 ab
LSD $_{(0.05)}$	6.56	22.48	40.25
CV (%)	20.54	25.61	21.98

No: 0 kg N/ha (control)
N_1: 75kg N/ha
N_2: 125kg N/ha
N_3:175 kgN/ha

S_0: 0 kg S/ha (control)
S_1: 50kgS/ha
S_2: 100 kg S/ha
S_3: 150kg S/ha

4.1.3 Number of Branches per plant

Significant difference was recorded for nitrogen on number of branches per plant only at 60DAS (Figure 05). The highest number of branches per plant (11.48) was obtained from N_1 (75kg N/ha). The lowest number of branches per plant (4.70) was recorded from N_0 (control) which was statistically similar with N_2(125kg N/ha) and N_3 (175kg N/ha). Mitra and Pal (1999) also reported similar findings.



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No: 0 kg N/ha (control) N_2: 125kg N/ha
N_1: 75kg N/ha N_3:175 kg N/ha

Figure 05. Effect of different levels of nitrogen on branches plant^{-1} of sesame at different days after sowing (LSD $_{(0.05)}$ = NS, NS and 2.57 at 30, 45 and 60 DAS, respectively)

Significant difference was recorded for sulphur on number of branches per plant only at 60DAS (Figure 06). The highest number of branches per plant (7.64) was obtained from S_1 (50kg N/ha) which was statistically similar with control and S_2 (100kg S/ha).The lowest number of branches per plant (5.79) was recorded from S_3 (150kg S/ha).

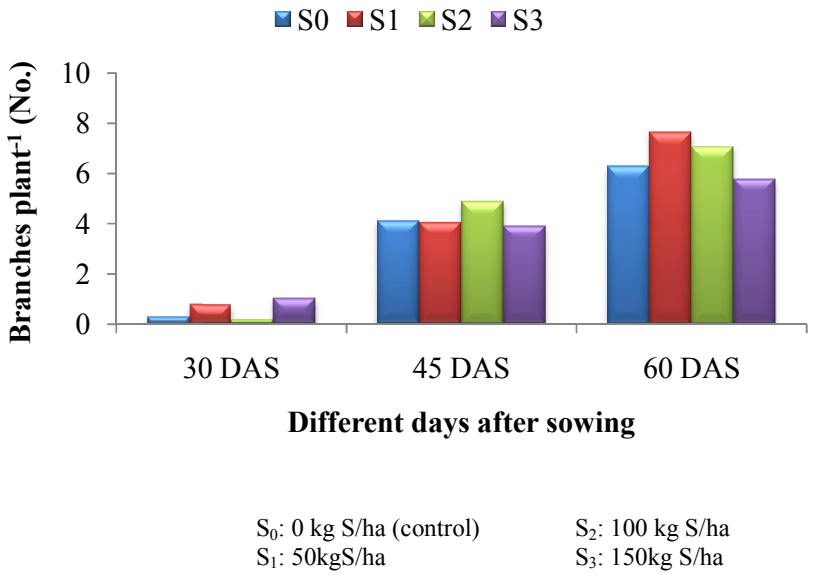


Figure 06. Effect of different levels of sulphur on branches plant^{-1} of sesame at different days after sowing (LSD $_{(0.05)}$ = NS, NS and 1.63 at 30, 45 and 60 DAS, respectively)

Significant difference was recorded for the interaction effect of nitrogen and sulphur in terms of number of branches per plant at 45 and 60 DAS (Table 03). The highest of number of branches per plant (5.890) was recorded from N_3S_2 treatment combination (75kg N/ha and 50kg S/ha) at 45 DAS and the lowest number of branches per plant (2.443) was recorded at from control. At 60 DAS, the highest number of branches per plant (13.00) was recorded from N_1S_1 treatment combination ((75kg N/ha and 50kg S/ha) and the lowest number of branches per plant (2.89) was recorded from N_0S_0 (control).

Table 05. Combined effect of different levels of nitrogen and sulphur on branches plant^{-1} of sesame at different days after sowing

Treatment combination	Different days after sowing		
	30	45	60
N_0S_0	0	2.443 d	2.890 d
N_0S_1	0	4.780 a-c	6.773 b
N_0S_2	0	4.223 a-d	4.810 b-d
N_0S_3	0.56	3.667 a-d	4.327 b-d
N_1S_0	0.22	4.000 a-d	10.67 a
N_1S_1	1.00	5.413 ab	13.00 a
N_1S_2	0	4.780 a-c	11.56 a
N_1S_3	0	4.557 a-d	10.70 a
N_2S_0	0	4.500 a-d	4.333 b-d
N_2S_1	1.45	2.790 cd	6.667 bc
N_2S_2	0.67	4.680 a-d	5.443 b-d
N_2S_3	1.33	3.777 a-d	3.443 cd
N_3S_0	1.00	5.553 ab	7.220 b
N_3S_1	0.67	3.277 b-d	4.113 b-d
N_3S_2	0	5.890 a	6.433 bc
N_3S_3	2.22	3.667 a-d	4.667 b-d
LSD $_{(0.05)}$	NS	2.33	3.27
CV (%)	235.05	32.54	28.98

No: 0 kg N/ha (control) S_0: 0 kg S/ha (control)

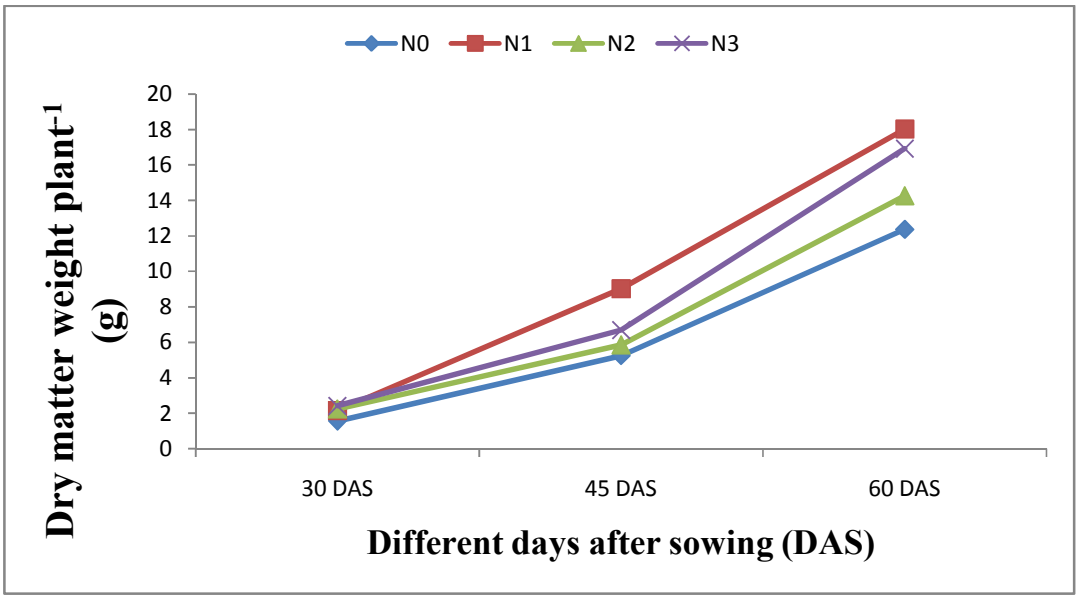
N_1: 75kg N/ha S_1: 50kgS/ha

N_2: 125kg N/ha S_2: 100 kg S/ha

N_3:175 kgN/ha S_3: 150kg S/ha

4.1.4 Dry matter content per plant

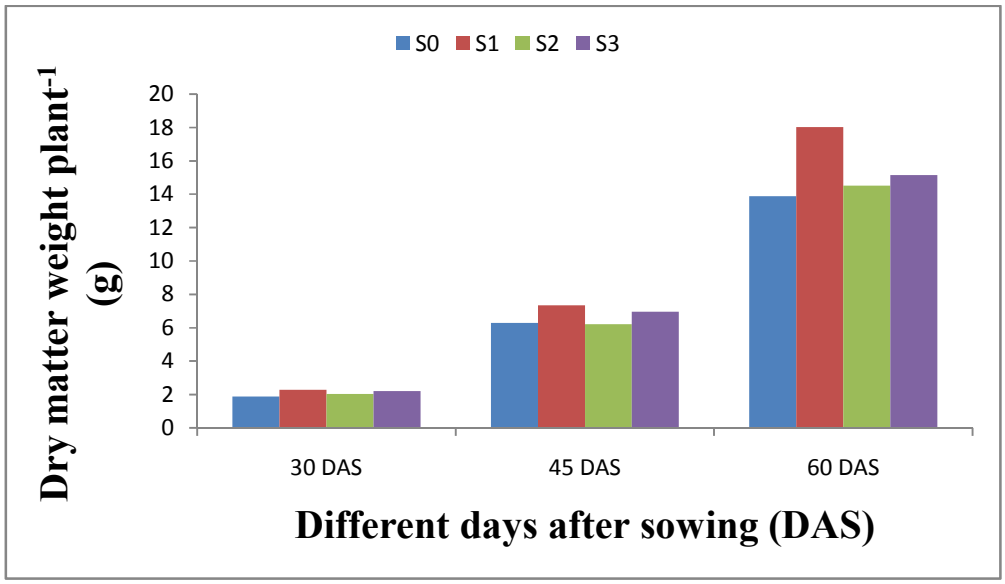
Significant difference was recorded for nitrogen on dry matter content per plant at 30DAS (Figure 07). The highest dry matter content per plant (9.03) was obtained from N_1 (75kg N/ha) which was statistically similar with N_3 (175kg N/ha).The lowest dry matter content per plant (5.25) was recorded from N_0 (control) .



No: 0 kg N/ha (control) N_2: 125kg N/ha
N_1: 75kg N/ha N_3:175 kgN/ha

Figure 07. Effect of different levels of nitrogen on dry matter content plant^{-1} of sesame at different days after sowing (LSD $_{(0.05)}$ = 2.74 and NS at 30, 45 and 60 DAS, respectively)

Significant difference was recorded for sulphur on dry matter content per plant at 60DAS (Figure 08). The highest dry matter content per plant (18.04) was obtained from S_1 (50kg S/ha) which was statistically similar (15.15) with S_3 (150kg S/ha). The lowest dry matter content per plant (13.88) was recorded from S_0 (control).



S_0: 0 kg S/ha (control)
S_1: 50kgS/ha
S_2: 100 kg S/ha
S_3: 150kg S/ha

Figure 08. Effect of different levels of sulphur on dry matter content plant^{-1} of sesame at different days after sowing (LSD $_{(0.05)}$ = NS and 2.92 at 30, 45 and 60 DAS, respectively)

Significant difference was recorded for the interaction effect of nitrogen and sulphur in terms of dry matter content per plant at 30 and 45 DAS (Table 04). The highest dry matter content per plant (10.11g) was recorded from N_1S_1 treatment combination (75kg N/ha and 50kg S/ha) at 30 DAS. At 45 DAS, the highest dry matter content per plant (21.64 g) was recorded from N_3S_1 treatment combination ((175kg N/ha and 50kg S/ha) which was statistically similar with N_1S_1 combination (75kg N/ha and 50kg S/ha). The lowest dry matter content per plant (3.96 g and 10.56 g) was recorded at 30 DAS and 45 DAS respectively from N_0S_0 (control).

Table 06. Combined effect of different levels of nitrogen and sulphur on dry matter content plant^{-1} of sesame at different days after sowing

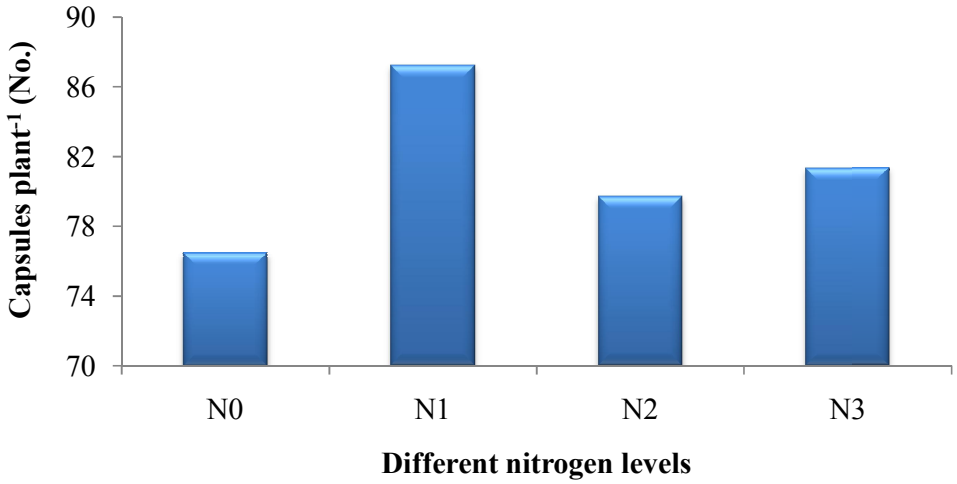
Treatment combination	30DAS	45DAS	60DAS
N0S0	1.41 f	3.958 f	10.56 f
N0S1	1.61 ef	6.21 b-f	13.28 c-f
N0S2	1.45 f	4.65 d-f	11.20 ef
N0S3	1.80 e	6.22 b-f	14.46 b-f
N1S0	1.61 ef	8.67 a-c	17.89 a-c
N1S1	2.81 a	10.11 a	20.00 ab
N1S2	2.16 cd	8.56 a-c	17.33 a-d
N1S3	2.12 d	8.78 ab	16.89 a-e
N2S0	2.27 cd	6.48 b-f	12.58 c-f
N2S1	2.29 cd	6.61 b-e	17.24 a-d
N2S2	2.16 cd	4.42 ef	11.64 d-f
N2S3	2.24 cd	5.91 d-f	15.62 b-f
N3S0	2.20 cd	6.13 c-f	14.49 b-f
N3S1	2.45 bc	6.48 b-f	21.64 a
N3S2	2.40 bcd	7.22 b-d	17.92 a-c
N3S3	2.650 ab	6.96 b-e	13.62 c-f
LSD (0.05)	0.37	2.63	5.84
CV(%)	8.63	23.3	22.52

No: 0 kg N/ha (control)
N_1: 75kg N/ha
N_2: 125kg N/ha
N_3:175 kgN/ha

S_0: 0 kg S/ha (control)
S_1: 50kgS/ha
S_2: 100 kg S/ha
S_3: 150kg S/ha

4.1.5 Number of capsule per plant

Significant difference was recorded for nitrogen on number of capsule per plant of sesame (Figure 09). The maximum number of capsule per plant (87.24) was obtained from N_1 (75kg N/ha) and the minimum number (76.46) was recorded from N_0 (control) .Mondal *et.al*. (2001) and Pathak *et al.(*2002) also found similar results.



No: 0 kg N/ha (control) N_2: 125kg N/ha
N_1: 75kg N/ha N_3:175 kgN/ha

Figure 09. Effect of different levels of nitrogen on capsules plant^{-1} of sesame (LSD $_{(0.05)}$ = 7.38)

Significant difference was recorded for sulphur on number of capsule per plant of sesame (Figure 10). The maximum number of capsule per plant (85.31) was obtained from S_1 (50kg S/ha). The minimum number (79.32) was recorded from S_3 (150kg S/ha) which is statistically similar with S_0(control).

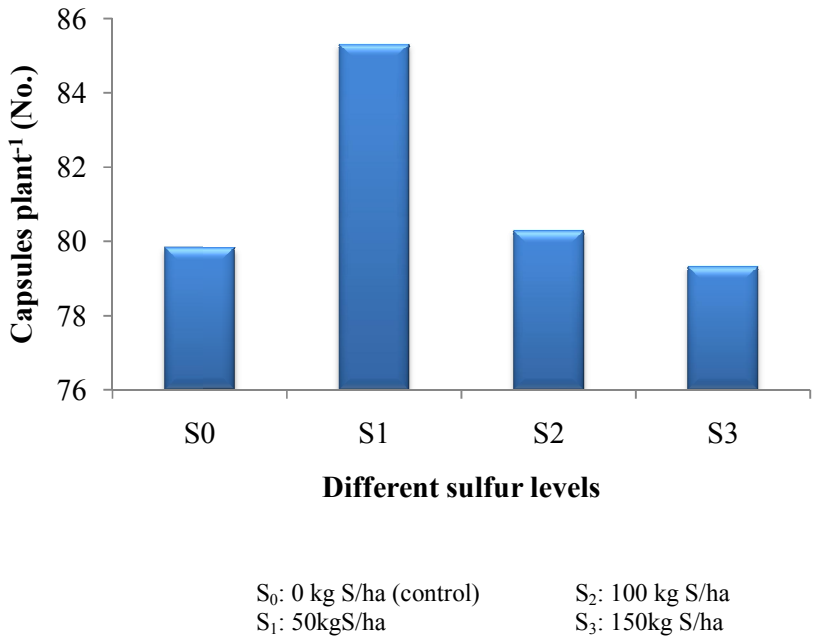
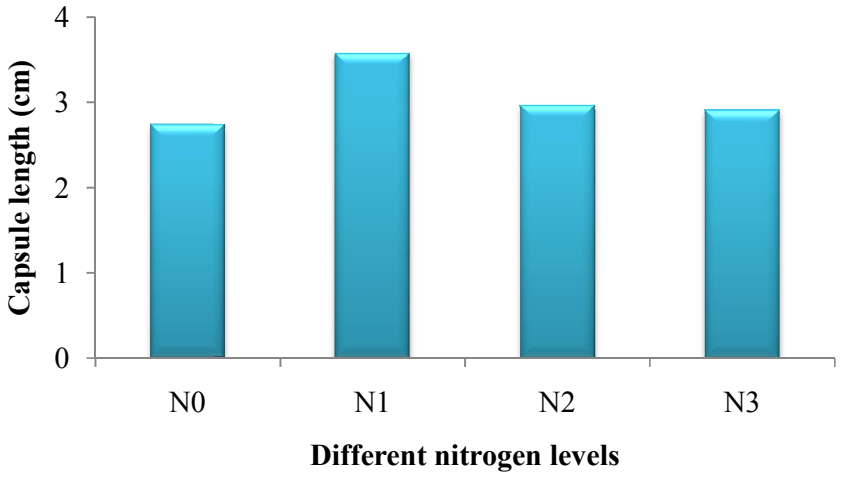


Figure 10. Effect of different levels of sulphur on capsules plant^{-1} of sesame (LSD $_{(0.05)}$= 3.05)

Significant difference was recorded for the interaction effect of nitrogen and sulphur in terms of number of capsule per plant (Table 5). The maximum number of capsule per plant (88.67) was recorded from N_1S_1 treatment combination (75kg N/ha and 50kg S/ha) and the minimum number of capsule per plant (74.83) was recorded from N_0S_2 treatment combination (control and 100kg S/ha) which is statistically similar with N_0S_0 (control)

4.1.6 Length of capsule

Significant difference was recorded for nitrogen on length of capsule per plant of sesame (Figure 11). The longest of capsule (3.58 cm) was obtained from N_1 (75kg N/ha), whereas shortest (2.74 cm) was recorded from N_0 (control) .Mitra and Pal (1999) also found similar results.



No: 0 kg N/ha (control) N_2: 125kg N/ha
N_1: 75kg N/ha N_3:175 kgN/ha

Figure 11. Effect of different levels of nitrogen on capsule length of sesame (LSD $_{(0.05)}$ = 0.13)

Significant difference was recorded for sulphur on length of capsule per plant of sesame (Figure 12). The longest of capsule (3.27cm) was obtained from S_1 (150kg S/ha), which was statistically similar with S_3 (150kg S/ha. The shortest capsule (2.84 cm) was recorded from S_0 (control) which was statistically similar with S_2 (100kg S/ha). Mitra and Pal (1999) also found similar results.

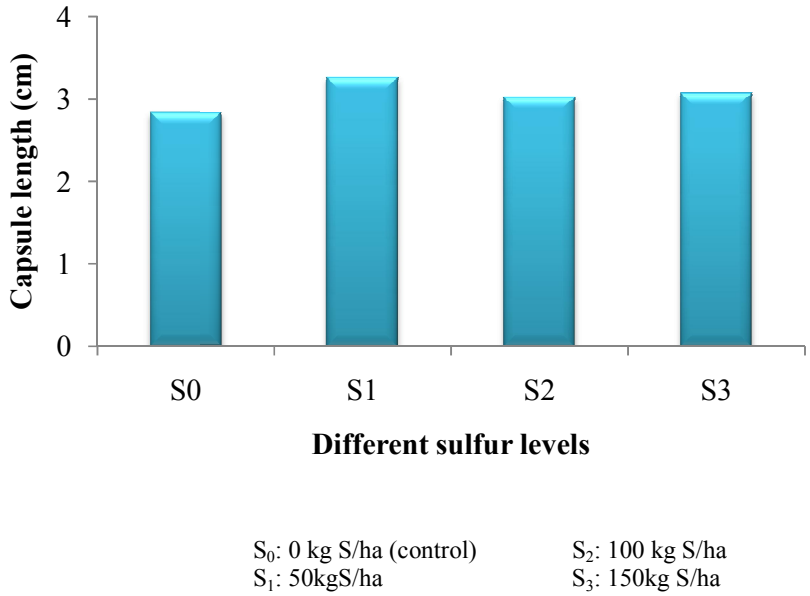
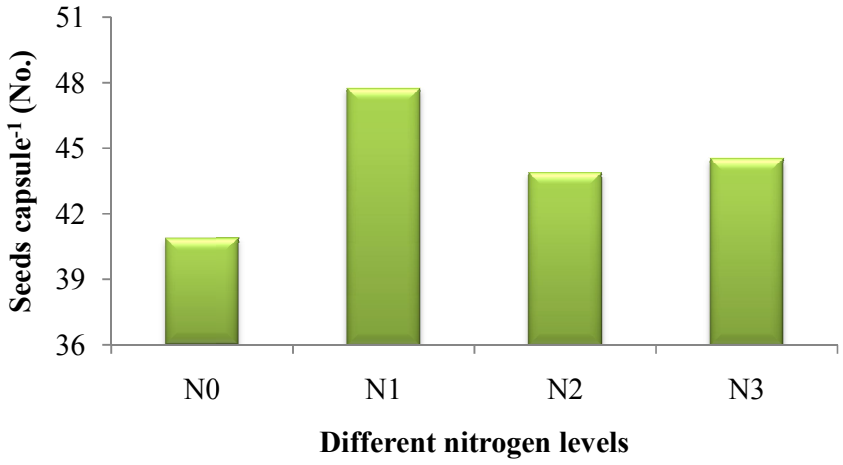


Figure 12. Effect of different levels of sulphur on capsule length of sesame (LSD $_{(0.05)}$ = 0.22)

Significant difference was recorded for the interaction effect of nitrogen and sulphur in terms of length of capsule (Table 5). The longest capsule (3.59) was recorded from N_1S_3 treatment combination (75kg N/ha and 150kg S/ha), which was statistically similar with N_1S_1(75kg N/ha and 50kg S/ha). The shortest capsule (2.25) was recorded from N_0S_0 treatment combination (control).

4.1.7 Number of seeds per capsule

Significant difference was recorded for nitrogen on number of seeds per capsule of sesame (Figure 13). The maximum number of seeds per capsule (47.74) was obtained from N_1 (75kg N/ha) and the minimum (40.88) was recorded from N_0 (control). Pathak *et al.(*2002) also found similar results.



No: 0 kg N/ha (control) N_2: 125kg N/ha
N_1: 75kg N/ha N_3:175 kgN/ha

Figure 13. Effect of different levels of nitrogen on seeds capsule^{-1} of sesame (LSD $_{(0.05)}$ = 4.20)

Significant difference was recorded for sulphur on number of seeds per capsule of sesame (Figure 14). The maximum number of seeds per capsule (46.55) was obtained from S_1(50kg S/ha). The minimum number (42.63) was recorded from S_0 (control) which is statistically similar with S_2 (100kg S/ha) and S_3 (150kg S/ha).

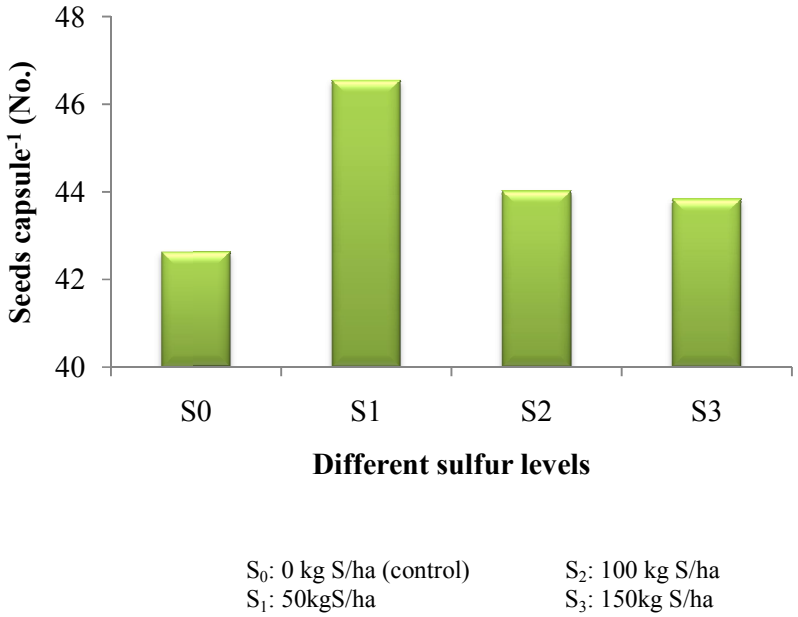
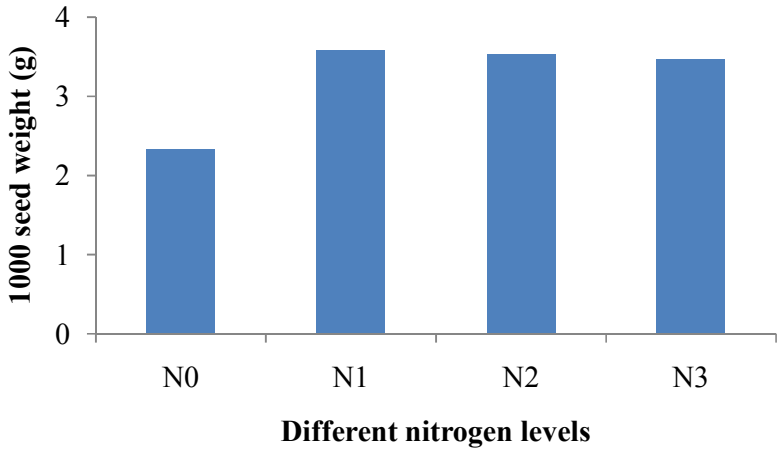


Figure 14. Effect of different levels of sulphur on seeds capsule^{-1} of sesame (LSD $_{(0.05)}$ = 2.96)

Significant difference was recorded for the interaction effect of nitrogen and sulphur in terms of number of seeds per capsule (Table 5). The maximum number of seeds per capsule (50.17) was recorded from N_1S_1 treatment combination (75kg N/ha and 50kg S/ha) and the minimum number of seeds per capsule (37.50) was recorded from N_0S_0 treatment combination (control).

4.1.8 Weight of 1000 seeds

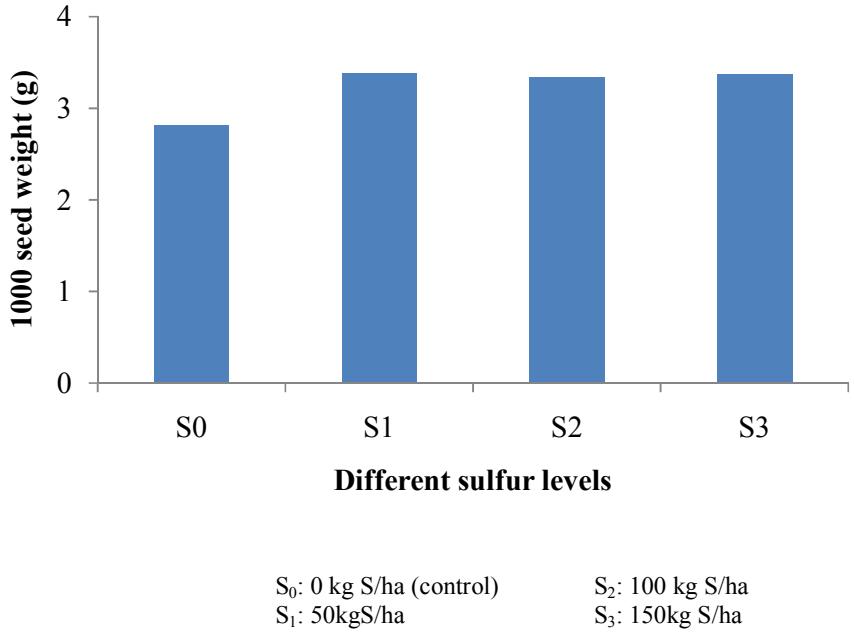
Significant difference was recorded for nitrogen on weight of 1000 seeds of sesame (Figure 15). The highest weight of 1000 seeds (3.58 g) was obtained from N_1 (75kg N/ha). The lowest weight (2.33g) was recorded from N_0 (control) which is statistically similar with N_3 (175 kg N/ha).



No: 0 kg N/ha (control) N_2: 125kg N/ha
N_1: 75kg N/ha N_3:175 kgN/ha

Figure 15. Effect of different levels of nitrogen on 1000 seed weight of sesame (LSD $_{(0.05)}$ = 0.18)

Significant difference was recorded for sulphur on weight of 1000 seeds of sesame (Figure 16). The highest weight of 1000 seeds (3.39 g) was obtained from S_1 (50kg S/ha). The lowest weight (2.81 g) was recorded from S_0 (control).



S_0: 0 kg S/ha (control)
S_1: 50kgS/ha
S_2: 100 kg S/ha
S_3: 150kg S/ha

Figure 16. Effect of different levels of sulphur on 1000 seed weight of sesame (LSD $_{(0.05)}$ = 0.22)

Significant difference was recorded for the interaction effect of nitrogen and sulphur in terms of weight of 1000 seeds of sesame (Table 5). The highest weight of 1000 seeds (3.98g) was recorded from N_1S_1 treatment combination (75kg N/ha and 50kg S/ha) and the lowest weight of 1000 seeds (2.10) was recorded from N_0S_0 treatment combination (control)

4.1.9 Seed yield

Significant difference was recorded for nitrogen on seed yield of sesame (Figure 17). The highest seed yield (1.380t/ha) was obtained from N_1 (75kg N/ha). The lowest seed yield (1.09 t/ha) was recorded from N_0 (control) which is statistically similar with N_2 (125kg N/ha) and N_3 (175 kg N/ha). Abdel *et al.* (2003) recorded almost similar result.

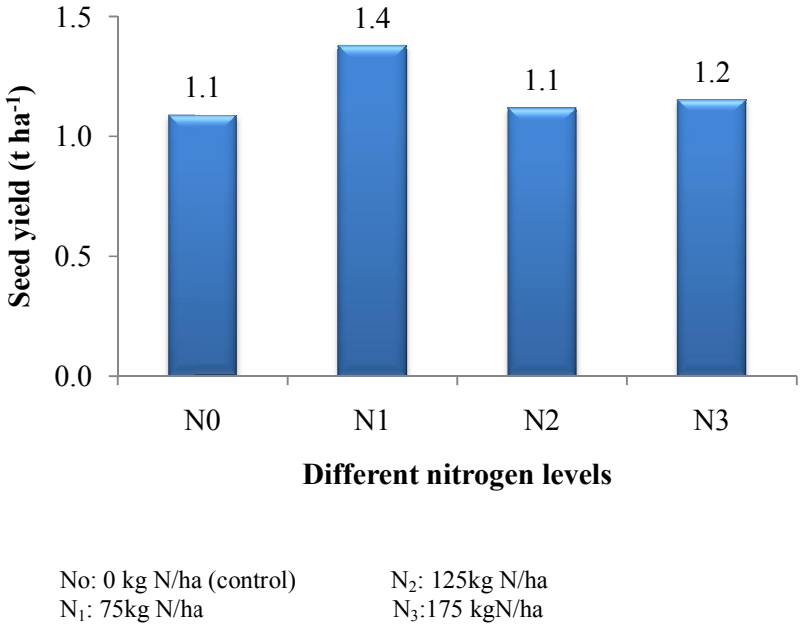


Figure 17. Effect of different levels of nitrogen on seed yield of sesame (LSD $_{(0.05)}$ = 0.09)

Significant difference was recorded for sulphur on seed yield of sesame (Figure 18). The highest seed yield (1.31t/ha) was obtained from S_1 (50kg S/ha) which is statistically similar with S_2 (100kg S/ha). The lowest seed yield (1.05 t/ha) was recorded from S_0 (control). Amudha et al. reported maximum yield with the application of 45 kg S/ha.

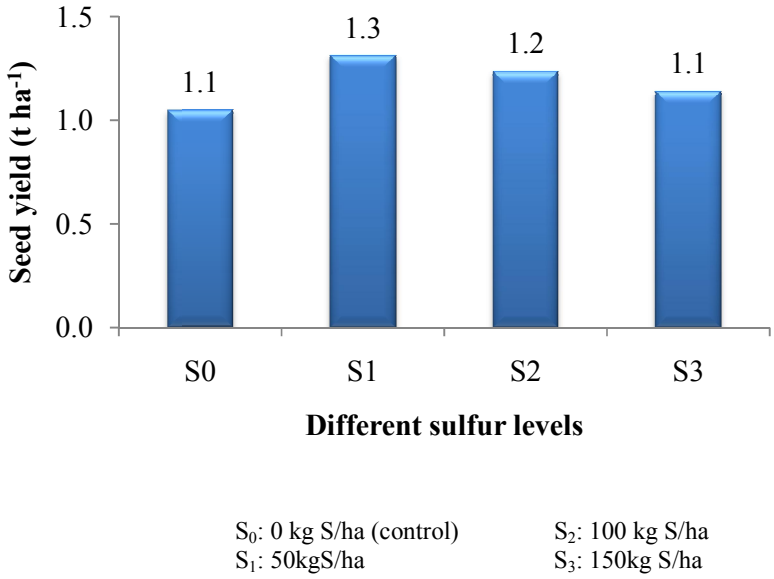
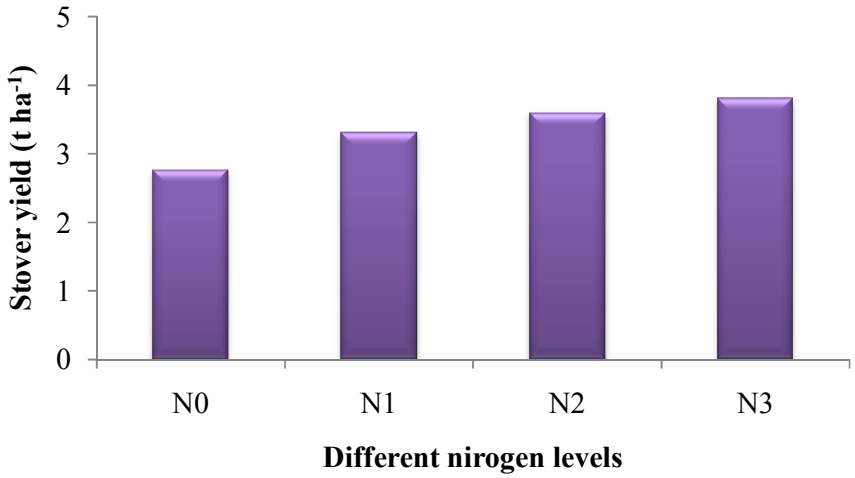


Figure 18. Effect of different levels of sulphur on seed yield of sesame (LSD $_{(0.05)}$ = 0.08)

Significant difference was recorded for the interaction effect of nitrogen and sulphur in terms of seed yield of sesame (Table 5). The highest seed yield (1.43t/ha) was recorded from N_1S_1 treatment combination (75kg N/ha and 50kg S/ha) and the lowest seed yield (0.80) was recorded from N_0S_0 treatment combination (control).

4.1.10 Stover yield

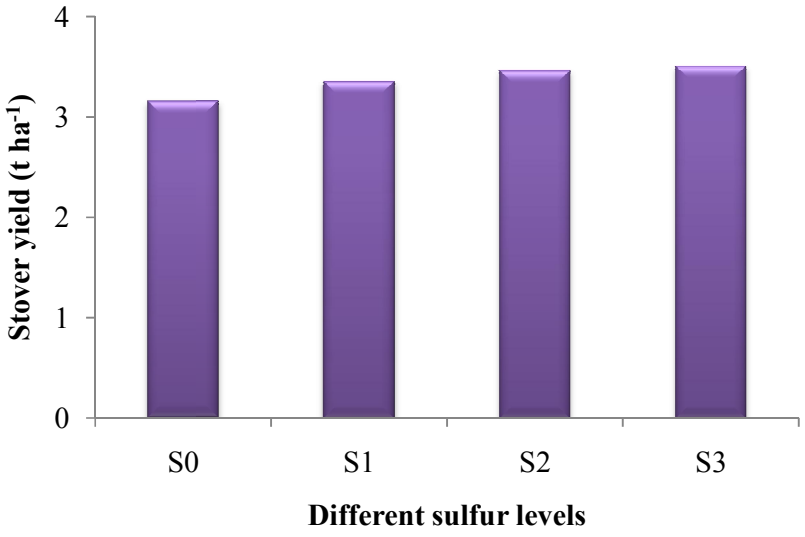
Significant difference was recorded for nitrogen on stover yield of sesame (Figure 19). The highest stover yield (3.81t/ha) was obtained from N_3 (175kg N/ha). The lowest strover yield (2.77 t/ha) was recorded from N_0 (control). An adequate supply of nitrogen is essential for vegetative growth (Yoshiazawa *et al*., 1981)



No: 0 kg N/ha (control) N_2: 125kg N/ha
N_1: 75kg N/ha N_3:175 kgN/ha

Figure 19. Effect of different levels of nitrogen on stover yield of sesame (LSD $_{(0.05)}$ = 0.13)

Significant difference was recorded for sulphur on stover yield of sesame (Figure 20). The highest stover yield (3.51t/ha) was obtained from S_3 (15 kg S/ha) which is statistically similar with S_2 (100kg S/ha) . The lowest stover yield (3.16 t/ha) was recorded from S_0 (control).



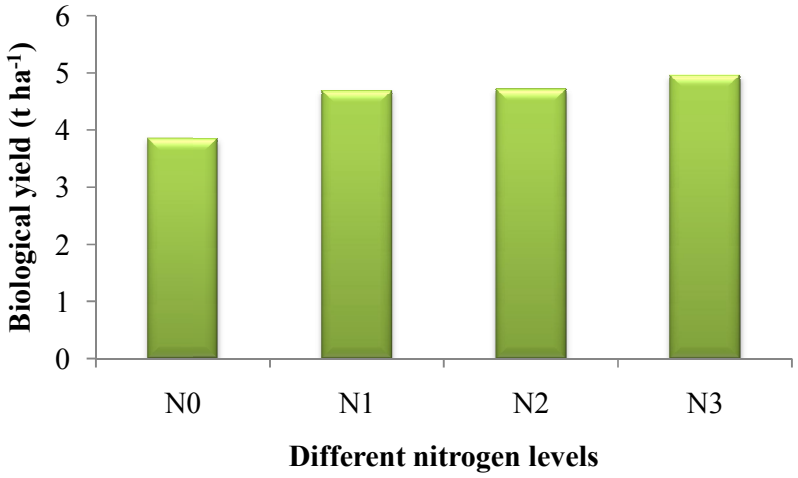
S_0: 0 kg S/ha (control)
S_1: 50kgS/ha
S_2: 100 kg S/ha
S_3: 150kg S/ha

Figure 20. Effect of different levels of sulphur on stover yield of sesame (LSD $_{(0.05)}$ = 0.14)

Significant difference was recorded for the interaction effect of nitrogen and sulphur in terms of stover yield per of sesame (Table 5). The highest stover yield (3.88t/ha) was recorded from N_3S_3 treatment combination (175kg N/ha and 150kg S/ha) and the lowest stover yield (2.17 t/ha) was recorded from N_0S_0 treatment combination (control).

4.1.11 Biological yield

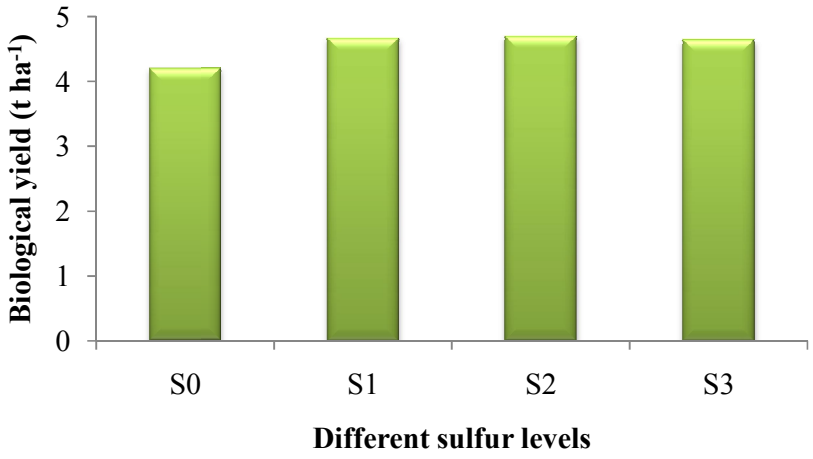
Significant difference was recorded for nitrogen on biological yield of sesame (Figure 21). The highest biological yield (4.96 t/ha) was obtained from N_3 (175kg N/ha). The lowest biological yield (3.85 t/ha) was recorded from N_0 (control).



No: 0 kg N/ha (control) N_2: 125kg N/ha
N_1: 75kg N/ha N_3:175 kgN/ha

Figure 21. Effect of different levels of nitrogen on biological yield of sesame (LSD $_{(0.05)}$ = 0.18)

Significant difference was recorded for sulphur on biological yield of sesame (Figure 22). The highest biological yield (4.70 t/ha) was obtained from S_2 (100kg S/ha) which is statistically similar with S_1(50kg S/ha) and S_3 (150kg S/ha). The lowest biological yield (4.21 t/ha) was recorded from S_0 (control).



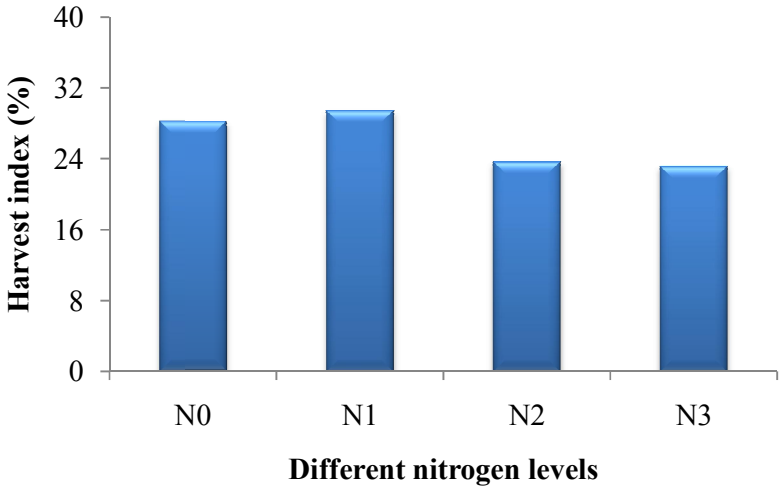
S_0: 0 kg S/ha (control)
S_1: 50kgS/ha
S_2: 100 kg S/ha
S_3: 150kg S/ha

Figure 22. Effect of different levels of sulphur on biological yield of sesame ($LSD_{(0.05)}$ = 0.19)

Significant difference was recorded for the interaction effect of nitrogen and sulphur in terms of biological yield of sesame (Table 5). The highest biological yield (5.13 t/ha) was recorded from N_3S_1 treatment combination (175kg N/ha and 50kg S/ha) which is statistically similar with N_3S_3 treatment combination (175kg N/ha and 150kg S/ha). The lowest biological yield (2.97 t/ha) was recorded from N_0S_0 treatment combination (control).

4.1.12 Harvest index

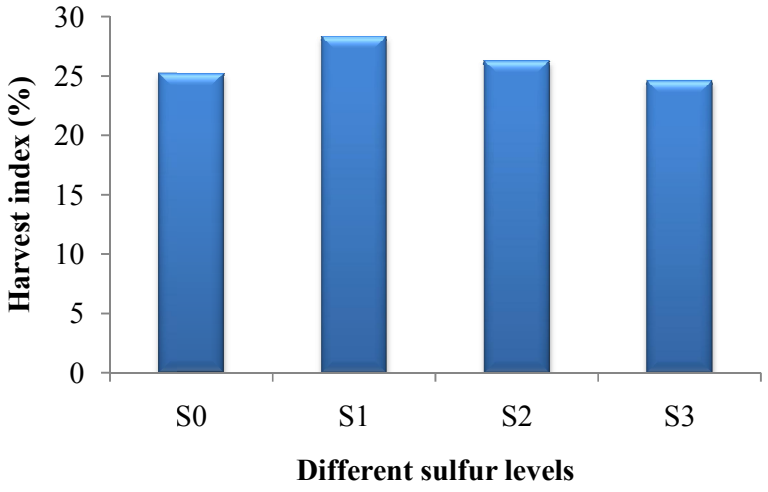
Significant difference was recorded for nitrogen on harvest index of sesame (Figure 23). The highest harvest index (29.43%) was obtained from N_1 (75kg N/ha). The lowest harvest index (23.14%) was recorded from N_3 (175kg N/ha), which is statistically similar with N_2 (125kg N/ha).



No: 0 kg N/ha (control) N_2: 125kg N/ha
N_1: 75kg N/ha N_3:175 kgN/ha

Figure 23. Effect of different levels of nitrogen on harvest index of sesame (LSD $_{(0.05)}$ = 1.47)

Significant difference was recorded for sulphur on harvest index of sesame (Figure 24). The highest harvest index (28.35%) was obtained from S_1 (50kg S/ha). The lowest harvest index (24.62%) was recorded from S_3 (150kg S/ha), which is statistically similar with S_0 (control).



S_0: 0 kg S/ha (control)
S_1: 50kgS/ha
S_2: 100 kg S/ha
S_3: 150kg S/ha

Figure 24. Effect of different levels of sulphur on harvest index of sesame (LSD $_{(0.05)}$ = 1.26)

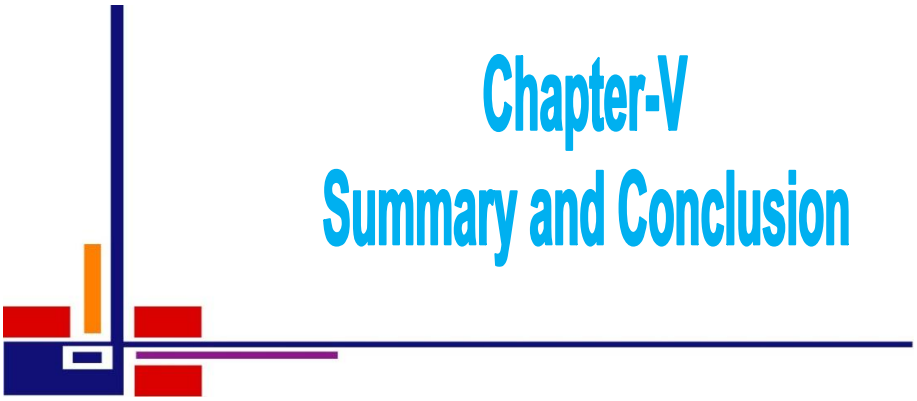
Significant difference was recorded for the interaction effect of nitrogen and sulphur in terms of harvest index of sesame (Table 5). The highest harvest index (32.62 %) was recorded from N_0S_1 treatment combination (control and 50kg S/ha). The lowest harvest index (21.27%)was recorded from N_3S_0 treatment combination (175kg N/ha and control).

Table 06. Interaction effect of different levels of nitrogen and sulphur on capsules plant^{-1}, capsule length, seeds capsule^{-1}, 1000 seed weight, seed yield, stover yield, biological yield and harvest index of sesame

Treatment combination	Capsules plant^{-1} (No.)	Capsule length (cm)	Seeds capsule^{-1} (No.)	1000 seed weight (g)	Seed yield (t ha^{-1})	Stover yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
N_0S_0	75.00 fg	2.250 e	37.50 e	2.100 e	0.8033 g	2.17 h	2.97 g	27.10 c-e
N_0S_1	81.00 b-f	3.02 b-d	46.81a-c	2.430 e	1.300 a-c	2.683 g	3.983 f	32.62 a
N_0S_2	74.83 g	2.807 cd	39.83 de	2.383 e	1.183 c-e	3.093 f	4.277 ef	27.61b-d
N_0S_3	75.00 fg	2.89 b-d	39.39 de	2.393 e	1.070 d-f	3.117 f	4.187 ef	25.57 d-f
N_1S_0	85.89 a-c	3.567 a	43.52b-d	2.950 d	1.347 ab	3.147 f	4.493 de	29.99 b
N_1S_1	88.67 a	3.573 a	50.17 a	3.980 a	1.430 a	3.370 d-f	4.800 a-d	29.81 b
N_1S_2	86.67 ab	3.567 a	49.07 ab	3.680 abc	1.387 a	3.433 de	4.820 a-d	28.77 bc
N_1S_3	87.74 a	3.593 a	48.22a-c	3.727 ab	1.357 ab	3.297 ef	4.65 b-d	29.16 bc
N_2S_0	77.22 e-g	2.86 b-d	43.50b-d	2.920 d	1.02 f	3.517 c-e	4.54 c-e	22.47 g-i
N_2S_1	84.59 a-d	3.250 ab	44.33a-d	3.707 abc	1.223 b-d	3.533 b-e	4.76 b-d	25.71 d-f
N_2S_2	79.33d-g	2.780 d	44.39a-d	3.770 ab	1.20 b-d	3.617 a-d	4.820 a-d	24.91e-g
N_2S_3	77.67 eg	2.98 b-d	43.33b-e	3.727 ab	1.027 ef	3.733 a-c	4.760 b-d	21.57 hi
N_3S_0	81.22b-e	2.67de	46.0 a-c	3.267 cd	1.030 ef	3.800 ab	4.830 a-d	21.27 i
N_3S_1	87.00 ab	3.22 a-c	44.89a-d	3.427 bc	1.297 a-c	3.837 a	5.133 a	25.25d-f
N_3S_2	80.33 c-g	2.94b-d	42.78c-e	3.530 bc	1.173c-f	3.727 a-c	4.900 a-c	23.89f-h
N_3S_3	76.89 e-g	2.82b-d	44.41a-d	3.627 abc	1.11 d-f	3.880 a	4.987 ab	22.17 hi
LSD $_{(0.05)}$	6.09	0.43	5.92	0.44	0.16	0.28	0.37	2.52
CV (%)	4.45	8.43	7.93	8.17	8.04	4.86	4.81	5.72

No: 0 kg N/ha (control)
N_1: 75kg N/ha
N_2: 125kg N/ha
N_3:175 kgN/ha

S_0: 0 kg S/ha (control)
S_1: 50kgS/ha
S_2: 100 kg S/ha
S_3: 150kg S/ha



Chapter-V
Summary and Conclusion

CHAPTER 5

SUMMARY AND CONCLUSION

The experiment was conducted at research field of Sher-e-Bangla Agricultural University farm located in Sher-e-Bangla Nagar, Dhaka-1207, Bangladesh. Experiment was executed during the period of March to July, 2014. The objective of the experiment was to determine the effect of nitrogen and sulphur on growth and yield. BARI Til4 was used as a test crop for the study. The experiment was consisted of two factors. Factor A: 4 levels of Nitrogen, such as N_0: 0 kg N/ha, N_1: 75 kg N/ha, N_2: 125kg N/ha) and N_3: 175 kg N/ha) and Factor B: 4 levels such as S_0: 0 kg S/ha, S_1: 50 kg S/ha, S_2: 100kg S/ha) and S_3: 150 kg S/ha in a Split Plot design with three replications.

In case of Nitrogen the tallest plant (34.36cm,111.10cm and 104.50cm) was observed from N_1(75kg N/ha). Where the shortest plant (24.98cm, 88.76cm and 86.04cm) was recorded from N_0 treated plots (control) at 30DAS, 60DAS and harvest respectively

The maximum number of capsule per plant (87.24) was obtained from N_1 (75kg N/ha) and the minimum number (76.46) was recorded from N_0 (control).

The longest capsule (3.58cm) was obtained from N_1 (75kg N/ha), whereas shortest (2.74 cm) was recorded from N_0 (control).

The maximum number of seeds per capsule (47.74) was obtained from N_1 (75kg N/ha) and the minimum number (40.88) was recorded from N_0 (control).

The maximum weight of 1000 seeds (3.58 g) was obtained from N_1 (75kg N/ha). The lowest weight (2.33g) was recorded from N_0 (control).

The highest seed yield (1.38 t/ha) was obtained from N_1 (75kg N/ha). The lowest seed yield (1.09 t/ha) was recorded from N_0 (control).

The highest stover yield (3.81t/ha) was obtained from N_3 (175kg N/ha). The lowest stover yield (2.77 t/ha) was recorded from N_0 (control).

In case of Sulphur, at 30,45, 60DAS and harvest the tallest plant (32.49cm,71.72cm,103.40 cm and 101.80 cm) was recorded from S_1(50 kg S/ha).

Whereas the shortest plant (27.31cm, 60.30cm, 90.01cm and 88.83cm) was recorded from S_0 treated plots (control) at 30DAS, 45 DAS, 60DAS and harvest respectively.

The maximum number of capsule per plant (85.31) was obtained from S_1(50kg S/ha). The minimum number (79.32) was recorded from S_3(150kg S/ha) which is statistically similar with S_0(control).

The longest capsule (3.27cm) was obtained from S_1 (150kg S/ha). The shortest (2.837) was recorded from S_0 (control).

The maximum number of seeds per capsule (46.55) was obtained from S_1(50kg S/ha). The minimum number (42.63) was recorded from S_0(control).

The maximum weight of 1000 seeds (3.86g) was obtained from S_1 (50kg S/ha). The lowest weight (2.81g) was recorded from S_0 (control)..

The highest seed yield (1.31 t/ha) was obtained from S_1 (50kg S/ha). The lowest seed yield (1.05 t/ha) was recorded from S_0 (control).

The highest stover yield (3.51t/ha) was obtained from S_3 (150kg S/ha). The lowest stover yield (3.16 t/ha) was recorded from S_0 (control).

In the interaction effect of nitrogen and sulphur, the tallest plant (35.78 cm, 83.14 cm, 124.7 cm, 111.00 cm was recorded from N_1S_1 treatment combination (75kg N/ha and 50kg S/ha) and the shortest plant (15.11cm, 36.33cm,67.90 cm and 75.00cm) was recorded from N_0S_0 treatment combination(control)

The maximum number of capsule per plant (88.67) was recorded from N_1S_1 treatment combination (75kg N/ha and 50kg S/ha) and the minimum number of capsule per plant (74.83) was recorded from N_0S_2 treatment combination (control and 100kg S/ha) which is statistically similar with N_0S_0 (control)

The longest capsule (3.59 cm) was recorded from N_1S_3 treatment combination (75kg N/ha and 150kg S/ha), which was statistically similar with N_1S_1(75kg N/ha and 50kg S/ha). The shortest capsule (2.25 cm) was recorded from N_0S_0 treatment combination (control).

The maximum number of seeds per capsule (50.17) was recorded from N_1S_1 treatment combination (75kg N/ha and 50kg S/ha) and the minimum number of seeds per capsule (37.50) was recorded from N_0S_0 treatment combination (control).

The maximum number of seeds per capsule (11.70) was recorded from N_1S_1 treatment combination (75 kg N/ha and 50kg S/ha) and the minimum number of seeds per capsule (8.22) was recorded from N_0S_0 treatment combination (control).

The highest seed yield (1.43 t/ha) was recorded from N_1S_1 treatment combination (75kg N/ha and 50kg S/ha) and the lowest seed yield (0.80 t/ha) was recorded from N_0S_0 treatment combination (control).

The highest stover yield (1.43 t/ha) was recorded from N_3S_3 treatment combination (175kg N/ha and 150kg S/ha) and the lowest stover yield (2.17 t/ha) was recorded from N_0S_0 treatment combination (control).

From the above discussion it may be concluded that the combination of N_1S_1 treatment combination *i.e.,* 75kg N/ha and 50kg S/ha is optimum for the maximum growth and yield of sesame. Under the consideration of the findings of this experiment, further studies may be suggested in different regions of Bangladesh for regional adaptability.

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Appendices

APPENDICES

Appendix I. Monthly record of air temperature, relative humidity and rainfall of the experimental site during the period of March to July 2014

Month	Air temperature (^{0}C)		Relative humidity (%)		Rainfall (mm)
	Maximum	Minimum	Maximum	Minimum	(total)
March, 2014	37.4	20.2	80.2	32.4	3.80
April, 2014	39.4	19.4	80.2	39.2	65.60
May, 2014	38.2	19.3	89.2	40	202
June, 2014	37.2	17.4	88.4	46.3	282.7
July, 2014	35.6	18.2	88.2	55.4	107.8

Appendix II. Analysis of variance of the data on plant height (cm) of sesame as influenced by nitrogen and sulphur

Source of variation	df	Mean square of plant height (cm) at days after sowing			
		30	45	60	At harvest
Replication	2	95.130	1294.067	668.025	301.118
FactorA (Nitrogen)	3	189.453*	411.025^{NS}	1225.336*	694.128*
Error	6	207.653	229.685	91.872	204.718
Factor B(Sulphur)	3	200.642*	543.550*	551.330*	344.430*
Interaction(AXB	9	318.931*	281.944*	322.954*	29.076*
Error	24	227.666	71.924	92.849	28.993

*Significant at 5% level of significance, ^{NS} Non significant

Appendix III. Analysis of variance of the data on leaf number (cm) of sesame as influenced by nitrogen and sulphur

Source of variation	df	Mean square of leaf number (cm) at days after sowing		
		30	45	60
Replication	2	56.142	753.879	59.150
Factor A(Nitrogen)	3	220.504*	2014.977*	1082.831 ^{NS}
Error	6	10.121	169.029	2701.216
Factor B(Sulphur)	3	21.358^{NS}	172.653 ^{NS}	1676.300*
Interaction(AXB	9	11.830*	179.286*	1224.942*

*Significant at 5% level of significance ^{NS} Non significant

Appendix IV. Analysis of variance of the data on yield contributing characters and yield of sesame as influenced by nitrogen and sulphur

Source of variation	df	Mean square at days after sowing							
		Capsule number	Capsule length (cm)	Seed/ capsule	Weight of 1000 seeds (g)	Seed yield (t/ha)	Stover yield (t/ha)	Biological yield (t/ha)	Harvest index(%)
Replication	2	92.062	0.016	56.359	301.118	0.037	0.085	0.217	2.604
Factor A (Nitrogen)	3	244.964*	1.586*	94.983*	694.128*	0.211*	0.896*	1.966*	3.300*
Error	6	54.587	0.160	17.669	204.718	0.008	0.175	0.203	7.466
Factor B (Sulphur)	3	92.541*	0.372*	32.575*	344.430*	0.157*	0.598*	1.254*	16.540*
Interaction (AXB)	9	8.865*	0.086*	16.465*	29.076*	0.019*	0.107*	0.168*	4.876*
Error	24	13.064	0.066	12.331	28.993	0.009	0.055	0.046	7.137

*Significant at 5% level of significance ^{NS} Non significant