EFFECT OF NITROGEN LEVELS ON THE GROWTH AND YIELD PERFORMANCE OF SESAME (*SESAMUM INDICUM* L.) VARIETIES

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A Thesis

submitted to the Agrotechnology Discipline in partial fulfillment of the requirement for the degree of Master of Science in Agronomy

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DEDICATED TO MY
BELOVED PARENTS

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ABSTRACT

An experiment was conducted in the Field Laboratory, Agrotechnology Discipline, Khulna University, Khulna, during February to May 2008 with a view to study the effect of nitrogen on the growth and yield performance of sesame varieties. The experiment consisted of three varieties (Botiaghata Local Til, BARI Til-2 and BARI Til-3) and four nitrogen levels (0, 25, 50 and 75 kg N ha^{-1}). The experiment was laid out in a randomized complete block design with three replications. The result showed significant variations among the varieties for all the crop characters viz. plant height, number of leaves, number of branches $plant^{-1}$, number of capsules $plant^{-1}$, capsule length, number of seeds $capsule^{-1}$, 1000-seed weight, dry matter content, days to first flowering, days to harvest, stover yield (t ha^{-1}), seed yield (t ha^{-1}) and harvest index. The highest seed yield (1.58 t ha^{-1}) was recorded from BARI Til-2, followed by the yield (1.10 t ha^{-1}) from BARI Til-3 and the lowest yield (0.95 t ha^{-1}) from the Botiaghata Local Til. Nitrogen had significant effect on all parameters studied. The highest seed yield (1.51 t ha^{-1}) was recorded from the 75 kg N ha^{-1} and the lowest seed yield (0.95 t ha^{-1}) was recorded from the control. The interactions of variety with nitrogen exerted its significant effect on all parameters studied except capsule length and 1000-seed weight of sesame. The highest seed yield was obtained from the combination of BARI Til-2 with 75 kg N ha^{-1}.

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CHAPTER I

INTRODUCTION

Sesame (*Sesamum indicum* L.) is one of the important oil crops and widely grown in different parts of the world. Sesame is locally known as Til in Bangladesh. It is the second important edible oil crop of Bangladesh (Alim, 1974). Bangladesh produced 49.03 thousand metric tons of sesame from 79.69 thousand hectare of land every year (BARI, 2001).

Sesame is a versatile crop with high quality edible oil having diversified usage. Due to varietal difference it contains 42 to 50% oil, 14 to 20% carbohydrate and 25% protein (BARI, 2001). Sesame oil is used mostly for edible purposes and in confectionary and for illumination.

Bangladesh is not self-sufficient in edible oil and industrial oil and as a result huge amount of foreign currency is being drained every year for importing oil of both the categories. Bangladesh imported 376 thousand metric tons of oil from other countries costing an amount of Tk. 457 crores in 2002-2003 (BBS, 2004).

Yield and quality seeds of sesame are very low in Bangladesh. Sesame yield is very low due to poor management practices (Rahman *et al.,* 2003). For successful production of crop many factors, such as, quality seed, weed control, proper fertilization, irrigation, method of sowing, optimum sowing time, seed rate, and time of harvest are indispensable.

Insufficient N availability to sesame plants results in low yields and significantly reduces profits compared to a properly fertilized crop. Nitrogen fertilizer rate and timing are the major tools available after planting to manipulate sesame to produce higher yields per acre.

Nitrogen is one of the accelerating factors of crop production. As an essential of protein it is needed for growth and development of all living tissues. It is an important constituent of chlorophyll, the green pigment of healthy tissues. So, nitrogen is one of the dominant factors for low yield of sesame. Nitrogen stress decreases leaf area index (LAI), leaf area duration, and crop photosynthetic rate, and leads to lower radiation interception and lower radiation use efficiency in all the crops.

The practice of intensive cropping with modern varieties causes a marked depletion of inherent nutrient reserves in soil of Bangladesh. Deficiency of primary nutrient especially nitrogen has been reported since a long time. Every year a large amount of nitrogen is lost by different processes such as leaching, volatilization, denitrification etc. So as an accelerating factor for production, nitrogen should be added for better production.

Nitrogen deficiency is the most widespread nutritional problem in sesame production. In addition, nitrogen fertilizer recovery tends to be low; in Bangladesh N recovery was estimated at about 30 percent.

Proper N application timing and rates are critical for meeting plant needs and improving nitrogen use efficiency. In addition, the growth stage of plants at the time of fertilizer application also determines nitrogen use efficiency. The timing of fertilizer N applications has a significant effect on the uptake of fertilizer N by the crop and the resulting partitioning of added N between soil and plant. Nitrogen applications split doses have been found to increase yield, nitrogen use efficiency, and N uptake efficiency.

N fertilizer use in sesame should be improved, not only in view of its increasing contribution to the cost of sesame production but also because of the detrimental environmental effects that are associated with improper N management and its excessive use.

Nitrogen has been found to be most important nutrient for sesame production. However, most sesame production soils have low nitrogen level. In view of this low N status in the soil, N is usually supplemented with chemical N fertilizer and the importance of this source has increased over the years.

There is a great scope of increasing sesame yield per unit area with proper use of nitrogen fertilizer. High yielding varieties of sesame are very responsible to fertilizers especially nitrogen.

Hence, the present experiment was undertaken with the following objective:

- To study the effect of different levels of nitrogen on growth and seed yield of sesame varieties.

CHAPTER II

REVIEW OF LITERATURE

Seed yield, oil and protein content of sesame are greatly influenced by environmental factors like temperature, rainfall and humidity variety used and agronomic practices like fertilization, irrigation, seed rate, sowing time and spacing. Among the factors, variety and nitrogen fertilization are important for the production of sesame. Many works on different aspects of sesame cultivation have been done for the improvement of yield of sesame. Research works related to the effect of variety and nitrogen fertilization on growth and seed yield have been reviewed in this chapter.

Sujathamma *et al.* (2003) conducted an experiment on the direct and residual effects of N fertilizers on sesame in rice-groundnut-sesame cropping system and found that seed yield was the highest with 60 kg N ha^{-1}. Nitrogen was supplied to sesame at 0, 50 or 100% of the recommended rates of 60 kg ha^{-1} but in rice nitrogen was supplied as green manure (25%) + urea (75%), FYM (25%) + urea (75%), green manure (25%) + FYM (25%) + urea (50%), green manure (50%) + FYM (50%) or urea (100%), and in case of groundnut at 0, 50, or 100% of recommended dose (30 kg N ha^{-1}). They found that, the number of capsules $plant^{-1}$, seed and stalk yield of sesame was highest in case of 60 kg N ha^{-1} (100% of recommended dose) and application of nitrogen as green manure (50%) + FYM (50%) but highest number of seeds $capsules^{-1}$ and 1000-seed weight were obtained with the application of 100% of the recommended rate.

Rahman *et al.* (2003) conducted an experiment on response of sesame to sowing dates, nitrogen fertilization and plant population in sandy soil to investigate the effects of sowing date (10 and 25 May and 10 June), N fertilizer rate (60, 80 and 100 kg feddan^{-1} and plant population 70000, 35000 and 235000 plants feddan^{-1}) on the performance of sesame cv. Giga 32. The height of the first branch and first capsule as well as the length of the fruiting zone was the highest at 60 kg N feddan^{-1} (1 feddan = 0.42 ha).

Paul and Savitheri (2003) undergone a study to evaluate the possibility of using bio-fertilizer either alone or as supplement to chemical fertilizers for sesame cv. Thilak grown in summer rice-fallow in Mannuth, Kerala, India during January, April 1995. The treatments included the recommended dose of inorganic nitrogen at 30 kg ha^{-1} alone, inoculation of *Agospirillum* or *Azotobacter* each at 600 g ha^{-1} along with 25% or 50% nitrogen, either with or without time at 600 kg ha^{-1} and an absolute control. The plots that received the recommended dose of nitrogen (30 kg N ha^{-1}) alone produced the tallest plants with the highest number of branches plant^{-1} and dry matter. The better vegetative growth of plants in plots applied 30 kg N ha^{-1} alone resulted in a larger photosynthetic area and thereby the highest number of capsules plant^{-1}, number of seed capsule^{-1} and seed yield.

The effect of N 45, 60 and 75 kg feddan^{-1} (1 feddan = 0.42 ha) on sesame cv. Giga-32 was studied. N as ammonium nitrate was applied after thinning and 3 weeks thereafter increasing N rate increased plant height, length of fruiting zone, number of branches and capsule $plant^{-1}$. Seed index and capsule length were highest with 60 and 75 kg N $feddan^{-1}$ (Allam, 2002).

Imayavaramban *et al.* (2002) reported that application of an extra 25% of nitrogen than the recommended in combination with seed inoculation with *Azospirillum* significantly recorded the maximum seed, net income, and benefit cost ratio in both the cropping seasons.

Pathak *et al.* (2002) evaluated the effect of nitrogen levels (0, 15, 30 and 45 kg ha^{-1}) on the growth and yield of sesame. N at 45 kg ha^{-1} recorded the highest mean values for plant height (74.3 cm), number of branches $plant^{-1}$ (4.50), number of capsules $plant^{-1}$ (39.0) and 1000 grain weight (2.91 g) at 45 kg ha^{-1} also recorded the highest value for seed yield, net return and benefit cost ratio.

An experiment of sesame was given 6 fertilizer treatments such as no N (control); *Azospirillum* (3 kg ha^{-1}) soil application; 60 kg N ha^{-1} 30 kg N ha^{-1} + *Azospirillum*; 45 kg N h^{-1} + *Azospirillum* ; 60 kg N ha^{-1} +*Azospirillum* N was applied at split doses (basal and top dressing 30 days after sowing). N @ 60 kg ha^{-1} recorded more number of capsules and seed $capsule^{-1}$ which was at par with 45 kg N ha^{-1} + *Azospirillum* treatment. The highest seed yield was obtained with application of 60 kg N ha^{-1}, which was at par with 45 Kg N ha^{-1} + *Azospirillum* and 30 Kg N ha^{-1} + *Azospirillum* (Sarala *et al.*, 2002).

Kathiresan (2002) carried out an experiment to study the response of 2 cultivars (TMV-3 and TMV-4) of sesame (*S. indicum*) of different fertilizer levels: control to different fertilizer levels (control, 100% recommended N P K of 35: 23: 23 kg ha^{-1} and 150% recommended N P K of 52:35: 35 kg ha^{-1}) on a sandy loam soil. He found that higher dose of nutrient significantly increase seed yield (1522 kg ha^{-1}) during summer than the lower nutrient level. Between the varieties TMV-4 produced significantly higher plant height, capsule bearing length, number of branches $plant^{-1}$, capsule length, seed $capsule^{-1}$, seed yield, oil content and protein content.

Ashfaq *et al.* (2001) studied the response of two sesame genotypes (92001 and TS 3) to different rates of N and P (0, 40, 80 and 120 kg ha^{-1}) grain yield, yield components and harvest index increased with increasing N rates. The highest yields were obtained with 120 kg N ha^{-1} and 40 kg ha^{-1} phosphorous, respectively.

Patra (2001) found out the effects of N on yield and yield attributes of sesame cv. Kalika. N was applied at 0, 30, 60 and 90 kg ha^{-1}, plant height, branches $plant^{-1}$, seeds $capsule^{-1}$, capsule length, 1000-seed weight and seed yield significantly increased with increasing N rates up to 60 kg N ha^{-1}.

Om *et al.* (2001) gave 0, 30, 60 and 90 kg N ha^{-1}, they obtained highest number of capsules $plant^{-1}$, seeds $capsule^{-1}$, 1000-seed weight, seed yield, straw yield and harvest index from 90 kg N ha^{-1}.

Wang *et al.* (2001) observed dynamics of the flowering rate of autumn season from early-blooming stage to final flowering stage. Nitrogenous fertilizers applied in the flower-bud period made the autumn season enter flowering two days earlier and one day earlier into full bloom stage compared with control. Its yield increased by 5.1 %.

Ahmed *et al.* (2001) carried out a field experiment during the summer seasons of 1996-97 in Pakistan to study the response of two sesame genotypes (92001 and TS 3) to different rates of nitrogen (0, 40, 80 and 120 kg ha^{-1}). Application of nitrogen at 120 kg ha^{-1} significantly increased the seed and stalks yield, and protein and oil content of cv. TS 3 than in 92001.

SenlRilkumar *et al.* (2000) evaluated the effect of intra row spacing and nitrogen levels with and without *Azospirillum* inoculation on growth and yield of sesame. Yield was the highest with 43.75 kg N ha^{-1} plus seed inoculation with *Azospirillum*.

Tiwari *et al.* (1999) in a field experiment nitrogen (15, 30 or 60 kg ha^{-1}) and sulphur (0, 15 or 30 kg ha^{-1}) were applied to sesame varieties (TKG 21, TKG 22 and RS 226) in Madhya Pradesh, India to investigate optimum dose of nitrogen and sulphur. They found that significant improvement in growth and yield (plant height, number of seeds $capsule^{-1}$, 1000-seed weight and seed and straw yield) was observed for nitrogen at 60 kg ha^{-1} compared with 15 kg ha^{-1}. Sulphur at 30 kg ha^{-1}

resulted significant increase only in the number of capsules plant^{-1}, seed capsule^{-1}, 1000-seed weight and seed yield, compared with sulphur at 0 and 15 kg ha^{-1}. Plant height, capsule plant^{-1}, seed capsule^{-1}, length of capsule bearing area, 1000-seed weight, seed yield, stover yield, oil yield, protein yield and net return were statistically highest in cv. TKG 21 grown with 60 kg N ha^{-1} and 30 kg S ha^{-1}. Seed oil decreased and seed protein content increased significantly with increasing nitrogen, while sulphur application enhanced both seed oil and seed protein.

Mitra and Pal (1999) reported that dry matter, number of capsules plan^{-1}, seeds capsule^{-1} and seed yield of sesame increased significantly up to 100 kg N ha^{-1} ;further increase in N depressed the seed yield and yield attributes.

Sumathi and Jaganadham (1999) conducted an experiment with 4 sesame cultivars giving 0-90 kg N ha^{-1}. Seed yield increased with up to 60 kg N (388 kg ha^{-1}).

Tiwari *et al.* (1999) reported sesame cv. Tka-21 produced mean seed yields of 3.71, 3.17 and 2.57 t ha^{-1} respectively while N rates of 0, 30, 45, 60 and 75 kg ha^{-1} and produced mean yields of 1.66, 2.27, 3.17, 4.19 and 4.41 t ha^{-1}.

Subrahmaniyan and Arulmozhi (1999) conducted a field experiment at Vridhachalam, Tamil Nadu with sesame cv. VS 9104 and VRI 1. They apply nitrogen (0, 35, 45 or 55 kg ha^{-1}) and found that VS 9104 had a higher number of branches and capsule plant^{-1}, higher dry matter production plant^{-1}, 1000-seed weight and seed yield that at VRI 1. Yield and yield component values: plant height, number of branches plant^{-1}, number of capsules plant^{-1}, and number of seeds capsule^{-1} increased with increasing nitrogen rate in case of both varieties.

Parihar *et al.* (1999) in a field experiment on clay loam soil observed that yield of sesame (*S. indicum* L.) increased with increasing nitrogen rate up to 80 kg ha^{-1}.

El-serogy (1998) evaluated the effect of nitrogen application such as 1/3 of N rate during sowing and 2/3 during thinning, 1/3 of N rate during sowing, 1/3 during thinning, 1/3 at the set of flowering, full N rate during thinning, on the yield and yield components of sesame cv. Giga-32. Taller plant, lower stem height to the first capsule and higher fruiting zone, number of capsule plant^{-1} , seed weight plant^{-1}, 1000-seed weight and seed yield feddan^{-1} (1 feddan = 0.42 ha) were obtained with application of 1/3 N at sowing, 1/3 at thinning, 1/3 at the on set of flowering.

Singaravel and Govindasamy (1998) conducted an experiment with sesame cv. TW-4 was given 35 kg N ha^{-1} and/or *Azospirillum* together with 0, 10, 20 or 30 kg humic acid ha^{-1}. Seed yield and dry matter production were greatest with N fertilizer + 20 kg humic acid.

Dixit *et al.* (1997) assessed productivity of sesame cv. TC-25 and Rasua-17 with the application of 0-90 kg N ha^{-1}. Application of up to 60 kg N ha^{-1} increased the seed yield significantly and gave the highest net profit.

In a trial sesame was given 0, 30, 60, 90 and 120 kg N ha^{-1}, plant height, dry matter accumulation, number of capsules plant^{-1}, number of seeds capsule^{-1}, 1000-seed weight, seed yield, were all increased as N fertilizer rate increased. Harvest index was not significantly affected by N application (Mandal *et al.*, 1997).

Thorve *et al.* (1997) in a field experiment evaluate the yield and yield attributing characters of three sesame cultivars on the same management level and found that cv. Tapi, Phule and Hawari (local) produced seed yields of 0.95, 0.91 and 0.52 t ha^{-1}, respectively.

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Singh *et al.* (1997) in a field experiment on a sandy clay loam soil at Madhya Pradesh, India found that sesame (cv. JT 7) performed better in terms of mean seed yield and net returns with 10 t ha^{-1} poultry manure alone than 40, 80 or 120 kg N ha^{-1} or combination of 10 ton poultry manure with them.

Awad *et al.* (1997) observed that sesame cv. Giza 25 yielded significantly highest seed yield and oil yield with 45 kg N feddan^{-1}(1 feddan = 0.42 ha).

Tiwari and Namdeo (1997) observed that sesame (*Sesamum indicum* L.) cultivars varied significantly for mean seed yield and seed oil and protein content. Application of nitrogen at the rate of 90 kg ha^{-1} produced the highest seed yield. Seed oil and protein contents were increased with increasing nitrogen rate.

In a field experiment during 1992-93 with sesame cv. TMV-4 and TMV-6 were given 0, 35 and 50 kg N ha^{-1}. Highest seed yield was 644 and 758 kg ha^{-1} when it was given 50 kg N ha^{-1} (Balasubramaniyan, 1996a).

Balasubramaniyan (1996b) grew sesame 0, 30, 60 and 90 kg N ha^{-1}. Yield was significantly affected by increasing nitrogen rates. Sharma *et al.,* (1996) applied 0-90 kg nitrogen to sesame cv. TC-25 and TKG-9. Mean seed yield (343 kg N ha^{-1}) increased with up to 60 kg N ha^{-1}.

Sesame cv. Rama was given 0, 60 or 120 kg N ha^{-1} gave highest seed yield and was the highest seed yield and was the highest gross return (Dutta *et al.,* 1996).

Patil *et al.* (1996a) reported that sesame cv. Padma was given 0-50 kg N ha^{-1} and obtained mean seed yield was 0.58 tha^{-1} and return was the highest at 50 kg N ha^{-1}.

Patil *et al.* (1996b) worked with two varieties of sesame treated with 0, 25 and 50 kg N ha^{-1} and obtained the highest yield 732 kg ha^{-1} when it was treated with 50 kg N ha^{-1}. Ashok *et al.* (1996) obtained the highest sesame seed yield when it was treated with 90 kg N ha^{-1} in 1990 and 60 kg N ha^{-1} in 1991.

Sesame cv. Rajeshwari was grown in 0, 50 or 100 kg N ha^{-1}. Seed yield was the highest 923 kg ha^{-1} (1992) and 884 kg ha^{-1} (1993) and mean seed yield was the highest with 100 kg N ha^{-1} (870 kg) (Satyanarayana *et al.,* 1996).

Sharma *et al.* (1996) in a field experiment observed that sesame cv. FC-25 produced higher plant height, number of capsul^{-1} plant, seed capsule^{-1}, seed yield and straw yield than TC-25 (329.2-259.2 kg). Mean seed yield increased up to 60 kg N ha^{-1}.

Ravinder *et al.* (1996) stated that the seed yield of sesame was the highest with 100 kg N ha^{-1}. Uptake of nitrogen, phosphorus and potassium were positively correlated with yield.

Nageshwar *et al.* (1995) used 40, 80 and 120 kg N ha^{-1} in five selected varieties. Seed yield was highest in 120 kg N ha^{-1} (1.82 t ha^{-1}) with net return highest.

Shewal *et al.* (1995) observed that sesame cv. Tapi and Hawari gave the highest seed yield of 541 kg ha^{-1} when 50 kg N ha^{-1} was applied.

Ramakrishnan *et al.* (1994) used five sesame cultivars with 0-90 kg N ha^{-1}. Seed yield plant^{-1} increased with up to 45.5 kg N ha^{-1}. They also reported that seed yield was positively correlated with number of branches, number of capsules plant^{-1}, number of seeds capsules^{-1} and 1000-seed weight. Number of seeds capsules^{-1} had the highest positive effect on seed yield followed by number of capsules plant^{-1}.

Rao *et al.* (1994) applied 0, 40, and 80 kg N ha^{-1} and reported that seed yield $plant^{-1}$ was positively correlated within the order seeds $plant^{-1}$ > capsules $plant^{-1}$ > 1000-seed weight > leaf area $plant^{-1}$ > branches $plant^{-1}$ > capsule length > plant height.

Sesame cv. N-32 was given 0-60 kg N ha^{-1} applied 50% basal + 50% at 40 days after sowing (DAS), 50% at 40 DAS or 50% basal + 50% at 15 DAS. Seed yield increased significantly up to 40 kg N ha^{-1} and was the highest with 50% at 15 DAS + 50% at 40 DAS (Sharma and Kewat, 1994).

Chandrakar *et al.* (1994) reported that seed yield increased with increasing nitrogen rates (0, 50, 100 or 150 kg N ha^{-1}). Rao *et al.* (1993) observed seed yields increased with increasing nitrogen application from 0, 40 and 80 kg N ha^{-1}.

Tiwari *et al.* (1994) conduct a field experiment with no fertilizer, 60 kg N ha^{-1}, 60 kg N + 30 kg P + 0 or 20 kg N or 60 kg N + 30 kg P + 20 kg + 25 kg Zn. Mean seed yields were the highest (0.53) t ha^{-1}) with the application of 60 kg N + 30 kg P) + 20 kg K.

Ishwar *et al.* (1994) reported sesame given 0, 30 and 60 kg N ha^{-1} gave mean seed yield of 470, 531 and 590 kg ha^{-1}. Pawar *et al.* (1993) used 0, 40, 80 or 120 kg N ha^{-1} in sesame. Seed yield increased up to 120 kg N ha^{-1}.

EI-Ouesni *et al.* (1994) conducted an experiment with 15, 30 and 45 kg N feddan^{-1} and obtain greatest crop plant height and seed yield of 134 cm and 11.58 g plant^{-1} respectively when it was treated with 45 kg N feddan^{-1} [1 feddan = 0.42 ha].

Sharma (1994) carried out a field experiment in the rainy season of 1985-86 at Diphu, Assam; sesame cv. TC 25, Madhavi and Gouri were given 0, 15, 30 or 45 kg N ha^{-1} and found that, seed capsule^{-1}, seed yield and oil yield were significantly lower in TC 25 than Madhavi or Gouri in 1985 but in 1986 there were no significant difference in yield among the cultivars. Seed yield and yield contributing characters were influenced with the application of nitrogen fertilizer.

Sharma and Kakati (1993) in a field experiment on sandy clay loam soil at Diphu, Assam observed that sesame (cv. C 7, TC 25 and Vinayak) seed yield increased with increase in nitrogen rate (0, 15, 30 or 45 kg ha^{-1}). C 7 produced statistically highest number of seed capsule^{-1}, 1000-seed weight, seed yield, stover yield, harvest index and oil content with highest nitrogen rate.

Kumar and Prasad (1993) in a field trial found that seed yield of sesame increased with nitrogen fertilizer rate from 0.13 t ha^{-1} (without nitrogen) to 0.92 t ha^{-1} with 90 kg N ha^{-1} but seed oil concentration was the highest (47%) with 30 kg N ha^{-1} and after this oil content was in decreasing trend.

Gnanamurthy *et al.* (1992) observed in a field trial in the kharif season in Vriddhachalam, India that seed yield increased with application of nitrogen up to 20 kg ha^{-1}.

Prakasha and Thimmegowda (1992) stated that seed yield of sesame cv. Kanakapura local grown on sandy loam soil increased with increasing nitrogen rate from 0 to 60 kg N ha^{-1}. It was also observed that high dose of nitrogen increased the susceptibility of sesame plant to water stagnantion.

Shrivastava and Tripathi (1992) in a field trial at Raipur, Madya Pradesh, India observed that nitrogen rates (30, 60 or 90 kg ha^{-1}) increased the seed yield from 0.87 t ha^{-1} with 30 kg N ha^{-1} to 1.27 t ha^{-1} with 90 kg N ha^{-1}.

Jadhav *et al.* (1992) stated that seed yield and protein content of sesame increased with increasing nitrogen rate up to 120 kg ha^{-1} in sesame variety cv. Punjab 1. But higher nitrogen dose increased the susceptibility to *Fusarium*.

Dwivedi and Namdeo (1992) observed in a field experiment in the monsoon seasons of 1987-89 on clay loam soil at Madhya Pradesh, India; seed yield of sesame cv. JT7 increased with up to 30 kg N; after or before of this rate seed yield and economic returns decreased.

Sinharoy *et al.* (1990) reported application of 30 and 60 kg N ha^{-1} increased plant height and number of primary branches $plant^{-1}$ and seeds $capsule^{-1}$ and gave average yield of 651 and 801 kg ha^{-1}.

Samui *et al.* (1990) found that dry matter production and N, P and K uptake in 3 sesame cultivars, increased when 30 or 60 kg N ha^{-1} was applied.

Puste and Maiti (1990) obtained 632, 775, 895 and 919 kg ha^{-1} yield when it was treated with 0, 40, 80 and 120 kg N ha^{-1}, respectively.

Kandam (1989) observed 0.60, 0.69 and 0.61 (t ha^{-1}) seed when it was treated with 0, 25 and 50 kg N ha^{-1}. Seed yield increased with increasing N rates.

Majumdar *et al.* (1987) reported N application (60 kg ha^{-1}) to lateritic acidic soil increased the capsule number $plant^{-1}$, seed number $capsule^{-1}$, 1000-seed weight, plant height and seed yield.

Silva (1987) conducted an experiment with 0, 50 and 100 lb N/manzaha as urea of which 50% was applied at sowing and 50% at 45 days later. Posolegta application of 100 lb N increased from 1.92 to 1.72 t $manhaza^{-1}$. (1 manhaza =0.7 ha).

Vijan *et al.* (1987) applied 40 kg N ha^{-1} to sesame cv. C-6 and found that increased seed yields from 0.73 to 0.98 t ha^{-1}, seed oil content 48.1 to 56.3% and protein content 19.4 to 20.9%.

Seo *et al.* (1986) conducted an experiment with 0-180 kg N ha^{-1} and obtained the highest yield 1.01 kg ha^{-1} when it was treated with 80 kg N ha^{-1}.

Chakraborty *et al.* (1984) reported that increasing nitrogen rates from 0 to 120 kg ha^{-1} in sesame increased seed yields from 238 to 990 kg ha^{-1}.

Velazquez *et al.* (1983) reported that at Tapanatepae, sesame cv. Nardo was given 0-150 kg N ha^{-1}. The highest yield was obtained with 100 kg N ha^{-1} and the optimum economic treatment was 45.5 kg N ha^{-1}.

Venkatesan *et al.* (1983) conducted an experiment with 0-60 kg N ha^{-1} in summer and monsoon season in Tamil Nadu. They reported optimum economic N rate was 20 kg ha^{-1} for both the season.

Kamel *et al.* (1983) applied 0, 36 and 72 kg N ha^{-1} and reported seed yield was highest with 72 kg N ha^{-1} application.

Abdel-Rahaman *et al.* (1980) grew sesame cv. Giza-25 with 0, 30 and 45 kg N $feddan^{-1}$. The highest seed yield (4.25 ardeb $feddan^{-1}$) and yield components were obtained when it was given 45 N feddan^{-1}. N application also increased plant height and number of effective capsules plant^{-1}.

Satyanarayn (1978) applied 25-50 kg N ha^{-1} to sesame and obtained the highest yield when it was treated with 25 kg N under irrigated consideration.

Mehrotra *et al.* (1978) reported that average seed yield of sesame was increased from 400 to 760 kg ha^{-1} with increased rates of N from 0 to 30 kg ha^{-1}. Further increases in yield with 45 kg N ha^{-1} were not significant.

From the foregoing review, it was evident that plant height, number of capsules plant^{-1}, seed yield and stover yield are influenced by different levels of nitrogen application. Seed yield of sesame showed differential behavior due to different levels of applied nitrogen in different parts of the globe. It is, therefore, more researches on this aspect are necessary to arrive at a definite conclusion.

CHAPTER III

MATERIALS AND METHODS

The research work was conducted in the Field Laboratory, Agrotechnology Discipline of Khulna University during the period from February to May, 2008. The details of the materials used and methods followed in the study are described in the following headings

Experimental site

The experimental site was located at the latitude of $22^0 47'$ N and longitude of $89^0 34'$ E. It belongs to the agro-ecological zone of Ganges Tidal Flood Plain (AEZ 13).

Plant Materials

Three sesame varieties viz. Botiaghata Local Til, BARI Til-2 and BARI Til-3 were used as plant materials of the study. The characters of the varieties are given below.

Experimental Treatments

The factorial treatment was consisted of two factors as follows:

Factor A: Variety 3

- Botiaghta Local Til (V_1)
- BARI Til-2 (V_2)
- BARI Til-3 (V_3)

Factor B: Nitrogen Level 4

- 0 kg N ha^{-1} (control) (No)
- 25 kg N ha^{-1} (N_1)
- 50 kg N ha^{-1} (N_2)
- 75 Kg N ha^{-1} (N_3)

Experimental Design and Layout

The experiment was laid out in a randomized complete block design (RCBD) with three replications. The size of each unit plot was 5 m^2 (2.00 m ×2.5 m). The spaces between blocks and between plots were 50 cm and 30 cm respectively. The total number of plots was 36.

Collection of seeds

The seeds of sesame variety BARI Til-2 and BARI Til-3 were collected from Bangladesh Agricultural Research Institute, Joydebpur, Gazipur. and Botiaghata local Til seed was collected from the local farmers.

Land Preparation

The experimental land was first open on February 15, 2008 using a power tiller followed by laddering to obtain desirable tith. The lay out of experiment was done in accordance with the design adopted. Finally, individual plot was prepared by using spade before sowing of seeds.

Fertilization

The plots were fertilized with triple super phosphate, muriate of potash, gypsum, zinc sulphate and boric acid at the rate of 140, 45, 105, 5 and 10 kg ha^{-1}, respectively (BARI, 2004). One half of urea and other fertilizers were applied during final land preparation (as per experimental treatments) and rest urea was applied at 30 days after sowing.

Germination Test

Before sowing the germination test of seeds were done in Petri-dish in the laboratory condition and the percentage of seed germination was found more or less to 95% in all the varieties.

Seed rate and sowing

The seed was sown at the rate of 8 kg ha^{-1} by hand on 25 February, 2008. The rows were 30 cm. apart from each other. Seeds were placed approximately 5 cm apart in furrow and were covered with soil.

Intercultural operation

The experimental field was weeded at 15 and 30 days after sowing. Drainage operation for draining out of rain water was done as and when required for proper growth and development of crop. Thinning was done once at 15 days after sowing to maintain optimum plant population. The pesticide was sprayed at flowering period to keep the field free from pests.

Harvesting of crops

The crops were harvest where the crop attains full maturity. After harvesting, the plants were bundled, tagged properly and brought to the threshing floor. The bundles were dried in open sunshine, threshed and the seeds were cleaned.

Collection of Data

Data were colleted from ten randomly selected plants from each unit plot on the following yield and yield contributing parameters.

1. Plant height (cm)
2. Number of leaves plant^{-1}
3. Number of primary branch plant^{-1}
4. Dry matter content
5. Days to first flowering
6. Capsule length (cm)
7. Capsule number plant^{-1}
8. Number of seeds capsule^{-1}
9. 1000-seed weight (g)
10. Seed yield (t ha^{-1})
11. Days to harvest (DAE)
12. Stover yield (t ha^{-1})

13. Harvest index (%)

Plant height

The height of each sampled plant was measured unit plot wise from the base to the tip of main stem of the plant in different branches and then averaged.

Number of leaves plant^{-1}

The leaves of each sampled plant were counted unit plot wise from the base to the tip of the plant and then averaged.

Number of primary branch plant^{-1}

The number of primary branches plant^{-1} was counted from ten sampled plants and then averaged.

Dry matter content

Ten plants was randomly collected from each plot then measuring their fresh weight was measured in g, then the weighing sample were put in the oven for 48 hours in a 72° C and the dry weight was taken and then converted into dry matter percentage.

Days to first flowering

Each plot was closely observed every day to detect the first opening of flowers.

Capsule length (cm)

The capsule length was measured from taking the three capsules of each of 5 randomly selected sample plants. The length was measured for 3 positions, one capsule from bottom, and another from middle and top of the plant and then averaged.

Capsule number plant^{-1}

The capsules were counted separately from each sample plant in each stem and averaged for obtaining number of capsules plant^{-1}.

Number of seeds capsules^{-1}

The number of seeds capsules^{-1} were counted separately from each 5 sample capsule in each plant and averaged for obtaining number of seeds capsules^{-1}.

1000-seed weight (g)

One thousand sun-dried seeds were counted at random from the seed stock of sample plants. Weight of thousand seeds was then recorded by means of a digital electric balance.

Seed yield (t ha^{-1})

The crop from middle portion (1 m^2) of each unit plot was harvested. The entire quantity of seeds obtained from each unit plot was threshed and dried in the sun to bring them to a normal storable state and the seed weight was recorded in terms of kg m^{-2}. Thereafter the yields were converted to t ha^{-1}.

Days to harvest (DAE)

Harvesting was done depending on the maturity of each plot.

Stover yield (t ha^{-1})

After separating the seeds from the crop of the middle portion (1 m^2) of each plot, the stover was sun-dried to constant weight and the weight was recorded in terms of kg m^{-2} and it was, thereafter converted to t ha^{-1}.

Harvest index (%)

It denotes the ratio of economic yield to biological yield and was calculated with the following formula (Gardner *et al.,* 1985).

$$\text{Harvest index (HI)} = \frac{\text{Grain Yield (t ha}^{-1}\text{)}}{\text{Biological Yield (t ha}^{-1}\text{)}} \times 100$$

Biological Yield = Grain yield + Stover yield.

Data Analysis

All the data was analyzed with computer package MSTAT-C and differences among treatment means was adjudged by Duncan's Multiple Range Test (DMRT) (Gomez and Gomez, 1984).

CHAPTER IV

RESULTS AND DISCUSSION

The experiment was conducted to evaluate the effect of nitrogen levels on growth and yield of sesame varieties. Results of experiment have been presented in Tables 1-6 and the mean square value, together with the sources of variation in their corresponding degrees of freedom have been presented in appendices I and II, Results obtained from the study have been presented and discussed in the following headings.

Plant height

Plant height varied significantly among the varieties (Appendix I) at 20, 35, 50 and 65 days after emergence (DAE) (Table 1). The tallest plant (116.9 cm) was observed in variety BARI Til-2 which was statistically similar to BARI Til-3 (115.2 cm) and the shortest plant in Botiaghata Local Til (96.3 cm) (Table 1). One of the major reasons of variation in plant height in varieties might be due to variable nutrient consumption capacity. Subrahmaniyan and Arulmozi (1999) also reported that plant height may vary according to variety.

Levels of nitrogen fertilizer had significant effect on plant height of sesame varieties (Appendix I). Increasing rate of nitrogen levels enhanced plant height gradually in DAE (Table 2). The tallest plant (123.7 cm) was obtained from 75 kg N ha^{-1} which was followed by 50 kg N ha^{-1} (111.5 cm). The shortest plant (91.26 cm) was obtained from the control (0 kg N ha^{-1}) in 65 DAE. Data were collected from 20 DAE to 65 DAE at 15 days interval. The tallest plant obtained from the 75 kg N ha^{-1} application and lowest value obtained from control (0 kg N ha^{-1}), detailed in (Table 2). One of the major reasons of this effect might be due to increased plant metabolism and cellular activity of the plant that enhanced plant growth as well as plant height. This result is in agreement of Tiwari *et al.* (1997). Sujathamma *et al.* (2003) found similar results of nitrogen on plant height.

Interaction of variety and nitrogen levels was statistically significant in respect of plant height of sesame varieties (Appendix I). BARI Til-3 with 75 kg N ha^{-1} produced the highest height of plant (135.8 cm) at 65 DAE, followed by BARI Til-2 with 75 kg N ha^{-1} (129.3 cm) and BARI Til-2 with 50 kg N ha^{-1} (118.9 cm). On the other hand, the lowest plant height (75.60 cm) was recorded from Botiaghata Local Til with control (0 kg N ha^{-1}) preceded by Botiaghata Local Til with 50 kg N ha^{-1} (96.02 cm). It was evident that BARI Til-3 was most sensitive to nitrogen fertilization than other varieties (Table 3).

Number of Leaves Plant^{-1}

There was significant variation in number of leaves $plant^{-1}$ among the varieties tested in different DAE (Appendix I). The number of leaves $plant^{-1}$ increased with the advancement of time (Fig. 1). The highest leaves were found in BARI Til-2 (103 at 65 DAE) and the lowest in Botiaghata Local Til (52.50 at 65 DAE).

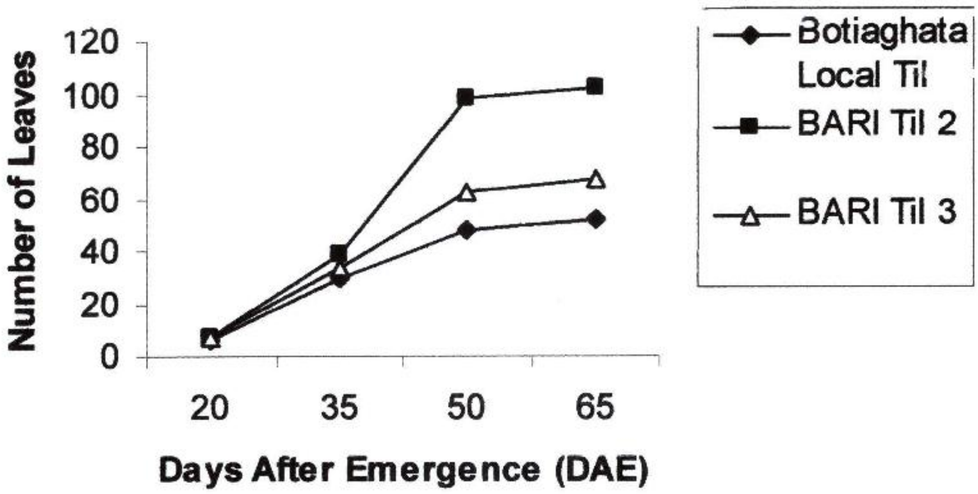

Fig. 1 Plant leaves of sesame varieties in different days after emergence

Nitrogen levels had significant effect on number of leaves plant^{-1} (Appendix I). The highest number of leaves plant^{-1} (85.02) was counted from 75 kg N ha^{-1} which was statistically similar to 50 kg N ha^{-1} (81.31) and the lowest number of leaves was obtained from the control (60.04) at 65 DAE (Fig 2). Data collected from 20 DAE to 65 DAE and all data showed the similar trend of results discussed earlier. These results might be due to the availability of nitrogen which was applied on the soil.

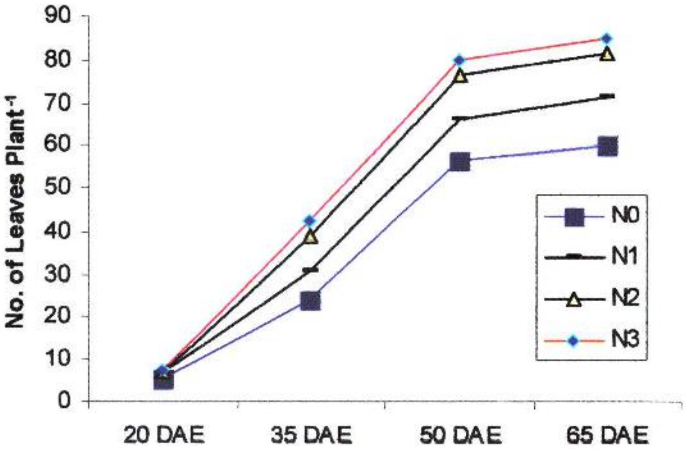

Fig. 2 Effect of nitrogen levels on number of leaves plant^{-1} of sesame

Interaction of variety and nitrogen level had significant effect on number of leaves plant^{-1} of sesame varieties (Appendix I). BARI Til-2 with 75 kg N ha^{-1} produced the highest number of leaves plant^{-1} (118.7 at 65 DAE) followed by BARI Til-2 with 75 kg N ha^{-1} (102). On the other hand, the lowest number of leaves (34.60 at 65 DAE) was recorded from Botiaghata Local Til with the control, preceded by BARI Til-3 with 25 kg N ha^{-1} (48.87) (Table 3).

Number of branches plant^{-1}

Variety had significant effect on number of branches plant^{-1} (Appendix II). The highest number of branches plant^{-1} (3.78) was recorded from the variety BARI Til-2 which was statistically similar to the branches of Botiaghata Local Til (3.62) and the lowest number of branches plant^{-1} (2.60) was recorded from the BARI Til-3 (Table 4). The variation in number of branches plant^{-1} among the varieties might be due to genetic causes and nutritional effect.

Nitrogen fertilizer had significant effect on number of branches plant^{-1} (Appendix II). The highest number of branches plant^{-1} (4.56) was recorded from nitrogen levels @ 75 kg ha^{-1} which was followed by 50 kg ha^{-1} (3.32). The lowest number of branches plant^{-1} was produced by the control (2.42) (Table 5). It is evident from the result that with the increased rate of nitrogen branches plant^{-1} increased. Sinharoy *et al.* (1990) reported that 60 kg N ha^{-1} increased number of primary branches plant^{-1}.

Number of branches plant^{-1} was significantly differed due to interaction of nitrogen and variety (Appendix II). From the result it was observed that Botiaghata Local Til with 75 kg N ha^{-1} gave the highest number of branches plant^{-1} (6.23) followed by BARI Til-2 with 75 kg N ha^{-1} (4.53) and BARI Til-2 with 50 kg N ha^{-1} (4.20). On the other hand, the lowest number of branches plant^{-1} (2.33) was recorded from the BARI Til-2 with 0 kg N ha^{-1} preceded by Botiaghata Local Til with 0 kg N ha^{-1} (2.6) and Botiaghata Local Til with 25 kg N ha^{-1} (2.37) (Table 6).

Number of capsules plant^{-1}

It is evident from the results that number of capsules plant^{-1} was highest (64.05) in BARI Til-2 and lowest (27.00) in BARI Til-3 which was statistically similar in Botiaghata Local Til (27.88) and this difference among the three varieties were statistically significant (Appendix II and Table 4). The variation in number of capsules plant^{-1} might be attributable to varietal characters. These results are in agreement with that of Kathiresan (2002) and Subrahmaniyan and Arulmozhi (1999). Tiwari *et al.* (2000) reported that number of capsules plant^{-1} was significantly affected by different cultivars. They also reported that capsule bearing ability of the variety TKG 21 was much higher than that of TKG 22 and RS 226. Levels of nitrogen fertilizer significantly influenced the number of capsules plant^{-1} (Appendix II). The highest number of capsules plant^{-1} (49.20) was produced by 75 kg N ha^{-1} while the lowest number (27.59) was recorded from the control treatment (Table 5). From the result, it was appeared that capsules plant^{-1} increased due to the increased rates of nitrogen application.

Number of capsules plant^{-1} was significantly differed due to interaction effect of nitrogenous fertilizer and variety (Appendix II). From the result it was observed that BARI Til-2 with 75 kg N ha^{-1} gave the highest number (81.13) of capsules plant^{-1} followed by BARI Til-2 with 50 kg N ha^{-1} (76.60) (Table 6). On the other hand, the lowest number of capsules plant^{-1} (22.17) was recorded from the Botiaghata Local Til with 0 kg N ha^{-1} preceded by BARI Til-3 with 25 kg N ha^{-1} (24.67).

Capsule length (cm)

The differences among the varieties in respect of capsule length were found to be statistically significant (Appendix II). The highest length of capsule was found in BARI Til-3 (2.96 cm) and the lowest in BARI Til-2 (2.59 cm) (Table 4). Length of capsule is an important varietal character and is considered as important yield component which is governed by genetic make-up. The findings of variation in capsule length in the present experiment are in agreement with that of Kathiresan (2002) who also reported variable capsule length among the varieties.

Data revealed that levels of nitrogen significantly influenced the length of capsule (Appendix II). The highest length of capsule (3.10 cm) was recorded from 75 kg N ha^{-1} that was followed by 50 kg N ha^{-1} (2.86 cm) and the lowest capsule length (2.63 cm) was found from 25 kg N ha^{-1} which was statistically similar to the control (Table 5). Findings of the present study revealed that length of capsule increased with the increased level of nitrogen that it was might be due to high cellular activity of capsule.

Interaction of nitrogenous fertilizer and variety was not statistically significant in respect of length of capsule. However, numerically the highest individual capsule length (3.44 cm) was observed from the BARI Til-3 with 75 kg N ha^{-1} combination and the lowest capsule length (2.56 cm) was observed in the combination of BARI Til-2 with 25 kg N ha^{-1} (Table 6).

Number of seeds $capsule^{-1}$

There was significant variation among the sesame varieties in respect of number of seeds $capsule^{-1}$ (Appendix II). Data revealed that BARI Til-3 produced the highest seeds $capsule^{-1}$ (74.28) followed by BARI Til-2 (67.50) and the lowest number of seeds $capsule^{-1}$ was recorded from Botiaghata Local Til (69.02) (Table 4). Number of seeds $capsule^{-1}$ is an important yield component which may vary for the genetic make-up of the varieties. Growing environment has remarkable influences on production of fertile seed of sesame. These findings corroborate with those reported by Kathiresan (2002). Sarala *et al.* (2002) found that number of seeds $capsule^{-1}$ much higher in cv. Madhavi and VRI-1 than C7.

It was observed that number of seeds $capsule^{-1}$ was significantly increased with application of increased level of nitrogen over control (Appendix II). The highest number of seeds $capsule^{-1}$ (84.22) was recorded from 75 kg N ha^{-1} which was followed by 50 kg N ha^{-1} (69.40) and the lowest number of seeds $capsule^{-1}$ (62.09) was recorded from the control (Table 5). This results also agreed with Paul and Savitheri (2003); Mitra and Pal (1999) and Tiwari *et al.* (2000).

Interaction of nitrogen and variety had significant effect on number seeds capsule^{-1} (Appendix II). The highest number of seeds capsule^{-1} (92.67) was observed from the treatment combination of Botiaghata Local Til with 75 kg N ha^{-1} followed by BARI Til-3 with 75 kg N ha^{-1} (82.27) and the lowest number of seeds capsule^{-1} (57.47) was observed from the combination of Botiaghata Local Til with 0 kg N ha^{-1} preceded by BARI Til-2 with 25 kg N ha^{-1} (64.00) (Table 6).

Days to first flowering

Variety had significant effect on days to first flowering from emergence (Appendix II). From the result it was observed that earliest flowering (28.83 DAE) was obtained from Botiaghata Local Til and the latest flowering (37.83 DAE) was obtained from BARI Til-2 (Table 4). These significant differences might be happened due to life cycle pattern of different varieties.

Nitrogen had significant effect on days to first flowering from emergence (Appendix II). From the result it was observed that the earliest flowering (30.22 DAE) was observed in the highest levels of nitrogen (75 kg N ha^{-1}) while the highest flowering time (34.33 DAE) was required for control treatment. This might be due to appropriate vegetative growth by optimum nitrogenous fertilization (Table 5).

Interaction of levels of nitrogen and variety was statistically significant for days to first flowering (Appendix II). The treatment combination of Botiaghata Local Til with 75 kg N ha^{-1} gave the earliest flowering (26.33 DAE) followed by Botiaghata Local Til with 50 kg N ha^{-1} and the latest flower appearance (39.67 DAE) was recorded from the BARI Til-2 with 25 kg N ha^{-1} preceded by BARI Til-2 with 50 kg N ha^{-1} (38.33 DAE) (Table 6).

Days to harvest

Results from the experiment revealed that Botiaghata Local Til variety mature earliest (68.08 DAE) among all other varieties and the highest time taken to mature by BARI Til-2 variety (83.25 DAE). This might be due to Botiaghata Local Til variety blooms early and mature early and vice-versa. This is might be due to genetic make up of different variety (Table 4).

The nitrogen levels had significant effect on the time required for harvesting (Appendix II). The highest time (77.33 DAE) was required for maturity when no nitrogenous fertilizer was used, followed by 25 kg N ha^{-1} (76.67 DAE) applied and that was the lowest days to maturity (71.67 DAE) with 75 kg N ha^{-1} used (Table 5).

Interaction effect of levels of nitrogen and variety was statistically significant in respect of days to harvest (Appendix II). The treatment combination of Botiaghata Local Til with 75 kg N ha^{-1} gave the earliest harvesting (64.67 DAE) than all other combination preceded by BARI Til-2 with 25 kg N ha^{-1} (85.33 DAE) which was statistically similar to BARI Til-2 with control treatment (Table 6).

Dry matter content

There were significant differences in dry matter content among the varieties (Appendix I). The highest percentage of dry matter (11.65 % at 35 DAE) was found from the BARI Til-2 which was statistically similar to Botiaghata Local Til (10.28 at 35 DAE) and the lowest dry matter content was found in the BARI Til-3 (8.03 at 35 DAE). This might be genetical differences among different varieties (Table 4).

There were significant variations among the nitrogen levels in respect of dry matter content of sesame (Appendix II). The highest dry matter (12.39 %) was accumulated from highest nitrogen levels (75 kg N ha^{-1}) followed by 50 kg N ha^{-1} (10.06 %). The lowest dry matter content (8.40 %) was recorded from the control treatment (Table 5). These results revealed that higher nitrogen application associate with higher dry matter accumulation.

Interaction effect of variety and nitrogen levels were significant in regard to dry matter content of sesame (Appendix II). The highest dry matter (13.75%) was obtained from the treatment combination of BARI Til-2 with 75 kg N ha^{-1} followed by the treatment combination of Botiaghata Local Til with 75 kg N ha^{-1} (12.36%) and the lowest dry matter (6.26%) was recorded from the BARI Til-3 with 0 kg N ha^{-1} preceded by BARI Til-3 with 25 kg N ha^{-1} (6.98 %) (Table 6).

1000-seed weight (g)

The 1000-seed weight among the varieties differed significantly (Appendix II). BARI Til-2 produced the highest 1000-seed weight (2.71 g) which was statistically similar in BARI Til-3 (2.69 g) and that was the lowest in Botiaghata Local Til (2.59 g) (Table 4). The variation in 1000-weight might be due to differences of length and breadth of seed grain that is controlled by genetic-make up of the varieties. Tiwari *et al.* (1999), Subrahmanyan and Arulmozhi (1999) reported similar results as obtained by sesame cultivars. Sharma and Kakati (1993) showed that sesame cv. C7 produced higher 1000-seed weight than cv. TC 25 and Vinayak.

Weight of 1000-seed differed significantly due to the application of different levels of nitrogen fertilizer (Appendix II). The highest 1000-seed weight (2.75 g) was found by applying nitrogen @ 75 kg ha^{-1} which was statistically similar (2.68 g) to that of 50 kg N ha^{-1} (Table 5). The lowest 1000-seed weight (2.60 g) was obtained from the control (Fig. 13).

The interaction effect of nitrogen levels and variety was not statistically significant in respect of 1000-seed weight (Appendix II). However, numerically the highest 1000-seed weight (2.82 g) observed from the treatment combination of BARI Til-2 with 75 kg N ha^{-1} and the lowest 1000-seed weight (2.52 g) was recorded from Botiaghata Local Til with 0 kg N ha^{-1} (Table 6).

Seed yield

It was observed that there were significant differences in seed yield among the sesame varieties (Appendix II). BARI Til-2 produced the highest seed yield (1.58 t ha^{-1}) followed by BARI Til-3 (1.10 t ha^{-1}) and the lowest yield was observed from Botiaghata Local Til (0.98 t ha^{-1}) (Fig 3). The yield variation among the varieties might be due to genetic make-up of the varieties. Differences in seed yield due to varietal performance have also been reported by many workers

Kathirsan (2002); Ahmed *et al.* (2001); Tiwari *et al.* (1999); Subrahmaniyan and Arulmozhi (1999) and Thorne *et al.* (1997).

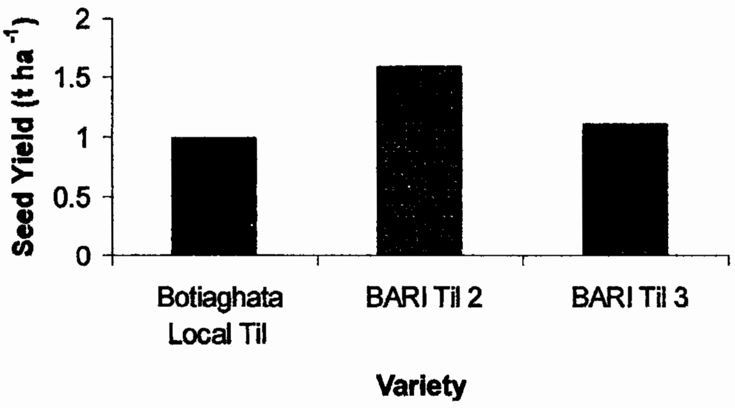

Fig. 3 Effect of variety on seed yield (t ha^{-1})

Nitrogen, the prime nutrient element had significant influences on seed yield of sesame (Appendix IV). Seed yield significantly increased with increasing nitrogen levels (Table 5). The highest seed yield (1.51 t ha^{-1}) was obtained from 75 kg N ha^{-1} which was superior to all other levels of nitrogen. The lowest seed yield was recorded from the control (0.95 t ha^{-1}). The causes of yield increase might be due to highest nitrogen consumption and favorable effect of yield contributing characters of sesame.

Interaction effect of levels of nitrogen and variety was statistically significant in respect of seed yield (Appendix II). The highest seed yield (1.91 t ha^{-1}) was obtained from the combination of BARI Til-2 with 75 kg N ha^{-1} and the lowest seed yield (0.75 t ha^{-1}) from the combination of Botiaghata Local Til with 0 kg N ha^{-1} (Table 6).

Stover yield

There were significant variations among the varieties in respect of stover yield (Appendix II). BARI Til-2 produced the highest stover yield (3.95 t ha^{-1}) followed by BARI Til-3 (3.49 t ha^{-1}) and that was the lowest in Botiaghata Local Til (3.37 t ha^{-1}), (Fig 4). It might be due to high branching habit of BARI Til-2 but less or no branching habit in other variety that were controlled by genetic make up of the varieties. This result is in conformity with those obtained by Ahmed *et al.* (2001); Tiwari *et al.* (1999) and Sharma and Kakati (1993).

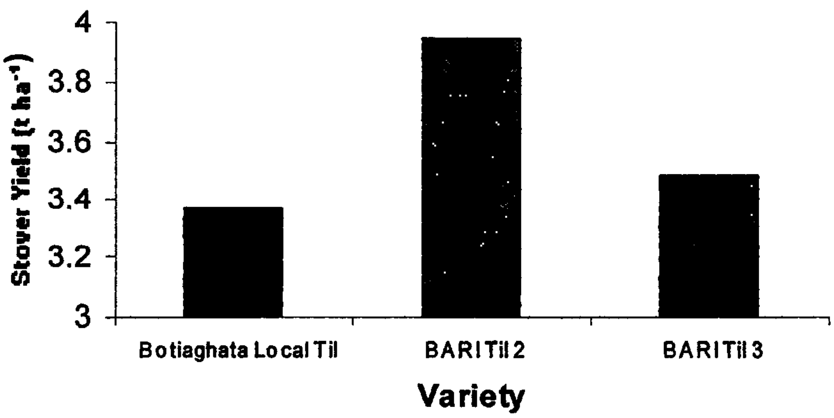

Fig. 4 Effect of variety on stover yield (t ha^{-1})

Nitrogen fertilization exerted significant influence on stover yield of sesame (Appendix II). It was observed that the highest stover yield (3.80 t ha^{-1}) was recorded from the application of 75 kg N ha^{-1} which was followed by 50 kg N ha^{-1}(3.63 t ha^{-1}) and 25 kg N ha^{-1} (3.57 t ha^{-1}). The lowest stover yield (3.41 t ha^{-1}) was produced from the control (Table 5). These results indicated that stover yield was directly proportional to nitrogen fertilization and this might be due to luxuriant vegetative growth of plants with increased levels of nitrogen which tended to enhance dry matter production and finally stover yield. These results were in consistent with the results obtained by Tiwari *et al.* (1999) and Om-Prakash *et al.* (2001).

The combined effect of nitrogen levels and variety was significant in respect of stover yield (Appendix II). The highest stover yield (4.20 t ha^{-1}) was obtained from the combination of BARI Til-2 with 75 kg N ha^{-1} followed by BARI Til-2 with 50 kg N ha^{-1} (3.98 t ha^{-1}) and the lowest stover yield (3.22 t ha^{-1}) was recorded from the Botiaghata Local Til with 0 kg N ha^{-1} preceded by BARI Til-3 with 0 kg N ha^{-1} (3.35 t ha^{-1}) (Table 6).

Harvest index

Data revealed that a significant differences among the varieties in respect of harvest index (Appendix II). BARI Til-2 produced highest harvest index (28.39 %) followed by BARI Til-3 (23.80 %) and that was lowest in Botiaghata Local Til (22.37 %) (Fig. 5). It might be due to varietal effect which influences seed yield and stover yield of sesame. The result of this study confirms the findings of Tiwari *et al.* (1999) and Sharma and Kakati (1993).

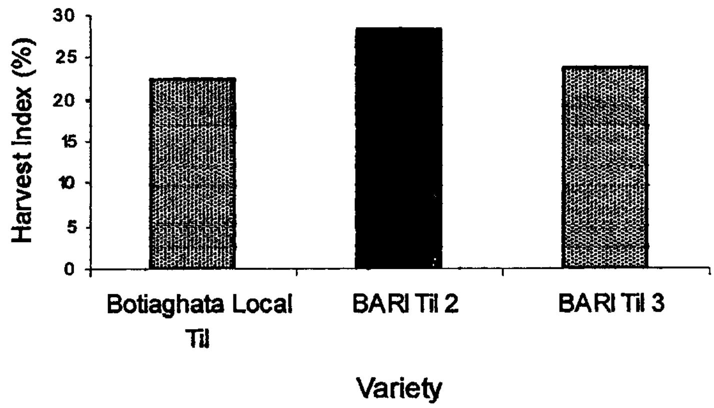

Fig. 5 Effect of variety on harvest index (%)

Harvest index differed significantly due to effect of different levels of nitrogen (Appendix II). The highest harvest index (28.12 %) was obtained from 75 kg N ha^{-1} and further decrease in nitrogen doses, harvest index was decreased. This might be due to highest stover yield and highest seed yield as highest nitrogen fertilization, increasing flowering and fruiting capacity. The lowest harvest index (21.50 %) was obtained from the control (Table 5). These results were in agreed with Om *et al.* (2001) and Mondal *et al.* (1997).

The combined effect of nitrogen levels and variety was significant in respect of harvest index (Appendix II). The highest harvest index (31.26 %) was obtained from the combination of BARI Til-2 with 75 kg N ha^{-1} followed by BARI Til-2 with 50 kg N ha^{-1} (28.76 %) and the lowest harvest index (19.02 %) was obtained from the combination of Botiaghata Local Til with 0 kg N ha^{-1} preceded by BARI Til-3 with 0 kg N ha^{-1} (Table 6).

Functional relationship between grain yield and yield contributing characters

Relationship between nitrogen levels and number of capsules $plant^{-1}$ of sesame

Regression analysis between nitrogen levels and number of capsules $plant^{-1}$ showed that number of capsules $plant^{-1}$ had a positive relation with nitrogen levels. Over 97% of the variation in number of capsules $plant^{-1}$ could be explained by the variation in nitrogen levels (Fig. 6)

Relationship between nitrogen levels and number of seeds $capsules^{-1}$ of sesame

Regression analysis between nitrogen levels and number of seeds $capsules^{-1}$ revealed that number of seeds $capsules^{-1}$ had a positive relation with nitrogen levels. Over 86% of the variation in number of seeds $capsules^{-1}$ could be explained by the variation in nitrogen levels (Fig. 7)

Relationship between nitrogen levels and 1000-seed weight of sesame

Regression analysis between nitrogen levels and 1000-seed weight revealed that 1000-seed weight was highly depended on nitrogen levels and over 98% (R^2 = 0.984) of the variation in 1000-seed weight could be explained by the variation in nitrogen levels (Fig. 8)

Relationship between nitrogen levels and stover yield of sesame

Regression analysis between nitrogen levels and stover yield showed that stover yield had a positive relation with nitrogen levels. Over 96% of the variation in stover yield could be explained by the variation in nitrogen levels (Fig. 9).

Relationship between nitrogen levels and seed yield of sesame

Regression analysis between nitrogen levels and seed yield revealed that seed yield was highly depended on nitrogen levels and over 96% ($R^2 = 0.967$) of the variation in seed yield could be explained by the variation in nitrogen levels (Fig. 10).

Relationship between nitrogen levels and harvest index of sesame

Regression analysis between nitrogen levels and harvest index showed that harvest index had a positive relation with nitrogen levels. Over 97% of the variation in harvest index could be explained by the variation in nitrogen levels (Fig. 11)

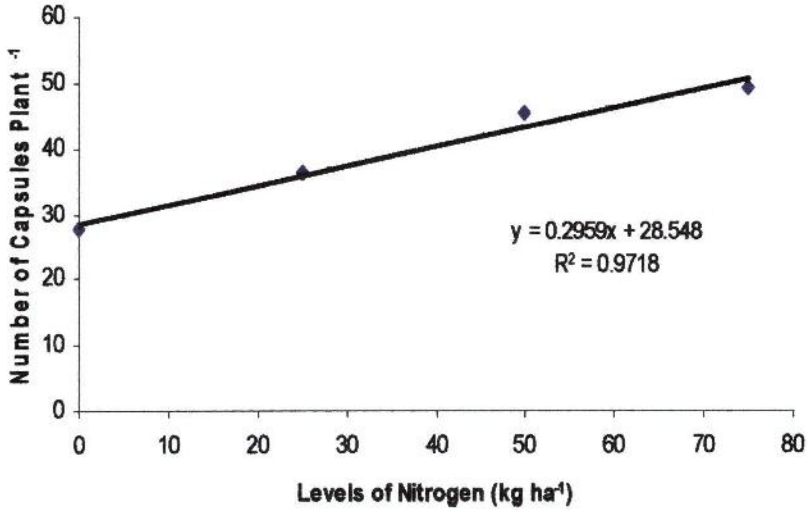

Fig. 6 Relationship between nitrogen levels and number of capsules plant^{-1} of sesame

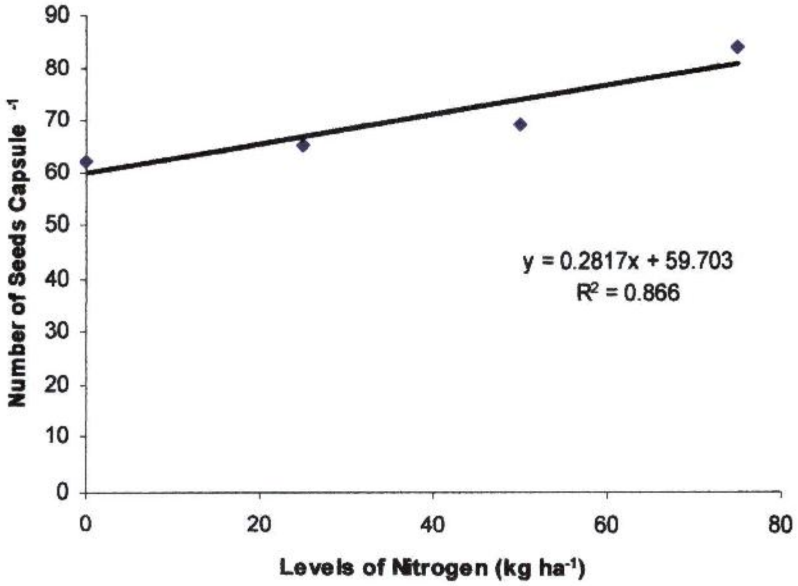

Fig. 7 Relationship between nitrogen levels and number of seeds capsules^{-1} of sesame

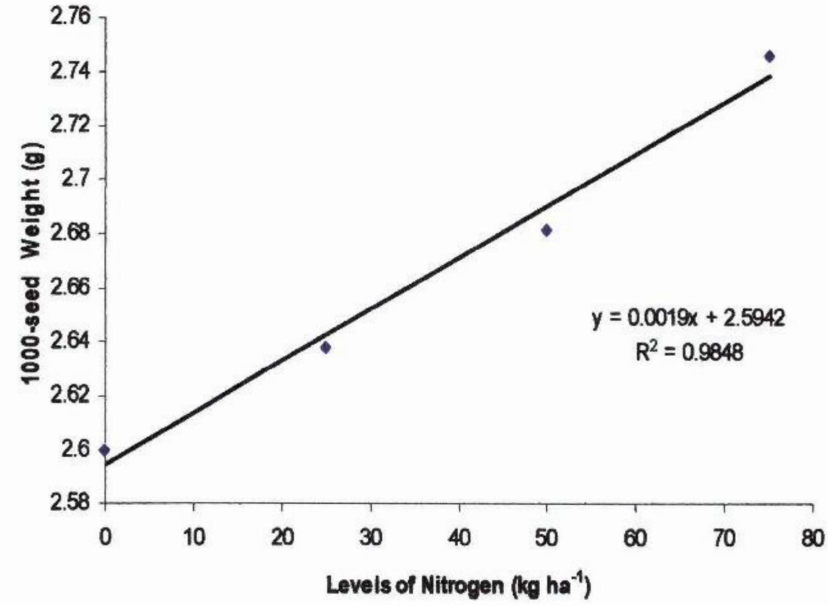

Fig. 8 Relationship between nitrogen levels and 1000-seed weight of sesame

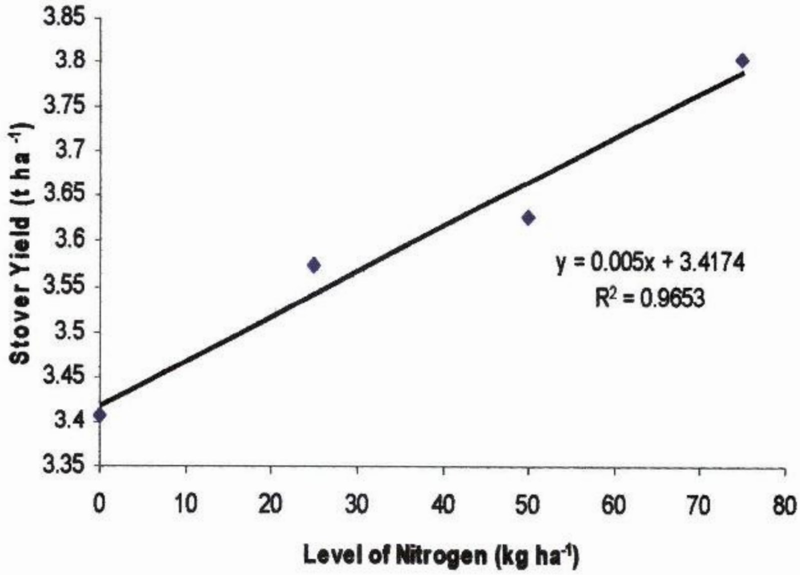

Fig. 9 Relationship between nitrogen levels and stover yield of sesame

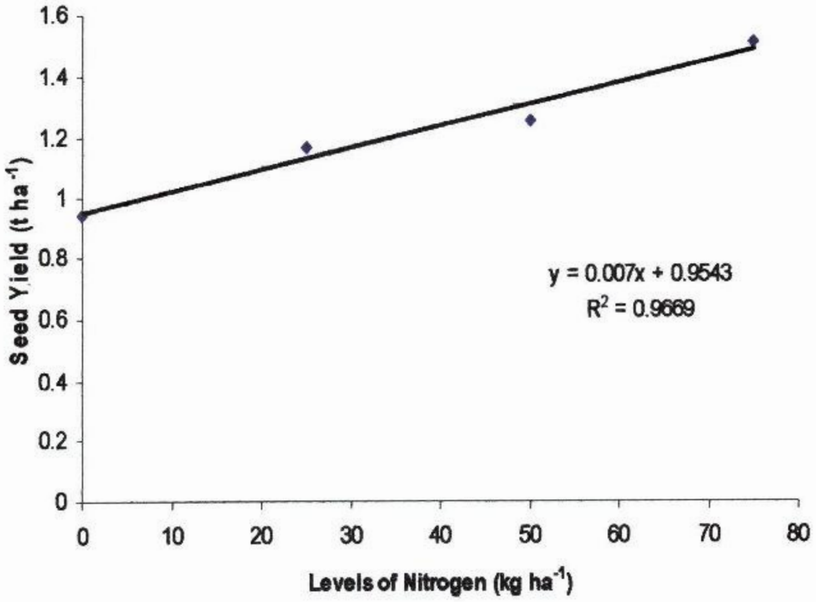

Fig. 10 Relationship between nitrogen levels and seed yield of sesame

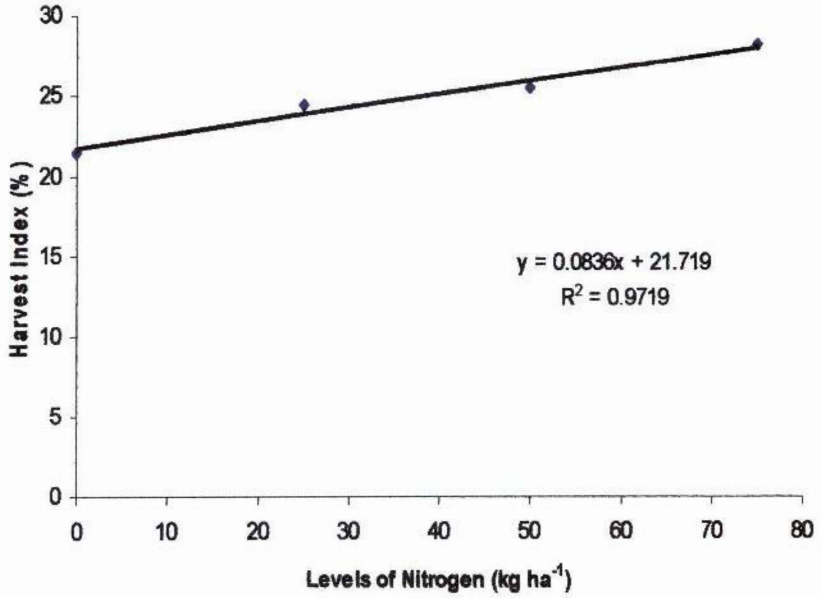

Fig. 11 Relationship between nitrogen levels and harvest index of sesame

Table 1. Effect of variety on the growth of sesame

	Plant height (cm) at			
Variety	20 DAE	35 DAE	50 DAE	65 DAE
Botiaghata Local Til	11.01b	58.32a	92.45b	96.24b
BARI Til-2	11.65ab	57.72a	112.5a	116.9a
BARI Til-3	12.06a	60.82a	111.2a	115.2a
CV (%)	4.68	5.21	2.55	2.47
Level of Significance	**	**	**	**

In a column, figures having dissimilar letter(s) differ significantly.
DAE = Days after emergence.
CV = Coefficient of variation.
** = Significant at 1% level of significance.

Table 2. Effect of nitrogen levels on the growth of sesame

	Plant height (cm) at			
Nitrogen levels (kg ha^{-1})	20 DAE	35 DAE	50 DAE	65 DAE
0 control	8.96 d	43.05 d	88.21c	91.26c
25	10.44 c	56.70 c	107.3b	111.3b
50	12.10 b	62.33 b	106.8b	111.5b
75	14.78 a	73.73 a	119.1a	123.7a
CV (%)	4.68	5.21	2.55	2.47
Level of Significance	**	**	**	**

In a column, figures having dissimilar letter(s) differ significantly.
CV = Coefficient of variation.
** = Significant at 1% level of significance.

Table 3. Interaction of variety and nitrogen levels on the growth of sesame

	Plant height (cm) at				Number of leaves at			
Treatment combination	20 DAE	35 DAE	50 DAE	65 DAE	20 DAE	35 DAE	50 DAE	65 DAE
V_1N_0	8.67g	47.39e	73.40g	75.60g	5.27f	21.60g	31.27i	34.60h
V_1N_1	10.40ef	55.24d	103.8e	107.3e	6.27e	24.80fg	63.33f	68.67e
V_1N_2	11.54d	62.14c	90.33f	96.02f	5.40f	31.20de	49.27g	55.33f
V_1N_3	13.42c	68.50b	102.3e	106.1e	7.40bc	41.40b	49.20g	51.40fg
V_2N_0	8.45g	38.14f	101.3e	106.6e	5.40f	29.40ef	91.73c	94.87c
V_2N_1	10.90de	53.27d	108.9d	112.8d	7.66b	36.13cd	91.00c	96.53c
V_2N_2	10.82de	62.16c	115.2c	118.9c	8.46a	47.27a	97.27b	102.0b
V_2N_3	16.43a	77.31a	124.5b	129.3b	7.33c	42.07b	112.9a	118.7a
V_3N_0	9.76f	43.61e	89.91f	91.55f	5.40f	22.07g	46.20gh	50.67fg
V_3N_1	10.03ef	61.69c	109.2d	113.7d	6.60d	31.33e	45.00h	48.87g
V_3N_2	13.96bc	62.59c	114.9c	119.6c	7.53bc	38.53bc	82.20d	86.60d
V_3N_3	14.50b	75.39a	130.7a	135.8a	7.33c	43.20ab	77.13e	84.93d
CV (%)	4.68	5.21	2.55	2.47	2.60	8.25	3.27	3.91
Level of Significance	**	**	**	**	**	**	**	**

In a column, figures having dissimilar letter(s) differ significantly.
N_0 = Control (0 kg N ha^{-1}), N_1= 25 kg N ha^{-1}, N_2= 50 kg N ha^{-1}, N_3= 75 kg N ha^{-1}.
V_1 = Botiaghata Local Til, V_2 = BARI Til-2, V_3 = BARI Til-3.
CV = Coefficient of variation.
** = Significant at 1% level of significance

Table 4. Effect of variety on yield and yield components of sesame

Variety	Number of Branches Plant^{-1}	Number of Capsules Plant^{-1}	Capsule Length (cm)	Number of Seeds Capsule^{-1}	1000-seed Weight (g)	Dry Matter Content % at 35 (DAE)	Days to First Flowering (DAE)	Days to Harvest (DAE)
Botiaghata Local Til	3.625a	27.88b	2.877b	69.02b	2.596b	10.28a	28.83a	68.08a
BARI Til-2	3.783a	64.05a	2.590c	67.50b	2.712a	11.65a	37.83c	83.25c
BARI Til-3	2.600b	27.00b	2.958a	74.28a	2.692a	8.034b	31.92b	73.00b
CV (%)	5.16	2.62	7.72	3.59	1.90	8.74	2.01	1.06
Level of Significance	**	**	**	**	**	**	**	**

In a column, figures having dissimilar letter(s) differ significantly.
CV = Coefficient of variation.
** = Significant at 1% level of significance

Table 5. Effect of nitrogen levels on yield and yield components of sesame

Nitrogen Level (Kg ha^{-1})	Number of Branches $Plant^{-1}$	Number of Capsules $Plant^{-1}$	Individual Capsule Length (cm)	Number of Seeds $Capsule^{-1}$	1000-seed Weight (g)	Dry Matter content (at 35 DAE)	Days to First Flowering (DAE)	Days to Harvest (DAE)	Stover Yield (t ha^{-1})	Seed Yield (t ha^{-1})	Harvest Index (%)
N_0	2.422c	27.59d	2.638b	62.09c	2.60b	8.404c	34.33c	77.33c	3.409c	0.947d	21.50d
N_1	3.033b	36.32c	2.632b	65.36bc	2.638b	9.088bc	34.33c	76.67c	3.573b	1.169c	24.38c
N_2	3.322b	45.47b	2.862ab	69.40b	2.682ab	10.06b	32.56b	73.44b	3.627b	1.250b	25.41b
N_3	4.567a	49.20 a	3.101a	84.22a	2.746a	12.39a	30.22a	71.67a	3.804a	1.506a	28.12a
CV (%)	5.16	2.62	7.72	3.59	1.90	8.74	2.01	1.06	3.64	4.72	4.47
Level of Significance	**	**	**	**	**	**	**	**	**	**	**

In a column, figures having dissimilar letter(s) differ significantly.
N_0 = Control (0 kg N ha^{-1}), N_1= 25 kg N ha^{-1}, N_2= 50 kg N ha^{-1}, N_3= 75 kg N ha^{-1}.
CV = Coefficient of variation.
** = Significant at 1% level of significance

Table 6. Interaction of variety and nitrogen levels on the yield and yield components of sesame

Treatment Combination	Number of Branches $Plant^{-1}$	Number of Capsules $Plant^{-1}$	Capsule Length (cm)	Number of Seeds $Capsule^{-1}$	1000-Seed Weight (g)	Dry matter content (at 35 DAE)	Days to First Flowering DAE	Days to Harvest DAE	Stover Yield ($t ha^{-1}$)	Seed Yield ($t ha^{-1}$)	Harvest Index (%)
V_1N_0	2.600fg	22.17 i	2.680	57.47g	2.523	8.61ef	30.67 fg	70.67e	3.217h	0.7533k	19,02 i
V_1N_1	2.367fg	23.35hi	2.697	61.13fg	2.553	9.52de	30.67 fg	70.33e	3.360fg	0.9333i	21,74g
V_1N_2	3.300d	30.67fg	2.963	64.80ef	2.620	10.64cd	27.67h	66.67f	3.407ef	1.023h	23.14f
V_1N_3	6.233a	35.33 e	3.167	92.67a	2.687	12.36ab	26.33 i	64.67g	3.503d	1.200f	25,55d
V_2N_0	2.333g	37.53 d	2.467	60.47fg	2.647	10.34cd	38.67ab	85.67a	3.663c	1.247e	25,42d
V_2N_1	4.067c	60.93 c	2.567	64.00ef	2.693	10.76bcd	39.67 a	85.33a	3.943b	1.540c	28,11c
V_2N_2	4.200c	76.60 b	2.630	67.80de	2.687	11.73bc	38.33 b	82.00b	3.983b	1.607b	28,76b
V_2N_3	4.533b	81.13 a	2.697	77.73c	2.820	13.75a	34.67 c	80.00c	4.203a	1.910a	31,26a
V_3N_0	2.333g	23,07 hi	2.767	68.33de	2.630	6.26h	33.67 cd	75.67d	3.347g	0.8400j	20,07h
V_3N_1	2.667ef	24.67 h	2.633	70.93d	2.667	6.98gh	32.67 de	74.33d	3.417e	1.033h	23.25f
V_3N_2	2.467fg	29.13 g	2.993	75.60c	2.740	7.83fg	31.67 ef	71.67e	3.490d	1.20g	24,33e
V_3N_3	2.933e	31.13 f	3.440	82.27b	2.730	11.07bcd	29.67 g	70.33e	3.707c	1.407d	27,54c
CV (%)	5.16	2.62	7.72	3.59	1.90	8.74	2.01	1.06	3.64	4.72	4,47
Level of Significance	**	**	NS	**	NS	**	**	**	**	**	**

In a column, figures having dissimilar letter(s) differ significantly.
N_0 = Control (0 kg N ha^{-1}), N_1= 25 kg N ha^{-1}, N_2= 50 kg N ha^{-1}, N_3= 75 kg N ha^{-1}.
V_1 = Botlaghata Local Til, V_2 = BARI Til-2, V_3 = BARI Til-3.
CV = Coefficient of variation.
** = Significant at 1% level of significance
NS= Not Significant.

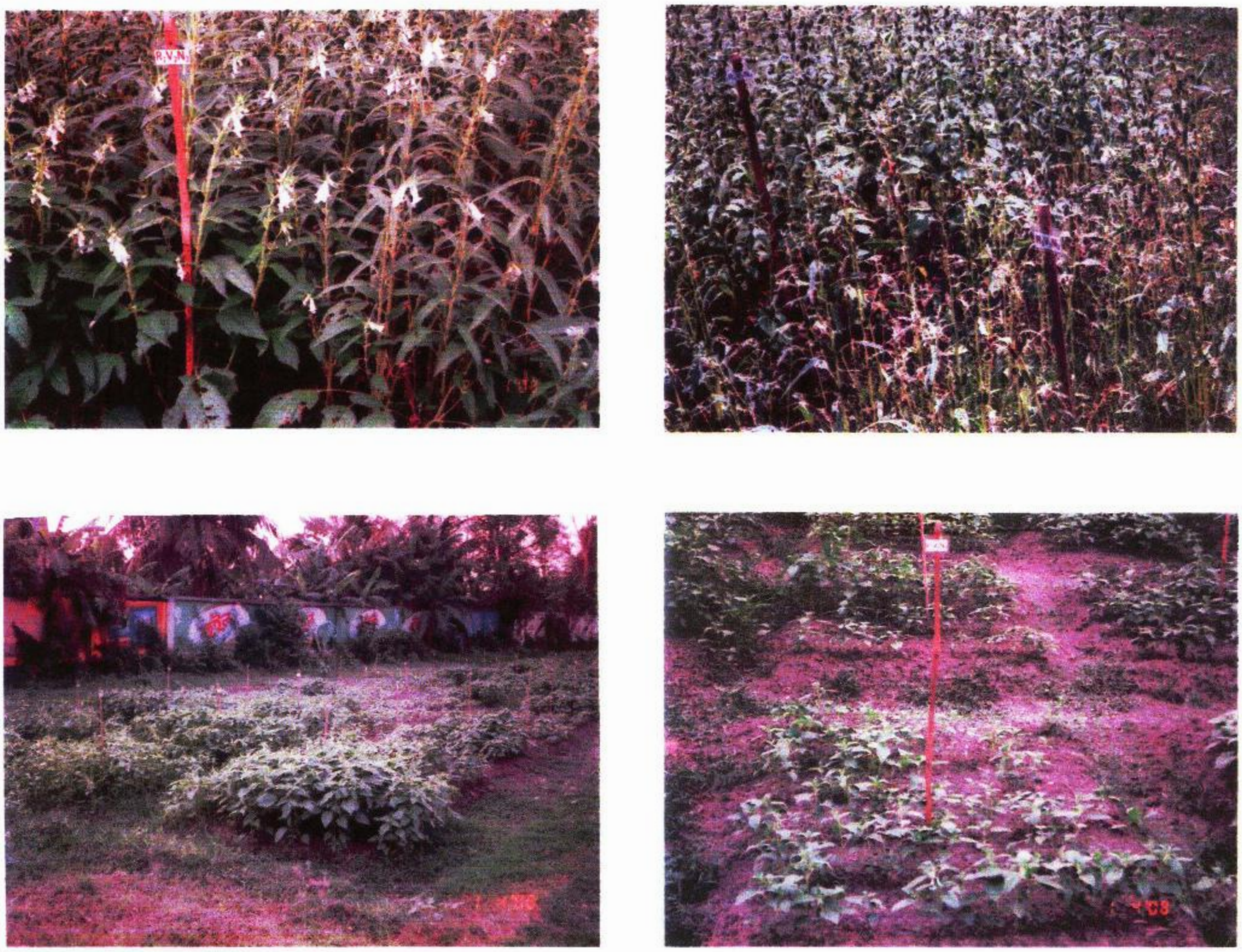

Plate 1. An overview of sesame field

CHAPTER V

SUMMARY AND CONCLUSION

An experiment was conducted in the, Field Laboratory, Agrotechnology Discipline, Khulna University, Khulna, during February to May 2008 with a view to studying the effect of nitrogen levels on the growth and yield performance of sesame varieties. The experiment consisted of three sesame varieties (BARI Til-2, BARI Til-3 and Botiaghata Local Til) and four nitrogen levels (0, 25, 50 and 75 kg N ha^{-1}).

The experiment was laid out in a randomized complete block design with three replications. Each plot was fertilized with triple super phosphate, muriate of potash, gypsum, zinc sulphate and boric acid at the rate of 150, 50, 110, 5 and 10 kg ha^{-1} respectively. Nitrogen was applied in the form of urea as per experimental treatments.

The data recorded were plant height, number of branches $plant^{-1}$, number of capsules $plant^{-1}$, capsule length, number of seeds $capsule^{-1}$, 1000-seed weight, dry matter content at 35 DAE, days to first flowering (DAE), days to harvest (DAE), stover yield, seed yield and harvest index. All the data were statistically analyzed and mean differences were adjudged by Duncan's Multiple Range Test (DMRT).

Significant variations among the varieties were observed for all the characters. Among the varieties, BARI Til-2 performed significantly better than all other varieties (BARI Til-3 and Botiaghata Local Til) in respect of all the characters measured, except capsule length. The growth performances were best in BARI Til-2 than all other varieties. The number of leaves and plant height were counted at different DAE 20, 35, 50 and finally 65 DAE; the highest plant height (116.9 cm) and highest number of leaves (103) at 65 DAE were observed in BARI Til-2 and the lowest in Botiaghata Local Til. It is observed that, there was significant difference in seed yield among the sesame varieties. BARI Til-2 yielded the highest (1.58 t ha^{-1}) followed by BARI Til-3 (1.10 t ha^{-1}) and the lowest in Botiaghata Local Til (0.98 t ha^{-1}). BARI Til-2 also produced highest stover yield (3.95 t ha^{-1}) followed by other varieties BARI Til-3 (3.49 t ha^{-1}) and that was lowest in Botiaghata Local Til (3.37 t ha^{-1}).

All the characters were significantly influenced by levels of nitrogen. The growth performance were best in highest levels of nitrogen (75 kg ha^{-1}), the tallest plant (123.7 cm) and highest number of leaves (85.02) were recorded at 65 DAE in 75 kg ha^{-1} and the shortest plant (91.26 cm), lowest number of leaves (60) at 65 DAE were recorded from the control treatment. The highest seed yield (1.51 t ha^{-1}) was achieved from 75 kg N ha^{-1} and the lowest seed yield (0.95 t ha^{-1}) was obtained from the control (0 kg N ha^{-1}). The highest stover yield (3.80 t ha^{-1}) was recorded from application of 75 kg N ha^{-1} and the lowest stover yield (3.41 t ha^{-1}) was produced from control.

Interaction between variety and nitrogen level was statistically significant in all other characters except capsule length and 1000-seed weight. BARI Til-2 with 75 kg N ha^{-1} produce significantly highest seed yield (1.91 t ha^{-1}). The lowest seed yield (0.75 t ha^{-1}) was recorded from Botiaghata Local Til with the control (0 kg N ha^{-1}). It was also evident that BARI Til-2 was greatly influenced by nitrogen fertilization than all other varieties.

From the present study it is observed that the highest seed yield (1.91 t ha^{-1}) was obtained from BARI Til-2 with 75 kg N ha^{-1}. It was a preliminary investigation regarding seed yield and yield attributes in sesame. The present research work needs to be repeated in the forth coming years in other agro-ecological zones of the country to confirm its fitness and for its generalization.

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