EFFECT OF SOWING DATES ON THE YIELD CONTRIBUTING CHARACTERS AND YIELD OF MUSTARD (*Brassica campestris*)

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DECEMBER, 2014

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REG. NO. : 06-02068

A Thesis
Submitted to the Faculty of Agriculture
Sher-e-Bangla Agricultural University, Dhaka
in partial fulfillment of the requirements
for the degree
of

MASTER OF SCIENCE (MS)
IN
AGRICULTURAL BOTANY

SEMESTER: JULY-DECEMBER, 2014

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CERTIFICATE

This is to certify that the thesis entitled **'Effect of Sowing Dates on the Yield Contributing Characters and Yield of Mustard (*Brassica campestris*)'** submitted to the Department of Agricultural Botany, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **Master of Science in Agricultural Botany,** embodies the results of a piece of bonafide research work carried out by **Mahmuda Akter,** Registration No. **06-02068** 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 been duly acknowledged.

Dated:
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ACKNOWLEDGEMENTS

All praises are due to the Allah, the supreme ruler of the universe who enables the author to complete this present piece of work. The author deems it a great pleasure to express her profound gratefulness to her respected parents, who entiled much hardship inspiring for prosecuting her studies, receiving proper education.

The author feels proud to express her heartiest sence of gratitude, sincere appreciation and immense indebtedness to her supervisor Dr. Kamal Uddin Ahamed, Professor, Department of Agricultural Botany, Sher-e-Bangla Agricultural University (SAU), Dhaka, for his continuous scholastic and intellectual guidance, cooperation, constructive criticism and suggestions in carrying out the research work and preparation of thesis, without his intense co-operation this work would not have been possible.

The author feels proud to express her deepest respect, sincere appreciation and immense indebtedness to her co-supervisor Dr. Md. Moinul Haque, Professor Department of Agricultural Botany, SAU, Dhaka, for his scholastic and continuous guidance, constructive criticism and valuable suggestions during the entire period of course and research work and preparation of this thesis.

The author expresses his sincere gratitude towards the sincerity of the Chairman, Dr. Md. Ashabul Hoque, Associate Professor, Department of Agricultural Botany, SAU, Dhaka for his valuable suggestions and cooperation during the study period. The author also expresses her heartfelt thanks to all the teachers of the Department of Agricultural Botany, SAU, for their valuable teaching, suggestions and encouragement during the period of the study.

The author expresses her sincere appreciation to her colleages, relatives, well wishers and friends for their inspiration, help and encouragement throughout the study.

The Author

EFFECT OF SOWING DATES ON THE YIELD CONTRIBUTING CHARACTERS AND YIELD OF MUSTARD (*Brassica campestris*)

ABSTRACT

The experiment was conducted in the experimental field of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka during the period from November, 2013 to February, 2014 to find out the effect of sowing dates on the yield contributing characters and yield of mustard. The experiment comprised of two factors- Factors A: Sowing date (3 times)- S_1: Sowing at 13 November, 2013, S_2: Sowing at 20 November, 2013, S_3: Sowing at 27 November, 2013, Factor B: Mustard varieties (5 mustard varieties)- V_1: SAU Sarisha-14, V_2: SAU Sarisha-15, V_3: SAU Sarisha-16,V_4: SAU Sarisha-18 and V_5: BARI Sarisha-15. The two factors experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. Data on different yield contributing characters and yield were recorded and significant variation was recorded for different treatments. For different sowing dates, at 30, 40, 50, 60 DAS and at harvest, the tallest plant (33.39, 54.89, 71.88, 88.83 and 93.07 cm) was recorded from S_2, while the shortest plant (29.46, 50.45, 67.75, 83.79 and 88.30 cm) from S_3. The highest number of siliqua per plant was found from S_2 (89.27), whereas the lowest number from S_3 (80.47). The longest siliqua was observed from S_2 (5.07 cm), while the shortest siliqua from S_3 (3.91 cm). The highest seed yield was recorded from S_2 (1.70 t per ha) and the lowest from S_3 (1.37 t per ha). The highest stover yield was found from S_2 (2.59 t per ha), while the lowest from S_3 (2.16 t per ha). In case of different varieties of mustard, at 30, 40, 50, 60 DAS and at harvest, the tallest plant (34.34, 55.96, 72.76, 89.82 and 93.68 cm) was observed from V_4, whereas the shortest plant (29.06, 48.03, 65.59, 81.69 and 86.26 cm) from V_1. The highest number of siliqua per plant was obtained from V_4 (89.78), while the lowest number from V_1 (80.44). The longest siliqua was obtained from V_4 (5.00 cm), whereas the shortest siliqua from V_1 (4.13 cm). The highest seed yield was recorded from V_4 (1.68 t / ha), while the lowest from V_1 (1.42 t / ha). The highest stover yield was observed from V_4 (2.55 t per ha) and the lowest from V_1 (2.25 t per ha). Due to the interaction effect of sowing dates and mustard varieties, at 30, 40, 50, 60 DAS and at harvest, the tallest plant (39.57, 62.60, 76.46, 96.87 and 98.86 cm) was observed from S_2V_4, while the shortest plant (27.87, 46.20, 63.85, 79.83 and 85.25 cm) from S_3V_1. The highest number of siliqua per plant was observed from S_2V_4 (97.67) and the lowest number from S_3V_1 (76.00). The longest siliqua was observed from S_2V_4 (6.40 cm), while the shortest siliqua from S_3V_1 (3.47 cm). The highest seed yield was recorded from S_2V_4 (1.89 t/ ha), whereas the lowest from S_3V_1 (1.27 t/ ha). The highest stover yield was observed from S_2V_4 (2.84 t per ha) and the lowest from S_3V_1 (2.08 t / ha). Sowing on 20 November and SAU Sarisha-18 was more potential in regards to yield contributing characters and yield of mustard.

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CHAPTER I

INTRODUCTION

Mustard belongs to the genus *Brassica* under the family Cruciferae, is one of the most important oil crops of the world after soybean and groundnut (FAO, 2012). It has three species those produce edible oil, namely *Brassica napus, B. campestris* and *B. juncea.* Mustard is one of the most important and widely grown oilseed crops of Bangladesh occupying 0.483 million ha and the production was 0.525 million metric ton and yield 0.109 million ton per hectare (AIS, 2013). Vegetable oils and fats (lipids) constitute an important component of human diet. Oils of plant origin are nutritionally superior to that of animal origin (Singh, 2000). It is an important source of cooking oil in Bangladesh meeting one third of the edible oil requirement of the country (Ahmed, 2008). It is not only a high energy food but also a carrier of fat soluble vitamins (A, D, E and K) in the body.

Mustard is grown particularly in the districts of Comilla, Tangail, Jessore, Faridpur, Pabna, Rajshahi, Dinajpur, Kushtia, Kishoregonj, Rangpur and Dhaka (BBS, 2011). Bangladesh has been facing acute shortage of edible oil for the last several decades. Our internal production can meet only about 21% of our consumption which can meet only a fraction of the cooking oil, requirement of the country and the rest 79% is needed to import (Begum *et al.,* 2012). It needs to import oil and oilseeds to meet up the deficit every year spending huge foreign exchange. Due to insufficient oil production, a huge amount of foreign exchange involving over 160 million US Dollar is being spent every year for importing edible oils in Bangladesh (Rahman, 2002). Mustard seed contains about 40-45% oil and 20-25% protein which can meet the shortage of oil. The average per hectare yield of mustard in this country is alarmingly very poor compared to that of advanced countries like Germany, France, UK and Canada producing 6,667

kg /ha, 5,070 kg/ha, 3,264 kg/ ha, 3,076 kg/ ha, respectively. The world average yield of mustard is 1,575 kg/ ha.

Mustard is the principal oilseed crop in Bangladesh. It also serves as an important raw material for industrial use such as in soaps, paints, varnishes, hair oils, lubricants, textile auxiliaries, pharmaceuticals etc. Its oil is also used by the villagers for hair dressing and body massage before bath. Dry mustard straw is also used as fuel. Although it is an important crop but the cultivation of mustard has to compete with other grain crops and it has been shifted to marginal lands of poor productivity. Moreover, mustard oil cake is also used as a feed for cattle and fish and as a good manure. With increasing population, the demand of edible oil is increasing day by day. It is, therefore, highly accepted that the production of edible oil should be increased considerably to fulfill the demand. The area under mustard is declining due to late harvesting of high yielding T. *aman* rice and increased cultivation of *boro* rice loosing in an area of 104,000 hectare and production 68,000 tons of mustard and rapeseed in last ten years (Anon., 2006). The major reasons for low yield of rapeseed-mustard in our country are due to lack of high yielding variety, appropriate population density and want of knowledge of sowing date and proper management practices etc.

Variety plays an important role in producing high yield of mustard because different varieties perform differently for their genotypic characters. Improved variety is the first and foremost requirement for initiation and accelerated crop production program. High yielding varieties (HYVs) can contribute to get optimum yield. There are some HYVs of mustard, which have been released by the Sher-e-Bangla Agricultural University (SAU), Bangladesh Agricultural Research Institute (BARI) and Bangladesh Institute of Nuclear Agriculture (BINA). The yields of these cultivars range between 1.4 to 2.1 t ha^{-1} (BARI, 2002). The yield of mustard in Bangladesh has been increased obviously with the introduction of high yielding varieties and improvement of management practices. Among the management practices, selection of variety, seed rate and sowing dates have remarkable influence on mustard yield. Yield and its formation process

depend on genetic, environmental and agronomic factors as well as the interaction between them (Sidlauskas and Bernotas, 2003).

Therefore, there is a scope to increase the yield level of mustard by using HYV seed and by adopting proper management practices such as date of seeding, seed rate, irrigation, fertilizer application and other cultural operations among them sowing time is an important management factor in the production of all. In Bangladesh, mustard is sown in early October to November. The temperature in the country remains fairly high up to mid October which gradually comes down afterwards. Sowing at proper time allows sufficient growth and development of a crop to obtain a satisfactory yield and modify the undesirable effect of drought stress. Sowing either too early or too late has been reported to be unfavorable (Hocking and Stapper, 2001; Robertson *et al*., 2004; Uzun *et al*., 2009). Delay on sowing date causes flowering period falls when evapo-transpiration reaches high values and the crop experiences water stress (Yau, 2007). For producing high yield, it is important that the plant flowers as early as possible. By bringing forward the date of flowering, yield can ultimately be increased (Koutroubas *et al*., 2004; Yau, 2007; Dordas *et al*., 2008). Seed yield of mustard declined gradually by 11.7, 21.5, 43.4 and 62.9%, respectively, for each week delay after 1 November sowing (Rahman *et al.,* 1993). Yield reduction due to late sowing is of common occurrence owing to low level of dry matter accumulation accompanied by pod abortion and decrease in seed set.

Considering the above situations the present experiment was conducted to find out the effect of sowing dates and variety on the yield of mustard with the following objectives-

- To find out suitable sowing date for optimum yield.
- To study the seed yield and yield contributing characters of varieties.
- To find out the interaction effect of different sowing dates and mustard varieties for optimum yield .

CHAPTER II

REVIEW OF LITERATURE

Mustard is an important oilseed crop in Bangladesh and as well as many countries of the world. The crop is grown conventionally and less attention is given by the researchers on various aspects because normally it grows without or minimum care or management practices. Based on this a very few research works related to growth, yield and development of newly developed mustard varieties have been carried out in our country. However, research works are pursued by scientist in home and abroad to maximize the yield of mustard. Sowing date and variety play an important role in improving mustard yield. But research works related to sowing date as a management practices and variety on mustard are limited in Bangladesh context. However, some of the important and informative works and research findings related to the sowing date and variety so far been done at home and abroad have been reviewed in this chapter under the following headings:

2.1 Effect of sowing dates on mustard

2.1.1 Plant height

A field experiment was conducted by Singh *et al*. (2014) to assess the influence of different dates of sowing and irrigation scheduling on growth and yield of mustard (*Brassica juncea* L.). Results revealed that all the growth and plant height were increased significantly after 30 October sowing.

A study was carried out by Khatun *et al*. (2011) to find out the effect of sowing dates and varieties and reported the tallest plant was recorded under 01 November sowing followed by 21 October sowing.

Afroz *et al*. (2011) carried out an experiment at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh with two varieties; three sowing date viz. 10, 20 and 30 November and recorded the longest plant in 10 November sowing and the shortest plant in 30 November sowing.

Angrej *et al.* (2002) found that, early sowing was showed higher value for the different plant height.

Mondal and Islam (1993) found that the longest plants were found in the plots of November 1 sowing which was followed by November 15, and October 15 sowing. The shortest plant height was found in the plots of December 1 sowing. In case of late sowing in December 1 plants faced higher temperature during later stages of growth, so the plants were shorter than the other sowing dates.

2.1.2 Number of branches per plant

A field experiment was conducted by Gawariya *et al*. (2015) with four dates of sowing (1st October, 16th October, 31st October and 15th November) and six crop geometry reported sowing during 1st October recorded significantly higher crop yield attributing characters viz. no. of primary, secondary and tertiary branches compared to 31st October and 15th November.

The number of primary branches per plant has a very low direct effect on seed yield but it has an indirect positive effect via pods per plant (Rahman *et al*., 1993).

Islam *et al.* (1994) found that early sown crop produced more primary branches than late plant crop on end October and mid November and he also observed that delayed sowing significantly reduced branches per plant except that the difference was similar between sowing of November 4 and November 18 over the varieties. The maximum (4.55) number of branches per plant produced on October 20 and minimum (3.31) on December 2.

2.1.3 Days to flowering

A study was carried out by Khatun *et al*. (2011) to find out the effect of sowing dates and varieties and reported the minimum days to flowering was recorded under 01 November sowing followed by 21 October sowing.

Robertson *et al.* (2004) conducted experiment with three cultivars viz. an early and late flowering canola and an advanced breeding line of Indian mustard. They found that a delay in sowing shortened the time to 50% flowering for all the genotypes. Seeds sowing in May 15, 1 day delay in sowing delayed flowering by 0.42, 0.42 and 0.37 days in Indian mustard, Monty and Oscar, respectively.

Mondal *et al.* (1999) stated that, seeding date significantly influenced days to flowering and delayed sowing reduced days to flowering.

Mondal and Islam (1993) found that maximum days to flowering (38 days) were required by the October 15 sown plant which was followed by November 1, November 15, and December 1 sowing. Delay in sowing reduced the number of days to flowering. In case of early sowing plant experienced little warm temperature during vegetative stage as a result the growth became slow that is why maturity periods were longer, and later sowing plants completed vegetative growth earlier than the plant of early sowing.

2.1.4 Days to maturity

Islam *et al.* (1994) stated that delayed sowing curtailed the period of crop duration in all varieties. In all sowings, varieties Tori-7 and TS-72 matured much earlier (75-78 days) than the other (90-107 days). It appears that rise of temperature from January onwards might have greatly influenced the post flowering developments, particularly for late sown crops resulting in the shorter maturity periods.

Mondal and Islam (1993) found that maximum days to maturity of mustard (115 days) were required by the October 15 sown plant which was followed by November 1, November 15, and December 1 sowing. Delay in seeding reduced the number of days to maturity. In case of early sowing plant faced little warm temperature during vegetative stage and the growth was slow that is why maturity periods were longer and later sowing plants completed vegetative growth earlier than the plant of early sowing.

Mondal *et al.* (1992) observed that there was a trend of reduction in days to maturity with delayed plantings. In the first planting it took 89 days to mature and in the last planting, this was 83 days.

2.1.5 Number of siliquae per plant

A field experiment was conducted by Gawariya *et al*. (2015) with four dates of sowing (1st October, 16th October, 31st October and 15th November) and six crop geometry reported sowing during 1st October recorded significantly higher crop yield attributing characters viz. siliquae/plant compared to 31st October and 15th November.

A field experiment was conducted by Singh *et al*. (2014) to assess the influence of different dates of sowing and irrigation scheduling on growth and yield of mustard (*Brassica juncea* L.). Results revealed that all the growth and yield attributes were increased significantly under 30 October sowing.

Shivani *et al.* (2002) experimented sowing on September 25 and October 5 recorded significantly higher number of siliquae per plant and number of siliquae plant^{-1} was significantly influenced by sowing date.

Buttar and Aulakh (1999) found pods per plant were higher in October 25 (1stdate) sowing. This was due to the fact that under earlier sown crop, the temperature and other climatological parameters played a major role for growth and yield attributes.

Mondal *et al*. (1999) stated that the highest number of siliquae per plant was found in the plants of third planting (1 November). The number of siliquae was less in the last two plantings and first planting.

Brar *et al*. (1998) stated that early sown crop produced higher number of siliquae per plant compared to late sowing. Sowing at October 30 and November 15 were at par with each other but further delay in sowing caused significant reduction in number of siliquae per plant.

Shahidullah *et al*. (1997) reported that number of siliquae per plant was decreased with delay in sowing among the three sowing dates on October 27, November 6 and November 16.

Monndal and Islam (1993) found that the highest number of siliquae per plant was in the plants of November 1 sowing and the lowest number of siliquae per plant was in the plants of December 1 sowing.

Mondal *et al*. (1992) stated that number of siliquae per plant decreased in late planting.

According to Saran and Giri (1987) pods plant^{-1} decreased gradually from early (October 15) to later (October 25; November 5 and November 15) sowings. Ghosh and Chatterjee (1988) also reported that fifteen days to one month delay in sowing produced 24 to 57% reduced pods sqare m.

Uddin *et al*. (1986) reported that numbers of siliqua per plant were generally reduced with delay in sowing among the four sowing dates on October 25, November 14 and November 24.

2.1.6 Number of seeds per siliqua

A field experiment was conducted by Singh *et al*. (2014) to assess the influence of different dates of sowing and irrigation scheduling on growth and yield of mustard (*Brassica juncea* L.). Results revealed that all the growth and yield attributes were increased significantly under 30 October sowing.

A study was carried out by Khatun *et al*. (2011) to find out the effect of sowing dates and varieties and reported the highest number of seeds siliqua (5.67) was recorded under 01 November sowing followed by 21 October sowing.

Shivani *et al*. (2002) experimented sowing on September 25 and October 5 recorded significantly higher number of seeds per siliquae than that on October 15, October 25 and November 4. Number of seeds per siliqua decreased

progressively with delay in planting. Number of seeds per siliqua was significantly influenced by sowing date.

Angrej *et al*. (2002) observed that early sowing gives higher values of seeds per siliqua in mustard.

Mondal *et al*. (1999) stated that the highest number of seeds per siliqua was found in the plants of third planting (November 1).

Shahidullah *et al.* (1997) reported that number of seeds per siliqua was decreased with delay in sowing among the three sowing dates on October 27, November 6 and November 16.

2.1.7 Length of siliqua

A field experiment was conducted by Singh *et al*. (2014) to assess the influence of different dates of sowing and irrigation scheduling on growth and yield of mustard (*Brassica juncea* L.). Results revealed that all the growth and yield attributes were increased significantly under 30 October sowing.

Hossain *et al*. (1996) found significant variation in siliqua length due to planting time. In each case length decreased from first date to 4^{th} date of sowing. i.e. delayed sowing reduced the siliqua length.

BARI (1992) conducted an experiment during rabi season at Joydepur, Jessore, Ishurdi and Rajshahi. Five dates of planting (October 1, October 16, November 1, November 16 and December 1) and two genotypes of rapeseed were used. Significant variations due to different dates of sowing were found in respect of siliqua length and other traits. Siliqua length showed decreasing tendency with delay in sowing. Highest length (6.8 cm) was found from October 15 sowing and lowest (5.8 cm) in December 1 sowing.

2.1.8 Thousand seed weight

A field experiment was conducted by Singh *et al*. (2014) to assess the influence of different dates of sowing and irrigation scheduling on growth and yield of mustard

(*Brassica juncea* L.). Results revealed that all the growth and yield attributes were increased significantly under 30 October sowing.

A study was carried out by Khatun *et al*. (2011) to find out the effect of sowing dates and varieties and reported the highest weight of 1000 seeds (5.02 g) was recorded under 01 November sowing followed by 21 October sowing.

Shivani *et al*. (2002) experimented that, 1000-seed weight was significantly influenced by sowing date. Sowing on September 25 and October 5 recorded significantly higher 1000-seed weight than that on October 15, October 25 and November 4. 1000-seed weight decreased progressively with delay in planting.

Mondal *et al*. (1999) stated that, 1000 seed weight reduced with the delayed planting time.

Ghosh and Chatterjee (1988) reported that one month later planting produced 32% reduction in seed weight. Saran and Giri (1987) observed that sowing in October 25 gave 11% higher 1000-seed weight than that of November 15 sowing.

2.1.9 Grain yield

A field experiment was conducted by Gawariya *et al*. (2015) with four dates of sowing (1st October, 16th October, 31st October and 15th November) and six crop geometry reported sowing during 1st October recorded significantly higher crop yield attributing characters and ultimately seed yield (2013 kg/ha) compared to 31st October and 15th November.

Sattar *et al*. (2013) carried out an experiment with three varieties of canola viz; Bulbul-98, Zafar-2000 and Rainbow sown at three different sowing dates, early (15th October), late (30th October) and very late (15^{th} November). Results indicate that from all these three varieties, seed yield, protein and oil contents of all cultivars were decreased due to delayed sowing. The decline of grain yield with delay in sowing date could be largely explained by the decline in biomass at maturity.

Afroz *et al*. (2011) carried out an experiment at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh to study the effect of sowing date and seed rate on the yield and yield components of two mustard varieties. The treatments included two varieties viz. BARI Sarisha-9 and BARI Sarisha-6; three sowing date viz. 10, 20 and 30 November, and three seed rates viz. 8, 10 and 12 kg seeds ha^{-1}. The highest seed yield (1.53 t/ ha) was recorded in 10 November sowing and the lowest one was achieved in 30 November sowing.

A study was carried out by Khatun *et al*. (2011) to find out the effect of sowing dates and varieties and reported the highest seed yield (1727 kg /ha) was recorded under 01 November sowing followed by 21 October sowing.

A study was carried out by Turhan *et al*. (2011) to find out the effect of sowing dates and varieties and significant differences were found between sowing times for most of the traits measured. The lowest average seed yield (1027.40 kg/ ha) was obtained from the latest sowing time, whereas the highest average seed yield (2437.50 kg /ha) was obtained from the earliest sowing time.

Patel *et al*. (2004) observed that Indian mustard seeds were sown on November 8, November 18 and November 28, and December 8 December 18 in field experiment conducted in Indian during winter of 1995-98. The yield of Indian mustard decreased with delay in sowing. The highest seed yield (1409 kg/ha) was recorded with November 8 sowing.

Panda *et al*. (2004) conducted a field experiment on sandy-loam soil in New Delhi, India, to study the effect of dates of sowing (October 16, October 31 and November 15) on Indian mustard (*B. juncea*). The crop sown on October 16 recorded a higher seed yield (1945 kg ha^{-1}) than the crops sown on October 31 (1556 kg ha^{-1}) and November 15 (872 kg /ha) and delayed sowing beyond October 16 significantly reduced yields.

Sihag *et al*. (2003) found that among the sowing dates October 15, October 30, November 14 and November 29 the highest dry matter accumulation at 90 days of

crop growth (31.07 g per plant) and at harvest (42.40 g per plant) was obtained in October 15 sown crops. The highest seed (21.50 q /ha) was obtained in October 15 sown crops.

Razzaque *et al*. (2002) mentioned that, the crop sown on November 15 recorded the highest seed yield (1164.4 kg /ha) but it did not differ significantly from that of November 23 sowing (1001.9 kg /ha). Inferior yield was obtained from December 7 (612 kg /ha) sowing which was identical to that from November 30 (700.6 kg ha^{-1}) due to the high temperature at reproductive stage.

Angrej *et al*. (2002) found that, the highest yield was obtained when the crop was sown between October 10 and October 30. Yield reductions of 26.4 and 40.2% were obtained when sowing was delayed to November 20 and December 10, respectively.

BARI (2001) reported that at Joydebpur location seed yield and other yield contributing characters were significantly varied among the dates of plantings.

Panwar *et al*. (2000) reported that yield of *Brassica* spp. Decreased when sown on November 5 (mean 1.17 t/ ha) compared with October 20 (1.70 and 1.77 t/ha respectively). Brar *et al.* (1998) reported that seed yield was influenced by sowing date. The highest yield was given by sowing on August 13 or September 5.

Buttar and Aulakh (1999) observed that the seed yield of Indian mustard obtained was significantly higher when the crop was sown on October 25 than sown on November 15 and September 5. Shastry and Kumar (1981) and Narang and Singh (1987) also made similar observations.

Mondal *et al.* (1999) showed that, the highest seed yield /ha (1.39 t) was from third planting (November 1) compared with the first and last four planting dates.

BARI (1999) stated that different sowing time significantly influenced the yield of mustard. Significantly highest yield grain yield was obtained from November 19

sowing. Yield reduction was (31 to 72%) when mustard was sown in December and 28% in October 29 sowing.

Brar *et al*. (1998) stated that crops sown on October 30 recorded highest seed yield (16.5 q ha^{-1} than November 30 and December 15 sowings. Chakraborty *et al*. (1991) reported that early sowing (October 16) produced 24% higher seed yield than that of later sowing (November 2). Ghosh and Chatterjee (1988) stated similar results in their experiment with sowing date.

Nair (1998) stated that mean grain yield in both the years among the varieties decreased with later sowing.

Yadav *et al*. (1996) observed that a 2-year field experiment was conducted during the winter seasons at Morena, Madhya Pradesh, to investigate the effects of sowing date (October 17 or October 27, November 6 November 16) on the seed yield of *Brassica juncea cv.* Pusa Bold. Early sowing (October) resulted significantly higher seed compared with later sowing.

Mondal and Islam (1993) found that the highest seed yield plant-^{1} and seed yield per ha^{-1} were obtained from the October 15 sowing which were similar to November 1. Seed yield decreased with delayed sowing.

Mondal *et al.* (1992) reported that the highest seed yield ha^{-1} (1.45 t) was from second planting (Octorber 16) and was significantly different from last planting (November 16.)

Zaman *et al*. (1991) suggested that October 18 and October 28 were better over November 7 for higher yield, and higher yield was attributed by pods per plant and seed per pod. They observed that the seed yield decreased generally with the delay in sowing in all varieties. This view was strengthened by the finding of Uddin *et al*. (1987).

Joshi *et al*. (1989) reported that sowing too early and too late resulted in seed reduction due to natural hazards like insect pest and disease infestation. Early

sowing reduced seed yield than in late sowing (mid July-mid August) since the former had a risk of rotting.

2.1.10 Stover yield

Sattar *et al*. (2013) carried out an experiment with three varieties of canola viz; Bulbul-98, Zafar-2000 and Rainbow sown at three different sowing dates, early (15th October), late (30th October) and very late (15^{th} November). Results indicate that from all these three varieties, stover yield were decreased due to delayed sowing. The decline of stover yield with delay in sowing date could be largely explained by the decline in biomass at maturity.

Afroz *et al*. (2011) carried out an experiment at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh to study the effect of sowing date and seed rate on the yield and yield components of two mustard varieties included two varieties viz. BARI Sarisha-9 and BARI Sarisha-6; three sowing date viz. 10, 20 and 30 November, and three seed rates viz. 8, 10 and 12 kg seeds ha^{-1} and recorded the highest stover yield (2.68 t/ha) was recorded in 10 November sowing and the lowest one was achieved in 30 November sowing.

BARI (2001) reported that sowing date have effect on stover yield. In sowing time November 16 stover yield (3991 kg/ha^{-1}) was higher than December sowing 3 (2417.56 kg/ha).

Brar *et al*. (1998) stated that straw yield of mustard decreased significantly with the each delay in sowing.

Islam *et al*. (1994) stated that stover yield was significantly influenced by sowing time. Higher stover yield was observed in October 20 sowing that gradually decreased in December 02 sowing.

Chakraborty *et al*. (1991) stated that delayed sowing significantly reduced stover yield. October sown crops produced higher dry matter than in November sown ones.

Ghosh and Chatterjee (1988) obtained higher dry matter accumulation from an October sown mustard compared to a crop sown in November.

2.1.11 Biological yield

A study was carried out by Turhan *et al*. (2011) to find out the effect of sowing dates and varieties and significant differences were found between sowing times for most of the traits measured. The lowest biological yield (3143.98 kg/ha) was obtained from the latest sowing time, whereas the highest average stover yield (4231.56 kg /ha) was obtained from the earliest sowing time.

Sihag *et al*. (2003) a field experiment was conducted in Bikaner, Rajasthan, India, to determine the effect of sowing date date (October 15, October 30, November 14 and November 29) of Indian mustard. The highest biological yield (65.23 q ha^{-1}) was obtained in October 15 sown crops.

Islam and Razzaque (1999) stated that biological yield reduced in general with delaying the day of sowing. Highest biological yield was obtained mainly between the first and second date of sowing. The last date of sowing (December 1) reduced biological yield.

2.1.12 Harvest index

Afroz *et al*. (2011) carried out an experiment at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh to study the effect of sowing date and seed rate on the yield and yield components of two mustard varieties included two varieties viz. BARI Sarisha-9 and BARI Sarisha-6; three sowing date viz. 10, 20 and 30 November, and three seed rates viz. 8, 10 and 12 kg seeds per ha and recorded the highest harvest index was recorded in 10 November sowing and the lowest one was achieved in 30 November sowing.

Gfadakar *et al*. (1988) stated that seed yield and dry matter accumulation was positively correlated with heat unit accumulation and accumulation of heat unit varied with growth stage, variety and sowing time. The temperature fluctuation

caused the variation in the accumulation of thermal units in plants and it affected harvest index.

2.2 Effect of different varieties on mustard

2.2.1 Plant height

Hakim *et al*. (2014) evaluated two varieties (Early Mustard and S-9) were against six Zn levels and reported that S-9 ranked 1st with 216.50 cm plant height, while variety Early Mustard resulted 186.56 cm plant height.

Mamun *et al*. (2014) evaluated the effect of variety and different plant densities on growth and yield of rapeseed mustard under rainfed conditions at Sher-e-Bangla Agricultural University, Dhaka, Bangladesh. Four varieties (BARI Sarisha-13, BARI Sarisha-15, BARI Sarisha-16 and SAU Sarisha-3) and four plant densities were applied during the course of study and reported that BARI Sarisha-13 performed well in terms of plant height.

Laxminarayana and Pooranchand (2000) conducted an experiment during the rabi seasons at Madhira to determine the most suitable mustard (*Brassica juncea*) cultivar and found no significant variations in plant height among the cultivars.

Ahmed *et al.* (1999) stated that the tallest plant (102.56 cm) was recorded in the variety Daulat. No significant difference was observed in plant height of Dhali and Nap-8509. Jahan and Zakaria (1997) reported that Dhali was the tallest plant (142.5 cm) which was at par with Sonali (139.5) and Japrai (138.6 cm). The shortest plant was observed in Tori-7 (90.97 cm) which was significantly shorter than other varieties. The exotic varieties were of intermediate types of plants.

Hussain *et al.* (1996) observed the highest plant height in Narendra (175 cm) which was identical with AGA-95-21 (166 cm) and Hyola-51 (165 cm). The shortest variety was Tori-7.

Mondal *et al.* (1992) found that variety had significant effect on plant height. They found the highest plant height (134.4 cm) in the variety J-5004, which was identical with SS-75 and significantly taller than JS-72 and Tori-7.

Ali *et al.* (1986**)** observed significant variation in plant height in different varieties of mustard and rape.

2.2.2 Number of branches per plant

Hakim *et al*. (2014) evaluated two varieties (Early Mustard and S-9) were against six Zn levels and reported that S-9 ranked 1st with 10.84 branches plant^{-1}, while variety Early Mustard resulted 9.25 branches per plant.

Mamun *et al*. (2014) evaluated the effect of variety and different plant densities on growth and yield of rapeseed mustard under rainfed conditions at Sher-e-Bangla Agricultural University, Dhaka, Bangladesh. Four varieties (BARI Sarisha-13, BARI Sarisha-15, BARI Sarisha-16 and SAU Sarisha-3) and four plant densities were applied during the course of study and reported that BARI Sarisha-13 performed well in terms of branches plant^{-1} (6.14).

BARI (2000) reputed that under poor management number of branch plant^{-1} was higher (4.2) in the variety SS-75 and lower (2.1) in the variety BARI Sarisha-8. Under medium management, best performance was Dhali (5.5) and worst performance was BARI Sarisha-8. Under higher management, highest was in Dhali (5.9) and lowest in (3.0) Nap-248.

Jahan and Zakaria (1997) found that the local varieties Tori and Sampad produced the highest number of primary branches plant (4.07). The minimum number of primary branches plant of 2-90 was found in Jatarai which was identical to those found in BARI Sarisha-8 varieties.

Hussain *et al.* (1996) reported that the varieties were statistically different with respect to number of primary branches per plant. The maximum number of primary branches was recorded in the Hyola-401 (5.0) and the minimum number was recorded in Semu-249/84.

Khaleque (1989) observed 3.9 and 3.1 branches per plant in TS-72 and Sonali sarisha, respectively.

2.2.3 Days to flowering

Mamun *et al*. (2014) evaluated the effect of variety and different plant densities on growth and yield of rapeseed mustard under rainfed conditions at Sher-e Bangla Agricultural University, Dhaka, Bangladesh. Four varieties (BARI Sarisha-13, BARI Sarisha-15, BARI Sarisha-16 and SAU Sarisha-3) and four plant densities were applied during the course of study and reported that BARI Sarisha-13 produced early flower than the others.

BARI (2001) concluded that there was significant variation days to flowering of mustard found in different varieties and highest days to flowering (32 days) was found in Jamalpur-1 variety and lowest in BARI Sarisha-10.

Karim *et al.* (2000) stated that varieties showed significant influence in days to flowering. They found maximum days to flowering in J-3023 variety.

2.2.4 Number of siliqua per plant

Mamun *et al*. (2014) evaluated the effect of variety and different plant densities on growth and yield of rapeseed mustard under rainfed conditions at Sher-e-Bangla Agricultural University, Dhaka, Bangladesh. Four varieties (BARI Sarisha-13, BARI Sarisha-15, BARI Sarisha-16 and SAU Sarisha-3) and four plant densities were applied during the course of study and reported that BARI Sarisha-13 performed well in terms of siliqua per plant (126.90).

Hakim *et al*. (2014) evaluated two varieties (Early Mustard and S-9) were against six Zn levels and reported that S-9 ranked 1st with 581.11 pods per plant, while variety Early Mustard resulted 484.67 pods per plant.

Pooran *et al.* (2000) found the highest number of siliqua per plant (180) in GM-1. Jahan and Zakaria (1997) reported that in case of number of siliqua per plant, the highest number was recorded in BLN-900 (130-9) which was identical to Dhali (126.3). Tori-7 had the lowest (46.3) number of siliqua per plant.

Hossain *et al.* (1996) observed the highest number of siliqua per plant (187.3) in BLN-900 and the lowest (150.4) in Semu 249/84.

Mondal *et al.* (1992) obtained maximum number of siliquas per plant (136) in the variety J-5004, which was identical with the variety Tori-7. The lowest number of siliqua plant^{-1} (45-9) was found in the variety SS-75.

2.2.5 length of siliqua

Hussain *et al.* (2008) conducted an experiment to show the effect of boron application on yield and yield attributes of different mustard varieties. The experiment involved five boron levels and three mustard varieties viz. BARI sharisha-8, BARI sharisha-9 and BARI sharisha-11. BARI sharisha-11 and BARI sharisha-8 performed better in terms of siliqua length.

BARI (1999) reported that varieties had significant variation in of siliqua length. The highest siliqua length was found in Daulat and lowest in Dhali.

Hussain *et al.* (1996) observed the longest siliqua (8.07 cm) in BLN-900 and the shortest (4.83 cm) in Hyola-401.

2.2.6 Number of seeds per siliqua

Mamun *et al.* (2014) evaluated the effect of variety and different plant densities on growth and yield of rapeseed mustard under rainfed conditions at Sher-e-Bangla Agricultural University, Dhaka, Bangladesh. Four varieties (BARI Sarisha-13, BARI Sarisha-15, BARI Sarisha-16 and SAU Sarisha-3) and four plant densities were applied during the course of study and reported that BARI Sarisha-13 performed well in terms of seeds per siliqua (25.36).

Laxminarayana and Pooranchand (2000) found no significant variations in seeds per siliqua among the cultivars. Das *et al.* (1999) reported that MM 7 (Mutant) produced the highest number of seeds per siliqua (29.2) followed by MM 20 (Mutant) (28.0) and Bina sarisha-4 (27.8) at Dinajpur.

Hussain *et al.* (1996) stated that there were significant differences among the varieties with respect to number of seeds per siliqua. The maximum number of

seeds siliqua^{-1} was produced in the hybrid BLN-900 (29.5) and the minimum number was recorded in Tori-7 as well as in Semu-249/84.

Mondal *et al.* (1992) found highest number of seeds per siliqua (27.6) in SS-75 which was significantly different from all other varieties. The lowest number of seeds per siliqua (13.8) was found in J-5004.

2.2.7 Weight of 1000 seeds

Mamun *et al*. (2014) evaluated the effect of variety and different plant densities on growth and yield of rapeseed mustard under rainfed conditions at Sher-e Bangla Agricultural University, Dhaka, Bangladesh. Four varieties (BARI Sarisha-13, BARI Sarisha-15, BARI Sarisha-16 and SAU Sarisha-3) and four plant densities were applied during the course of study and reported that BARI Sarisha-13 performed well in terms of 1000 seed weight (4.00) considering the other variety.

Mondal and Wahab (2001) observed that thousand seed weight ranged 2.5- 2.65 g in improved Tori-7 *(B. campestris)* and 1.5-7.8 g in *Rai (B. juncea).* BARI (2001) concluded that there was significant variation in 1000-seed weight of mustard found in different varieties and highest weigh of 1000-seed was found in Jamalpur-1 variety and lowest in BARI Sarisha-10.

Karim *et al.* (2000) stated that varieties showed significant influence in weight of thousand seeds. They found higher weight of 1000-seed in J-3023 (3.43 g) J-3018 (3.42 g) and J-4008 (3.50 g).

Hussain *et al.* (1998) observed significant variation in case of 1000-seed weight as influenced by different varieties. They found Hyda-401 had the highest 1000-seed weight (3.4 g) and the lowest 1000-seed weight was recorded in Tori-7 (2.1 g) among the mustard variety. Jahan and Zakaria (1997) found variation in 1000-seed weight and the highest weight was in the variety BCN-900 (3.37 g) and the lowest in Tori-7 (2.27 g).

2.2.8 Seed yield

Hakim *et al*. (2014) evaluated two varieties (Early Mustard and S-9) were against six Zn levels and reported that S-9 ranked 1st with 1960.30 seed yield kg/ha, while variety Early Mustard resulted 1677.90 seed yield kg/ ha.

Mamun *et al*. (2014) evaluated the effect of four varieties (BARI Sarisha-13, BARI Sarisha-15, BARI Sarisha-16 and SAU Sarisha-3) and four plant densities were applied during the course of study and reported that maximum seed yield (1.60 t/ ha) was recorded for BARI Sarisha-13.

Afroz *et al*. (2011) conducted an experiment at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh with two varieties viz. BARI Sarisha-9 and BARI Sarisha-6; three sowing date and three seed rates and higher seed yield was obtained by the variety BARI Sarisha-9.

Rahman (2002) stated that yield variation existed among varieties and the highest seed yield was observed in BARI Sarisha-7, BARI Sarisha-8 and BARI Sarisha11 (2.00-2.50 t/ ha) and lowest yield in variety Tori-7 (0.95-1.10 t/ ha).

BARI (2001) showed that seed yield and other yield contributing characters significantly varied among the varieties.

Pooran *et al.* (2000) studied 6 cultivars of mustard and observed that among the mustard cultivars, GM-1 gave the highest seed yield (1050 kg/ ha), followed by Kranti and Pusa Bold (790 and 760 kg/ha, respectively) and Varuna and Sita produced comparable yields (680 and 610 kg/ha, respectively).

Jahan and Zakaria (1997) stated that yield variation is present in different varieties. They found highest yield in the exotic variety BLN-400 (2013 kg ha^{-1}) and the lowest seed yield was in AGA-95-21 (819 kg/ ha).

Bukhtiar *et al.* (1992) showed that *Brassica carinata* yielded best (1578 kg ha^{-1}) followed by RL18 (1092 kg/ha) and DGL (828 kg/ ha). The poorest yield (683 kg ha^{-1}) was given by Taranira *(Eruca sativa).*

Chakraborty *et al.* (1991) stated that seed yields are different from species to species. Chaudhury *et al.* (1988) in an experiment on irrigation with four cultivars of *B. juncea* obtained the highest yield from cv. RH-7513 without irrigation and from cv. Varuna with irrigation. Jain *et al.* (1989) observed yield variations in different varieties of *B. juncea.*

2.2.9 Stover yield

BARI (2000) reported that in case of poor management Isd-local gave the highest straw yield (3779 kg/ ha) and lowest yield (1295 kg ha^{-1}) was found from Nap-248. In case of medium management, highest weight (6223.3 kg ha^{-1}) was recorded from the same variety and lowest (3702.3 kg ha^{-1}) from PT-303 under high management practices. The highest straw yield, 6400 kg was obtained from the variety Rai-5 and lowest 4413.3 kg per ha was obtained from variety Tori-7.

2.2.10 Harvest index

Islam *et al.* (1994) showed that varieties had significant effect on harvest index of mustard. They found highest harvest index in variety TS-72 which was identical to Daulat and lowest in Sonali sarisha (21.9%) followed by Sambal (26.7%).

Bhargava and Tomer (1982) analyzed the biomass production of harvest index and yield of four *Brassica* genotypes. They noticed variation in harvest index values from 27 to 40 percent with maximum in early maturing mustard.

Mendham *et al.* (1981) stated that a low harvest index of rapeseed might be due to excessive siliqua and seed losses during flowering.

As per the above cited reviews, it may be concluded that the sowing dates and variety are the important factors for attaining optimum growth and as well as highest yield of mustard. The literature revealed that the effects of sowing dates and variety have not been studied well and have no definite conclusion for the production of mustard in the agro climatic condition of Bangladesh.

CHAPTER III

MATERIALS AND METHODS

The experiment was conducted to find out the effect of sowing dates on the yield contributing characters and yield of mustard. The materials and methods those were used for conducting the experiment have been presented in this chapter. It includes a short description of the location of experimental site, soil and climatic condition of the experimental area, materials used for the experiment, design of the experiment, data collection and data analysis procedure.

3.1 Description of the experimental site

3.1.1 Experimental period

The experiment was conducted during the period from November, 2013 to February, 2014.

3.1.2 Description of experimental site

The present piece of research work was conducted in the experimental field of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka. The location lies between $23^0 74^/$N latitude and $88^0 35^/$E longitude with an elevation of 8.2 meter from the sea level.

3.1.3 Climatic condition

The climate of experimental site is subtropical, characterized by three distinct seasons, the monsoon from November to February and the pre-monsoon period or hot season from March to April and the monsoon period from May to October. The monthly average temperature, humidity and rainfall during the crop growing period were collected from Weather Yard, Bangladesh Meteorological Department, and presented in Appendix I. During the experimental period the maximum temperature (27.1^0C) was recorded from February, 2014 and the minimum temperature (12.4^0C) from January, 2014, highest relative humidity (78%) was observed from November, 2013, whereas the lowest relative humidity (67%) and highest rainfall (30 mm) was recorded in February, 2014.

3.1.4 Characteristics of soil

The soil of the experimental field belongs to the Tejgaon series under the Agroecological Zone, Madhupur Tract (AEZ- 28) and the general soil type is Shallow Red Brown Terrace soil. A composite sample was made by collecting soil from several spots of the field at a depth of 0-15 cm before conducting the experiment. The collected soil was air-dried, grind and passed through 2 mm sieve and analyzed at Soil Resources Development Institute (SRDI), Khamarbari, Farmgate, Dhaka for some important physical and chemical properties. The soil was having a texture of silty clay with pH and organic matter 6.1 and 1.13, respectively. The results showed that the soil composed of 27% sand, 43% silt and 30% clay, which have been presented in Appendix II.

3.2 Experimental details

3.2.1 Treatment of the experiment

The experiment comprised of two factors

Factors A: Sowing date (3 times)

i) S_1: Sowing at 13 November, 2013

ii) S_2: Sowing at 20 November, 2013

iii) S_3: Sowing at 27 November, 2013

Factor B: Mustard varieties (5 mustard varieties)

i) V_1: SAU Sarisha-14

ii) V_2: SAU Sarisha-15

iii) V_3: SAU Sarisha-16

iv) V_4: SAU Sarisha-18

v) V_5: BARI Sarisha-15

There were in total 15 (3×5) treatment combinations such as S_1V_1, S_1V_2, S_1V_3, S_1V_4, S_1V_5, S_2V_1, S_2V_2, S_2V_3, S_2V_4, S_2V_5, S_3V_1, S_3V_2, S_3V_3, S_3V_4 and S_3V_5.

3.2.2 Experimental design and layout

The two factors experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. The experiment area was divided into three equal blocks. Each block contained 15 plots where 15 treatments combination were allotted at random. There were 45 unit plot altogether in the experiment. The size of each plot was 2.0 m × 1.0 m. The distance maintained between two blocks and two plots were 1.0 m and 0.5 m respectively. The layout of the experiment is shown in Figure 1.

3.3 Growing of crops

3.3.1 Seed collection

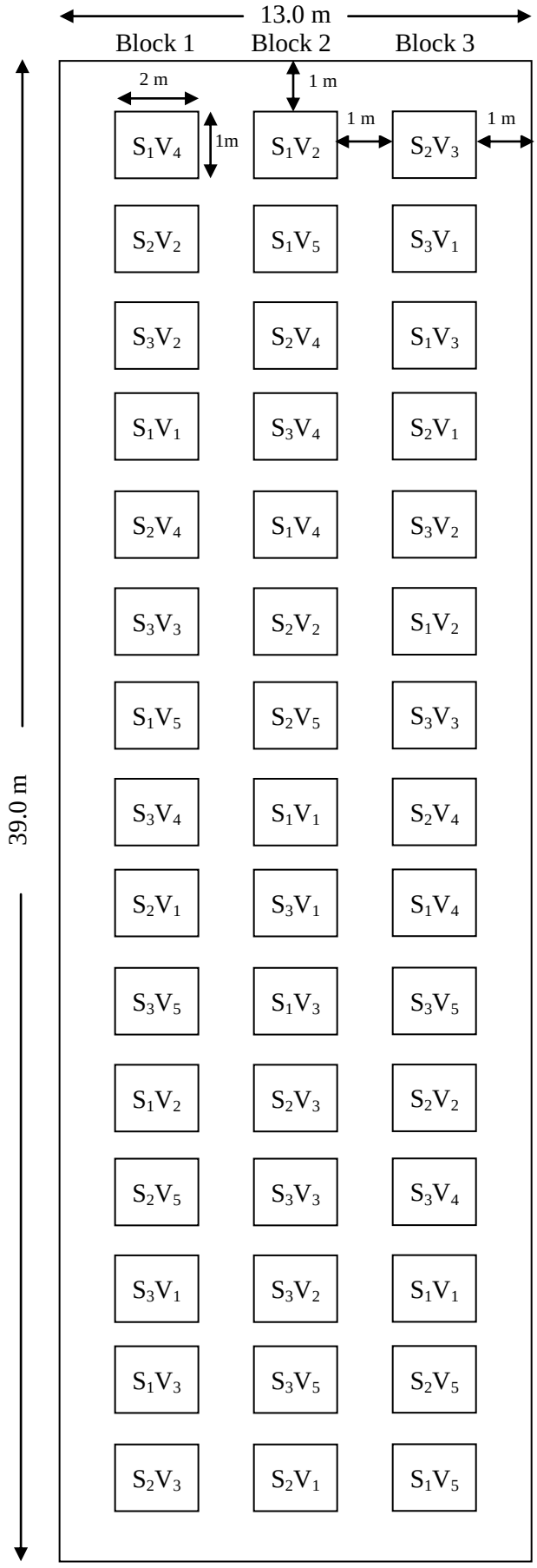
SAU Sarisha-14, SAU Sarisha-15, SAU Sarisha-16, SAU Sarisha-18 and BARI Sarisha-15, were used as plating materials in this experiment. SAU Sarisha-14, 15, 16 and 18 is a new high yielding varieties of mustard developed by the Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka. BARI sarisha-15 also is a new high yielding varieties of mustard developed by the Bangladesh Agricultural Research Institute, Joydebpur, Gazipur. The seeds were collected from the SAU, Sher-e-Bangla Nagar, Dhaka and BARI, Joydebpur, Gazipur.

3.3.2 Land preparation

The experimental plot was opened on 02 November, 2013, with a power tiller and left exposed to the sun for a week. After one week the land was harrowed, ploughed and cross-ploughed for three times followed by laddering to obtain good tilth. Weeds and stubbles were removed and finally obtained a desirable tilth of soil. Finally land was prepared at 12th November, 2013.

3.3.3 Application of manure and fertilizers

The total amount of urea, triple super phosphate, muriate of potash and borax at the rate of 230, 140, 50 and 10 kg/ ha, respectively were applied at the time of final land preparation except urea. Urea was applied in three equal splits. First dose of urea fertilizer was applied at the time of final land preparation, second and third dose of urea fertilizer were applied at 20 and 45 days after sowing (DAS) respectively.



Plot size = 2.0 m × 1.0 m

Plot spacing = 0.5 m

Between replication= 1.0 m

Factors A: Sowing date (3 times)

S_1: Sowing at 13 November, 2013

S_2: Sowing at 20 November, 2013

S_3: Sowing at 27 November, 2013

Factor B: Mustard varieties (5 mustard varieties)

V_1: SAU Sarisha-14

V_2: SAU Sarisha-15

V_3: SAU Sarisha-16

V_4: SAU Sarisha-18

V_5: BARI Sarisha-15

Figure 1. Layout of the experimental field

3.3.4 Seed sowing

The seeds of mustard were sown on 13 November, 2013, 20 November, 2013 and 27 November, 2013 as per treatment in rows in the furrows having a depth of 2-3 cm .

3.3.5 Intercultural operations

3.3.5.1 Thinning

Seeds started of germinate four days after sowing (DAS). Thinning was done two times; first thinning was done at 8 DAS and second was done at 15 DAS to maintain optimum plant population in each plot.

3.3.5.2 Irrigation and weeding

Irrigation was provided for three times viz: 20 days before flowering and 50 days after sowing for pod development for all experimental plots equally. The crop field was weeded before providing irrigation.

3.3.5.3 Protection against insect and pest

At early stage of growth few worms (*Agrotis ipsilon*) infested the young plants and at later stage of growth pod borer (*Maruca testulalis*) attacked the plants. Plants were attacked by aphids at last stage. Ripcord 10 EC was sprayed at the rate of 1 ml with 1 litre water for two times at 15 days interval after seedlings germination to control the insects.

3.4 Crop sampling and data collection

Five plants from each treatment were randomly selected and marked with sample card. Plant height, branches per plant and leaf area index were recorded from selected plants at an interval of 10 days started from 30 DAS to 60 DAS and at harvest.

3.5 Harvest and post harvest operations

Harvesting was done when 90% of the siliqua became brown in color**.** The matured pods were collected by hand picking from each plot.

3.6 Data collection

The following data were recorded

i. Plant height
ii. Number of branches plan
iii. Days to flowering
iv. Days to harvest
v. Number of siliqua plant
vi. Length of siliqua (cm)
vii. Number of seeds per siliqua
viii. Weight of 1000 seeds
ix. Seed yield per hectare
x. Stover yield per hectare
xi. Biological yield per hectare
xii. Harvest index

3.7 Procedure of data collection

3.7.1 Plant height

The plant height was measured at 30, 40, 50 and 60 DAS and at harvest with a meter scale from the ground level to the top of the plants and the mean height was expressed in cm.

3.7.2 Number of branches per plant

The number of branches per plant was counted at 30, 40, 50 and 60 DAS and at harvest from selected plants. The average number of branches per plant was determined and recorded.

3.7.3 Days to 1st flowering

Days to 1st flowering were recorded by counting the number of days required to start flower initiation of mustard plant in each plot.

3.7.4 Days to harvest

Days to harvest were recorded by counting the number of days required to harvest of mustard plant in each plot.

3.7.5 Number of siliqua per plant

Numbers of total siliqua of selected plants from each plot were counted and the mean numbers were expressed as per plant basis. Data were recorded as the average of 5 plants selected at random from the inner rows of each plot.

3.7.6 Length of siliqua

Length of siliqua was taken from randomly selected ten siliqua and the mean length was expressed on per siliqua basis.

3.7.7 Number of seeds per siliqua

The number of seeds per siliqua was recorded from randomly selected 10 siliqua at the time of harvest. Data were recorded as the average and express in per siliqua.

3.7.8 Weight of 1000 seeds

One thousand cleaned, dried seeds of mustard were counted from each harvest sample and weighed by using a digital electronic balance and weight was expressed in gram (g).

3.7.9 Seed yield

The seeds collected from 6 (2 m × 1 m) square meter of each plot were sun dried properly. The weight of seeds was taken and converted into yield in t ha^{-1}.

3.7.10 Stover yield

The stover collected from 6 (2 m × 1 m) square meter of each plot was sun dried properly. The weight of stover was taken and converted into yield in t/ ha.

3.7.11 Biological yield

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

Biological yield (t/ ha) = Grain yield + Stover yield

3.7.12 Harvest index

Harvest index was calculated from the seed and stover yield of mustard and expressed in percentage.

$$HI = \frac{\text{Economic yield (seed weight)}}{\text{Biological yield (Total dry weight)}} \times 100$$

3.8 Statistical analysis

The data obtained for different parameters were statistically analyzed to find out the effect of sowing dates and variety on yield contributing characters and yield of mustard. The mean values of all the characters were calculated and analysis of variance was performed by the 'F' (variance ratio) test. The significance of the difference among the treatment means was estimated by the Least Significant Difference (LSD) at 5% level of probability (Gomez and Gomez, 1984).

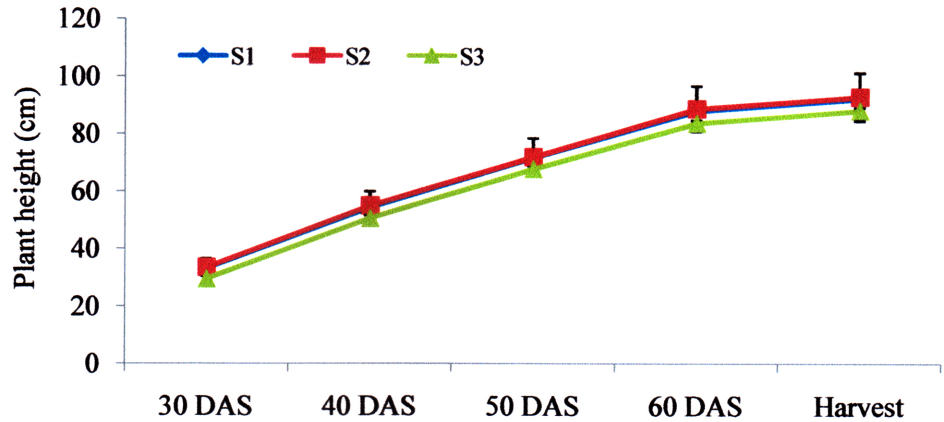
CHAPTER IV

RESULTS AND DISCUSSION

The experiment was conducted to find out the effect of sowing dates on the yield contributing characters and yield of mustard. The analyses of variance (ANOVA) of the data on different yield contributing characters and yield are presented in Appendix III-VI. The results have been presented and discussed in the different tables and graphs and possible interpretations have been given under the following headings:

4.1 Plant height

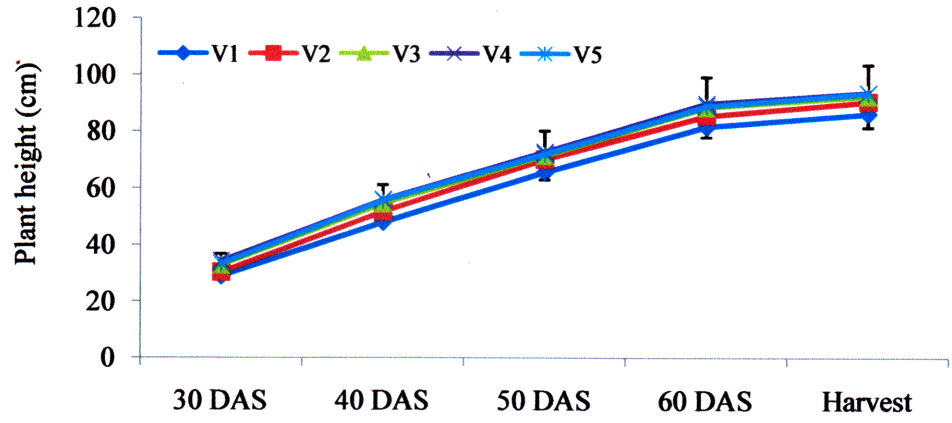
Different sowing dates showed statistically significant variation in terms of plant height of mustard at 30, 40, 50, 60 DAS and at harvest (Appendix III). At 30, 40, 50, 60 DAS and at harvest, the tallest plant (33.39, 54.89, 71.88, 88.83 and 93.07 cm) was recorded from S_2 (Sowing at 20 November), which was statistically similar (33.10, 54.22, 71.64, 88.10 and 92.46 cm) to S_1 (Sowing at 13 November), while the shortest plant (29.46, 50.45, 67.75, 83.79 and 88.30 cm) was found from S_3 (Sowing at 27 November), respectively (Figure 2). Management factor, soil moisture content and weather condition influence plant height of mustard and all of these factors are governed by time of seed sowing. In case of delayed planting, the development of plant organs and transfers from source to sink were remarkably affected, which was influenced and also reflected by overall shortening of plant height. In case of late sowing plants faced stress of higher temperature during later stages of growth, so the plants were shorter than the other sowing dates. Mondal and Islam (1993) found that the longest plants were found in November 1 sowing which was followed by November 15, and October 15 sowing and the shortest plant height was found in December 1 sowing. In another experiment Afroz *et al*. (2011) recorded the longest plant in 10 November sowing and the shortest plant in 30 November sowing. But Khatun *et al*. (2011) reported the tallest plant from 01 November sowing followed by 21 October sowing.



S_1: Sowing at 13 November S_2: Sowing at 20 November

S_3: Sowing at 27 November

Figure 2. Effect of different sowing dates on plant height of mustard. Vertical bars represent LSD value at 5% level of probability



V_1: SAU Sarisha-14 V_2: SAU Sarisha-15 V_3: SAU Sarisha-16

V_4: SAU Sarisha-18 V_5 BARI Sarisha-15

Figure 3. Effect of different varieties on plant height of mustard. Vertical bars represents LSD value at 5% level of probability

Plant height at 30, 40, 50, 60 DAS and harvest varied significantly due to different varieties of mustard (Appendix III). At 30, 40, 50, 60 DAS and at harvest, the tallest plant (34.34, 55.96, 72.76, 89.82 and 93.68 cm) were observed from V_4 (SAU Sarisha-18) which were statistically similar (33.39, 55.68, 72.08, 89.01 and 93.53 cm) to V_5 (BARI Sarisha-15) and then followed (32.80, 54.55, 71.54, 88.54 and 92.46 cm) by V_3 (SAU Sarisha-16), whereas the shortest plants (29.06, 48.03, 65.59, 81.69 and 86.26 cm) were recorded from V_1 (SAU Sarisha-14) which were followed (30.32, 51.71, 70.15, 85.49 and 90.45 cm) by V_2 (SAU Sarisha-15), respectively (Figure 3). Different genotypes produced different plant height on the basis of their varietal characters. Laxminarayana and Pooranchand (2000) recorded no significant variations in plant height among the cultivars which was different from the findings of this study. Mamun *et al*. (2014) reported that BARI Sarisha-13 performed well in terms of plant height among the mustard variety BARI Sarisha-13, BARI Sarisha-15, BARI Sarisha-16 and SAU Sarisha-3.

Interaction effect of sowing dates and mustard varieties varied significantly on plant height at 30, 40, 50, 60 DAS and at harvest (Appendix III). At 30, 40, 50, 60 DAS and at harvest, the tallest plants (39.57, 62.60, 76.46, 96.87 and 98.86 cm) were observed from S_2V_4 (Sowing at 20 November and SAU Sarisha-18), while the shortest plant (27.87, 46.20, 63.85, 79.83 and 85.25 cm) were found from S_3V_1 (Sowing at 27 November and SAU Sarisha-14), respectively (Table 1).

4.2 Number of branches per plant

Statistically significant variation was recorded due to different sowing dates in terms of number of branches plant^{-1} of mustard at 30, 40, 50, 60 DAS and at harvest (Appendix IV). At 30, 40, 50, 60 DAS and at harvest, the highest number of branches per plant was found from S_2 (2.03, 4.07, 6.85, 8.43 and 9.41), which was statistically similar to S_1 (2.02, 3.88, 6.65, 7.91 and 8.49), whereas the lowest number of branches per plant was observed from S_3 (1.84, 2.91, 5.65, 6.71 and 7.45), respectively (Figure 4). Gawariya *et al*. (2015) reported sowing during 1st October recorded significantly higher in no. of primary, secondary and tertiary branches compared to 31st October and 15th November.

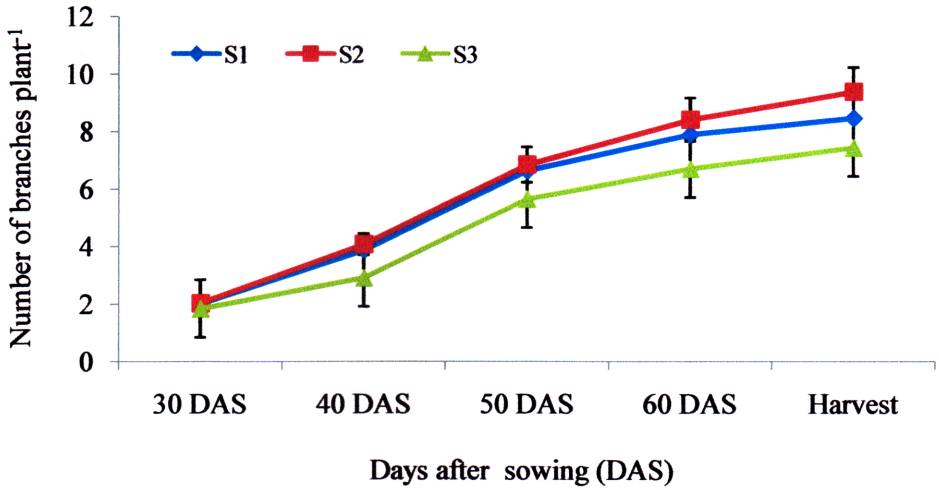
Table 1. Effect of different sowing dates and varieties on plant height at different days after sowing (DAS) of mustard

Treatments	Plant height (cm) at				
	30 DAS	40 DAS	50 DAS	60 DAS	Harvest
S_1V_1	29.40 cd	50.38 d-g	67.46 b-d	84.05 c-f	87.80 b-d
S_1V_2	32.12 b-d	52.86 c-f	70.63 a-d	86.66 b-e	91.13 b-d
S_1V_3	34.42 b	56.36 bc	73.88 ab	90.36 bc	94.77 ab
S_1V_4	35.58 ab	56.10 bc	74.30 ab	90.16 bc	95.17 ab
S_1V_5	33.97 bc	55.39 b-d	71.92 a-c	89.25 bc	93.42 a-c
S_2V_1	29.21 cd	47.51 fg	65.46 cd	81.17 ef	85.72 cd
S_2V_2	30.84 b-d	51.32 c-g	68.73 b-d	84.99 c-f	89.06 b-d
S_2V_3	32.55 b-d	54.43 b-e	72.23 a-c	88.36 b-d	93.03 a-c
S_2V_4	39.57 a	62.60 a	76.46 a	96.87 a	98.86 a
S_2V_5	34.78 b	58.58 ab	76.54 a	92.78 ab	98.67 a
S_3V_1	27.87 d	46.20 g	63.85 d	79.83 f	85.25 d
S_3V_2	27.99 d	50.94 c-g	71.09 a-c	84.81 c-f	91.16 b-d
S_3V_3	31.43 b-d	52.87 c-f	68.50 b-d	86.90 b-e	89.57 b-d
S_3V_4	28.58 d	49.17 e-g	67.53 b-d	82.44 d-f	87.03 cd
S_3V_5	31.43 b-d	53.06 c-f	67.78 b-d	84.99 c-f	88.51 b-d
$LSD_{(0.05)}$	4.264	4.895	5.926	5.485	6.637
Level of significance	0.05	0.01	0.05	0.05	0.05
CV(%)	8.50	5.61	5.86	4.90	5.57

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

S_1: Sowing at 13 November
S_2: Sowing at 20 November
S_3: Sowing at 27 November

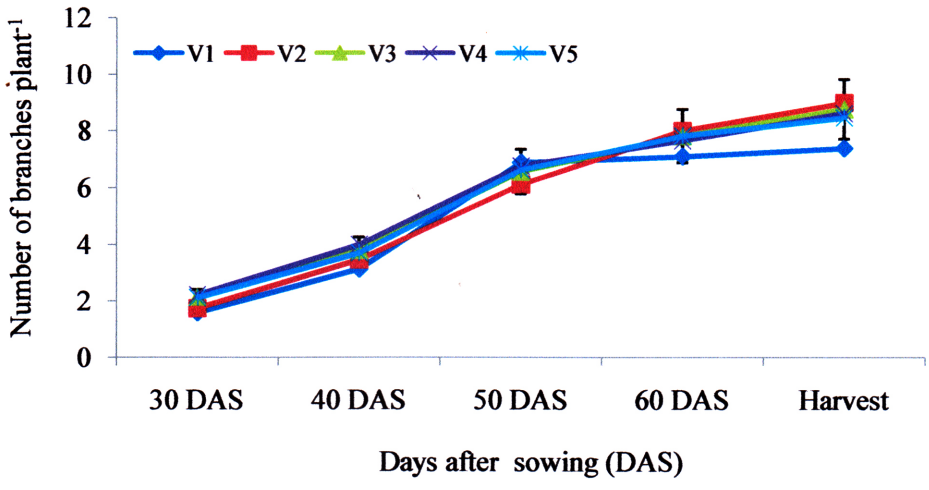
V_1: SAU Sarisha-14
V_2: SAU Sarisha-15
V_3: SAU Sarisha-16
V_4: SAU Sarisha-18
V_5: BARI Sarisha-15



S_1: Sowing at 13 November S_2: Sowing at 20 November

S_3: Sowing at 27 November

Figure 4. Effect of different sowing dates on number of branches plant^{-1} of mustard. Vertical bars represent LSD value at 5% level of probability



V_1: SAU Sarisha-14 V_2: SAU Sarisha-15 V_3: SAU Sarisha-16

V_4: SAU Sarisha-18 V_5 BARI Sarisha-15

Figure 5. Effect of different varieties on number of branches plant^{-1} of mustard. Vertical bars represents LSD value at 5% level of probability

Different varieties of mustard showed statistically significant variation in terms of number of branches plant^{-1} at 30, 40, 50, 60 DAS and harvest (Appendix IV). At 30, 40, 50, 60 DAS and at harvest, the highest number of branches plant^{-1} were recorded from V_4 (2.22, 4.00, 6.76, 7.66 and 8.62) which were statistically similar to V_5 (2.12, 3.70, 6.62, 7.83 and 8.47) and V_3 (2.14, 3.80, 6.56, 7.82 and 8.77), while the lowest number of branches plant^{-1} were observed from V_1 (1.59, 3.13, 6.88, 7.10 and 7.39) which was followed by V_2 (1.74, 3.46, 6.11, 8.00 and 8.99), respectively (Figure 5). These results are in conformity with that of Jahan and Zakaria (1997) who observed varietal differences in terms of primary branches per plant. Hakim *et al*. (2014) reported that S-9 ranked 1st with 10.84 branches per plant, while variety Early Mustard resulted 9.25 branches per plant.

Number of branches plant^{-1} at 30, 40, 50, 60 DAS and at harvest showed significant differences due to the interaction effect of sowing dates and mustard varieties (Appendix IV). At 30, 40, 50, 60 DAS and at harvest, the highest number of branches per plant was recorded from S_2V_4 (2.46, 5.40, 7.80, 9.07 and 9.98) and the lowest number was recorded from S_3V_1 (1.38, 2.47, 4.67, 6.00 and 6.27), respectively (Table 2).

4.3 Days to first flowering

Different sowing dates showed significant variation in terms of days to flowering (Appendix V). The minimum days to flowering was found from S_3 (28.73 days) which was statistically similar to S_2 (29.00 days), while the maximum days to flowering was recorded from S_1 (30.40) treatment (Table 3). Delay in sowing reduced the number of days to flowering. In case of early sowing plant experienced little warm temperature during vegetative stage as a result the growth became slow that is why maturity periods were longer, and later sowing plants completed vegetative growth earlier than the plant of early sowing. Mondal *et al.* (1999) stated that, seeding date significantly influenced days to flowering and delayed sowing reduced days to flowering. Khatun *et al*. (2011) reported the minimum days to flowering under 01 November sowing followed by 21 October sowing.

Table 2.Interaction effect of different sowing dates and varieties on number of branches per plant at different days after sowing (DAS) of mustard

Treatments	Number of branches plant^{-1} at				
	30 DAS	40 DAS	50 DAS	60 DAS	Harvest
S_1V_1	1.49 g	3.60 c-f	5.80 bc	7.60 cd	7.33 fg
S_1V_2	1.86 f	3.67 c-e	6.33 bc	8.20 bc	9.20 bc
S_1V_3	2.03 de	4.20 bc	6.67 b	7.93 c	8.93 cd
S_1V_4	2.37 ab	4.13 b-d	7.80 a	7.90 c	8.87 cd
S_1V_5	2.26 bc	3.80 c-e	6.67 b	7.90 c	8.10 d-g
S_2V_1	1.92 ef	3.20 e-g	5.87 bc	8.20 bc	8.57 c-e
S_2V_2	1.52 g	3.73 c-e	6.27 bc	8.80 ab	9.92 ab
S_2V_3	2.12 cd	3.47 d-f	6.60 b	8.07 c	9.17 bc
S_2V_4	2.46 a	5.40 a	7.80 a	9.07 a	9.98 a
S_2V_5	2.23 bc	4.53 b	7.73 a	8.00 c	8.97 cd
S_3V_1	1.38 g	2.47 h	4.67 d	6.00 f	6.27 h
S_3V_2	1.83 f	2.97 f-h	5.73 bc	7.00 de	7.67 e-g
S_3V_3	2.28 b	3.73 c-e	6.40 bc	6.47 e	7.13 gh
S_3V_4	1.82 f	2.60 gh	5.97 bc	7.00 de	7.83 e-g
S_3V_5	1.88 ef	2.77 gh	5.47 cd	7.60 cd	8.33 c-f
$LSD_{(0.05)}$	0.150	0.605	0.850	0.673	0.930
Level of significance	0.01	0.01	0.01	0.01	0.05
CV(%)	4.67	7.83	6.05	4.63	5.32

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

S_1: Sowing at 13 November
S_2: Sowing at 20 November
S_3: Sowing at 27 November

V_1: SAU Sarisha-14
V_2: SAU Sarisha-15
V_3: SAU Sarisha-16
V_4: SAU Sarisha-18
V_5: BARI Sarisha-15

Table 3. Effect of different sowing dates and varieties on days to flowering and days to harvest, number of siliqua per plant and number of seeds per siliqua of mustard

Treatments	Days to flowering	Days to harvest	Number of siliqua plant^{-1}	Number of seeds siliqua^{-1}
Sowing dates				
S_1	30.40 a	92.87 a	88.33 a	24.85 a
S_2	29.00 b	90.00 b	89.27 a	25.08 a
S_3	28.73 b	89.00 b	80.47 b	22.20 b
$LSD_{(0.05)}$	0.700	1.986	3.510	0.870
Varieties				
V_1	33.44 a	93.33 a	80.44 b	21.27 d
V_2	28.56 b	91.67 ab	83.33 b	23.04 c
V_3	28.67 b	90.36 bc	88.44 a	25.20 ab
V_4	27.22 c	88.33 c	89.78 a	26.00 a
V_5	29.00 b	89.44 bc	88.11 a	24.71 b
$LSD_{(0.05)}$	0.903	2.564	4.531	1.122
Level of significance	0.01	0.01	0.01	0.01
CV(%)	6.58	5.29	5.45	4.83

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

S_1: Sowing at 13 November
S_2: Sowing at 20 November
S_3: Sowing at 27 November

V_1: SAU Sarisha-14
V_2: SAU Sarisha-15
V_3: SAU Sarisha-16
V_4: SAU Sarisha-18
V_5: BARI Sarisha-15

Days to flowering showed statistically significant variation due to different varieties of mustard (Appendix V). The minimum days to flowering was recorded from V_4 (27.22 days) which was closely followed by V_2 (28.56 days), V_3 (28.67 days) and V_5 (29.00 days) and they were statistically similar, whereas the maximum days to flowering was observed from V_1 (33.44 days) treatment (Table 3). Days to 1st flowering varied for different varieties might be due to genetical and environmental influences as well as management practices. BARI (2001) concluded that there was significant variation in days to flowering of mustard found in different varieties and highest days to flowering (32 days) was found in Jamalpur-1 variety and lowest in BARI Sarisha-10. Mamun *et al*. (2014) reported that BARI Sarisha-13 produced early flower than the others.

Interaction effect of sowing dates and mustard varieties showed significant differences on days to flowering (Appendix V). The minimum days to flowering was found from S_1V_4 (26.33 days), while the maximum days to flowering was obtained from S_1V_1 (38.67 days) treatment combination (Table 4).

4.4 Days to harvest

Days to harvest showed statistically significant differences due to different sowing dates (Appendix V). The minimum days to harvest was recorded from S_3 (89.00 days) which was statistically similar to S_2 (90.00 days), while the maximum days to harvest was observed from S_1 (92.87 days) treatment (Table 3). In case of early sowing plant faced little warm temperature during vegetative stage and the growth was slow that is why maturity periods were longer and later sowing plants completed vegetative growth earlier than the plant of early sowing due to highest temperature. Islam *et al.* (1994) stated that delayed sowing curtailed the period of crop duration in all varieties. In all sowings, varieties Tori-7 and TS-72 matured much earlier (75-78 days) than the other (90-107 days). Mondal *et al.* (1992) observed that there was a trend of reduction in days to maturity with delayed plantings. In the first planting it took 89 days to mature and in the last planting, this was 83 days.

Table 4. Interaction effect of different sowing dates and varieties on days to flowering & harvest, number of siliqua per plant and number of seeds per siliqua of mustard

Treatments	Days to flowering	Days to harvest	Number of siliqua plant^{-1}	Number of seeds siliqua^{-1}
S_1V_1	38.67 a	92.67 a-c	80.67 e-g	21.80 fg
S_1V_2	29.33 cd	93.33 a-c	85.67 b-f	24.07 c-e
S_1V_3	28.67 c-e	93.00 a-c	90.33 a-d	25.73 bc
S_1V_4	26.33 f	94.67 a	95.67 a	27.40 b
S_1V_5	29.00 c-e	90.67 a-d	89.33 a-e	25.27 b-d
S_2V_1	30.33 bc	94.00 ab	81.33 e-g	21.40 fg
S_2V_2	28.00 d-f	91.67 a-c	83.00 c-g	23.20 d-f
S_2V_3	29.00 c-e	89.40 b-d	91.00 a-c	24.00 c-e
S_2V_4	28.00 d-f	86.00 de	97.67 a	30.20 a
S_2V_5	29.67 cd	89.00 b-e	93.33 ab	26.60 b
S_3V_1	31.33 b	93.33 a-c	76.00 g	20.40 g
S_3V_2	28.33 de	90.00 a-d	81.33 e-g	21.87 fg
S_3V_3	28.33 de	88.67 c-e	84.00 c-g	25.87 bc
S_3V_4	27.33 ef	84.33 e	79.33 fg	20.60 g
S_3V_5	28.33 de	88.67 c-e	81.67 d-g	22.27 e-g
$LSD_{(0.05)}$	1.564	4.441	7.848	1.943
Level of significance	0.01	0.05	0.05	0.01
CV(%)	6.58	5.29	5.45	4.83

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

S_1: Sowing at 13 November
S_2: Sowing at 20 November
S_3: Sowing at 27 November

V_1: SAU Sarisha-14
V_2: SAU Sarisha-15
V_3: SAU Sarisha-16
V_4: SAU Sarisha-18
V_5: BARI Sarisha-15

Different varieties of mustard varied significantly in terms of days to harvest (Appendix V). Data revealed that the minimum days to harvest was recorded from V_4 (88.33 days) which was statistically similar to V_5 (89.44 days) and V_3 (90.36 days). On the other hand, the maximum days to harvest was found from V_1 (93.33 days) which was statistically similar to V_2 (91.67 days) treatment (Table 3). Days to harvest varied due to genetical and environmental influences but management practices also influenced it.

Statistically significant variation was recorded due to the interaction effect of sowing dates and mustard varieties in terms of days to harvest (Appendix V). The minimum days to harvest was recorded from S_3V_4 (84.33 days) and the maximum days to harvest was recorded from S_1V_4 (94.67 days) treatment combination (Table 4).

4.5 Number of siliqua per plant

Different sowing dates showed significant variation in terms of number of siliqua per plant (Appendix V). The highest number of siliqua per plant was found from S_2 (89.27) which was statistically similar to S_1 (88.33), whereas the lowest number of siliqua per plant from S_3 (80.47) treatment (Table 3). Gawariya *et al*. (2015) reported sowing during 1st October recorded significantly higher crop yield attributing characters viz. siliquae per plant compared to 31st October and 15th November.

Number of siliqua per plant showed statistically significant variation due to different varieties of mustard (Appendix V). The highest number of siliqua per plant was obtained from V_4 (89.78) which was statistically similar to V_3 (88.44) and V_5 (88.11), while the lowest number of siliqua per plant was recorded from V_1 (80.44) which was statistically similar to V_2 (83.33) treatment (Table 3). Different varieties responded differently for siliqua per plant to input supply, method of cultivation and the prevailing environment during the growing season. Mamun *et al*. (2014) reported that BARI Sarisha-13 performed well in terms of siliqua per

plant (126.90). Hossain *et al.* (1996) found the highest siliqua per plant (187.3) in BLN-900 and the lowest (150.4) in Semu 249/84.

Interaction effect of sowing dates and mustard varieties showed significant differences on number of siliqua per plant (Appendix V). The highest number of siliqua per plant was observed from S_2V_4 (97.67) and the lowest number of siliqua per plant was found from S_3V_1 (76.00) treatment combination (Table 4).

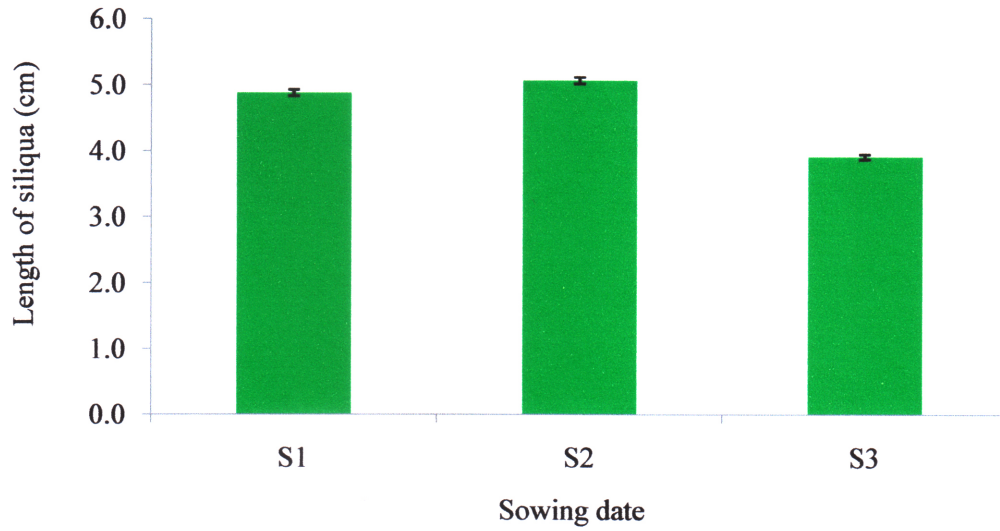
4.6 Length of siliqua

Statistically significant variation was recorded due to different sowing dates in terms of length of siliqua (Appendix V). The longest siliqua was observed from S_2 (5.07 cm) which was statistically similar to S_1 (4.88 cm), while the shortest siliqua was found from S_3 (3.91 cm) treatment (Figure 6). Significant variations due to different dates of sowing were found in respect of siliqua length and other traits. Siliqua length showed decreasing tendency with delay in sowing. Hossain *et al.* (1996) found significant variation in siliqua length in mustard due to planting time.

Length of siliqua showed statistically significant variation due to different varieties of mustard (Appendix V). The longest siliqua was obtained from V_4 (5.00 cm) which was statistically similar to V_3 (4.80 cm) and V_5 (4.70 cm), whereas the shortest siliqua was recorded from V_1 (4.13 cm) which was statistically similar to V_2 (4.46 cm) treatment (Figure 7). Hussain *et al.* (2008) reported that BARI sharisha-11 and BARI sharisha-8 performed better in terms of siliqua length. BARI (1999) reported that varieties had significant variation in siliqua length. The highest siliqua length was found in Daulat and lowest in Dhali. Hussain *et al.* (1996) observed the longest siliqua (8.07 cm) in BLN-900 and the shortest (4.83 cm) in Hyola-401.

Interaction effect of sowing dates and mustard varieties showed significant differences on length of siliqua (Appendix V). The longest siliqua was observed

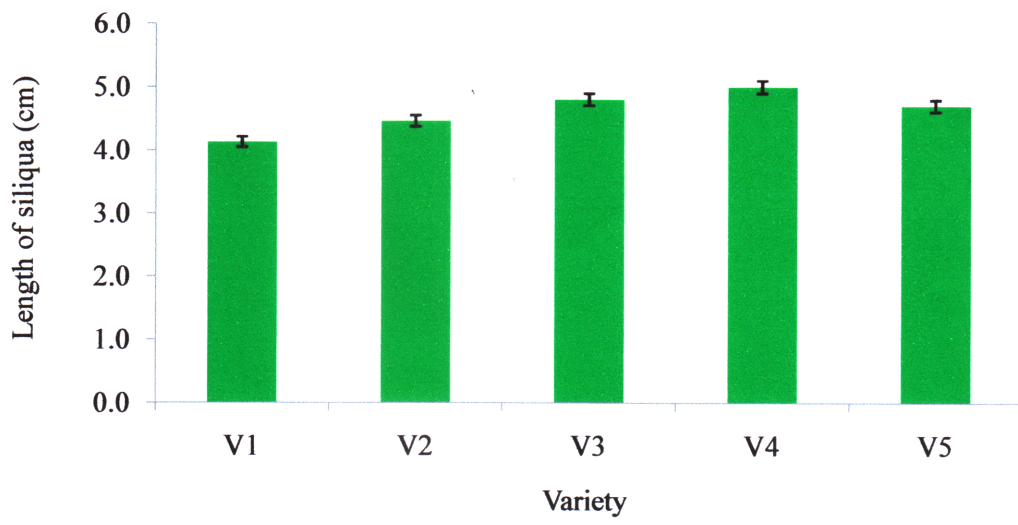
from S_2V_4 (6.40 cm), while the shortest siliqua was found from S_3V_1 (3.47 cm) treatment combination (Figure 8).



S_1: Sowing at 13 November S_2: Sowing at 20 November

S_3: Sowing at 27 November

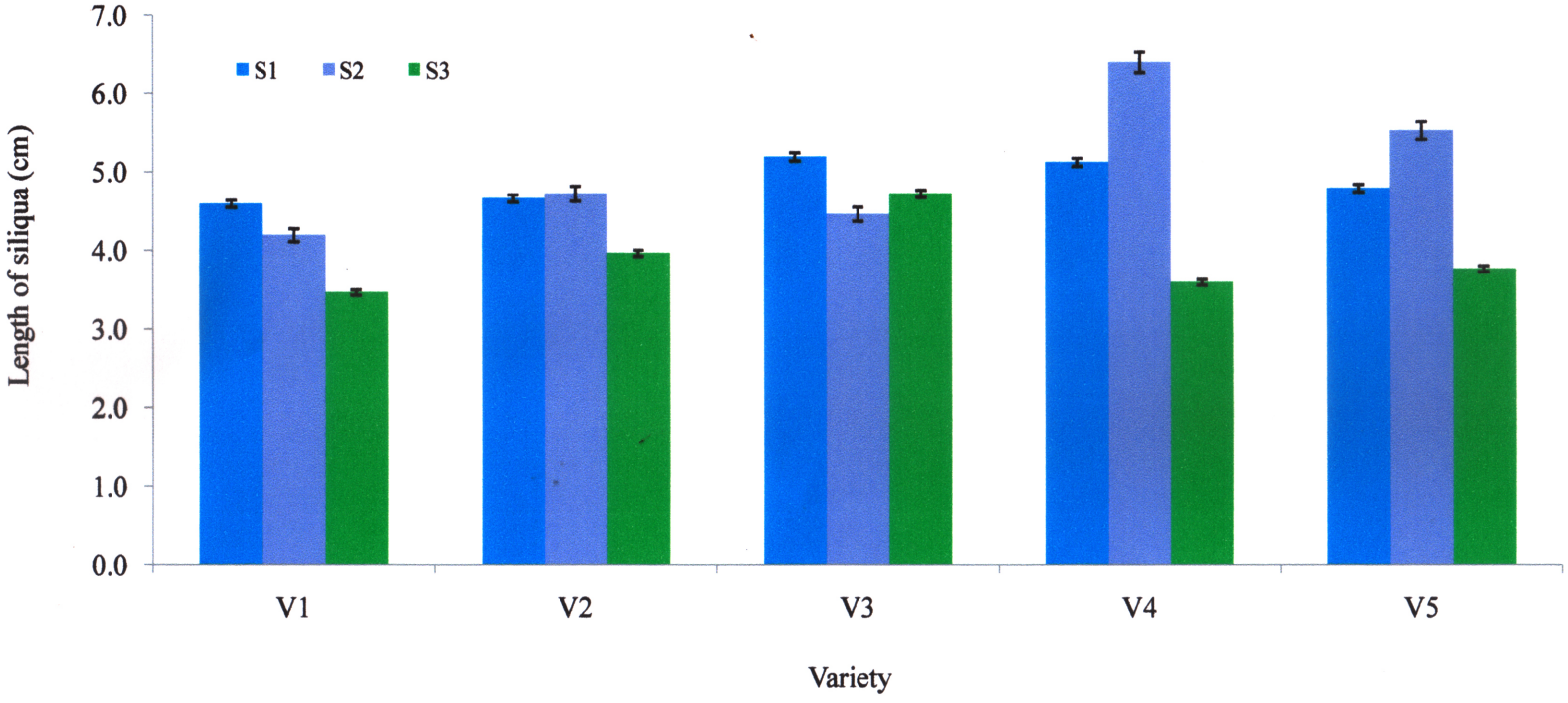
Figure 6. Effect of different sowing dates on length of siliqua of mustard. Vertical bars reporesnt LSD value



V_1: SAU Sarisha-14 V_2: SAU Sarisha-15 V_3: SAU Sarisha-16

V_4: SAU Sarisha-18 V_5 BARI Sarisha-15

Figure 7. Effect of different varieties on length of siliqua of mustard. Vertical bars reporesnt LSD value



S_1: Sowing at 13 November S_2: Sowing at 20 November V_1: SAU Sarisha-14 V_2: SAU Sarisha-15 V_3: SAU Sarisha-16

S_3: Sowing at 27 November V_4: SAU Sarisha-18 V_5 BARI Sarisha-15

Figure 8. Interaction effect of different sowing dates and varieties on length of siliqua of mustard. Vertical bars reporesnt LSD value.

4.7 Number of seeds siliqua^{-1}

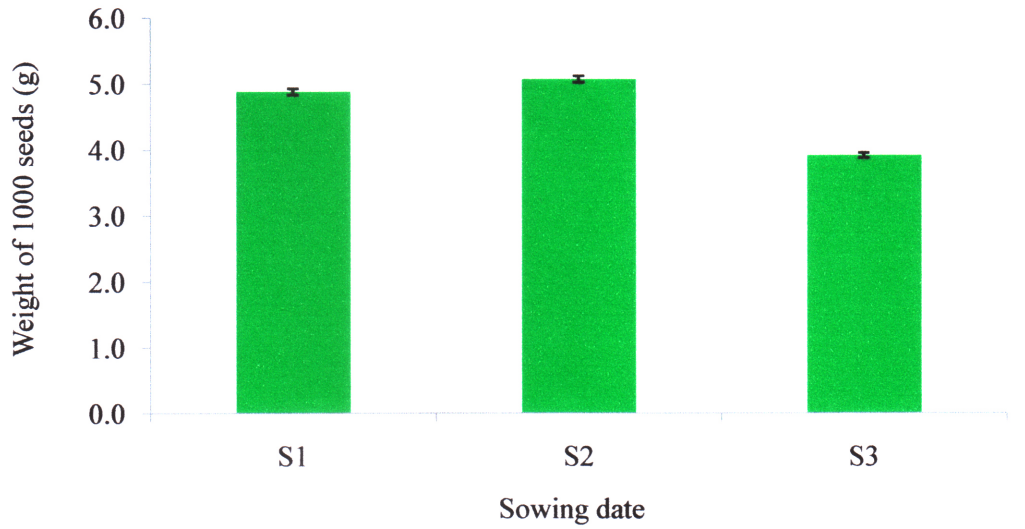
Different sowing dates showed significant variation in terms of number of seeds siliqua^{-1} (Appendix V). The highest number of seeds siliqua^{-1} was recorded from S_2 (25.08) which was statistically similar to S_1 (24.85), whereas the lowest number of seeds siliqua^{-1} was observed from S_3 (22.20) treatment (Table 3). Number of seeds siliqua^{-1} decreased progressively with delay in planting. Khatun *et al*. (2011) to find out the effect of sowing dates and varieties and reported the highest number of seeds siliqua (5.67) was recorded under 01 November sowing followed by 21 October sowing.

Number of seeds siliqua^{-1} showed statistically significant variation due to different varieties of mustard (Appendix V). The highest number of seeds siliqua^{-1} was recorded from V_4 (26.00) which was statistically similar to V_3 (25.20) and closely followed by V_5 (24.71). On the other hand, the lowest number of seeds siliqua^{-1} was found from V_1 (21.27) which was followed by V_2 (23.04) treatment (Table 3). Mamun *et al*. (2014) reported that BARI Sarisha-13 performed well in terms of seeds per siliqua^{-1} (25.36).

Statistically significant variation was recorded due to the interaction effect of sowing dates and mustard varieties in terms of number of seeds siliqua^{-1} (Appendix V). The highest number of seeds siliqua^{-1} was recorded from S_2V_4 (30.20) and the lowest number of seeds siliqua^{-1} was recorded from S_3V_1 (20.40) treatment combination (Table 4).

4.8 Weight of 1000 seeds

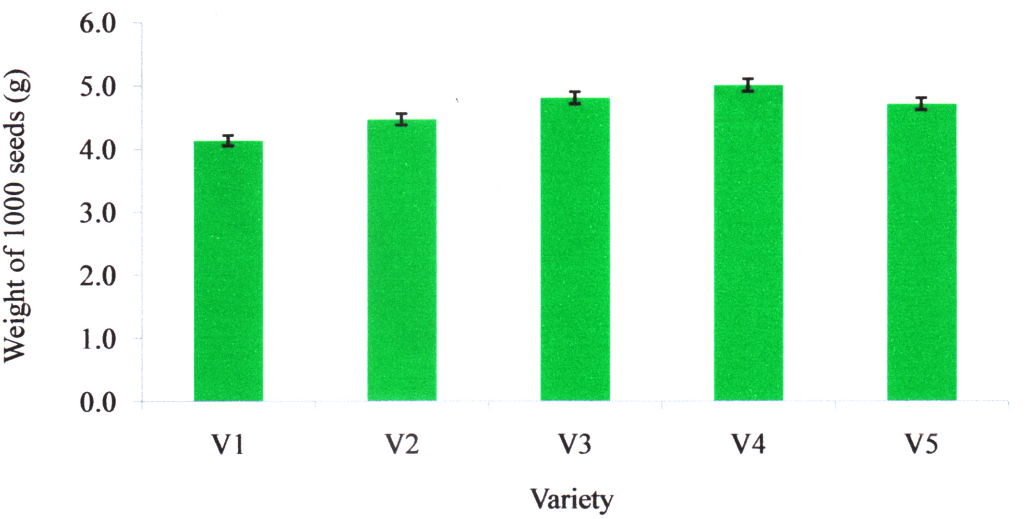
Different sowing dates showed significant variation in terms of weight of 1000 seeds (Appendix VI). The highest weight of 1000 seeds was found from S_2 (4.01 g) which was statistically similar to S_1 (3.93 g), while the lowest weight of 1000 seeds was recorded from S_3 (3.64 g) treatment (Figure 9). Ghosh and Chatterjee (1988) reported that one month later planting produced 32% reduction in seed weight. Saran and Giri (1987) observed that sowing in October 25 gave 11% higher 1000-seed weight than that of November 15 sowing.



S_1: Sowing at 13 November S_2: Sowing at 20 November

S_3: Sowing at 27 November

Figure 9. Effect of different sowing dates on weight of 1000 seeds of mustard. Vertical bars reporesnt LSD value



V_1: SAU Sarisha-14 V_2: SAU Sarisha-15 V_3: SAU Sarisha-16

V_4: SAU Sarisha-18 V_5 BARI Sarisha-15

Figure 10. Effect of different varieties on weight of 1000 seeds of mustard. Vertical bars reporesnt LSD value

Weight of 1000 seeds showed statistically significant variation due to different varieties of mustard (Appendix VI). The highest weight of 1000 seeds was recorded from V_4 (3.97 g) which was statistically similar to V_5 (3.96 g) and V_3 (3.90 g), while the lowest weight of 1000 seeds was observed from V_1 (3.65 g) which was statistically similar to V_2 (3.82 g) treatment (Figure 10). Karim *et al.* (2000) stated that varieties showed significant influence in weight of thousand seeds.

Interaction effect of sowing dates and mustard varieties showed significant differences on weight of 1000 seeds (Appendix VI). The highest weight of 1000 seeds was found from S_2V_4 (4.32 g) and the lowest weight of 1000 seeds was observed from S_3V_4 (3.42 g) treatment combination (Figure 11).

4.9 Seed yield

Seed yield showed statistically significant variation due to different sowing dates (Appendix VI). The highest seed yield was recorded from S_2 (1.70 t/ha) which was statistically similar to S_1 (1.66 t ha) and the lowest seed yield was observed from S_3 (1.37 t/ha) treatment (Table 5). Gawariya *et al*. (2015) recorded significantly higher crop yield attributing characters and ultimately seed yield (2013 kg/ha) compared to 31st October and 15th November.

Statistically significant variation due to different varieties of mustard in terms of seed yield (Appendix VI). Data revealed that the highest seed yield was recorded from V_4 (1.68 t ha) which was statistically similar to V_5 (1.66 t/ha) and V_3 (1.63 t/ha), while the lowest seed yield was found from V_1 (1.42 t/ha) which was closely followed by V_2 (1.50 t/ha) treatment (Table 5). Varieties plays an important role in producing high yield of mustard and yield varied for different varieties might be due to genetical and environmental influences as well as management practices. BARI (2001) reported that seed yield and other yield contributing characters significantly varied among the varieties. Hakim *et al*. (2014) reported that S-9 ranked 1st with 1960.30 kg seed yield/ha, while variety Early Mustard resulted 1677.90 kg seed yield/ha.

Table 5. Effect of different sowing dates and varieties on grain, straw & biological yield and harvest index of mustard

Treatments	Seed yield (t ha^{-1})	Stover yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
Sowing dates				
S_1	1.66 a	2.55 a	4.21 a	39.42
S_2	1.70 a	2.59 a	4.29 a	39.65
S_3	1.37 b	2.16 b	3.53 b	38.83
$LSD_{(0.05)}$	0.063	0.108	0.147	--
Level of significance	0.01	0.01	0.01	NS
Varieties				
V_1	1.42 c	2.25 c	3.67 c	38.71
V_2	1.50 b	2.39 b	3.89 b	38.57
V_3	1.63 a	2.47 ab	4.10 a	39.75
V_4	1.68 a	2.55 a	4.23 a	39.55
V_5	1.66 a	2.49 ab	4.15 a	39.93
$LSD_{(0.05)}$	0.081	0.140	0.188	--
Level of significance	0.01	0.01	0.01	NS
CV(%)	5.35	6.08	4.88	3.81

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

S_1: Sowing at 13 November
S_2: Sowing at 20 November
S_3: Sowing at 27 November

V_1: SAU Sarisha-14
V_2: SAU Sarisha-15
V_3: SAU Sarisha-16
V_4: SAU Sarisha-18
V_5: BARI Sarisha-15

Seed yield of mustard showed significant differences due to the interaction effect of sowing dates and mustard varieties (Appendix VI). The highest seed yield was recorded from S_2V_4 (1.89 t/ha), whereas the lowest seed yield was recorded from S_3V_1 (1.27 t/ha) treatment combination (Table 6).

4.10 Stover yield

Different sowing dates showed significant variation in terms of stover yield (Appendix VI). The highest stover yield was found from S_2 (2.59 t/ha) which was statistically similar to S_1 (2.55 t/ha), while the lowest stover yield was obtained from S_3 (2.16 t/ ha) treatment (Table 5). Sattar *et al*. (2013) reported that stover yield was decreased due to delayed sowing. The decline of stover yield with delay in sowing date could be largely explained by the decline in biomass at maturity. Islam *et al*. (1994) stated that stover yield was significantly influenced by sowing time and higher stover yield was observed in October 20 sowing that gradually decreased in December 02 sowing.

Stover yield showed statistically significant variation due to different varieties of mustard (Appendix VI). The highest stover yield was observed from V_4 (2.55 t ha^{-1}) which was statistically similar to V_5 (2.49 t ha) and V_3 (2.47 t/ ha). On the other hand, the lowest stover yield was recorded from V_1 (2.25 t/ha) which was closely followed by V_2 (2.39 t/ha) treatment (Table 5). BARI (2000) reported that in case of poor management Isd-local provided the highest straw yield (3779 kg/ha) and lowest yield (1295 kg/ha) was found from Nap-248. The highest straw yield, 6400 kg was obtained from the variety Rai-5 and lowest 4413.3 kg/ha was obtained from variety Tori-7.

Interaction effect of sowing dates and mustard varieties showed significant differences on stover yield (Appendix VI). The highest stover yield was observed from S_2V_4 (2.84 t/ha) and the lowest stover yield was found from S_3V_1 (2.08 t/ ha) treatment combination (Table 6).

Table 6. Interaction effect of different sowing dates and varieties on grain, straw & biological yield and harvest index of mustard

Treatments	Seed yield (t ha^{-1})	Stover yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
S_1V_1	1.47 de	2.37 c-f	3.84 de	38.35
S_1V_2	1.61 cd	2.48 b-e	4.09 cd	39.28
S_1V_3	1.72 bc	2.64 ab	4.36 bc	39.45
S_1V_4	1.81 ab	2.72 ab	4.53 ab	39.95
S_1V_5	1.70 bc	2.54 b-d	4.24 bc	40.08
S_2V_1	1.52 d	2.30 d-g	3.82 de	39.82
S_2V_2	1.60 cd	2.45 b-e	4.05 cd	39.52
S_2V_3	1.69 bc	2.61 a-c	4.30 bc	39.22
S_2V_4	1.89 a	2.84 a	4.73 a	39.92
S_2V_5	1.80 ab	2.73 ab	4.52 ab	39.76
S_3V_1	1.27 f	2.08 g	3.35 f	37.95
S_3V_2	1.30 f	2.23 e-g	3.53 ef	36.89
S_3V_3	1.47 de	2.16 fg	3.63 ef	40.59
S_3V_4	1.33 ef	2.10 fg	3.42 f	38.78
S_3V_5	1.47 de	2.22 e-g	3.69 ef	39.96
$LSD_{(0.05)}$	0.140	0.242	0.326	--
Level of significance	0.05	0.05	0.05	NS
CV(%)	5.35	6.08	4.88	3.81

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

S_1: Sowing at 13 November
S_2: Sowing at 20 November
S_3: Sowing at 27 November

V_1: SAU Sarisha-14
V_2: SAU Sarisha-15
V_3: SAU Sarisha-16
V_4: SAU Sarisha-18
V_5: BARI Sarisha-15

4.11 Biological yield

Different sowing dates showed significant variation in terms of biological yield (Appendix VI). The highest biological yield was observed from S_2 (4.29 t/ha) which was statistically similar to S_1 (4.21 t/ha), whereas the lowest biological yield was recorded from S_3 (3.53 t/ ha) treatment (Table 5). Sihag *et al.* (2003) recorded the highest biological yield (65.23 q / ha) was obtained in October 15 sown crops.

Biological yield showed statistically significant variation due to different varieties of mustard (Appendix VI). The highest biological yield was recorded from V_4 (4.23 t/ ha) which was statistically similar to V_5 (4.15 t /ha) and V_3 (4.10 t/ ha), while the lowest biological yield was found from V_1 (3.67 t /ha) which was closely followed by V_2 (3.89 t/ ha) treatment (Table 5). Jahan and Zakaria (1997) stated that yield variation is present in different varieties. They found highest biological yield in the exotic variety BLN-400 (5134.34 kg/ ha) and the lowest seed yield was in AGA-95-21 (2155.8 kg/ ha).

Statistically significant variation was observed due to the interaction effect of sowing dates and mustard varieties in terms of biological yield (Appendix VI). The highest biological yield was recorded from S_2V_4 (4.73 t /ha) and the lowest biological yield was recorded from S_3V_1 (3.35 t /ha) treatment combination (Table 6).

4.12 Harvest index

Different sowing dates showed statistically non significant variation in terms of harvest index yield (Appendix VI). The highest harvest index was found from S_2 (39.65%) and the lowest harvest index was observed from S_3 (38.83%) treatment (Table 5). Seed yield and dry matter accumulation was positively correlated with heat unit accumulation and accumulation of heat unit varied with growth stage, variety and sowing time. The temperature fluctuation caused the variation in the accumulation of thermal units in plants and it affected harvest index of mustard (Gfadakar *et al*., 1988).

Harvest index showed statistically non significant variation due to different varieties of mustard (Appendix VI). The highest harvest index was observed from V_5 (39.93%), while the lowest harvest index was recorded from V_2 (38.57%) treatment (Table 5). Bhargava and Tomer (1982) noticed variation in harvest index values from 27 to 40 percent.

Interaction effect of sowing dates and mustard varieties showed non significant differences on harvest index (Appendix VI). The highest harvest index was recorded from S_3V_3 (40.59%), whereas the lowest harvest index was observed from S_3V_2 (36.89%) treatment combination (Table 6).

CHAPTER V

SUMMARY AND CONCLUSION

For different sowing dates, at 30, 40, 50, 60 DAS and at harvest, the tallest plants (33.39, 54.89, 71.88, 88.83 and 93.07 cm) was recorded from S_2, while the shortest plants (29.46, 50.45, 67.75, 83.79 and 88.30 cm) was found from S_3. At 30, 40, 50, 60 DAS and at harvest, the highest number of branches plant^{-1} was found from S_2 (2.03, 4.07, 6.85, 8.43 and 9.41), whereas the lowest number of branches per plant was observed from S_3 (1.84, 2.91, 5.65, 6.71 and 7.45), respectively. The minimum days to flowering was found from S_3 (28.73 days), while the maximum days to flowering was recorded from S_1 (30.40). The minimum days to harvest was recorded from S_3 (89.00 days), while the maximum days to harvest was observed from S_1 (92.87 days). The highest number of siliqua per plant was found from S_2 (89.27), whereas the lowest number of siliqua plant^{-1} was recorded from S_3 (80.47). The longest siliqua was observed from S_2 (5.07 cm), while the shortest siliqua was found from S_3 (3.91 cm). The highest number of seeds per siliqua was recorded from S_2 (25.08), whereas the lowest number of seeds per siliqua was observed from S_3 (22.20) treatment. The highest weight of 1000 of seeds was found from S_2 (4.01 g), while the lowest weight of 1000 of seeds was recorded from S_3 (3.64 g). The highest seed yield was recorded from S_2 (1.70 t ha^{-1}) and the lowest seed yield was observed from S_3 (1.37 t ha^{-1}). The highest stover yield was found from S_2 (2.59 t ha^{-1}), while the lowest stover yield was attained from S_3 (2.16 t ha^{-1}). The highest biological yield was observed from S_2 (4.29 t ha^{-1}), whereas the lowest biological yield was recorded from S_3 (3.53 t ha^{-1}). The highest harvest index was found from S_2 (39.65%) and the lowest harvest index was observed from S_3 (38.83%).

In case of different varieties of mustard, at 30, 40, 50, 60 DAS and at harvest, the tallest plants (34.34, 55.96, 72.76, 89.82 and 93.68 cm) was observed from V_4, whereas the shortest plants (29.06, 48.03, 65.59, 81.69 and 86.26 cm) was

recorded from V_1. At 30, 40, 50, 60 DAS and at harvest, the highest number of branches per plant was recorded from V_4 (2.22, 4.00, 6.76, 7.66 and 8.62), while the lowest number of branches plant^{-1} was observed from V_1 (1.59, 3.13, 6.88, 7.10 and 7.39). The minimum days to flowering was recorded from V_4 (27.22 days), whereas the maximum days to flowering was observed from V_1 (33.44 days). The minimum days to harvest was recorded from V_4 (88.33 days) and the maximum days to harvest was found from V_1 (93.33 days). The highest number of siliqua plant was obtained from V_4 (89.78), while the lowest number of siliqua per plant was recorded from V_1 (80.44). The longest siliqua was obtained from V_4 (5.00 cm), whereas the shortest siliqua was recorded from V_1 (4.13 cm). The highest number of seeds per siliqua^{-1} was recorded from V_4 (26.00) and the lowest number of seeds per siliqua was found from V_1 (21.27). The highest weight of 1000 of seeds was recorded from V_4 (3.97 g), while the lowest weight of 1000 of seeds was observed from V_1 (3.65 g). The highest seed yield was recorded from V_4 (1.68 t ha^{-1}), while the lowest seed yield was found from V_1 (1.42 t ha^{-1}). The highest stover yield was observed from V_4 (2.55 t ha^{-1}) and the lowest stover yield was recorded from V_1 (2.25 t ha^{-1}). The highest biological yield was recorded from V_4 (4.23 t ha^{-1}), while the lowest biological yield was found from V_1 (3.67 t ha^{-1}). The highest harvest index was observed from V_5 (39.93%), while the lowest harvest index was recorded from V_2 (38.57%).

Due to the interaction effect of sowing dates and mustard varieties, at 30, 40, 50, 60 DAS and at harvest, the tallest plants (39.57, 62.60, 76.46, 96.87 and 98.86 cm) was observed from S_2V_4, while the shortest plants (27.87, 46.20, 63.85, 79.83 and 85.25 cm) was found from S_3V_1. At 30, 40, 50, 60 DAS and at harvest, the highest number of branches per plant was recorded from S_2V_4 (2.46, 5.40, 7.80, 9.07 and 9.98) and the lowest number was recorded from S_3V_1 (1.38, 2.47, 4.67, 6.00 and 6.27), respectively. The minimum days to flowering was found from S_1V_4 (26.33 days), while the maximum days to flowering was obtained from S_1V_1 (38.67 days). The minimum days to harvest was recorded from S_3V_4 (84.33 days) and the maximum days to harvest was recorded from S_1V_4 (94.67 days). The

highest number of siliqua per plant was observed from S_2V_4 (97.67) and the lowest number of siliqua per plant was found from S_3V_1 (76.00). The longest siliqua was observed from S_2V_4 (6.40 cm), while the shortest siliqua was found from S_3V_1 (3.47 cm). The highest number of seeds per siliqua was recorded from S_2V_4 (30.20) and the lowest number of seeds per siliqua was recorded from S_3V_1 (20.40). The highest weight of 1000 of seeds was found from S_2V_4 (4.32 g) and the lowest weight of 1000 of seeds was observed from S_3V_4 (3.42 g). The highest seed yield was recorded from S_2V_4 (1.89 t ha^{-1}), whereas the lowest seed yield was recorded from S_3V_1 (1.27 t ha^{-1}). The highest stover yield was observed from S_2V_4 (2.84 t ha^{-1}) and the lowest stover yield was found from S_3V_1 (2.08 t ha^{-1}). The highest biological yield was recorded from S_2V_4 (4.73 t ha^{-1}) and the lowest biological yield was recorded from S_3V_1 (3.35 t ha^{-1}). The highest harvest index was recorded from S_3V_3 (40.59%), whereas the lowest harvest index was observed from S_3V_2 (36.89%).

conclusion

It was revealed that 20 November sowing provided better yield with bette ield contributing characters .Among the varieties SAU Sharisha-18 was the least in performance .

More experiments may be carried out with other organic, inorganic and also macro nutrients and also other management practices.

RECOMMENDATION

Considering the above results of this experiment, further studies in the following areas may be suggested:

Such study is needed in different agro-ecological zones (AEZ) of Bangladesh for regional compliance and other performances.

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APPENDICES

Appendix I. Monthly record of air temperature, relative humidity, rainfall and sunshine hour of the experimental site during the period from November 2013 to February 2014

Month	*Air temperature (°c)		*Relative humidity (%)	Total Rainfall (mm)	*Sunshine (hr)
	Maximum	Minimum			
November, 2013	25.8	16.0	78	00	6.8
December, 2013	22.4	13.5	74	00	6.3
January, 2014	24.5	12.4	68	00	5.7
February, 2014	27.1	16.7	67	30	6.7

* Monthly average,

* Source: Bangladesh Meteorological Department (Climate & weather division) Agargoan, Dhaka – 1212

Appendix II. Characteristics of soil of experimental field

A. Characteristics of the experimental field

Morphological features	Characteristics
Location	Agricultural Botany field , SAU, Dhaka
AEZ	Madhupur Tract (28)
General Soil Type	Shallow red brown terrace soil
Land type	High land
Soil series	Tejgaon
Topography	Fairly leveled

B. Physical and chemical properties of the initial soil

Characteristics	Value
% Sand	27
% Silt	43
% clay	30
Textural class	Silty-clay
pH	6.1
Organic matter (%)	1.13
Total N (%)	0.03
Available P (ppm)	20.00
Exchangeable K (me/100 g soil)	0.10
Available S (ppm)	23

Source: Soil Resources Development Institute (SRDI), Khamarbari, Farmgate, Dhaka

Appendix III. Analysis of variance of the data on plant height of mustard at different days after sowing (DAS) as influenced by different sowing dates and varieties

Source of variation	Degrees of freedom	Mean square				
		Plant height (cm) at				
		30 DAS	40 DAS	50 DAS	60 DAS	Harvest
Replication	2	1.426	6.695	0.889	3.562	3.580
Sowing date (A)	2	134.472**	170.344**	175.048**	214.390**	221.635**
Variety (B)	4	81.236**	150.292**	134.153**	170.297**	209.434**
Interaction (A×B)	8	15.936*	25.990**	29.316*	27.981*	31.940**
Error	28	6.400	8.416	12.215	10.692	13.408

** Significant at 0.01 level of probability; * Significant at 0.05 level of probability

Appendix IV. Analysis of variance of the data on number of branches plant^{-1} of mustard at different days after sowing (DAS) as influenced by different sowing dates and varieties

Source of variation	Degrees of freedom	Mean square				
		Number of branches plant^{-1} at				
		30 DAS	40 DAS	50 DAS	60 DAS	Harvest
Replication	2	0.007	0.002	0.182	0.058	0.269
Sowing date (A)	2	0.588**	7.604**	9.349**	11.576**	14.424**
Variety (B)	4	0.831**	1.986**	1.764**	1.087**	3.480**
Interaction (A×B)	8	0.182**	1.230**	1.721**	0.798**	0.858*
Error	28	0.008	0.134	0.264	0.162	0.309

** Significant at 0.01 level of probability; * Significant at 0.05 level of probability

Appendix V. Analysis of variance of the data on yield contributing characters of mustard as influenced by different sowing dates and varieties

Source of variation	Degrees of freedom	Mean square				
		Days to flowering	Days to harvest	Number of siliqua plant^{-1}	Length of siliqua (cm)	Number of seeds siliqua^{-1}
Replication	2	0.422	0.779	6.489	0.002	0.097
Sowing date (A)	2	12.022**	129.099**	440.689**	7.604**	59.006**
Variety (B)	4	50.644**	34.061**	161.111**	1.986**	42.822**
Interaction (A×B)	8	13.828**	15.321*	38.244*	1.230**	15.202**
Error	28	0.875	7.050	21.537	0.134	1.350

** Significant at 0.01 level of probability; * Significant at 0.05 level of probability

Appendix VI. Analysis of variance of the data on weight of 1000 seeds, grain, straw and biological yield, harvest index of mustard as influenced by different sowing dates and varieties

Source of variation	Degrees of freedom	Mean square				
		Weight of 1000 seeds (g)	Seed yield (t ha^{-1})	Stover yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
Replication	2	0.021	0.0001	0.009	0.011	0.736
Sowing date (A)	2	0.557**	0.494**	0.847**	2.636**	2.646
Variety (B)	4	0.154*	0.110**	0.125**	0.463**	3.506
Interaction (A×B)	8	0.125*	0.018*	0.043*	0.102*	2.407
Error	28	0.045	0.007	0.021	0.038	2.246

** Significant at 0.01 level of probability; * Significant at 0.05 level of probability

Appendix VII. Effect of different sowing dates and varieties on plant height at different days after sowing (DAS) of mustard

Treatments	Plant height (cm) at				
	30 DAS	40 DAS	50 DAS	60 DAS	Harvest
Sowing dates					
S_1	33.10 a	54.22 a	71.64 a	88.10 a	92.46 a
S_2	33.39 a	54.89 a	71.88 a	88.83 a	93.07 a
S_3	29.46 b	50.45 b	67.75 b	83.79 b	88.30 b
$LSD_{(0.05)}$	1.907	2.189	2.650	2.453	2.968
Level of significance	0.01	0.01	0.01	0.01	0.01
Varieties					
V_1	29.06 b	48.03 c	65.59 b	81.69 c	86.26 b
V_2	30.32 b	51.71 b	70.15 a	85.49 b	90.45 a
V_3	32.80 a	54.55 a	71.54 a	88.54 ab	92.46 a
V_4	34.34 a	55.96 a	72.76 a	89.82 a	93.68 a
V_5	33.39 a	55.68 a	72.08 a	89.01 a	93.53 a
$LSD_{(0.05)}$	2.462	2.826	3.421	3.167	3.832
Level of significance	0.01	0.01	0.01	0.01	0.01
CV(%)	8.50	5.61	5.86	4.90	5.57

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

S_1: Sowing at 13 November
S_2: Sowing at 20 November
S_3: Sowing at 27 November

V_1: SAU Sarisha-14
V_2: SAU Sarisha-15
V_3: SAU Sarisha-16
V_4: SAU Sarisha-18
V_5: BARI Sarisha-15

Appendix VIII. Effect of different sowing dates and variety on number of branches plant^{-1} at different days after sowing (DAS) of mustard

Treatments	Number of branches plant^{-1} at				
	30 DAS	40 DAS	50 DAS	60 DAS	Harvest
Sowing dates					
S_1	2.02 a	3.88 a	6.65 a	7.91 b	8.49 b
S_2	2.03 a	4.07 a	6.85 a	8.43 a	9.41 a
S_3	1.84 b	2.91 b	5.65 b	6.71 c	7.45 c
$LSD_{(0.05)}$	0.067	0.271	0.380	0.301	0.416
Level of significance	0.01	0.01	0.01	0.01	0.01
Varieties					
V_1	1.59 d	3.13 c	6.88 c	7.10 b	7.39 b
V_2	1.74 c	3.46 bc	6.11 bc	8.00 a	8.99 a
V_3	2.14 ab	3.80 ab	6.56 ab	7.82 a	8.77 a
V_4	2.22 a	4.00 a	6.76 a	7.66 a	8.62 a
V_5	2.12 b	3.70 ab	6.62 ab	7.83 a	8.47 a
$LSD_{(0.05)}$	0.086	0.350	0.491	0.389	0.537
Level of significance	0.01	0.01	0.01	0.01	0.01
CV(%)	4.67	7.83	6.05	4.63	5.32

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

S_1: Sowing at 13 November
S_2: Sowing at 20 November
S_3: Sowing at 27 November

V_1: SAU Sarisha-14
V_2: SAU Sarisha-15
V_3: SAU Sarisha-16
V_4: SAU Sarisha-18
V_5: BARI Sarisha-15

Appendix IX. Effect of different sowing dates and varieties on length of siliqua and weight of 1000 seeds of mustard

Treatments	Length of siliqua (cm)	Weight of 1000 seeds (g)
S_1	4.88 a	3.93 a
S_2	5.07 a	4.01 a
S_3	3.91 b	3.64 b
$LSD_{(0.05)}$	0.271	0.159
Level of significance	0.01	0.01
V_1	4.13 c	3.65 b
V_2	4.46 bc	3.82 ab
V_3	4.80 ab	3.90 a
V_4	5.00 a	3.97 a
V_5	4.70 ab	3.96 a
$LSD_{(0.05)}$	0.350	0.205
Level of significance	0.01	0.05
S_1V_1	4.60 c-f	3.62 de
S_1V_2	4.67 c-e	3.85 b-d
S_1V_3	5.20 bc	4.05 a-c
S_1V_4	5.13 b-d	4.16 ab
S_1V_5	4.80 c-e	3.95 a-d
S_2V_1	4.20 e-g	3.67 c-e
S_2V_2	4.73 c-e	3.81 b-e
S_2V_3	4.47 d-f	4.06 a-c
S_2V_4	6.40 a	4.32 a
S_2V_5	5.53 b	4.18 ab
S_3V_1	3.47 h	3.65 c-e
S_3V_2	3.97 f-h	3.80 b-e
S_3V_3	4.73 c-e	3.59 de
S_3V_4	3.60 gh	3.42 e
S_3V_5	3.77 gh	3.74 c-e
$LSD_{(0.05)}$	0.605	0.355
Level of significance	0.01	0.05
CV(%)	7.83	5.52

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

S_1: Sowing at 13 November
S_2: Sowing at 20 November
S_3: Sowing at 27 November

V_1: SAU Sarisha-14
V_2: SAU Sarisha-15
V_3: SAU Sarisha-16
V_4: SAU Sarisha-18
V_5: BARI Sarisha-15