GROWTH AND YIELD OF SESAME AS INFLUENCED BY POULTRY MANURE AND NITROGENOUS FERTILIZER

BY

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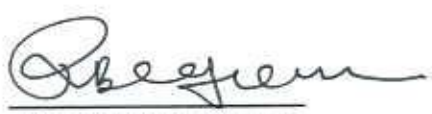

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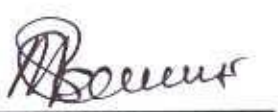

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This is to certify that the thesis entitled **"Growth and Yield of Sesame as Influenced by Poultry Manure and Nitrogenous Fertilizer"** submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **Master of Science** in **Agricultural Chemistry**, embodies the result of a piece of bonafide research work carried out by **AHMED RASHED-UN-NABI**, Registration number: **06-02012** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

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

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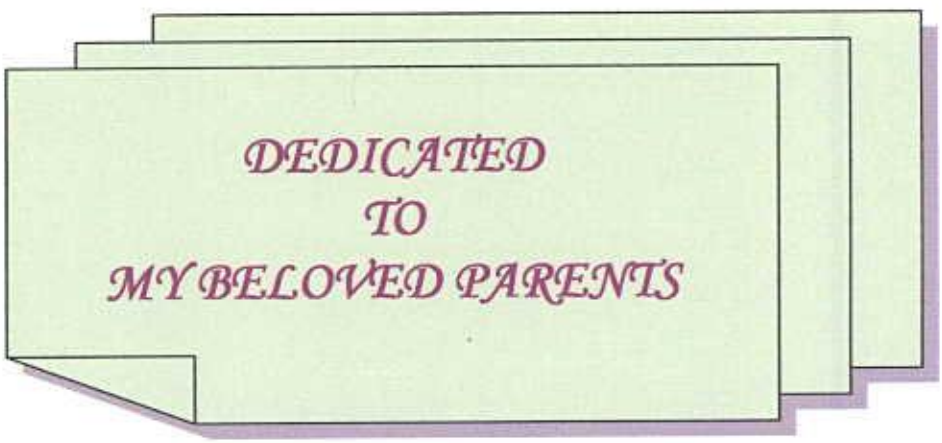
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TO
MY BELOVED PARENTS

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GROWTH AND YIELD OF SESAME AS INFLUENCED BY POULTRY MANURE AND NITROGENOUS FERTILIZER

ABSTRACT

An experiment was conducted in the research field of Sher-e-Bangla Agricultural University farm, Dhaka, Bangladesh during the period from March to June, 2013 to study the growth and yield of sesame as influenced by poultry manure and nitrogenous fertilizer following Randomized Complete Block Design (RCBD) with three replications. BARI Til-4 used was treated by 4 levels of poultry manure viz., PM_0: 0 t ha^{-1} (control), PM_1: 2.5 t ha^{-1}, PM_2: 5.0 t ha^{-1} and PM_3: 7.5 t ha^{-1}; and 4 levels of nitrogen viz., N_0: 0 kg N ha^{-1} (control), N_1: 50 kg N ha^{-1}, N_2: 60 kg N ha^{-1} and N_3: 70 kg N ha^{-1}. In case of poultry manure, the tallest plant (88.69 cm) was recorded from 5.0 ton poultry manure ha^{-1}, while the shortest plant (70.58 cm) was recorded from 0 ton poultry manure ha^{-1} at harvest. The maximum number of capsule per plant (66.37), highest seed yield per hectare (1.67 ton) and maximum oil content in seeds (40.47%) were observed from 5.0 ton poultry manure ha^{-1}, while the minimum results were recorded from 0 ton poultry manure ha^{-1}. For nitrogenous fertilizer, the tallest plant (90.24 cm) was observed from 60 kg N ha^{-1}, whereas the shortest plant (73.38 cm) from 0 kg N ha^{-1} at harvest. The maximum number of capsule per plant (65.62), highest seed yield per hectare (1.76 ton) and maximum oil content in seeds (39.42%) was found from 60 kg N ha^{-1}, whereas the minimum results were observed from 0 kg N ha^{-1}. In combination of poultry manure and nitrogenous fertilizer, the tallest plant (97.43 cm) was found from 5.0 ton poultry manure ha^{-1} and 60 kg N ha^{-1} at harvest, whereas the 0 ton poultry manure ha^{-1} and 0 kg N ha^{-1} provided shortest plant (62.77 cm). The maximum number of capsule per plant (72.76), highest seed yield per hectare (2.03 ton) and maximum oil content in seeds (45.67%) was found from 5.0 ton poultry manure ha^{-1} and 60 kg N ha^{-1}, while the minimum results were found from 0 ton poultry manure ha^{-1} and 0 kg N ha^{-1}. Among the combinations, 5.0 ton poultry manure ha^{-1} and 60 kg N ha^{-1} performed better in growth, yield contributing characters and yield of sesame.

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LIST OF ABBREVIATED TERMS

ABBREVIATION	FULL NAME
AEZ	Agro-Ecological Zone
BBS	Bangladesh Bureau of Statistics
cm	Centimeter
DAS	Date After Sowing
et al.	and others
Etc	Etcetera
FAO	Food and Agriculture Organization
LAI	Leaf Area Index
m^2	Square meter
MP	Muriate of Potash
PM	Poultry Manure
RCBD	Randomized Complete Block Design
SAU	Sher-e-Bangla Agricultural University
TSP	Triple Super Phosphate
UNDP	United Nations Development Program
^0C	Degree Celsius

CHAPTER I

INTRODUCTION

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

Sesame oil is generally used 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 pyrethrum, 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 2009-2010, the crop covered an area of 78.48 thousand hectares in Bangladesh with the production of 51,000 tons (BBS, 2011). 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 (Anon., 2004).

Yield and quality of seeds of sesame are very low in Bangladesh compare to the other sesame growing country. 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 considerably higher production and quality yield for any crop it is necessary to ensure proper management and availability of essential nutrients in proper doses.

Organic fertilizers are very active and important component of soil, furnishe large portion of macro and micro nutrients, protect soil against erosion, supply the cementing substance for desirable aggregate of soil formation and loosen the soil. Evidences from different AEZ of Bangladesh have shown a decreasing trend of organic matter ranging from 15 to 30% over the last 20 years. Poultry manure (PM) is the waste from poultry that is applied for sustain cropping system through better nutrient recycling and improving physical and biological properties of soil. In addition, the product from organic fertilizer is not harmful for health and not hazardous for the natural eco-system (Abou El-Magd *et al.*, 2006).

Nitrogen is 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 and Roan, 1981). On the other hand excessive application of nitrogen is not only uneconomical, but can also prolong the growth period and delay crop maturity. Excessive nitrogen application causes physiological disorder (Obreza and Vavrina, 1993).

Hence, considering the above facts the present study was undertaken with the following objectives:

i. To study the effect of poultry manure and nitrogen or in combination on the growth and yield of sesame and their optimum dose and oil content of sesame.

CHAPTER II

REVIEW OF LITERATURE

In Bangladesh and in many countries of the world sesame is an important 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 works related to growth, yield and development of sesame have been carried out in our country. Organic manure especially poultry manure and nitrogenous fertilizer play important role in improving sesame yield. But research works related to poultry manure and nitrogenous fertilizer on sesame are limited in Bangladesh. However, some of the important and informative research findings related to the poultry manure and nitrogenous fertilizer on sesame and other oil crops have been reviewed in this chapter under the following headings-

2.1 Effect of poultry manure on growth and yield

Amudha *et al.* (2005) carried out an experiment in Tamil Nadu, India, during the summer and kharif seasons in 2001 to study the effect of sulfur at varying rates and different organics (farmyard manure, poultry manure and pressmud each applied at 10 t/ha) on the yield and sulfur 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).

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 N (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 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.

The direct effects of crop residues and residual effects of chicken manure (0.0, 1.6, 3.2 or 4.8 t/feddan [1 feddan=0.42 ha]), treated town refuse (0.0, 2.4 or 6.0 t/feddan) and tafla (0, 12, 24 or 36 t/feddan) on the growth and yield of sesame (cv. Giza 24) were studied by Abou *et al.* (1999) in Ismailia, Egypt, during the summer season. Lupine termis residues were more effective in the enhancement of seed yield, leaf dry weight, and leaf N, K, Na, Ca, Mg and Zn contents than wheat residues. However, these treatments did not significantly vary in terms of leaf P, Fe and Mn contents. Chicken manure, treated town refuse and tafla significantly increased seed yield, leaf dry weight and N content of leaves over the control, but did not markedly affect the P, K, Fe and Mn contents of leaves. The

highest rates of these treatments reduced the Na content, and increased the Ca and Mg contents of leaves. The Zn content of leaves was enhanced by the application of 4.8, 6.0 and 36.0 t chicken manure, treated town refuse and tafla, respectively.

2.2 Effect of nitrogen on growth and yield

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 season.

The effect of nitrogen (N) rates (0, 60 and 90 kg/ha) and plant densities on the yield and yield components of sesame (*Sesamum indicum*) 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 when applied 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 (0.79 t/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. Sixty 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 soyabean 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 indicum*). 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 VRI 1 were grown at densities of 111,000 or 166,000 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 spacings of 30 × 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 Cuttack, 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 *et al.* (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, DM 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 *et al.* (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 Hisar, 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 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 t with 40-120 kg N/ha. Applied N 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).

CHAPTER 3

MATERIALS AND METHODS

The experiment was conducted during the period from March to June, 2013 to study the growth and yield of sesame as influenced by poultry manure and nitrogenous fertilizer. 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 carried out in the research field of Sher-e-Bangla Agricultural University Farm, Dhaka, Bangladesh. The location of the experimental site is $23^0 74^/N$ latitude and $90^0 35^/E$ longitude and an elevation of 8.2 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 Appendix I.

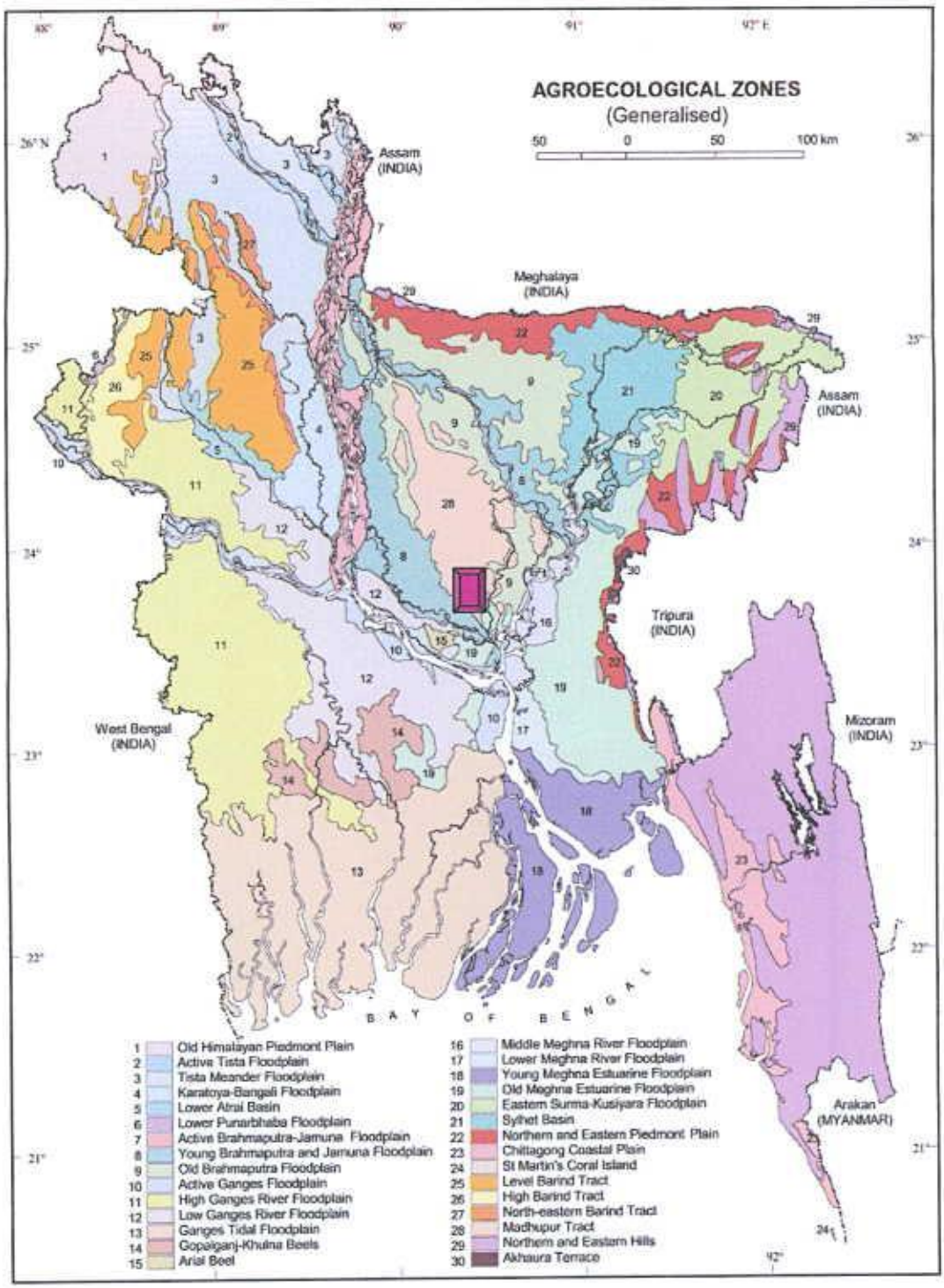


Plate 1. Map showing the experimental site under study

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 pre-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 II.

3.4 Treatment of the experiment

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

Factor A: Levels of poultry manure (4 levels)

i. PM_0: 0 t ha^{-1} (control)

ii. PM_1: 2.5 t ha^{-1}

iii. PM_2: 5.0 t ha^{-1}

iv. PM_3: 7.5 t ha^{-1}

Factor B: Levels of nitrogen (4 levels)

i. N_0: 0 kg N ha^{-1} (control)

ii. N_1: 50 kg N ha^{-1}

iii. N_2: 60 kg N ha^{-1}

iv. N_3: 70 kg N ha^{-1}

There were 16 (4 × 4) treatment combinations such as PM_0N_0, PM_0N_1, PM_0N_2, PM_0N_3, PM_1N_0, PM_1N_1, PM_1N_2, PM_1N_3, PM_2N_0, PM_2N_1, PM_2N_2, PM_2N_3, PM_3N_0, PM_3N_1, PM_3N_2 and PM_3N_3.

3.5 Planting material

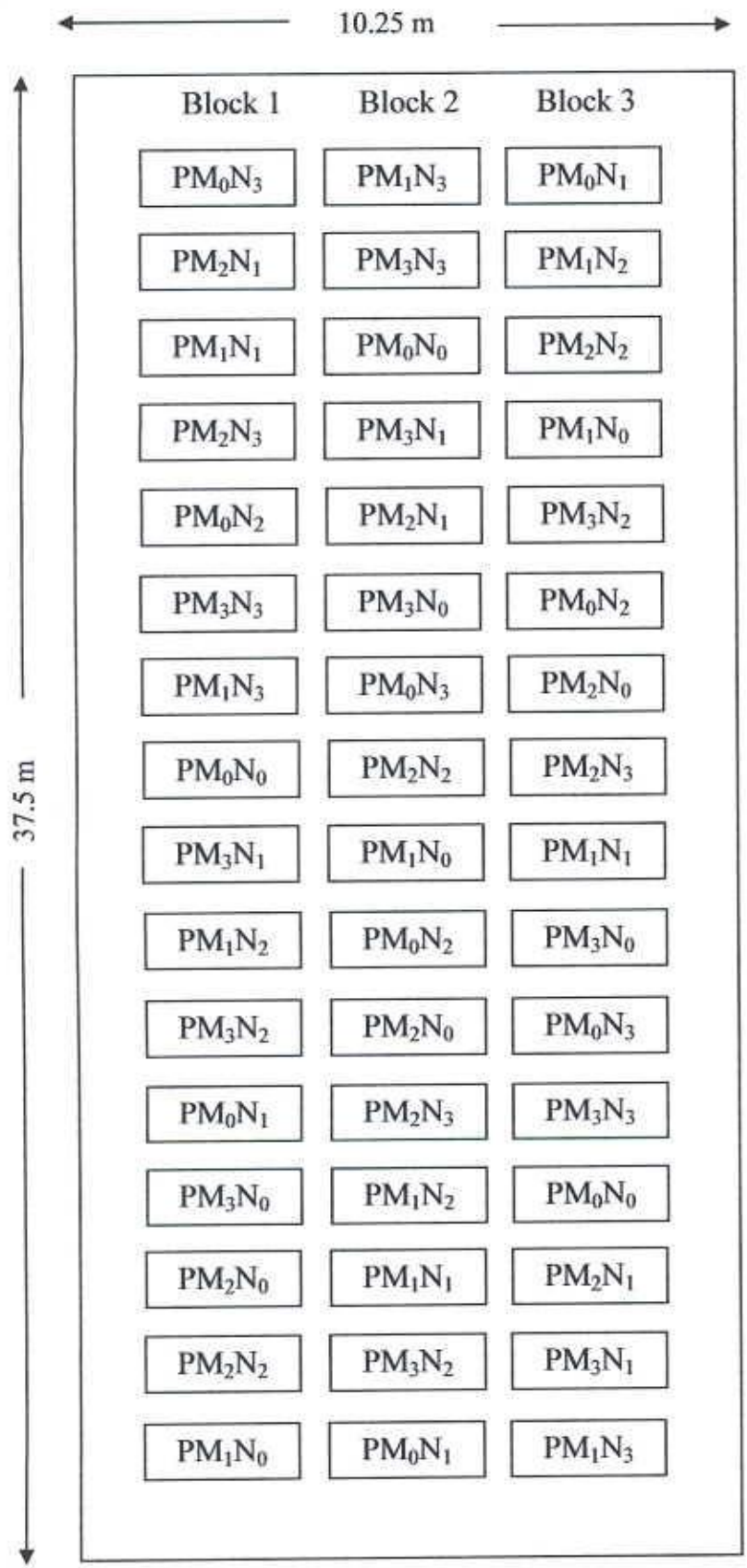
Seeds of BARI Til-4 used as a test crop for the study were collected from Supreme Seed Company Bangladesh Limited, Dhaka. It is a non-hairy medium sized plant with primary and secondary branches with high yield potential plant.

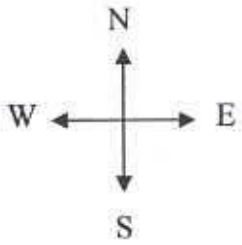
3.6 Layout of the experiment

The experiment consisted of two factors and was laid out following Randomized Complete Block Design (RCBD) with three replications. The layout of the experiment was prepared as per treatment combination for distributing the treatments in each plot of each block. Each block was divided into 16 plots where 16 treatment combinations were allotted at random. There were 48 unit plots altogether in the experiment. The size of the plot was 2.0 m × 1.5 m. The distance between two blocks was 1 m and between two plots was 50 cm.

3.7 Land preparation

The experimental field was first opened on March 25, 2013 with the help of a power tiller and prepared by three successive ploughing and cross-ploughing for easy operation of agronomic practices and germination of seedlings. Each ploughing was followed by laddering to have a desirable fine tilth. 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.





Plot size = 2.0 m ×1.5 m

Plot to plot: 0.5 m

Replication to replication: 1.0 m

Factor A: Level of poultry manure

PM_0: 0 t ha^{-1}

PM_1: 2.5 t ha^{-1}

PM_2: 5.0 t ha^{-1}

PM_3: 7.5 t ha^{-1}

Factor B: Level of nitrogen

N_0: 0 kg N ha^{-1}

N_1: 50 kg N ha^{-1}

N_2: 60 kg N ha^{-1}

N_3: 70 kg N ha^{-1}

Figure 1. Layout of the experimental plot according to factorial experiment in the Randomized Complete Block Design (RCBD)

3.8 Fertilizer application

Manures and fertilizers applied to the experimental plot have been presented in Table 1. The total amount of TSP, half of MP, total zinc and sulfur was applied as basal dose at the time of land preparation. The rest amount of MP and total amount of urea (as per treatment of nitrogenous fertilizer) were applied in two installments at 15 and 30 day after seed sowing.

Table 1. Dose and method of application of fertilizers in sesame field

Manures and Fertilizers	Dose ha^{-1}	Application (%)		
		Basal	15 DAS	30 DAS
Poultry Manure	As per treatment	100	--	--
Urea	As per treatment	--	50	50
TSP	150 kg	100	--	--
MP	50 kg	50	25	25
Sulphur	120 kg	100		
Zinc Sulphate	5 kg	100	--	--

Source: BARI, 2008

3.9 Sowing of seeds

The seeds of BARI Til-4 were sown on 04 April 2013 in rows in broadcasting.

3.10 Intercultural operation

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 palnts and it was done manually after 22 days of sowing, on April 26, 2013. 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 03 days for the establishment of seedlings.

3.10.4 Weeding

Weeding was done 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 was 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 the attaining ripening stage of capsule when plant become brownish and the harvesting was done manually. Enough care was taken during harvest.

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 in respect of the plant growth characters and yield of sesame.

3.12.1 Plant height

The height of plant was recorded at 30, 40, 50, 60 DAS and at harvest by using a meter scale. The height was measured from the ground level to the tip of 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 from randomly selected 10 plants at 30, 40, 50, 60 DAS and harvest 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, 40, 50, 60 DAS and at harvest and mean value was counted and recorded.

3.12.4 Number of days required from sowing to first appearance of flower

The number of days required from sowing to first appearance of flower was recorded from 10 randomly selected plants.

3.12.5 Number of capsule per plant

The number of capsules from 10 randomly selected plants from each unit plot was counted and their mean values were recorded.

3.12.6 Length of capsule

The capsules from each randomly selected plant were measured using centimeter scale and the mean value was calculated and was expressed in centimeter (cm).

3.12.7 Diameter of capsule

The 10 capsules randomly selected from harvest plant and measured using a Digital Caliper-515 (DC-515) and the mean value was expressed in millimeter (mm).

3.12.8 Number of seeds per capsule

Number of seeds per capsule was counted from 10 randomly selected capsules as harvested from each unit plot.

3.12.9 1000-seeds weight

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

3.12.10 Seed yield per hectare

Mature capsule pods were harvested from each plot and seeds were separated from capsules and their weight was recorded. The seed yield per plot was finally converted to yield per hectare and expressed in ton (t).

3.12.11 Stover yield per hectare

Mature sesame plants were harvested from each plot. Seeds and stover were separated and weight of stover was recorded. The stover yield per plot was finally converted to stover yield per hectare and expressed in ton (t).

3.12.12 Biological yield per hectare

Seed yield and stover yield together were regarded as biological yield of sesame. The biological yield was calculated with the following formula:

Biological yield = Seed yield + stover yield

3.12.13 Oil content

The percentage of oil content of sesame seed was determined by Folch method (Folch, *et al.*, 1957). One gram sesame seeds were taken in a mortar. The seeds were completely ground with a pestle. Thirty milliliter Folch reagent (chloroform: methanol = 2: 1) was added to it. After thorough mixing, the extract was filtered through Whatman No. 42 filter paper and the filtrate was taken in a beaker. The filtrate was allowed to stand for about six hours for air drying and then dried in an oven for about half an hour to determine total oil. Proper care was taken so that chloroform and methanol mixture completely had dried out. Oil content was calculated by the following formula:

$$\text{Oil content (\%)} = \frac{\text{Weight of extract (g)}}{\text{Sample weight (g)}} \times 100$$

3.13 Statistical analysis

The data obtained for different characters were statistically analyzed by using MSTAT-C computer package program to find out the significance of the difference. The mean values of all the characters were evaluated and analysis of variance was done by the 'F' (variance ratio) test. The mean differences were evaluated by Duncan's Multiple Range Test (DMRT) at 0.05 level of probability (Gomez and Gomez, 1984).

CHAPTER IV

RESULTS AND DISCUSSION

The study was conducted to find the growth and yield of sesame as affected by poultry manure and nitrogenous fertilizer. The analyses of variance (ANOVA) of the data on different growth and yield parameters are presented in Appendix II-VI. The results have been presented and discusses with the help of table and graphs and possible interpretations given under the following headings:

4.1 Plant height

Plant height of sesame varied significantly for different levels of poultry manure at 30, 40, 50, 60 DAS and at harvest (Table 2). At 30, 40, 50, 60 DAS and at harvest, the tallest plant (27.54 cm, 49.95 cm, 70.97 cm, 79.08 cm and 88.69 cm) was recorded from PM_2 (5.0 ton poultry manure ha^{-1}) which was statistically similar (26.24 cm, 48.39 cm, 67.98 cm, 78.17 cm and 87.53 cm) to that of PM_3 (7.5 ton poultry manure ha^{-1}) and to PM_1 (25.52 cm, 47.38 cm, 66.98 cm, 74.11 cm and 84.52 cm), respectively, while the shortest plant (19.65 cm, 39.92 cm, 55.77 cm, 62.30 cm and 70.58 cm) was found in PM_0 (control treatment). Organic fertilizers are very active and important component that furnishe large portion of macro and micro nutrients and ensure maximum vegetative growth. Abou El-Magd *et al.* (2006) reported that poultry manure applied in the field for sustain cropping system through better nutrient recycling provides all necessary nutrients and improve physical and biological properties of soil which leads to better plant growth.

Table 2. Effect of poultry manure and nitrogenous fertilizer on plant height of sesame at different days after sowing (DAS) and at harvest

Treatment	Plant height (cm) at				
	30 DAS	40 DAS	50 DAS	60 DAS	Harvest
Poultry manure					
PM_0	**19.65 c**	**39.92 c**	**55.77 c**	**62.30 c**	**70.58 c**
PM_1	25.52 b	47.38 b	66.98 b	74.11 b	84.52 b
PM_2	**27.54 a**	**49.95 a**	**70.97 a**	**79.08 a**	**88.69 a**
PM_3	26.24 ab	48.39 ab	67.98 ab	78.17 a	87.53 a
$LSD_{(0.05)}$	1.709	2.141	3.589	4.024	4.120
Level of significance	0.01	0.01	0.01	0.01	0.01
Nitrogenous fertilizer					
N_0	**20.80 c**	**41.21 c**	**56.19 c**	**63.33 c**	**73.38 c**
N_1	24.00 b	46.17 b	65.39 b	72.69 b	82.11 b
N_2	**27.50 a**	**49.27 a**	**71.01 a**	**80.39 a**	**90.24 a**
N_3	26.65 a	49.00 a	69.10 a	77.25 a	87.51 a
$LSD_{(0.05)}$	1.709	2.141	3.589	4.024	4.120
Level of significance	0.01	0.01	0.01	0.01	0.01
CV(%)	8.29	5.53	6.58	6.57	5.93

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

PM_0: 0 t ha^{-1} (control)

PM_1: 2.5 t ha^{-1}

PM_2: 5.0 t ha^{-1}

PM_3: 7.5 t ha^{-1}

N_0: 0 kg N ha^{-1} (control)

N_1: 50 kg N ha^{-1}

N_2: 60 kg N ha^{-1}

N_3: 70 kg N ha^{-1}

Significant variations were observed on plant height of sesame at 30, 40, 50, 60 DAS and at harvest (Table 2). At 30, 40, 50, 60 DAS and at harvest, due to the effect of different levels of nitrogenous fertilizer the tallest plant (27.50 cm, 49.27 cm, 71.01 cm, 80.39 cm and 90.24 cm) was observed from N_2 (60 kg N ha^{-1}), which was statistically identical (26.65 cm, 49.00 cm, 69.10 cm, 77.25 cm and 87.51 cm) with that of N_3 (70 kg N ha^{-1}) and to N_1 treatment (24.00 cm, 46.17 cm, 65.39 cm, 72.69 cm and 82.11 cm), whereas the shortest plant (20.80 cm, 41.21 cm, 56.19 cm, 63.33 cm and 73.38 cm) was recorded from N_0 treatment (0 kg N ha^{-1}). It was revealed that with the increase of nitrogen fertilizer plant height increased upto a certain level. Nitrogen ensured favorable condition for sesame plant and with optimum level of nitrogen the tallest plant was produced. Pathak *et al.* (2002) reported that the application of N at 45 kg ha^{-1} gave the highest mean values for plant height (74.3 cm).

There were significant differences in plant height of sesame at 30, 40, 50, 60 DAS and at harvest due to combined effect of different levels of poultry manure and nitrogenous fertilizer (Table 3). At 30, 40, 50, 60 DAS and at harvest, the tallest plant (32.57 cm, 56.12 cm, 80.82 cm, 91.02 cm and 97.43 cm) was found from PM_2N_2 (5.0 ton poultry manure ha^{-1} and 60 kg N ha^{-1}) and the shortest plant (16.94 cm, 33.91 cm, 46.66 cm, 54.80 cm and 62.77 cm) was attained from PM_0N_0. Vaiyapuri *et al.* (2004) reported that poultry manure with nitrogenous fertilizer produced the maximum plant height of sesame with ensuring proper growth and development.

Table 3. Combined effect of poultry manure and nitrogenous fertilizer on plant height of sesame at different days after sowing (DAS) and at harvest

Treatment	Plant height (cm) at				
	30 DAS	40 DAS	50 DAS	60 DAS	Harvest
PM_0N_0	**16.94 i**	**33.91 h**	**46.66 g**	**54.80 f**	**62.77 e**
PM_0N_1	19.01 hi	40.39 g	56.40 ef	62.30 d-f	70.19 de
PM_0N_2	22.42 f-h	43.36 e-g	61.64 d-f	68.02 d	77.74 cd
PM_0N_3	20.23 hi	42.03 fg	58.36 fe	64.09 de	71.60 de
PM_1N_0	22.06 gh	42.99 fg	63.32 c-e	69.43 d	77.49 cd
PM_1N_1	24.20 e-g	46.24 d-f	63.67 c-e	68.42 d	82.28 bc
PM_1N_2	26.57 c-e	48.34 cd	70.32 bc	80.57 b	90.50 ab
PM_1N_3	29.27 a-c	51.94 a-c	70.59 bc	78.01 bc	95.52 a
PM_2N_0	19.19 hi	39.46 g	53.83 fg	57.97 ef	69.90 de
PM_2N_1	27.41 b-e	50.39 b-d	72.17 b	80.65 b	90.71 ab
PM_2N_2	**32.57 a**	**56.12 a**	**80.82 a**	**91.02 a**	**97.43 a**
PM_2N_3	30.98 ab	53.81 ab	77.07 ab	86.67 ab	96.73 a
PM_3N_0	25.00 d-g	48.46 cd	60.96 ef	71.11 cd	83.35 bc
PM_3N_1	25.36 d-g	47.64 c-e	69.32 b-d	79.40 bc	85.27 bc
PM_3N_2	28.45 b-d	49.25 b-d	71.25 bc	81.94 b	95.29 a
PM_3N_3	26.14 c-f	48.21 cd	70.40 bc	80.23 b	86.21 bc
$LSD_{(0.05)}$	3.419	4.282	7.179	8.049	8.241
Level of significance	0.01	0.01	0.05	0.01	0.01
CV(%)	8.29	5.53	6.58	6.57	5.93

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

PM_0: 0 t ha^{-1} (control)

PM_1: 2.5 t ha^{-1}

PM_2: 5.0 t ha^{-1}

PM_3: 7.5 t ha^{-1}

N_0: 0 kg N ha^{-1} (control)

N_1: 50 kg N ha^{-1}

N_2: 60 kg N ha^{-1}

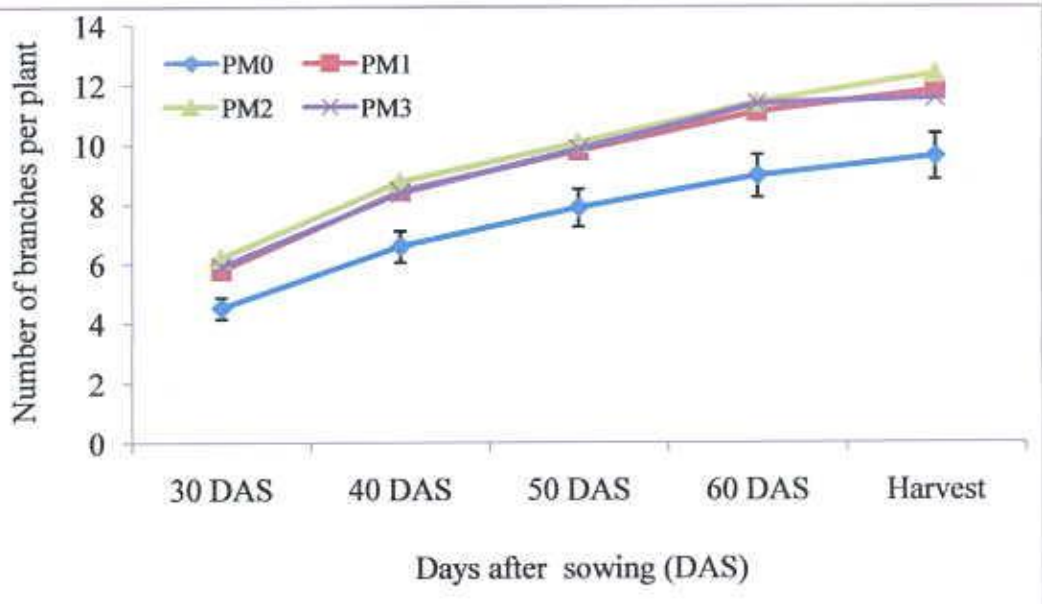
N_3: 70 kg N ha^{-1}

4.2 Number of branches per plant

Statistically significant variations were recorded in number of branches per plant of sesame due to different levels of poultry manure at 30, 40, 50, 60 DAS and at harvest (Figure 2). At 30, 40, 50, 60 DAS and at harvest, the maximum number of branches per plant (6.20, 8.75, 10.05, 11.40 and 12.37) was observed from PM_2 which was statistically similar or to that of treatments PM_3 or PM_1, whereas the minimum number of branches per plant (4.53, 6.60, 7.90, 8.97 and 9.62) was in PM_0. Vaiyapuri *et al.* (2004) reported that poultry manure gave the maximum number of branches per plant of sesame.

Number of branches per plant of sesame at 30, 40, 50, 60 DAS and at harvest varied significantly due to the effect of different levels of nitrogenous fertilizer (Figure 3). At 30, 40, 50, 60 DAS and harvest, the maximum number of branches per plant (6.13, 8.55, 10.15, 11.43 and 12.65) was observed in N_2, which was statistically identical (5.83, 8.50, 9.90, 11.20 and 11.82) to N_3 and followed (5.35, 8.15, 9.55, 10.77 and 11.52) by N_1, and the minimum number of branches per plant (5.15, 7.00, 8.00, 9.43 and 9.48) in N_0. Pathak *et al.* (2002) reported that the application of N at 45 kg ha^{-1} gave the highest mean values for number of branches per plant (4.50) of sesame.

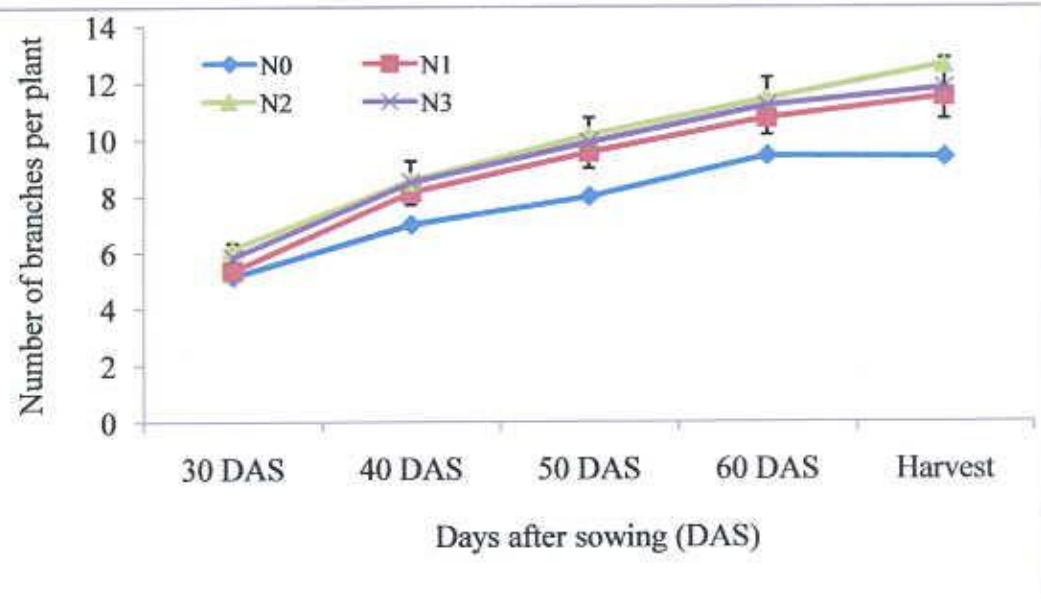
Different levels of poultry manure and nitrogenous fertilizer when used combinedly showed significant differences on number of branches per plant of sesame at 30, 40, 50, 60 DAS and at harvest (Table 4). Data revealed that at 30, 40, 50, 60 DAS and harvest, the maximum number of branches per plant (6.63, 9.80, 11.20, 12.33 and 14.00) was observed from PM_2N_2, while the minimum number (4.00, 5.20, 6.60, 7.93 and 8.80) was recorded from PM_0N_0.



PM_0: 0 t ha^{-1} (control) PM_1: 2.5 t ha^{-1}

PM_2: 5.0 t ha^{-1} PM_3: 7.5 t ha^{-1}

Figure 2. Effect of poultry manure on number of branches per plant of sesame



N_0: 0 kg N ha^{-1} (control) N_1: 50 kg N ha^{-1}

N_2: 60 kg N ha^{-1} N_3: 70 kg N ha^{-1}

Figure 3. Effect of nitrogenous fertilizer on number of branches per plant of sesame

Table 4. Combined effect of poultry manure and nitrogenous fertilizer on number of branches per plant of sesame at different days after sowing (DAS) and at harvest

Treatment	Number of branches per plant at				
	30 DAS	40 DAS	50 DAS	60 DAS	Harvest
PM_0N_0	**4.00 f**	**5.20 h**	**6.60 g**	**7.93 e**	**8.80 e**
PM_0N_1	4.03 f	7.00 g	8.20 ef	9.27 d	9.47 de
PM_0N_2	5.53 cd	7.20 g	8.60 de	9.53 d	10.40 d
PM_0N_3	4.60 e	7.00 g	8.20 ef	9.13 d	9.80 de
PM_1N_0	5.27 d	8.20 ef	9.40 cd	10.60 bc	9.47 de
PM_1N_1	5.53 cd	8.20 ef	9.40 cd	10.60 bc	11.80 c
PM_1N_2	6.07 a-c	8.40 d-f	10.20 bc	11.80 a	13.47 ab
PM_1N_3	6.33 ab	9.00 b-d	10.20 bc	11.40 ab	12.53 bc
PM_2N_0	5.53 cd	6.60 g	7.60 f	9.40 d	9.87 de
PM_2N_1	6.07 a-c	9.20 a-c	10.40 ab	11.67 a	12.67 bc
PM_2N_2	**6.63 a**	**9.80 a**	**11.20 a**	**12.33 a**	**14.00 a**
PM_2N_3	6.60 a	9.40 ab	11.00 ab	12.20 a	12.93 a-c
PM_3N_0	5.80 b-d	8.00 f	8.40 ef	9.80 cd	9.40 de
PM_3N_1	5.80 b-d	8.20 ef	10.20 bc	11.53 a	12.13 c
PM_3N_2	6.33 ab	8.80 b-e	10.60 ab	12.07 a	12.73 a-c
PM_3N_3	5.80 b-d	8.60 c-f	10.20 bc	12.07 a	12.00 c
$LSD_{(0.05)}$	0.585	0.624	0.874	0.820	1.183
Level of significance	0.05	0.01	0.01	0.05	0.05
CV(%)	6.25	4.66	5.57	4.60	6.25

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

PM_0: 0 t ha^{-1} (control)

PM_1: 2.5 t ha^{-1}

PM_2: 5.0 t ha^{-1}

PM_3: 7.5 t ha^{-1}

N_0: 0 kg N ha^{-1} (control)

N_1: 50 kg N ha^{-1}

N_2: 60 kg N ha^{-1}

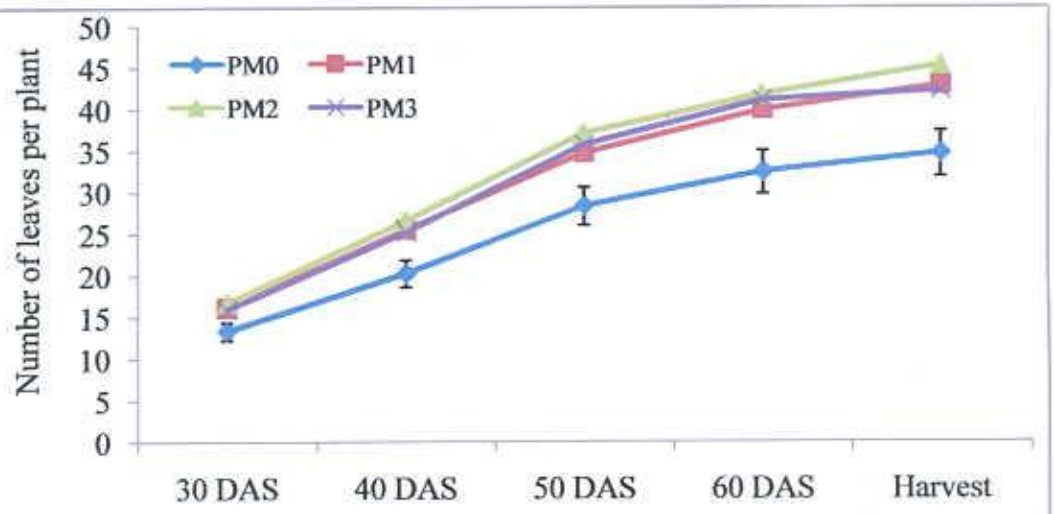
N_3: 70 kg N ha^{-1}

4.3 Number of leaves per plant

Different levels of poultry manure showed statistically significant variation on number of leaves per plant of sesame at 30, 40, 50, 60 DAS and at harvest (Figure 4). At 30, 40, 50, 60 DAS and at harvest, the maximum number of leaves per plant (16.67, 26.55, 37.05, 41.75 and 45.27) was found from PM_2 which was statistically similar (16.15, 25.52, 35.72, 41.10 and 42.23) with PM_3 and the minimum number (13.37, 20.28, 28.37, 32.45 and 34.68) from PM_0.

Statistically significant variation was recoded due to different levels of nitrogenous fertilizer on number of leaves per plant of sesame at 30, 40, 50, 60 DAS and at harvest under the present trial (Figure 5). At 30, 40, 50, 60 DAS and at harvest, the maximum number of leaves per plant (16.42, 26.37, 37.02, 42.32 and 44.45) was recorded from N_2, which was statistically identical (16.17, 25.67, 36.05, 40.87 and 43.22) with N_3, whereas the minimum number (13.95, 20.37, 28.60, 33.93 and 36.23) was found from N_0. Fayed *et al.* (2000) reported that increase in N rates more than 60 kg ha^{-1} had no significant effects on yield components and maximum number of leaves was attained within this level of nitrogenous fertilizer.

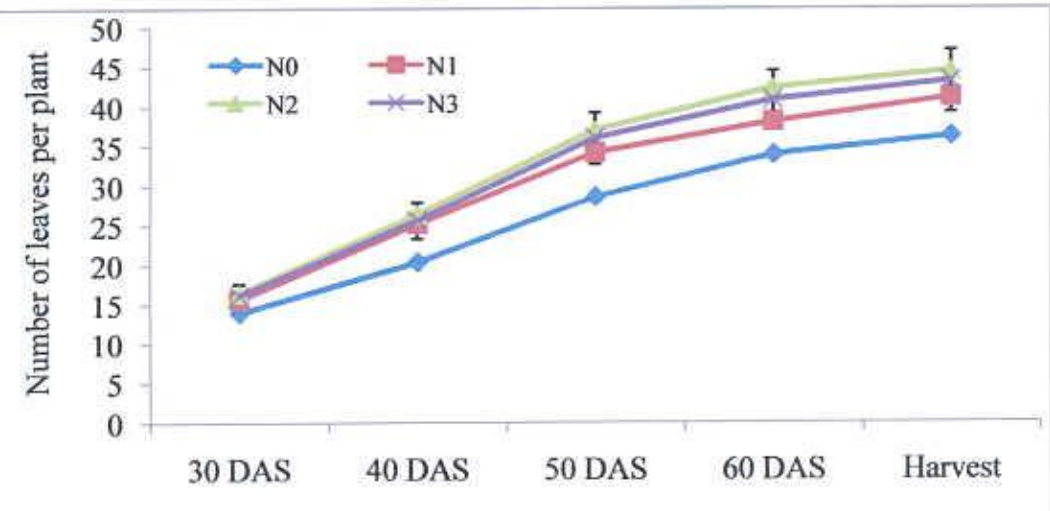
Number of leaves per plant of sesame at 30, 40, 50, 60 DAS and at harvest showed significant differences due to the combined effect of different levels of poultry manure and nitrogenous fertilizer (Table 5). At 30, 40, 50, 60 DAS and at harvest, the maximum number of leaves per plant (18.33, 29.73, 41.73, 47.00 and 51.60) was attained from PM_2N_2, again the minimum number (11.53, 15.80, 23.67, 28.13 and 31.47) was recorded from PM_0N_0.



PM_0: 0 t ha^{-1} (control) PM_1: 2.5 t ha^{-1}

PM_2: 5.0 t ha^{-1} PM_3: 7.5 t ha^{-1}

Figure 4. Effect of poultry manure on number of leaves per plant of sesame



N_0: 0 kg N ha^{-1} (control) N_1: 50 kg N ha^{-1}

N_2: 60 kg N ha^{-1} N_3: 70 kg N ha^{-1}

Figure 5. Effect of nitrogenous fertilizer on number of leaves per plant of sesame

Table 5. Effect of poultry manure and nitrogenous fertilizer on number of leaves per plant of sesame at different days after sowing (DAS) and at harvest

Treatment	Number of leaves per plant at				
	30 DAS	40 DAS	50 DAS	60 DAS	Harvest
PM_0N_0	**11.53 g**	**15.80 g**	**23.67 g**	**28.13 h**	**31.47 h**
PM_0N_1	13.60 f	21.67 ef	29.80 f	32.53 g	34.27 h
PM_0N_2	14.47 d-f	22.33 ef	30.60 ef	35.93 fg	38.27 fg
PM_0N_3	13.87 ef	21.33 ef	29.40 f	33.20 g	34.73 gh
PM_1N_0	15.60 c-e	23.73 de	31.93 ef	35.87 fg	40.60 ef
PM_1N_1	15.87 cd	25.60 cd	33.40 de	38.07 ef	41.73 d-f
PM_1N_2	16.20 b-d	26.40 b-d	37.81 bc	41.73 b-e	43.07 c-e
PM_1N_3	16.93 a-c	26.33 b-d	35.80 cd	44.00 a-d	46.07 bc
PM_2N_0	13.47 f	19.80 f	28.60 f	32.53 g	33.60 h
PM_2N_1	17.07 a-c	27.87 a-c	37.40 bc	41.73 b-e	46.73 bc
PM_2N_2	**18.33 a**	**29.73 a**	**41.73 a**	**47.00 a**	**51.60 a**
PM_2N_3	17.80 ab	28.80 ab	40.47 ab	45.73 ab	49.13 ab
PM_3N_0	15.20 c-f	22.13 ef	30.20 ef	39.20 ef	39.27 ef
PM_3N_1	15.93 b-d	25.67 cd	36.20 cd	40.07 d-f	41.87 d-f
PM_3N_2	16.67 a-c	27.00 bc	37.93 bc	44.60 a-c	44.87 cd
PM_3N_3	16.07 b-d	26.20 b-d	38.53 bc	40.53c-e	42.93 c-e
$LSD_{(0.05)}$	1.644	2.500	3.007	3.863	3.708
Level of significance	0.05	0.05	0.01	0.01	0.01
CV(%)	6.34	6.14	5.31	5.97	5.39

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

PM_0: 0 t ha^{-1} (control)

PM_1: 2.5 t ha^{-1}

PM_2: 5.0 t ha^{-1}

PM_3: 7.5 t ha^{-1}

N_0: 0 kg N ha^{-1} (control)

N_1: 50 kg N ha^{-1}

N_2: 60 kg N ha^{-1}

N_3: 70 kg N ha^{-1}

4.4 Number of days required from sowing to first appearance of flower

Number of days required from sowing to first appearance of flower of sesame varied significantly for different levels of poultry manure (Table 6). The highest number of days required from sowing to first appearance of flower (54.25) was recorded from PM_0 which was statistically similar (53.25 and 52.00) with PM_1 and PM_3, whereas the lowest days (49.25) from PM_2. Probably excess poultry manure prolongs vegetative growth.

Different levels of nitrogenous fertilizer showed significant variation on number of days required from sowing to first appearance of flower (Table 6). The highest number of days required from sowing to first appearance of flower (55.08) was observed from N_0, which was statistically identical (53.17) to N_1, and the lowest days (50.00) was observed from N_2 which was closely followed (50.50) by N_3.

Combined effect of different levels of poultry manure and nitrogenous fertilizer showed significant differences on number of days required from sowing to first flowering of sesame (Table 7). The highest number of days required from sowing to first appearance of flower (57.67) was observed from PM_3N_0, while the lowest days (45.33) from PM_2N_1.

4.5 Number of capsules per plant

The number of capsule per plant of sesame under the present study varied significantly due to different levels of poultry manure (Table 6). The maximum number of capsules per plant (66.37) was observed from PM_2 which was (63.13 and 61.36) to that of treatment PM_3 and PM_1 and they were statistically similar, while the minimum number (54.74) was obtained from PM_0. Vaiyapuri *et al.* (2004) reported that poultry manure gave the maximum number of capsules per plant of sesame.

Table 6. Effect of poultry manure and nitrogenous fertilizer on yield contributing characters of sesame

Treatment	Days from sowing to flowering	Number of capsule per plant	Length of capsule (cm)	Diameter of capsule (mm)
Poultry manure				
PM_0	**54.25 a**	**54.74 c**	**2.36 c**	**64.02 b**
PM_1	53.25 a	61.36 b	2.95 b	73.35 a
PM_2	**49.25 b**	**66.37 a**	**3.14 a**	**74.20 a**
PM_3	52.00 a	63.13 b	2.91 b	73.70 a
$LSD_{(0.05)}$	2.286	2.790	0.152	1.269
Level of significance	0.01	0.01	0.01	0.01
Nitrogenous fertilizer				
N_0	**55.08 a**	**53.93 c**	**2.42 c**	**63.07 c**
N_1	53.17 a	61.55 b	2.82 b	73.15 b
N_2	**50.00 b**	**65.62 a**	**3.08 a**	**75.03 a**
N_3	50.50 b	64.51 a	3.04 a	74.02 ab
$LSD_{(0.05)}$	2.286	2.790	0.152	1.269
Level of significance	0.01	0.01	0.01	0.01
CV(%)	5.25	5.45	6.43	4.13

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

PM_0: 0 t ha^{-1} (control)

PM_1: 2.5 t ha^{-1}

PM_2: 5.0 t ha^{-1}

PM_3: 7.5 t ha^{-1}

N_0: 0 kg N ha^{-1} (control)

N_1: 50 kg N ha^{-1}

N_2: 60 kg N ha^{-1}

N_3: 70 kg N ha^{-1}

Table 7. Combined effect of poultry manure and nitrogenous fertilizer on yield contributing characters of sesame

Treatment	Days from sowing to flowering	Number of capsule per plant	Length of capsule (cm)	Diameter of capsule (mm)
PM_0N_0	56.00 a-c	**52.42 f**	**2.09 h**	**55.53 f**
PM_0N_1	57.33 a	55.51 ef	2.22 h	66.07 de
PM_0N_2	51.67 c-f	55.87 ef	2.58 fg	67.67 d
PM_0N_3	51.67 c-f	55.15 ef	2.53 g	66.80 d
PM_1N_0	57.00 ab	52.02 f	2.71 e-g	67.73 d
PM_1N_1	54.33 a-d	60.22 de	2.86 d-g	73.60 c
PM_1N_2	49.33 d-g	65.45 b-d	3.00 c-e	76.87 ab
PM_1N_3	52.33 b-e	67.75 a-c	3.24 bc	75.20 bc
PM_2N_0	49.67 d-g	54.12 ef	2.19 h	63.40 e
PM_2N_1	**45.33 g**	67.40 a-c	3.30 bc	76.93 ab
PM_2N_2	51.00 c-f	**72.76 a**	**3.63 a**	**78.53 a**
PM_2N_3	51.00 c-f	71.22 ab	3.43 ab	77.93 ab
PM_3N_0	**57.67 a**	57.16 ef	2.67 e-g	65.60 de
PM_3N_1	55.33 a-c	63.07 cd	2.89 d-f	76.00 a-c
PM_3N_2	48.00 e-g	68.38 a-c	3.13 b-d	77.07 ab
PM_3N_3	47.00 fg	63.91 cd	2.97 c-e	76.13 a-c
$LSD_{(0.05)}$	4.572	5.580	0.303	2.538
Level of significance	0.01	0.01	0.01	0.05
CV(%)	5.25	5.45	6.43	4.13

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

PM_0: 0 t ha^{-1} (control)

PM_1: 2.5 t ha^{-1}

PM_2: 5.0 t ha^{-1}

PM_3: 7.5 t ha^{-1}

N_0: 0 kg N ha^{-1} (control)

N_1: 50 kg N ha^{-1}

N_2: 60 kg N ha^{-1}

N_3: 70 kg N ha^{-1}

Significant variation was recorded due to different levels of nitrogenous fertilizer on number of capsule per plant (Table 6). The maximum number of capsule per plant (65.62) was found from N_2, which was statistically identical (64.51) with N_3 and closely followed (61.55) by N_1, whereas the minimum number (53.93) was recorded from N_0. Pathak *et al.* (2002) reported that the application of N at 45 kg/ha gave the highest mean values for number of capsules per plant (39.0).

Number of capsule per plant of sesame showed significant differences due to the combined effect of different levels of poultry manure and nitrogenous fertilizer (Table 7). The maximum number of capsule per plant (72.76) was found from PM_2N_2 and the minimum number (52.42) was attained from PM_0N_0.

4.6 Length of capsule

Statistically significant difference was observed for length of capsule of sesame due to different levels of poultry manure (Table 6). The highest length of capsule (3.14 cm) was recorded from PM_2 which was closely followed (2.95 cm and 2.91 cm) by PM_1 and PM_3 and they were statistically similar, whereas the lowest length (2.36 cm) was obtained from PM_0.

Different levels of nitrogenous fertilizer showed significant variation on length of capsule (Table 6). The highest length of capsule (3.08 cm) was observed from N_2, which was statistically identical (3.04 cm) with N_3 and closely followed (2.82 cm) by N_1, again the lowest length (2.42 cm) was observed from N_0. Fayed *et al.* (2000) reported that increase in N rates more than 60 kg/ha had no significant effects on yield components.

Combined effect of different levels of poultry manure and nitrogenous fertilizer showed significant differences on length of capsule of sesame (Table 7). The highest length of capsule (3.63 cm) was observed from PM_2N_2, while the lowest length (2.09 cm) was recorded from PM_0N_0.

4.7 Diameter of capsule

The diameter of capsule of sesame varied significantly due to different levels of poultry manure (Table 6). The highest diameter of capsule (74.20 mm) was found from PM_2 which was statistically similar (73.70 mm and 73.35 mm) to PM_3 and PM_1, again the lowest diameter (64.02 mm) was recorded from PM_0.

Different levels of nitrogenous fertilizer showed significant variation on diameter of capsule (Table 6). Data revealed that the highest diameter of capsule (75.03 mm) was recorded from N_2, which was statistically identical (74.02 mm) with N_3 and closely followed (73.15 mm) by N_1, while the lowest diameter (63.07 mm) was obtained from N_0.

Significant difference on diameter of capsule of sesame was recorded due to the combined effect of different levels of poultry manure and nitrogenous fertilizer under the present trial (Table 7). The highest diameter of capsule (78.53 mm) was found from PM_2N_2, whereas the lowest diameter (55.53 mm) was observed from PM_0N_0. Vaiyapuri *et al.* (2004) reported that poultry manure with nitrogenous fertilizer produced the highest diameter of sesame capsule with ensuring proper growth and development.

4.8 Number of seeds per capsule

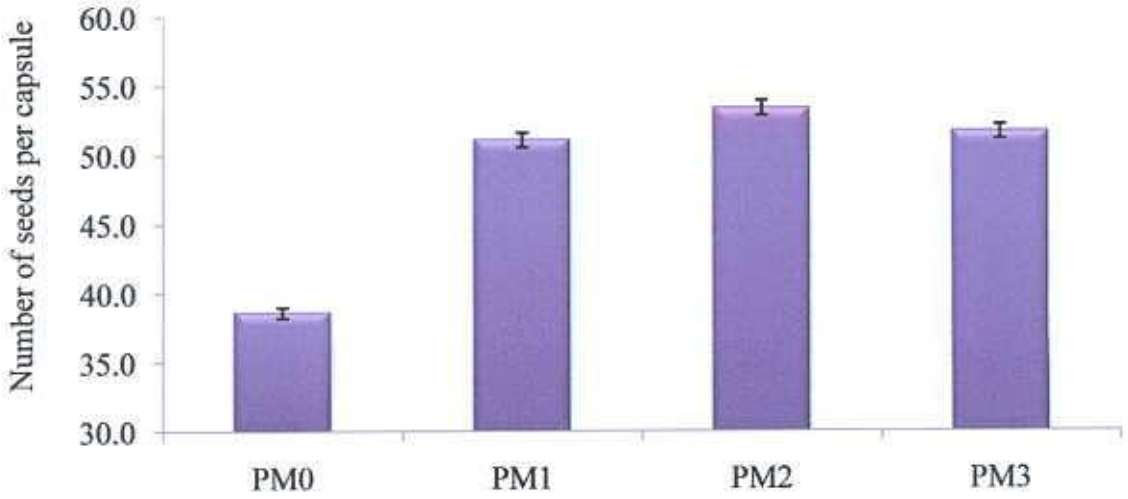
Number of seeds per capsule of sesame varied significantly for different levels of poultry manure (Figure 6). The maximum number of seeds per capsule (53.45) was recorded from PM_2 which was statistically similar (51.73) with PM_3 and closely followed (51.13) by PM_1, while the minimum number (38.63) from PM_0. Vaiyapuri *et al.* (2004) reported that poultry manure gave the maximum number of seeds per capsule of sesame.

Different levels of nitrogenous fertilizer varied significantly on number of seeds per capsule (Figure 7). The maximum number of seeds per capsule (54.74) was observed from N_2, which was statistically identical (53.52) with N_3 and closely followed (48.43) by N_1, while the minimum number (38.24) from N_0. Prakash *et al.* (2001) reported that 90 kg N/ha resulted highest number of seeds per capsule.

Combined effect of different levels of poultry manure and nitrogenous fertilizer showed significant differences on number of seeds per capsule of sesame (Figure 8). The maximum number of seeds per capsule (60.83) was found from PM_2N_2 and the minimum number (32.80) was recorded from PM_0N_0.

4.9 1000 seeds weight

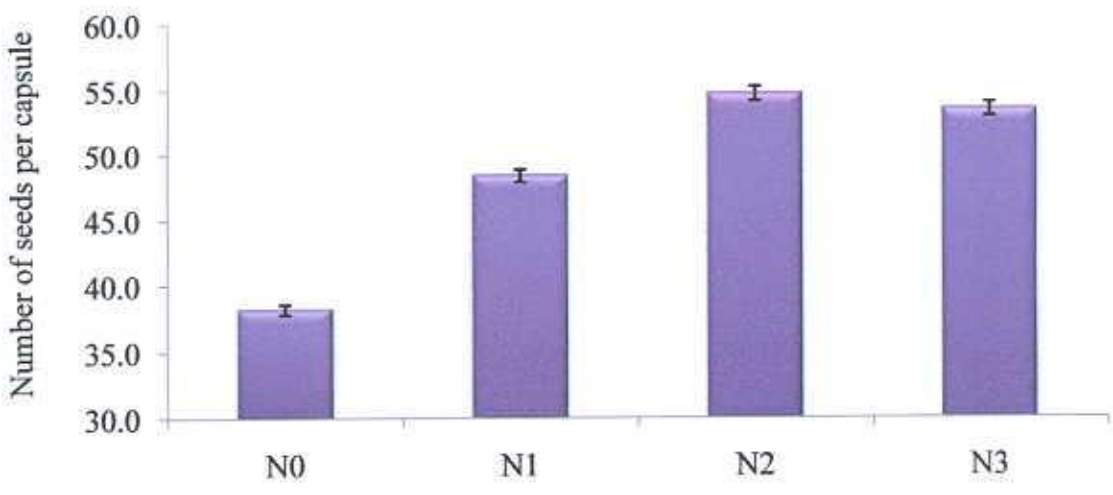
Significant variation was found for 1000 seeds weight due to different levels of poultry manure (Table 8). The highest 1000 seeds weight (13.91 g) was observed from PM_2 which was statistically similar (13.41 g and 13.28 g) with PM_1 and PM_3, again the lowest weight (11.44 g) from PM_0. Vaiyapuri *et al.* (2004) reported that poultry manure gave the maximum 1000-seed weight of sesame.



PM_0: 0 t ha^{-1} (control) PM_1: 2.5 t ha^{-1}

PM_2: 5.0 t ha^{-1} PM_3: 7.5 t ha^{-1}

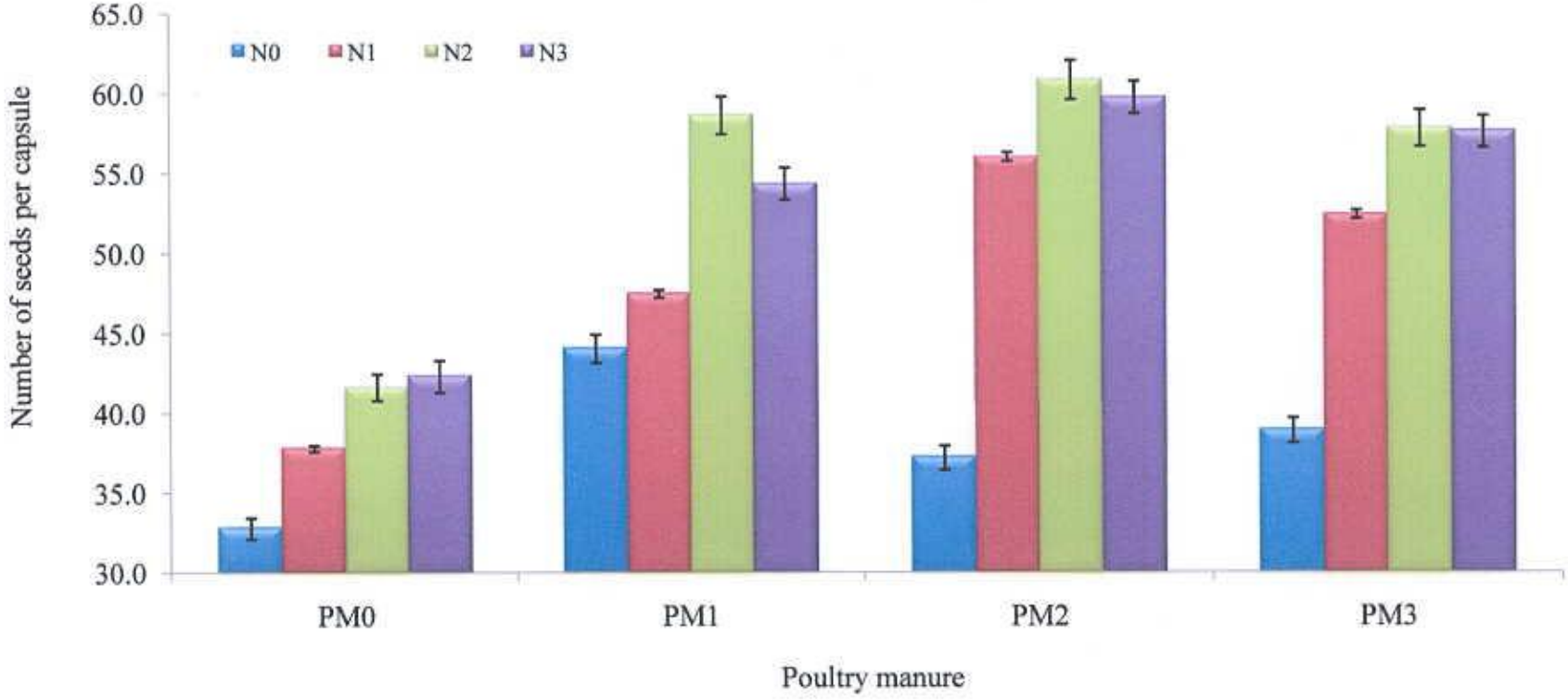
Figure 6. Effect of poultry manure on number of seeds per capsule of sesame



N_0: 0 kg N ha^{-1} (control) N_1: 50 kg N ha^{-1}

N_2: 60 kg N ha^{-1} N_3: 70 kg N ha^{-1}

Figure 7. Effect of nitrogenous fertilizer on number of seeds per capsule of sesame



PM_0: 0 t ha^{-1} (control) PM_1: 2.5 t ha^{-1} N_0: 0 kg N ha^{-1} (control) N_1: 50 kg N ha^{-1}

PM_2: 5.0 t ha^{-1} PM_3: 7.5 t ha^{-1} N_2: 60 kg N ha^{-1} N_3: 70 kg N ha^{-1}

Figure 8. Combined effect of poultry manure and nitrogenous fertilizer on number of seeds per capsule of sesame

Table 8. Effect of poultry manure and nitrogenous fertilizer on yield of sesame

Treatment	1000 seeds weight (g)	Seed yield per hectare (ton)	Stover yield per hectare (ton)	Biological yield per hectare (ton)
Poultry manure				
PM_0	**11.44 b**	**1.19 c**	**5.46 c**	**6.65 c**
PM_1	13.41 a	1.56 b	5.93 b	7.50 b
PM_2	**13.91 a**	**1.67 a**	**6.28 a**	**7.95 a**
PM_3	13.28 a	1.62 ab	6.04 b	7.67 b
$LSD_{(0.05)}$	0.645	0.0834	0.140	0.219
Level of significance	0.01	0.01	0.01	0.01
Nitrogenous fertilizer				
N_0	**11.57 b**	**1.12 c**	**5.24 d**	**6.36 d**
N_1	13.18 a	1.50 b	5.88 c	7.37 c
N_2	**13.65 a**	**1.76 a**	**6.39 a**	**8.15 a**
N_3	13.63 a	1.68 a	6.21 b	7.89 b
$LSD_{(0.05)}$	0.645	0.0834	0.140	0.219
Level of significance	0.01	0.01	0.01	0.01
CV(%)	5.95	6.52	4.80	5.53

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

PM_0: 0 t ha^{-1} (control)

PM_1: 2.5 t ha^{-1}

PM_2: 5.0 t ha^{-1}

PM_3: 7.5 t ha^{-1}

N_0: 0 kg N ha^{-1} (control)

N_1: 50 kg N ha^{-1}

N_2: 60 kg N ha^{-1}

N_3: 70 kg N ha^{-1}

Different levels of nitrogenous fertilizer showed significant variation on 1000 seeds weight (Table 8). The highest 1000 seeds weight (13.65 g) was observed from N_2, which was statistically identical (13.63 g and 13.13.18 g) with N_3 and N_1, again the lowest weight (11.57 g) was found from N_0. Prakash *et al.* (2001) reported that application of 90 kg N/ha resulted in the highest 1000-seed weight.

Combined effect of different levels of poultry manure and nitrogenous fertilizer showed significant differences on 1000 seeds weight (Table 9). The highest 1000 seeds weight (15.10 g) was attained from PM_2N_3, while the lowest weight result (10.18 g) was found from PM_0N_0.

4.10 Seed yield per hectare

Different levels of poultry manure varied significantly for seed yield per hectare of sesame (Table 8). The highest seed yield per hectare (1.67 ton) was observed from PM_2 which was statistically similar (1.62 ton) with PM_3 and closely followed (1.56 ton) by PM_1, whereas the lowest seed yield (1.19 ton) from PM_0. Vaiyapuri *et al.* (2004) reported that poultry manure gave the maximum seed yield of sesame.

Significant variation on seed yield per hectare was recorded for different levels of nitrogenous fertilizer (Table 8). The highest seed yield per hectare (1.76 ton) was found from N_2, which was statistically identical (1.68 ton) with N_3 and closely followed (1.50 ton) by N_1, again the lowest seed yield (1.12 ton) was recorded from N_0. It was revealed that nitrogen ensured favorable condition for the growth of sesame plant with optimum vegetative growth and the ultimate results was the

Table 9. Combined effect of poultry manure and nitrogenous fertilizer on yield of sesame

Treatment	1000 seeds weight (g)	Seed yield per hectare (ton)	Stover yield per hectare (ton)	Biological yield per hectare (ton)
PM_0N_0	**10.18 h**	1.04 gh	5.15 gh	6.19 gh
PM_0N_1	11.65 fg	1.25 ef	5.53 ef	6.77 ef
PM_0N_2	11.95 e-g	1.30 ef	5.76 de	7.06 e
PM_0N_3	11.98 e-g	1.17 f-h	5.39 fg	6.57 fg
PM_1N_0	13.35 b-e	1.21 fg	5.37 fg	6.58 e-g
PM_1N_1	12.81 d-f	1.41 e	5.61 ef	7.02 ef
PM_1N_2	14.22 a-d	1.81 bc	6.35 b	8.16 c
PM_1N_3	13.27 c-e	1.83 bc	6.39 b	8.22 c
PM_2N_0	11.15 gh	**1.00 h**	**5.04 h**	**6.04 h**
PM_2N_1	14.60 a-c	1.71 cd	6.35 b	8.06 cd
PM_2N_2	14.80 ab	**2.03 a**	**6.95 a**	**8.99 a**
PM_2N_3	**15.10 a**	1.94 ab	6.78 a	8.72 ab
PM_3N_0	11.62 fg	1.22 f	5.40 fg	6.62 e-g
PM_3N_1	13.66 a-d	1.63 d	6.01 cd	7.64 d
PM_3N_2	13.66 a-d	1.88 a-c	6.49 b	8.37 bc
PM_3N_3	14.16 a-d	1.77 b-d	6.27 bc	8.04 cd
$LSD_{(0.05)}$	1.291	0.167	0.279	0.438
Level of significance	0.01	0.01	0.01	0.01
CV(%)	5.95	6.52	4.80	5.53

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

PM_0: 0 t ha^{-1} (control)

PM_1: 2.5 t ha^{-1}

PM_2: 5.0 t ha^{-1}

PM_3: 7.5 t ha^{-1}

N_0: 0 kg N ha^{-1} (control)

N_1: 50 kg N ha^{-1}

N_2: 60 kg N ha^{-1}

N_3: 70 kg N ha^{-1}

highest yield. Pathak *et al.* (2002) reported that the application of N at 45 kg ha^{-1} gave the highest seed yield (7.25 q ha^{-1}). Fayed *et al.* (2000) reported that increase in N rates more than 60 kg/ha had no significant effects on seed yield. Bassiem and Anton (1998) reported that seed yield increased significantly by increasing N upto 90 kg ha^{-1}, whereas yield attributes increased significantly by adding N upto 60 kg N ha^{-1}.

Seed yield per hectare showed significant differences due to the combined effect of different levels of poultry manure and nitrogenous fertilizer (Table 9). The highest seed yield per hectare (2.03 ton) was found from PM_2N_2, while the lowest seed yield (1.04 ton) was recorded from PM_0N_0.

4.11 Stover yield per hectare

Stover yield per hectare of sesame varied significantly for different levels of poultry manure (Table 8). The highest stover yield per hectare (6.28 ton) was recorded from PM_2 which was followed (6.04 ton and 5.93 ton) by PM_3 and PM_1 and they were statistically similar whereas the lowest stover yield (5.46 ton) from PM_0. Vaiyapuri *et al.* (2004) reported that poultry manure gave the maximum stover yield of sesame.

Different levels of nitrogenous fertilizer showed significant variation on stover yield per hectare (Table 8). The highest stover yield per hectare (6.39 ton) was observed from N_2, which was closely followed (6.21 ton) by N_3, again the lowest stover yield (5.24 ton) was observed from N_0. Prakash *et al.* (2001) reported that application of 90 kg N/ha resulted in the highest straw yield.

Combined effect of different levels of poultry manure and nitrogenous fertilizer showed significant differences on stover yield per hectare (Table 9). The highest stover yield per hectare (6.95 ton) was observed from PM_2N_2, while the lowest stover yield (5.15 ton) was recorded from PM_0N_0.

4.12 Biological yield per hectare

Statistically significant variation was recorded for biological yield per hectare of sesame due to different levels of poultry manure (Table 8). The highest biological yield per hectare (7.95 ton) was observed from PM_2 which was followed (7.67 ton and 7.50 ton) by PM_3 and PM_1 and they were statistically similar, whereas the lowest biological yield (6.65 ton) was recorded from PM_0. Vaiyapuri *et al.* (2004) reported that poultry manure gave the maximum biological yield of sesame.

Biological yield per hectare showed significant variation for the application of different levels of nitrogenous fertilizer (Table 8). The highest biological yield per hectare (8.15 ton) was observed from N_2, which was closely followed (7.89 ton) by N_1, again the lowest biological yield (6.36 ton) was found from N_0. It was revealed that nitrogen ensured favorable condition for the growth of sesame plant with optimum vegetative growth and the ultimate results was the highest biological yield of sesame.

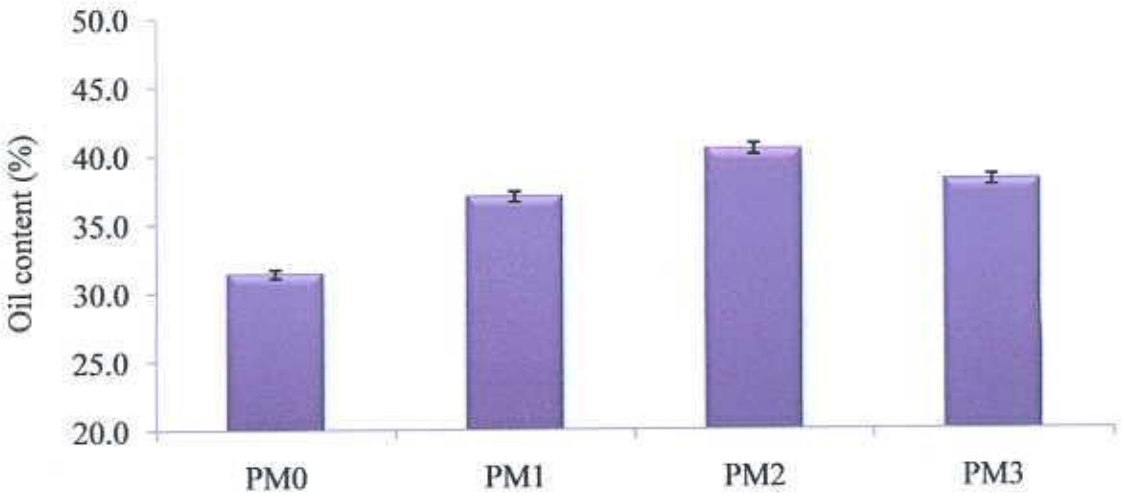
Combined effect of different levels of poultry manure and nitrogenous fertilizer showed significant differences on biological yield per hectare (Table 9). Data revealed that the highest biological yield per hectare (8.99 ton) was attained from PM_2N_2, while the lowest biological yield (6.04 ton) was found from PM_2N_0.

4.13 Oil content in seeds

Statistically significant variation was recorded for oil content in seeds of sesame varied significantly for different levels of poultry manure (Figure 9). The maximum oil content in seeds (40.47%) was found from PM_2 which was statistically similar (38.17%) with PM_3 and closely followed (37.02%) by PM_1, whereas the minimum oil content (31.43%) from PM_0.

Different levels of nitrogenous fertilizer showed significant variation on oil content in seeds (Figure 10). From the data it was observed that the maximum oil content in seeds (39.42%) was attained from N_2, which was statistically identical (38.99%) with N_3 and closely followed (36.00%) by N_1, while the minimum oil content (32.69%) was found from N_0. Fard and Bahrani (2005) reported that seed oil percentage was a stable yield component and was not affected by either N rate. Malik *et al.* (2003) reported that N at 80 kg ha^{-1} produced the highest seed oil content (45.88%). Moorthy *et al.* (1997) reported that seed oil content increased with up to 60 kg N ha^{-1}.

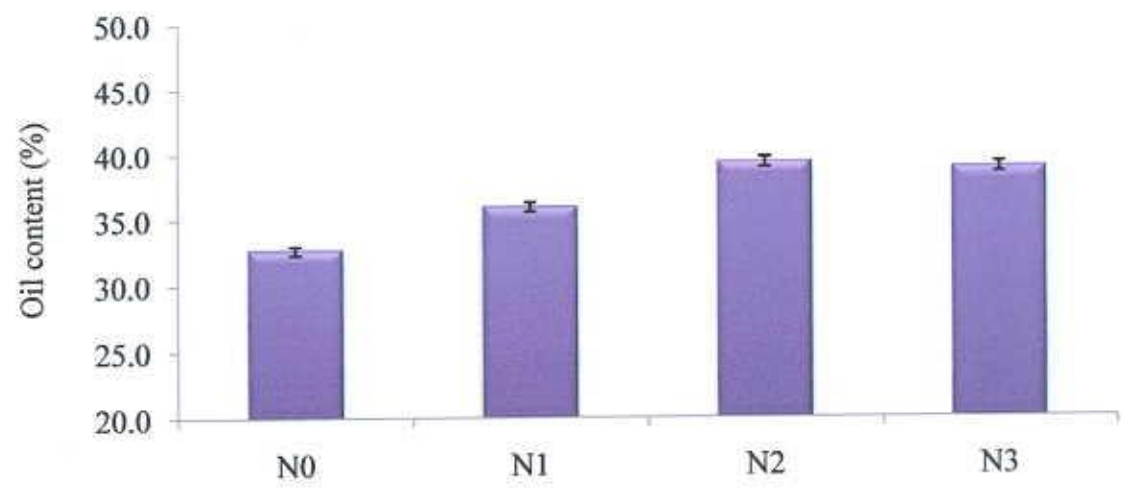
Significant difference in terms of oil content in seeds was recorded due to the combined effect of different levels of poultry manure and nitrogenous fertilizer under the present study (Figure 11). The maximum oil content in seeds (45.67%) was attained from PM_2N_3, whereas the minimum oil content (26.47%) was observed from PM_0N_0.



PM_0: 0 t ha^{-1} (control) PM_1: 2.5 t ha^{-1}

PM_2: 5.0 t ha^{-1} PM_3: 7.5 t ha^{-1}

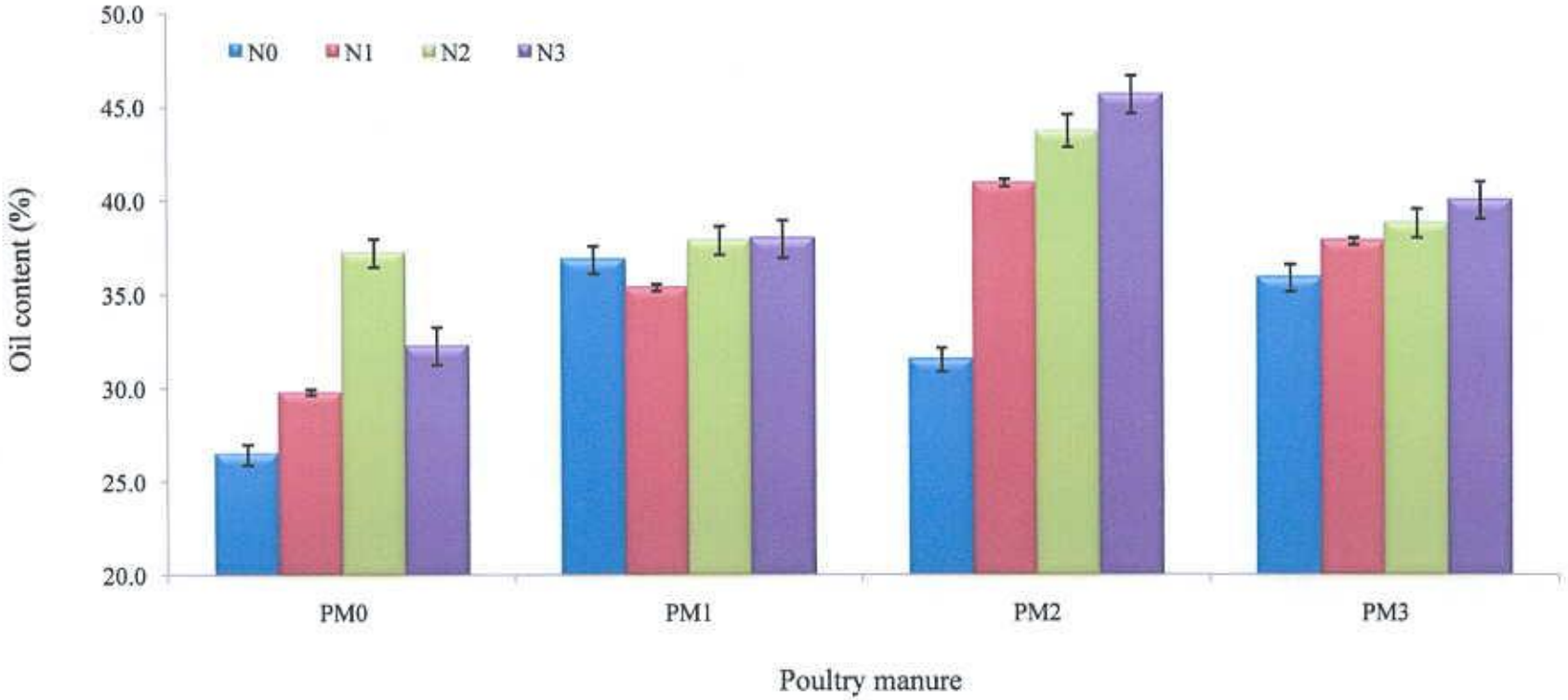
Figure 9. Effect of poultry manure on oil content in seeds of sesame



N_0: 0 kg N ha^{-1} (control) N_1: 50 kg N ha^{-1}

N_2: 60 kg N ha^{-1} N_3: 70 kg N ha^{-1}

Figure 10. Effect of nitrogenous fertilizer on oil content in seeds of sesame



PM_0: 0 t ha^{-1} (control) PM_1: 2.5 t ha^{-1} N_0: 0 kg N ha^{-1} (control) N_1: 50 kg N ha^{-1}

PM_2: 5.0 t ha^{-1} PM_3: 7.5 t ha^{-1} N_2: 60 kg N ha^{-1} N_3: 70 kg N ha^{-1}

Figure 11. Combined effect of poultry manure and nitrogenous fertilizer on oil content in seeds of sesame

CHAPTER V

SUMMARY AND CONCLUSION

The experiment was conducted in the research field of Sher-e-Bangla Agricultural University Farm, Dhaka, Bangladesh during the period from March to June, 2013 to study the growth and yield of sesame as influenced by poultry manure and nitrogenous fertilizer. Seeds of BARI Til-4 were used as a test crop for the study. The experiment consisted of two factors. Factor A: Levels of poultry manure (4 levels)- PM_0: 0 t ha^{-1} (control), PM_1: 2.5 t ha^{-1}, PM_2: 5.0 t ha^{-1} and PM_3: 7.5 t ha^{-1}; Factor B: Levels of nitrogen (4 levels)- N_0: 0 kg N ha^{-1} (control), N_1: 50 kg N ha^{-1}, N_2: 60 kg N ha^{-1} and N_3: 70 kg N ha^{-1}. The experiment was laid out in two factors Randomized Complete Block Design (RCBD) with three replications. Data on different growth parameters and yield were recorded and significant versions were recorded for the studied characters.

In case of poultry manure, PM_2 produced tallest plant at 30, 40, 50, 60 DAS and at harvest, viz. 27.54 cm, 49.95 cm, 70.97 cm, 79.08 cm and 88.69 cm, while the shorter plant (19.65 cm, 39.92 cm, 55.77 cm, 62.30 cm and 70.58 cm) was obtained from control. Similarly at 30, 40, 50, 60 DAS and harvest, the same level of poultry manure PM_2 produced the maximum number of branches per plant (6.20, 8.75, 10.05, 11.40 and 12.37) and it was least 4.53, 6.60, 7.90, 8.97 and 9.62) in control (PM_0) treatment. At 30, 40, 50, 60 DAS and harvest, the maximum number of leaves per plant (16.67, 26.55, 37.05, 41.75 and 45.27) was found from PM_2 and the minimum number (13.37, 20.28, 28.37, 32.45 and 34.68)

from PM_0. The highest number of days from sowing to first appearance of flower (54.25) was recorded from PM_0, whereas the lowest days (49.25) from PM_2. The maximum number of capsule per plant (66.37) was observed from PM_2, while the minimum number (54.74) from PM_0. The highest length of capsule (3.14 cm) was recorded from PM_2, whereas the lowest length (2.36 cm) from PM_0. The highest diameter of capsule (74.20 mm) was found from PM_2, again the lowest diameter (64.02 mm) from PM_0. The maximum number of seeds per capsule (53.45) was recorded from PM_2, while the minimum number (38.63) from PM_0. The highest weight of 1000 seeds (13.91 g) was observed from PM_2, whereas the lowest weight (11.44 g) from PM_0. The highest seed yield per hectare (1.67 ton) was observed from PM_2, whereas the lowest (1.19 ton) from PM_0. The highest stover yield per hectare (6.28 ton) was recorded from PM_2 whereas the lowest (5.46 ton) from PM_0. The highest biological yield per hectare (7.95 ton) was observed from PM_2, whereas the lowest (6.65 ton) from PM_0. The maximum oil content in seeds (40.47%) was found from PM_2, whereas the minimum (31.43%) from PM_0.

For nitrogenous fertilizer, at 30, 40, 50, 60 DAS and harvest, the tallest plant (27.50 cm, 49.27 cm, 71.01 cm, 80.39 cm and 90.24 cm) was observed from N_2, whereas the shortest plant (20.80 cm, 41.21 cm, 56.19 cm, 63.33 cm and 73.38 cm) from N_0. At 30, 40, 50, 60 DAS and harvest, the maximum number of branches per plant (6.13, 8.55, 10.15, 11.43 and 12.65) was observed from N_2, again the minimum number (5.15, 7.00, 8.00, 9.43 and 9.48) from N_0. At 30, 40, 50, 60 DAS and harvest, the maximum number of leaves per plant (16.42, 26.37, 37.02, 42.32 and 44.45) was recorded from N_2, whereas the minimum number

(13.95, 20.37, 28.60, 33.93 and 36.23) from N_0. The highest number of days from days from sowing to first appearance of flower (55.08) was observed from N_0, and the lowest days (50.00) from N_2. The maximum number of capsule per plant (65.62) was found from N_2, whereas the minimum number (53.93) from N_0. The highest length of capsule (3.08 cm) was observed from N_2, again the lowest length (2.42 cm) from N_0. The highest diameter of capsule (75.03 mm) was recorded from N_2, while the lowest diameter (63.07 mm) from N_0. The maximum number of seeds per capsule (54.74) was observed from N_2, while the minimum number (38.24) from N_0. The highest weight of 1000 seeds (13.65 g) was observed from N_2, again the lowest weight (11.57 g) from N_0. The highest seed yield per hectare (1.76 ton) was found from N_2 and the lowest seed yield (1.12 ton) from N_0. The highest stover yield per hectare (6.39 ton) was observed from N_2, again the lowest (5.24 ton) from N_0. The highest biological yield per hectare (8.15 ton) was observed from N_2, again the lowest (6.36 ton) from N_0. The maximum oil content in seeds (39.42%) was attained from N_2, while the minimum (32.69%) from N_0.

Due to combined effect of different level of poultry manure and nitrogenous fertilizer, at 30, 40, 50, 60 DAS and harvest, the tallest plant (32.57 cm, 56.12 cm, 80.82 cm, 91.02 cm and 97.43 cm) was found from PM_2N_2 and the shortest plant (16.94 cm, 33.91 cm, 46.66 cm, 54.80 cm and 62.77 cm) from PM_0N_0. At 30, 40, 50, 60 DAS and harvest, the maximum number of branches per plant (6.63, 9.80, 11.20, 12.33 and 14.00) was observed from PM_2N_2, while the minimum number (4.00, 5.20, 6.60, 7.93 and 8.80) from PM_0N_0. At 30, 40, 50, 60 DAS and harvest, the maximum number of leaves per plant (18.33, 29.73, 41.73, 47.00 and 51.60)

was attained from PM_2N_2, again the minimum number (11.53, 15.80, 23.67, 28.13 and 31.47) from PM_0N_0. The highest number of days from sowing to first appearance of flower (57.67) was observed from PM_3N_0, while the lowest days (45.33) from PM_2N_1. The maximum number of capsule per plant (72.76) was found from PM_2N_2 and the minimum number (52.42) from PM_0N_0. The highest length of capsule (3.63 cm) was observed from PM_2N_2, while the lowest length (2.09 cm) from PM_0N_0. The highest diameter of capsule (78.53 mm) was found from PM_2N_2, whereas the lowest diameter (55.53 mm) from PM_0N_0. The maximum number of seeds per capsule (60.83) was found from PM_2N_2 and the minimum number (32.80) from PM_0N_0. The highest weight of 1000 seeds (15.10 g) was attained from PM_2N_3, while the lowest weight (10.18 g) from PM_0N_0. The highest seed yield per hectare (2.03 ton) was found from PM_2N_2, while the lowest (1.04 ton) from PM_0N_0. The highest stover yield per hectare (6.95 ton) was observed from PM_2N_2, while the lowest (5.15 ton) from PM_0N_0. The highest biological yield per hectare (8.99 ton) was attained from PM_2N_2, while the lowest (6.04 ton) from PM_2N_0. The maximum oil content in seeds (45.67%) was attained from PM_2N_3, whereas the minimum (26.47%) from PM_0N_0.

It is interesting to note that at highest level of poultry manure and nitrogenous fertilizer used singly or in combination there was a negative effect on all the parameters studied in plant height, number of branches per plant, number of capsules, length of capsules, diameter of capsules, number of seeds per capsules, yield per hectare, biological yield, oil content etc. reduced to a considerable extent except number of leaves per plant.

Conclusion

In case of poultry manure and nitrogenous fertilizer, 5.0 ton poultry manure ha^{-1}, 60 kg N ha^{-1} individually and the combinations of 5.0 ton poultry manure ha^{-1} and 60 kg N ha^{-1} were found best in respect to growth, yield contributing characters and yield of sesame.

Recommendations

Considering the situation of the present experiment, further studies in the following areas may be suggested:

1. Such study needs to be conducted in different agro-ecological zones (AEZ) of Bangladesh for regional adaptability;
2. Considering different growth stages another level of poultry manure and other organic manure may be in the future study.
3. Other level of nitrogenous fertilizer need to be considered before final recommendation.

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APPENDICES

Appendix I. Physical characteristics of field soil analyzed in Soil Resources Development Institute (SRDI) laboratory, Khamarbari, Farmgate, Dhaka

A. Morphological characteristics of the experimental field

Morphological features	Characteristics
Location	SAU Labortory field, SAU, Dhaka
AEZ	Madhupur Tract (28)
General Soil Type	Shallow red brown terrace soil
Land type	High land
Soil series	Tejgaon
Topography	Fairly leveled
Flood level	Above flood level
Drainage	Well drained

B. Physical and chemical properties of the initial soil

Characteristics	Value
% Sand	27
% Silt	43
% clay	30
Textural class	Silty-clay
pH	5.6
Organic carbon (%)	0.45
Organic matter (%)	0.78
Total N (%)	0.03
Available P (ppm)	20.00
Exchangeable K (me/100 g soil)	0.10
Available S (ppm)	45

Source: Soil Resources Development Institute (SRDI)

Appendix II. Monthly record of air temperature, rainfall, relative humidity, rainfall and sunshine of the experimental site from the month of March to June, 2013

Month (2013)	Air temperature (°C)		*Relative humidity (%)	*Rainfall (mm)	*Sunshine (hr)
	Maximum	Minimum			
March	31.4	19.6	54	11	8.2
April	33.6	23.6	69	163	6.4
May	34.7	25.9	70	185	7.8
June	32.4	25.5	81	228	5.7

* Monthly average;

Source: Bangladesh Meteorological Department, Agargoan, Dhaka-1212

Appendix III. Effect of poultry manure and nitrogenous fertilizer on number of leaves per plant at different days after sowing (DAS) and harvest of sesame

Treatment	Number of branches per plant at				
	30 DAS	40 DAS	50 DAS	60 DAS	Harvest
Poultry manure					
PM_0	**4.53 c**	**6.60 c**	**7.90 b**	**8.97 b**	**9.62 c**
PM_1	5.80 b	8.45 ab	9.80 a	11.10 a	11.82 ab
PM_2	**6.20 a**	**8.75 a**	**10.05 a**	**11.40 a**	**12.37 a**
PM_3	5.93 ab	8.40 b	9.85 a	11.37 a	11.57 b
$LSD_{(0.05)}$	0.292	0.312	0.437	0.410	0.591
Level of significance	0.01	0.01	0.01	0.01	0.01
Nitrogenous fertilizer					
N_0	**5.15 c**	**7.00 c**	**8.00 c**	**9.43 c**	**9.48 c**
N_1	5.35 c	8.15 b	9.55 b	10.77 b	11.52 b
N_2	**6.13 a**	**8.55 a**	**10.15 a**	**11.43 a**	**12.65 a**
N_3	5.83 b	8.50 a	9.90 ab	11.20 a	11.82 b
$LSD_{(0.05)}$	0.292	0.312	0.437	0.410	0.591
Level of significance	0.01	0.01	0.01	0.01	0.01
CV(%)	6.25	4.66	5.57	4.60	6.25

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

PM_0: 0 t ha^{-1} (control)

PM_1: 2.5 t ha^{-1}

PM_2: 5.0 t ha^{-1}

PM_3: 7.5 t ha^{-1}

N_0: 0 kg N ha^{-1} (control)

N_1: 50 kg N ha^{-1}

N_2: 60 kg N ha^{-1}

N_3: 70 kg N ha^{-1}

Appendix IV. Effect of poultry manure and nitrogenous fertilizer on number of leaves per plant at different days after sowing (DAS) and harvest of sesame

Treatment	Number of leaves per plant at				
	30 DAS	40 DAS	50 DAS	60 DAS	Harvest
Poultry manure					
PM_0	**13.37 b**	**20.28 b**	**28.37 c**	**32.45 b**	**34.68 c**
PM_1	15.97 a	25.25 a	34.74 b	39.92 a	42.87 b
PM_2	**16.67 a**	**26.55 a**	**37.05 a**	**41.75 a**	**45.27 a**
PM_3	16.15 a	25.52 a	35.72 ab	41.10 a	42.23 a
$LSD_{(0.05)}$	0.822	1.250	1.504	1.932	1.854
Level of significance	0.01	0.01	0.01	0.01	0.01
Nitrogenous fertilizer					
N_0	**13.95 b**	**20.37 b**	**28.60 c**	**33.93 c**	**36.23 c**
N_1	15.62 a	25.20 a	34.20 b	38.10 b	41.15 b
N_2	**16.42 a**	**26.37 a**	**37.02 a**	**42.32 a**	**44.45 a**
N_3	16.17 a	25.67 a	36.05 a	40.87 a	43.22 a
$LSD_{(0.05)}$	0.822	1.250	1.504	1.932	1.854
Level of significance	0.01	0.01	0.01	0.01	0.01
CV(%)	6.34	6.14	5.31	5.97	5.39

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

PM_0: 0 t ha^{-1} (control)

PM_1: 2.5 t ha^{-1}

PM_2: 5.0 t ha^{-1}

PM_3: 7.5 t ha^{-1}

N_0: 0 kg N ha^{-1} (control)

N_1: 50 kg N ha^{-1}

N_2: 60 kg N ha^{-1}

N_3: 70 kg N ha^{-1}

Appendix V. Effect of poultry manure and nitrogenous fertilizer on number of seeds per capsule and oil content in seeds of sesame

Treatment	Number of seeds per capsule	Oil content (%)
Poultry manure		
PM_0	**38.63 c**	**31.43 c**
PM_1	51.13 b	37.02 b
PM_2	**53.45 a**	**40.47 a**
PM_3	51.73 ab	38.17 ab
$LSD_{(0.05)}$	2.154	2.337
Level of significance	0.01	0.01
Nitrogenous fertilizer		
N_0	**38.24 c**	**32.69 c**
N_1	48.43 b	36.00 b
N_2	**54.74 a**	**39.42 a**
N_3	53.52 a	38.99 a
$LSD_{(0.05)}$	2.154	2.337
Level of significance	0.01	0.01
Combined effect of poultry manure and nitrogenous fertilizer		
PM_0N_0	**32.80 h**	**26.47 h**
PM_0N_1	37.80 fg	29.80 gh
PM_0N_2	41.63 efg	37.21 cde
PM_0N_3	42.30 ef	32.26 efg
PM_1N_0	44.03 de	36.86 cde
PM_1N_1	47.47 d	35.38 def
PM_1N_2	58.63 ab	37.88 cd
PM_1N_3	54.37 bc	37.95 cd
PM_2N_0	37.20 g	31.52 fg
PM_2N_1	56.03 abc	40.96 abc
PM_2N_2	**60.83 a**	43.74 ab
PM_2N_3	59.73 a	**45.67 a**
PM_3N_0	38.93 fg	35.90 cdef
PM_3N_1	52.43 c	37.86 cd
PM_3N_2	57.87 ab	38.83 bcd
PM_3N_3	57.67 ab	40.07 bcd
$LSD_{(0.05)}$	4.308	4.675
Level of significance	0.01	0.01
CV(%)	5.30	7.62

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

PM_0: 0 t ha^{-1} (control)

PM_1: 2.5 t ha^{-1}

PM_2: 5.0 t ha^{-1}

PM_3: 7.5 t ha^{-1}

N_0: 0 kg N ha^{-1} (control)

N_1: 50 kg N ha^{-1}

N_2: 60 kg N ha^{-1}

N_3: 70 kg N ha^{-1}

Appendix VI. Analysis of variance of the data on plant height at different days after sowing and harvest of sesame as influenced by poultry manure and nitrogenous fertilizer

Source of variation	Degrees of freedom	Mean square				
		Plant height at				
		30 DAS	40 DAS	50 DAS	60 DAS	Harvest
Replication	2	1.783	0.259	15.000	3.693	16.731
Factor A (Poultry manure)	3	146.352**	237.946**	532.061**	714.792**	874.953**
Factor B (Nitrogen)	3	109.664**	168.017**	519.792**	662.333**	663.244**
Interaction (A×B)	9	16.385**	30.476**	50.109*	86.423**	76.487**
Error	30	4.203	6.595	18.534	23.299	24.424

**: Significant at 0.01 level of significance; *: Significant at 0.05 level of significance

Appendix VII. Analysis of variance of the data on number of branches per plant at different days after sowing and harvest of sesame as influenced by poultry manure and nitrogenous fertilizer

Source of variation	Degrees of freedom	Mean square				
		Number of branches per plant at				
		30 DAS	40 DAS	50 DAS	60 DAS	Harvest
Replication	2	0.141	0.052	0.202	0.043	0.336
Factor A (Poultry manure)	3	6.591**	11.500**	12.140**	16.394**	17.210**
Factor B (Nitrogen)	3	2.411**	6.260**	11.180**	9.586**	23.212**
Interaction (A×B)	9	0.290*	1.187**	1.027**	0.682**	1.926*
Error	30	0.123	0.140	0.275	0.242	0.503

**: Significant at 0.01 level of significance; *: Significant at 0.05 level of significance

Appendix VIII. Analysis of variance of the data on number of leaves per plant at different days after sowing and harvest of sesame as influenced by poultry manure and nitrogenous fertilizer

Source of variation	Degrees of freedom	Mean square				
		Number of leaves per plant at				
		30 DAS	40 DAS	50 DAS	60 DAS	Harvest
Replication	2	0.052	0.007	0.470	2.340	3.332
Factor A (Poultry manure)	3	26.187**	94.153**	178.092**	222.250**	251.339**
Factor B (Nitrogen)	3	14.781**	89.517**	170.084**	163.227**	157.136**
Interaction (A×B)	9	2.215*	6.260**	9.671**	17.835**	30.871**
Error	30	0.972	2.247	3.253	5.36	4.944

**: Significant at 0.01 level of significance; *: Significant at 0.05 level of significance

Appendix IX. Analysis of variance of the data on yield contributing characters sesame as influenced by poultry manure and nitrogenous fertilizer

Source of variation	Degrees of freedom	Mean square				
		Days from sowing to first flowering	Number of capsule per plant	Length of capsule (cm)	Diameter of capsule (cm)	Number of seeds per capsule
Replication	2	3.563	1.157	0.020	0.463	0.147
Factor A (Poultry manure)	3	56.188**	288.597**	1.357**	285.679**	555.701**
Factor B (Nitrogen)	3	67.910**	332.925**	1.125**	370.120**	676.592**
Interaction (A×B)	9	32.484**	33.273**	0.182**	6.504**	37.679**
Error	30	7.518	11.196	0.033	2.317	6.674

**: Significant at 0.01 level of significance; *: Significant at 0.05 level of significance

Appendix X. Analysis of variance of the data on yield of sesame and oil content as influenced by poultry manure and nitrogenous fertilizer

Source of variation	Degrees of freedom	Mean square				
		Weight of 1000 seeds (g)	Seed yield (t/ha)	Stover yield (t/ha)	Biological yield (t/ha)	Oil content (%)
Replication	2	0.369	0.002	0.016	0.029	2.233
Factor A (Poultry manure)	3	14.008**	0.581**	1.430**	3.777**	176.769**
Factor B (Nitrogen)	3	11.562**	0.973**	3.070**	7.495**	116.700**
Interaction (A×B)	9	1.932**	0.084**	0.281**	0.668**	25.443**
Error	30	0.599	0.010	0.028	0.069	7.860

**: Significant at 0.01 level of significance; *: Significant at 0.05 level of significance