EFFECT OF SOWING METHODS AND VARIETY ON YIELD AND YIELD COMPONENTS OF SESAME

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CERTIFICATE

*This is to certify that the thesis entitled **"Effect of sowing methods and variety on yield and yield components of sesame"** submitted to the Department of Agronomy, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **Master of Science** in **Agronomy**, embodies the result of a piece of bonafide research work carried out by **RAFIQUL ISLAM**, Registration No. **11-04664** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

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

***Dated:** June, 2017*
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Dedicated To
My Beloved Parents

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The Author

EFFECT OF SOWING METHODS AND VARIETY ON YIELD AND YIELD COMPONENTS OF SESAME

ABSTRACT

The experiment was conducted at the Agronomy farm of Sher-e-Bangla Agricultural University, Dhaka during March to June 2017 to study the effect of sowing methods and variety on yield and yield components of sesame. The experiment comprised of four varieties *viz*. BARI til 2, BARI til 3, BARI til 4 and Lal til (local) designed V_1, V_2, V_3 and V_4 respectively combined with three sowing methods named Broadcasting, Line sowing and Line sowing on ridges designed M_1, M_2 and M_3. The experiment was laid out in Randomized Complete Block Design (RCBD) with 3 replications. In terms of varietal performance, the highest dry weight plant^{-1} (27.35 g), number of capsules plant^{-1} (47.89), number of seeds capsule^{-1} (62.34), seed weight plant^{-1} (8.10 g), 1000 seed weight (2.64 g), seed yield (1265.00 kg ha^{-1}), stover yield (1601.33 kg ha^{-1}), oil yield (550.80 kg ha^{-1}) and harvest index (44.06%) were achieved from BARI til 4. All the studied parameters were found lowest with Lal til (local). In case of sowing methods, line sowing showed the best performance on dry weight plant^{-1} (26.33 g), number of capsule plant^{-1} (42.94), number of seeds capsule^{-1} (56.39), seed weight plant^{-1} (6.47 g), 1000 seed weight (2.55 g), seed yield (1103.70 kg ha^{-1}), stover yield (1460.67 kg ha^{-1}), oil yield (480.32 kg ha^{-1}) and harvest index (42.67%). Broadcasting method showed the lowest performance on the same parameters mentioned. On the other hand the interaction of the variety with sowing methods, the highest dry weight plant^{-1} (30.36 g), number of capsules plant^{-1} (56.33), number of seeds capsule^{-1} (67.67), seed weight plant^{-1} (10.5 g), 1000 seed weight (2.75 g), seed yield (1368.00 kg ha^{-1}), stover yield (1635.00 kg ha^{-1}), oil yield (598.10 kg ha^{-1}) and harvest index (45.56%) were found from treatment combination of V_3M_2 where treatment combination of V_4M_1 showed lowest results in most of the cases.

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ABBREVIATIONS AND ACRONYMS

%	=	Percentage
AEZ	=	Agro-Ecological Zone
BBS	=	Bangladesh Bureau of Statistics
BCSRI	=	Bangladesh Council of Scientific Research Institute
Ca	=	Calcium
cm	=	Centimeter
CV %	=	Percent Coefficient of Variation
DAS	=	Days After Sowing
DMRT	=	Duncan's Multiple Range Test
e.g.	=	exempli gratia (L), for example
et al.,	=	And others
etc.	=	Etcetera
FAO	=	Food and Agriculture Organization
g	=	Gram (s)
GM	=	Geometric mean
i.e.	=	id est. (L), that is
K	=	Potassium
Kg	=	Kilogram (s)
L	=	Liter
LSD	=	Least Significant Difference
M.S.	=	Master of Science
m^2	=	Meter squares
mg	=	Milligram
mL	=	Milliliter
NAOH	=	Sodium hydroxide
No.	=	Number
^oC	=	Degree Celsius
P	=	Phosphorus
SAU	=	Sher-e-Bangla Agricultural University
USA	=	United States of America
var.	=	Variety
WHO	=	World Health Organization
μg	=	Microgram

CHAPTER 1

INTRODUCTION

Sesame (*Sesamum indicum* L.), the queen of vegetable oils belonging to family Pedaliaceae is one of the oldest oil-rich plants (Janick and Whipkey, 2002) originated in Africa (Ram *et al*., 1990). Sesame commonly known as Til has been recognized as one of the earliest domesticated edible oilseeds used by the mankind. It grows well in tropical and subtropical areas, while its yield performance is relatively high in temperate climate (Alegbejo *et al*., 2003). Sesame is not only an oil-rich seed (42-45%) but also in protein (20%) and carbohydrates (14-20%). It contains 50-60% oil which has excellent stability due to the presence of the endogenous antioxidants sesamol and sesaminol in combination with tocopherols (Ball *et al*., 2000). Sesame is the second largest source of edible oil in Bangladesh next to mustard both in respect of acreage and production (Anonymous, 1989). It occupies 80,000 ha of land and produces 49,000 tons of sesame (BBS, 2015). However the average yields level of sesame (500-600 kg ha^{-1}) in Bangladesh is quite low (Khaleque and Begume, 1991). The average cultivated yield of the crop might be due to traditional varieties and cultivated with poor management practices. But yield can be improved up to 1000-1200 kg ha^{-1} under best management practices (Ali *et al*., 1997).

The low yields coupled with problems encountered during harvesting sesame have tended to discourage growers, leading to a decline in the total area devoted to its cultivation. In general, the production constraints include poor agronomic practice, pest and disease, weed infestation, poor soil fertility, low yielding cultivars. Yet a major breakthrough could not be made in realizing high yields in sesame varieties. It is a seasonal and location bound crop hence, a particular variety does not perform uniformly in all locations and in all seasons. The yielding ability of sesame crop is determined by many yield components, all of which are

substantially influenced by environmental conditions and agronomic packages. The grain yield of sesame is significantly influenced by cultivars (Hazarika, 1998). Moreover, temperature and variety affected seed yield variation by 69 and 39%, respectively (Sharma, 2005). Varietal difference performed significant variation in seed yield and oil yield (Hamdollah *et al.*, 2009). Awasthi *et al.* (2006) evaluated with 17 genotypes of *Sesamum* and exhibited a wide variation in yield and quality parameters.

Moreover the factors contributing to lower productivity of sesame are lodging, method of planting and fertilizer application; the combined effect of those factors result up to 22% reduction seed and stover yield (Hailu and Seyfu, 2001). The most common way of planting is by broadcasting the sesame seed at the rate of 25-30 kg ha^{-1} (Tareke and Nigusse, 2008). This sowing method results in lodging; which is the main cause for low yield of sesame due to high plant density (Tareke, 2009).

Sowing method had greater influence on sesame yield (Katanga *et al*., 2017). As such, it is necessary to compare the productivity of sesame grown with different sowing methods (Broadcasting, Line sowing, Line sowing on ridges) in the study. So, the study was undertaken with the following objectives:

1. To determine the effect of different sowing methods on yield of sesame
2. To evaluate the performance of varieties of sesame and
3. To find out the best interaction of treatments for higher yield improvement of sesame

CHAPTER 2

REVIEW OF LITERATURE

Sesame is a vital oil crop in Bangladesh which can contribute to a large extent in the national economy. However, the research reports so far published on this crop have been reviewed and some of the reviews related to our topic have been furnished below:

2.1 Performance of sesame varieties

2.1.1 Growth parameters

Patil *et al.* (1990) observed the growth characters of *Sesamum* varieties *viz*., Punjab 1, T85, Phule 1 and revealed significant variation in mean plant height, number of leaves plant^{-1}, LAI and dry matter plant^{-1} between the varieties. *Sesamum* genotype Gouri produced significantly taller plants and more number of branches plant^{-1} as compared to Madhavi (Rao *et al.,* 1990).

Balasubramaniyan *et al.* (1995) observed that *Sesamum* varieties showed significant differences in growth characters; among the two varieties (TMV 3 and VS 350) tested, TMV 3 grew taller and produced more dry matter plant^{-1} but VS 350 produced higher number of branches plant^{-1} as compared to TMV 4.

Moorthy *et al.* (1997) conducted field experiments with *Sesamum* varieties *viz*., Kanak, Kalika, OMT 10, Uma, Usha and Vinayak and found that among six varieties, Kalika registered the maximum plant height and number of branches plant^{-1} as compared to other varieties.

Subba *et al.* (1997) demonstrated that the maximum plant height and number of branches plant^{-1} were recorded in *Sesamum* variety YLM 17 followed by YLM 11 as compared to Gouri and Madhavi.

Tiwari and Namdeo (1997) stated that all the four varieties studied viz., TKG 9,

TKG 21, JLSC 8 and JT 7 differed significantly with each other in vegetative growth characters due to genetic variability. Among the varieties tested, TKG 21 recorded significantly the highest number of branches plant^{-1} whereas JT 7 recorded the maximum plant height and leaf area.

Shanker *et al.* (1999) examined the performance of *Sesamum* varieties *viz*., T_4, T_{12} and T_{78} and found that T_{12} proved better with regard to plant height, number of leaves, dry matter production and number of branches plant'^{1} as compared to T_4 and T_{78}.

Subrahmaniyan and Arulmozhi (1999) considered the response of pre-released *Sesamum* cultivar VS 9104 and ruling variety VRI 1 and found that VS 9104 registered the taller plants, highest number of branches plant^{-1} and largest dry matter production as compared to that of VRI 1.

Subrahmaniyan *et al.* (2001a) witnessed that *Sesamum* culture ORM 17 recorded the maximum plant height (106.60 cm), number of branches plant^{-1} (5.6) and dry matter production (33.2 g plant^{-1}*)* as compared to ORM 7 and ORM 14.

Subrahmaniyan *et al.* (2001b) explored the performance of *Sesamum* varieties viz., TMV 3, TMV 4, TMV 6, VRI 1 and VS 9104 and reported that the variety TMV 6 was the tallest 100.2 cm; however, the prerelease culture VS 9104 recorded significantly the highest values of other growth characters *viz*., number of branches plant^{-1} and dry matter production plant^{-1} as compared to other varieties.

Malam *et al.* (2003) monitored the performance of *Sesamum* varieties viz., RT 54, RT 46 and TC 25 and reported that the variety RT 46 showed the tallest plants (100.8 cm); nonetheless, the variety RT 54 recorded significantly higher number of branches plant^{-1} as compared to RT 46 and TC 25.

Thanunathan *et al.* (2004) observed significant differences in growth characters due to varieties. A newly developed white *Sesamum* variety GT 13 (AT 93) was

compared along with two checks *viz*., G Til 1 and G Til 2 at six locations and found that G Til 3 (white seeded) recorded the largest mean seed yield (average of 28 trials) of 697 kg ha^{-1} as against 582 kg ha^{-1} of G Til 1 and G Til 2 (618 kg ha^{-1}) with a yield improvement of 19.8 percent and 12.8 percent over check variety G Til 1 and G Til 2 respectively.

Valiki *et al*. (2015) carried out a field experiment to investigate the effect of plant density on growth and yield of three cultivar of sesame (*Sesamum indicum* L.). Among the three cultivars of sesame (Naz, Yekta and Oltan); Yekta cultivar was the best cultivar for plant height.

Chongdar *et al*. (2015a) carried out an experiment to study the effect of dates of sowing and improved cultivars on growth and yield of summer sesame in North Bengal. Three improved cultivars of sesame (Rama, Savitri and Tillotama) were used. Among the improved cultivars of sesame, the variety Rama recorded higher plant height, dry matter accumulation, leaf area index and crop growth rate compared to Savitri and Tillotoma.

2.1.2 Yield attributes and yield

Narayan and Narayanan (1987) compared six *Sesamum* genotypes and found that seed yield of TMV 3 was significantly superior to all other genotypes tested. Further, it was also reported that the number of capsules and yield contribution from the main stem were substantial in less branching cultivars *viz*-, Madhavi, NP 6 and T 12 as compared to relatively high branching Gouri and TMV 3.

Bikram *et al.* (1988) disclosed that number of capsules $plant^{-1}$ and harvest indices were consistently influenced by all the cultivars studied and indicated that the average seed yield of the cultivar HT 6 was significantly higher by 18.9 and 49.4 percent than that of the cultivars H 7-1 and AT 3.

Among the 22 tests conducted at research stations in Khandesh and adjoining area

of the Maharashtra state, a new variety JLT gave 769 kg ha^{-1} as against 562 kg ha^{-1} of Phule Til No. 1 and 489 kg ha^{-1} of TC 25 which showed 37 and 57 percent higher yield, respectively (Deokar *et al.*, 1989).

Rao *et al.* (1990) found that variety Gouri produced significantly the highest number of capsules $plant^{-1}$ on main branch as well as secondary branches and more 1000 seed weight as compared to Madhavi that resulted in the highest seed yield during all the three seasons.

Yadav *et al.* (1991) declared that in varietal trials, TKG 2-86 gave the highest yield of 7.8q ha^{-1} and it was 42 percent more than that of local variety TNAU 10 as well as TM V 5 and also suitable for September sowing, but their yield potential in Madhya Pradesh was only 4.5 q ha^{-1}.

Ashok *et al.* (1992) reported that *Sesamum* variety JLT 7 proved significantly superior to Punjab No. 1 for number of capsules $plant^{-1}$ and grain yield.

Chimanshette and Dhoble (1992) indicated that *Sesamum* variety JLT 7 produced significantly the highest seed yield and it was 26 percent higher than that of T 85. Across the two seasons, G-Till-1 and TMV 3 registered yield increase of 22.3 and 17.7 percent over local cultivar G Till-1 through 20.8 and 28.5 percent higher number of capsules $plant^{-1}$ (Itnal *et al*., 1993).

Palaniappan *et al.* (1993) evaluated genotypes (viz., TMV 3, TMV 4, TMV 5, TMV 6, CO 1, VS 117, VS 339 and VS 350) in farmer's fields under different situations and reported that the performance of TMV3 and VS350 was superior to other varieties.

Sarma and Kakati (1993) reported that the seed yield of Vinayak (5.08 q ha^{-1}) and TC 25 (4.89 q ha^{-1}) were significantly superior to C 7 (7.3 q ha^{-1}). Sarma (1994) stated that the seed yield of *Sesamum* varieties Madhavi (7.92 q ha^{-1}) and Gouri (7.78 q ha^{-1}) were significantly superior to TC 25 (4.76 q ha^{-1}).

Parameswar *et al.* (1995) observed that there was a wide range of variability among the entries with regard to the yield, ranging from 420.1 to 738.6 kg ha^{-1}. The entry T_7 consistently recorded the highest seed yield of 738.6 kg ha^{-1} followed by Kalika (590.6 kg ha^{-1}) and Vinayak (571.5 kg ha^{-1}) which were statistically on par with one another but superior to local check (420.1 kg ha^{-1}). The yield increase in variety T_7 was 75.7 percent over local check due to higher number of capsules $plant^{-1}$.

According to Jebaraj and Mohamed (1996), variety SVPR 1 possessed large sized capsules, densely arranged on the main stem and it registered an average seed yield of 1,155 kg ha^{-1} at the cotton Research station Srivilliputhur as compared to 848 and 879 kg ha^{-1} with TMV 3 and TMV 4, respectively.

Tiwari and Namdeo (1997) stated that *Sesamum* genotype TKG 22 gave significantly the highest seed yield (4.97 q ha^{-1}) followed by TKG 67 and check (JT 7/21) except TKG 32. Among seven promising varieties of *Sesamum* studied *viz.*, Type 13, Shekhar, Type 12, HT 37, Type 4, Type 78 and local, Type 78 gave 27.13 percent higher seed yield than that of the most popular local variety (Singh and Chaubey, 1999).

Sesamum varieties RT 54 and RT 46 recorded significantly the highest seed yield which was 54.5 and 11.6 percent higher to varieties TC 25. Significantly more number of capsules $capsule^{-1}$ was observed by Malam *et al.* (2003).

Deshmukh *et al.* (2005) reported that variety RT 54 out yielded all the ten varieties tested and further observed significant differences in yield attributes. Experiments were conducted with nine varieties and concluded that the varieties RT 46, Gowri and CO 1 recorded significantly the highest seed yield and capsule number.

Abou *et al.* (2007) opined that cultivar Shandaweel surpassed Giza 32 in most of the yield parameters. Seed yield of the culture YLM 66 was significantly superior to YLM 17 over seasons. YLM 66 performed well in AICRP trials in initial

varietal evaluation and advanced varietal trial over locations.

Kokilavani *et al.* (2007) evaluated three varieties viz., SVPR 1, TMV 3 and TMV 4 and concluded that white *Sesamum* SVPR 1 gave the highest capsules number plant^{-1} and seed yield.

Suryabala *et al.* (2008) opined that white *Sesamum* cultivar Pragati gave the highest seed yield (24.76 percent) compared to T-78. Olowe (2007) opined that variety Yandev 55 recorded significantly the highest grain yield than E8 by 20 percent. Hamdollah *et al.* (2009) indicated that thousand grain weight of cultivar TS 3 was significantly the lowest among other *Sesamum* cultivars studied, but it produced the highest grains plant^{-1} and grain yield.

Fathy *et al*. (2009) conducted a study to improve the seed yield of sesame (*Sesamum indicum* L.). Four nitrogen rates (0, 100, 150 and 200 kg N/ha) and three diverse sesame cultivars, Saudi Local cv., Egyptian cv. "Shandaweel" and Sudanese cv. "Sudan-1" were as treatments. Saudi Local cv. produced the highest significant seed yield/ha comparing with the other treatments. Shandaweel cv. Occupied the 2nd rank concerning seed yield/ha with 733.37 and 729.89 kg/ha respectively. Sudan-1 cv. produced the lowest seed yield. Oil contents of the three cultivars were 45.37, 45.96 and 45.80%, for Saudi Local cv., Shandaweel cv. and Sudan-1 cv., respectively.

Roy *et al*. (2009) conducted a field experiment to evaluate the effect of row spacing on the yield and yield contributing characters of sesame using the varieties (V_1 = T_6, V_2 = Batiaghata local Til and V_3 = BINA Til) and the row spacing (S_1 = 15 cm, S_2 = 30 cm and S_3 = 45 cm). The highest seed yield was produced by the variety BINA Til while the lowest was by the variety Batiaghata local Til and the highest seed yield was produced by row spacing 30 cm while the lowest was by row spacing 45 cm. Seed yield was well correlated with capsules plant^{-1} and seeds capsule^{-1}.

Ali and Jan (2014) conducted an experiment on the performance of sesame cultivars (*Sesamum indicum* L.) (Local black and local white) with different sowing dates (20th June, 10th and 30th July) and nitrogen levels (0, 40, 80 and 120 kg N ha^{-1}). The cultivar local black had more capsules $plant^{-1}$ (71), seed $capsule^{-1}$ (61), seed yield (696 kg ha^{-1}), stover yield (4297 kg ha^{-1}) and harvest index (14%) as compared to cultivar local white.

Yahaya *et al*. (2014) carried out an experiment to investigate the characteristics and performance of all the accessions entries on seed-oil and yield parameters. Twelve accessions of sesame were used for the experiment. The accessions NG-03, NG-04, NA-01 and BE-02 had the least means with the number of flowers $plant^{-1}$ and number of capsules $plant^{-1}$. This is an indication that these Accessions have good potential for high seed yield.

Valiki *et al*. (2015) carried out a field experiment to investigate the effect of plant density on growth and yield of three cultivar of sesame (*Sesamum indicum* L.). Three cultivars of sesame (Naz, Yekta and Oltan) were assigned with three row spacing (40, 50 and 60 cm). The results showed that cultivar treatments significantly effect on traits such as, the number of capsule per plant, yield per plant, 1000 seed weight, harvest index, seed oil percentage, seed yield, seed protein percentage and protein yield. The results indicated that Yekta cultivar as parameters such as, the number of capsule per plant, the number of seed per capsule, seed yield, oil yield and protein yield was the best cultivar. The highest harvest index and yield per plant observed by Naz cultivar.

Mesera and Mitiku (2015) conducted a field experiment using seven improved Sesame (*Sesamum indicum* L.) varieties (Sesamenamely: E, Tate, Kelafo-74, Mehando-80, T-85, Adi, and Abasena) under irrigation to select the best performing Sesame varieties that will increase productivity and production of Sesame in the target areas. The effect of varieties on seed yield was not significant

and the best performing varieties of Sesame varieties numerically were Mehando-80 (11 qt ha^{-1}), E (10.3 qt ha^{-1}) and T-85 (10 qt ha^{-1}) and would be recommended for the specific community and its vicinity.

Chongdar *et al*. (2015b) carried out an investigation to find the effect of sowing dates and cultivars on yield and economic attributes of summer sesame (*Sesamum indicum* L.) with five different dates of sowing and three cultivars of sesame (Rama, Savitri and Tillotama). Cultivar Rama recorded highest seed yield 17.70 percent and 12.06 percent during 2013 and 2014, respectively followed by Savitri and Tillotama. Rama produced the higher values with respect to number of capsules $plant^{-1}$, number of seeds $capsule^{-1}$ and test weight. Irrespective of cultivars, Rama (V_1) gave significantly higher economic return as compared to Savitri and Tillotama during 2013 and 2014, respectively. Based on the result obtained, it can be concluded that cultivar Rama can be adopted in this region during summer season, because of its highest seed yield ability.

Chongdar *et al*. (2015) carried out an experiment to study the effect of dates of sowing and improved cultivars on growth and yield of summer sesame in North Bengal. Three improved cultivars of sesame (Rama, Savitri and Tillotama) were used. Among the improved cultivars of sesame, the variety Rama exhibited highest seed yield recording 17.70 and 12.06% higher than the cultivars Tillotama and Savitri. Improved cultivar, Rama recorded the highest yield attributing characters compared to the Savitri and Tillotoma.

Jat *et al*. (2017) conducted a field experiment using four levels of sulphur (0, 20, 40 and 60 kg/ha) along with four sesame varieties (RT-125, RT-127, RT-346 and RT-351). Variety RT-351 was found significantly superior among all the varieties with respect to growth and yield determining characters of sesame. It also improved the seed, stalk and biological yield to the extent of 11.7, 10.5 and 10.8 per cent over RT-127 and 26.4, 21.3 and 22.5 per cent over RT-125, respectively.

It also represented significant improvement is nutrient uptake, oil content in seed and oil yield and fetched the maximum net returns of 52073/ha With the highest B: C ratio (2.74) among all the varieties. Application of sulphur at 49.19 kg/ha was found as the optimum dose for sesame as derived from response function.

2.1.3 Quality characters

Tashiro *et al.* (1990) observed that the average oil content found for the white seeded strains was 55.0 percent and for the black seeded strains 47.8 percent with the difference of 7.2 percent; further, they noted that the white and black seed strains also differed significantly in sesamin content, but not in sesamolin content.

Tiwari *et al.* (1994) studied different genotypes *viz.,* CO 1, TKG 9 and TKG 21 and reported that TKG 9 registered the highest oil content of 54.25 percent followed by TKG 21 (53.93 percent) and CO 1 (52.56 percent).

Ansari *et al.* (1995) observed that the oil content was significantly the highest in P253 than Gouri 78 and the difference between varieties regarding oil content might be due to the genetic makeup of the material.

Kandasamy *et al.* (1995) suggested that *Sesamum* cultivar VS 350 contained the highest oil content of 51.0 percent when compared to other varieties *viz.*, TMV 3 and TMV 4.

Jebaraj and Mohammed (1996) reported that SVPR 1 (white *Sesamum*) recorded an average oil content of 52.3 percent which was 2.1 percent higher than that of the existing cultivars TMV 3 and TMV 4.

Ganga *et al.* (1997) reported that Swetha Til (white *Sesamum*) was a promising new variety for Andhra Pradesh state with high oil content (52 percent) as compared to Rajeswari which showed only 50 percent.

Moorthy *et al.* (1997) made a study with six *Sesamum* varieties *viz.,* Kanak, Kalika, OMT 10, Uma, Usha and Vinayak and reported that the highest oil content was recorded in Vinayak followed by Uma and Kalika.

Subba *et al.* (1997) reported that *Sesamum* variety YLM 17 registered the highest oil content of 49.2 percent as compared to other varieties. Tiwari and Namdeo (1997) suggested that all the four varieties *viz.,* TKG 9, TKG 2, JLSC 8 and JT 7 attained variable quantities of seed oil and variety JLSC 8 registered the highest oil content of 57.9 percent as compared to the other varieties.

Mishra (2001) observed that *Sesamum* TKG 55 contained 52.3 percent oil, which was 2.53 percent, 0.28 percent and 5.23 percent higher than that of cultivars TC 25, Krishna / JT 21 and JT 7, respectively.

Awasthi *et al.* (2006) evaluated 17 genotypes of *Sesamum* for various biochemical constituents that exhibited wide variation in quality parameters *viz*., oil (41.91-53.36 percent) protein (10.20-26.59 percent) carbohydrates (10.65-24.17 percent), total sugars (5.01-12.04 percent) crude fiber (2.18-4.83 percent) and ash (4.20-6.88 percent) content. They further stated that the genotypes IVT-10, AVT-01 and IVT-18 showed higher values for oil content, where as genotypes RT-125, LTK 4 and RT-127 were found superior in seed protein content in that order.

Arslan *et al.* (2007) reported that the oil contents of *Sesamum* seeds ranged from 46.4 to 62.7 percent. Abou *et al.* (2007) stated that on comparing between cultivars, Shandawed 3 surpassed Giza 32 in oil content and unsaturated fatty acids percentage.

In Faizabad, T 4 registered the highest protein content (38.91 percent) and oil content (50.15) than that of the variety Shekhar (Suryabala *et al.,* 2008). Uzun *et al.* (2008) observed the variation in oil content of 103 accessions and concluded the oil content of *Sesamum* seeds varied from 41.3 to 62.7 percent.

Significant difference in oil content, protein content, oil yield and protein yield was noticed between varieties (Hamdollah *et al.*, 2009). Nzikou *et al.* (2009) observed that *Sesamum* seeds contained 5 percent moisture, 48.5 percent crude oil, 20 percent crude proteins, 7.78 percent carbohydrate, 9.4 percent crude fiber and 4.2 percent ash.

Yahaya *et al*. (2014) carried out an experiment to investigate the characteristics and performance of all the accessions entries on seed-oil and yield parameters. Twelve accessions of sesame were used for the experiment. The highest seed-oil Content were recorded for NG01 (57%), NG02 (57.5%), KG02 (57%), KD (56.5%) and BE01 (56%). This is an indication that these Accessions have good potential for high Oil content.

2.2 Effect of sowing methods

Katanga *et al*. (2017) conducted an experiment to determine the effect of sowing method, seed rate and variety on the yield and seed quality of sesame (*Sesamum indicum* L). The treatments evaluated consisted of three sowing methods (broadcasting, dibbling and drilling), four seed rate (2.5/ha, 5.0/ha, 7.5/ha and 10.0/ha Kg^{-1}) and two varieties (Ex-Sudan and E8). The result shows that, 1000-seed weight and seed yield was significantly affected by the sowing methods and dibbling method produced heavier seed weight. Crude protein and oil content of the seed were not significantly affected by the sowing method and variety.

Adnan *et al*. (2013) conducted an experiment on the effect of sowing method, variety and seed rate on the growth and phenology of sesame (*Sesamum indicum* L.). The treatments consisted of three sowing methods (Broadcasting, Dibbling and Drilling), two varieties (Ex-Sudan and E8) and four seed rates (2.5, 5.0, 7.5 and 10.0 kg ha^{-1}). Results showed that the different sowing methods had no significant effects on plant height at 4 and 10 weeks after sowing. However, significantly taller plants were recorded with broadcasting method while drilling

and dibbling remained at par with shorter plants. Broadcasting also produced plants with significantly higher number of leaves, branches and capsules. Variety E8 produced plants that are significantly taller, with more leaves and flowers and but produced the lowest yield. Variety Ex-Sudan flowered and matured earlier and also produced higher grain yield than variety E8.

Ehsanullah *et al*. (2007) conducted a field study pertaining to the effect of different planting patterns on the growth and yield of two varieties of sesame (*Sesamum indicum* L.). Two varieties TS-3 and Punjab-89 were sown in planting patterns of 30 cm spaced single rows, 45 cm spaced single rows, 45 cm spaced double-row strips with 15 cm space between the rows and 60 cm spaced double-row strips with 30 cm space between the rows. The results revealed that plantation of sesame 45 cm spaced double-row strips with 15 cm space between rows gave maximum yields of 845 and 865 kg ha^{-1} for TS-3 and Punjab-89, respectively and it was attributed to increase in 1000 seed weight and number of seeds $capsule^{-1}$. Out of two varieties, Punjab-89 produced more number of capsules per plant and 1000 seed weight than TS-3. The number of seeds were, however, high in cv. TS-3 than Punjab-89.

Caliskan *et al*. (2004) studied the effects of planting method (row and broadcast) and plant population (102 000, 127 500, 170 000, 255 000 and 510 000 plants ha^{-1}) on yield and yield components of sesame were under irrigated conditions. Seed yield and yield components of sesame were significantly affected by planting methods. The row planting had positive effects on yield and yield components and produced around 34% higher seed yield comparing to broadcast planting. The population density also significantly affected to all growth and yield parameters. Plant height, branch number, capsule number, capsule length, seed number per capsule, seed weight, seed yield and protein content decreased with the increasing plant population in both years, except for seed yield, harvest index and oil content.

Wakweya and Meleta (2016) conducted an experiment on the effect of sowing method and seed rate on the growth, yield and yield components of faba bean. Two faba bean cultivars (Shallo and Gebelcho), Two sowing methods (Broadcast and row planting) and Five seed rates (125, 150, 175, 200 and 225 kg/ha) were used as treatments. The results revealed that cultivars significantly affected seed and biomass yield, harvest index and 1000 seed weight. Gebelcho cultivar surpasses shallo. Similarly sowing method also significantly affected plant height, pods plant^{-1}, biomass and seed yield. The seed yield gained by row sowing method was 20.2% higher than broadcast sowing method. On the other hand, the interaction effect between cultivars and sowing methods showed it was significantly affected all the tested traits. The interaction between cultivar, sowing method and seed rates were also significantly affected all the tested parameters. Gebelcho in row sowing method at 200 and 225 kg/ha gave the first and the second highest mean seed yield (kg/ha).

Hamid *et al*. (2002) conducted an experiment on the growth and yield of soybean using two factors *viz*., methods of sowing (line sowing and broadcasting) and seed rates (40, 60 80 and 100 kg ha^{-1}). Results revealed that leaf area index (LAI) and shoot dry matter weight were higher in line sowing than broadcasting throughout the entire course of development. Significantly highest number of plant population/plot, branches/plant, filled pods/plant, seed and stover yield were obtained in line sowing method.

Sesame yields are generally very low 300-350 kgha^{-1} (Imoloame *et al*., 2007) when compared to Venezuala (1960 kg/ha) and Saudi Arabia (1083 kg ha^{-1}). Use of inappropriate sowing method is one of the major causes of low sesame yield in the country, for the fact that improved and high yielding cultivars of sesame can give 15-40% more yield than local traditional cultivars when sowed better and adding that most farmers lack access to improved agronomic practices and varieties (Malik *et al*., 2003).

Sowing method had greater influence on sesame yield yet most farmers adopt the popular dibbling method. On the other hand, planting method has a significant effect on resource utilization like water, nitrogen and phosphorus economy, energy savings and soil compaction (Trodson *et al*., 1989). Moreover, absorption of photosynthetically active radiations has also been found to be influenced by planting methods (Lal *et al*., 1991). Row planting method in general has many advantageous in contrast to broadcasting. Since, one of the major constraints of broadcasting method in the field is weed management which requires higher labor, requires higher seed rate and results in lower plant population (Umed *et al*., 2009).

CHAPTER III

MATERIALS AND METHODS

The experiment was conducted during March to June 2017 to study the effect of sowing methods and variety on yield and yield components of sesame. In this chapter the details of different materials used and methodology followed during the experimental period are presented under the following heads:

3.1 Experimental site

The present experiment was conducted in the Agronomy farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, Bangladesh. The location of the experimental site is $23^0 74'$ N latitude and $90^0 35'$ E longitude and at an elevation of 8.2 m from sea level.

3.2 Climate

The experimental area was under the sub-tropical climate characterized by high temperature, high humidity, and heavy rainfall with occasional gusty winds during April - September (kharif season) and less rainfall associated with moderately low temperature during October-March (rabi season). The weather data of the experimental site during the study period have been presented in Appendix I.

3.3 Characteristics of the soil of experimental site

The soil of the experimental area is medium high land having red brown terrace soil, which belongs to the Modhupur Tract under AEZ no. 28 and the Tejgaon soil series. The soil characteristics of the experimental plot are presented in Appendix II.

3.4 Methods

3.4.1 Treatments

Two treatment factors were used in the present experiment to get 12 treatment combinations which were as follows:

Factor A: Variety: Levels: 04

1. V_1 = BARI til 2
2. V_2 = BARI til 3
3. V_3 = BARI til 4
4. V_4 = Lal til (Local)

Factor B: Sowing methods: Levels: 03

1. M_1 = Broadcasting
2. M_2 = Line sowing
3. M_3 = Line sowing on ridges
4. **Treatment combinations:** Twelve treatment combinations are as follows

V_1M_1, V_1M_2, V_1M_3, V_2M_1, V_2M_2, V_2M_3, V_3M_1, V_3M_2, V_3M_3, V_4M_1, V_4M_2 and V_4M_3

3.4.2 Experimental design and layout

The experiment was laid out in a randomized complete block design with three replications. Each block, representing a replication, was divided into 12 unit plots where the 12 treatment combinations were allocated at random. The total number of unit plots was 36. The size of each unit plot was 2.25 m × 2 m. The distance maintained between the unit plots and blocks were 0.50 m and 1.0 m, respectively. Layout of the experimental field is presented in Appendix III.

3.5 Collection of seeds

Healthy seeds of BARI til 2, BARI til 3 and BARI til 4 were collected from BARI (Bangladesh Agricultural Research Institute), Joydevpur, Gazipur and Lal til (Local) was collected from local market of Kushtia district.

3.6 Germination test

Germination test was performed before sowing the seeds in the field. For laboratory test, petridishes were used. Filter paper was placed on petridishes and the papers were soaked with water. Seeds were distributed at random in

petridishes. Data on emergence were calculated expressed as percentage by using the following formula:

$$\text{Germination (\%)} = \frac{\text{Number of germinated seeds}}{\text{Number of seeds set for germination}} \times 100$$

3.7 Land preparation

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

3.8 Fertilizer application

Manures and fertilizers that were applied to the experimental plot presented in Table1. Total amount of TSP, M_0P, Gypsum, Zinc sulphate, Boric acid and half of Urea were applied as basal dose at the time of land preparation. The rest amount of Urea was applied at 25 days after seed sowing before flowering.

Table1. Dose and method of application of fertilizers in sesame field

Name of manure and fertilizer	Doses	Methods of application
Cow dung	5 t ha^{-1}	Total as basal
Urea	120 kg ha^{-1}	Half as basal and half as top dressing
TSP	140 kg ha^{-1}	Total as basal
M_0P	45 kg ha^{-1}	Total as basal
Gypsum	110 kg ha^{-1}	Total as basal
$ZnSO_4$	3 kg ha^{-1}	Total as basal
Boric acid	10 kg ha^{-1}	Total as basal

Source: BARI, 2016

3.9 Sowing of seeds

Seeds were sown on the 19th March, 2017 according to the treatment of sowing methods as stated before. In line sowing, seeds were sown continuous in line, broadcasted in broadcasting method and also lined in ridges for line sown ridge method. 20 DAS, thinning was done maintaining plant to plant distance and row to row distance of approximately 5 and 30 cm respectively but in broadcast spacing was not exact. All methods applied for seed sowing according to the treatments, immediately after sowing seeds were covered with soil to protect moisture for good germination of seeds.

3.10 Intercultural operations

The following intercultural operations were done for ensuring the normal growth of the experimental crop:

3.10.1 Irrigation

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

3.10.2 Thinning

Thinning was done carefully for better growth of plants approximately 5 cm spacing and it was done manually after 20 days of sowing, on April 8, 2017.

3.10.3 Gap Filling

Dead, injured and week seedlings were replaced by healthy one from the stock kept on the border lines of the experimental plot. Those seedlings were transplanted with a mass of soil with undisturbed roots to minimize transplanting shock at 20 DAS.

3.10.4 Weeding

Weeding was done twice at 10 and 25 days after seed sowing followed by irrigation.

3.10.5 Plant Protection

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

3.11 Harvesting and post harvest processing

The crop was harvested at 21st June, 2017 when the leaves, stems, and pods of sesame became yellowish in color. One squire meter area from each of the plots was harvested for recording the yield data. The harvested plants were tied into bundles and carried to the threshing floor. The crops were sun dried by spreading on the threshing floor. The seeds were separated from the pods by beating with bamboo sticks and later were cleaned, dried and weighed. The weights of the dry stover were also recorded.

3.12 Sampling

The sampling was done first at 40 DAS and it was continued at an interval of 15 days till harvest. At each sampling, five plants were selected randomly from each plot. The selected plants of each plot were uprooted carefully by a Khurpi and washed in a running tape water to remove the soil. The samples were oven dried at 60^{o}C for 72 hours to record constant dry weights.

3.13 Recording of data

The data on the following parameters of five plants were recorded at each harvest.

3.13.1 Growth parameters

1. Plant height (cm)
2. Number of branches plant^{-1}
3. Dry weight plant^{-1} (g)
4. Days to 1st flowering

3.13.2 Yield contributing parameters

1. Number of capsules plant^{-1}
2. Number of seeds capsule^{-1}
3. Seed weight plant^{-1} (g)
4. 1000 seed weight (g)

3.13.3 Yield parameters

1. Seed yield ha^{-1} (kg)
2. Stover yield ha^{-1} (kg)
3. Oil yield ha^{-1} (kg)
4. Harvest index (%)

3.14 Procedure of recording data at harvest

Randomly selected 5 plants, at harvest, were used to collect data or the parameter chosen.

The procedure of recording data at harvest is given below:

3.14.1 Plant height (cm)

The plant height was measured from the ground level to the tip of the individual plant. Mean value of five selected plants was calculated for each unit plot and expressed in centimeter (cm).

3.14.2 Number of branches plant^{-1}

Number of branches per plant was counted and the data were recorded from randomly selected 5 plants and the calculated mean value was recorded.

3.14.3 Dry weight plant^{-1} (g)

For measuring the dry matter weight plant^{-1}, the parts of the plants were separated and then dried in oven at 60 – 70^{0}C for 72 hours and weights were taken carefully. The sum of the plant parts constituted the total dry matter of a single plant.

3.14.4 Number of capsule plant^{-1}

Number of total capsule of pre-selected plants from each unit plot was noted and the mean number was recorded.

3.14.5 Number of seeds capsule^{-1}

The number of seeds was counted from randomly taking ten capsules from each sample of each plot and recorded as per treatment.

3.14.6 Seed weight plant^{-1} (g)

Seed weight of five plants from each plot was noted and the average weight was expressed per plant basis.

3.14.7 1000 seed weight (g)

One thousand cleaned and dried seeds were counted randomly from each of the harvested samples and weighed by using a digital electric balance and the mean weight was expressed in gram.

3.14.8 Seed yield ha^{-1} (kg)

Mature capsules were harvested from each plot and seeds were separated from capsule and weight was recorded. The seed yield per m^2 was finally recorded kg and expressed in ton per hectare (ton ha^{-1}).

3.14.9 Stover yield ha^{-1} (kg)

After separating seeds, the stover per plant was weighted in kilogram. The obtained weight was converted in ton ha^{-1}.

3.14.10 Oil yield ha^{-1} (kg)

Oil yield was calculated by multiplying the oil content with seed yield as follows –

$$\text{Oil yield (kg ha}^{-1}) = \frac{\text{Oil \\% } \times \text{ Seed yield (kg ha}^{-1})}{100}$$

3.14.11 Harvest Index (%)

It denotes the ratio of grain yield to biological yield and is expressed in

percentage. The following formula was used to calculate harvest index:

$$(\%)\ \text{Harvest index} = \frac{\text{Grain yield}}{\text{Biological yield}} \times 100$$

Biological yield (kg) = Seed yield (kg) + Stover yield (kg)

3.15 Oil extraction

Modern laboratory methods normally employed in the analysis of oils usually includes soxhlet extraction usually using n-hexane and the enzymatic extraction. Extraction of crude sesame oil by the use of a soxhlet extractor with n –hexane solvent was reported by Mohammed and Hamza (2008). Extraction of sesame oil from sesame seeds using supercritical CO_2 was carried out by Doker *et al*. (2010).

3.16 Statistical analysis

The data recorded on different parameters were tabulated as per block laid out in the experimental field. The analyses of variance were done following randomized complete block design (RCBD) with the help of a computer package program MSTAT-C. The mean differences among the treatments of a parameter were adjudged by Duncan's Multiple Range Test (Gomez and Gomez, 1984).

CHAPTER IV

RESULTS AND DISCUSSION

The results obtained from the study have been presented, discussed and compared in this chapter through different tables, figures and appendices. The possible interpretation has also been given under the following headings:

4.1 Growth parameters

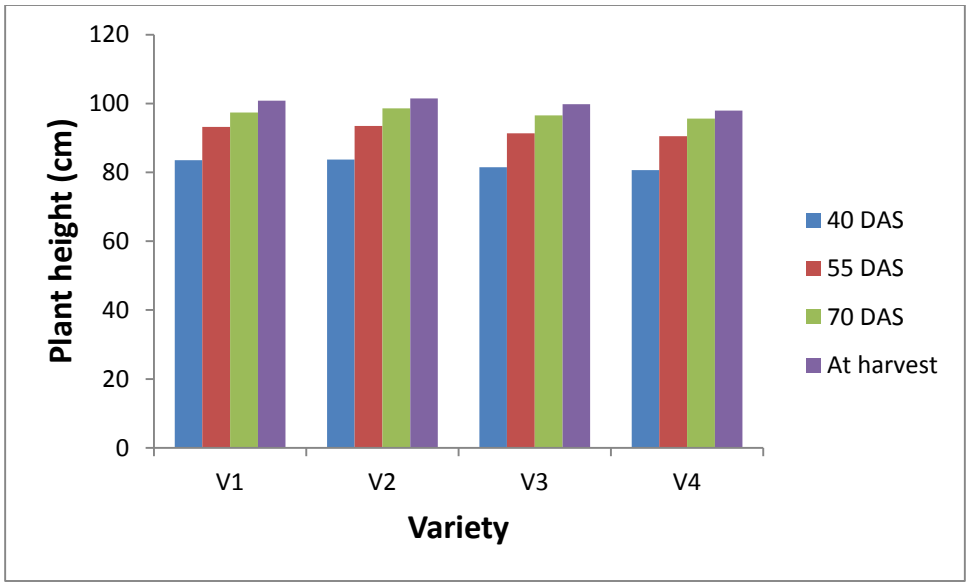
4.1.1 Plant height (cm)

Effect of variety

Plant height was significantly influenced by different variety at different growth stages of sesame (Fig. 1 and Appendix IV). Results indicated the tallest plant (83.70, 93.47, 98.59 and 101.42 cm at 40, 55, 70 DAS and at harvest, respectively) with the variety, V_2 (BARI til 3) which was statistically similar with V_1 (BARI til 2). The smallest plant (80.61, 90.51, 95.60 and 97.90 at 40, 55, 70 DAS and at harvest, respectively) was found from the variety, V_4 (Lal til; local) followed by the variety V_3 (BARI til 4). Tiwari and Namdeo (1997), Subrahmaniyan *et al.* (2001a), Valiki *et al*. (2015) and Chongdar *et al*. (2015a) also observed similar results and found that plant height of sesame differed significantly due to varieties.

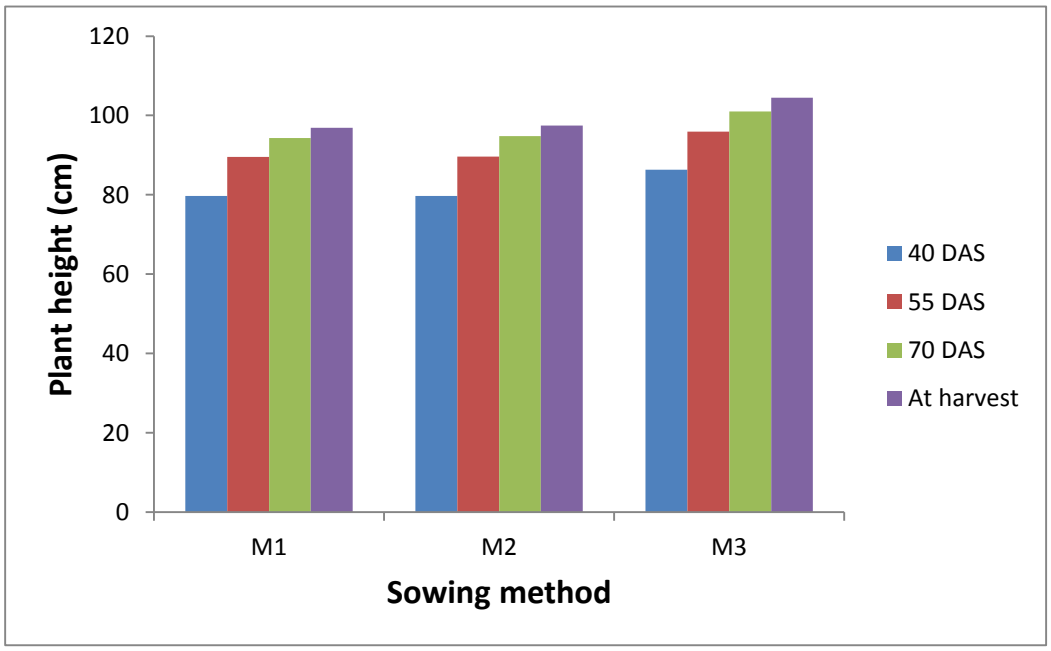
Effect of sowing methods

Sowing methods had significant effect on plant height at different growth stages of sesame (Fig. 2 and Appendix IV). Results exposed that the tallest plant (86.32, 95.95, 101.03 and 104.48 at 40, 55, 70 DAS and at harvest, respectively) was obtained from M_3 where the smallest plant (79.68, 89.59, 94.32 and 96.89 at 40, 55, 70 DAS and at harvest, respectively) was found from M_1 which was statistically similar with M_2 **(**Line sowing). Similar results were also found by Adnan *et al*. (2013) and Caliskan *et al*. (2004) and they found that plant height differed significantly by sowing methods due to variation in population density.



V_1 = BARI til 2, V_2 = BARI til 3, V_3 = BARI til 4, V_4 = Lal til (Local)

Fig. 1. Influence on plant height of sesame affected by different varieties



M_1 = Broadcasting, M_2 = Line sowing, M_3 = Line sowing on ridges

Fig. 2. Influence on plant height of sesame affected by sowing methods

Combined effect of variety and sowing method

Significant variation was observed on plant height influenced by combined effect of variety and sowing methods (Table 2 and Appendix IV). Results revealed that the tallest plant (89.21, 98.90, 104.10 and 108.10 at 40, 55, 70 DAS and at harvest, respectively) was achieved from the treatment combination of V_2M_3 followed by V_1M_1. Again, the shortest plant (73.37, 83.43, 88.65 and 89.91 at 40, 55, 70 DAS and at harvest, respectively) was obtained from the treatment combination of V_4M_1 which was statistically similar with V_2M_2 at harvest.

Table 2. Influence on plant height of sesame as affected by combined effect of different varieties and sowing methods

Treatment combination	Plant height (cm) at			
	40 DAS	**55 DAS**	**70 DAS**	**At harvest**
V_1M_1	88.54 a	97.60 a	100.20 b	105.10 b
V_1M_2	78.63 ef	88.63 e	93.47 de	98.35 e
V_1M_3	83.45 bc	93.34 bc	98.45 b	100.80 de
V_2M_1	79.49 de	89.68 de	94.81 cd	99.35 e
V_2M_2	75.83 fg	85.39 f	90.71 ef	91.91 f
V_2M_3	89.21 a	98.90 a	104.10 a	108.10 a
V_3M_1	84.12 bc	93.90 bc	98.80 b	100.90 de
V_3M_2	81.75 cd	91.91 cd	97.21 bc	99.36 e
V_3M_3	85.22 b	94.61 bc	99.77 b	102.10 cd
V_4M_1	73.37 g	83.43 f	88.65 f	89.91 f
V_4M_2	83.03 bc	93.12 bc	98.27 b	99.89 de
V_4M_3	85.42 b	94.97 b	99.89 b	103.90 bc
$LSD_{(0.05)}$	**2.836**	**2.589**	**2.822**	**2.421**
CV (%)	**9.74**	**11.25**	**10.51**	**13.27**

V_1 = BARI til 2, V_2 = BARI til 3, V_3 = BARI til 4, V_4 = Lal til (Local)
M_1 = Broadcasting, M_2 = Line sowing, M_3 = Line sowing on ridges

4.1.2 Number of branches plant^{-1}

Effect of variety

Number of branches/plant was significantly influenced by different variety at different growth stages of sesame (Fig. 3 and Appendix V). The highest number of

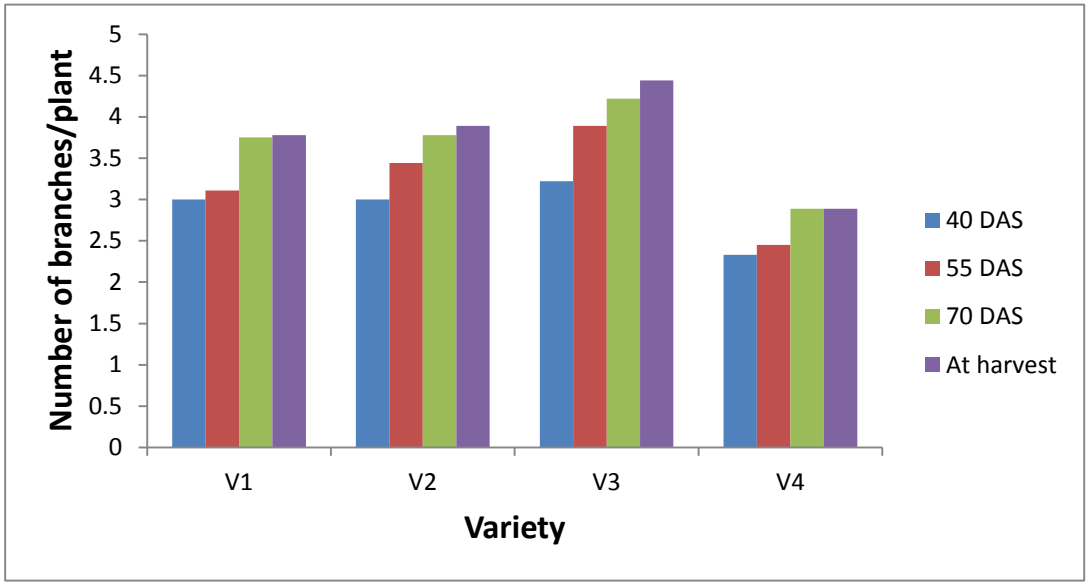
branches plant^{-1} (3.22, 3.89, 4.22 and 4.44 at 40, 55, 70 DAS and at harvest, respectively) was obtained from V_3 which was significantly different from V_2 and V_4 where the V_4 showed lowest number of branches plant^{-1} (2.33, 2.45, 2.89 and 2.89 at 40, 55, 70 DAS and at harvest, respectively). Similar results were also observed by Patil *et al.* (1990), Malam *et al.* (2003) and Adnan *et al*. (2013).

Effect of sowing methods

Sowing methods had also significant effect on number of branches/plant at different growth stages of sesame (Fig. 4 and Appendix V). Results indicated the highest number of branches plant^{-1} (3.17, 3.50, 4.00 and 4.05 at 40, 55, 70 DAS and at harvest, respectively) from the sowing method of M_2 where the lowest number of branches plant^{-1} (2.45, 2.67, 3.11 and 3.11 at 40, 55, 70 DAS and at harvest, respectively) was found from the sowing method, M_1 which was significantly different from M_3. Adnan *et al*. (2013) also found similar results with the present study. Hamid *et al*. (2002) also found, highest number of branches/plant in line sowing method.

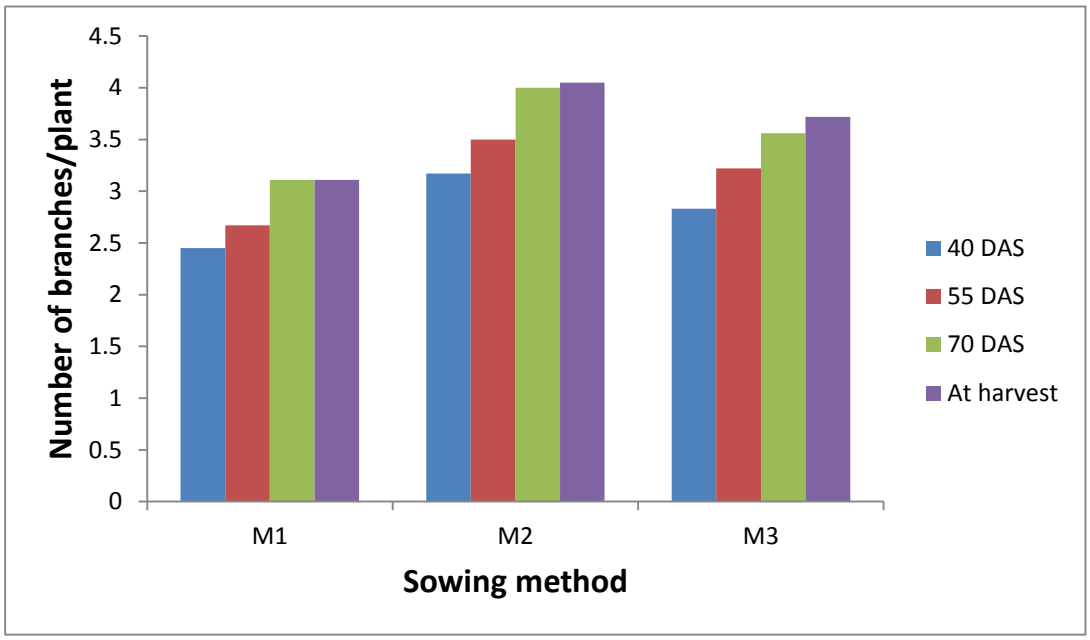
Combined effect of variety and sowing method

Significant variation was observed on number of branches plant^{-1} influenced by combined effect of variety and sowing method at different growth stages of sesame (Table 3 and Appendix V). It was observed that the highest number of branches plant^{-1} (3.67, 4.33, 5.00 and 5.33 at 40, 55, 70 DAS and at harvest, respectively) was obtained from the treatment combination of V_3M_2 followed by V_3M_3 which was significantly different from all other treatment combinations. Significantly the lowest number of branches plant^{-1} (2.00, 2.00, 2.67 and 2.67 at 40, 55, 70 DAS and at harvest, respectively) was observed from the treatment combination of V_4M_1 followed by V_4M_2 and V_4M_3.



V_1 = BARI til 2, V_2 = BARI til 3, V_3 = BARI til 4, V_4 = Lal til (Local)

Fig. 3. Influence on number of branches plant^{-1} of sesame affected by different varieties



M_1 = Broadcasting, M_2 = Line sowing, M_3 = Line sowing on ridges

Fig. 4. Influence on number of branches plant^{-1} of sesame affected by sowing methods

Table 3. Influence on number of branches plant^{-1} of sesame affected by combined effect of different varieties and sowing methods

Treatment combination	Number of branches plant^{-1} at			
	40 DAS	**55 DAS**	**70 DAS**	**At harvest**
V_1M_1	2.67 d	2.67 e	3.33 d	3.33 f
V_1M_2	3.33 b	3.33 c	4.33 b	4.33 c
V_1M_3	3.00 c	3.33 c	3.67 c	3.67 e
V_2M_1	2.67 d	3.00 d	3.33 d	3.33 f
V_2M_2	3.33 b	4.00 b	4.33 b	4.33 c
V_2M_3	3.00 c	3.33 c	3.67 c	4.00 d
V_3M_1	2.67 d	3.33 c	3.33 d	3.33 f
V_3M_2	3.67 a	4.33 a	5.00 a	5.33 a
V_3M_3	3.33 b	4.00 b	4.33 b	4.67 b
V_4M_1	2.00 f	2.00 f	2.67 f	2.67 h
V_4M_2	2.67 d	2.67 e	3.00 e	3.00 g
V_4M_3	2.33 e	2.67 e	3.00 e	3.00 g
$LSD_{(0.05)}$	**0.186**	**0.214**	**0.204**	**0.227**
CV (%)	**4.32**	**6.22**	**5.22**	**3.72**

V_1 = BARI til 2, V_2 = BARI til 3, V_3 = BARI til 4, V_4 = Lal til (Local)
M_1 = Broadcasting, M_2 = Line sowing, M_3 = Line sowing on ridges

4.1.3 Dry weight plant^{-1}(g)

Effect of variety

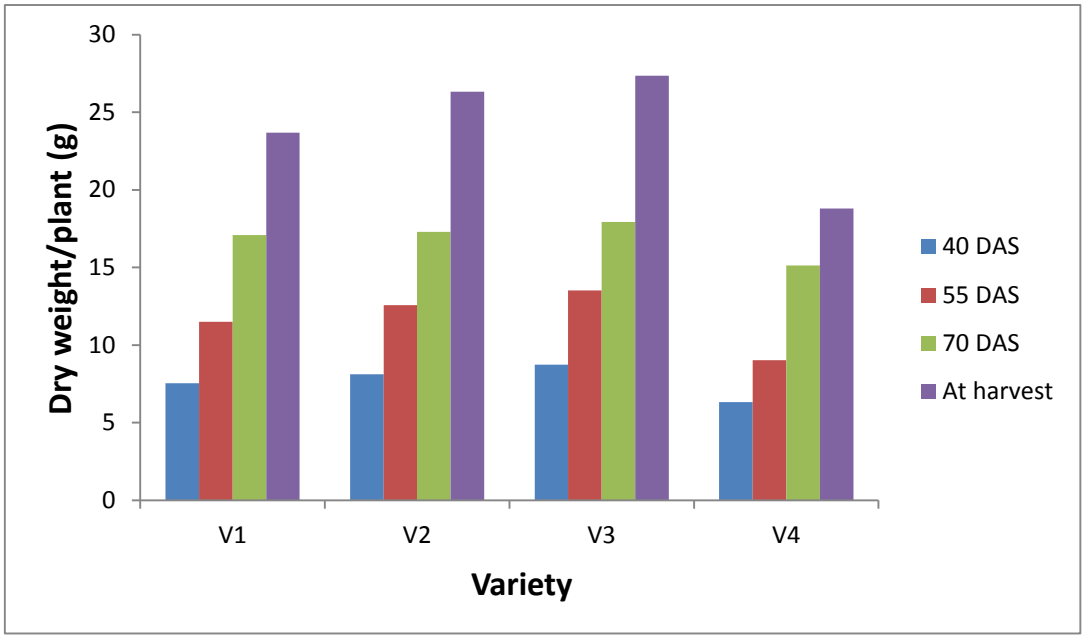
Dry weight plant^{-1} of sesame as influenced by different variety was significant at different growth stages (Fig. 5 and Appendix VI). It was examined that the highest dry weight plant^{-1} (8.73, 13.52, 17.93 and 27.35 g at 40, 55, 70 DAS and at harvest, respectively) was obtained from the variety, V_3 followed by V_2 where the lowest dry weight plant^{-1} (6.33, 9.03, 15.13 and 18.80 g at 40, 55, 70 DAS and at harvest, respectively) was found from the variety, V_4 compared to all other tested varieties. Balasubramaniyan *et al.* (1995), Shanker *et al.* (1999), Subrahmaniyan *et al.* (2001a) and Chongdar *et al*. (2015b) also found signification variation on dry weight plant^{-1} affected by different varieties which was similar with the present investigation.

Effect of sowing methods

At different crop duration, sowing methods exhibited significant influence on dry weight plant^{-1}(g) (Fig. 6 and Appendix VI). Results exposed that the highest dry weight plant^{-1} (8.43, 13.02, 17.40 and 26.33 g at 40, 55, 70 DAS and at harvest, respectively) was achieved from the sowing method, M_2 where the lowest dry weight plant^{-1} (6.65, 10.12, 15.74 and 21.24 g at 40, 55, 70 DAS and at harvest, respectively) was found from M_1 and M_3 gave intermediate results. Hamid *et al*. (2002) also obtained similar results with the present study and they also found that shoot dry matter weight were higher in line sowing than broadcasting throughout the entire course of development.

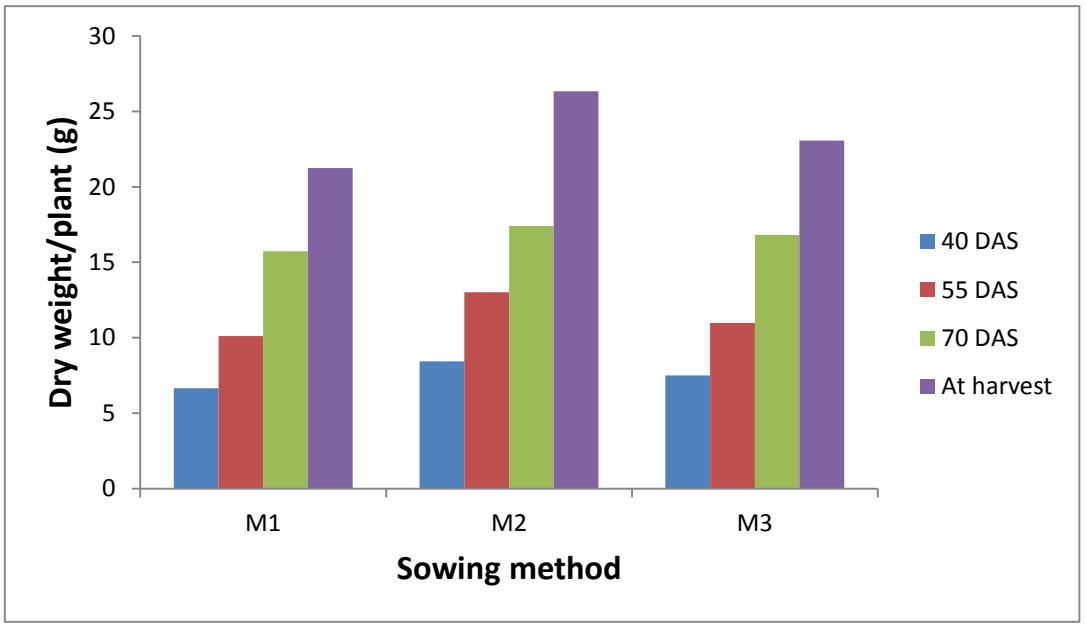
Combined effect of variety and sowing method

Dry weight plant^{-1} (g) of sesame was found significant due to different treatment combination of variety and sowing method (Table 4 and Appendix VI). The highest dry weight plant^{-1} (9.84, 15.46, 19.15 and 30.36 g at 40, 55, 70 DAS and at harvest, respectively) was obtained from treatment combination of V_3M_2 which was statistically identical with V_2M_2 followed by V_1M_2 and V_3M_3. The lowest dry weight plant^{-1} (5.86, 8.81, 13.62 and 16.96 g at 40, 55, 70 DAS and at harvest, respectively) was obtained from treatment combination of V_4M_1 which was significantly different from all other treatment combinations during the crop duration.



V_1 = BARI til 2, V_2 = BARI til 3, V_3 = BARI til 4, V_4 = Lal til (Local)

Fig. 5. Influence on dry weight plant^{-1} of sesame affected by different varieties



M_1 = Broadcasting, M_2 = Line sowing, M_3 = Line sowing on ridges

Fig. 6. Influence on dry weight plant^{-1} of sesame affected by sowing methods

Table 4. Influence on dry weight plant^{-1} (g) of sesame affected by combined effect of different varieties and sowing methods

Treatment combination	Dry weight plant^{-1} (g)			
	40 DAS	**55 DAS**	**70 DAS**	**At harvest**
V_1M_1	6.65 e	9.65 f	16.61 d	21.43 d
V_1M_2	8.72 b	13.71 b	17.66 bc	26.07 b
V_1M_3	7.23 c-e	11.11 c-e	16.96 cd	23.53 c
V_2M_1	7.01 de	11.03 de	16.92 d	23.25 c
V_2M_2	9.39 ab	15.04 ab	17.88 b	29.89 a
V_2M_3	7.96 c	11.67 c	17.11 cd	25.85 b
V_3M_1	7.52 cd	11.36 cd	16.72 d	25.57 b
V_3M_2	9.84 a	15.46 a	19.15 a	30.36 a
V_3M_3	8.83 b	13.73 b	17.92 b	26.11 b
V_4M_1	5.86 f	8.81 g	13.62 g	16.96 f
V_4M_2	6.63 e	9.42 f	15.91 ef	20.89 d
V_4M_3	6.51 ef	8.85 g	15.87 ef	18.54 e
$LSD_{(0.05)}$	**0.712**	**0.557**	**0.6290**	**1.019**
CV (%)	**5.83**	**7.23**	**9.14**	**10.26**

V_1 = BARI til 2, V_2 = BARI til 3, V_3 = BARI til 4, V_4 = Lal til (Local)

M_1 = Broadcasting, M_2 = Line sowing, M_3 = Line sowing on ridges

4.1.4 Days to 1st flowering

Effect of variety

Significant variation was found for days to 1st flowering of sesame due to different varieties (Fig. 7 and Appendix VII). It was found that the highest days to 1st flowering (42.56) was obtained from the variety, V_2 which was significantly different from the variety, V_1 and V_3 where V_4 showed significantly lowest days to 1st flowering (41.11). Significant influence was observed on flowering habit of sesame by Yahaya *et al*. (2014) and Adnan *et al*. (2013).

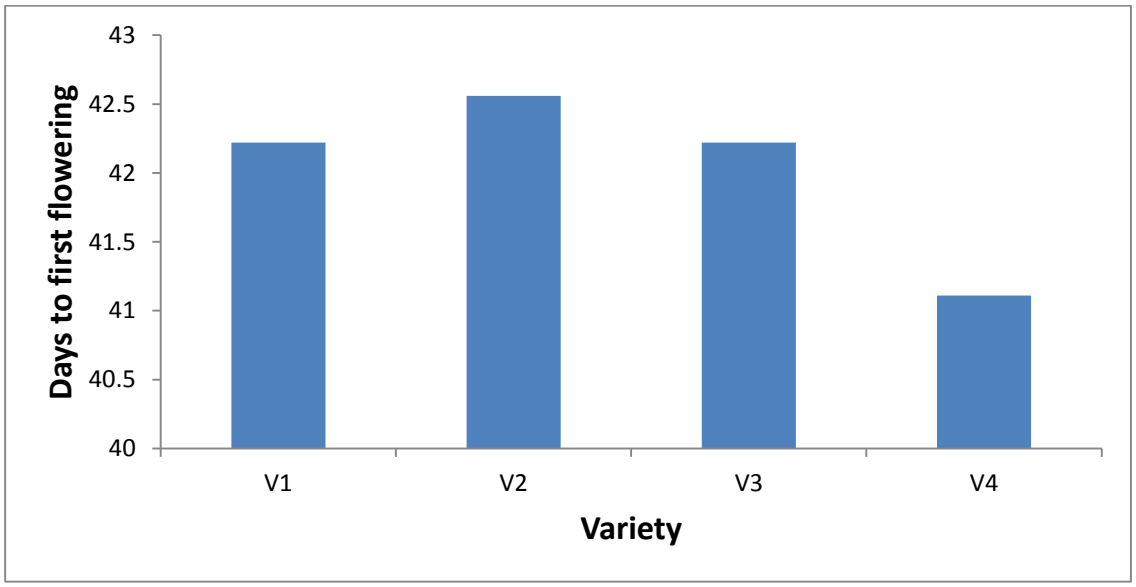
Effect of sowing methods

Days to 1st flowering of sesame affected by sowing methods were significant (Fig. 8 and Appendix VII). Results revealed that the highest days to 1st flowering (42.28) was observed from the sowing method, M_3 which was statistically similar

with M_2 where the lowest days to 1st flowering (41.45) were found from the sowing method, M_1. Similar effect was also observed by Adnan *et al*. (2013).

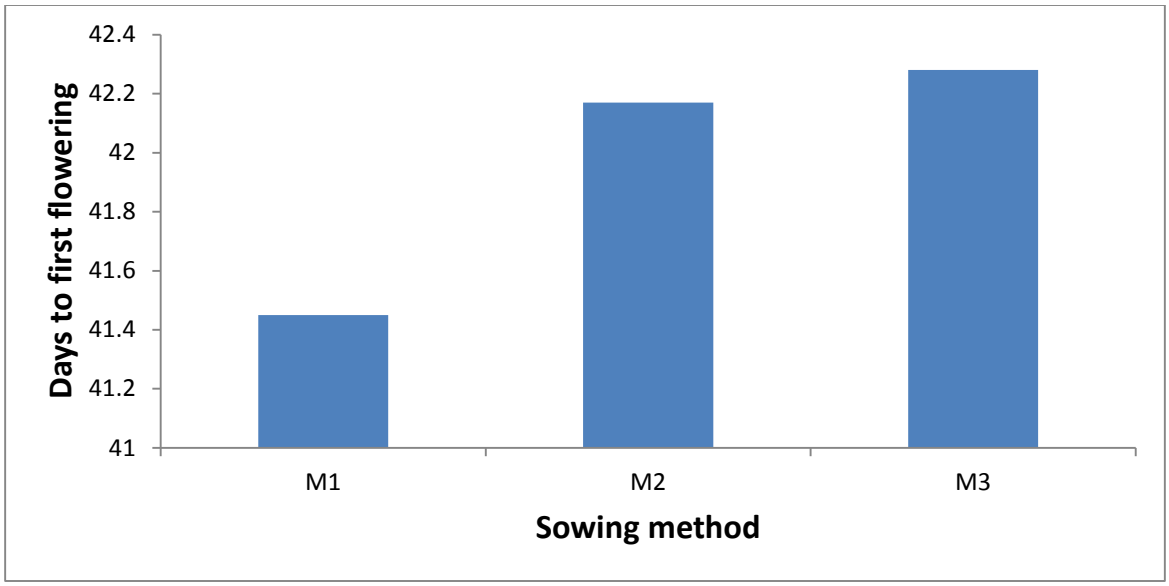
Combined effect of variety and sowing method

Treatment combination of variety and sowing method showed significant variation on days to 1st flowering of sesame (Fig. 9 and Appendix VII). The highest days required for 1st flowering (43.00) from treatment combination of V_2M_3 which was statistically similar with V_1M_2, V_2M_2, V_3M_1 and V_3M_2. Significant by the lowest days to 1st flowering (40.00) was obtained from treatment combination of V_4M_1 which was significantly different from all other treatment combinations.



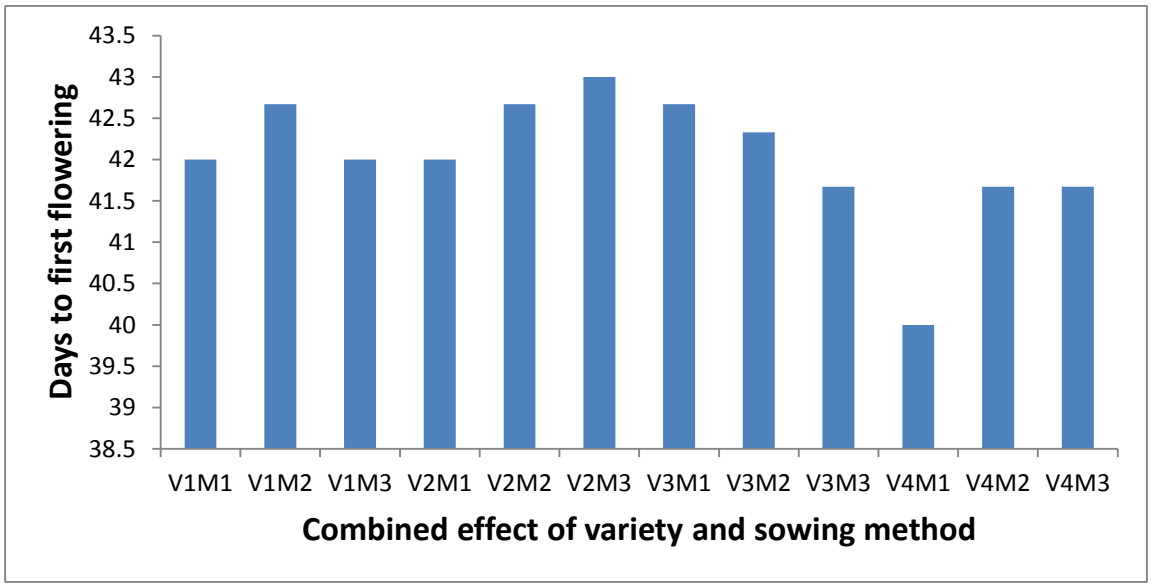
V_1 = BARI til 2, V_2 = BARI til 3, V_3 = BARI til 4, V_4 = Lal til (Local)

Fig. 7. Influence on days to 1st flowering of sesame affected by different varieties



M_1 = Broadcasting, M_2 = Line sowing, M_3 = Line sowing on ridges

Fig. 8. Influence on days to 1st flowering of sesame affected by sowing methods



V_1 = BARI til 2, V_2 = BARI til 3, V_3 = BARI til 4, V_4 = Lal til (Local)

M_1 = Broadcasting, M_2 = Line sowing, M_3 = Line sowing on ridges

Fig. 9. Influence on days to 1st flowering of sesame affected by combination of different varieties and sowing methods

4.2 Yield contributing parameters

4.2.1 Number of capsules plant^{-1}

Effect of variety

Number of capsules plant^{-1} was significantly influenced by different variety of sesame (Table 5 and Appendix VII). Results showed that the variety, V_3 gave the highest number of capsules plant^{-1} (47.89) which was significantly different from V_1, V_2 and V_4 where V_4 gave significantly lowest number of capsules plant^{-1} (39.00). The findings on number of capsules plant^{-1} by Ashok *et al.* (1992), Deshmukh *et al.* (2005), Roy *et al*. (2009) and Ali and Jan (2014) affect by different varieties of sesame was similar with the present study.

Effect of sowing methods

Number of capsules plant^{-1} was significantly influenced by sowing methods (Table 5 and Appendix VII). Results exposed that the highest number of capsules plant^{-1} (42.94) was obtained from the sowing method, M_2, M_1 showed lowest number of capsules plant^{-1} (32.78). The M_3 gave intermediate result on number of capsules plant^{-1}. The results obtained from the present investigation was similar with the findings of Hamid *et al*. (2002) and Wakweya and Meleta (2016) and they observed that significantly highest number of pods/plant were obtained in line sowing method than broadcast method. Similar result was also obtained from the findings of Adnan *et al*. (2013) and Caliskan *et al*. (2004).

Combined effect of variety and sowing method

Significant variation was observed on number of capsules plant^{-1} influenced by combined effect of variety and sowing method (Table 5 and Appendix VII). It was examined that the treatment combination of V_3M_2 gave highest number of capsules plant^{-1} (56.33) followed by V_2M_2 and V_3M_3. The lowest number of

capsules plant^{-1} (24.00) was obtained from treatment combination of V_4M_1 which was statistically similar with V_4M_3.

4.2.2 Number of seeds capsule^{-1}

Effect of variety

Number of seeds capsule^{-1} was significant due to different varieties of sesame (Table 5 and Appendix VII). The highest number of seeds capsule^{-1} (62.34) was obtained from the variety, V_3 which was significantly different from V_1 and V_2 where significantly lowest number of seeds capsule^{-1} (44.89) was found from the variety, V_4. Ali and Jan (2014) and Valiki *et al*. (2015) also found variety had significant influence on number of seeds capsule^{-1} of sesame.

Effect of sowing methods

Number of seeds capsule^{-1} influenced by sowing methods of sesame was significant (Table 5 and Appendix VII). The highest number of seeds capsule^{-1} (56.39) was obtained from the sowing method, M_2 which was significantly different from M_1 and M_3 sowing method, M_1 showed significantly lowest number of seeds capsule^{-1} (48.94). Similar result was also obtained by Ehsanullah *et al*. (2007) and Caliskan *et al*. (2004). Number of seeds capsule^{-1} was significantly influenced by sowing methods.

Combined effect of variety and sowing method

Number of seeds capsule^{-1} of sesame at harvest was found Significant due to different treatment combination of variety and sowing methods (Table 5 and Appendix VII). Results exhibited that the highest number of seeds capsule^{-1} (67.67) was obtained from the treatment combination of V_3M_2 which was statistically similar with V_3M_3 followed by V_2M_2 and V_1M_2. The lowest number of seeds capsule^{-1} (42.33) was obtained from treatment combination of V_4M_1 followed by V_4M_1 and V_4M_3.

4.2.3 Seed weight plant^{-1} (g)

Effect of variety

Significant variation was observed on seed weight plant^{-1} of sesame influenced by different variety (Table 5 and Appendix VII). Results revealed that the highest seed weight plant^{-1} (8.10 g) was obtained from the variety, V_3 which was significantly different from V_1 and V_2 where significantly lowest seed weight plant^{-1} (2.74 g) was found from the variety, V_4 (Lal til; local). The results obtained from the present study on seed weight plant^{-1} were supported by the findings of Hamdollah *et al.* (2009) and Valiki *et al*. (2015).

Effect of sowing methods

Sowing methods showed significant influence regarding seed weight plant^{-1} (Table 5 and Appendix VII). The highest seed weight plant^{-1} (6.47 g) was obtained from the sowing method, M_2 which was significantly different from M_3 where sowing method, M_1 **(**Broadcasting) gave significantly lowest seed weight plant^{-1} (3.89 g). Sowing methods also significantly affected per plant seed weight found by Wakweya and Meleta (2016) which was similar with the present study.

Combined effect of variety and sowing method

Combined effect of variety and sowing method exposed significant variation on seed weight plant^{-1} (Table 5 and Appendix VII). The highest seed weight plant^{-1} (10.5 g) was obtained from treatment combination of V_3M_2 followed by V_3M_3 where the lowest seed weight plant^{-1} (2.13 g) was obtained from treatment combination of V_4M_1 which was statistically similar with V_4M_3.

4.2.4 1000 seed weight (g)

Effect of variety

Significant variation was found for 1000 seed weight affected by different variety (Table 5 and Appendix VII). Results demonstrated that the highest 1000 seed weight (2.64 g) was obtained from the variety, V_3 followed by V_1 and V_2 where the lowest 1000 seed weight (2.23 g) was found from the variety, V_4. Rao *et al.* (1990) and Valiki *et al*. (2015) also found that cultivar treatments significantly effect on 1000 seed weight.

Effect of sowing methods

Data obtained on 1000 seed weight affected by sowing methods was significant (Table 5 and Appendix VII). It was examined that the highest 1000 seed weight (2.55 g) was obtained from the sowing method, M_2 which was statistically similar with M_3 where the lowest 1000 seed weight (2.34 g) was found from the sowing method, M_1. Similar results were also found by Katanga *et al*. (2017) and Ehsanullah *et al*. (2007) and they also observed that 1000-seed weight was significantly affected by the sowing methods.

Combined effect of variety and sowing method

Combined effect of variety and sowing method designated significant variation on 1000 seed weight of sesame (Table 5 and Appendix VII). Results showed that the highest 1000 seed weight (2.75 g) was obtained from treatment combination of V_3M_2 followed by V_3M_3. The lowest 1000 seed weight (2.09 g) was obtained from treatment combination of V_4M_1 which was immediately less than V_4M_3.

Table 5. Influence on yield contributing parameters of sesame affected by different varieties and sowing methods

Treatments	Yield contributing parameters			
	Number of capsules plant^{-1}	**Number of seeds capsule^{-1}**	**Seed weight plant^{-1} (g)**	**1000 seed weight (g)**
Effect of variety				
V_1	39.00 c	55.00 b	5.42 c	2.50 b
V_2	42.67 b	55.67 b	6.14 b	2.57 b
V_3	47.89 a	62.34 a	8.10 a	2.64 a
V_4	27.11 d	44.89 c	2.74 d	2.23 c
$LSD_{(0.05)}$	**1.751**	**2.349**	**0.874**	**0.012**
CV (%)	**10.26**	**11.42**	**6.23**	**3.51**
Effect of sowing methods				
M_1	32.78 c	48.94 c	3.89 c	2.34 b
M_2	42.94 a	56.39 a	6.47 a	2.55 a
M_3	37.50 b	53.89 b	5.28 b	2.48 a
$LSD_{(0.05)}$	**2.661**	**2.342**	**0.738**	**0.103**
CV (%)	**10.26**	**11.42**	**6.23**	**3.51**
Combined effect of variety and sowing method				
V_1M_1	35.00 f	51.67 e	4.27 g	2.36 f
V_1M_2	43.33 c	58.00 bc	6.54 d	2.60 c
V_1M_3	38.67 de	55.33 d	5.44 ef	2.54 de
V_2M_1	37.67 ef	52.33 e	4.91 fg	2.49 e
V_2M_2	48.67 b	58.67 b	7.50 c	2.63 c
V_2M_3	41.67 cd	56.00 cd	6.01 de	2.58 cd
V_3M_1	38.33 def	52.67 e	5.03 f	2.49 e
V_3M_2	56.33 a	67.67 a	10.50 a	2.75 a
V_3M_3	49.00 b	66.67 a	8.79 b	2.69 b
V_4M_1	24.00 h	42.33 g	2.13 i	2.09 h
V_4M_2	30.33 g	47.67 f	3.39 h	2.34 f
V_4M_3	27.00 gh	44.67 g	2.71 hi	2.25 g
$LSD_{(0.05)}$	**3.361**	**2.500**	**0.694**	**0.054**
CV (%)	**10.26**	**11.42**	**6.23**	**3.51**

V_1 = BARI til 2, V_2 = BARI til 3, V_3 = BARI til 4, V_4 = Lal til (Local)

M_1 = Broadcasting, M_2 = Line sowing, M_3 = Line sowing on ridges

4.3 Yield parameters

4.3.1 Seed yield (kg ha^{-1})

Effect of variety

Significant difference was recorded for different variety on seed yield of sesame (Table 6 and Appendix VIII). Results exhibited that the highest seed yield (1265.00 kg ha^{-1}) was obtained from the variety, V_3 followed by the variety, V_2 where the lowest seed yield (697.30 kg ha^{-1}) was found from the variety, V_4 which was significantly different from V_1, V_2 and V_3. The highest yield with this variety, under the present study was obtained might be due to cause of higher number of pods per plant, seeds per pod and 1000-seed weight. Similar influence on seed yield by different varieties was found by Yahaya *et al*. (2014), Ali and Jan (2014), Valiki *et al*. (2015) and Chongdar *et al*. (2015a).

Effect of sowing methods

Seed yield of sesame was significantly affected by sowing methods (Table 6 and Appendix VIII). The highest seed yield (1103.70 kg ha^{-1}) was obtained from the sowing method, M_2 which was significantly different from M_1 and M_3. The lowest seed yield (925.50 kg ha^{-1}) was found from the sowing method, M_1. Line sowing method gave the highest yield under the present study, might be attributed to higher number of pods per plant, seeds per pod and 1000-seed weight with this practice. Katanga *et al*. (2017), Wakweya and Meleta (2016), Caliskan *et al*. (2004) and Hamid *et al*. (2002) also found that seed yield was significantly affected by the sowing methods.

Combined effect of variety and sowing method

Significant difference was also recorded for the combined effect of variety and sowing method in terms of seed yield of sesame (Table 6 and Appendix VIII). It was found that the highest seed yield (1368.00 kg ha^{-1}) was obtained from treatment combination of V_3M_2 which was significantly different from all other

treatment combinations. The second highest seed yield (1310.00 kg ha^{-1}) was achieved from the treatment combination of V_3M_3 but significantly different from others. The lowest seed yield (597.00 kg ha^{-1}) was obtained from treatment combination of V_4M_1 which was immediate lower than the from treatment combination of V_4M_3 (701.30 kg ha^{-1}) which was also significantly different from all other treatment combinations.

4.3.2 Stover yield (kg ha^{-1})

Effect of variety

Different variety had significant variation on stover yield of sesame (Table 6 and Appendix VIII). The highest stover yield (1601.33 kg ha^{-1}) was obtained from the variety, V_3 followed by V_2 where the lowest stover yield (1143.00 kg ha^{-1}) was found from the variety, V_4. Rao *et al.* (1990), Ashok *et al.* (1992) and Deshmukh *et al.* (2005) also found similar results with the present study.

Effect of sowing methods

Significant variation was observed due to sowing method for stover yield of sesame (Table 6 and Appendix VIII). Significantly the highest stover yield (1460.67 kg ha^{-1}) was obtained from the sowing method, M_2 which was significantly different from M_1 and M_3 where the lowest stover yield (1363.17 kg ha^{-1}) was found from the sowing method, M_1. Sowing methods significantly affected biomass yield obtained by Wakweya and Meleta (2016) that supported the present findings on stover yield.

Combined effect of variety and sowing method

Combined effect of variety and sowing method demonstrated significant influence on stover yield of sesame (Table 6 and Appendix VIII). Results showed that the highest stover yield (1635.00 kg ha^{-1}) was obtained from the treatment

combination of V_3M_2 which was statistically similar with the treatment combination of V_3M_3 but significantly different from all other treatment combinations. The lowest stover yield (1053.00 kg ha^{-1}) was obtained from the treatment combination of V_4M_1 followed by V_4M_3 and V_4M_2.

4.3.3 Oil yield (kg ha^{-1})

Effect of variety

Different variety had significant variation on oil yield of sesame (Table 6 and Appendix VIII). Significantly the highest oil yield (550.80 kg ha^{-1}) was obtained from the variety, V_3 compared to V_1, V_2 and V_4. The lowest oil yield (302.19 kg ha^{-1}) was found from the variety, V_4. Similar result was also observed by Yahaya *et al*. (2014), Fathy *et al*. (2009) and Hamdollah *et al.*, 2009).

Effect of sowing methods

Significant variation was observed due to sowing methods for oil yield of sesame (Table 6 and Appendix VIII). It was observed that the highest oil yield (480.32 kg ha^{-1}) was obtained from the sowing method, M_2 followed by M_3 where the lowest oil yield (397.78 kg ha^{-1}) was obtained from the sowing method, M_1. Caliskan *et al*. (2004) found that oil content of the seed were not significantly affected by the sowing method but oil yield varied significantly by sowing method.

Combined effect of variety and sowing method

Combined effect of variety and sowing method registered significant variation on oil yield of sesame (Table 6 and Appendix VIII). Result exhibited that the highest oil yield (598.10 kg ha^{-1}) was obtained from treatment combination of V_3M_2 followed by V_3M_3. The lowest oil yield (256.20 kg ha^{-1}) was obtained from treatment combination of V_4M_1 which was immediate after V_4M_3 but significantly different from all other treatment combinations.

4.3.4 Harvest Index (%)

Effect of variety

Harvest index was significantly varied due to different variety of sesame (Table 6 and Appendix VIII). Significantly the highest harvest index (44.06%) was obtained from the variety, V_3 followed by V_1 and V_2 where the lowest harvest index (37.74%) was found from the variety, V_4. Abou *et al.* (2007), Ali and Jan (2014) and Valiki *et al*. (2015) also found significant influence on harvest index due to different varieties.

Effect of sowing methods

Significant variation was found on harvest index influenced by sowing methods of sesame (Table 6 and Appendix VIII). The highest harvest index (42.67%) was obtained from the sowing method, M_2 and next to M_3 regarding harvest index where the lowest (39.91%) was found from the sowing method, M_1 **(**Broadcasting).

Combined effect of variety and sowing method

Combined effect of variety and sowing method recorded significant influence on harvest index of sesame (Table 6 and Appendix VIII). The highest harvest index (45.56%) was obtained from treatment combination of V_3M_2 followed by V_2M_2 and V_3M_3. The lowest harvest index (36.14%) was obtained from treatment combination of V_4M_1 which was significantly different from all other treatment combinations.

Table 6. Influence on yield parameters of sesame affected by different varieties and sowing methods

Treatments	Yield parameters			
	Seed yield (kg ha^{-1})	**Stover yield (kg ha^{-1})**	**Oil yield (kg ha^{-1})**	**Harvest index (%)**
Effect of variety				
V_1	1130.00 c	1538.33 c	490.41 c	42.32 b
V_2	1169.33 b	1553.33 b	504.09 b	42.92 b
V_3	1265.00 a	1601.33 a	550.80 a	44.06 a
V_4	697.30 d	1143.00 d	302.19 d	37.74 c
$LSD_{(0.05)}$	**7.669**	**8.933**	**10.841**	**1.129**
CV (%)	**13.29**	**15.27**	**10.51**	**7.54**
Effect of sowing methods				
M_1	925.50 c	1363.17 c	397.78 c	39.91 c
M_2	1103.70 a	1460.67 a	480.32 a	42.67 a
M_3	1034.93 b	1442.33 b	448.78 b	41.28 b
$LSD_{(0.05)}$	**7.415**	**7.334**	**10.693**	**1.021**
CV (%)	**13.29**	**15.27**	**10.51**	**7.54**
Combined effect of variety and sowing method				
V_1M_1	1060.00 i	1496.00 f	455.30 h	41.46 e
V_1M_2	1193.00 d	1571.00 bc	519.00 d	43.16 c
V_1M_3	1137.00 f	1548.00 d	496.90 e	42.34 cd
V_2M_1	1091.00 h	1518.00 e	468.20 g	41.83 de
V_2M_2	1237.00 c	1576.00 b	536.70 c	43.97 b
V_2M_3	1180.00 e	1566.00 c	507.30 e	42.97 c
V_3M_1	1117.00 g	1541.00 d	482.50 f	42.03 de
V_3M_2	1368.00 a	1635.00 a	598.10 a	45.56 a
V_3M_3	1310.00 b	1628.00 a	571.00 b	44.59 b
V_4M_1	597.00 l	1053.00 i	256.20 k	36.14 h
V_4M_2	793.60 j	1203.00 g	345.70 i	39.68 f
V_4M_3	701.30 k	1173.00 h	304.70 j	37.41 g
$LSD_{(0.05)}$	**6.662**	**7.557**	**11.41**	**0.803**
CV (%)	**13.29**	**15.27**	**10.51**	**7.54**

V_1 = BARI til 2, V_2 = BARI til 3, V_3 = BARI til 4, V_4 = Lal til (Local)

M_1 = Broadcasting, M_2 = Line sowing, M_3 = Line sowing on ridges

CHAPTER V

SUMMARY AND CONCLUSION

The present study was conducted at the Agronomy farm of Sher-e-Bangla Agricultural University, Dhaka during March to June 2017 to investigate the effect of sowing methods and variety on yield and yield components of sesame. The experiment comprised of two factors; (1) Varieties *viz*. (i) V_1 (BARI til 2), (ii) V_2 (BARI til 3), (iii) V_3 (BARI til 4) and (iv) V_4 (Lal til; local) and (2) Sowing methods *viz*. (i) M_1 **(**Broadcasting**)**, (ii) M_2 **(**Line sowing**)** and (iii) M_3 **(**Line sowing on ridges). The experiment was conducted in a Randomized Complete Block Design (RCBD) with 3 replications. Data on different growth, yield and yield parameters were recorded and analyzed statistically.

Results showed that varieties and sowing methods and their interactions had significant effect on growth, yield attributes and yield parameters of sesame. The highest plant height (83.70, 93.47, 98.59 and 101.42 cm at 40, 55, 70 DAS and at harvest, respectively) was obtained from V_2 where the highest number of branches plant^{-1} (3.22, 3.89, 4.22 and 4.44 at 40, 55, 70 DAS and at harvest, respectively) and dry weight plant^{-1} (8.73, 13.52, 17.93 and 27.35 g at 40, 55, 70 DAS and at harvest, respectively) were found from the variety, V_3. Considering yield attributes and yield parameters, the highest days required for 1st flowering (42.56) were with the variety, V_2 where the highest number of capsule plant^{-1} (47.89), number of seeds capsule^{-1} (62.34), seed weight plant^{-1} (8.10 g), 1000 seed weight (2.64 g), seed yield (1265.00 kg ha^{-1}), stover yield (1601.33 kg ha^{-1}), oil yield (550.80 kg ha^{-1}) and harvest index (44.06%) were achieved from the variety, V_3. The lowest plant height (80.61, 90.51, 95.60 and 97.90 at 40, 55, 70 DAS and at harvest, respectively), number of branches plant^{-1} (2.33, 2.45, 2.89 and 2.89 at 40, 55, 70 DAS and at harvest, respectively) and dry weight plant^{-1} (6.33, 9.03, 15.13 and 18.80 g at 40, 55, 70 DAS and at harvest, respectively) were found from the

variety, V_4. Again, the variety, V_4 also showed lowest days to 1st flowering (41.11), number of capsule plant^{-1} (39.00), number of seeds capsule^{-1} (44.89), seed weight plant^{-1} (2.74 g), 1000 seed weight (2.23 g), seed yield (697.30 kg ha^{-1}), stover yield (1143.00 kg ha^{-1}), oil yield (302.19 kg ha^{-1}) and harvest index (37.74%).

In terms of sowing methods, the highest plant height (86.32, 95.95, 101.03 and 104.48 at 40, 55, 70 DAS and at harvest, respectively) was obtained from M_3 where the highest number of branches plant^{-1} (3.17, 3.50, 4.00 and 4.05 at 40, 55, 70 DAS and at harvest, respectively) and dry weight plant^{-1} (8.43, 13.02, 17.40 and 26.33 g at 40, 55, 70 DAS and at harvest, respectively) were found from the M_2. Considering yield attributes and yield parameters, sowing method of M_3 showed highest days to 1st flowering (42.28) where the highest number of capsules plant^{-1} (42.94), number of seeds capsule^{-1} (56.39), seed weight plant^{-1} (6.47 g), 1000 seed weight (2.55 g), seed yield (1103.70 kg ha^{-1}), stover yield (1460.67 kg ha^{-1}), oil yield (480.32 kg ha^{-1}) and harvest index (42.67%) were achieved from the sowing method, M_2. In case of growth parameters, the lowest plant height (79.68, 89.59, 94.32 and 96.89 at 40, 55, 70 DAS and at harvest, respectively), number of branches plant^{-1} (2.45, 2.67, 3.11 and 3.11 at 40, 55, 70 DAS and at harvest, respectively) and dry weight plant^{-1} (6.65, 10.12, 15.74 and 21.24 g at 40, 55, 70 DAS and at harvest, respectively) were found from the sowing method, M_1. Regarding yield attributes and yield, the lowest days to 1st flowering (41.45), number of capsules plant^{-1} (32.78), number of seeds capsule^{-1} (48.94), seed weight plant^{-1} (3.89 g), 1000-seed weight (2.34 g), seed yield (925.50 kg ha^{-1}), stover yield (1363.17 kg ha^{-1}), oil yield (397.78 kg ha^{-1}) and harvest index (39.91%) were also found from the sowing method, M_1.

In case of interaction of variety with sowing method, regarding growth parameters, the highest plant height (89.21, 98.90, 104.10 and 108.10 at 40, 55, 70 DAS and at harvest, respectively) was obtained from treatment combination of

V_2M_3 where the highest number of branches plant^{-1} (3.67, 4.33, 5.00 and 5.33 at 40, 55, 70 DAS and at harvest, respectively) and dry weight plant^{-1} (9.84, 15.46, 19.15 and 30.36 g at 40, 55, 70 DAS and at harvest, respectively) were achieved from the treatment combination of V_3M_2. In terms of yield attributes and yield, the highest days to 1st flowering (43.00) was obtained from treatment combination of V_2M_3 whereas the highest number of capsules plant^{-1} (56.33), number of seeds capsule^{-1} (67.67), seed weight plant^{-1} (10.5 g), 1000-seed weight (2.75 g), seed yield (1368.00 kg ha^{-1}), stover yield (1635.00 kg ha^{-1}), oil yield (598.10 kg ha^{-1}) and harvest index (45.56%) were also found from treatment combination of V_3M_2. The lowest plant height (73.37, 83.43, 88.65 and 89.91 at 40, 55, 70 DAS and at harvest, respectively), number of branches plant^{-1} (2.00, 2.00, 2.67 and 2.67 at 40, 55, 70 DAS and at harvest, respectively), dry weight plant^{-1} (5.86, 8.81, 13.62 and 16.96 g at 40, 55, 70 DAS and at harvest, respectively), days to 1st flowering (40.00), number of capsules plant^{-1} (24.00), number of seeds capsule^{-1} (42.33), seed weight plant^{-1} (2.13 g), 1000 seed weight (2.09 g), seed yield (597.00 kg ha^{-1}), stover yield (1053.00 kg ha^{-1}), oil yield (256.20 kg ha^{-1}) and harvest index (36.14%) were found from treatment combination of V_4M_1.

However, it might be concluded that variety and sowing method of sesame are very much indicative for higher sesame yield. However, based on the experimental results, following inference could be made -

1. Variety had magnificent effect on growth, yield attributes and yields in sesame.
2. BARI til 4 performed best regarding growth and yield parameters over BARI til 2, BARI til 3 and Lal til (local).
3. Higher yield potentiality observed in Line sowing plots compare to Broadcasting and Line sowing on ridges plots.
4. BARI til 4 combined with Line sowing practice was found as the best treatment combination towards higher yield attributes and yield of sesame.

However, to reach a specific conclusion and recommendation, more research work on growing sesame can be conducted using different varieties and cultivation practices with proper agronomic application over different AEZ of Bangladesh.

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APPENDICES

Appendix I: Monthly records of air temperature, relative humidity, rainfall and sunshine hours during the period from March to June, 2017

Month	RH (%)	Air temperature (C)			Rainfall (mm)
		Max.	Min.	Mean	
March	52.44	35.20	21.00	28.10	0
April	65.40	34.70	24.60	29.65	165
May	68.30	32.64	23.85	28.25	182
June	71.28	27.40	23.44	25.42	190

Source: Bangladesh Meteorological Department (Climate division), Agargaon, Dhaka-1212.

Appendix II: Characteristics of experimental soil analyzed at Soil Resources Development Institute (SRDI), Farmgate, Dhaka.

A. Morphological characteristics of the experimental field

Morphological features	Characteristics
Location	Agronomy Farm, SAU, Dhaka
AEZ	Modhupur Tract (28)
General Soil Type	Shallow red brown terrace soil
Land type	High land
Soil series	Tejgaon
Topography	Fairly leveled
Flood level	Above flood level
Drainage	Well drained
Cropping pattern	Not Applicable

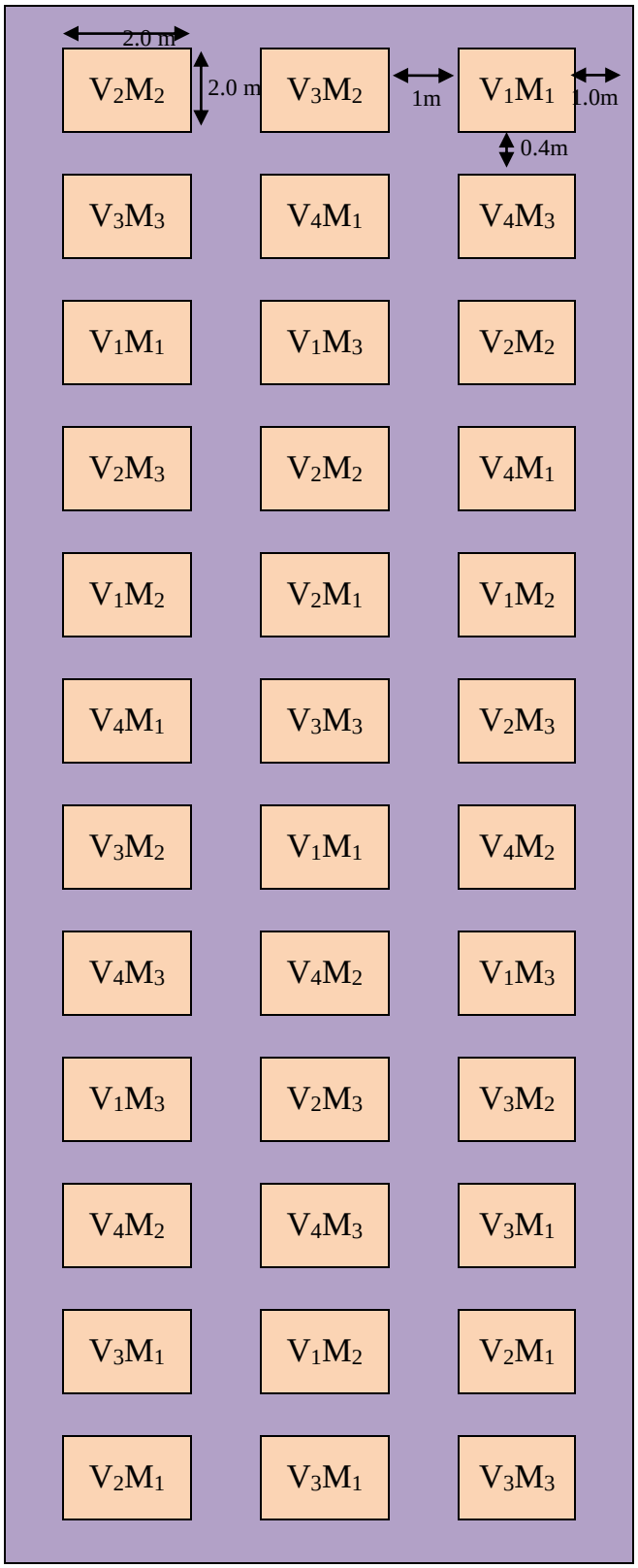
Source: Soil Resource Development Institute (SRDI)

B. Physical and chemical properties of the initial soil

Characteristics	Value
Partical size analysis % Sand	27
%Silt	43
% Clay	30
Textural class	Silty Clay Loam (ISSS)
pH	5.6
Organic carbon (%)	0.45
Organic matter (%)	0.78
Total N (%)	0.03
Available P (ppm)	20
Exchangeable K (me/100 g soil)	0.1
Available S (ppm)	45

Source: Soil Resource Development Institute (SRDI)

Appendix III: Layout of the experiment field



Appendix IV: Influence on plant height of sesame affected by different varieties and sowing methods

Sources of variation	Degrees of freedom	Mean square values of plant height			
		40 DAS	55 DAS	70 DAS	At harvest
Replication	2	0.298	1.799	1.966	1.539
Factor A	3	1.144*	5.781*	12.87*	23.23*
Factor B	2	3.236*	16.68*	33.48*	63.15*
AB	**6**	**0.747****	**8.778***	**7.690***	**13.99***
Error	**22**	**2.017**	**3.338**	**5.777**	**8.045**

Appendix V: Influence on number of branches plant^{-1} of sesame affected by different varieties and sowing methods

Sources of variation	Degrees of freedom	Mean square values of number of branches plant^{-1}			
		40 DAS	55 DAS	70 DAS	At harvest
Replication	2	0.028	0.694	0.528	0.333
Factor A	3	1.111**	2.028*	0.481**	1.296*
Factor B	2	0.528*	1.778*	2.028*	1.083*
AB	**6**	**0.528***	**1.333***	**0.954****	**1.269***
Error	**22**	**0.452**	**0.240**	**0.316**	**0.303**

Appendix VI: Influence on dry weight plant^{-1} of sesame affected by different varieties and sowing methods

Sources of variation	Degrees of freedom	Mean square values of dry weight plant^{-1}			
		40 DAS	55 DAS	70 DAS	At harvest
Replication	2	0.934	0.734	1.056	1.647
Factor A	3	3.665**	5.669*	8.752*	12.77*
Factor B	2	11.41*	15.55*	16.68*	25.37*
AB	**6**	**3.171****	**5.838***	**7.623***	**11.55***
Error	**22**	**2.777**	**3.627**	**3.638**	**4.262**

Appendix VII: Influence on yield contributing parameters of sesame affected by different varieties and sowing methods

Sources of variation	Degrees of freedom	Mean square values of				
		Days to 1st flowering	Number of capsule plant^{-1}	Number of seeds capsule^{-1}	Seed weight plant^{-1}	1000 seed weight
Replication	2	1.58	1.336	2.361	0.114	0.668
Factor A	3	1.22*	11.15*	37.58*	1.324*	0.007**
Factor B	2	0.25**	16.58*	68.86*	3.417*	0.142*
AB	**6**	**0.58***	**12.51***	**28.97***	**0.526****	**0.149****
Error	**22**	**0.644**	**4.939**	**6.179**	**0.124**	**0.164**

Appendix VIII: Influence on yield parameters of sesame affected by different varieties and sowing methods

Sources of variation	Degrees of freedom	Mean square values of			
		Seed yield ha^{-1}	Stover yield ha^{-1}	Oil yield ha^{-1}	Harvest index
Replication	2	13.782	23.753	6.251	0.295
Factor A	3	350.27*	405.90*	198.36*	69.29*
Factor B	2	249.79*	295.17*	137.04*	22.34*
AB	**6**	**171.48***	**143.03***	**96.532***	**0.960***
Error	**22**	**15.480**	**19.918**	**9.227**	**0.925**