J Bangladesh Agril Univ 18(4): 949–955, 2020 https://doi.org/10.5455/JBAU.135411

ISSN 1810-3030 (Print) 2408-8684 (Online)

Journal of Bangladesh Agricultural University

Journal home page: http://baures.bau.edu.bd/jbau

Effect of Levels of Nitrogen on the Growth and Yield of Sesame (*Sesamum indicum* L.) Cultivars

Md. Abdus Salam✉, Akhi Khatun, Md. Abdul Kader

Department of Agronomy, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh

ARTICLE INFO

Article history
Received: 16 Sep 2020
Accepted: 15 Nov 2020
Published: 30 Dec 2020

Keywords
Growth,
Nitrogen level,
Sesame cultivars,
Yield

Correspondence
Md. Abdus Salam
✉: salamma71@yahoo.com

OPEN ACCESS

ABSTRACT

An experiment was conducted at Central Farm, Farm Management Section of Bangladesh Agricultural University, Mymensingh during March to June 2018 to find out the effect of levels of nitrogen on the growth and yield of sesame (*Sesamum indicum* L.). The experiment comprised five cultivars of sesame viz. BARI Til-3, BARI Til-4, Binatil-1, Binatil-2, Binatil-3 and four levels of nitrogen in the form of urea viz. 0, 40, 80 and 120 kg urea ha^{-1}. The experiment was laid out in a randomized complete block design with three replications. Growth, yield components and yield of sesame were significantly influenced by cultivars, levels of nitrogen and their interaction. At vegetative stage, the tallest plant and highest dry matter were observed in BARI Til-4 at 50 days after sowing (DAS) and 70 DAS, respectively. Application of 120 kg urea ha^{-1} (150 % of recommended dose) produced the tallest plant and highest dry matter at 70 DAS. Interaction of cultivar and level of nitrogen did not exert any significant effect on plant height and dry matter production at different days after sowing. Plant height, number of capsule plant^{-1}, seeds capsule^{-1}, 1000-seed weight, seed yield and biological yield were varied significantly with increasing urea level up to 80 kg ha^{-1} whereas stover yield was increased up to 120 kg urea ha^{-1} but branches plant^{-1} and harvest index showed non-significant variation. From the interaction it is observed that BARI Til-4 fertilized with 80 kg urea ha^{-1} gave the highest plant height (80.49 cm), highest number of branches plant^{-1} (3.20), highest number of capsules plant^{-1} (35.30), maximum seed yield (2.23 t ha^{-1}) and highest harvest index (18.82%). The highest stover yield (10.34 t ha^{-1}) was found in BARI Til-4 fertilized with 120 kg urea ha^{-1}. Therefore, BARI Til-4 fertilized with 80 kg urea ha^{-1} was found to be promising practice in respect of growth and yield of sesame.

Introduction

In Bangladesh, sesame is an important summer oilseed crop occupying 9.4% of the total oilseed area (BBS, 2018). It is the third largest source of edible oil in Bangladesh next to *Brassica* and *Arachis* both in respect of acreage and production. It occupies 92671 acres of land and produces 33999 tons of sesame (BBS, 2018). Prospect of large scale sesame farming on the fallow lands in the barind tract is very bright and that can be the effective means of mitigating the existing drought condition alongside the adverse impact of climate change in the dried area.

Sesame is a versatile crop having diversified usage and contains 42-45% oil, 20% protein and 14-20% carbohydrate (BARI, 2004). Due to presence of potent antioxidants, sesame seeds are called as "the seeds of immortality". Sesame seeds have a high nutritive value i.e. all essential amino acids and fatty acids are present in it. It is a good source of vitamins and minerals such as calcium and phosphorus (Malik *et al.*, 2003). The crop has high content of both excellent quality edible oil which shows high degrees of stability and resistant to oxidative rancidity due to the presence of endogenous antioxidants such as sesamol, sesamolinol and sesaminol (Alpaslan *et al.*, 2001). Sesame seed is used for preparation of varieties of foods, such as confectioneries, cakes and pastries. The high grades of oil are used for cooking margarine manufacturing and in pharmaceutical industries (Naim *et al.,* 2012). Sesame oil-cake is good feed for poultry, goat, sheep, fish, cattle, etc. It is a short duration and photo insensitive crop with wider adaptability. It can be cultivated both in *R*abi and *Kharif* seasons. The climate and edaphic conditions of Bangladesh are quite suitable for sesame cultivation. Yield and quality seeds of sesame are very low in Bangladesh comparison to other sesame producing countries of the world. The low yield of sesame in Bangladesh however is not an indication of low yielding potentially of this crop, but of the fact that the low yield

Cite This Article
Salam, M.A., Khatun, A., Kader, M.A. 2020. Effect of Levels of Nitrogen on the Growth and Yield of Sesame (*Sesamum indicum* L.) Cultivars. *Journal of Bangladesh Agricultural University*, 18(4): 949–955. https://doi.org/10.5455/JBAU.135411

may be attributed due to a number of reasons viz. unavailability of quality seeds of high yielding cultivars, lack of proper fertilizer management, disease and insect infestation and improper irrigation facilities. Deficiency of soil nutrient is considered as one of the major constraints to successful upland crop production in Bangladesh (Moslehuddin *et al*., 1997).

Cultivar plays an important role on the yield and quality of sesame. The traditional cultivar of sesame shows an average yield of 630 kg ha^{-1} whereas high yielding cultivars yield up to 1700 kg ha^{-1} (BINA, 2004). The seed yield of sesame varied due to the varietal potentiality (Raja *et al*., 2007; Mohsana, 2009). Sesame yield is highly variable depending upon the growing environment, cultural practices and cultivars used and proper fertilizer management (Sarkar and Banik, 2002). Detailed fertilizer studies have indicated that application of nitrogen fertilizers to sesame gives a reasonable chance of increased economic return. Several investigators reported the positive effects of nitrogen fertilization (or, applying nitrogen fertilizers) on growth, yield attributes, seed yield and quality of sesame (WARC, 2006; Muhaman and Gungula, 2008; Umar *et al*., 2012; Ali *et al.*, 2017). Different cultivars of sesame may respond differentially in growth and yield to similar levels of nutrients (Weiss, 2000) owing to differences in nutrient uptake and use efficiency. Adequate supply of nitrogen is beneficial both for carbohydrates and protein metabolism. In sesame culture, chemical fertilizers, particularly nitrogen (N), are one of the greatest production inputs. Nitrogen plays a major role in the synthesis of proteins, nucleic acid, nucleotides, enzymes, alkaloids, vitamins and chlorophyll in plants. It also affects flowering and fruit setting in sesame (Jasimuddin, 2014). An adequate supply of nitrogen is essential for vegetative growth and desirable yield (Yoshizawa *et al.,* 1981). Young *et al*. (2003) and Iorlamen *et al.* (2014) reported that application of nitrogen fertilizer on soils that are below N critical range of 10 to 15 kg ha^{-1} causes optimum growth of the crop. On the other hand, excessive application of nitrogen is not only uneconomical, but it can prolong the growing period and delay crop maturity. Excessive nitrogen application causes physiological disorder (Obreza and Vavrina, 1993). Neither high yielding cultivars nor nitrogen alone can improve the yield of sesame, but their appropriate use in combination with proper agronomic management can increase the yield of this crop. Keeping all these points in view, the present study was, therefore, undertaken to determine the effect of nitrogenous fertilizer on the growth and yield of sesame cultivars and to select best cultivar(s) for obtaining maximum yield with optimum nitrogenous fertilizer dose.

Materials and Methods

The experiment was carried out at the Central Farm, Farm Management Section of Bangladesh Agricultural University, Mymensingh during the period from March to June 2018. The experimental area was a medium high land belonging to the Agro-ecological Zone (AEZ-9) comprising the Old Brahmaputra Floodplain soil (UNDP and FAO, 1988). Soil of the experiment mainly non-calcareous and texture was sandy loam with pH value 6.5. Soil organic matter and fertility status is low as well as neutral in reaction. The experimental site belongs to sub-tropical climate with high relative humidity from April to June, a hot humid monsoon season with heavy rainfall from June to October and relatively cool and dry winter season from November to March. The experiment consisted two factors, Factor A: Sesame cultivar (5)- BARI Til-3, BARI Til-4, Binatil-1, Binatil-2 and Binatil-3, Factor B: Level of nitrogen (4)- No nitrogenous fertilizer (control), 40 kg urea ha^{-1} (50% of recommended dose), 80 kg urea ha^{-1} (100% of recommended dose) and 120 kg urea ha^{-1} (150% of recommended dose). The experiment was laid out in a randomized complete block design (RCBD) with three replications. Each of the replication represented a block in the experiment. Each block comprises 20 unit plots which were assigned with the combination of five cultivars and four nitrogen fertilizer treatments. Treatments were assigned randomly in the unit plots. Spaces between blocks and unit plots were 1.0 m and 0.75 m, respectively. The experimental plot was prepared by 4-5 ploughings and cross ploughings with power tiller. Clods were broken into small pieces and leveled by ladder.

The experimental field was fertilized with N as per treatments. The dose of TSP and MoP were 120, and 50 kg ha^{-1}, respectively. Sesame seeds were sown in continuous line on 16 March 2018 in 2-3 cm deep furrows made by hand rake. After placement of seeds in furrow, seeds were covered with soil by hand. The seed rate was 6.0 kg ha^{-1}. Seedling emergence started after 3 days and completed within 7 days of sowing. After seedling establishment, weeding was done manually with nirani on April 2018 at 30 days after sowing (DAS). Healthy seedlings were kept at a distance of 5 cm and excess seedlings were carefully uprooted by hand pulling. The crop was infested with leaf hopper (*Orosius albicinctus*) at vegetative stage which was successfully controlled by spraying insecticide Clorothin 505EC (Clorpyriphos plus cypermethrin) at 10 ml per 10 L water. Plant height, root length and number of branches $plant^{-1}$ were recorded from five sample plants/ plot at vegetative stage, flowering stage, reproductive stage at 30, 50 and 70 days on 16 April, 06 May and 26 May 2018, respectively.

Dry weight of these samples was also recorded after oven drying. Five sample plants plot^{-1} were first collected (excluding boarder row) just prior to crop harvesting, which was done on 7 June 2018. All plant materials were carried carefully to the threshing floor, to collect necessary data on yield components. For collecting data on seed and stover yields, just prior to crop harvesting central 1 m^2 area was harvested, threshed and dried. Finally, seed yield and stover yield were converted to t ha^{-1}. Five plants were selected randomly for taking the data of yield components and data were collected on plant height, number of branches plant^{-1}, number of capsules plant^{-1}, number of seeds capsule^{-1}, 1000-seed weight, seed yield, stover yield and harvest index. The collected data were analyzed statistically using "Analysis of Variance" technique with MSTATC computer package programme and mean differences were adjudged by Duncan's Multiple Range Test (DMRT) (Gomez and Gomez, 1984).

Results and Discussion

Growth parameters

Effect of cultivar

Significant variation was observed for cultivar on plant height of sesame at 50 DAS (days after sowing) and non-significant variation was recorded at 30 DAS and 70 DAS (Table 1). At 50 DAS, the tallest plant (60.89 cm) was observed in BARI Til-4 and the shortest plant (53.83 cm) was found in Binatil-1 which was also statistically similar with Binatil-2. Cultivar had significant influence on total dry matter production (Table. 1). Significant difference was recorded at 30 and 70 DAS but non-significant difference was found at 50 DAS. At 30 DAS, BARI Til-4 produced the highest dry matter (2.26 g plant^{-1}) and the lowest dry matter (1.9 g plant^{-1}) was produced in Binatil-3. At 70 DAS, the highest dry matter was accumulated in BARI Til-4 whereas the lowest accumulation (1.93 g plant^{-1}) was occurred in BARI Til-3 which was statistically similar with Binatil-1, Binatil-2 and Binatil-3.

Effect of level of nitrogen

Plant height was significantly affected by levels of nitrogen at 30 and 70 DAS at 1% level of probability (Table 2). At 30 DAS, the tallest plant (32.86 cm) was observed in 80 kg urea ha^{-1} where the shortest plant (30.31 cm) was found in control (no nitrogen) treatment. At 70 DAS, the tallest plant (81.82 cm) was recorded at 120 kg urea ha^{-1} whereas the shortest plant (73.75 cm) was observed in control (no nitrogen) treatment which was statistically similar with 40 kg urea and 120 kg urea ha^{-1}. Significant variation in dry matter accumulation per plant was recorded for nitrogen at 30 and 70 DAS (Table 2). At 30 DAS, the highest dry matter per plant (2.20 g plant^{-1}) was obtained from 120 kg urea ha^{-1} which was statistically similar with 80 kg urea ha^{-1}. This finding partially corroborates the finding of Umar *et al*. (2012). The lowest dry matter accumulation plant^{-1} (1.83 g plant^{-1}) was recorded from control (N_0) treatment (Table 2). This could be attributed due to the fact that greater assimilates were partitioned to the stem and root when there was higher nutrient in the root zone.

Interaction effect of cultivar and levels of nitrogen

The interaction of cultivar and level of nitrogen did not show any significant effect on plant height (Table 3). Plant height ranged from 31.00 cm to 85.94 cm. Table 3 indicates that numerically the tallest plant (85.94 cm) was obtained in BARI Til-4 with 120 kg urea ha^{-1} at 70 DAS and the lowest one (29.22 cm) was recorded in Binatil-1 with 0 kg urea ha^{-1} at 30 DAS. Statistically non-significant difference was recorded for the interaction effect of nitrogen and cultivar in terms of dry matter accumulation per plant at 30, 50 and 70 DAS (Table 3). Numerically the highest dry matter per plant (2.71 g) was recorded from BARI Til-3 with 40 kg urea ha^{-1} at 50 DAS and the lowest dry matter accumulation per plant (1.71 g) was recorded at 30 DAS from BARI Til-3 with 80 kg urea ha^{-1}.

Yield and yield contributing characters of sesame

Effect of cultivar

Cultivar showed significant effect on plant height of sesame at harvest (Table 4). The highest plant height (80.49 cm) was observed in cultivar BARI Til-4 and the lowest one (77.02 cm) was observed in BARI Til-3 which was statistically identical (78.97 cm) with Binatil-3. Similar research finding was also reported by Kashani *et al.* (2015) who reported that plant height varied between sesame varieties. This is might be the fact that plant height is a genetic character and it varies from cultivar to cultivar. Number of branches in sesame is one of the genetical characters which varied cultivar to cultivar. From the Table 4, it is observed that number of branches plant^{-1} varied significantly due to cultivar. The highest number of branches plant^{-1} (2.50) was observed in BARI Til-4 which was statistically similar to Binatil-2. The lowest number of branches plant^{-1}(1.70) was observed in Binatil-1 (Table 4). Cultivar exhibited significant effect on production of capsules plant^{-1} (Table 4). Data reveal that the highest number of capsules plant^{-1} (29.95) was produced in Binatil-3 which was statistically similar with BARI Til-3 and BARI Til-4. The lowest number of capsules plant^{-1} (26.49) was obtained in Binatil-2 (Table 4). The cultivar exhibited significant difference on number of seeds capsule^{-1} (Table 4). The maximum number of seeds capsule $^{-1}$ (52.54) was found in BARI Til-4 and the minimum one (46.94) was found in Binatil-1 which was statistically similar (47.19) with Binatil-3 and BARI Til-3 (47.56) (Table 4).

1000-seed weight is a genetic character and it is supposed to be varied among the cultivars. But in this experiment, it did not vary significantly (Table 4). Numerically BARI Til-4 produced the heaviest 1000-seed weight (3.17 g) and Binatil-1 and Binatil-2 produced the lowest 1000-seed weight (3.06 g) (Table 4). This result somewhat different from Tiwari *et. al.* (2000), Subrahmaniyan *et al.* (1999) who showed that sesame cv. C7 produced higher 1000-seed weight than cv. TC25 and Vinaya. The cultivars exhibited significant effect on seed yield (Table 4). BARI Til-4 produced the highest seed yield (1.41 t ha^{-1}). Abdel *et al*. (2003) found almost similar result. The highest number of branches plant^{-1}, highest number of seeds capsule^{-1} and heaviest 1000-seed weight positively contributed to the higher seed yield in BARI Til-4 compared to other cultivars. Moreover, the highest dry matter accumulation in BARI Til-4 contributed to highest seed yield in this cultivar. Akinoso *et al.* (2010) reported that variety played important roles on the seed yield of sesame**.** The highest stover yield (7.52 t ha^{-1}) was found in BARI Til-4 and the lowest one (5.53 t ha^{-1}) was found in BARI Til-3 which was statistically identical with other cultivars (Table 4). Numerically the highest harvest index (15.92%) was obtained from BARI Til-4. Tiwari *et al.* (2000) found almost similar result. The lowest harvest index (14.63%) was recorded from Binatil-5 (Table 4).

Effect of level of nitrogen

Nitrogen level exerted significant influence on plant height (Table 5). The tallest plant (83.14 cm) was found in 40 kg urea ha^{-1} and the shortest plant height (73.96 cm) was observed in control (no nitrogen) treatment. Nitrogen level had significant influence on number of branches plant^{-1} (Table 5). The highest number of branches plant^{-1} (2.68) was obtained from 80 kg urea ha^{-1} which was statistically similar (2.44) with 120 kg urea ha^{-1} . The lowest number of branches plant^{-1} (1.70) was recorded from control treatment (Table 5). This might be due to the fact that the highest assimilates were partitioned to the stem in this treatment which ultimately helped to produce the highest number of branches plant^{-1}. Similar research finding was also reported by Mekonnen *et al*. (2016). Nitrogen level exhibited significant effect on production of capsules plant^{-1} (Table 5). The maximum number of capsules plant^{-1} (33.02) was obtained with the application of 120 kg urea ha^{-1} which was followed by 80 kg N ha^{-1}. This might be due to the fact that increased N levels at maximum vegetative stage increased the total dry matter accumulation which ultimately enhanced the number of capsules plant^{-1}. The lowest number of capsules plant^{-1} (22.28) was recorded in control treatment where no nitrogen was applied (Table 5). Number of seeds capsule^{-1} significantly varied with application of increased levels of nitrogen over control. The highest number of seeds capsule^{-1} (58.91) was recorded from 80 kg urea ha^{-1} whereas the lowest number of seeds capsule^{-1} (39.81) was found from control treatment (Table 5). These findings corroborate the finding of Paul and Savithri (2003) and Mekonnen *et al*. (2016) who reported that 80 kg urea ha^{-1} produced the highest number of seeds capsule^{-1}. Significant variation was observed in 1000-seed weight of sesame for level of nitrogen. The highest 1000-seed weight (3.33g) was attained from 80 kg urea ha^{-1} which was statistically followed by 40 kg and 120 kg urea ha^{-1}. The lowest 1000-seed weight (2.83 g) was recorded from control (no nitrogen) treatment (Table 5). Seed yield ranged from 0.56 t ha^{-1} to 1.40 t ha^{-1}. Seed yield increased with increased nitrogen level. The highest seed yield (1.40 t ha^{-1}) was obtained from 120 kg urea ha^{-1} which was statistically identical to 80 kg urea ha^{-1} (Table 5). The lowest seed yield (0.56 t ha^{-1}) was obtained from control treatment where no nitrogen was applied (Table 5). The increasing trend in seed yield with increasing N level to a certain level might be attributed due to the positive effect of N on capsules plant $^{-1}$ and 1000-seed weight. Malik *et al*. (2003) also reported that 80 kg urea ha^{-1} produced the maximum seed yield. The superiority of 120 urea ha^{-1} for studied parameters of sesame varieties could possibly be because of optimum availability and uptake of nutrients (Bhatti and Nazir, 2005). The highest stover yield (7.74 t ha^{-1}) was found in 80 kg urea ha^{-1} which was statistically identical to 120 kg urea ha^{-1}. The lowest stover yield (3.39 t ha^{-1}) found in control (no nitrogen) treatment. Statistically non-significant difference was recorded for nitrogen on harvest index of sesame (Table 5). Numerically the highest harvest index (16.02%) was obtained from 120 kg urea ha^{-1} whereas the lowest harvest index (13.98%) was obtained in control treatment.

Table 1. Effect of cultivar on plant height(cm)and total dry matter (g plant^{-1}) at different days after sowing (DAS)

Cultivar	Plant height (cm) at different DAS			Dry matter production (g plant^{-1}) at different DAS		
	30	50	70	30	50	70
BARI Til-3	33.54	58.25ab	78.03	1.93b	2.620	1.93b
BARI Til-4	31.94	60.89a	78.79	2.26a	2.594	2.25a
Binatil-1	30.81	53.83b	76.49	1.99b	2.473	2.03b
Binatil-2	32.08	56.97b	77.25	2.03b	2.589	1.90b
Binatil-3	31.360	54.97ab	78.04	1.90b	2.387	1.98b
CV (%)	8.96	9.45	3.20	12.60	15.86	12.63
Level of sig.	NS	0.05	NS	0.05	NS	0.05

*In a column figures having common letter(s) do not differ significantly as per DMRT

Table 2. Effect of level of nitrogen on plant height and total dry matter production at different DAS

Cultivar	Plant height (cm) at different DAS			Dry matter production (g plant^{-1}) at different DAS		
	30	50	70	30	50	70
Control (No urea)	30.31b	55.27	73.75c	1.83c	2.431	1.83c
40	32.42ab	57.18	76.80b	2.00bc	2.61	1.20bc
80	32.86a	58.18	78.50b	2.05ab	2.54	2.20ab
120	32.20ab	57.31	81.82a	2.20a	2.55	2.05a
CV (%)	8.96	9.45	3.20	12.59	15.9	12.63
Level of sig.	0.01	NS	0.01	0.01	NS	0.01

*In a column figures having common letter(s) do not differ significantly as per DMRT

Table 3. Interaction effect of cultivar and level of nitrogen on plant height and total dry matter production (g plant^{-1}) at different DAS

Cultivar	Plant height (cm) at different DAS			Dry matter production (g plant^{-1}) at different DAS		
	30	50	70	30	50	70
V1N0	30.11	54.11	73.89	1.88	2.66	1.85
V1N1	35.78	59.00	75.55	2.13	2.71	1.71
V1N2	35.72	62.89	80.00	1.71	2.65	2.13
V1N3	32.56	57.00	82.67	2.00	2.46	2.00
V2N0	30.11	57.22	75.11	1.86	2.61	1.85
V2N1	31.45	57.55	77.00	2.45	2.70	2.45
V2N2	34.00	61.44	77.11	2.26	2.69	2.26
V2N3	32.20	67.33	85.94	2.44	2.59	2.44
V3N0	29.22	53.56	72.00	1.78	2.48	1.78
V3N1	31.22	53.67	75.66	1.81	2.15	1.93
V3N2	32.56	55.67	78.61	1.96	2.67	1.82
V3N3	30.22	52.45	79.67	1.97	2.48	2.39
V4N0	32.33	55.78	74.44	2.21	2.59	2.21
V4N1	32.11	56.78	78.87	1.83	2.22	1.89
V4N2	31.00	54.67	76.89	1.89	2.52	1.91
V4N3	32.89	52.67	78.78	1.92	2.33	1.96
V5N0	29.78	55.67	73.33	1.96	2.47	1.81
V5N1	31.55	58.89	76.89	1.81	2.51	2.00
V5N2	31.00	56.22	79.89	2.00	2.45	2.11
V5N3	33.11	57.11	82.06	2.11	2.70	1.83
CV (%)	8.96	9.45	3.20	3.26	15.86	12.63
Level of sig.	NS	NS	NS	NS	NS	NS

NS= Non-significant; V_1= BARI Til-3; V_2= BARI Til-3; V_3=Binatil-1; V_4= Binatil-2; V_5= Binatil-3; N_0=0 kg urea ha^{-1}; N_1=40 kg urea ha^{-1}; N_2=80 kg urea ha^{-1}; N_3=120 kg urea ha^{-1}

Table 4. Effect of cultivar on the yield and yield attributes of sesame

Cultivar	Plant height (cm)	Branches plant^{-1} (no.)	Capsules plant^{-1} (no.)	Seeds capsule^{-1} (no.)	1000- seed weight (g)	Seed yield (t ha^{-1})	Stover yield (t ha^{-1})	Harvest index (%)
BARI Til-3	77.02b	2.02b	28.98ab	47.56b	3.08	1.41a	5.538b	15.65
BARI Til-4	80.49a	2.50a	27.38a	52.54a	3.17	1.01b	7.517a	15.92
Binatil-1	77.72b	1.70c	26.49c	46.94b	3.06	1.02b	5.634b	14.99
Binatil-2	77.71b	2.31ab	27.51bc	49.04b	3.06	1.05b	6.109b	14.90
Binatil-3	78.97ab	2.11b	29.95a	47.19b	3.13	14.13	5.816b	14.63
CV (%)	3.26	15.95	7.12	7.40	6.23	14.13	10.61	9.45
Level of sig.	0.05	0.01	0.01	0.01	NS	0.05	0.01	NS

*In a column figures having common letter(s) do not differ significantly as per DMRT

Table 5. Effect of level of nitrogen on the yield and yield attributes of sesame

Cultivar	Plant height (cm)	Branches plant^{-1} (no.)	Capsules plant^{-1} (no.)	Seeds capsule^{-1} (no.)	1000- seed weight (g)	Seed yield (t ha^{-1})	Stover yield (t ha^{-1})	Harvest index (%)
0 (control)	73.9d*	1.31c	22.28d	39.81c	2.83c	0.56c	3.39c	13.98
40	83.14a	2.09b	27.25c	47.94b	3.15b	1.09b	6.09b	15.58
80	80.32b	2.68a	29.70b	58.91a	3.33a	1.28a	7.74a	15.31
120	76.11c	2.44a	33.02a	47.95b	3.10b	1.4 a	7.26a	16.02
CV (%)	3.26	15.95	7.12	7.40	6.23	14.13	10.61	13.38
Level of sig.	0.01	0.01	0.01	0.01	0.01	0.01	0.01	NS

*In a column figures having common letter(s) do not differ significantly as per DMRT

Table 6. Interaction effect of cultivar and level of nitrogen on the yield and yield attributes of sesame

Cultivar	Plant height (cm)	Branches plant^{-1} (no.)	Capsules plant^{-1} (no.)	Seeds capsule^{-1} (no.)	1000- seed weight (g)	Seed yield (t ha^{-1})	Stover yield (t ha^{-1})	Harvest index (%)
V1N0	72.90e*	1.21	22.33g	40.63gh	2.91	0.50g	3.17e	13.73
V1N1	74.83de	2.10	29.24cde	46.69d-g	3.07	1.00ef	5.50d	17.03
V1N2	81.10bc	2.40	34.47 ab	54.88bc	3.33	1.27cde	7.10bc	15.25
V1N3	90.317a	2.35	29.89cd	41.70fgh	3.00	1.14c-f	6.38cd	16.62
V2N0	72.95e	1.68	23.38 fg	48.05def	2.88	0.56g	2.94e	13.90
V2N1	73.97cde	2.57	30.60cd	49.01cde	2.98	1.32cd	7.05bc	15.75
V2N2	81.64bc	3.20	35.30 a	61.77a	3.43	2.23a	10.34a	18.82
V2N3	82.35b	2.53	29.56cde	57.66ab	3.38	1.85b	9.73a	15.22
V3N0	76.70e	1.00	21.10 g	37.27h	2.88	0.58g	3.50e	14.25
V3N1	75.96e	1.25	26.14 ef	48.38c-f	3.12	0.96f	5.35d	15.17
V3N2	81.35bc	2.37	30.29cd	61.16ab	3.22	1.32cd	7.13bc	15.62
V3N3	73.73b	2.30	28.43de	40.93gh	3.05	1.25c-f	6.56bcd	14.90
V4N0	78.80de	1.30	21.31g	48.86cde	3.18	1.03def	6.29cd	14.42
V4N1	80.90cde	2.20	26.10ef	56.81ab	3.25	1.36c	7.70b	15.18
V4N2	81.45bc	2.92	32.63abc	50.51cd	3.04	1.18c-f	6.74bc	14.90
V4N3	73.73b	2.80	30.00cd	39.47h	3.24	1.15c-f	3.51e	13.97
V5N0	81.35e	1.33	23.29fd	46.77d-g	3.15	1.18c-f	6.44cd	15.50
V5N1	78.81bcd	2.33	31.57bcd	59.93ab	3.43	1.10c-f	7.03bc	15.22
V5N2	80.88bc	2.49	32.42abc	39.99gh	2.71	0.56g	6.13cd	14.92
V5N3	90.32a	2.19	23.21fg	40.63gh	2.91	1.14c-f	3.17e	13.73
CV (%)	3.26	15.95	7.12	7.40	6.23	14.13	10.61	13.38
Level of sig.	0.01	0.01	0.01	0.01	0.01	0.01	0.01	NS

NS= Non-significant; V_1= BARI Til-3; V_2= BARI Til-3; V_3=Binatil-1; V_4= Binatil-2; V_5= Binatil-3; N_0=0 kg urea ha^{-1}; N_1=40 kg urea ha^{-1}; N_2=80 kg urea ha^{-1}; N_3=120 kg urea ha^{-1}

Interaction effect of cultivar and level of nitrogen

The interaction of cultivars and nitrogen levels exerted significant effect on plant height (Table 6**)**. Plant height ranged from 72.90 cm to 90.32 cm. Table 6 indicates that the tallest plant (90.32 cm) was obtained in Binatil-3 fertilized with 120 kg urea ha^{-1}and the shortest plant (72.90 cm) was recorded in BARI Til-3 along with 0 kg urea ha^{-1}. Number of branches plant^{-1} was not significantly influenced by the interaction between cultivar and levels of nitrogen. Binatil-3 produced numerically the highest number of branches plant^{-1} (2.92) interacted with 80 kg urea ha^{-1} interaction whereas the lowest number of branches plant^{-1} (1.00) was recorded in Binatil-3 interacted with no nitrogen (Table 6). The interaction effect between cultivar and nitrogen level was found to be significant to the respect of number of capsules plant^{-1} (Table 6). The maximum number of capsules plant^{-1} (35.30) was produced in BARI Til-4 along with 80 kg urea which was statistically similar (34.47) with BARI Til-4 × 80 kg urea ha^{-1}. The lowest number of capsules plant^{-1} (21.10) was recorded in Binatil-1 with no nitrogen (control) treatment (Table 6). The highest number of seeds capsule^{-1} (61.77) was recorded from BARI til-2 along with 80 kg urea ha^{-1}. The lowest number of seeds capsule^{-1} (37.27) from Binatil-1 along with no nitrogen (Table 6). The interaction effect of cultivar and nitrogen levels was found to be non-significant on 1000-seed weight. Numerically the highest 1000-seed weight (3.43g) obtained in BARI Til-4 along with 80 kg urea ha^{-1} (N_2) and the lowest one (2.71g) was found in Binatil-3 along with 80 kg urea ha^{-1} (V_5N_2) interaction (Table 6). Significant variation on seed yield was observed due to the interaction effect of cultivar and level of nitrogen. Maximum seed yield (2.23 t ha^{-1}) was found in BARI Til-4 fertilized with 120 kg urea ha^{-1} whereas the minimum seed yield (0.5 t ha^{-1}) was found in treatment V_1N_0 combination i.e. BARI Til-3 along with no nitrogen (Table 6). Significant difference was recorded for the interaction effect of nitrogen and cultivar in terms of stover yield of sesame. The highest stover yield (10.34 t ha^{-1}) was recorded in BARI Til-4 with 80 kg urea ha^{-1} (V_2N_2) and the lowest stover yield (2.94 t ha^{-1}) was obtained from BARI Til-4 with no nitrogen (control) (V_2N_0) (Table 6). Numerically the highest harvest index (18.82%) was recorded in BARI Til-4 along with 80 kg urea ha^{-1} (V_2N_2). The lowest harvest index (13.73%) was recorded in BARI Til-3 × control (no nitrogen) (V_1N_0) (Table 6).

Conclusions

BARI Til-4 produced the highest seed yield among the sesame cultivars used. Eighty kg urea ha^{-1} produced the highest seed yield which was statistically identical to 120 kg urea ha^{-1}. Among the interaction BARI Til-4 with 80 kg urea ha^{-1} produced the highest seed yield ha^{-1}. From results of the present study, it might be concluded that BARI Til-4 and 80 kg urea ha^{-1} is the best combination for highest yield of sesame. However, further research in this respect is necessary in other Agro-ecological zones of the country to confirm the results of the present study and to draw a definite conclusion for recommendation.

Acknowledgements

The authors are very much grateful to Chief Farm Superintendent (CFS), Bangladesh Agricultural University for providing the land to conduct the experiment.

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

References

Abdel-Rahman, K.A., Allam, A.Y., Galal, A.H. and Bakry, B.A. 2003. Response of sesame to sowing dates, nitrogen fertilization and plant populations in sandy soil. *Asian Journal of Agricultural Science*, 34(3): 1-13

Akinoso, R., Aboaba, S.A. and Olayanju, T.M.A. 2010. Effects of moisture content and heat treatment on peroxide value and oxidative stability of un-refined sesame oil. *AJFAND,* 10(10): 4268- 42850

Ali, S., Jana, A., Zhikuanc, J., Shoaib, A., Tiec, C., Tings, W., Pengc, Z., Manzoora, A.I., Rahman, I.M., Xialonce., Yuec, Y.X. 2017. Growth and fatty acid composition of sesame (*Sesamum indicum* L.) Genotypes as influence by planting dates and nitrogen fertilization in semi-arid region of northwest Pakistan. *Russian Agricultural Sciences,* 42(3-4): 224-229.

Alpaslan, M., Boydak, E., Hayta, M., Gerçek, S. and Simsek, M. 2001. Effect of row spacing and irrigation on seed composition of Turkish sesame (*Sesamum indicum* L.). *Journal of American Oil Chemistry,* 9: 933-935. https://doi.org/10.1007/s11746-001-0366-0

BBS (Bangladesh Bureau of Statistics). 2018. Yearbook of Agricultural Statistics of Bangladesh, 29th series, Ministry of Planning, Government of the People's Republic of Bangladesh. pp.148-50.

BARI (Bangladesh Agricultural Research Institute). 2004. Annual Report for 2003. BARI, Joydebpur, Gazipur. p. 28.

BINA (Bangladesh Institute of Nuclear Agriculture). 2004. *Tiler Unnata Jat Binatil-1.* Bangladesh BINA, Mymensingh. Folder: May, 2004.

Bhatti, I.H., Ahmad, R.M. and Nazir, M.S. 2005. Agronomic traits of sesame as affected by grain legumes intercropping and planting patterns. *Pakistan Journal of Agricultural Sciences,* 42(1-2): 56-60.

Gomez, K.A. and Gomez, A.A. 1984. *Statistical Procedures for Agricultural Research*. John Wiley and Sons, New York.

Iorlamen, T., Ayam, F.M. and Akombo, R.A. 2014. Growth and yield responses of sesame (*Sesamum indicum* L.) to foliar and soil applied fertilizer in Makurdi, Benue State. *International Journal of Scientific Research and Mamagement*, 2: 528-541.

Jasimuddin, S.K. 2014. Effect of integrated nutrient management practices in summer sesame. Retrieved from https://www.blogger.com/.

Kashani, H., Shahab-u-Din Kandhrol, M.N., Ahmed, N., Saeed, Z., and Nadeem, A. 2016. Seed yield and oil content of sesame (*Sesamum indicum* L.) genotypes in response to different methods of nitrogen application. *Indian Journal of Science and Technology,* 9(30): https://doi.org/10.17485/ijst/2016/v9i30/89371

Malik, M.A., Saleem, M.R., Cheema, M.A. and Shamim, A. 2003. Influence of different nitrogen levels on productivity of sesame (*Sesamum indicum* L.) under varying planting patterns. *International Journal of Agricultural and Biological Science*, 5(4): 490-492.

Mekonnen, S.B., Sharma, J. and Dechassa, N. 2016. Effects of nitrogen fertilizer rates on yield and yield components of sesame (*Sesamum indicum* L.) varieties under irrigation in Gode, South-Eastern Ethiopia. *International Journal of Plant Breeding and Crop Science*, 3(1): 71-78.

Mohsana, A. 2009. Effect of different levels of sulphur and boron on the yield and oil content of sesame. M.S. Thesis. Department of Agronomy, *Bangladesh Agricultural University*. pp. 43-48.

Moslehuddin, A.Z.M., Laizoo, S. and Egashira, K. 1997. Fertility status of Bangladesh soils -A Review *Journal of Faculty of Agriculture, Kyushu University*, 41(3.4): 257-267.

Muhamman, M.A. and Gungula, D.T. 2008. Growth parameters of sesame (*Sesamum indicum* L.) as affected by nitrogen and phosphorus levels in Mubi, Nigeria. *Journal of Sustainable Development in Agriculture & Environment*, 3: 80-86.

Naim, A.M., El dey, E.M., Jabereldar, A.A., Ahmed, S.E. and Ahmed, A.A. 2012. Determination of suitable variety and seed rate of sesame (*Sesamum indicum* L.) in sandy dunes of Kordofan, Sudan. *International Journal of Agricultural Forestry,* 2(4): 175-179. https://doi.org/10.5923/j.ijaf.20120204.08

Obreza, T.A. and Vavrina, C.S. 1993. Production of Chinese cabbage in relation to nitrogen source, rate and leaf nutrient concentration in soil. *Plant Analysis*, 24: 13-14

Paul, I.K. and Savithri, K.E. 2003. Effect of bio-fertilizers vs. perfected chemical fertilization for sesame grown in summer rice fallow, *Journal of Tropical Agriculture*, 41: 47-49. http://krishikosh.egranth.ac.in/handle/1/5810063363

Raja, A., Hattab, O.K., Gurusamy, L. and Suganya, S. 2007. Sulphur levels on nutrient uptake and yield of sesame varieties and nutrient availability. *International Journal of Soil Science*, 2: 278–285. https://doi.org/1039/ijss.2007.278.285

Ramanathan. S.P. and Chandrasekaran, B. 1998. Effect of nipping, plant geometry and fertilizer on summer sesame (*Sesamum indicum* L.) *Indian Journal of Agronomy*. 43: 329-332.

Sarkar, R.K. and P. Banik, 2002. Effect of planting geometry, direction of planting and sulphur application on growth and productivity of sesame (*Sesamum indicum*). *Indian Journal of Agricultural Sciences*, 72: 70-73.

Subrahmaniyan, K., Sridhar, P. and Arulmozhi, N. 1999. Response of sesame (*Sesamum indicum* L.) to sulphur and micronutrients with and without farmyard manure under irrigated condition. *Indian Journal of Agriculture,* 44(4): 826-829.

Sujathamma, P., Reddy, D.S. and Reddy, B.S. 2003. Direct, residual and cumulative residual effect of nitrogen uptake by sesame in rice-groundnut-sesame cropping system. *Annual Agricultural Research,* 24(3): 587-592.

Tiwari, R.C., Namdeo, K. and Girisha, K.N. 2000. Effect of nitrogen and sulphur on growth, yield and quality of sesame varieties. *European Journal of Agronomy,* 1: 163-167.

Umar, U.A., Mahmud, M., Abubakar, I.U., Babaji, B.A. and Idris, U.D. 2012. Effect of nitrogen fertilizer level and intra-row spacing on growth and yield of sesame (*Sesamum indicum* L.) varieties. *International Journal of Agronomy and Plant Production*, 3: 139-144.

UNDP and FAO. 1988: Land Resources Appraisal of Bangladesh for Agricultural Development. Report No. 2. Agro-ecological Zones of Bangladesh. United Nations Development Program and Food and Agriculture Organization, Rome. pp. 63

Vaccaro, A.E. 2017. The effects of nitrogen and irrigation application rates and timings in two cultivars of sesame (*Sesamum indicum* L.) in a Florida field setting, M.Sc. Thesis, University of Florida, United States of America. pp. 45-46.

Weiss, E.A. 2000. *Oil Seed Crops*. 2nd edition, Blackwell Science, Inc., Malden, MA.

WARC. 2006. *Sesame Production Training Manual.* Werer Agricultural Research Center, Mlka Werer, Ethiopia.

Yoshizawa, T.C.H.M. and Roan, Y.C. 1981. *Management of Summer Pulse in Taiwan*. AVRDC, Shanhua, Taiwan, p. 125.

Young, C.C., Lai, W.A., Shen, F.T., Hung, W.S. and Arun, A.B. 2003. Proceedings of the 6th ESAFS International conference: Soil management technology on low productivity and degraded soils (Taipei, Taiwan*), Exploring the microbial potentiality to augment soil fertility in Taiwan*, pp. 25-27.