EFFECT OF INFLORESCENCE-TOP CUTTING ON THE YIELD AND YIELD ATTRIBUTES OF MUSTARD VARIETIES UNDER DIFFERENT SOWING TIMES

MARJANA YEASMIN

DEPARTMENT OF AGRONOMY

SHER-E-BANGLA AGRICULTURAL UNIVERSITY

DHAKA -1207

June, 2013

EFFECT OF INFLORESCENCE-TOP CUTTING ON THE YIELD AND YIELD ATTRIBUTES OF MUSTARD VARIETIES UNDER DIFFERENT SOWING TIMES

BY

MARJANA YEASMIN

REGISTRATION NO. 06-01858

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

MASTER OF SCIENCE
IN
AGRONOMY
SEMESTER: JANUARY-JUNE, 2013

Approved by:

……………………………..

(Prof. Dr. Md. Jafar Ullah)
Supervisor

………………………..

(Prof. Dr. A. K. M. Ruhul Amin)
Co-supervisor

…………………………………

(Prof. Dr. A. K. M. Ruhul Amin)

Chairman

Depertment of Agronomy

CERTIFICATE

This is to certify that the thesis entitled, **"EFFECT OF INFLORESCENCE-TOP CUTTING ON THE YIELD AND YIELD ATTRIBUTES OF MUSTARD VARIETIES UNDER DIFFERENT SOWING TIMES"** submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in the partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE (M.S.) IN AGRONOMY,** embodies the result of a piece of *bona fide* research work carried out by **MARJANA YEASMIN,** Registration No. **06-01858** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

I further certify that such help or source of information, as has been availed during the course of this investigation has been duly acknowledged and style of this thesis have been approved and recommended for submission.

Dated:

Place: Dhaka, Bangladesh

____

(Prof. Dr. Md.Jafar Ullah)

Spervisor

Dedicated

To

My Beloved

Parents

DECLARATION

I do hereby declare that the thesis entitled ***"Effect of Inflorescence –top cutting on the yield and yield attributes of mustard varieties under different sowing times"*** has been written and composed by myself with my own investigated research data.

I further declare that this thesis has not been submitted anywhere in any form for any academic degree.

June 2013 (Marjana Yeasmin)

ACKNOWLEDGEMENT

At the beginning, the author bows the grace and mercy of the "Almighty Allah", the omnipresent, omnipotent and omniscient, Who enabled her to complete this thesis.

The author is proud of acknowledging his sincere and deepest sense of gratitude and immense indebtedness to his respected teacher and research Supervisor Prof. Dr. Md. Jafar Ullah , Department of Agronomy, Sher-e-Bangla Agricultural University, Dhaka for his untiring efforts, inspiration, encouragement, affectionate feelings, painstaking guidance, support and invaluable suggestions during research work and constructive criticism to improve the manuscript.

The author would like to express his boundless sincere and heartfelt gratitude to his Co-supervisor and Departmental Chairman Prof. Dr. A. K. M. Ruhul Amin, Department ofAgronomy, Sher-e-Bangla Agricultural University, Dhaka for his valuable suggestions, continuous and cordial help to successfully complete the study.

The author is deeply indebted to Prof. Dr. Md. Hazrat Ali, Prof. Dr. Parimal Kanti Biswas, Prof Dr. Fazlul Karim, Dr. Mirza Hasanuzzaman, Associate Professor, Department of Agronomy, Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka for his advice, sincere cooperation and suggestions in connection with this piece of research work.

The author is also grateful to all the teachers and staffs of the Department of Agronomy, Sher-e-Bangla Agricultural University, Dhaka for their co-operation.

Heartist thanks and gratitude are due to the officials of Sher-e-Bangla Agricultural University Research System (SAURES) and Farm Division of Sher-e-Bangla Agricultural University for their support to conduct the research.

The author is especially grateful to Prof. Noor Md. Rahmatullah, Department of Agricultural Statistics, and Prof. Dr. Md. Abdur Razzaque, Department of Agricultural Chemistry, Sher-e-Bangla Agricultural University, Dhaka for their advice and sincere co-operation in the completion of the study.

The author deeply owes his whole hearted thanks to all the relatives, friends, well wishers specially Md. Javed Azad, Mithun Roy, Debu Kumar Bhattacharjya and Ratina Chakma for their inspiration and help during the period of study.

Above all, the author reserves his boundless gratitude and indebtedness to his beloved parents, siblings, cousins, aunts, uncles, grandparents, for their love, prayers, sacrifice, encouragement and moral support which inspired him to complete this work in entire study period.

The Author

ABBREVIATIONS AND UNITS

Abbreviation

AEZ	Agro Ecological Zone
BARI	Bangladesh Agricultural Research Institute
BBS	Bangladesh Bureau of Statistics
BINA	Bangladesh Institute of Nuclear Agriculture
C.V.	Coefficient of Variation
E	East
et al.	*et alibi* (and others)
etc.	*et cetra* (and so on)
FAO	Food and Agricultural Organization
Fig.	Figure
HI	Harvest index
i.e.	id est (that is)
DMRT	Duncun’s Multiple Range Test
N	North
SAU	Sher-e-Bngla Agricultural University
viz.	Videlict (namely)

UNIT

%	Percentage
^{0}C	Degree Celsius
cm	Centimeter
g	Gram
ha	Hectare
kcal	Kilocalorie
kg	Kilogram
m	Meter
t	Ton

ABSTRACT

An experiment was conducted at the Agronomy field of Sher-e-Bangla Agricultural University, Dhaka-1207 to evaluate the effect of inflorescence top cutting on the seed yield and yield attributes of mustard varieties under varying sowing and cutting times during November, 2011 to February, 2012. It was laid out in a split split plot design with three replications, three sowing times (01 November- S_1, 15 November- S_2 and 30 November-S_3), three varieties (V_1-Tori-7, V_2- BARI Sarisha-9 and V_3- BARI Sarisha-15) and three inflorescence top-cutting times (C_0, C_1 and C_2) were tested. S_2 had significantly higher plant height. Significantly higher number of inflorescence were obtained in S_1C_2 (6.67), S_2C_1 (6.50), V_1C_1 (5.17), V_1C_2 (6.37) and $S_1V_1C_2$ (7.80). Significantly higher number of siliqua was obtained in S_1 and S_2 of V_1 (140.47, 144.90) and V_2 (137.17, 144.90). Significantly higher filled siliqua was obtained in $S_2V_2C_2$ (165.17). S_1 and S_2 in V_3 had significantly higher siliqua fresh weight with both C_1 and C_2 (0.30 g, 0.31g to 0.30g, 0.29g). Significantly higher 1000-seed weight was also obtained with both the cutting in V_1 (2.66 g, 2.69 g) and V_2 (2.69 g, 2.65 g); and also with V_3C_2 (2.64 g), $S_2V_1C_2$ (3.22 g), $S_2V_3C_2$ (3.01 g) and $S_1V_3C_0$ (3.76 g). S_2, V_2 and C_0 had significantly higher seed yield (1566.50 kg ha^{-1}, 1448.20 kg ha^{-1} and 1538.55 kg ha^{-1} respectively). $S_1V_1C_1$ had significantly higher sterile siliqua (17.26) and $S_2V_1C_1$ showed significantly higher chaff dry weight (5.14 g).Inflorescence top cutting increased siliqua fresh weight positioned at the top of the inflorescence, number of filled siliqua and 1000-seed weight. $S_2V_1C_2$ in most of the cases maintained higher values of stem dry weight, above ground dry weight, inflorescence dry weight, flower fresh weight and 1000-seed weight. The highest HI was observed in $S_2V_1C_0$ (41.97%).

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

CHAPTER I

INTRODUCTION

Mustard (Brassica spp.) is one of the most important oilseed crops throughout the world after soybean and groundnut (FAO, 2004). It has a remarkable demand for edible oil in Bangladesh. It occupies first position of the list in respect of area and production among the oilseed crops grown in this country (BBS, 2004). Oilseeds are important in the economy of Bangladesh. They constitute the most important group of crop next to cereals occupying 4.22% of the total cropped area (BBS, 2009). In the year 2011-12, the total oilseed production was 8.44 Mt and total area covered by oilseed crops was 7.23 ha and yield 1.17 Mt ha^{-1}. In the year of 2011-12, mustard covered 4.83 ha land and the production was 5.25 Mt and yield 1.09 Mt ha^{-1}. (Krishi Diary, 2013).

Mustard seeds contain 40-45% oil and 20-25% protein (Mondal and Wahhab, 2001). Using local oil-extraction mechine average 33% oil may be extracted. Oil cake is a nutritious food item for cattle and fish, which is also used as a good organic fertilizer. Dry mustard plants may be used as fuel.

Rapeseed-mustard is grown more or less all over Bangladesh, but more particularly in the districts of Comilla, Tangail, Jessore, Faridpur, Pabna, Rajshahi, Dinajpur, Kushtia, Kishoregonj, Rangpur, Dhaka (BBS, 2012).

Mustard is a cold loving crop and grows during Rabi (cold) season (October-February) usually under rainfed and low input condition in this country. Its low yield can be attributed to several factors, the nutritional deficiency, among others is highly important. There is very little scope of expansion for mustard and other oilseed acreage in the country, due to competition from more profitable alternative crops such as boro rice. The cultivation of mustard has to compete with other food grain crops have shifted to marginal lands of poor productivity.

With increasing growth rate of 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 of the country. The major reasons for low yield of rapeseed-mustard in our country are due to lack of high yielding variety, inadequate use of fertilizers and in want of the knowledge of sowing time and proper management practices etc.

Mustard (*Brassica campestris* L.) is a thermosensitive as well as photosensitive crop (Ghosh and Chatterjee, 1988b). The average yield in Bangladesh is 739 kg/ha. But the world average yield is 1575 kg/ha (FAO, 2003). So, local production only can meet up one third of the requirement, which is about 5 lakh metric tons (Mondal and Wahhab, 2001). Bangladesh has been facing acute shortage of edible oil for the last several decades.Our internal productions can meet only about 21% of our consumption.The rest 79 % is met from the import (Begum *et al.,* 2012).

Bangladesh Agricultural Research Institute (BARI), Bangladesh Agricultural University, Bangladesh Institute of Nuclear Agriculture (BINA) and Sher-e-Bangla Agricultural University (SAU) has released a number of new high yielding varieties of rapeseed/mustard for farmer's cultivation. The yield of HYV cultivars ranges from 1.4 to 2.1 t ha^{-1} (BARI, 2002). But the yields in farmer's fields are still low compared to the potentialities due to lack of proper management practice. Developing new high yielding varieties with a package of production technologies is useful to increase the productivity of oilseed crops.

Time of sowing is very important for growth and development of a crop to obtain a satisfactory yield. Sowing time pose the crop to varying climate parameters. Inflorescence cutting at different times may have differential effect on grain yield.

Tori-7, BARI Sarisha-9 and BARI Sarisha-15 are short durated. Tori-7 is widely grown in farmer's field. BARI Sarisha-9 is dwarf type plant, its sowing time is mid-October to mid-November and its harvesting time is January to February. In case of BARI Sarisha-15 its plant height is 90-100cm; its sowing time is the last week of October to mid-November and harvesting time is February. Therefore, the present study was undertaken to find out the effect of inflorescence-top cutting of mustard genotypes under varying sowing times on the yield attributes and yield of mustard.

In mustard or rape, inflorescence initiates at 22 to 27 DAS and thereafter flowers continues to bloom from the base to the tip of the inflorescence. Being a source limited plant the current or post flowering photosynthates in mustard are not enough to feed all the blooming flowers. As a result, only some siliqua are filled leaving rest of the siliqua (at the inflorescence top) unfilled. Mustard having a receemose type of inflorescence continues flowering up to 45 DAS. Although these unfilled siliqua and flowers at the inflorescence top contribute nothing towards the grain yield, although they consume a lot of photosynthates or assimilate. So, if this unproductive portion of the inflorescence is removed, there would be a scope of providing an extra-supply of photosynthates to the basal siliqua. Such attempt may increase the yield through increasing the weight of the seed. In Sweden, farmers use growth retardants (eg. Ethylene, cycocelor) to restrict excess flowering in the inflorescence at the later stage of inflorescence development (Personal Com. Dr. Md. Ali Akbar, Ex-Oil seed breeder, BARI).

In Bangladesh, mustard is cultivated for different purposes. Mainly it is grown for grains as an oilseed crop. A substantial area is also used to grow mustard with the aim of using its leaf as green vegetable. Another use of mustard, although not frequent, is to use its flowers/inflorescence as a recipe for making a special fried diet diving it with thoroughly broken eggs indicating that there is an economic importance of its flowers using them as edible item. The crops, which are produced for edible flowers, may also be used as a grain producing one if instead of using the complete inflorescence some portion of it is removed. This aspect needs to be evaluated.

Removal of non effective flowers may be removed from the inflorescence may be done through cutting the top. Moreover, different variety may also differently response to the inflorescence-top cutting. However, information is lacking regarding how many flowers do not convert into siliqua. So, the only the way is to marking visually the time when the baby/young siliquas on the top of the inflorescence do not show the symptoms of further being filled. And as mustard is indeterminate in flowering, the removal of inflorescence-top must be done several times to identify the exact time of flower removal. An attempt was therefore desired to undertake an experiment on the role of sowing and cutting time of three mustard varieties for yield and yield contributing attributes.

Objectives of the Research Work:

i) To identify the optimum sowing time of three varieties of mustard (Tori-7, BARI Sarisha-9 and BARI Sarisha-15).

ii) To compare the yield variability of three varieties (Tori-7, BARI Sarisha-9 and BARI Sarisha-15) of mustard under varying sowing time.

iii) To examine the possibility of increasing partitioning of phtosynthate towards the growing sliqua below by removing the non-effective flowers at the top of the inflorescence.

iv) To compare increased seed weight of Tori-7, BARI Sarisha-9 and BARI Sarisha-15 due to inflorescence-top cutting under varying environmental conditions set by different sowing times (%).

CHAPTER II

REVIEW OF LITERATURE

2.1 Effect of sowing time on different crop characters

Different sowing dates create different environments for crop growth and development within the same area. This in turn affects the crop characters.

2.1.1 Plant Height

Plant height is a varietal character of rapeseed but environmental conditions and cultural operations may affect it .Date of planting has direct effect on plant height.

Hossen (2005) carried out an experiment on mustard in Sher-e-Bangla Agricultural University farm, October 2004 to February 2005 to test the performance of different sowing dates from October 20 to December 4. He reported that BARI Sharisa-9 showed higher plant height with 4 November sowing.

Mondal (1986) conducted an experiment on sowing date on seven sites of New York State with Canola varieties and found that early sowing (05 May) for both the varieties in each case produced tallest plants than in late sowing (20 April) decreased plant height. In India, Maini *et al.* (1964) found that too early (September 28) and too late (October 29) planting reduced the height of toria.

Pronay *et al* (2011) worked on Improved Tori-7 and BARI Sarisha-10 with seven sowing date viz. Nov-8, Nov-15, Nov-22, Nov-29, Dec-6 and Dec-13. It was observed that among the sowing dates 8 November sowing was the best for mustard and BARI Sarisha -10 was better than that of improved Tori-7

Saran and Giri (1987) reported that plant height decreased gradually (151 to 140 cm) with delaying the sowing by one month (15 October to 15 November). Mohammed *et al.* (1987) observed similar results at Aligarh (India). A number of authors also reported that the seedling mustard in October produced the highest plant height (Kandil, 1983; Ansari *et al.*, 1990). Majumder and Sandhu (1964) reported that sowing in October was superior with respect to growth characteristics in sarson. Angrej *et al*. (2002) found that, early sowing was recorded higher value for the different plant height.

Kolsarici and Er (1988) in Turkey found that plant height was not significantly influenced by sowing date. BARI (1992) also reported that sowing date had no influence on 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. Islam *et al.* (1994) observed a significant lower plant height in the crops sown on 2 December, which resulted in 24% shorter plants compared to that of sowing on 2 November. Shahidullah *et al.* (1997) reported that plant height was the highest in the second sowing date (6 November) among the three sowing dates on 27 October, 6 November and 16 November.

2.1.2 Number of primary branches/plant

Hossen (2005) studied on mustard to test the performance of different sowing dates from October 20 to December 4 with three varieties viz. Tori-7, BARI Sarisha-8 and BARI Sarisha-9. He reported that BARI Sharisa- 9 early sowing with BARI Sharisa-9 produced highest number of primary branches.

Maini *et al.* (1964) found that the number of primary branches was reduced with each delay in sowing from mid-September late October. Late sowing in oil seed rape suppressed the number of branches /plant (Ali *et al.*, 1985). Shahidullah *et al.* (1997) reported that number of branches/plant were higher with the first two sowing dates (27 October and 6 November) among the three sowing dates on 27 October, 6 November and 18 November.

Uddin *et al.* (1986) reported that sowing date had no significant effect on number of primary and secondary branches/plant.

Bukhtiar *et al.* (1992) found that early sown crop produced more primary branches than that of late planted crop in the end of October and mid November. Islam *et al.* (1994) stated that delayed sowing significantly reduced branches/plant except that the differences were statistically similar between sowing of 04 and 18 November over the varieties. The maximum (4.55) number of branches /plant produced on 20 October and minimum (3.31) on 2 December.

Generally, development of primary branches depends on planting space and vegetative growth of the whole plant. Although the number of primary branches /plant has a very low direct effect on seed yield but it has an indirect positive effect via pods/plant (Rahman *et al.* 1993). Majumder and Sandhu (1964) found that the number of primary branches/plant had a significant positive correlation with number of pods/plant and seed yield. Number of primary branches/plant was influenced by different sowing dates (Chatterjee *et al.,* 1985; Mondal *et al.,* 1992; Uddin *et al.,* 1987).

Angrej *et al.* (2002) found that, the highest numbers of primary and secondary branches/plant were obtained when the crop was sown between 10 to 30 October.

Shivani *et al.* (2002) experimented on the sowing dates from25 September to 5 November; and recorded significantly higher number of branches on 25 September and 5 October than that on 15 October, 25 October and 4 November. Number of branches decreased progressively with delay in planting.

2.1.3 Number of siliqua/plant

The number of siliqua per plant is an important yield contributing character of oil seed rape. Several studies suggest that a higher number of siliqua/plant has the greatest effect on seed yield on rape and mustard (Mendham and Scott, 1975; Thurling, 1974; Rahman *et al.*, 1988). Mendham *et al.* (1981) strongly pointed out that delayed sowing always reduced the number of pods/plant. Shivani *et al.* (2002) experimented sowing on 25 September and 5 October recorded significantly higher number of siliqua/plant. Number of siliqua/plant was significantly influenced by sowing date.

Scott *et al.* (1973) observed that late sowing produced plants with minimum numbers of pod/plant. It occurred due to rapid inflorescence initiation, insect and disease pest infestation and frost damage. On the other hand, several scientists observed that early sowing produced too many pods/plant (Patel *et al.,* 1980; Mendham *et al.,* 1981; Chauhan and Bhargava, 1984; Uddin *et al.*, 1987, and Chay and Thurling, 1989).

According to Saran and Giri(1987) siliqua/plant decreased gradually from early (15 October) to late (25 October; 5 November and 15 November) sowings. Ghosh and Chatterjee (1988) also reported that fifteen days to one month delay in sowing produced 24 to 57% reduced pods per sq. metre.

Mondal *et al.* (1992) reported that number of siliqua/plant decreased in late planting. Buttar and Aulakh (1999) found pods/plant were higher in 25 October (1st date) 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. Brar *et al.* (1998) stated that early sown crop produced higher number of siliqua/plant compared to late sown crop. Sowing on 30 October and 15 November were apart with each other but further delay in sowing caused significant reduction in number of siliqua/plant.

Mondal and Islam (1993) found that the highest number of siliqua /plant was in the plants of 1 November sowing and the lowest number of siliqua/plant was in the plants ofg 1 December sowing.

Shahidullah *et al.* (1997) reported that number of siliqua /plant was decreased with delay in sowing among the three sowing dates on 27 October, 6 November and 19 November. Uddin *et al.* (1986) also reported that numbers of siliqua/plant were gradually reduced with delay in sowing among the four sowing dates on 25 October, 4 November, 14 November and 24 November.

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

2.1.4 Length of siliqua

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

2.1.5 Thousand Seed Weight

Seed weight is an important yield contributing character of rapeseed. It is mainly controlled by genetic factor. But it may also be influenced by many factors like nutrition, management practices and planting time. A number of studies revealed that planting date has significant effect on seed weight.

Majumder and Sandhu (1964) found highest 1000-seed weight in 1 October sowing. Delayed sowing decreased the seed weight (Lutman and Dixon, 1987). Similar findings were reported by many scientists (Scott *et al.,* 1973; Beech and Norman, 1964; Uddin *et al.*, 1986; Ansari *et al.*, 1990; Kalra *et al.*, 1985). Delayed sowing in oil seed rape severely reduces 1000-seed weight (Mendham *et al.*, 1981; Scarisbrick *et al.*, 1981). Mondal *et al.* (1999) stated that, 1000-seed weight reduced with the delayed planting time.

Hossain *et al.* (1984) found no significant influence of sowing dates on individual seed weight in terms of 1000-seed weight.

Ghosh and Chatterjee (1988a) reported that one month later planting produced 32% reduction in seed weight. Saran and Giri (1987) observed that sowing in 25 October gave 11% higher 1000-seed weight than that of 15 November sowing. Shivani *et al.* (2002) experimented and found that 1000-seed weight was significantly influenced by sowing date. Sowing on 25 September and 5 October recorded significantly higher 1000-seed weight than that of 15 October, 25 October and 4 November sowing. 1000-seed weight decreased progressively with delay in planting.

2.1.6 Seed yield per ha

In India, several studies on date of planting on mustard and rapeseed indicate that a suitable sowing time for higher seed yield is specified for a particular area. Best time in Punjab is the last week of September (Maini *et. al.*, 1964); In West Bengal and in Haryana, it was last week of October (Sen and Sur, 1964; Vacchani, 1952; Bishnoi and Singh, 1979; Ghosh and Chatterjee, 1988).

Hossen (2005) worked on mustard in Sher-e-Bangla Agricultural University farm, October 2004 to February 2005 to test the performance of different sowing dates (20 October, 4

November, 19 November and 4 December). He found that when the crop was sown October 20 maximum grain yield was produced.

Singh (1988), and Saran and Giri (1987) reported that delay in sowing by two and four weeks produced 27% and 57% lower yields respectively compared to normal planting time.

Jain *et al.* (1989) found with four *Brassica juncea* cultivars were sown on 19 October, 29 October, 8 November and 18 November in field trials at Gwalior, where seed yields of each cultivar decreased with delayed sowing.

Joshi *et al.* (1989) reported that in India sowing too early and sowing too late resulted in seed yield reduction due to natural hazards like insect pest and disease infestations. Early sowing reduced seed yield than in late sowing (mid July to mid August) since the former had a risk of rotting.

Rahman *et al.* (1989) studied with four sowing dates (25 October and 4, 14 and 24 November) to see the effects on yield of rapeseed. Sowing in October and early November gave the highest yields while later sowing gave the lowest yields. In field trials on 30 October, 10 November and 20 November gave the average seed yields of 0.84, 0.69 and 0.60 ton/ha, respectively.

Three varieties of mustard were evaluated for productivity under four sowing dates during Rabi seasons of 1984-85 and 1985-86 in Madhya Pradesh, India. Sowing on 8 October resulted higher seed yield as compared to late sowing (Bhagat and Singh, 1989).

Uddin *et al.* (1987) suggested 18 and 28 October sowings were better over 7 November sowing for higher yield; and higher yield was attributed by pods/plant and seed/pod. They also observed that seed yield decreased gradually with the delay in sowing in all varieties.

Mondal *et al.* (1992) reported that the highest seed yield per ha (1.45 ton) was obtained from second planting (October 16). Shah et al. (19875) also obtained the highest seed yield of mustard from middle of October sowing in Jessore areas.

Jadhav and Singh (1993) found that seed yield was higher in crops sown in October than in November. Bali et al. (1992) found that in a field experiment in 1985-88 at Shalimar, Jammu and Kashmir , mean seed yields of *B. juncea* cv. Kos 1 and EC 132142 sown on 25 September , 15 October or 4 November were 1.44, 1.27 and 0.51 ton/ha, respectively.

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

Choudhary and Thakuria (1994) found that, in a field experiment during the winter season of 1991/92 at Karimganj, Assam seed yield of *B. juncea* cv. TM 2 and TM 4 and B. campestris var toria cv. TWC 3 and M 27 were significantly decreased by delay sowing after 15 November.

Yadav *et al.* (1994) stated that, *B. juncea* cv. Vaibhav, Vardan, Rohini and Varuna seed yields were decreased by delaying sowing after 15 October in 1987/88 and 5 October in 1988/1989. Yadav et al. (1996) reported that, early sowing in October resulting significantly higher seed yield compared to the later sowings.

Dudhade *et al.* (1996) reported that in a field experiment conducted at Rahuri, Maharashtra during the winter seasons of 1991/92 and 1992/93, with *B. juncea* cv. Seeta, Pusa Bold and Pusa Barani were sown on 1, 15 or 30 October, or 15 or 30 November. Seed yield was the highest in Seeta and with the earliest sowing date.

Sarmah (1996) stated that, sowing on 25 October or 9 November resulted in substantial increases in seed yield as compared to delayed sowing on 24 November and 9 December. Delayed sowing on 24 November and 9 December resulted in a 24.8 and 51.6% yield reduction in comparison with sowing on 25 October.

Afroz *et al.* (2011) an experiment was conducted at the Agronomy Field, Bangladesh Agricultural University with two varieties viz. BARI Sarisha-9 and BARI Sarisha-6; three sowing date viz. 10, 20 and 30 November. They observed the highest seed yield was obtained by the BARI Sarisha-9 in 10 November sowing and lowest seed yield was achieved in 30 November sowing.

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

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^{-1}).

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.

Sowing time directly influenced plant dry weight (stover yield). Lutman and Dixon (1987) pointed out that sowing in sowing in soil seed rape beyond mid September produced significantly less vigorous plant and ultimately produced lower crop dry weight compared to early sown crops.

2.1.8 Biological yield

Sihag *et al.* (2003) a field experiment was conducted in Bikaner, Rajasthan, India, during the 1998/99 rabi season to determine the effect of sowing date (October 15, October 30, November 14 and November 29) of Indian mustard. The highest biological yield (65.23qha^{-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 dated of sowing. The last date of sowing (December 1) reduced biological yield. The dry weight of rape plants in the autumn and winter was severely reduced by delay in drilling (Lutman and Dixon, 1987). Thurling (1974) reported significant correlation between yield and total dry weight of totoal plant in both *B. campestries* and *B. napus.* High temperature at vegetative stage was conducive to high dry matter production

(Degenhardt and Kondra, 1981). Dry matter accumulation) / plant in the late sown crop was led at all staged of crop growth as reported by Saran and Giri (1987).

Majumder and Sandhu (1964) reported that the highest dry matter production was obtained from 1 sowing compared to each October 16 and November 4 plantings. In their another study, higher dry matter production was obtained from planting on September 29 than from planting on September 4 and October 24 (Maini *et al.,* 1964) and it happened to produce higher biological yield. Ghosh and Chatterjee (1988) made similar observation.

2.1.9 Harvest Index

Hossen (2005) worked on mustard in Sher-e-Bangla Agricultural University farm, October 2004 to February 2005 to test the performance of different sowing dates (20 October, 4 November, 19 November and 4 December). He found that when the crop was sown October 20 maximum Harvest index was obtained.

Gfadakar *et al.* (1988) stated that seed yield and dry matter accumulation was positively correlated with heat unit accumulation.The 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 variety on different crop charecters

Varietal performance of a crop depends on genetic makeup.

2.2.1 Plant height

Ahmed *et al.* (1990) stated that the tallest plant (102.56cm) was recorded in the variety Daulat. No significant difference was observed in plant height between Dhali and Nap-8509.

Ali *et al.* (1998) observed significant variation on plant height of different varieties of rape and mustard.

Jahan and Zakaria (1997) observed that Dhali was the tallest plant (142.5cm), which was similar with sonali (139.5cm), and Japari (138.6cm). The shortest plant was observed in Tori-7 (90.97cm) which was significantly shorter than other varieties.

Hussain *et al.* (1996) observed that the highest plant was in Narenda (175cm), which was identical with AGA-95-21 (166cm). The shortest variety was Tori-7.

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

Yadav (1983) evaluated yield and yield components of 21 *Brassica* genotypes and 15 F1s in two environments. There were significant differences for all characters among them. Days to flowering had high heritability estimated with high genetic advance. Additive and dominance effects were observed for all the characters. Seed yield was correlated with number of primary branches and siliqua per plant, number of inflorescences, 1000-seed weight and plant height.

Paul *et al*. (1978) studied eleven yields related characters in six *Brassica juncea* parents and all their F1s, excluding reciprocals and observed that seed yield /plant was significantly correlated with siliqua number/plant and with primary and secondary branch numbers, and that these three characters all had a high positive direct effect on seed yield. A discriminate function using siliqua number per plant, primary branch numbers and seed yield appeared the most effective for selection, giving expected genetic gains of 43.06 and 48.94% in the parental and F1 generations, respectively.

2.2.2 Primary branches/plant

The yield contributing characters such as number of primary, secondary and tertiary branches are important determinant of the seed yield of rape seed and mustard. Varieties among *Brassica* species showed a marked variation in the arrangement of the branches and their number per plant.

Campbell and Kondra (1978) reported that number of branches/plant played a significant role in the seed production.

Shamsuddin and Rahman (1977) and Mondal *et al.* (1992) found the differences in branch number/plant were identical to be due to varietals behavior.

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

BARI (2000) found that the number of primary branches/plant was higher (4.02) in the variety SS-75 and lower (2.1) in the variety BARI Sharisa-5 under poor management under medium management, the higher number of primary branches/plant was found in BARI Sharisha-6 (5.5) and lower in BARI Sharisa-8 under higher management. The highest number of primary branches /plant was with BARI Sharisha-6 (5.9) and lower (3.0) with Nap-248.

Jahan and Zakaria (1997) found that the local varieties Tori-7 and Sampad produce the highest number of primary branches / plant (4.07) which were at par with BLN-900. The minimum primary branches/plant (2.90) was found in Jatarai which was identical to those found in Hyola-40 and BARI sharisa-8.

Singh *et al.* (1969) studied 30 cultivars of *Brassica spp*. And showed that seed yield was positively correlated with number of primary, secondary and tertiary branches.

Mehrotra *et al.* (1976) reported in *Brassica* cultivars that the number of primary and secondary branches had positive association with seed yield.

Singh and Singh (1987) observed that higher seed yield was positively correlated with primary and secondary branches and pods/plant.

Tomar and Namedo (1989) concluded a study on *B. campestris* var.Toria and found that when plant was maintained 22.2 plants per meter that increased the number of primary and secondary branches/plant.

Ghosh and Chatterjee (1988b) conducted a field experiment at Kalyani in the winter season of 1983-84 to study the contribution to seed production of effective primary branches of 8 different elite CV. When sown on three different dates , the number of nodes on the main stem and the numbers of inflorescences bearing primary secondary and tertiary branches was significantly reduced due to delay in sowing , The 2nd and 4th primary branches (arising from apical side of the main stem) contributed most to seed yield . The test weights of seeds per effective primary branch were reduced successfully lower down the main stem. The number of siliqua, the number of effective secondary branches and the total seed weight were higher on the 2nd and 4th primary branches than on others in all cases.

The increase in the growth characters such as plant height, number of branches per plant might be ascribed to the functional role of nitrogen in the plant body. The chief function of N is cell multiplication, cell elongation and tissue differentiation. With adequate supply of N, the plants grow taller, produced more functional leaves with higher chlorophyll content. Thus photosynthesizing area might have increased resulting in greater production of dry matter per plant. These findings confirm the observations of Kumar and Gangwar (1985), Tomar and Mishra (1991) and Upasani and Sharma (1986).

2.2.3 Number of siliqua per plant

Hossen (2005) conducetd an experiment on mustard in Sher-e-Bangla Agricultural University farm, October 2004 to February 2005 to test the performance of different varieties viz. BARI Sarisha-8, BARI Sarisha-9 and Tori-7. He reported that BARI Sarisha-8 produced higher siliqua than BARI Sarisha-9 and Tori-7.

The shortest siliqua length (4.62cm) was found in the hybrid Semu-2was observed by Lebowitz (1989) and Olsson (1990).

Mondal *et al.* (1992) stated that maximum number of siliqua per plant was in the variety J-5004 which was identical with the variety Tori-7. The lowest number of siliqua per plant (45.9) was found in the variety SS-75.

Jahan and Zakaria (1997) reported that the highest number of siliqua/plant recorded in BLN-900(130.9) was identical with that observed in BARI Sharisha 6 (126.3). Tori-7 had the lowest (46.3) number of siliqua per plant.

Hussain *et al.* (1996) showed that there was a marked statistical variation in number of siliqua/plant. They observed that BLN-900 had the highest number of siliqua per plant (187.3) and the lowest in Semu 249/84(150.4).

Yadav *et al.* (1978) suggested that for ensuring high yield in *B. juncea* the plant type should have more number of siliqua per plant (100-125).

2.2.4 Length of siliqua

The shortest pod length (4.62 cm) was found in the hybrid Semu-249/84 which was identical to those of Semu-DNK_89/218, AGH-7 and Tori-7. The longest pod (8.07 cm) was found in BLN-900and Hyola-401 (Jahan and Zakaria, 1997).

Masood *et al.* (1999) found significant genetic variation in pod length among seven genotypes of *B. campestris* and a cultivar of *B. napus*. Similar result for pod length was observed by Lebowitz (1989) and Olsson (1990).

Gangasaran *et al.* (1981) revealed that siliqua weight significantly influenced the seed yield whereas siliqua length and siliqua diameter had a marginal effect. They further noticed that siliqua length and number served as the most reliable index of selection for yield improvement in brown sarson (*B. campestris* var. sarson).

Hussain *et al.* (1996) stated that the varieties differed significantly in respect of siliqua length. The longer siliqua (7.75 cm) was found in the hybrid BLN-900 which was identical to Hyola-101, Sampad, BARI Sharisa-6 and Hyola-512.

2.2.5 Thousand Seed weight

Singh *et al.* (2002) reported that 1000-seed weight ranged between 2.36 and 4.20gm in F_1; 2.36 and 4.20 in F_2 population. Significant genetic variations were observed among a large number of strains of *B. campestris* , *B. napus* and *B. juncea* ((Singh, 1996; (Choudhury *et al.* 1986 ; Jain *et al.* 1988; Yin 1989; Lebowitz 1989; Biswas 1989; Andrahennadi *et al.* 1991; Yadav *et al.* 1993; Kudla 1993; Kumar and Singh 1994; and Hossain *et al.* 1998.

Mondal and Wahab (2001) described that weight of 1000-seeds varied from variety to variety and species to species. They found 1000-seeds weight 2.50-2.60 gm in case of improved Tori-7 (*B. campestris*) and 1.50- 7.80 gm in case of Rai-5 (*B. juncea*).

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

Hussain *et al.* (1998) observed significant variation in case of 1000-seed weight as influenced by different varieties. They found Hyola-101 had the highest 1000-seed weight (3.4gm) and the lowest 1000-seed weight was recorded in Tori-7 (2.10 gm).

BARI (2001) found significant variation in 1000-seed weight of rapeseed and mustard in different variety and the highest weight of 1000-seed was observed in variety Jamalpur-1 and lowest on BARI Sharisa-10.

Kumar *et al.* (2000) studied on different induced quantitative characters in 23 and 13 mutants of Indian mustard cultivars Varuna and BR-40, respectively and found high coefficient of variation in yield/plant, pods/plant and branches/plant.

2.2.6 Seed yield

Seed yield of rapes and mustard differed widely from species to species as well as from variety of (Chauhan and Bhargava, (1984), Zaman *et al;* 1991 and Chakraborty *et al.*; 1991.

Rahman (2002) stated that yield variation existed among the varieties whereas the highest yield was observed in BARI Sarisha-7, BARI Sarisha-8 and BARI Sarisha-11 (2.00-2.50 t ha^{-1}) and the yield was in variety Torio-7 (0.95-1.10 t ha^{-1}).

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

Mondal (1995) reported that after continuous efforts plant breeders of Oilseed Research Centre, BARI have developed several short duration genotypes of *B. Napus* with high yield potential. The genotype, Nap-3 is one of these genotypes (Biswas and Zaman (1990) which is under active consideration for recommendation as a variety. It is likely to be a good variety for Bangladesh, but it has a problem of high shattering habit.

Zaman *et al.* (1991) reported that seed yields of rape and mustard are different in different varieties. Chakrabarty *et al.* (1991) stated that seed yield varied from species to species.

Mendham *et al.* (1990) showed that seed yield was dissimilar due to varietals difference in species of *B. Napus*. Similar findings were noticed by Chay and Thurling (1989), Sharaan and Gowad (1986).

Malik (1989) observed that *B. Carinata* produced 49% higher yield than each of *B. Juncea* and *B.campestries*.

Uddin *et al*. (1987) reported that there was a significant yield difference among the varieties of rapes and mustard with the same species. Shamsuddin and Rahman (1977) found that yields were different among the varieties within the same species.

Monir and McNeily (1987) reported that there was no significant yield difference between cultivars of *B. Napus*.

Cheema *et al.* (2001) observed that the higher number of siliqua per plant, number of seeds per siliqua and thousand-seed weight produced maximum yield (1.7-1.8 t ha^{-1}).

Rahman and Das (1991) reported that several mutants of *B. juncea*, gave 8-13% higher seed yield than the mother and 39-43% higher seed yield than the recommended variety, Rai-5.

A significant difference in seed yield existed due to global effects. In the temperate region like England, Netherlands etc. long duration rapes of 12 months produced seed yield of 5.0 t ha^{-1}. Whereas in Bangladesh a rapeseed cultivar of 70 days duration gave very low yield of only 10.0 t ha^{-1} (FAO, 1998; Khaleque, 1985).

Halva *et al.* (1986) reported that seed yield of mustard varied widely among the species but the variation was little within the species. They observed that seven varieties of *Sinapis alba*, eight varieties *B. juncea* and one variety of *B. nigra* produced an average yield of 2.2, 1.6 and 0.70 t ha^{-1} respectively. Similar result was obtained by Malik (1989) with *B. carinata* which produced 49% higher yield than each of *B. juncea* and *B. campestris*.

2.2.7 Stover yield

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

Hossen (2005) reported that stover yield was significantly influenced by variety. The lowest stover yield was obtained from Tori-7.

2.2.8 Biological yield

Mendham *et al.* (1990) showed that vernalization and photoperiod appear to affect the rate of development to flowering in a quantitative and additive fashion in all cultivars, which helped to biological yield.

2.2.9 Harvest index

Robertson *et al.* (2004) stated that Indian mustard had a lower harvest index.

Islam *et al.* (1994) showed that varieties had significant effect on harvest index (%) of mustard.

Mendham *et al.* (1981) stated that a low harvest index of rapeseed might be due to excessive pod and seed losses during flowering. In *brassica* species harvest index is strongly influenced by environment (Thurling 1974b).

Hossen (2005) conducetd an experiment on mustard in Sher-e-Bangla Agricultural University farm, October 2004 to February 2005 to test the performance of different sowing time (October 20 to December 4) and different varieties viz. BARI Sarisha-8, BARI Sarisha-9 and Tori-7. He observed that BARI Sarisha-8 produced higher siliuqua in early sowing.

2.3 Effect of inflorescence cutting on different crop characters

Plants have a balanced and definite relationship among its organs to maintain and complete it life cycle and all the related physiological and biochemical processes that need to be complete the life cycle. This relationship can be manipulated for achieving higher yields. Yields of plants depend on the source-sink relationship. In source limited plants, the yield can be increased by increasing the supply of photosynthates in the sink either removing the extra sink or increasing the activity/capacity of source (Wang, 1997) while in the sink limited plants, the yield can be increased by either removing the extra source or increasing the area of sink. All of these phenomena can be manipulated either by changing genetic makeup of the plants or by adopting proper agronomic means (Li, 2005).

Increasing the crop yield through removing the extra portion of an organ has been manifested by many scientists in different crops (Khan and Ahsan, 2000). Leaf removal in many plants increased yields through increasing reproductive buds and diverting photosynthates to the developing reproductive structure (Tadesse, 2012).

Effects of defoliation on the grain yield of corn have been well documented in numerous research studies (Hicks et. al., 1977; Singh, 1975; Tollenaar, 1978 and Thomson, 2003). Khan and Ahsan (2000) working on *B. Juncea* showed that eliminating the cost of maintaining senescing leaves by leaf removal might lead to increased plant yield.

Hortensteiner and Felller (2002), Khan *et al.* (2007) showed that defoliation of older and senescing leaves allowed the growth of functional and efficient leaves. This increased the photosynthetic potential of remaining leaves and leads to enhance biomass accumulation and seed yield.

Reduction in corn yield has been shown to be directly proportional to the percentage leaf area destroyed (Hicks and Nelson, 1977). The degree of yield loss caused by defoliation is also dependent on the growth stage when defoliation occurs with yield losses greatest during the late vegetative and reproductive stages (Singh, 1975 and Thomson, 2003). Defoliation may affect the “source-sink balance” and kernel weight of corn (Singh, 1975 and Tollenaar, 1978).

Halbrecq and Ledent (2001) demonstrated that small limitations of assimilates supplied by the defoliation of the leaves subtending the inflorescences seemed not to be an important factor in the regulation of buckwheat seed setting.

Bud removal in soybean resulted in an increase in the number of branches but there was no difference in total area and dry weight of the leaves (Hong *et al*. 1987).

Source reduction by partial defoliation increased leaf net photosynthetic rate and sink reduction decreased net photosynthetic rate of irrigated wheat. The source reduction decreased the partitioning of photosynthates into the upper parts of plant. Very little effects of sink reduction on the photosynthates occurred in rainfed wheat. It was showed that grain sink size was not a factor limiting the production of photosynthates, but controlled the partitioning of photosynthates. Sink reduction decreased photosynthate translocation into grains and increased it into upper parts of rainfed wheat plant (Wang, 1977).

Defoliation at tasseling and during grain fills, especially 100% leaf removal, reduced kernel size (Tollenaar, 1978 and Hicks, 1977). Post anthesis defoliation reduced rate of dry matter accumulation within 20 d after defoliation occurred and complete defoliation rate of grain fill within 10 days (5). Based on black layer development, post anthesis defoliation accelerated maturity. Therefore post anthesis defoliation reduces kernel size by decreasing both the rate of dry matter accumulation and the duration of grain fill. Defoliation after tasseling reduced test weight (Hicks and Nelson, 1977). Test weight was not affected when corn plants were defoliated either 50 or 100% prior to tasseling. Defoliation during grain fill increases stalk rot that can lead to greater stalk lodging.

Leaf destruction at or before the V4/V5 stages has been associated with delays in crop maturity and higher grain moisture at harvest. Defoliation at tasseling and during grain fill, especially during the early kernel development stages, can accelerate crop maturity and result in lower est weight. Severe leaf loss during grain fill affects the nutritional value of corn by changing the chemical composition of the kernels. (Thomison and Geyer, 2006).

Defoliation of corn during vegetative development (approx. V12) by hail and wind. Although such defoliation often results in yield loss, effects of this injury on stalk and grain quality are usually negligible. Defoliation of corn during grain fill (approximately R3-R4) caused by hail and wind. In addition to reducing grain yields by 40% or more, such defoliation injury may predispose corn to stalk rots that result in greater stalk lodging. This injury may also reduce test weight, hasten maturity, and alter kernel chemical composition (e.g. increase protein and reduce oil content). (Thomison and Geyer, 2006).

A field study to assess the effects of sowing time and leaf cuttings on the yield and quality of palak (*Beta vulgaris* L. var bengalensis) seed was carried out at Vegetable Research Farm of Punjab Agricultural University, Ludhiana during 2009–10 and 2010–11. The experiment was laid out in a split plot design with sowing time as main plot and cuttings as sub- plot treatment. The results revealed that crop sown in October with one cutting had maximum seed yield (27.83 q ha^{-1}), 100 seed weight (1.4 g), germination (80.33%), seed vigour index-I and vigour index-II, which was statistically at par with two cuttings but significantly higher than the November sown crop. Late sown crop coupled with more cuttings though increased the number of branches $plant^{-1}$ and total green leaf yield but the seed yield and quality in terms of germination, seedling dry weight and vigour indices I and II was considerably reduced due to less absorption and storage of photosynthates. Thus, the crop sown in October cut once or twice besides giving greener leaf yield produced maximum seed yield and better quality seed in palak (Singh, 2013).

A study was made on Ethiopian mustard (*Brassica carinata*) to evaluate the effect of seed rate and leaf topping in Ethiopia at Adet experimental station and on farmers' fields, for two consecutive years (2005-2006). Four topping treatments (no topping, topping at 20, 30 and 40 days-after emergence) and four seed rates (4, 6, 8, and 10 kg/ha) were tested. Results showed that leaf topping caused reduction in thousand seeds weight, seed and oil yield as compared to non-topping. From the experiment it was concluded that if the objective of the Ethiopian mustard production is for higher oil production, it should be planted at 8 kg ha^{-1} seed rate and avoiding leaf topping practice. However, if the objective of the production is for grain as well as leaf yields, planting it at a seed rate of 10 kg/ha and topping it 40 days after emergence is the best-recommended practice. (Tadesse, 2012)

Effect of inflorescence removal on yield was examined in potato. It was stated that there might have a relationships between fruit and vegetative growth with tuber yield. In the study in 1987, flower removal significantly increased yield at irrigated and dry land sites for the potato clone ND860-2. In 1988, flower removal did not significantly increase yield in Norchip, ND2008-2 or ND860-2 planted under dryland conditions. Response to flower removal appears to be dependent on environmental conditions (Jansky and Thomson, 2009).

Excision of the inflorescence resulted in greater proportions of assimilate being sent to all other sinks. Loss of the vegetative apical shoot had a quite different effect in that greater proportions of assimilate were exported only to the inflorescence. The complexity of source-sink relationships in indeterminate plant types showed simultaneous vegetative and reproductive growth. It was suggested that inflorescence growth in monopodial orchids such as Aranda was primarily source-limited although significant sink limitations for assimilate gain by the inflorescence exist because of a modulating effect of the vegetative apical shoot on inflorescence sink strength and the ability of source leaves to respond positively to increased sink demand (Clifford *et al.* 1995).

Perk *et al.* (2003) evaluated the effect of inflorescence removal on the photosynthesis, assimilation, and dry matter accumulation of buckwheat under both standard and increased fertilization. They observed that when inflorescence was removed, both the stomatal conduction and assimilation rate of most of the cultivar increased. The study also revealed that removal of inflorescence significantly increased the fresh weight of both leaf and stem under both standard and increased fertilization.

Partitioning of nutrients depends on the vegetative nature of the plants. In highly branched species, most of the nutrients are used for vegetative growth and only small amount are utilized for seed establishment (Kreft, 1986).

There is a very important relationship between flower initiation and the amount of blossoming and setting of seed. Ruszkowski (1990) found that the phenomenon of compensation and over compensation between the main stem and branches occurred only when the inflorescences were removed from the main stem. This information could be a clue for improving seed productivity of crops.

Effect of defoliation and depodding on yield was examined in soybean. It was stated that soybean plant to first regulate sink size by changes in pod number per plant and this changes occur at all main axis node. It was suggested that when the environmental condition for seed filling improved then the seed size might be increased.

Decreasing sink demand by removing fruit generally reduced leaf photosynthetic rate in many species, such as tomato (*Lycopersicum esculentum* Mill.) (Walker and Ho, 1977), grape (*Vitis vinifera* L.) (Downton *et al.*, 1987), kiwifruit (*Actinidia deliciosa* Liang et Ferguson) (Buwalda and Smith, 1990), and *Satsuma mandarin* (Citrus unshiu Marc.) (Iglesias *et al.*, 2002). Similarly, in peach trees, the photosynthetic rate was greater for leaves with a high crop load than a low crop load (Quilot *et al.*, 2004). Li *et al.* (2005)

reported that fruit removal resulted in a 50% to 56% reduction in net photosynthetic rate in ‘Okubo’ peach and a 22% to 39% reduction in ‘Yanfeng 1’peach, compared with fruit-bearing shoots. The responses of leaf photosynthetic rate to sink –source modification may be due to differences in genotypic factors or developmental stage and the number of removed fruit.

Alados *et al.* (1997) reported an enlargement of the stem, increase in leaf and flower number, greater vegetative growth and inflorescence length in albaida (*Anthylis cylisoides* L.) after 10 % and 50 % of leaf removal by clipping.

CHAPTER III

MATERIALS AND METHODS

3.1 Experimental site

The experiment was conducted at the Agronomy field of Sher-e-Bangla Agricultural University, Dhaka-1207, during the period from November 2011 to February 2012. The experimental field was located at $90^0 33^{'}$ E longitude and $23^0 77^{'}$ N latitude at a height of 8.2 meter above the sea level. The land was medium high and well drained.

3.2 Climate

The annual rainfall of the site was 1776 mm. The average maximum and minimum temperature was 30.5^0C and 21.9^0C, respectively with the mean temperature of 26.2^0c. Temperature during cropping period range between 10^0C to 31^0C. The humidity varied from 67% to 80%. The day length ranged between 10.5 to 11.0 hours only. The monthly average rainfall, air temperature and relative humidity of the site during the experimental work have been shown in Appendices.

3.3 Soil

The soil of the experimental site belongs to the agro-ecological region of “Madhupur Tract” (AEZ No. 28). It was Deep Red Brown Terrace soil. The top soil is silty clay loam in texture. Organic matter content is very low (0.78%) and soil pH varied from 5.4 - 5.6.

3.4 Experimental materials

The experiment was done with three mustard varieties namely Tori – 7, BARI Sarisha - 9 and BARI Sarisha – 15, which were collected from Bangladesh Agricultural Research Institute, Joydevpur, Gazipur.

3.5 Experimental treatments

There were three treatment factors in this experiment, viz.

Factor A: sowing time

Factor B: variety

Factor C: Inflorescence top-cutting time.

The sowing times were denoted as S_1 (01 November), S_2 (15 November) and S_3 (30 November). Varieties were V_1 (Tori – 7), V_2 (BARI Sharisa – 9) and V_3 (BARI Sharisa – 15). Cutting times were C_0 (control), C_1 (first cut) and C_2 (second cut). First cut (C_1) was shown in appendices (Plate 1-3).

Inflorescence top-cutting was done at times when no further flowers at the top seemed not being converted into siliqua or the young siliqua were seemed not being filled. The cutting time varied depending upon the developmental phase of each variety. Following table shows the cutting time of the varieties.

Varieties	First cutting (d)	Second cutting (d)
V_1 (Tori – 7),	10 th December,11	17th December,11
V_2 (BARI Sharisa – 9)	10 th December,11	17th December,11
V_3 (BARI Sharisa – 15)	17th December,11	24 th December,11

3.6 Experimental layout and design

The experiment was laid out in a split-split plot design with three replications. Sowing time was given in the main plot; variety in sub plot and cutting was in sub-sub plot. Each replication was divided into 9 equal plots randomly. Further each main plot was divided into 3 sub plots. Thus the total plot number was 81. The size of each plot was 4m x2m.The distance between two adjacent main plots was 0.5 m and distance between two replications was 1.5 m.

3.7 Land preparation

The experimental field was ploughed with power tilier drawn rotovator. Subsequent ploughing and cross ploughing was done followed by laddering to make the land level. All weeds, stubbles and residues were removed from the field.

3.8 Fertilization

The experimental plots were fertilized with a recommended dose of 300, 180, 100, 180, 5 and 10 kg ha^{-1} of N, P_2O_5, K_2O, (ZnO) and Boric Acid respectively (BARI, 2002).During final land preparation one half of the urea and total amount of other fertilizers were applied and incorporated into soil. Rest of the urea was top dressed on during second irrigation at 30 days after sowing of each crop.

3.9 Sowing of seed

Seeds were sown in the field on 01 November, 2011 maintaining 30 cm row spacing in each plot in case of first sowing. Second sowing was done 15 November and third sowing was on 30 November. Sowing was done continuously in rows at a seed rate of 7.5 kg ha^{-1}.

3.10 Weeding and thinning

The experimental plots were found to be infested with different kinds of weeds, viz., Biskatali (*Polygonium hydropiper L.*), Bathua (*Chenopodium album* L.) and Ban sharisa etc. Weeding was done two times manually with 'nirani'. Thinning was done to maintaining a constant plant population in each row. Finally plants were kept at 10 cm distance in rows.

3.11 Irrigation

Iirrigation was given as per requirement and done by check basin method.

3.12 Pest and disease management stage

The crop was sprayed with Dursban 50 w to prevent infestation of mustard saw fly at vegetative stage. Malathion 60 EC also applied to prevent mustard aphids at siliqua formation stage.

3.13 Harvesting and processing

At maturity when 80% of the siliqua turned straw yellowish in colour, the experimental crop was harvested. Harvesting was done in the morning to avoid shattering. 1.0 m^2 (1.25 m X 0.8 m) were harvested from each plot and area converted to 1 m^2. Yield was converted to kg ha^{-1}. The harvested plant from the center of each sub-sub plot were bundled separately, tagged and brought to a clean cemented threshing floor. The crop was sun dried by spreading them over the floor and seeds were separated from the siliqua by beating the bundles with bamboo sticks. The seeds thus collected were dried in the sun for reducing the moisture in the seed about 9% levels.

3.14 Data collection

Three plants were taken randomly from each plot leaving the border plants for destructive sampling. This sampling was done to record the following data.

1. Plant height (cm)
2. Number of primary inflorescence
3. Number of secondary inflorescence
4. Number of filled siliqua per plant
5. Number of unfilled siliqua per plant
6. Number of sterile siliqua per plant
7. Length of siliqua (cm)
8. Fresh weight of siliqua per plant (g)
9. Dry weight of chaff per plant (g)
10. Dry weight of seed per plant (g)
11. Dry weight of stem per plant (g)
12. Dry weight of inflorescence per plant (g)
13. Above ground total dry weight per plant (g)
14. 1000 - seed weight
15. Fresh weight of flower (g)
16. Dry weight of flower (g)
17. Grain yield (kg ha^{-1})
18. Stover yield (kg ha^{-1})
19. Biological yield (kg ha^{-1})
20. Harvest index (%)

3.15 Procedure for data collection

3.15.1 Plant height

The height of three plants was measured from ground level (stem base) to the tip of the plant. Mean plant height was calculated and expressed in cm.

3.15.2 Number of inflorescence

The number of primary and secondary inflorescence of three plants at harvest were counted and recorded. Average values of three plants were recorded.

3.15.3 Number of siliqua per plant

Number of filled, unfilled and sterile siliqua was counted from three plants and divided by three which indicated the number of filled siliqua per plant, number of unfilled siliqua per plant and number of sterile siliqua per plant.

3.15.4 Length of siliqua

Three siliqua were collected from the inflorescence (top, mid and bottom) of each plant. The length were measured .The average length of siliqua was recorded by three plants.

3.15.5 Fresh weight of siliqua per plant

Three siliqua were collected from inflorescence top, three from mid inflorescence and three from bottom inflorescence of each plant. Then the weight was measured and average weight of siliqua was recorded by three plants.

3.15.6 Dry weight of chaff per plant

Dry weight of chaff was measured and calculated and expressed in gram per plant.

3.15.7 Dry weight of seed per plant

Dry weight of seed was measured and calculated and expressed in gram per plant.

3.15.8 Dry weight of stem per plant

Dry weight of stem was measured and calculated and expressed in gram per plant.

3.15.9 Dry weight of inflorescence per plant

Dry weight of inflorescence was measured and calculated and expressed in gram per plant.

3.15.10 Aboveground total dry weight per plant

It was the sum of dry weight of stems, seeds, chaffs and inflorescence per plant.

3.15.11 1000-seed weight

From the seed stock of each plot, 1000-seed were randomly counted. Then the weight was taken by digital balance. The 1000-seed weight was recorded in gram.

3.15.12 Fresh weight of flower

After top-cutting the inflorescence the flower were collected and taken weight by digital balance immediately.

3.15.13 Dry weight of flower

The fresh flower were collected and dried in the oven at 70^0c for 24 hrs. Then weights were taken by digital balance.

3.15.14 Grain yield (kg ha^{-1})

After threshing, cleaning and drying total grain yield from the harvested area (1m^2) were recorded and was converted to (kg ha^{-1}).

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

After the separation of seeds from plant of harvested area, the straw and shell per plot was dried separately and the weight was recorded. These were then converted into stover yield (kg ha^{-1}).

3.15.16 Biological yield (kg ha^{-1})

Biological yield (sun dried) is the summation of seed yield and stover yield per hectare.

3.15.17 Harvest index (%)

Harvest index was calculated by the following formula.

Harvest index (%) = (Seed yield/ Biological yield) x100

3.16 Data analysis

The collected data were processed and analyzed using MSTAT –C package programme. The means were computed and compared using DMRT test at 5% level of significance.

CHAPTER IV

RESULTS AND DISCUSSION

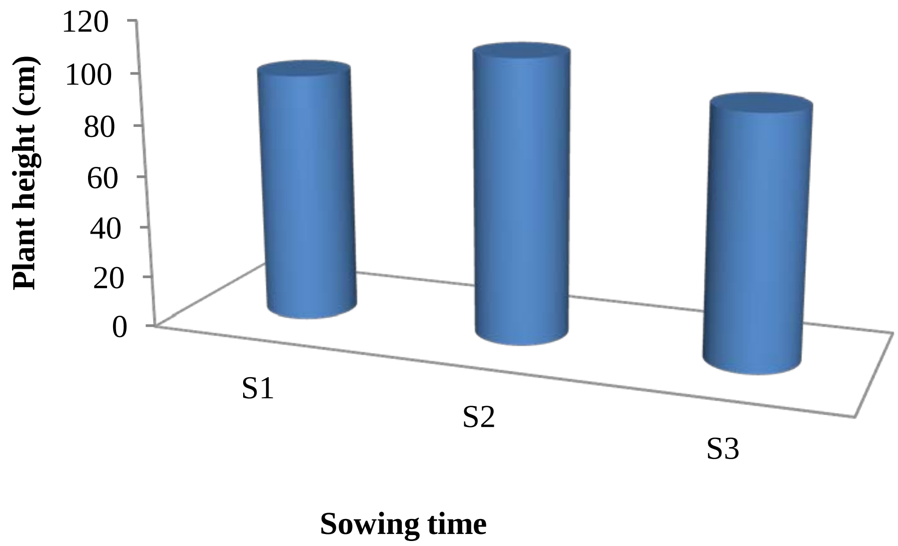
4.1 Plant height

4.1.1 Effect of sowing time

Effect of sowing time was significant on plant height (Fig. 1). The significantly highest plant height was with S_2 (109.61cm). The plant height of S_1 (97.18 cm) and that of S_3 (96.16 cm) was identical but significantly lower than that of S_2. From Figure 1 it was revealed that delayed sowing lowered the plant height. The results are in agreement with those of Pronay *et al*. (2011) and Mondal and Islam (1993) who stated that sowing in early November gave the highest plant height compare to October and December. Shahidullah *et al.* (1997) also reported the similar result. Mondal (1986) and Miani *et al.* (1964) supported the result and said that too early and too late planting reduced the plant height of mustard.

Majumder and Sandhu (1964), Saran and Giri (1987); and Mohammed *et al.* (1987) partially supported the results of the present study and reported that early sowing was recorded higher values of plant height. Kandil (1983), Ansari *et al.* (1990) and Angrej *et al. (*2002) also found similar results.

But the result was in contradiction with the findings of Kolsarici and Er (1988) and BARI (1992) who reported that change of sowing date did not significantly influenced the plant height.

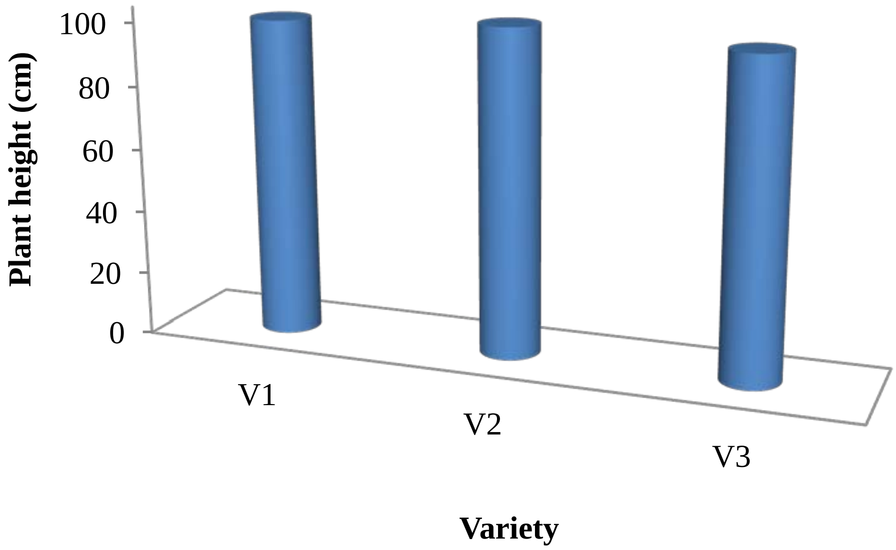


S_1 = 01 November, S_2 = 15 November, S_3 = 30 November,

Figure 1 Plant height of mustard as influenced by different sowing times (SE=1.77)

4.1.2 Effect of variety

Varietal effect was insignificant on plant height (Fig. 2). Though numerically higher plant height was found in V_2 (102.77 cm) and lower in V_3 (99.46 cm).

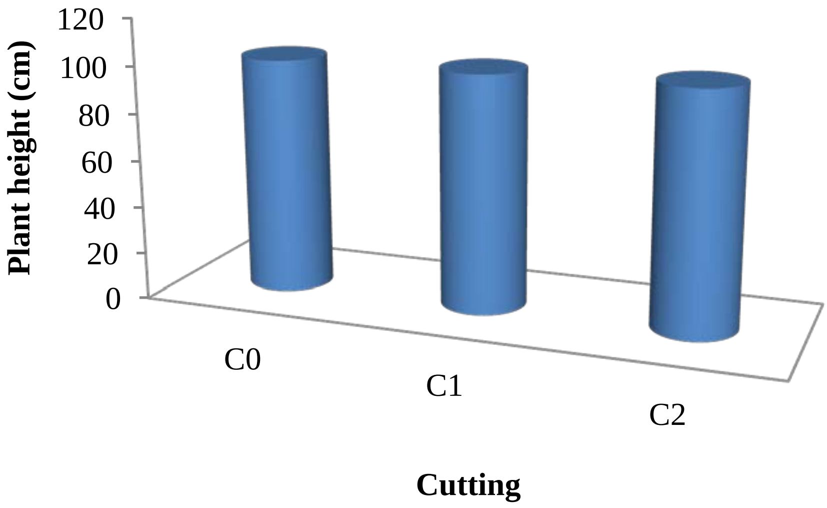


V_1 = Tori -7, V_2 = BARI Sharisha -9, V_3 = BARI Sharisha -15,

Figure 2 Plant height of mustard as influenced by different variety (SE=1.33)

4.1.3 Effect of cutting

Effect of inflorescence top-cutting was insignificant on plant height (Fig. 3). Though numerically higher plant height was found in C_2 (101.41 cm) and lower in C_0 (100.74 cm).

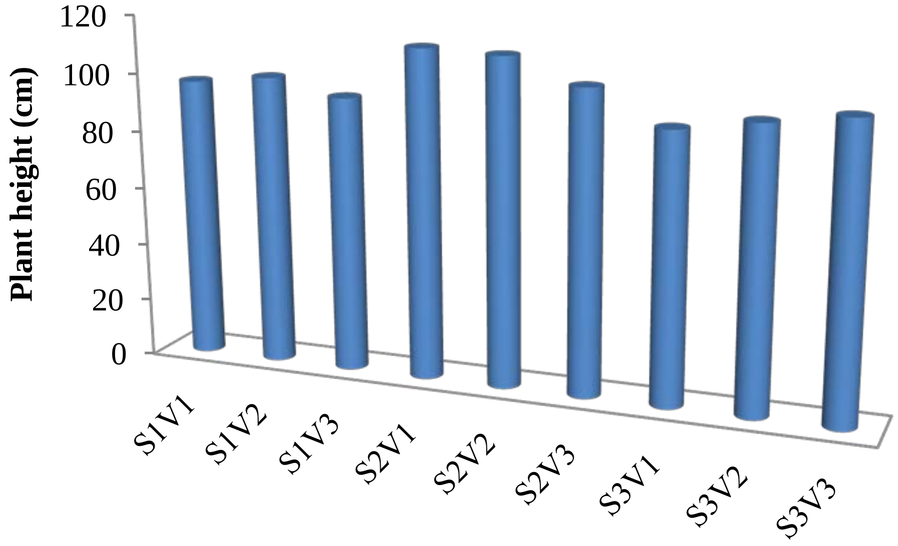


C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut,

Figure 3 Plant height of mustard as influenced by inflorescence top-cutting (SE=1.02)

4.1.4 Interaction effect of sowing time and variety

Significant variation was observed for plant height of mustard due to interaction effect of sowing time and variety (Fig. 4).The highest plant height was with S_2V_1 (113.03 cm) which was statistically similar with S_2V_2 (112.11 cm). The lowest plant height was with S_3V_1 (92.22 cm) which was statistically similar with S_1V_3 (94.74 cm). An intermediate plant height value was observed with S_2V_3 (103.70 cm) which was statistically similar with S_3V_3 (99.92 cm), S_1V_2 (99.89 cm), S_1V_1 (96.92 cm) and S_3V_2 (96.33 cm). This result is supported by Hossen (2005) who reported that BARI Sharisa-9 showed the highest plant height with 4 November sowing.

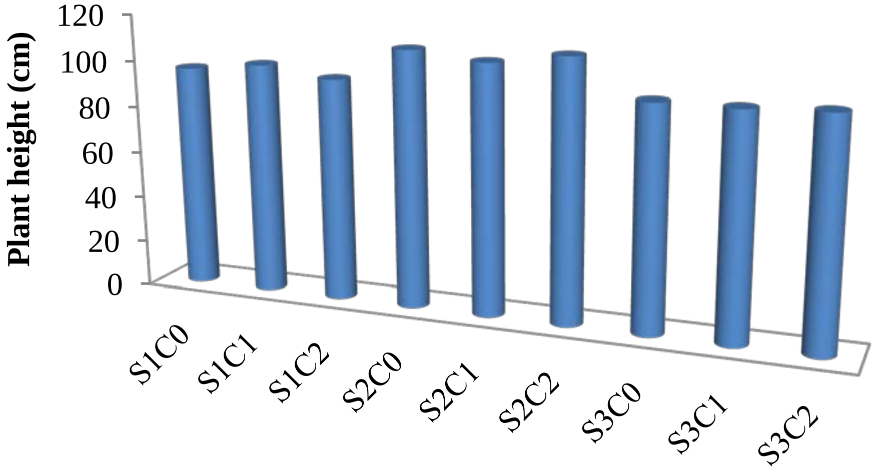


S_1 = 01 November, S_2 = 15 November, S_3 = 30 November, V_1 = Tori -7, V_2 = BARI Sarisha -9, V_3 = BARI Sarisha -15,

Figure 4 Plant height of mustard as influenced by different sowing times and variety (SE=2.30)

4.1.5 Interaction effect of sowing time and inflorescence top-cutting

Interaction effect of sowing time and inflorescence top-cutting was significant on plant height (Fig. 5). The significantly highest plant height was with S_2C_2 (111.63 cm) which was identical with S_2C_0 (110.22 cm) and S_2C_1 (107.00 cm). The lowest plant height was with S_1C_2 (95.66 cm) which was again identical with S_1C_0 (96.18 cm), S_1C_1 (99.70 cm), S_3C_0 (95.81 cm), S_3C_1 (95.73 cm) and S_3C_2 (96.92 cm).

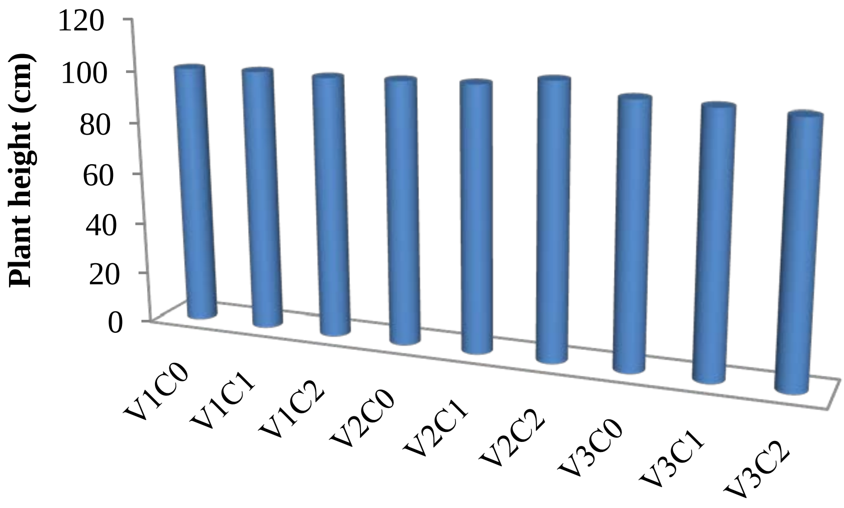


S_1 = 01 November, S_2 = 15 November, S_3 = 30 November, C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut,

Figure 5 Plant height of mustard as influenced by different sowing times and inflorescence top-cutting (SE=1.77)

4.1.6 Interaction effect of variety and inflorescence top-cutting

Significant variation was observed for plant height due to interaction effect of variety and inflorescence top-cutting (Fig. 6). The highest plant height was with V_2C_2 (105.11 cm) and lowest plant height was with V_3C_2 (98.51 cm). An intermediate plant height value was observed with V_2C_1 (101.92 cm) which was statistically similar with V_2C_0 (101.29 cm), V_1C_0 (100.52 cm), V_1C_1 (101.07 cm), V_1C_2 (100.59 cm), V_3C_0 (100.41 cm) and V_3C_1 (99.44 cm). Manipulation of dry matter transport was tried in albaida (*Anthylis cylisoides* L.) by Alados *et al.* (1997). Although not similar plants when some leaves were removed more current photosynthates were translocated towards stem resulting in the increased plant height.



V_1 = Tori -7, V_2 = BARI Sarisha -9, V_3 = BARI Sarisha -15, C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut.

Figure 6 Plant height of mustard as influenced by variety and inflorescence top-cutting (SE=1.77)

4.1.7 Interaction effect of sowing time, variety and inflorescence top-cutting

Interaction effect of sowing time, variety and inflorescence top-cutting was significant on plant height (Table 1). The highest plant height was with $S_2V_1C_2$ (116.55 cm) and lowest plant height was $S_3V_1C_2$ (90.33 cm). The highest plant height was identical with $S_2V_2C_2$ (114.667 cm), $S_2V_1C_0$ (113.33 cm), $S_2V_2C_0$ (11.77 cm) $S_2V_1C_1$ (109.22 cm), $S_2V_2C_1$ (109.88 cm). The lowest plant height was identical with $S_3V_1C_0$ (92.33 cm), $S_3V_2C_0$ (93.33 cm), $S_3V_2C_1$ (95.33 cm), $S_3V_1C_0$ (94.00 cm), $S_1V_3C_2$ (91.87 cm), $S_1V_1C_0$ (94.22 cm), $S_1V_1C_2$ (94.89 cm), $S_1V_2C_0$ (98.77 cm), $S_1V_3C_0$ (95.55 cm), $S_1V_3C_1$ (96.89 cm), $S_3V_2C_2$ (100.33 cm), $S_3V_3C_0$ (100.11 cm), $S_3V_3C_1$ (99.55 cm), $S_3V_3C_2$ (100.11 cm), $S_1V_2C_1$ (100.55 cm), $S_1V_2C_2$ (100.33 cm).The intermediate plant height was observed with $S_2V_3C_0$ (105.56 cm) which was identical with $S_2V_3C_2$ (103.6 6cm), $S_2V_3C_1$ (101.89 cm), $S_1V_1C_1$ (101.66 cm).

Table 1 Interaction effect of sowing time, variety and inflorescence top -cutting on plant height of mustard

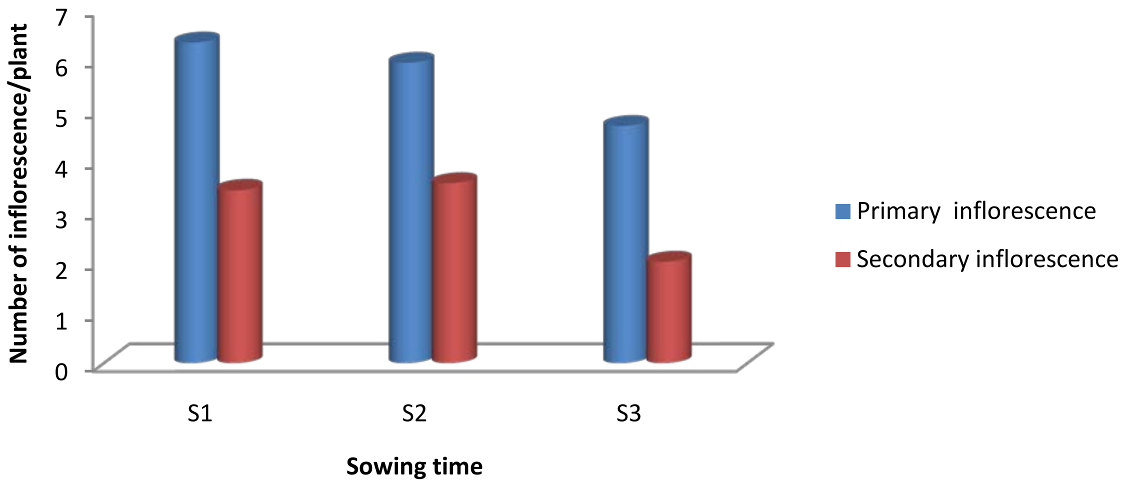
Treatments*	Plant height (cm)
S × V × C	
$S_1V_1C_0$	94.22 g-i
$S_1V_1C_1$	101.66 e-h
$S_1V_1C_2$	94.89 g-i
$S_1V_2C_0$	98.77 f-i
$S_1V_2C_1$	100.55 e-i
$S_1V_2C_2$	100.33 e-i
$S_1V_3C_0$	95.55 f-i
$S_1V_3C_1$	96.89 f-i
$S_1V_3C_2$	91.87 hi
$S_2V_1C_0$	113.33 a-c
$S_2V_1C_1$	109.22 a-e
$S_2V_1C_2$	116.55 a
$S_2V_2C_0$	111.77 a-d
$S_2V_2C_1$	109.88 a-e
$S_2V_2C_2$	114.66 ab
$S_2V_3C_0$	105.56 b-f
$S_2V_3C_1$	101.89 d-h
$S_2V_3C_2$	103.66 c-g
$S_3V_1C_0$	94.00 g-i
$S_3V_1C_1$	92.33 hi
$S_3V_1C_2$	90.33 i
$S_3V_2C_0$	93.34 g-i
$S_3V_2C_1$	95.33 f-i
$S_3V_2C_2$	100.33 e-i
$S_3V_3C_0$	100.11 e-i
$S_3V_3C_1$	99.55 e-i
$S_3V_3C_2$	100.11 e-i
SE	**3.07**
CV	**5.27**

* S_1 = 01 November, S_2 = 15 November, S_3 = 30 November V_1 = Tori-7, V_2 = BARI Sarisha-9, V_3 = BARI Sarisha-15
C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut

4.2 Number of inflorescence per plant

4.2.1 Effect of sowing time

Effect of sowing time was significant on the number of inflorescence (Fig. 7). The significantly highest number of primary inflorescence was with S_1 (6.32) and lowest number of primary inflorescence was with S_3 (4.67). The number of primary inflorescence of S_2 (5.92) and that of S_1 was identical. The significantly highest number of secondary inflorescence was with S_2 (3.54) which were statistically similar with S_1 (3.41). The lowest number of secondary inflorescence was with S_3 (2.00). The results are in agreement with those of Thurling (1974) who observed a marked effect on branches by variation in sowing dates. Islam *et al.* (1994), Ali *et al.* (1985) and Maini *et al.* (1964) also reported that delay in sowing suppressed the number of primary branches. Angrej et al. (2002) also supported and reported that primary and secondary branches per plant were obtained when the crop was sown in between 10 to 30 October. Ghosh and Chatterjee (1988) also reported that delay of sowing reduced the number of primary and secondary branches.



S_1 = 01 November, S_2 = 15 November, S_3 = 30 November

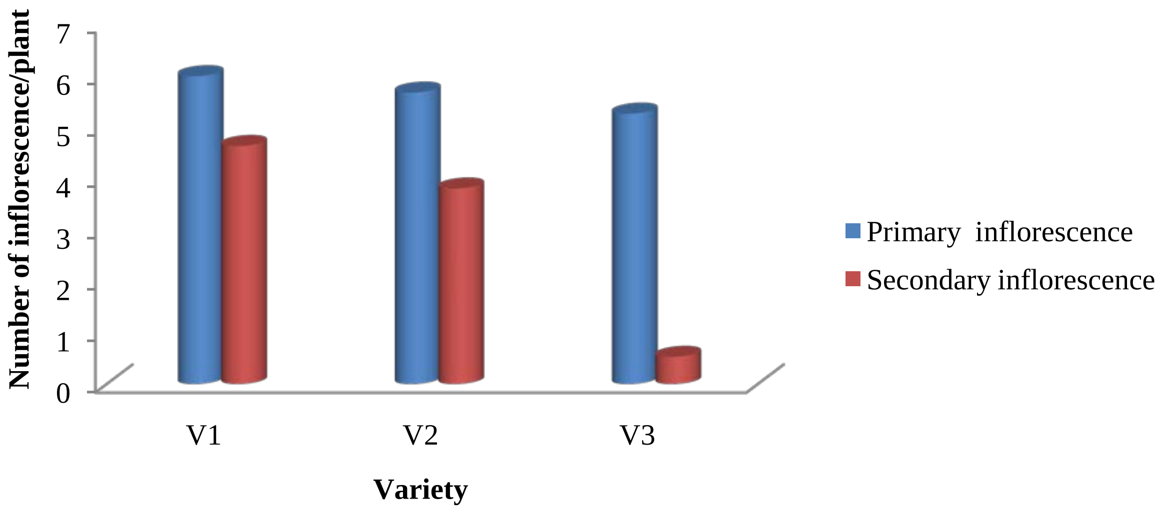
Figure 7 Number of inflorescence of mustard as influenced by different sowing times (SE= 0.50, 0.43 respectively)

4.2.2 Effect of variety

Effect of variety was insignificant on the number of primary inflorescence (Fig. 8). The higher number of primary inflorescence was found in V_1 (5.99) and lower in V_3 (5.26).

Significant variation was also observed for the number of secondary inflorescence (Fig. 8). The highest number of secondary inflorescence was with V_1 (4.63) and lowest number of secondary inflorescence was with V_3 (0.53). Intermediate value of secondary inflorescence was observed with V_2 (3.80).

The results are in agreement with those of Jahan and Zakaria (1997) who observed and reported that Tori-7 produce the highest number of primary branches / plant.

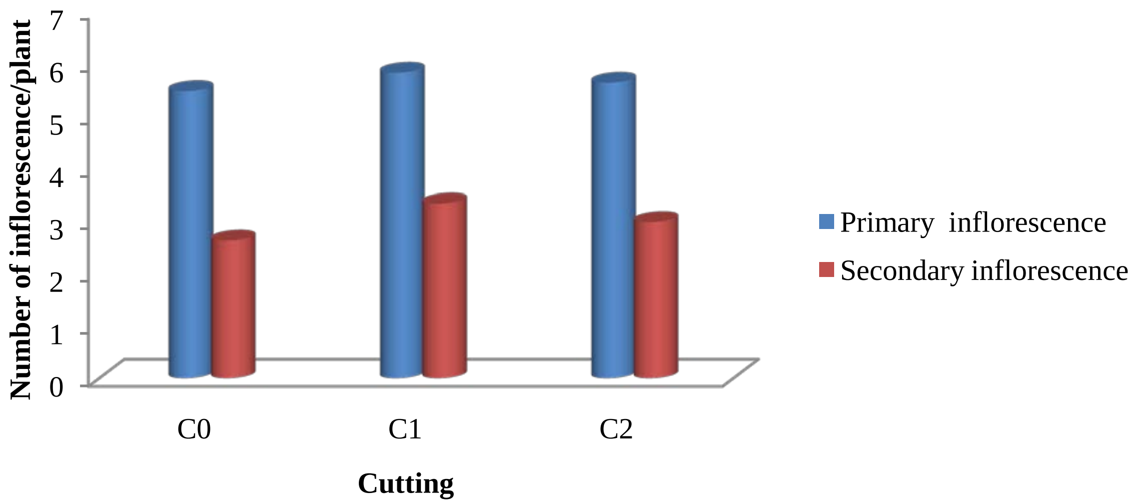


V_1 = Tori-7, V_2 = BARI Sarisha-9, V_3 = BARI Sarisha-15

Figure 8 Number of inflorescence of mustard as influenced by different varieties (SE=0.43, 0.33 respectively)

4.2.3 Effect of inflorescence top-cutting

Insignificant variation observed for the number of primary and secondary inflorescence of mustard due to inflorescence top-cutting (Fig. 9). The higher number of primary inflorescence was found in C_1 (5.82) and lower in C_0 (5.47) while numerically higher number of secondary inflorescence was found in C_1 (3.33) and lower in C_0 (2.63).

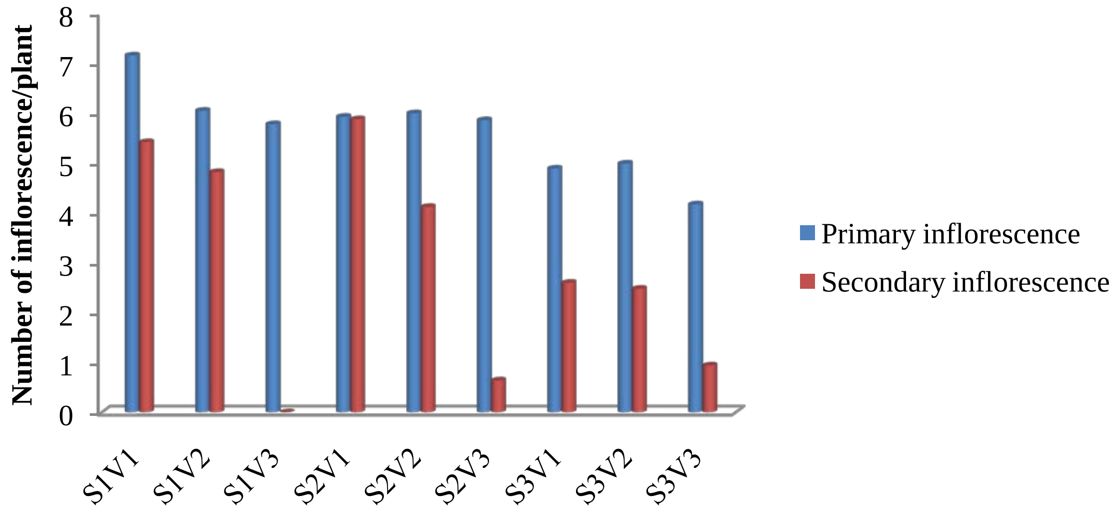


C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut

Figure 9 Number of inflorescence of mustard as influenced by different inflorescence top-cutting (SE=0.36, 0.40 respectively)

4.2.4 Interaction effect of sowing time and variety

Interaction effect of sowing time and variety was significant on number of inflorescence (Fig. 10). The significantly highest number of primary inflorescence was with S_1V_1 (7.15) and lowest was S_3V_3 (4.16). The highest value was identical with S_1V_2, S_1V_3, S_2V_1, S_2V_2, S_2V_3.The number of primary inflorescence S_3V_1 (4.88) and that of S_3V_2 (4.98) was identical and significantly lower than that of S_1V_1. The highest number of secondary inflorescence was with S_2V_1 (5.87) which was statistically similar with S_1V_1 (5.41) and S_1V_2 (4.81). The lowest number of secondary inflorescence was S_1V_3 (0) which was statistically similar to S_2V_3 (0.64), S_3V_3 (0.94).The intermediate number of secondary inflorescence of S_2V_2, S_3V_1 and S_3V_2 which were significantly lower than that of S_1V_1. The results are in partial agreement with those of Hossen (2005) who observed and reported that early sowing with BARI Sharisa-9 produced highest number of primary branches.

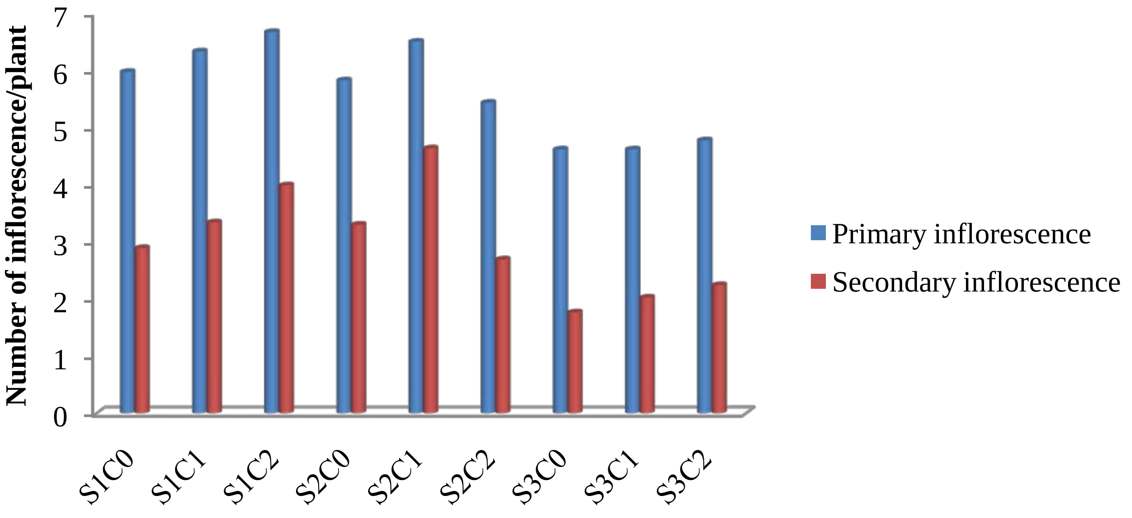


S_1 = 01 November, S_2 = 15 November, S_3 = 30 November, V_1 = Tori-7, V_2 = BARI Sarisha-9, V_3 = BARI Sarisha-15

Figure 10 Number of inflorescence of mustard as influenced by different sowing time and variety (SE=0.70, 0.58 respectively)

4.2.5 Interaction effect of sowing time and inflorescence top-cutting

Interaction effect of sowing time and inflorescence top-cutting was significant on number of inflorescence (Fig. 11). The highest number of primary inflorescence was with S_1C_2 (6.67), S_1C_1 (6.33) and S_2C_1 (6.50) which was statistically similar with S_1C_0 (5.97), S_2C_0 (5.82) and S_2C_2 (5.43). The lowest number of primary inflorescence was with S_3C_1 and S_3C_0 (4.62) which were statistically similar with S_3C_2 (4.78). The highest number of secondary inflorescence was with S_2C_1 (4.64) which were statistically similar with S_1C_1, S_1C_2 and S_2C_0. The significantly lowest number of secondary inflorescence was with S_3C_0 (1.76) which was statistically similar with S_3C_1, S_3C_2, S_2C_2 and S_1C_0.



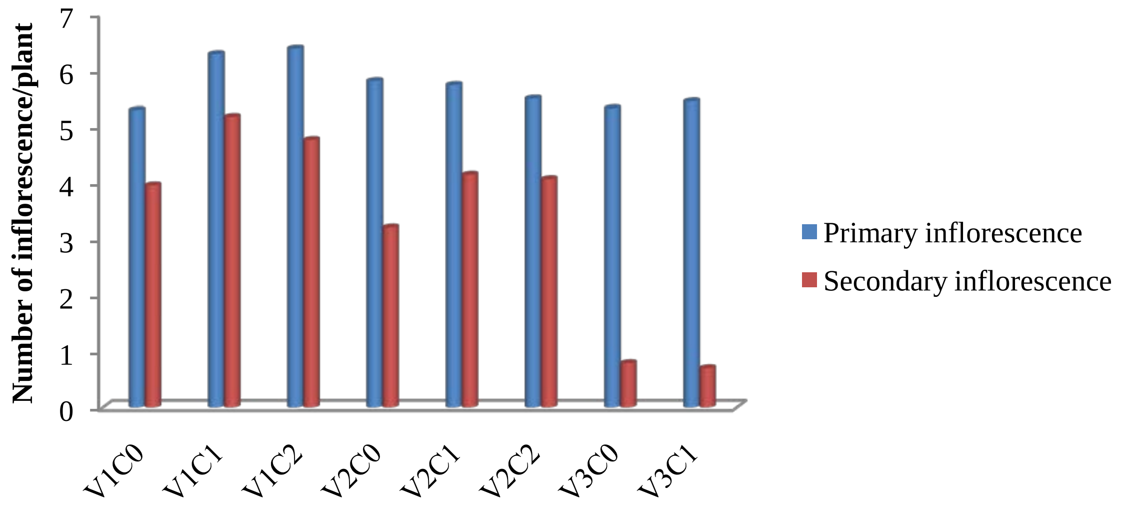
S_1 = 01 November, S_2 = 15 November, S_3 = 30 November, C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut

Figure 11 Number of inflorescence of mustard as influenced by different sowing time and inflorescence top-cutting (SE=0.63, 0.70 respectively)

4.2.6 Interaction effect of variety and inflorescence top-cutting

Interaction effect of variety and inflorescence top-cutting on primary inflorescence was insignificant (Fig. 12). Significantly higher number of primary inflorescence was found in V_1C_2 (6.38) and it was lowest in V_3C_2 (5.03).

Significant variation was observed for secondary inflorescence due to interaction effect of variety and inflorescence top-cutting. The significantly highest number of secondary inflorescence was with V_1C_1 (5.17) which were identical with V_1C_2, V_1C_0, V_2C_1 and V_2C_2. The lowest number of secondary inflorescence was with V_3C_2 (0.09) which was identical with V_3C_0, V_3C_1. The intermediate number of secondary inflorescence was with V_2C_0 (3.20).



V_1 = Tori-7, V_2 = BARI Sarisha-9, V_3 = BARI Sarisha-15, C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut

Figure 12 Number of inflorescence of mustard as influenced by different variety and inflorescence top-cutting (SE=0.63, 0.70 respectively)

4.2.7 Interaction effect of sowing time, variety and inflorescence top-cutting

Interaction effect of sowing time, variety and inflorescence top-cutting was significant on number of inflorescence (Table 2). The significantly highest number of primary inflorescence was with $S_1V_1C_2$ (7.80) which was statistically similar with $S_1V_1C_0$, $S_1V_1C_1$, $S_1V_2C_0$, $S_1V_2C_1$, $S_1V_2C_2$, $S_1V_3C_0$,$S_1V_3C_1$,$S_1V_3C_2$, $S_2V_1C_1$, $S_2V_1C_2$, $S_2V_2C_0$, $S_2V_2C_1$, $S_2V_3C_0$, $S_2V_3C_1$, $S_2V_3C_2$, $S_3V_1C_2$, $S_3V_2C_0$. The lowest number of primary inflorescence was with $S_3V_3C_2$ (4.04) which was statistically similar with $S_3V_3C_1$, $S_3V_2C_2$, $S_3V_2C_1$, $S_3V_1C_1$, $S_3V_1C_0$. Intermediate number of primary inflorescence were with $S_2V_1C_0$ (5.27) and $S_2V_2C_2$ (4.98) and were significantly lower than that of $S_1V_1C_2$. The significantly highest number of secondary inflorescence was with $S_2V_1C_1$ (7.59) which were statistically similar with $S_1V_1C_1$, $S_1V_2C_2$ and $S_2V_1C_0$. The lowest number of secondary inflorescence were with $S_1V_3C_0$ (0.00), $S_1V_3C_1$ (0.00), $S_1V_3C_2$ (0.00) which were statistically similar with $S_3V_3C_2$, $S_3V_3C_1$, $S_3V_3C_0$, $S_3V_2C_0$, $S_3V_1C_1$, $S_3V_1C_0$, $S_2V_3C_2$, $S_2V_3C_1$ and $S_2V_3C_0$. Intermediate numbers of secondary inflorescence were $S_1V_1C_0$, $S_1V_2C_0$, $S_1V_2C_1$, $S_2V_1C_2$, $S_2V_2C_0$, $S_2V_2C_1$, $S_2V_2C_2$, $S_3V_1C_2$, $S_3V_2C_1$ and $S_3V_2C_2$ which were significantly lower than $S_2V_1C_1$.

Table 2 Interaction effect of sowing time, variety and inflorescence top-cutting on the Number of inflorescence of mustard

Treatments*	Primary inflorescence	Secondary inflorescence
S X V X C		
$S_1V_1C_0$	6.28 a-d	4.26 b-f
$S_1V_1C_1$	7.36 ab	5.49 a-c
$S_1V_1C_2$	7.80 a	6.50 ab
$S_1V_2C_0$	5.77 a-d	4.40b-e
$S_1V_2C_1$	5.70 a-d	4.55 b-e
$S_1V_2C_2$	6.64 a-c	5.49 a-c
$S_1V_3C_0$	5.85 a-d	0.00 k
$S_1V_3C_1$	5.92 a-d	0.00 k
$S_1V_3C_2$	5.56 a-d	0.00 k
$S_2V_1C_0$	5.27 b-d	5.63 a-c
$S_2V_1C_1$	6.64 a-c	7.95 a
$S_2V_1C_2$	5.84 a-d	4.04 b-f
$S_2V_2C_0$	6.21 a-d	3.54 c-h
$S_2V_2C_1$	6.79 a-c	4.84 b-d
$S_2V_2C_2$	4.98 b-d	3.97 b-f
$S_2V_3C_0$	5.99 a-d	0.72 i-k
$S_2V_3C_1$	6.06 a-d	1.15 g-k
$S_2V_3C_2$	5.49 a-d	0.07 jk
$S_3V_1C_0$	4.33 cd	1.95 e-k
$S_3V_1C_1$	4.84 cd	2.09 e-k
$S_3V_1C_2$	5.49 a-d	3.75 c-g
$S_3V_2C_0$	5.41 a-d	1.66 f-k
$S_3V_2C_1$	4.69 cd	3.03 c-i
$S_3V_2C_2$	4.84 cd	2.74 d-j
$S_3V_3C_0$	4.11 d	1.66 f-k
$S_3V_3C_1$	4.33 cd	0.94 h-k
$S_3V_3C_2$	4.04 d	0.21 jk
SE	**1.10**	**1.22**
CV	**21.99**	**46.15**

*S_1 = 01 November, S_2 = 15 November, S_3 = 30 November V_1 = Tori-7, V_2 = BARI Sarisha-9, V_3 = BARI Sarisha-15
C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut

4.3 Number of siliqua per plant of mustard

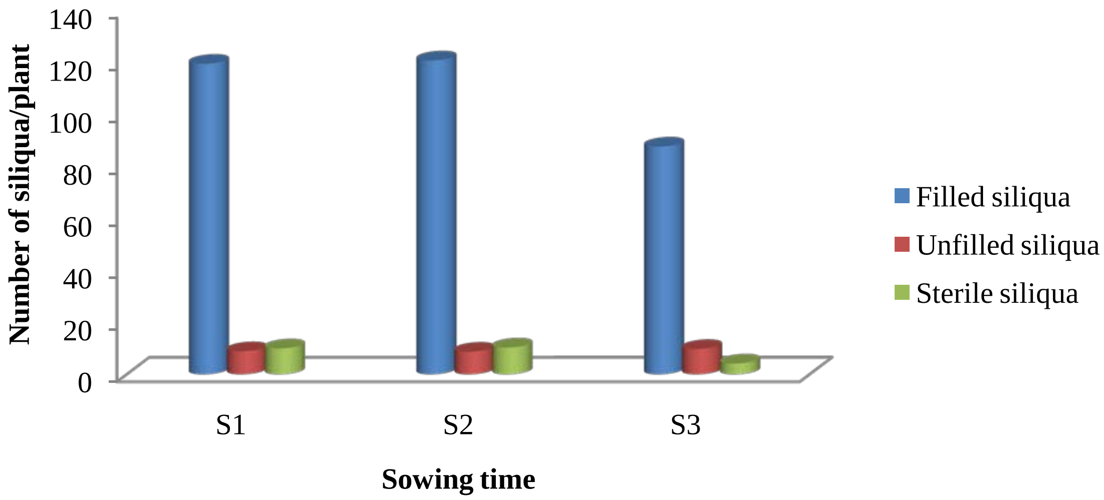
4.3.1 Effect of sowing time

Effect of sowing time was significant on the number of filled siliqua (Fig. 13). The significantly highest number of filled siliqua was recorded in S_2 (120.77) which were identical with S_1 (119.46). The significantly lowest number of filled siliqua was with S_3 (87.56).

Insignificant variation was observed for number of unfilled siliqua due to sowing time (Fig. 13).

Sterile siliqua had significant variation due to sowing time (Fig. 13). The significantly highest number of sterile siliqua was with S_2 (10.32) which were statistically similar with S_1 (9.96). The significantly lowest number of sterile siliqua was with S_3 (4.15).

The findings was in conformity with the findings of Scott *et al.* (1973), Thurling (1974) , Rahman *et al.* (1988), Mendham *et al.* (1981) and Uddin *et al.* (1986) who stated that delay sowing decrease the number of siliqua per plant.

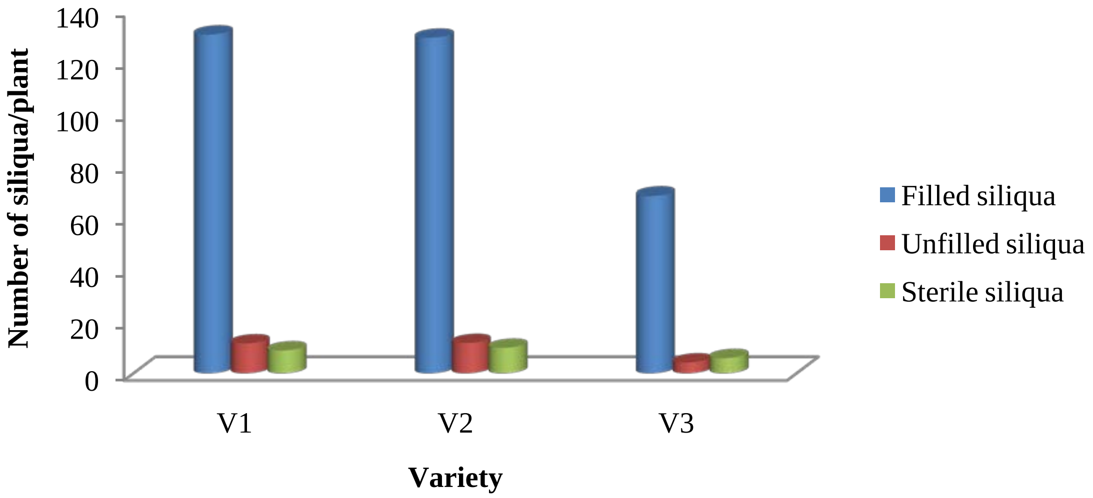


S_1 = 01 November, S_2 = 15 November, S_3 = 30 November

Figure 13 Number of siliqua of mustard as influenced by sowing times (SE=NS, NS and 0.99 respectively)

4.3.2 Effect of variety

Varietal effect was significant on the number of filled, unfilled and sterile siliqua (Fig. 14). Filled siliqua was highest in V_1 (130.36) and lowest in V_3 (68.31). On the other hand, unfilled siliqua and sterile siliqua were highest in V_2 (11.65 and 9.79 respectively) and lowest in V_3 (4.15 and 5.83 respectively). Hossen (2005), Mondal *et al*. (1992), Jahan and Zakaria (1997) and Hussain *et al.* (1996) reported that significant variation was found in number of siliqua per plant in different mustard varieties.



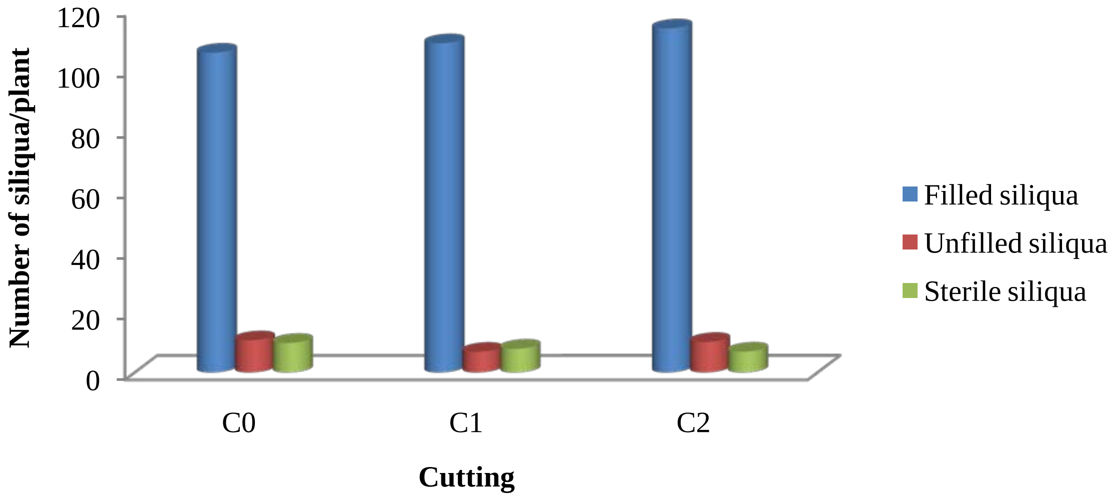
V_1 = Tori-7, V_2 = BARI Sarisha-9, V_3 = BARI Sarisha-15

Figure 14 Number of siliqua of mustard as influenced by variety (SE=10.98, 1.84 and 8.97 respectively)

4.3.3 Effect of inflorescence top-cutting

Effect of inflorescence top-cutting was insignificant on the number of filled and unfilled siliqua (Fig. 15).The highest number of filled and unfilled siliqua were recorded in C_2 (113.58) and C_0 (10.61) respectively while lowest number of filled and unfilled siliqua were recorded in C_0 (105.55) and C_1 (6.82) respectively.

Number of sterile siliqua differed significantly due to various cutting treatments (Fig. 15). The significantly highest number of sterile siliqua was recorded in C_0 (9.74) and it was lowest in C_2 (6.86).



C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut

Figure 15 Number of siliqua of mustard as influenced by different cuttings (SE=NS, NS and 1.30 respectively)

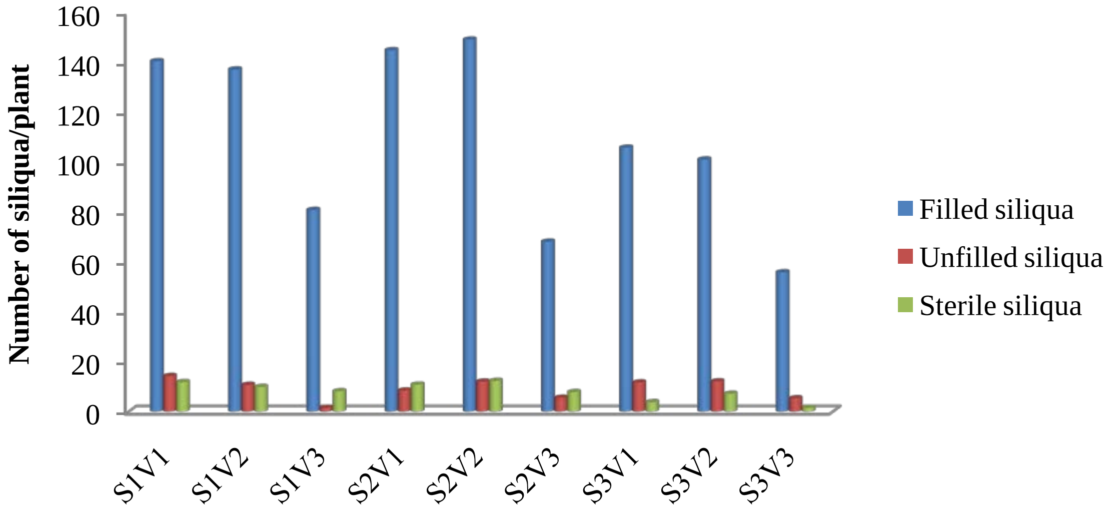
4.3.4 Interaction effect of sowing time and variety

Significant variation was observed for number of filled, unfilled and sterile siliqua of mustard due to interaction effect of sowing time and variety (Fig. 16) .The highest number of filled siliqua was with S_2V_2 (149.16) which was closely followed by S_2V_1 (144.90), S_1V_1 (140.47) and S_1V_2 (137.17) and lowest number of filled siliqua was with S_3V_3 (55.95). S_2V_3 (68.25) also showed lower value which was statistically similar with S_1V_3 (80.74). The intermediate number of filled siliqua was observed with S_3V_1 (105.73), S_3V_2 (101.02).

The highest number of unfilled siliqua was with S_1V_1 (14.30) which was closely followed by S_3V_2 (12.16), S_2V_2 (12.06) and S_3V_1 (11.72) and lowest number of unfilled siliqua was with S_1V_3 (1.54). S_3V_3 (5.35) also showed lower value which was statistically similar with S_2V_3 (5.56).

The highest number of sterile siliqua was with S_2V_2 (12.32) which was statistically similar with S_1V_1 (11.83), which was closely followed by S_2V_1 (10.81) and S_1V_2 (9.89) and lowest number of sterile siliqua was with S_3V_3 (1.52).

The result was in contradiction with the findings of Hoseen (2005) who reported that BARI Sarisha-8 with early sowing produced higher number of siliqua.



S_1 = 01 November, S_2 = 15 November, S_3 = 30 November, V_1 = Tori -7, V_2 = BARI Sarisha -9, V_3 = BARI Sarisha -15

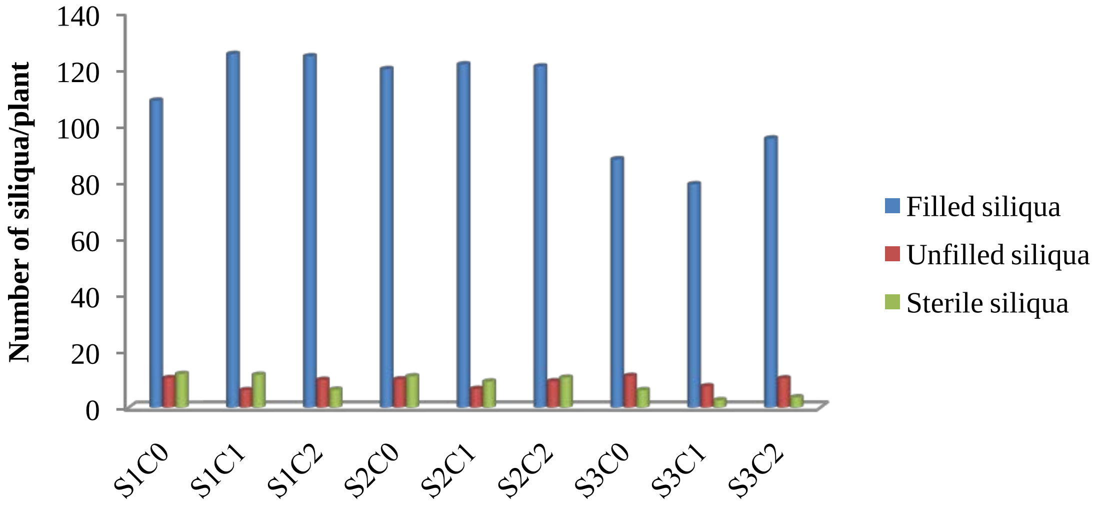
Figure 16 Number of siliqua of mustard as influenced by the interactions of sowing times and varieties (SE=19.01, 3.19 and 1.30 respectively)

4.3.5 Interaction effect of sowing time and inflorescence top-cutting

Interaction effect of sowing time and inflorescence top-cutting was significant on number of filled and sterile siliqua of mustard while number of unfilled siliqua showed no significant variation (Fig. 17). The highest number of filled siliqua was with S_1C_1 (125.26) and S_1C_2 (124.44) which were statistically similar with S_2C_1 (121.57), S_2C_2 (120.85) and S_2C_0 (111.89) and lowest number of filled siliqua was with S_3C_1 (79.18). S_3C_0 (88.06) also showed lower values.

The highest number of unfilled siliqua was with S_3C_0 (11.27) which was closely followed by S_1C_0 (10.52) and lowest number of unfilled siliqua was with S_1C_1 (6.21). S_2C_1 (6.67) also showed lower value.

The highest number of sterile siliqua was with S_1C_0 (11.93) which was statistically similar with S_1C_1 (11.63) and S_2C_0 (11.10) and was closely followed by S_2C_1 (9.24), S_2C_2 (10.62) and lowest number of filled siliqua was with S_3C_1 (2.62) which was statistically similar with S_3C_2 (3.63).



S_1 = 01 November, S_2 = 15 November, S_3 = 30 November, C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut

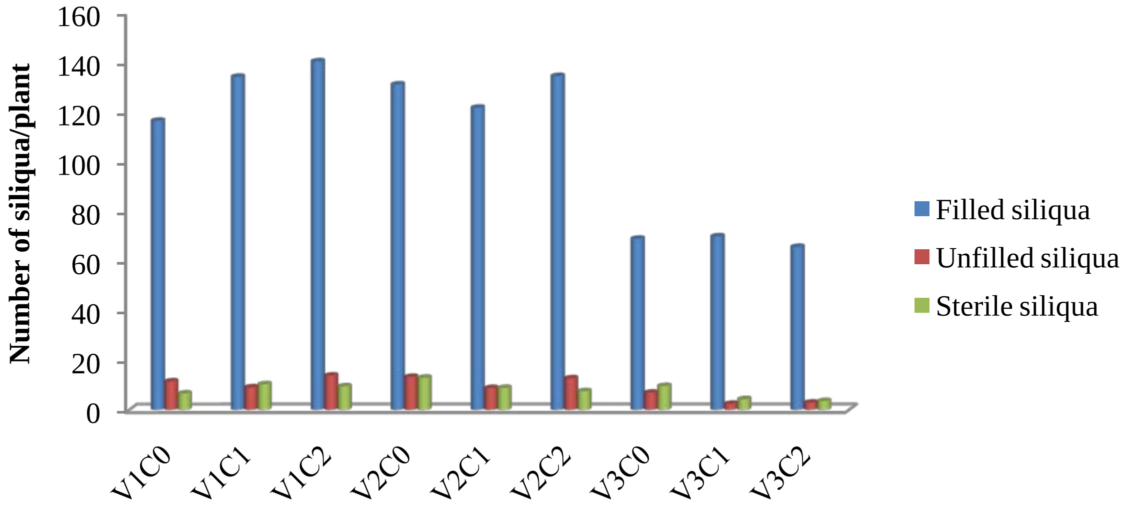
Figure 17 Number of siliqua of mustard as influenced by the interactions of sowing times and cuttings (SE=13.51, 3.37 and 2.25 respectively)

4.3.6 Interaction effect of variety and inflorescence top-cutting

Significant variation was observed for filled, unfilled and sterile siliqua of mustard due to interaction effect of variety and inflorescence top-cutting (Fig. 18). The highest number of filled siliqua was with V_1C_2 (140.45) which was statistically similar with V_2C_2 (134.50), V_1C_1 (134.21), V_2C_0 (131.11) and lowest was with V_3C_2 (65.79) which was statistically similar with V_3C_0 (69.09), V_3C_1 (70.06). The intermediate number of filled siliqua was observed with V_2C_1 (121.74) which was statistically similar with V_1C_0 (116.45).

The highest number of unfilled siliqua was with V_1C_2 (13.87) which was statistically similar with V_2C_0 (13.34), V_2C_2 (12.87), V_1C_0 (11.51) and lowest was with V_3C_1 (2.48) which was statistically similar with V_3C_2 (2.96). The intermediate number of unfilled siliqua was observed with V_1C_1 (9.13) which was statistically similar with V_2C_1 (8.86) and V_3C_0 (7.01).

The highest number of sterile siliqua was with V_2C_0 (12.98) and lowest was with V_3C_2 (3.56)



V_1 = Tori-7, V_2 = BARI Sarisha-9, V_3 = BARI Sarisha-15, C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut

Figure 18 Number of siliqua of mustard as influenced by the interactions of varieties and inflorescence top-cuttings (SE=13.51, 3.37 and 2.25 respectively)

4.3.7 Interaction effect of sowing time, variety and inflorescence top-cutting

Interaction effect of sowing time, variety and inflorescence top-cutting was significant for filled, unfilled and sterile siliqua of mustard (Table 3). The highest number of filled siliqua was with $S_2V_1C_1$ (165.17) and lowest number of filled siliqua was found in $S_3V_3C_2$ (49.76) which was statistically similar with $S_3V_3C_1$ (51.71). The highest number of filled siliqua was followed by $S_2V_2C_2$ (161.78), $S_2V_2C_0$ (155.85), $S_1V_2C_2$ (147.69), $S_1V_1C_1$ (150.58), $S_1V_1C_2$ (146.68), $S_3V_1C_2$ (142.56). On the other hand, the number of filled siliqua was also lower in $S_3V_3C_0$ (66.37), $S_2V_3C_0$ (66.37), $S_2V_3C_2$ (68.68), $S_2V_3C_1$ (69.69), $S_1V_3C_0$ (74.53).The intermediate number of filled siliqua was observed with $S_2V_1C_0$ (137.44) which was identical with $S_1V_2C_1$ (136.43), $S_2V_1C_2$ (132.09).

The highest number of unfilled siliqua was with $S_1V_1C_0$ and $S_3V_1C_2$ (both gave 17.33) and lowest number of unfilled siliqua was found in $S_1V_3C_2$ (1.22) which was statistically similar with $S_1V_3C_1$ (1.37), $S_1V_3C_0$ (2.02), $S_3V_3C_1$ (2.24), $S_3V_3C_2$ (3.32) and $S_2V_3C_1$ (3.82).

The highest number of sterile siliqua was with $S_1V_1C_1$ (17.26) which was followed by $S_1V_3C_0$ (14.81) and lowest number of sterile siliqua was found in $S_3V_3C_0$ (1.15) which was statistically similar with $S_3V_3C_1$ (1.66) and $S_3V_3C_2$ (1.73).

Table 3 Effect of interaction of sowing time, variety and inflorescence top-cutting on the number of siliqua of mustard

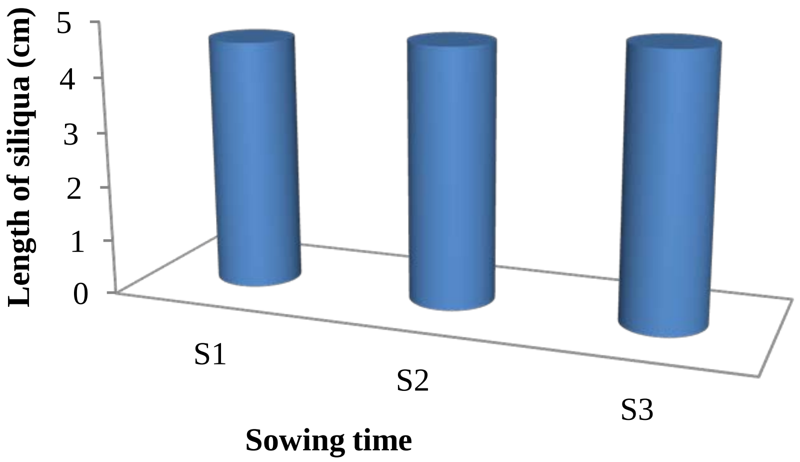
Treatments*	Filled siliqua	Unfilled siliqua	Sterile siliqua
S X V X C			
$S_1V_1C_0$	124.15 a-g	17.33 a	8.45 a-h
$S_1V_1C_1$	150.58 a-c	11.34 ab	17.26 a
$S_1V_1C_2$	146.68 a-c	14.23 ab	9.46 a-h
$S_1V_2C_0$	127.40 a-f	12.20 ab	12.21 a-e
$S_1V_2C_1$	136.43 a-e	5.92 ab	10.83 a-g
$S_1V_2C_2$	147.69 a-c	14.16 ab	6.64 b-h
$S_1V_3C_0$	74.53 g-i	2.02 b	14.81 ab
$S_1V_3C_1$	88.76 e-i	1.37 b	6.79 b-h
$S_1V_3C_2$	78.94 f-i	1.22 b	2.89 f-h
$S_2V_1C_0$	137.44 a-e	7.87 ab	8.16 b-h
$S_2V_1C_1$	165.17 a	7.51 ab	9.89 a-h
$S_2V_1C_2$	132.09 a-e	10.04 ab	14.37 a-c
$S_2V_2C_0$	155.85 ab	13.79 ab	12.20 a-e
$S_2V_2C_1$	129.86 a-f	8.66 ab	13.36 a-c
$S_2V_2C_2$	161.78 ab	13.72 ab	11.41 a-f
$S_2V_3C_0$	66.37 hi	8.52 ab	12.93 a-d
$S_2V_3C_1$	69.69 hi	3.82 b	4.48 d-h
$S_2V_3C_2$	68.68 hi	4.33 ab	6.06 c-h
$S_3V_1C_0$	87.74 e-i	9.31 ab	2.89 f-h
$S_3V_1C_1$	86.88 e-i	8.52 ab	3.83 e-h
$S_3V_1C_2$	142.56 a-d	17.33 a	4.62 d-h
$S_3V_2C_0$	110.06 b-h	14.01 ab	14.51 a-c
$S_3V_2C_1$	98.94 c-i	11.98 ab	2.38 gh
$S_3V_2C_2$	94.03 d-i	10.47 ab	4.55 d-h
$S_3V_3C_0$	66.37 hi	10.47 ab	1.15 h
$S_3V_3C_1$	51.71 i	2.24 b	1.66 h
$S_3V_3C_2$	49.76 i	3.32 b	1.73 h
SE	**23.40**	**5.83**	**3.89**
CV	**24.11**	**72.22**	**53.91**

*S_1 = 01 November, S_2 = 15 November, S_3 = 30 November V_1 = Tori-7, V_2 = BARI Sarisha-9, V_3 = BARI Sarisha-15
C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut

4.4 Length of siliqua (cm)

4.4.1 Effect of sowing time

Effect of sowing time was significant on length of siliqua (Fig. 19). The significantly longest siliqua was found in S_3 (4.91 cm) followed by S_2 (4.72 cm) and then that of S_1 (4.56 cm). The findings shows opposite result with the findings of Hossain et al. (1996) who found that siliqua length reduced due to delay of planting time.

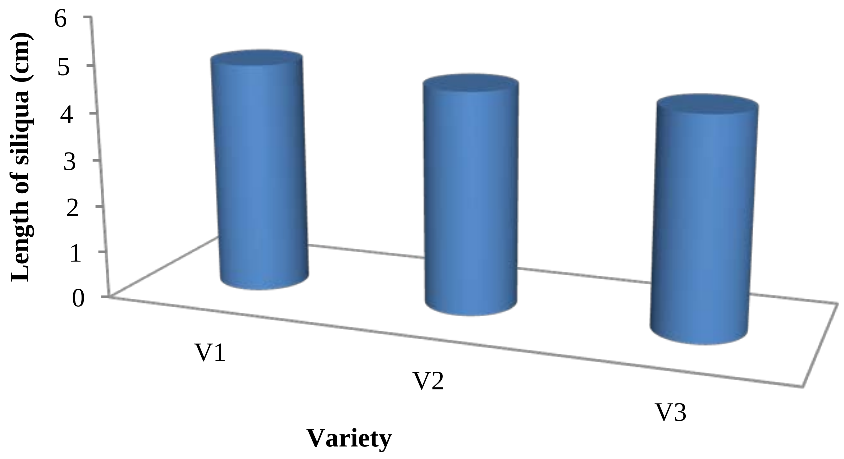


S_1 = 01 November, S_2 = 15 November, S_3 = 30 November

Figure 19 Length of siliqua of mustard as influenced by sowing times (SE=0.02)

4.4.2 Effect of variety

Varietal effect was insignificant on length of siliqua (Fig. 20). Significantly longer siliqua was found in V_1 (4.91cm) and shorter in V_3 (4.60 cm). The findings is in conformity with those of Jahan and Zakaria, (1997), Gangasaran *et al.* (1981) and Hussain *et al*. (1996) who observed a significant variation in siliqua length among the different varieties of mustard.

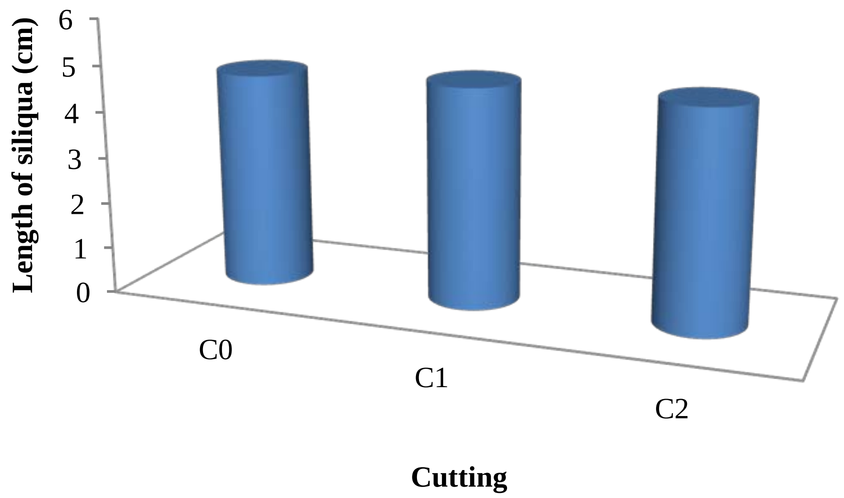


V_1 = Tori-7, V_2 = BARI Sarisha-9, V_3 = BARI Sarisha-15

Figure 20 Length of siliqua of mustard as influenced by varieties (SE=NS)

4.4.3 Effect of inflorescence top-cutting

Effect of inflorescence top-cutting was insignificant on length of siliqua (Fig. 21). The longer siliqua was found in C_1 (4.76 cm) and shorter in C_0 (4.68 cm).

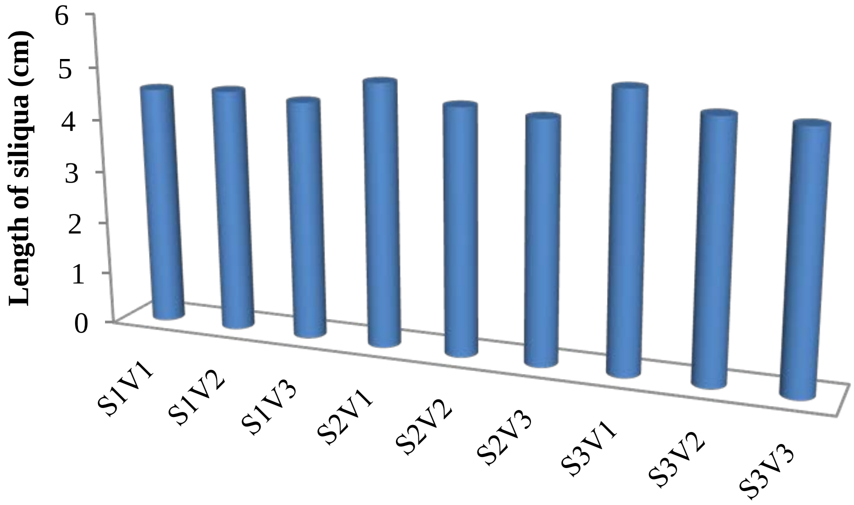


C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut

Figure 21 Length of siliqua of mustard as influenced by inflorescence top-cuttings (SE=NS)

4.4.4 Interaction effect of sowing time and variety

Significant variation was observed for length of siliqua of mustard due to interaction effect of sowing time and variety (Fig. 22) .The significantly longest siliqua was found in S_3V_1 (5.17 cm) which was followed by S_2V_1 (4.97 cm). S_2V1 was statistically similar with S_3V_2 (4.81 cm), S_3V_3 (4.75 cm), S_2V_2 (4.64 cm) and S_1V_2 (4.61 cm**).** The shortest siliqua was recorded in S_1V_3 (4.51 cm) which was statistically similar with S_2V_3 (4.54 cm) and S_1V_1 (4.55 cm).

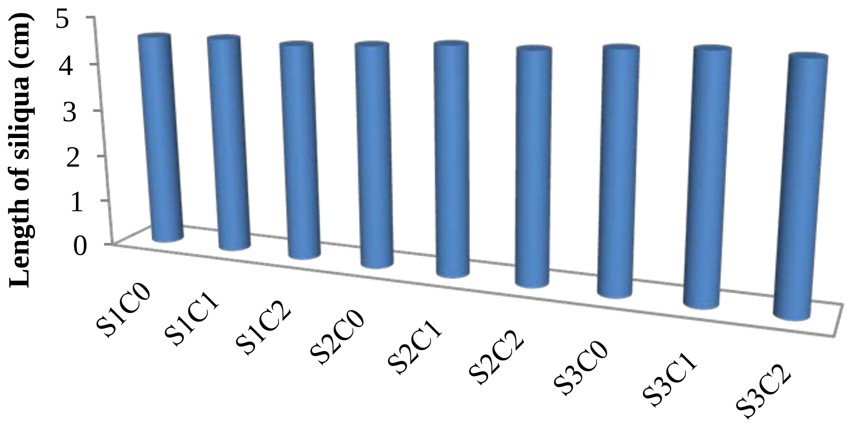


S_1 = 01 November, S_2 = 15 November, S_3 = 30 November, V_1 = Tori-7, V_2 = BARI Sarisha-9, V_3 = BARI Sarisha-15

Figure 22 Length of siliqua of mustard as influenced by interaction of sowing time and variety (SE=0.164)

4.4.5 Interaction effect of sowing time and inflorescence top-cutting

Interaction effect of sowing time and inflorescence top-cutting was insignificant on length of siliqua (Fig. 23). Significantly longer siliqua was found in S_3C_1 (4.95 cm) and shorter in S_1C_0 (4.54 cm).

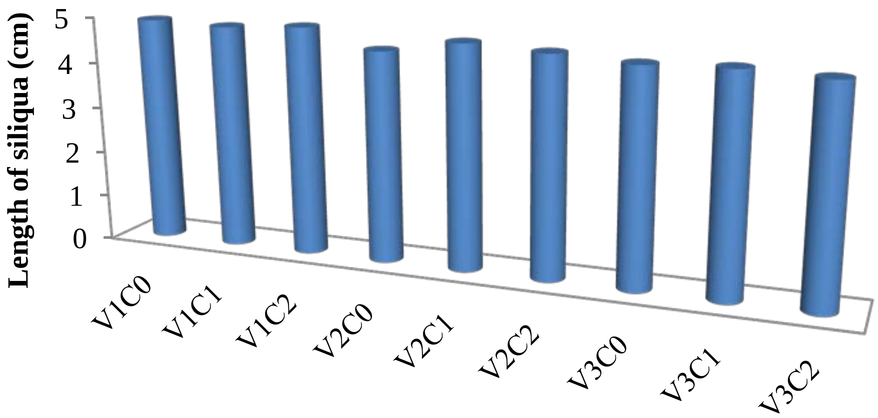


S_1 = 01 November, S_2 = 15 November, S_3 = 30 November, C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut

Figure 23 Length of siliqua of mustard as influenced by interaction of sowing time and inflorescence top-cuttings (SE=0.13)

4.4.6 Interaction effect of variety and inflorescence top-cutting

Insignificant variation was observed for length of siliqua due to interaction effect of variety and inflorescence top-cutting (Fig. 24). Significantly longer siliqua was found in V_1C_2 (4.94 cm) and shorter in V_3C_2 (4.56 cm).



V_1 = Tori-7, V_2 = BARI Sarisha-9, V_3 = BARI Sarisha-15, C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut

Figure 24 Length of siliqua of mustard as influenced by varieties and cuttings (SE=0.13)

4.4.7 Interaction effect of sowing time, variety and inflorescence top-cutting

Interaction effect of sowing time, variety and inflorescence top-cutting was significant on pod length (Table 4). The significantly highest pod length was with $S_3V_1C_1$ (5.26 cm) and lowest pod length was $S_1V_3C_2$ (4.40 cm). $S_3V_1C_1$ was followed by $S_2V_1C_2$ (5.207 cm) and $S_1V_3C_0$ (4.47 cm). The lowest pod length was identical with $S_1V_2C_0$ (4.41 cm) and $S_1V_1C_1$ (4.41 cm).

Table 4 Interaction effect of sowing time, variety and inflorescence top-cutting on pod length of mustard

Treatments*	Length of siliqua (cm)
S X V X C	
$S_1V_1C_0$	4.74 a-c
$S_1V_1C_1$	4.41 c
$S_1V_1C_2$	4.50 a-c
$S_1V_2C_0$	4.41 c
$S_1V_2C_1$	4.69 a-c
$S_1V_2C_2$	4.74 a-c
$S_1V_3C_0$	4.47 bc
$S_1V_3C_1$	4.68 a-c
$S_1V_3C_2$	4.40 c
$S_2V_1C_0$	4.83 a-c
$S_2V_1C_1$	4.88 a-c
$S_2V_1C_2$	5.20 ab
$S_2V_2C_0$	4.63 a-c
$S_2V_2C_1$	4.74 a-c
$S_2V_2C_2$	4.54 a-c
$S_2V_3C_0$	4.48 a-c
$S_2V_3C_1$	4.64 a-c
$S_2V_3C_2$	4.51 a-c
$S_3V_1C_0$	5.16 a-c
$S_3V_1C_1$	5.26 a
$S_3V_1C_2$	5.10 a-c
$S_3V_2C_0$	4.59 a-c
$S_3V_2C_1$	5.00 a-c
$S_3V_2C_2$	4.48 a-c
$S_3V_3C_0$	4.86 a-c
$S_3V_3C_1$	4.60 a-c
$S_3V_3C_2$	4.78 a-c
SE	**0.22**
CV (%)	**8.27**

*S_1 = 01 November, S_2 = 15 November, S_3 = 30 November V_1 = Tori-7, V_2 = BARI Sarisha-9, V_3 = BARI Sarisha-15
C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut

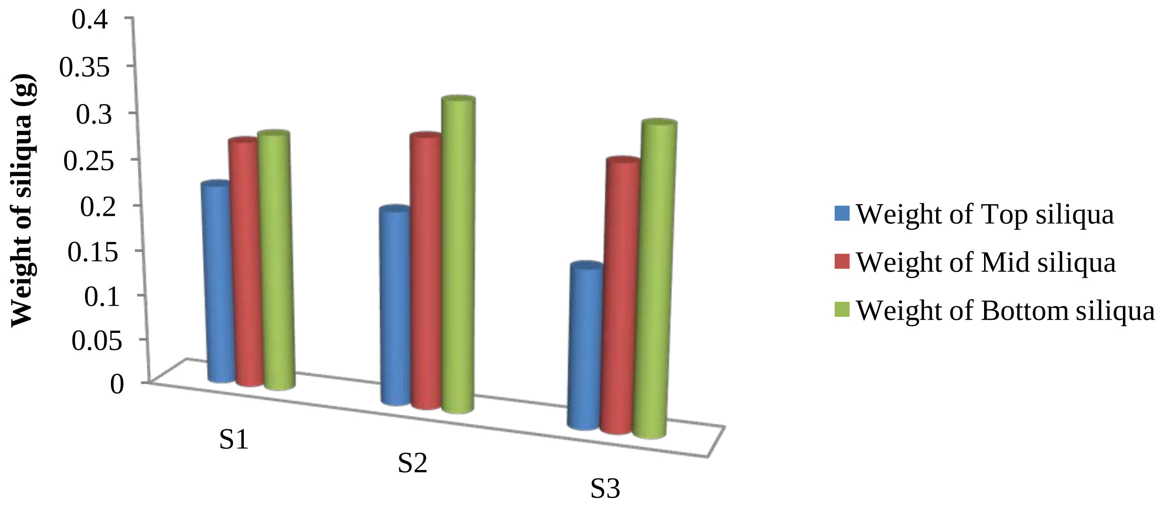
4.5 Fresh weight of siliqua (g)

4.5.1 Effect of sowing time

Effect of sowing time was significant on fresh weight of top siliqua (Fig. 25). The significantly highest fresh weight was with S_1 (0.22 g) which was statistically similar with S_2 (0.21 g). The significantly lowest fresh weight was with S_3 (0.17 g).

Effect of sowing time was insignificant on fresh weight of mid siliqua. But numerically the highest fresh weight was with S_2 (0.29 g) and lowest was with S_1 (0.27 g).

Effect of sowing time was significant on fresh weight of bottom siliqua. The significantly highest fresh weight was with S_2 (0.33 g) which was statistically similar with S_3 (0.32 g). The significantly lowest fresh weight was with S_1 (0.28 g).



S_1 = 01 November, S_2 = 15 November, S_3 = 30 November

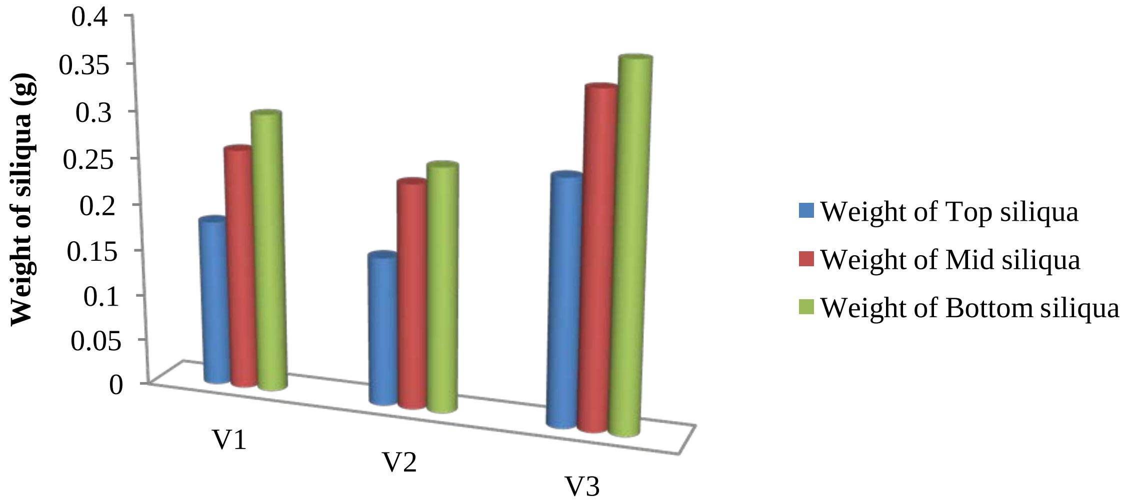
Figure 25 Fresh weight of siliqua of mustard as influenced by different sowing times (SE=0.10, 0.09 and 0.01 respectively)

4.5.2 Effect of variety

Effect of variety was significant on fresh weight of top siliqua (Fig. 26). The significantly highest fresh weight was with V_3 (0.26 g). The fresh weight of V_2 (0.16 g) and that of V_1 (0.18 g) was identical and significantly lower than that of V_3.

Effect of variety was significant on fresh weight of mid siliqua. The significantly highest fresh weight was with V_3 (0.35 g). The significantly lowest fresh weight was with V_2 (0.24 g) which was statistically similar with V_1 (0.26 g)

Effect of variety was significant on fresh weight of bottom siliqua. The significantly highest fresh weight was with V_3 (0.38 g). The fresh weight of V_2 (0.26 g) and that of V_1 (0.30 g) was identical and significantly lower than that of V_3.



V_1 = Tori -7, V_2 = BARI Sharisha -9, V_3 = BARI Sharisha -15

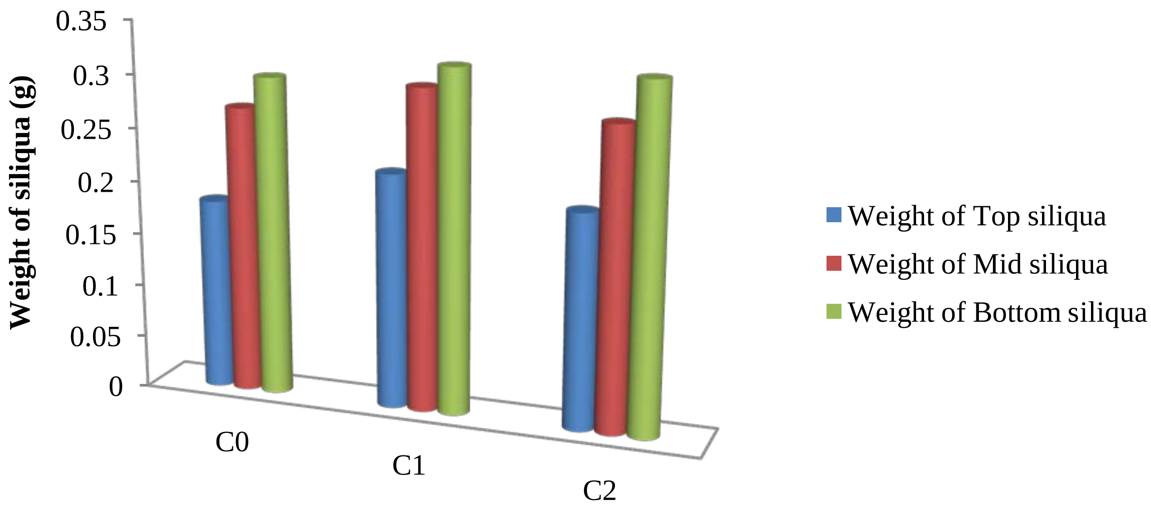
Figure 26 Fresh weight of siliqua of mustard as influenced by variety (SE=0.01, 0.08 and 0.01 respectively)

4.5.3 Effect of inflorescence top-cutting

Effect of inflorescence top-cutting was significant on fresh weight top siliqua (Fig. 27). The significantly highest fresh weight was with C_1 (022 g) which was identical with C_2 (0.20 g). The significantly lowest fresh weight was with C_0 (0.18 g). This suggests that there was a clear effect on siliqua due to the inflorescence top cutting.

Effect of inflorescence top-cutting was insignificant on fresh weight of mid siliqua. But numerically the highest fresh weight was with C_1 (0.30 g) and lowest was with C_0 (0.27 g).

Effect of inflorescence top-cutting was insignificant on fresh weight of bottom siliqua. But numerically the highest fresh weight was with C_1 (0.32 g) and C_2 (0.32 g).The lowest was with C_0 (0.30 g).



C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut

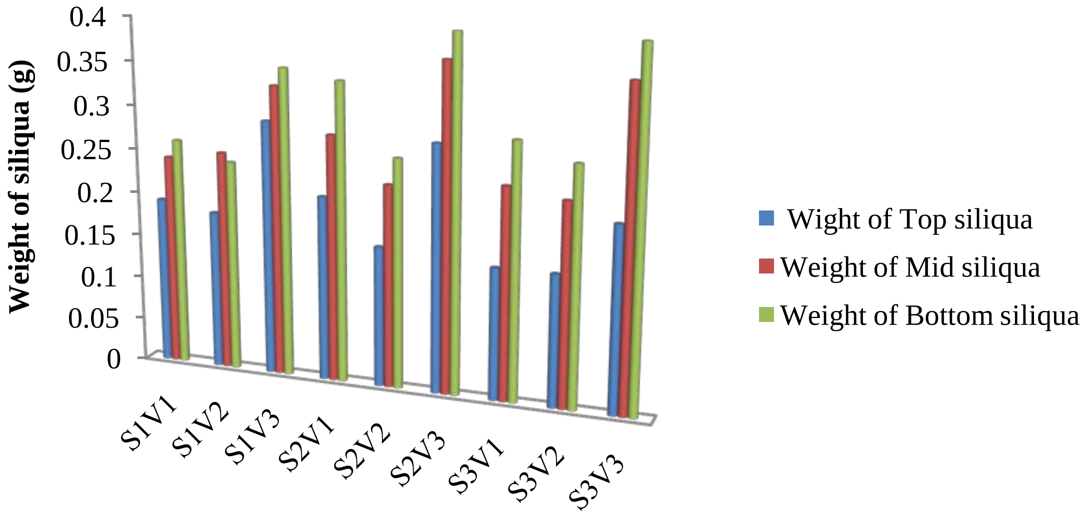
Figure 27 Fresh weight of siliqua of mustard as influenced by inflorescence top-cuttings (SE=0.01, 0.08 and 0.01respectively)

4.5.4 Interaction effect of sowing time and variety

The interaction effect of sowing time and variety was significant on fresh weight of siliqua (Fig.28). The significantly highest fresh weight of top siliqua was with S_1V_3 (0.29 g) and S_2V_3 (0.28 g). The significantly lowest fresh weight of top siliqua was S_3V_1 (0.15 g) and S_3V_2 (0.15 g). S_3V_1 was followed by S_1V_1, S_1V_2, S_2V_1, S_2V_2 and S_3V_3.

The significantly highest fresh weight of mid siliqua was with S_2V_3 (0.37 g) which was statistically similar with S_1V_3 and S_3V_3. The significantly lowest fresh weight of mid siliqua was with S_2V_2 (0.23 g) which was statistically similar with S_1V_3 and S_2V_1.

The significantly highest fresh weight of bottom siliqua was with S_2V_3 (0.40 g) and S_3V_3 (0.40 g) which were statistically similar with S_1V_3 and S_2V_1. The significantly lowest fresh weight of plant was with S_1V_2 (0.24 g) which was statistically similar with S_3V_1 and S_3V_2.



S_1 = 01 November, S_2 = 15 November, S_3 = 30 November, V_1 = Tori-7, V_2 = BARI Sarisha-9, V_3 = BARI Sarisha-15

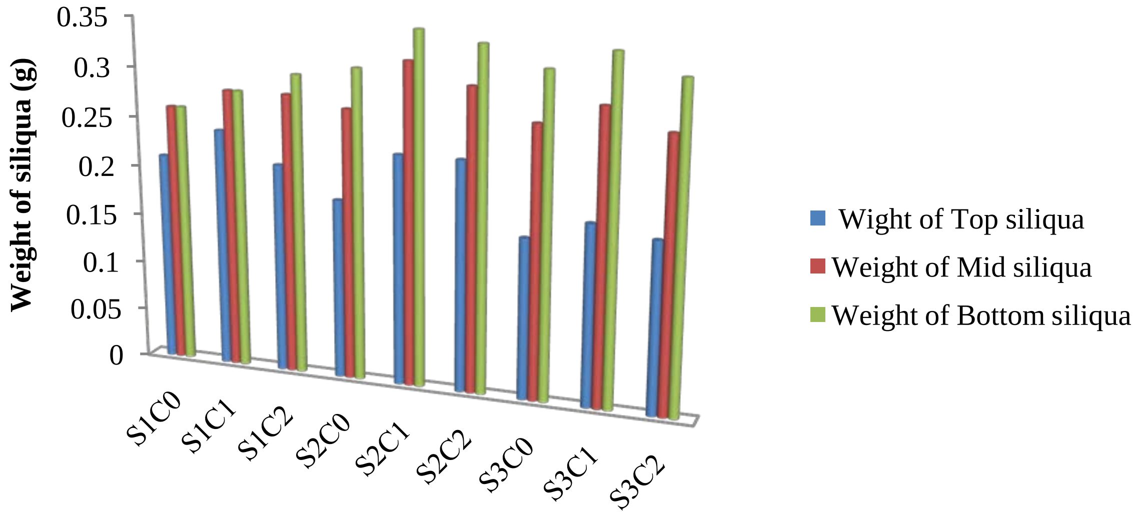
Figure 28 Fresh weight of siliqua of mustard as influenced by interaction of sowing times and varieties (SE=0.02, 0.14 and 0.02 respectively)

4.5.5 Interaction effect of sowing time and inflorescence top-cutting

Significant variation was observed for fresh weight of siliqua due to interaction effect of sowing time and variety (Fig.29). The significantly highest fresh weight of top siliqua was with S_1C_1 (0.24 g) and S_2C_1 (0.23 g) which were statistically similar S_2C_2, S_1C_0, S_1C_2, S_2C_0 and S_3C_1. The significantly lowest fresh weight of top siliqua was with S_3C_0 (0.16 g) which was statistically similar with S_3C_2 (0.17 g).

The interaction effect of sowing time and **inflorescence top-**cutting was insignificant on fresh weight of mid siliqua. But numerically the highest fresh weight of mid siliqua was with S_2C_1 (0.32 g) and lowest fresh weight was with S_1C_0 (0.26 g).

The significantly highest fresh weight of bottom siliqua was with S_2C_1 (0.35 g) which was statistically similar with S_2C_2, S_3C_0, S_3C_1, S_3C_2, S_1C_2 and S_2C_0. The significantly lowest fresh weight of plant was with S_1C_0 (0.26 g) which was statistically similar with S_1C_1 (0.28 g).



S_1 = 01 November, S_2 = 15 November, S_3 = 30 November, C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut

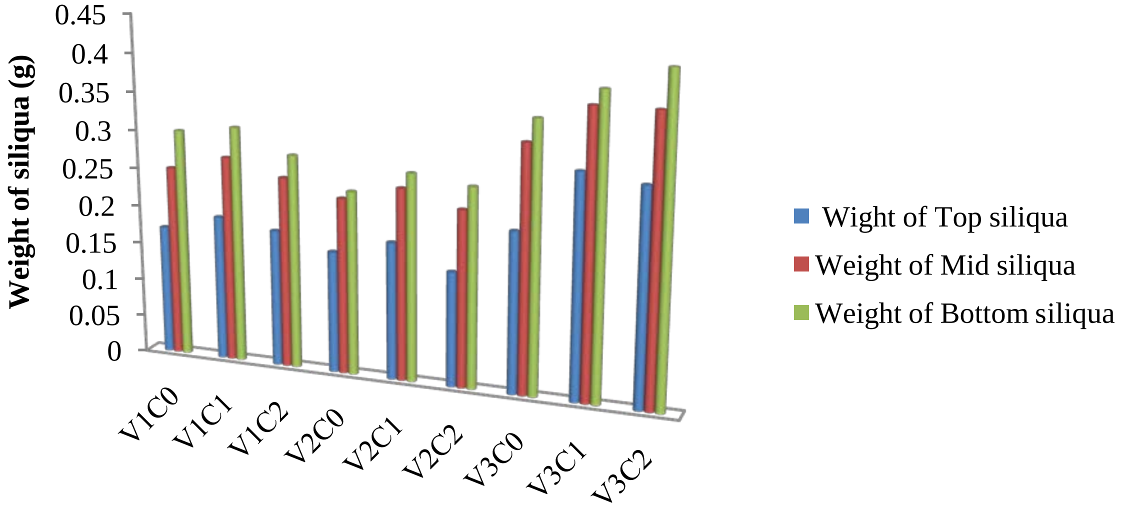
Figure 29 Fresh weight of siliqua of mustard as influenced by the interaction of sowing times and inflorescence top-cutting (SE=0.01, NS and 0.01respectively)

4.5.6 Interaction effect of variety and inflorescence top-cutting

The interaction effect of variety and inflorescence top-cutting was significant on fresh weight of siliqua (Fig.30). The significantly highest fresh weight of top siliqua was with V_3C_1 (0.29 g) and V_3C_2 (0.28 g). The significantly lowest fresh weight of top siliqua was V_2C_2 (0.15 g) which was statistically similar with V_1C_0, V_1C_1, V_1C_2, V_2C_0 and V_2C_1.

The significantly highest fresh weight of mid siliqua was with V_3C_1 (0.37 g) and V_3C_2 (0.37 g) which were statistically similar with V_3C_0 (0.32 g).The significantly lowest fresh weight of mid siliqua was with V_2C_0 (0.23 g) and V_2C_2 (0.23 g) which were statistically similar with V_1C_1 (0.27 g). The intermediate fresh weight of mid siliqua was with V_1C_1.

The significantly highest fresh weight of bottom siliqua was with V_3C_2 (0.42 g) which was statistically similar with V_3C_1 (0.39 g). The significantly lowest fresh weight of plant was with V_2C_0 (0.24 g) which was statistically similar with V_1C_0, V_2C_2, V_1C_2 and V_2C_1. The intermediate fresh weight of bottom siliqua was with V_1C_1 and V_3C_0.



V_1 = Tori-7, V_2 = BARI Sarisha-9, V_3 = BARI Sarisha-15, C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut

Figure 30 Fresh weight of siliqua of mustard as influenced by the interaction of variety and inflorescence top-cutting (SE=0.01, 0.15 and 0.01 respectively)

4.5.7 Interaction effect of sowing time, variety and inflorescence top-cutting

The interaction effect of sowing time, variety and inflorescence top-cutting was significant on fresh weight of siliqua (Table 5). The significantly highest fresh weight of top siliqua was with $S_2V_3C_1$ (0.31g) which was statistically similar with $S_2V_3C_2$, $S_1V_3C_0$, $S_1V_3C_0$, $S_1V_3C_1$, $S_1V_3C_2$, $S_2V_3C_1$, $S_1V_1C_1$, $S_2V_1C_1$, $S_2V_1C_2$, $S_2V_3C_0$, $S_3V_3C_1$ and $S_3V_3C_2$. The significantly lowest fresh weight of top siliqua was with $S_3V_1C_2$ (0.12g) which was statistically similar with $S_3V_2C_0$, $S_3V_2C_1$, $S_3V_2C_2$, $S_3V_3C_0$, $S_1V_1C_0$, $S_1V_1C_2$, $S_1V_2C_0$, $S_1V_2C_1$, $S_1V_2C_2$, $S_2V_1C_0$, $S_2V_2C_0$, $S_2V_2C_1$, $S_2V_2C_2$, $S_3V_1C_0$ and $S_3V_1C_1$.

The significantly highest fresh weight of mid siliqua was with $S_3V_3C_1$ (0.41g) which was statistically similar with $S_1V_3C_0$, $S_1V_3C_1$, $S_1V_3C_2$, $S_2V_1C_1$, $S_2V_1C_2$, $S_2V_3C_0$, $S_2V_3C_1$, $S_2V_3C_2$, $S_3V_3C_0$ and $S_3V_3C_2$. The significantly lowest fresh weight of mid siliqua was with $S_2V_2C_0$ (0.20g) which was identical with $S_1V_1C_0$, $S_1V_1C_2$, $S_1V_1C_1$, $S_1V_2C_0$, $S_1V_2C_1$, $S_1V_2C_2$, $S_3V_1C_0$, $S_3V_1C_1$, $S_3V_1C_2$, $S_3V_2C_0$, $S_3V_2C_1$, $S_3V_2C_2$, $S_2V_2C_0$, $S_2V_2C_1$ and $S_2V_2C_2$.

The significantly highest fresh weight of bottom siliqua was with $S_3V_3C_2$ (0.44g) which was statistically similar with $S_3V_3C_0$, $S_1V_3C_1$, $S_1V_3C_2$, $S_2V_1C_1$, $S_2V_1C_2$, $S_2V_3C_0$, $S_2V_3C_1$, $S_2V_3C_2$, $S_3V_3C_1$ and $S_3V_1C_0$. The significantly lowest fresh weight of bottom siliqua was with $S_2V_2C_0$ (0.23g) which was identical with $S_1V_1C_0$, $S_1V_1C_2$, $S_1V_1C_1$, $S_1V_2C_0$, $S_1V_2C_1$,

$S_1V_2C_2$, $S_3V_1C_1$, $S_3V_1C_2$, $S_3V_2C_0$, $S_3V_2C_1$, $S_3V_2C_2$, $S_2V_1C_0$, $S_2V_1C_0$,$S_2V_2C_1$, $S_1V_3C_0$ and $S_2V_2C_2$.

Table 5 Interaction effect of sowing time, variety and inflorescence top-cutting on the weight of siliqua (g) of mustard

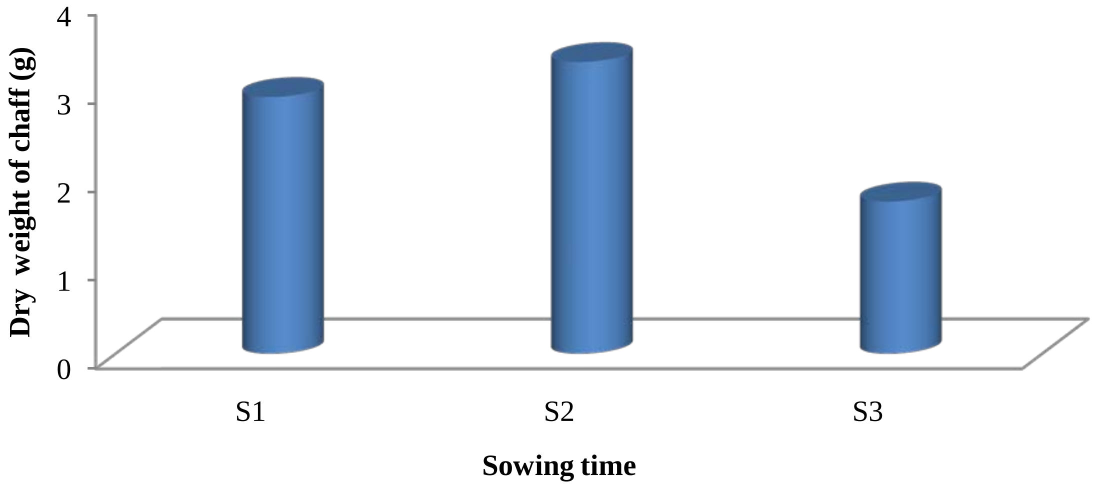
Treatments*	Fresh weight of siliqua (g)		
	Top	Mid	Bottom
S X V X C			
$S_1V_1C_0$	0.17 e-i	0.22 e	0.26 e-g
$S_1V_1C_1$	0.22 a-i	0.28 b-e	0.28 h-g
$S_1V_1C_2$	0.18 e-i	0.23 e	0.23 g
$S_1V_2C_0$	0.20 b-i	0.25 c-e	0.23 g
$S_1V_2C_1$	0.19 c-i	0.25 de	0.24 fg
$S_1V_2C_2$	0.16 e-i	0.24 de	0.26 e-g
$S_1V_3C_0$	0.26 a-e	0.31 a-e	0.30 c-g
$S_1V_3C_1$	0.30 a-c	0.31 a-e	0.33 a-g
$S_1V_3C_2$	0.30 a-c	0.38 a-c	0.41 ab
$S_2V_1C_0$	0.16 e-i	0.26 c-e	0.31 b-g
$S_2V_1C_1$	0.21 a-i	0.29 a-e	0.35 a-f
$S_2V_1C_2$	0.25 a-g	0.30 a-e	0.35 a-e
$S_2V_2C_0$	0.15 f-i	0.20 e	0.23 g
$S_2V_2C_1$	0.19 d-i	0.28 b-e	0.30 d-g
$S_2V_2C_2$	0.14 hi	0.22 e	0.26 e-g
$S_2V_3C_0$	0.24 a-h	0.36 a-d	0.40 a-d
$S_2V_3C_1$	0.31 a	0.39 ab	0.40 a-d
$S_2V_3C_2$	0.29 a-d	0.37 a-d	0.41 a-c
$S_3V_1C_0$	0.19 c-i	0.27 b-e	0.33 a-g
$S_3V_1C_1$	0.14 g-i	0.25 c-e	0.31 b-g
$S_3V_1C_2$	0.12 i	0.21 e	0.25 e-g
$S_3V_2C_0$	0.14 hi	0.24 e	0.27 e-g
$S_3V_2C_1$	0.16 e-i	0.22 e	0.28 e-g
$S_3V_2C_2$	0.15 f-i	0.23 e	0.27 e-g
$S_3V_3C_0$	0.14 hi	0.29 a-e	0.35 a-e
$S_3V_3C_1$	0.25 a-f	0.41 a	0.43 a
$S_3V_3C_2$	0.24 a-h	0.39 ab	0.44 a
SE	**0.03**	**0.03**	**0.03**
CV	**25.64**	**20.78**	**17.58**

*S1 = 01 November, S2 = 15 November, S3 = 30 November V1 = Tori-7, V2 = BARI Sarisha-9, V3 = BARI Sarisha-15
C0 = Control, C1 = First cut (40 days after sowing), C2 = 7 days after first cut

4.6 Dry weight of Chaff

4.6.1 Effect of sowing time

Effect of sowing time was significant on dry weight of chaff (Fig.31). The significantly highest dry weight of chaff was with S_2 (3.30) and it was statistically similar with S_1 (2.91 g). The significantly lower value was recorded from S_3 (1.72 g).

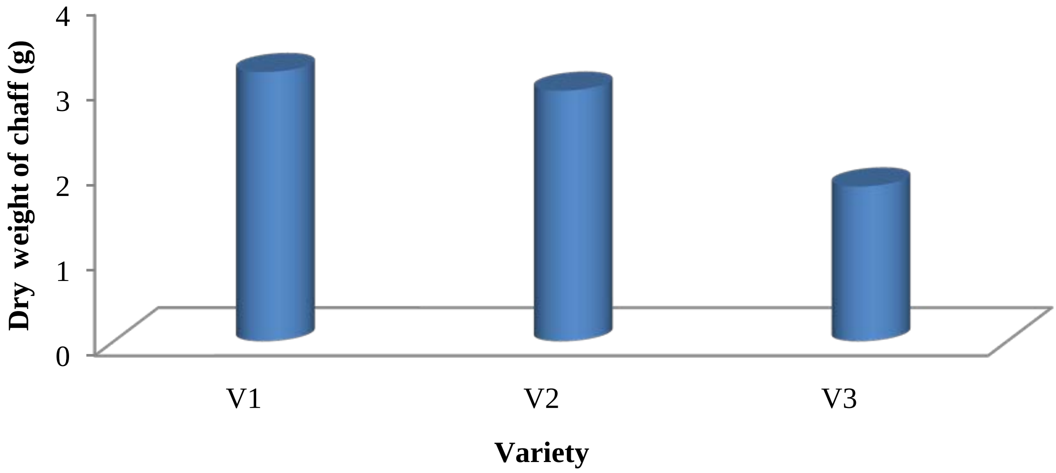


S_1 = 01 November, S_2 = 15 November, S_3 = 30 November

Figure 31 Dry weight of chaff of mustard as influenced by sowing time (SE=0.19)

4.6.2 Effect of variety

Varietal effect was significant on dry weight of chaff (Fig.32). The significantly highest dry weight of chaff was with V_1 (3.16 g) and it was statistically similar with V_2 (2.94 g). The significantly lower value was recorded from V_3 (1.82 g).

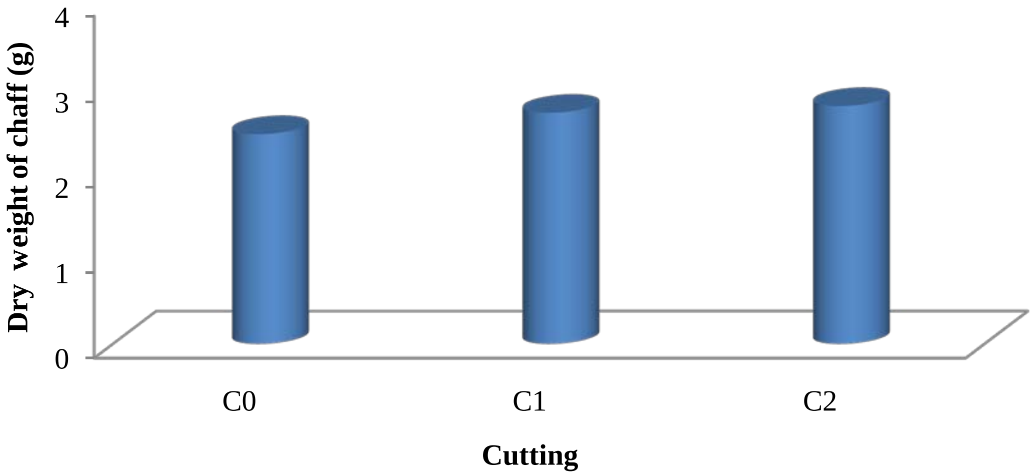


V_1 = Tori-7, V_2 = BARI Sarisha-9, V_3 = BARI Sarisha-15

Figure 32 Dry weight of chaff of mustard as influenced by variety (SE=0.12)

4.6.3 Effect of inflorescence top-cutting

Effect of inflorescence top-cutting was insignificant on dry weight of chaff (Fig.33). Significantly highest weight of chaff was recorded in C_2 (2.78 g) while C_0 gave the lowest value (2.45 g).

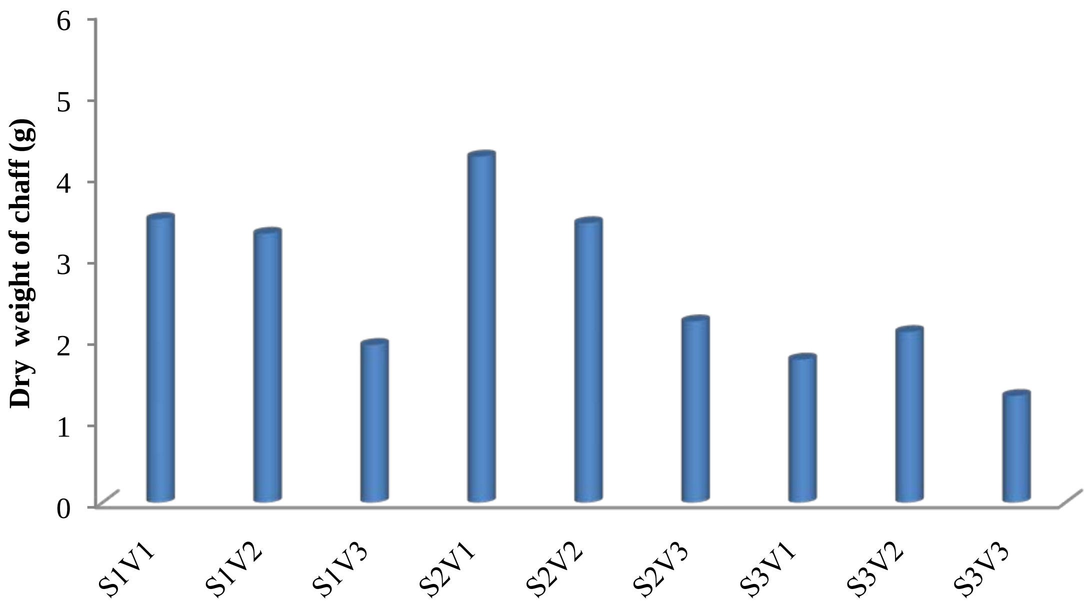


C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut

Figure 33 Dry weight of chaff of mustard as influenced by inflorescence top-cutting (SE=0.21)

4.6.4 Interaction effect of sowing time and variety

Significant variation was observed for dry weight of chaff of mustard due to interaction effect of sowing time and variety (Fig.34) .The highest dry weight of chaff was with S_2V_1 (4.25 g).the intermediate dry weight of chaff were with S_1V_1, S_2V_2 , S_1V_2, S_2V_3 and S_3V_2. The significantly lowest dry weight of chaff was with S_3V_3 (1.31 g) which was statistically similar with S_3V_1 (1.75g).

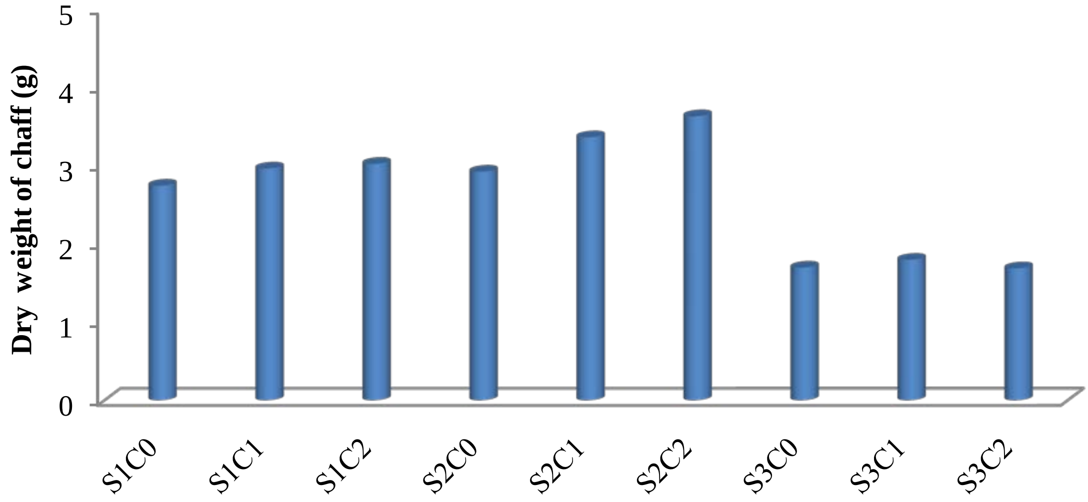


S_1 = 01 November, S_2 = 15 November, S_3 = 30 November, V_1 = Tori-7, V_2 = BARI Sarisha-9, V_3 = BARI Sarisha-15

Figure 34 Dry weight of chaff of mustard as influenced by the interaction of sowing time and variety (SE=0.22)

4.6.5 Interaction effect of sowing time and inflorescence top-cutting

Interaction effect of sowing time and inflorescence top-cutting was significant on dry weight of chaff (Fig.35). The significantly highest dry weight of chaff was with S_2C_2 (3.63 g) which was identical with S_2C_1, S_1C_2, S_1C_1 and S_2C_0. The lowest dry weight of chaff was with S_3C_2 (1.68 g) which was identical with S_3C_0 and S_3C_1. The intermediate dry weight of chaff was with S_1C_0 (2.74 g).

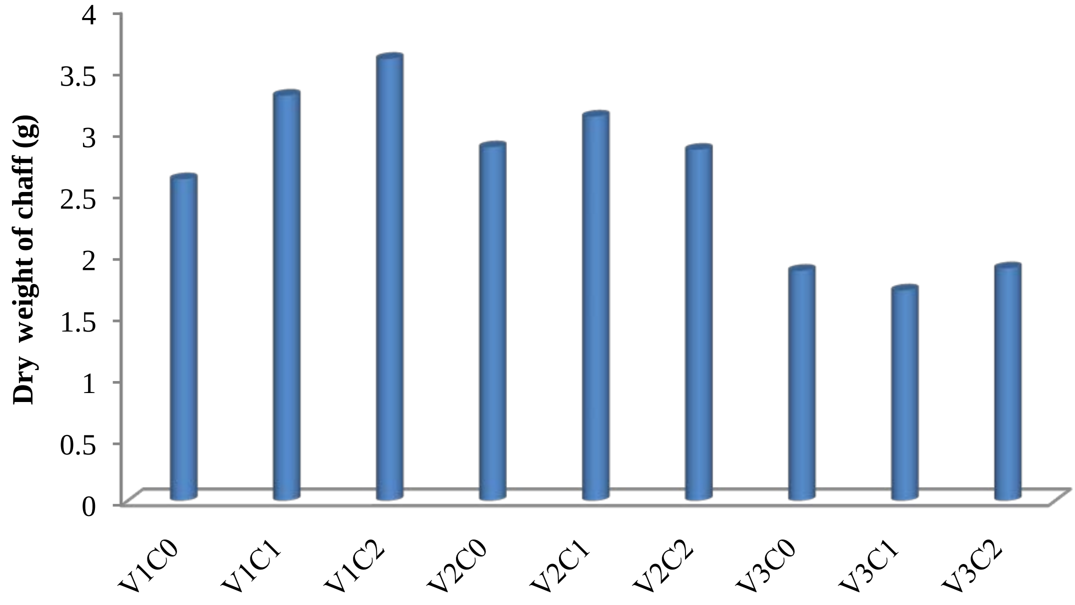


S_1 = 01 November, S_2 = 15 November, S_3 = 30 November, C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut

Figure 35 Dry weight of chaff of mustard as influenced by sowing time and inflorescence top-cutting (SE=0.36)

4.6.6 Interaction effect of variety and inflorescence top-cutting

Significant variation was observed for dry weight of chaff due to interaction effect of variety and inflorescence top-cutting (Fig.36). The dry weight of chaff plant height was with V_1C_2 (3.59 g) which was closely followed by V_1C_1 ,V_2C_1 ,V_2C_2 ,and V_2C_0 .On the other hand, lowest dry weight of chaff was with V_3C_1 (1.71 g) which was statistically similar with V_3C_2 (1.89 g) and V_3C_0 (1.87 g). The intermediate dry weight of chaff was with V_1C_0 (2.61 g).



V_1 = Tori-7, V_2 = BARI Sarisha-9, V_3 = BARI Sarisha-15, C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut

Figure 36 Dry weight of chaff of mustard as influenced by the interaction of variety and inflorescence top-cutting (SE=0.36)

4.6.7 Interaction effect of sowing time, variety and inflorescence top-cutting

Interaction effect of sowing time, variety and inflorescence top-cutting was significant on dry weight of chaff (Table 6). The significantly highest dry weight of chaff was with $S_2V_1C_2$ (5.14 g) and lowest dry weight of chaff was with $S_3V_3C_2$ (1.19 g), $S_3V_3C_0$ (1.25 g) and $S_3V_3C_1$ (1.50 g). $S_2V_1C_2$ was identical with $S_2V_1C_1$ (4.44 g). The lowest dry weight of chaff was identical with $S_1V_3C_0$, $S_1V_3C_1$, $S_1V\ {}_3C_2$, $S_2V_3C_0$, $S_2V_3C_1$, $S_2V_3C_2$, $S_3V_1C_0$, $S_3V_1C_1$, $S_3V_1C_2$, $S_3V_2C_0$, $S_3V_2C_1$ and $S_3V_2C_2$. The intermediate dry weight of chaff was with $S_1V_1C_1$, $S_1V_1C_2$, $S_2V_2C_0$, $S_1V_2C_1$, $S_1V_2C_2$, $S_2V_1C_1$, $S_2V_2C_1$, $S_2V_2C_2$ and $S_2V_1C_0$.

Table 6 Interaction effect of sowing time, variety and inflorescence top-cutting on the dry weight of chaff per plant of mustard

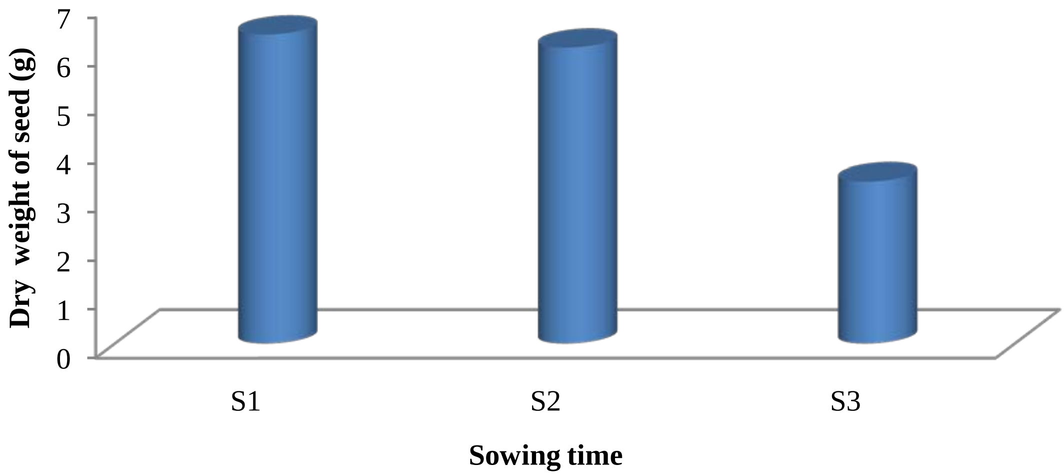
Treatments*	Dry weight of chaff
S X V X C	
$S_1V_1C_0$	2.94 c-h
$S_1V_1C_1$	3.81 bc
$S_1V_1C_2$	3.71 bc
$S_1V_2C_0$	3.47 b-d
$S_1V_2C_1$	3.31 b-e
$S_1V_2C_2$	3.12 b-g
$S_1V_3C_0$	1.79 f-i
$S_1V_3C_1$	1.77 g-i
$S_1V_3C_2$	2.22 d-i
$S_2V_1C_0$	3.19 b-f
$S_2V_1C_1$	4.44 ab
$S_2V_1C_2$	5.14 a
$S_2V_2C_0$	3.00 c-h
$S_2V_2C_1$	3.80 bc
$S_2V_2C_2$	3.50 b-d
$S_2V_3C_0$	2.56 c-i
$S_2V_3C_1$	1.85 f-i
$S_2V_3C_2$	2.26 d-i
$S_3V_1C_0$	1.70 hi
$S_3V_1C_1$	1.61 hi
$S_3V_1C_2$	1.93 e-i
$S_3V_2C_0$	2.12 d-i
$S_3V_2C_1$	2.26 d-i
$S_3V_2C_2$	1.90 f-i
$S_3V_3C_0$	1.25 i
$S_3V_3C_1$	1.50 i
$S_3V_3C_2$	1.19 i
SE	**0.63**
CV	**26.83**

*S_1 = 01 November, S_2 = 15 November, S_3 = 30 November V_1 = Tori-7, V_2 = BARI Sarisha-9, V_3 = BARI Sarisha-15
C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut

4.7 Dry weight of seed per plant

4.7.1 Effect of sowing time

Effect of sowing time was significant on dry weight of seed (Fig.37). The significantly highest dry weight of seed was with S_1 (6.35 g) and it was statistically similar with S_2 (6.08 g). S_3 (3.33 g) gave the lowest value.

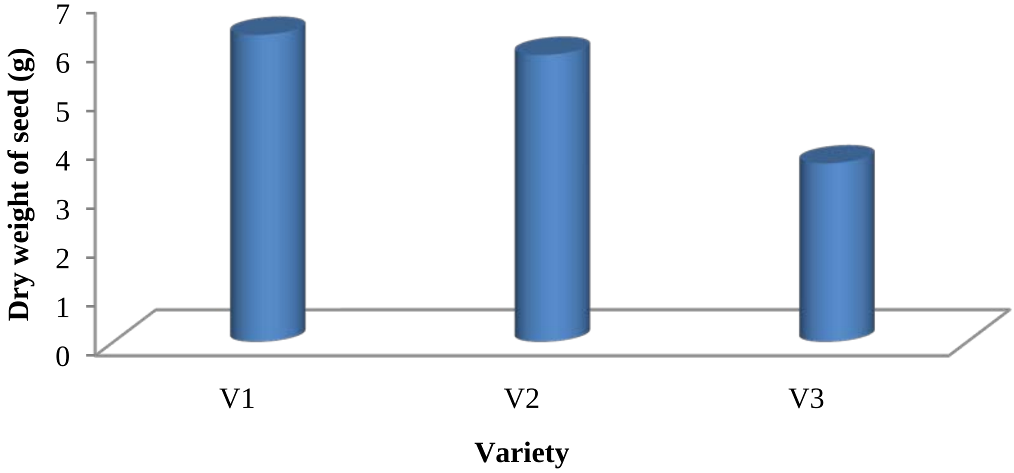


S_1 = 01 November, S_2 = 15 November, S_3 = 30 November

Figure 37 Dry weights of seed of mustard as influenced by sowing times (SE=0.46)

4.7.2 Effect of variety

Varietal effect was significant on dry weight of seed (Fig.38). The significantly highest dry weight of seed was with V_1 (6.27 g) and it was statistically similar with V_2 (5.86 g). V_3 (3.64 g) gave the lowest value among three.

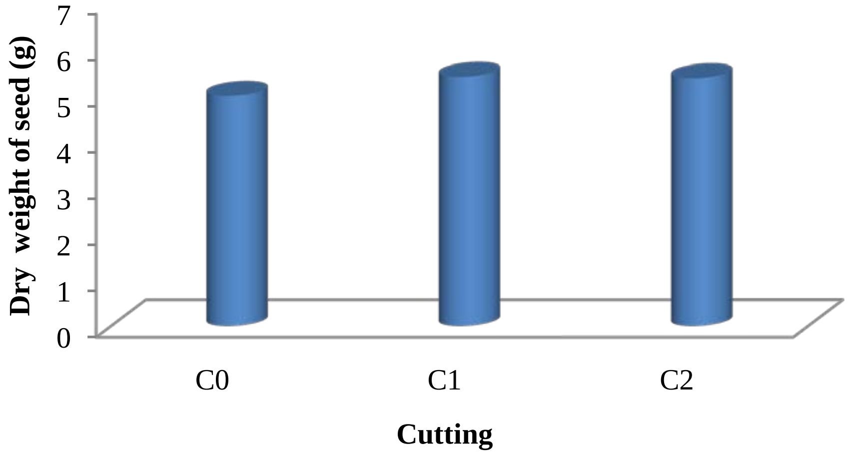


V_1 = Tori-7, V_2 = BARI Sarisha-9, V_3 = BARI Sarisha-15

Figure 38 Dry weights of seed of mustard as influenced by variety (SE=0.29)

4.7.3 Effect of inflorescence top-cutting

Effect of inflorescence top-cutting was insignificant on dry weight of seed (Fig.39). The higher dry weight of seed was found in C_1 (5.40 g) and lower in C_0 (4.99 g). Removing a specific organ of a plant, the growth of another organ may be modified (Hicks and Nelson, 1977; Singh, 1975; Tollenaar, 1978 and Thomson, 2003). Ahsan (2000) in an experiment removed the senesced leaves of mustard and found that due to this leaf removal, seed yield was increased. Hortensteiner and Fellller (2002), Carlos (2006), Khan *et al.* (2007) showed that defoliation of older and senescing leaves allowed the growth of functional and efficient leaves. This increased the photosynthetic potential of remaining leaves and leads to enhance biomass accumulation and seed yield.

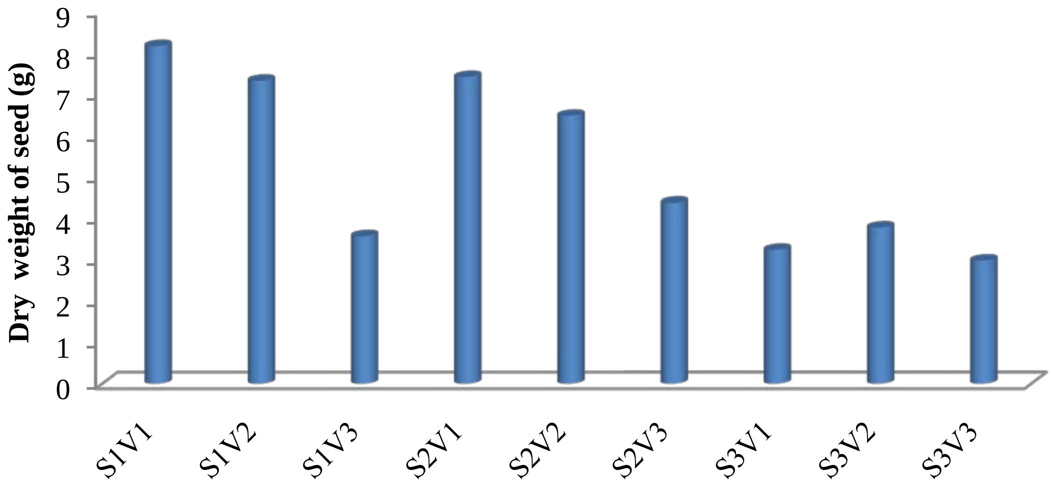


C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut

Figure 39 Dry weight of seed of mustard as influenced by inflorescence top-cutting (SE=NS)

4.7.4 Interaction effect of sowing time and variety

Significant variation was observed for dry weight of seed of mustard due to interaction effect of sowing time and variety(Fig.40) .The highest dry weight of seed was with S_1V_1 (8.16 g) which was closely followed by S_2V_1 (7.41 g) and S_1V_2 (7.32 g). Lowest dry weight of seed was with S_3V_3 (2.98 g) and S_3V_1 (3.24 g) which were identical with S_1V_3 and S_3V_2. S_2V_2 gave the intermediate value.

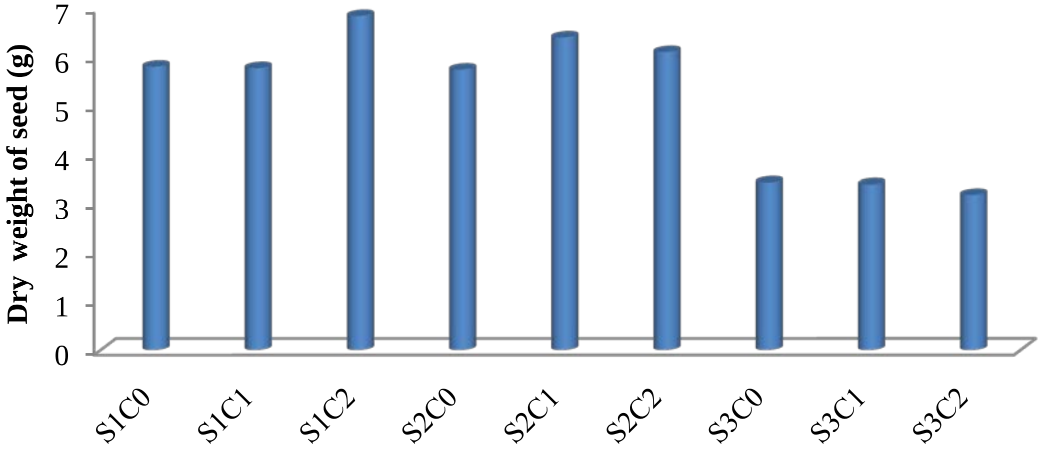


S_1 = 01 November, S_2 = 15 November, S_3 = 30 November, V_1 = Tori-7, V_2 = BARI Sarisha-9, V_3 = BARI Sarisha-15

Figure 40 Dry weight of seeds of mustard as influenced by the interaction of sowing time and variety (SE= 0.51)

4.7.5 Interaction effect of sowing time and inflorescence top-cutting

Interaction effect of sowing time and inflorescence top-cutting was significant on dry weight of seed (Fig.41). The significantly highest dry weight of seed was with S_1C_2 (6.84 g) which was identical with S_1C_1, S_2C_1, S_2C_2, S_1C_0 and S_2C_0. The lowest dry weight of seed was with S_3C_2 (3.18 g), S_3C_1 (3.39 g), and S_3C_0 (3.43 g).

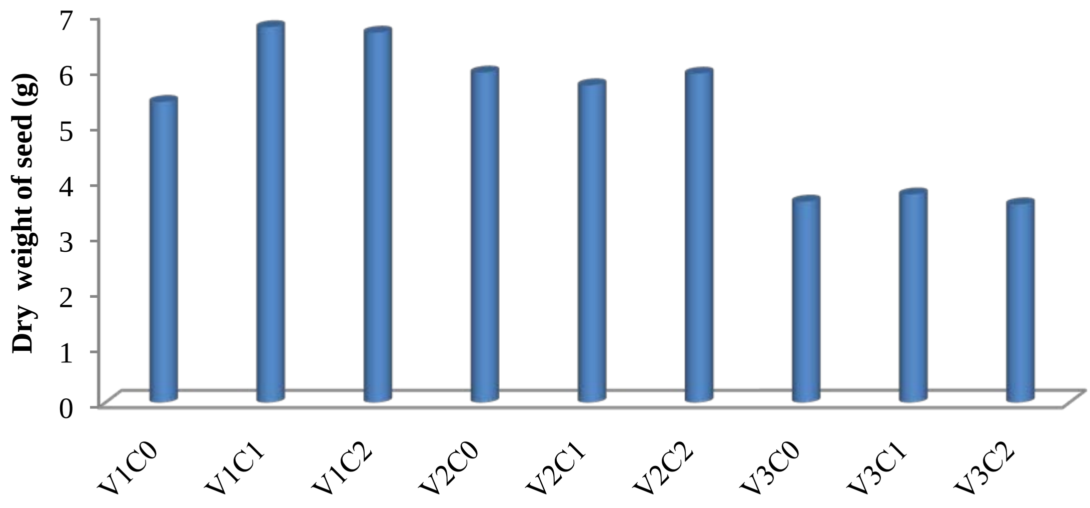


S_1 = 01 November, S_2 = 15 November, S_3 = 30 November, C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut

Figure 41 Dry weight of seed of mustard as influenced by the interaction of sowing time and inflorescence top-cutting (SE=0.63)

4.7.6 Interaction effect of variety and inflorescence top-cutting

Significant variation was observed for dry weight of seed due to interaction effect of variety and inflorescence top-cutting (Fig.42). The significantly highest dry weight of seed was with V_1C_1 (6.76 g) which was statistically similar with V_1C_2, V_2C_0, V_2C_1 and V_2C_2. The significantly lowest dry weight of seed was with V_3C_2 (3.56 g), which was statistically similar with V_3C_0 and V_3C_1.



V_1 = Tori-7, V_2 = BARI Sarisha-9, V_3 = BARI Sarisha-15, C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut

Figure 42 Dry weight of seeds of mustard as influenced by the interaction of variety and cutting (SE=0.63)

4.7.7 Interaction effect of sowing time, variety and inflorescence top-cutting

Interaction effect of sowing time, variety and inflorescence top-cutting was significant on dry weight of seed (Table 7). The significantly highest dry weight of seed was with $S_1V_1C_2$ (9.05 g) and lowest dry weight of seed was $S_3V_3C_0$ (2.85 g), $S_3V_2C_2$ (3.46 g), $S_3V_3C_2$ (3.02 g), $S_1V_3C_2$ (3.32 g), $S_1V_3C_0$ (3.05 g), $S_3V_1C_0$ (3.46 g), $S_3V_1C_1$ (3.22 g) and $S_3V_1C_2$ (3.05 g). $S_1V_1C_2$ was identical with $S_2V_1C_1$ (8.52 g), $S_1V_2C_2$ (8.13 g) and $S_1V_1C_1$ (8.52 g). The lowest dry weight of seed $S_3V_3C_0$ (2.85 g) was identical with $S_2V_3C_0$, $S_1V_3C_1$, $S_2V_3C_1$, $S_2V_3C_2$, $S_3V_2C_0$ and $S_3V_2C_1$. The intermediate dry weights of seed were with $S_1V_2C_1$, $S_2V_1C_0$, $S_2V_2C_2$ and $S_2V_2C_0$.

Table 7 Interaction effect of sowing time, variety and inflorescence top-cutting on the dry weight of seed per plant of mustard

Treatments*	Dry weight of seed (g)
S X V X C	
$S_1V_1C_0$	6.92 a-d
$S_1V_1C_1$	8.52 ab
$S_1V_1C_2$	9.05 a
$S_1V_2C_0$	7.43 a-c
$S_1V_2C_1$	6.40 b-e
$S_1V_2C_2$	8.13 a-c
$S_1V_3C_0$	3.05 g
$S_1V_3C_1$	4.34 e-g
$S_1V_3C_2$	3.32 g
$S_2V_1C_0$	5.86 c-f
$S_2V_1C_1$	8.52 ab
$S_2V_1C_2$	7.85 a-c
$S_2V_2C_0$	6.41 b-e
$S_2V_2C_1$	6.85 a-d
$S_2V_2C_2$	6.16 b-f
$S_2V_3C_0$	4.95 d-g
$S_2V_3C_1$	3.85 fg
$S_2V_3C_2$	4.30 e-g
$S_3V_1C_0$	3.46 g
$S_3V_1C_1$	3.22 g
$S_3V_1C_2$	3.05 g
$S_3V_2C_0$	3.98 fg
$S_3V_2C_1$	3.89 fg
$S_3V_2C_2$	3.46 g
$S_3V_3C_0$	2.85 g
$S_3V_3C_1$	3.06 g
$S_3V_3C_2$	3.02 g
SE	**1.10**
CV	**23.67**

*S_1 = 01 November, S_2 = 15 November, S_3 = 30 November V_1 = Tori-7, V_2 = BARI Sarisha-9, V_3 = BARI Sarisha-15
C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut

4.8 Dry weight of stem

4.8.1 Effect of sowing time

Effect of sowing time was significant on dry weight of stem (Table 8). The significantly highest dry weight of stem was with S_2 (3.25 g) and it was identical with S_1 (2.88 g) and significantly lowest dry weight of stem was recorded in S_3 (1.72 g).

4.8.2 Effect of variety

Varietal effect was insignificant on dry weight of stem (Table 8). Significantly higher dry weight of stem was found in V_2 (2.65 g) and lower in V_3 (2.57 g).

4.8.3 Effect of inflorescence top-cutting

Effect of inflorescence top-cutting was insignificant on dry weight of stem (Table 8). Significantly higher dry weight of stem was found in C_1 (2.78 g) and lower in C_0 (2.36 g). Stem weight is composed of the main stem and branches of mustard. There was evidence that removing even a vegetative part modified the growth of another vegetative organ. Although very few works have proved that removing whole or a portion of reproductive part have changed in the vegetative part. Bud removal in soybean resulted in an increase in the number of branches but there was no difference in total area and dry weight of the leaves (Hong *et al.* 1987).

Table 8 Effect of sowing time, variety and inflorescence top-cutting on the dry weight of stem per plant of mustard

Treatments*	Weight of stem (g)
Sowing time	
S_1	2.88 a
S_2	3.25 a
S_3	1.72 b
SE	**0.16**
CV	**8.27**
Variety	
V_1	2.63 a
V_2	2.65 a
V_3	2.57 a
SE	**0.10**
CV	**8.27**
Cutting	
C_0	2.36 b
C_1	2.78 a
C_2	2.70 ab
SE	**0.19**
CV (%)	**8.27**

*S_1 = 01 November, S_2 = 15 November, S_3 = 30 November V_1 = Tori-7, V_2 = BARI Sarisha-9, V_3 = BARI Sarisha-15
C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut

4.8.4 Interaction effect of sowing time and variety

Significant variation was observed for dry weight of stem of mustard due to interaction effect of sowing time and variety (Table 9).The highest dry weight of stem was with S_2V_1 (3.39 g) , S_2V_2 (3.20 g), S_2V_3 (3.17 g), S_1V_2 (3.02 g) and S_1V_1 (3.02 g). The significantly lowest dry weight of stem was with S_3V_1 (1.48 g) which was statistically similar with S_3V_2 (1.73 g). The intermediate dry weight of stem were S_3V_3 (1.94 g) and S_1V_3 (2.59 g).

4.8.5 Interaction effect of sowing time and inflorescence top-cutting

Interaction effect of sowing time and inflorescence top-cutting was significant on dry weight of stem (Table 9). The significantly highest dry weight of stem was with S_2C_2 (3.56 g) which was identical with S_2C_1 (3.39 g) and S_1C_1 (3.13 g). The lowest dry weight of stem was with S_3C_0 (1.63 g), S_3C_2 (1.71 g) and S_3C_1 (1.82 g). The intermediate dry weights of stem were S_1C_0, S_2C_0 and S_1C_2.

4.8.6 Interaction effect of variety and inflorescence top-cutting

Insignificant variation was observed for dry weight of stem due to interaction effect of Variety and inflorescence top-cutting (Table 9). Significantly higher dry weight of stem was found in V_1C_1 (2.94 g) and lower in V_1C_0 (2.29 g).

Table 9 Interaction effect of sowing time, variety and inflorescence top-cutting on the dry weight of stem per plant of mustard

Treatments*	Weight of stem (g)
SXV	
S_1V_1	3.02 a
S_1V_2	3.02 a
S_1V_3	2.59 b
S_2V_1	3.39 a
S_2V_2	3.20 a
S_2V_3	3.17 a
S_3V_1	1.48 d
S_3V_2	1.73 cd
S_3V_3	1.94 c
SE	**0.17**
CV	**12.96**
SXC	
S_1C_0	2.65 c
S_1C_1	3.13 a-c
S_1C_2	2.85 bc
S_2C_0	2.81 bc
S_2C_1	3.39 ab
S_2C_2	3.56 a
S_3C_0	1.63 d
S_3C_1	1.82 d
S_3C_2	1.71 d
SE	**0.33**
CV	**12.96**
VXC	
V_1C_0	2.29 a
V_1C_1	2.94 a
V_1C_2	2.65 a
V_2C_0	2.37 a
V_2C_1	2.64 a
V_2C_2	2.94 a
V_3C_0	2.42 a
V_3C_1	2.76 a
V_3C_2	2.52 a
SE	**0.33**
CV	**12.96**

*S_1 = 01 November, S_2 = 15 November, S_3 = 30 November V_1 = Tori-7, V_2 = BARI Sarisha-9, V_3 = BARI Sarisha-15
C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut

4.8.7 Interaction effect of sowing time, variety and inflorescence top-cutting

Interaction effect of sowing time, variety and inflorescence top-cutting was significant on dry weight of stem (Table 10). The significantly highest dry weight of stem was with $S_2V_1C_1$ (4.18 g) which was identical with $S_1V_1C_1$, $S_1V_1C_2$, $S_1V_2C_1$, $S_1V_2C_2$, $S_2V_1C_2$, $S_2V_2C_0$, $S_2V_3C_0$, $S_2V_3C_1$ and $S_2V_3C_2$. The significantly lowest dry weight of stem was $S_3V_1C_1$ (1.33 g) which was identical with $S_3V_2C_0$, $S_3V_1C_2$, $S_3V_1C_0$, $S_3V_2C_1$, $S_3V_2C_1$, $S_3V_3C_0$, $S_3V_3C_1$, $S_3V_3C_2$, $S_1V_3C_0$ and $S_2V_1C_0$ .The intermediate dry weight of stem was observed with $S_1V_1C_0$, $S_1V_2C_0$, $S_1V_3C_1$ and $S_2V_2C_1$.

Table 10 Interaction effect of sowing time, variety and inflorescence top-cutting on the dry weight of stem per plant of mustard

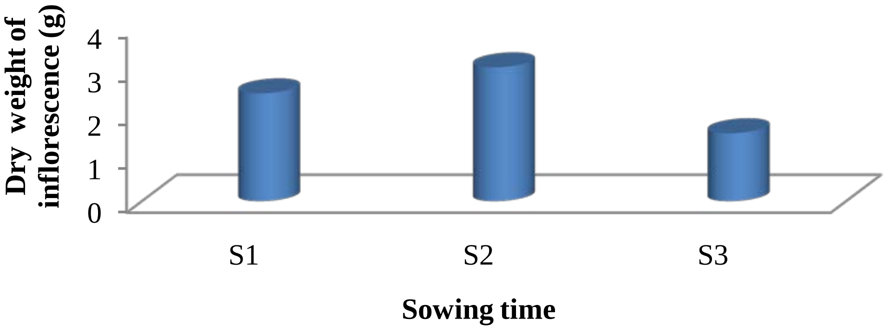
Treatments*	**Weight of stem (g)**
S X V X C	
$S_1V_1C_0$	2.81 b-h
$S_1V_1C_1$	3.32 a-d
$S_1V_1C_2$	2.93 a-h
$S_1V_2C_0$	2.81 b-h
$S_1V_2C_1$	3.25 a-d
$S_1V_2C_2$	3.01 a-g
$S_1V_3C_0$	2.33 c-j
$S_1V_3C_1$	2.83 b-h
$S_1V_3C_2$	2.61 c-i
$S_2V_1C_0$	2.41 c-j
$S_2V_1C_1$	4.18 a
$S_2V_1C_2$	3.58 a-c
$S_2V_2C_0$	2.91 a-h
$S_2V_2C_1$	2.78 b-h
$S_2V_2C_2$	3.91 ab
$S_2V_3C_0$	3.11 a-f
$S_2V_3C_1$	3.20 a-e
$S_2V_3C_2$	3.18 a-e
$S_3V_1C_0$	1.66 h-j
$S_3V_1C_1$	1.33 j
$S_3V_1C_2$	1.44 ij
$S_3V_2C_0$	1.39 ij
$S_3V_2C_1$	1.89 f-j
$S_3V_2C_2$	1.92 e-j
$S_3V_3C_0$	1.83 f-j
$S_3V_3C_1$	2.24 d-j
$S_3V_3C_2$	1.76 g-j
SE	**0.57**
CV	**24.81**

*S_1 = 01 November, S_2 = 15 November, S_3 = 30 November V_1 = Tori-7, V_2 = BARI Sarisha-9, V_3 = BARI Sarisha-15
C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut

4.9 Dry weight of inflorescence (g) without siliqua

4.9.1 Effect of sowing time

Effect of sowing time was significant on dry weight of inflorescence without siliqua (Fig.43). The significantly highest value was with S_2 (3.07 g). The dry weight of inflorescence of S_1 (2.47 g) was identical with S_2 and S_3 (1.55 g) was significantly lower than that of S_2**.**

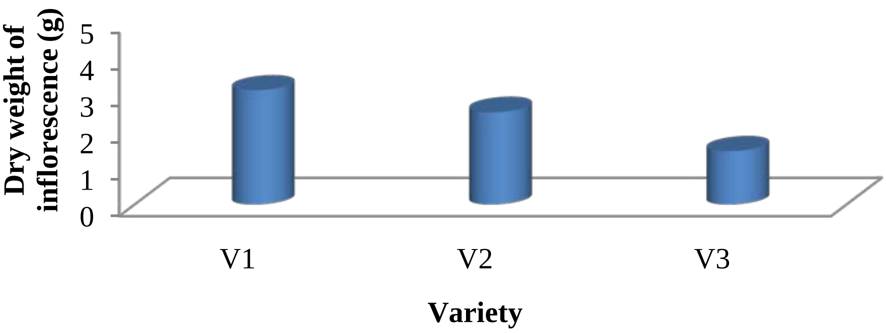


S_1 = 01 November, S_2 = 15 November, S_3 = 30 November

Figure 43 Dry weight of inflorescence without siliqua of mustard as influenced by sowing time (SE=0.23)

4.9.2 Effect of variety

Varietal effect was insignificant on dry weight of inflorescence without siliqua (Fig. 44). The significantly highest dry weight of inflorescence was with V_1 (3.11 g). The dry weight of inflorescence V_2 (2.52 g) was significantly lower than that of V_1. The significantly lowest dry weight of inflorescence was with V_3 (1.46 g).

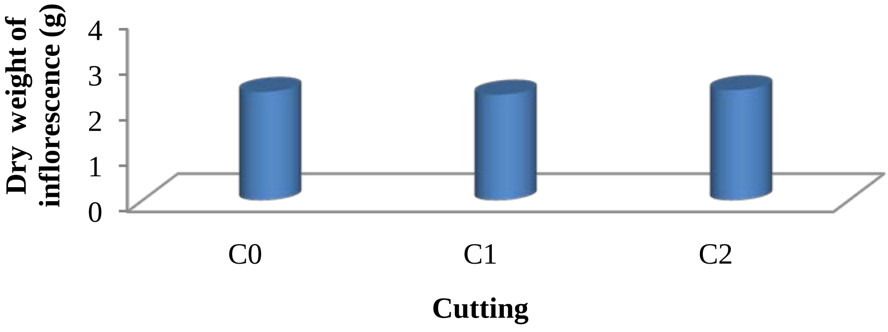


V_1 = Tori-7, V_2 = BARI Sharisha-9, V_3 = BARI Sharisha-15

Figure 44 Dry weights of inflorescence without siliqua of mustard as influenced by variety (SE=0.28)

4.9.3 Effect of inflorescence top-cutting

Effect of inflorescence top-cutting was insignificant on dry weight of inflorescence without siliqua (Fig. 45). But numerically highest value was found in C_2 (2.37 g) and lowest in C_1 (2.31 g).

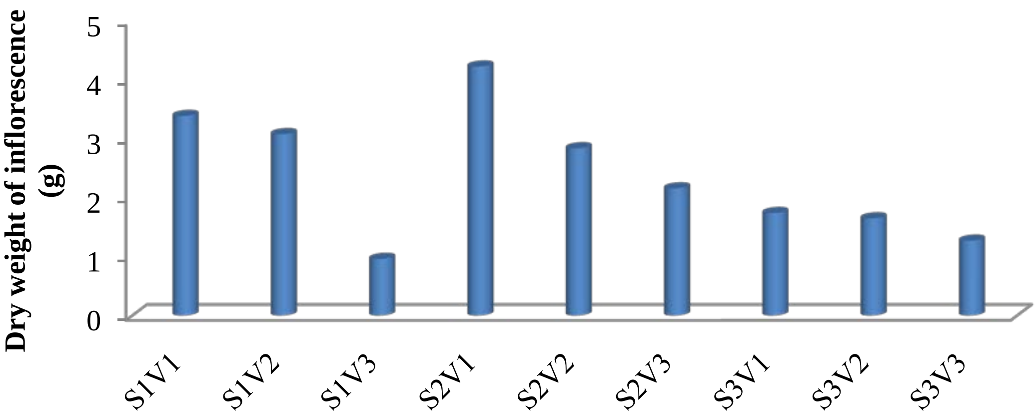


C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut

Figure 45 Dry weights of inflorescence without siliqua of mustard as influenced by inflorescence top- cutting (SE=0.26)

4.9.4 Interaction effect of sowing time and variety

Significant variation was observed for dry weight of inflorescence without siliqua of mustard due to interaction effect of sowing time and variety(Fig. 46) .The highest dry weight of inflorescence was with S_2V_1 (4.22 g) which was identical with S_1V_1 (3.38 g). The significantly lowest dry weight of inflorescence was with S_1V_3 (0.96 g) which was identical with S_3V_1, S_3V_2 and S_3V_3.

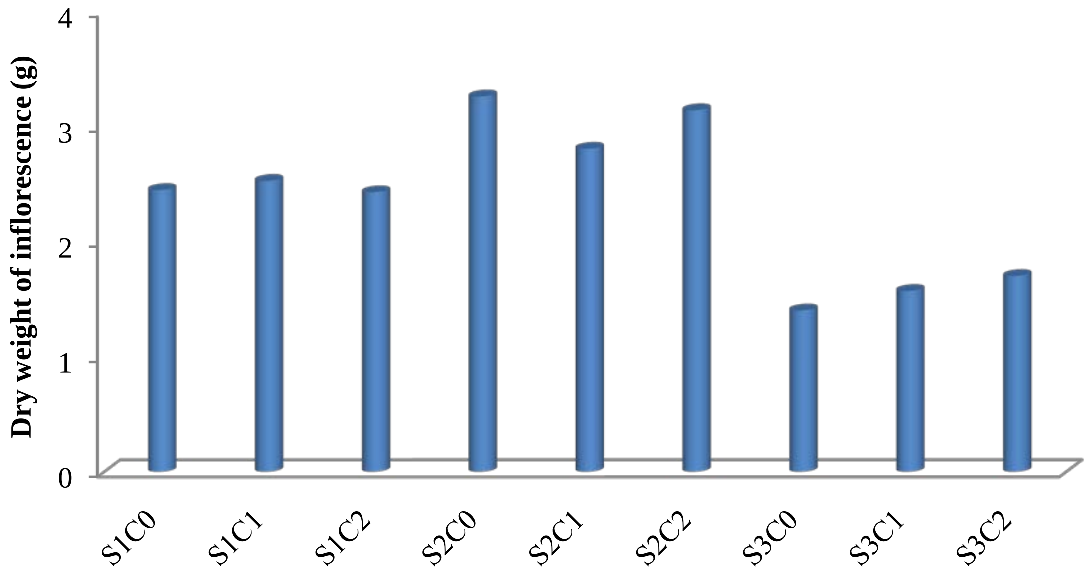


S_1 = 01 November, S_2 = 15 November, S_3 = 30 November, V_1 = Tori-7, V_2 = BARI Sarisha-9, V_3 = BARI Sarisha-15

Figure 46 Dry weights of inflorescence without siliqua of mustard as influenced by the interaction of sowing time and variety (SE=0.49)

4.9.5 Interaction effect of sowing time and inflorescence top-cutting

Interaction effect of sowing time and inflorescence top-cutting was significant on dry weight of inflorescence without siliqua (Fig. 47). The significantly highest dry weight of inflorescence was with S_2C_0 (3.26 g), S_2C_2 (3.14 g) and S_2C_1 (2.81 g) which were statistically similar with S_1C_0, S_1C_1 and S_1C_2. The lowest dry weight of inflorescence was with S_3C_0 (1.40 g) which was statistically similar with S_3C_1 and S_3C_2.

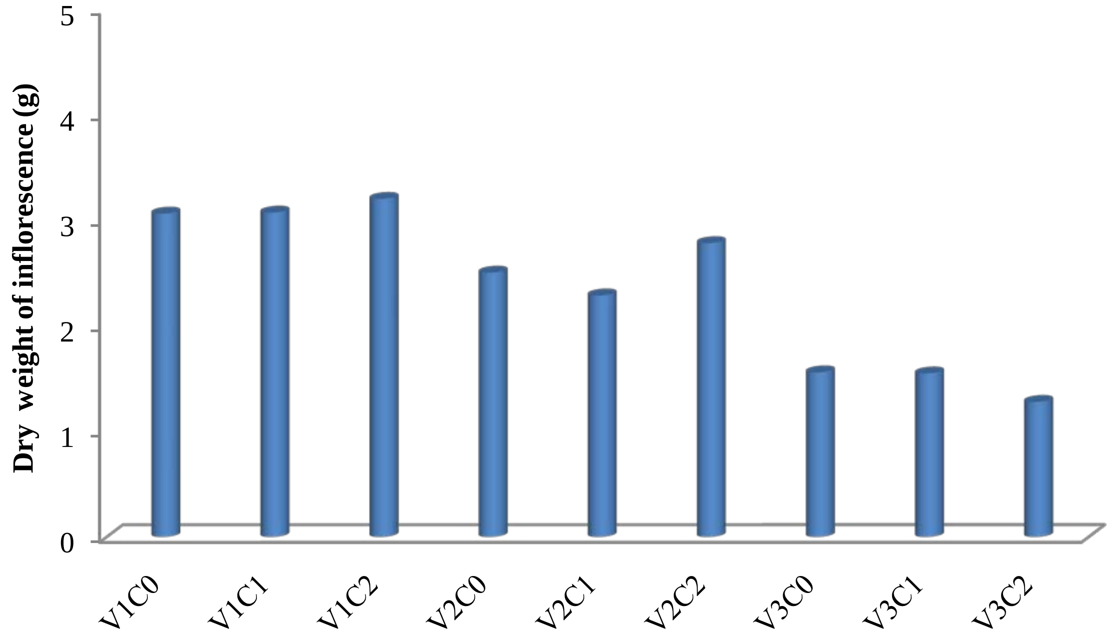


S_1 = 01 November, S_2 = 15 November, S_3 = 30 November, C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut

Figure 47 Dry weights of inflorescence without siliqua of mustard as influenced by the interaction of sowing time and inflorescence top-cutting (SE=0.45)

4.9.6 Interaction effect of variety and inflorescence top-cutting

Significant variation was observed for dry weight of inflorescence without siliqua due to interaction effect of variety and inflorescence top-cutting (Fig. 48). The significantly highest dry weight of inflorescence was with V_1C_2 (3.20 g), V_1C_1 (3.07 g), V_1C_0 (3.06 g), V_2C_2 (2.78 g) and V_2C_0 (2.50 g) which were identical with V_2C_1 (2.29 g). The significantly lowest dry weight of inflorescence was with V_3C_2 (1.28 g) which was identical with V_3C_1 and V_3C_0.



V_1 = Tori-7, V_2 = BARI Sarisha-9, V_3 = BARI Sarisha-15, C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut

Figure 48 Dry weights of inflorescence without siliqua of mustard as influenced by the interaction of variety and inflorescence top-cutting (SE=0.45)

4.9.7 Interaction effect of sowing time, variety and inflorescence top-cutting

Interaction effect of sowing time, variety and inflorescence top-cutting was significant on dry weight of inflorescence without siliqua (Table 11). The significantly highest dry weight of inflorescence was with $S_2V_1C_2$ (4.67 g) which was statistically similar with $S_1V_1C_0$, $S_1V_1C_1$, $S_1V_2C_0$, $S_1V_2C_2$, $S_2V_1C_0$, $S_2V_1C_1$ and $S_2V_2C_2$.The significantly lowest dry weight of inflorescence was $S_1V_3C_0$ (0.85 g) which was statistically similar with $S_1V_3C_1$, $S_1V_3C_2$, $S_2V_2C_1$, $S_2V_3C_1$, $S_2V_3C_2$, $S_3V_1C_0$, $S_3V_1C_1$, $S_3V_1C_2$, $S_3V_2C_0$, $S_3V_2C_1$, $S_3V_2C_2$, $S_3V_3C_0$, $S_3V_3C_1$ and $S_3V_3C_2$. The intermediate dry weights of inflorescence were with $S_1V_1C_2$, $S_1V_2C_1$, $S_2V_2C_0$ and $S_2V_3C_0$.

Table 11 Interaction effect of sowing time, variety and inflorescence top-cutting on the dry weight of inflorescence without siliqua per plant of mustard

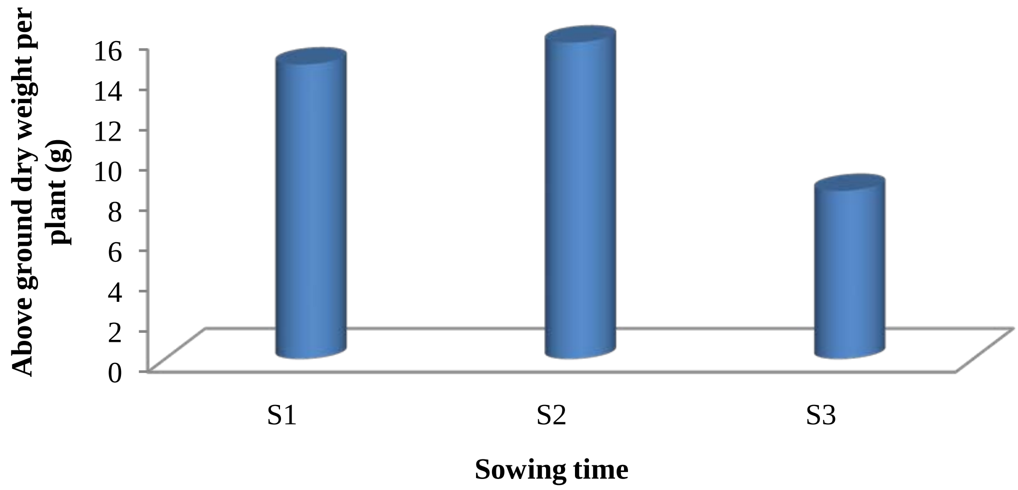
Treatments*	Dry weight of inflorescence without siliqua (g)
S X V X C	
$S_1V_1C_0$	3.26 a-f
$S_1V_1C_1$	3.97 a-c
$S_1V_1C_2$	2.91 b-h
$S_1V_2C_0$	3.25 a-f
$S_1V_2C_1$	2.62 b-i
$S_1V_2C_2$	3.35 a-e
$S_1V_3C_0$	0.85 j
$S_1V_3C_1$	1.00 ij
$S_1V_3C_2$	1.02 ij
$S_2V_1C_0$	4.30 ab
$S_2V_1C_1$	3.69 a-d
$S_2V_1C_2$	4.67 a
$S_2V_2C_0$	2.85 b-h
$S_2V_2C_1$	2.56 c-j
$S_2V_2C_2$	3.10 a-g
$S_2V_3C_0$	2.64 b-i
$S_2V_3C_1$	2.18 d-j
$S_2V_3C_2$	1.64 e-j
$S_3V_1C_0$	1.62 e-j
$S_3V_1C_1$	1.58 f-j
$S_3V_1C_2$	2.03 d-j
$S_3V_2C_0$	1.39 g-j
$S_3V_2C_1$	1.68 e-j
$S_3V_2C_2$	1.87 e-j
$S_3V_3C_0$	1.18 h-j
$S_3V_3C_1$	1.46 g-j
$S_3V_3C_2$	1.18 h-j
SE	**0.78**
CV	**37.32**

*S_1 = 01 November, S_2 = 15 November, S_3 = 30 November V_1 = Tori-7, V_2 = BARI Sarisha-9, V_3 = BARI Sarisha-15
C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut

4.10 Above ground total dry weight

4.10.1 Effect of sowing time

Effect of sowing time was significant on above ground dry weight of plant (Fig.49). The significantly highest above ground dry weight of plant was with S_2 (15.70 g). The above ground dry weight of plant of S_1 (14.61g) was identical with S_2. The significantly lowest above ground dry weight of plant was with S_3 (8.32 g).

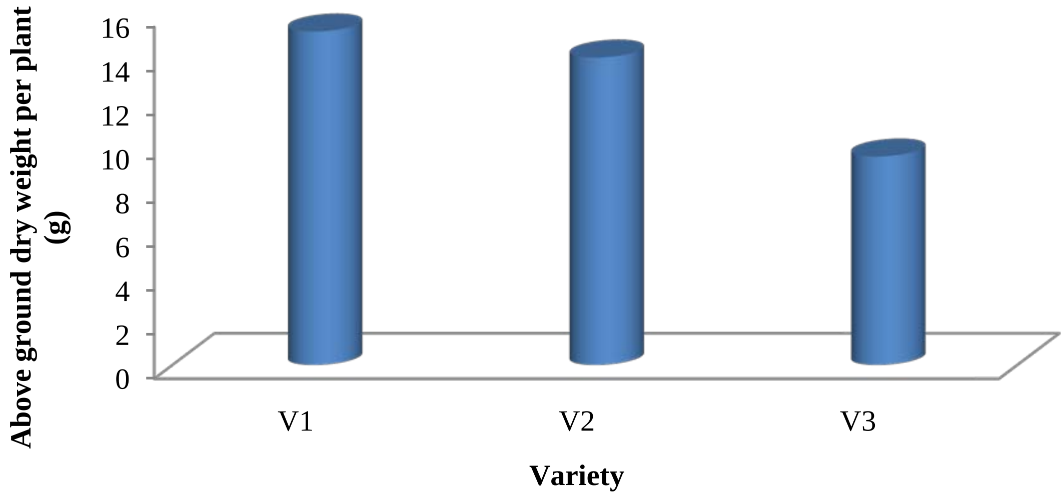


S_1 = 01 November, S_2 = 15 November, S_3 = 30 November

Figure 49 Aboveground dry weight per plant of mustard as influenced by sowing time (SE=0.63)

4.10.2 Effect of variety

Effect of variety was significant on above ground dry weight per plant of mustard (Fig.50). The significantly highest total dry weight of plant was with V_1 (15.17 g). The above ground dry weight of plant of V_2 (13.98 g) was significantly lower than that of V_1. The significantly lowest above ground dry weight of plant was with V_3 (9.49 g).

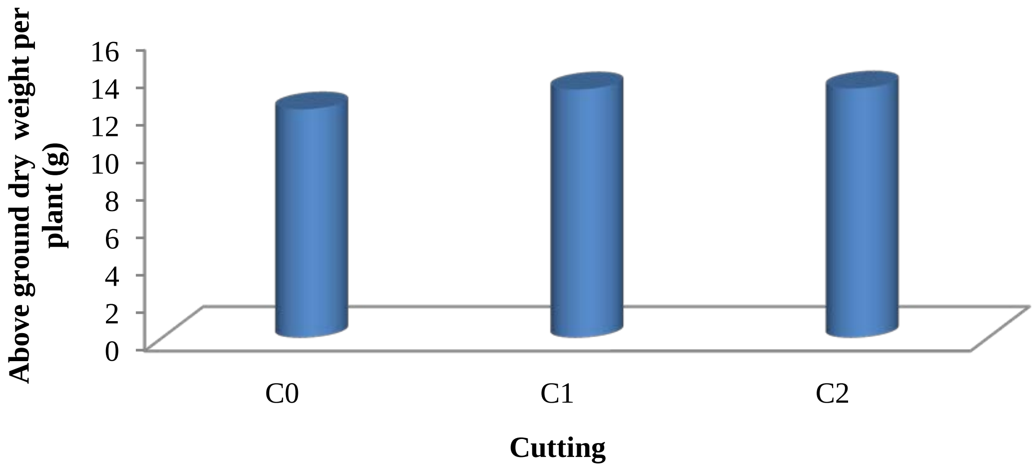


V_1 = Tori-7, V_2 = BARI Sharisha-9, V_3 = BARI Sharisha-15

Figure 50 Aboveground dry weight per plant of mustard as influenced by variety (SE=0.50)

4.10.3 Effect of inflorescence top-cutting

Effect of inflorescence top-cutting was insignificant on above ground dry weight per plant of mustard (Fig.51). But numerically highest value was found in C_2 (13.25 g) and lowest in C_1 (13.20 g). Although not in the same type of crops, there is evidence that removing the inflorescence increased dry weight of buckwheat. Park et al. (2003) observed that when inflorescence was removed, both the stomatal conduction and assimilation rate of most of the cultivar increased. The study also revealed that removal of inflorescence significantly increased the fresh weight both leaf and stem under standard and increased fertilization.

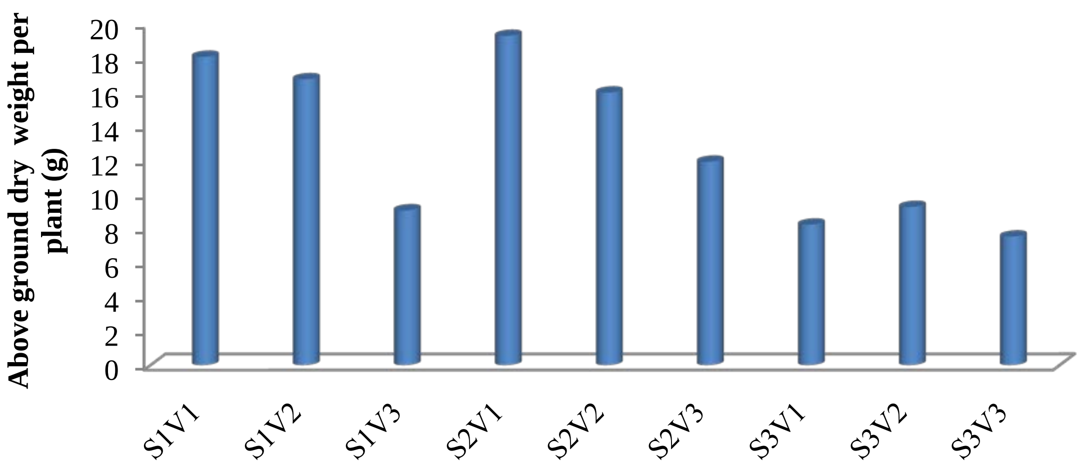


C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut

Figure 51 Aboveground dry weights per plant of mustard as influenced by inflorescence top-cutting (SE=0.85)

4.10.4 Interaction effect of sowing time and variety

Significant variation was observed for above ground dry weight per plant of mustard due to interaction effect of sowing time and variety (Fig.52) .The highest above ground dry weight was with S_2V_1 (19.27 g) which was identical with S_1V_1 (18.04 g). The significantly lowest above ground dry weight of plant was with, S_3V_3 (7.51 g), S_3V_1 (8.21 g), S_1V_3 (9.05 g) and S_3V_2 (9.25 g). The intermediate above ground dry weight was with S_1V_2, S_2V_2 and S_2V_3**.**

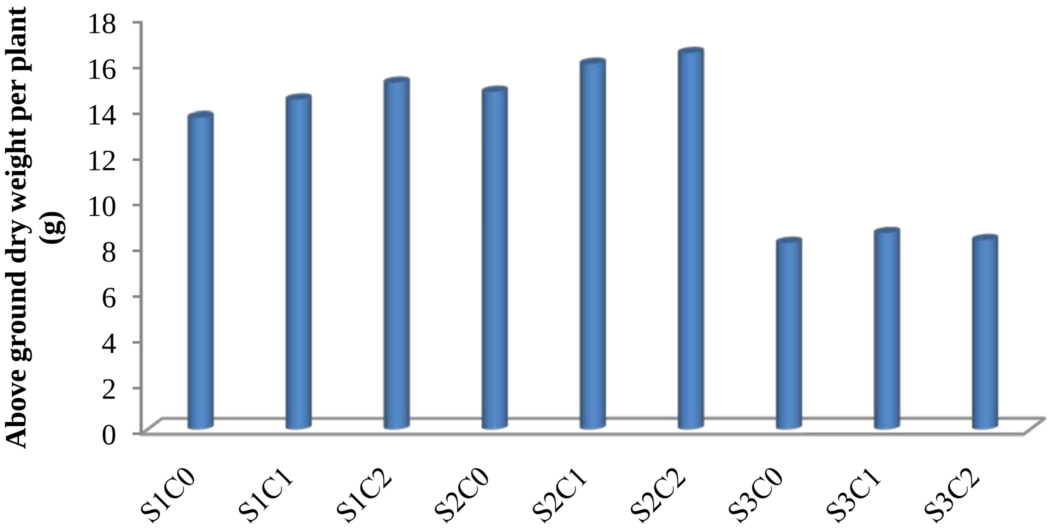


S_1 = 01 November, S_2 = 15 November, S_3 = 30 November, V_1 = Tori-7, V_2 = BARI Sarisha-9, V_3 = BARI Sarisha-15

Figure 52 Aboveground dry weights per plant of mustard as influenced by the interaction of variety and sowing time (SE=0.87)

4.10.5 Interaction effect of sowing time and inflorescence top-cutting

Interaction effect of sowing time and inflorescence top-cutting was significant on above ground dry weight per plant of mustard (Fig.53). The significantly highest above ground dry weight was with S_2C_2 (16.43 g), S_1C_0 (13.36g), S_1C_1 (14.39 g), S_1C_2 (15.13 g), S_2C_0 (14.73 g) and S_2C_1 (15.96 g). The significantly lowest above ground dry weight was with S_3C_0 (8.14 g), S_3C_1 (8.57 g) and S_3C_2 (8.26 g).

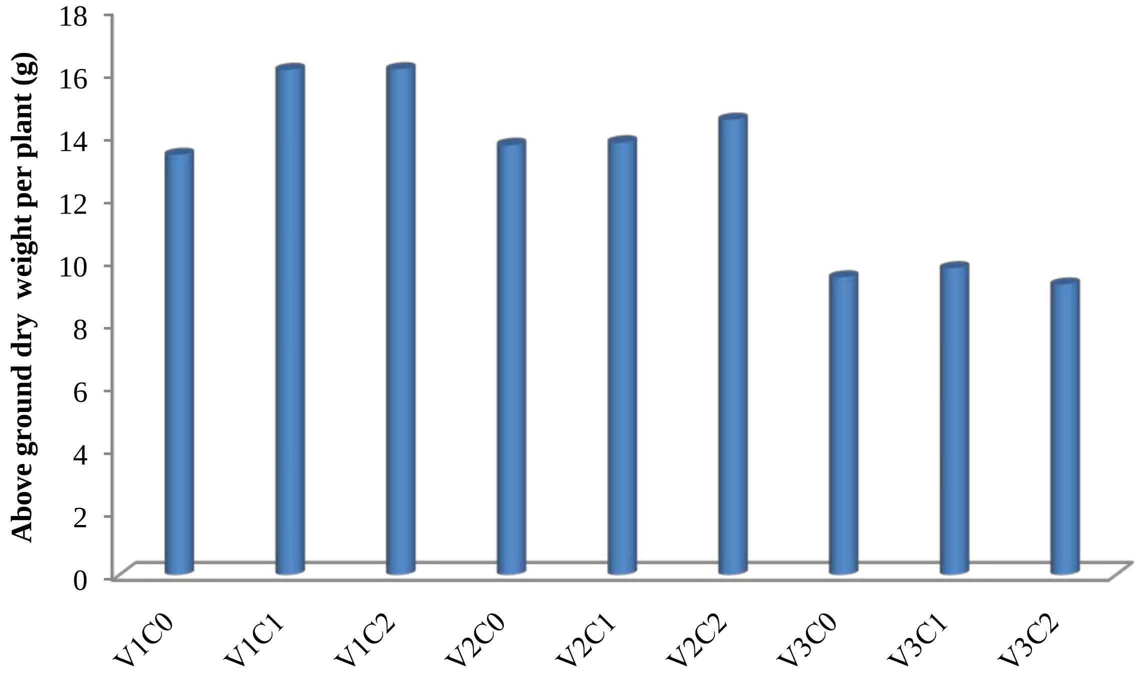


S_1 = 01 November, S_2 = 15 November, S_3 = 30 November, C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut

Figure 53 Aboveground dry weights per plant of mustard as influenced by the interaction of sowing time and inflorescence top-cutting (SE=1.47)

4.10.6 Interaction effect of variety and inflorescence top-cutting

Significant variation was observed for above ground dry weight of plant due to interaction effect of variety and inflorescence top-cutting (Fig.54). The significantly highest above ground dry weight of plant was with V_1C_2 (16.09 g), V_1C_1 (16.07 g), V_1C_0 (13.38 g), V_2C_2 (14.48 g), V_2C_1 (13.76 g) and V_2C_0 (13.68 g).The significantly lowest above ground dry weight of plant was with V_3C_2 (9.24 g), V_3C_1 (9.76 g) and V_3C_0 (9.47 g).



V_1 = Tori-7, V_2 = BARI Sarisha-9, V_3 = BARI Sarisha-15, C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut

Figure 54 Aboveground dry weights per plant of mustard as influenced by the interaction of variety and inflorescence top-cutting (SE=1.47)

4.10.7 Interaction effect of sowing time, variety and inflorescence top-cutting

Interaction effect of sowing time, variety and inflorescence top-cutting was significant on above ground dry weight of plant (Table 12). The significantly highest above ground dry weight of plant was with $S_2V_1C_2$ (21.24 g) which was statistically similar with $S_1V_1C_0$, $S_1V_1C_1$, $S_1V_2C_0$, $S_1V_2C_2$, $S_2V_1C_0$, $S_2V_1C_1$,and $S_2V_2C_2$.The significantly lowest above ground dry weight of plant was $S_3V_3C_0$ (7.11 g) and S3V3C2 (7.16 g) which were statistically similar with$S_1V_3C_1$,$S_1V_3C_0$, $S_1V_3C_2$, $S_2V_3C_1$, $S_2V_3C_2$, $S_3V_1C_0$, $S_3V_1C_1$, $S_3V_1C_2$, $S_3V_2C_0$, $S_3V_2C_1$, $S_3V_2C_2$ and $S_3V_3C_1$. The intermediate above ground dry weights of plant were with $S_1V_2C_1$, $S_2V_2C_0$ and $S_2V_3C_0$.

Table 12 Interaction effect of sowing time, variety and inflorescence top-cutting on the above ground dry weight per plant of mustard

Treatments*	Above ground dry weight (g)
S X V X C	
$S_1V_1C_0$	15.93 a-f
$S_1V_1C_1$	19.61 a-c
$S_1V_1C_2$	18.60 a-d
$S_1V_2C_0$	16.96 a-d
$S_1V_2C_1$	15.58 b-f
$S_1V_2C_2$	17.61 a-d
$S_1V_3C_0$	8.02 hi
$S_1V_3C_1$	9.95 g-i
$S_1V_3C_2$	9.18 hi
$S_2V_1C_0$	15.76 a-f
$S_2V_1C_1$	20.83 ab
$S_2V_1C_2$	21.24 a
$S_2V_2C_0$	15.17 c-g
$S_2V_2C_1$	15.98 a-f
$S_2V_2C_2$	16.67 a-e
$S_2V_3C_0$	13.27 d-h
$S_2V_3C_1$	11.09 f-i
$S_2V_3C_2$	11.38 e-i
$S_3V_1C_0$	8.44 hi
$S_3V_1C_1$	7.75 hi
$S_3V_1C_2$	8.45 hi
$S_3V_2C_0$	8.89 hi
$S_3V_2C_1$	9.72 hi
$S_3V_2C_2$	9.15 hi
$S_3V_3C_0$	7.11 i
$S_3V_3C_1$	8.26 hi
$S_3V_3C_2$	7.16 i
SE	**2.55**
CV	**22.30**

*S_1 = 01 November, S_2 = 15 November, S_3 = 30 November V_1 = Tori-7, V_2 = BARI Sarisha-9, V_3 = BARI Sarisha-15
C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut

4.11 Thousand Seed weight

4.11.1 Effect of sowing time

Effect of sowing time was insignificant on thousand seed weight (Table 13). Significantly higher thousand seed weight was found in S_2 (2.73) and lower in S_3 (2.34 g).

4.11.2 Effect of variety

Varietal effect was insignificant on thousand seed weight (Table 13). Significantly higher thousand seed weight was found in V_2 (2.58 g) and lower in V_3 (2.51 g).

4.11.3 Effect of inflorescence top-cutting

Effect of inflorescence top-cutting was found significant on thousand seed weight (Table 13). The significantly highest thousand seed weight was with C_2 (2.64 g) and it was statistically same with C_1 (2.61g).The significantly lowest thousand seed weight was with C_0 (2.37 g).

Table 13 Effect of sowing time, variety and inflorescence top-cutting on the thousand seed weight of mustard

Treatments*	Thousand seed weight (g)
Sowing time	
S_1	2.55 a
S_2	2.73 a
S_3	2.34 a
SE	**0.14**
CV	**11.95**
Variety	
V_1	2.52 a
V_2	2.58 a
V_3	2.51 a
SE	**0.077**
CV	**11.95**
Cutting	
C_0	2.37 b
C_1	2.61 a
C_2	2.64 a
SE	**0.08**
CV	**11.95**

*S_1 = 01 November, S_2 = 15 November, S_3 = 30 November V_1 = Tori-7, V_2 = BARI Sarisha-9, V_3 = BARI Sarisha-15
C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut

4.11.4 Interaction effect of sowing time and variety

Significant variation was observed for thousand seed weight of mustard due to interaction effect of sowing time and variety (Table 14).The highest thousand seed weight was with S_1V_2 (2.82 g), S_2V_1 (2.82 g) and S_2V_3 (2.80 g) which were statistically similar with S_1V_1 and S_2V_2. The significantly lowest thousand seed weight was with S_3V_1 (2.26 g), S_3V_3 (2.38g), S_3V_2 (2.35 g) and S_1V_3 (2.35 g).

4.11.5 Interaction effect of sowing time and inflorescence top- cutting

Interaction effect of sowing time and inflorescence top-cutting was significant on thousand seed weight (Table 14). The significantly highest thousand seed weight was with S_2C_2 (2.92 g) and S_3C_0 (2.91) which were followed by S_2C_1 (2.74 g), S_1C_2 (2.61 g) and S_1C_1 (2.58 g). The lowest thousand seed weight was with S_3C_2 (2.39 g).

4.11.6 Interaction effect of variety and inflorescence top-cutting

Significant variation was observed for thousand seed weight due to interaction effect of variety and inflorescence top-cutting (Table 14). The significantly highest thousand seed weight was with V_2C_1 (2.69 g), V_1C_1 (2.66 g), V_2C_2 (2.65 g), V_3C_2 (2.64 g) and V_1C_2 (2.63 g) which were statistically similar with V_2C_0, V_3C_0 and V_2C_1. The significantly lowest thousand seed weight was with V_1C_0 (2.26g).

Table 14 Interaction effect of sowing time, variety and inflorescence top-cutting on the thousand seed weight of mustard

Treatments*	Thousand seed weight (g)
SXV	
S_1V_1	2.48 ab
S_1V_2	2.82 a
S_1V_3	2.35 b
S_2V_1	2.82 a
S_2V_2	2.56 ab
S_2V_3	2.80 a
S_3V_1	2.26 b
S_3V_2	2.35 b
S_3V_3	2.38 b
SE	**0.13**
CV	**12.17**
SXC	
S_1C_0	2.47 b
S_1C_1	2.58 ab
S_1C_2	2.61 ab
S_2C_0	2.51 b
S_2C_1	2.74 ab
S_2C_2	2.92 a
S_3C_0	2.91 a
S_3C_1	2.49 b
S_3C_2	2.39 c
SE	**0.14**
CV	**12.17**
VXC	
V_1C_0	2.26 b
V_1C_1	2.66 a
V_1C_2	2.63 a
V_2C_0	2.39 ab
V_2C_1	2.69 a
V_2C_2	2.65 a
V_3C_0	2.43 ab
V_3C_1	2.46 ab
V_3C_2	2.64 a
SE	**0.14**
CV	**12.71**

*S_1 = 01 November, S_2 = 15 November, S_3 = 30 November V_1 = Tori-7, V_2 = BARI Sarisha-9, V_3 = BARI Sarisha-15
C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut

4.11.7 Interaction effect of sowing time, variety and inflorescence top-cutting

Interaction effect of sowing time, variety and inflorescence top-cutting was significant on thousand seed weight (Table 14). The significantly highest thousand seed weight was with $S_2V_1C_2$ (3.22 g) which was identical with $S_2V_3C_2$ (2.90 g), $S_1V_2C_2$ (2.85 g), $S_1V_2C_1$ (2.84 g), $S_2V_1C_1$, $S_2V_2C_1$, $S_2V_2C_2$, $S_2V_3C_0$, $S_2V_3C_1$ and $S_3V_1C_1$. The significantly lowest thousand seed weight was $S_3V_1C_0$ (1.94 g) which was identical with $S_1V_1C_0$, $S_1V_1C_1$, $S_1V_1C_2$, $S_1V_3C_0$, $S_1V_3C_1$, $S_1V_3C_2$, $S_2V_1C_0$, $S_2V_2C_0$, $S_3V_1C_2$, $S_3V_2C_0$, $S_3V_2C_1$, $S_3V_2C_2$, $S_3V_3C_0$, $S_3V_3C_1$ and $S_3V_3C_2$.

Table 15 Interaction effect of sowing time, variety and inflorescence top-cutting on the thousand seed weight of mustard

Treatments*	Thousand seed weight (g)
S X V X C	
$S_1V_1C_0$	2.41 b-e
$S_1V_1C_1$	2.54 b-e
$S_1V_1C_2$	2.50 b-e
$S_1V_2C_0$	2.79 a-d
$S_1V_2C_1$	2.84 a-c
$S_1V_2C_2$	2.85 a-c
$S_1V_3C_0$	3.01 ab
$S_1V_3C_1$	2.38 b-e
$S_1V_3C_2$	2.48 b-e
$S_2V_1C_0$	2.45 b-e
$S_2V_1C_1$	2.78 a-d
$S_2V_1C_2$	3.22 a
$S_2V_2C_0$	2.28 b-e
$S_2V_2C_1$	2.78 a-d
$S_2V_2C_2$	2.62 a-d
$S_2V_3C_0$	2.80 a-c
$S_2V_3C_1$	2.69 a-d
$S_2V_3C_2$	2.90 a-c
$S_3V_1C_0$	1.94 e
$S_3V_1C_1$	2.70 a-d
$S_3V_1C_2$	2.17 c-e
$S_3V_2C_0$	2.11 de
$S_3V_2C_1$	2.45 b-e
$S_3V_2C_2$	2.48 b-e
$S_3V_3C_0$	2.29 b-e
$S_3V_3C_1$	2.33 b-e
$S_3V_3C_2$	2.53 b-e
SE	**0.23**
CV	**13.31**

*S_1 = 01 November, S_2 = 15 November, S_3 = 30 November V_1 = Tori-7, V_2 = BARI Sarisha-9, V_3 = BARI Sarisha-15
C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut

4.12 Fresh weight of flower

We did not cut the flower in case of treatment C_0.So that C_0 is always 0**.**

4.12.1 Effect of sowing time

Effect of sowing time was insignificant on fresh weight of flower (Table 16).

4.12.2 Effect of variety

Effect of variety was significant on fresh weight of flower (Table 15). The significantly highest fresh weight of flower was with V_2 (46.10 g) which was statistically similar with V_1 (40.93 g). The lowest fresh weight of flower was with V_3 (18.51 g)

4.12.3 Effect of inflorescence top-cutting

Significant variation was observed for inflorescence top-cutting on fresh weight of flower (Table 15). The significantly highest fresh weight of flower was with C_1 (60.97 g). The lowest fresh weight of flower was with C_2 (44.56 g).

Table 16 Effect of sowing time, variety and inflorescence top-cutting on the fresh weight of mustard flower

Treatments*	Fresh weight of flower (g)
Sowing time	
S_1	37.17 a
S_2	35.78 a
S_3	32.58 a
SE	**1.33**
CV	**19.72**
Variety	
V_1	40.93 a
V_2	46.10 a
V_3	18.51 b
SE	**1.77**
CV	**19.72**
Cutting	
C_0	0.00 c
C_1	60.97 a
C_2	44.56 b
SE	**1.34**
CV	**19.72**

*S_1 = 01 November, S_2 = 15 November, S_3 = 30 November V_1 = Tori-7, V_2 = BARI Sarisha-9, V_3 = BARI Sarisha-15
C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut

4.12.4 Interaction of sowing time and variety

Interaction effect of sowing time and variety was significant on fresh weight of flower (Table 17). The significantly highest fresh weight of flower was with S_1V_2 (50.08 g) which was statistically similar with S_1V_1, S_2V_1, S_2V_2 and S_3V_2. The lowest fresh weight of flower was with S_2V_3 (15.08 g) which was identical with S_3V_3 and S_1V_3 and significantly lower than that of S_1V_2.

4.12.5 Interaction of sowing time and inflorescence top-cutting

Interaction effect of sowing time and inflorescence top-cutting was significant on fresh weight of flower (Table 17). The significantly highest fresh weight of flower was with S_2C_1 (69.10 g) which was statistically similar with S_1C_1. The lowest fresh weight of flower was with S_3C_1 (45.22 g) and S_1C_2 (42.93 g).The intermediate fresh weight of flower was S_3C_2 (52.52 g), which was significantly lower than that of S_2C_1.

4.12.6 Interaction of variety and inflorescence top-cutting

Interaction effect of variety and inflorescence top-cutting was significant on fresh weight of flower (Table 17). The significantly highest fresh weight of flower was with V_2C_1 (79.12 g) which was statistically similar with V_1C_1.The lowest fresh weight of flower was V_3C_1 (29.27 g) and V_3C_2 (26.26 g). The intermediate fresh weight of flower were V_2C_2 (59.17 g), V_1C_2 (48.26 g) which were significantly lower than that of V_2C_1.

Table 17 Interaction effect of sowing time, variety and inflorescence top-cutting on the fresh weight of mustard flower

Treatments*	Fresh weight of flower (g)
S X V	
S_1V_1	40.47 ab
S_1V_2	50.08 a
S_1V_3	20.96 c
S_2V_1	45.90 ab
S_2V_2	46.35 ab
S_2V_3	15.08 c
S_3V_1	36.39 b
S_3V_2	41.85 ab
S_3V_3	19.49 c
SE	**3.06**
CV	**26.16**
S X C	
S_1C_0	0.00 d
S_1C_1	68.60 a
S_1C_2	42.93 c
S_2C_0	0.00 d
S_2C_1	69.10 a
S_2C_2	38.24 c
S_3C_0	0.00 d
S_3C_1	45.22 c
S_3C_2	52.52 b
SE	**2.33**
CV	**26.16**
V X C	
V_1C_0	0.00 e
V_1C_1	74.52 a
V_1C_2	48.26 c
V_2C_0	0.00 e
V_2C_1	79.12 a
V_2C_2	59.17 b
V_3C_0	0.00 e
V_3C_1	29.27 d
V_3C_2	26.26 d
SE	**2.33**
CV	**26.16**

*S_1 = 01 November, S_2 = 15 November, S_3 = 30 November V_1 = Tori-7, V_2 = BARI Sarisha-9, V_3 = BARI Sarisha-15
C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut

4.12.7 Interaction of sowing time, variety and inflorescence top-cutting

Interaction of sowing time, variety and inflorescence top-cutting was significant on fresh weight of flower (Table 18). The significantly highest fresh weight of flower was with $S_2V_1C_1$ (94.71 g) which was statistically similar with $S_2V_2C_1$ and $S_1V_2C_1$. The significantly lowest fresh weight of flower were with $S_2V_3C_1$ (20.41 g), S_2V3C_2 (24.84 g), $S_1V_3C_2$ (21.99 g) and $S_3V_3C_1$ (26.52 g) which were identical with $S_3V_3C_2$ (31.96 g). The intermediate fresh weights of flowers were S_1V_1C1, $S_3V_2C_1$, $S_3V_2C_2$, $S_3V_1C_2$, $S_3V_1C_1$, $S_2V_2C_2$, $S_1V_1C_2$, $S_1V_3C_1$ and $S_2V_1C_2$.

Table 18 Interaction effect of sowing time, variety and inflorescence top-cutting on the fresh weight of mustard flower

Treatments*	Fresh weight of flower (g)
S X V X C	
$S_1V_1C_0$	0.00 g
$S_1V_1C_1$	80.52 b
$S_1V_1C_2$	40.93 de
$S_1V_2C_0$	0.00 g
$S_1V_2C_1$	84.38 ab
$S_1V_2C_2$	65.87 c
$S_1V_3C_0$	0.00 g
$S_1V_3C_1$	40.89 de
$S_1V_3C_2$	21.99 f
$S_2V_1C_0$	0.00 g
$S_2V_1C_1$	94.71 a
$S_2V_1C_2$	43.00 de
$S_2V_2C_0$	0.00 g
$S_2V_2C_1$	92.19 ab
$S_2V_2C_2$	46.88 d
$S_2V_3C_0$	0.00 g
$S_2V_3C_1$	20.41 f
$S_2V_3C_2$	24.84 f
$S_3V_1C_0$	0.00 g
$S_3V_1C_1$	48.33 d
$S_3V_1C_2$	60.85 c
$S_3V_2C_0$	0.00 g
$S_3V_2C_1$	60.81 c
$S_3V_2C_2$	64.75 c
$S_3V_3C_0$	0.00 g
$S_3V_3C_1$	26.52 f
$S_3V_3C_2$	31.96 ef
SE	**4.03**
CV	**19.87**

*S_1 = 01 November, S_2 = 15 November, S_3 = 30 November V_1 = Tori-7, V_2 = BARI Sarisha-9, V_3 = BARI Sarisha-15
C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut

4.13 Dry weight of flower

We did not cut the flower in case of treatment C_0.So that C_0 is always 0.

4.13.1 Effect of sowing time

Effect of sowing time was insignificant on dry weight of flower (Table 19).

4.13.2 Effect of variety

Effect of variety was significant on dry weight of flower (Table 19). The significantly highest dry weight of flower was with V_2 (5.98 g) which was statistically similar with V_1 (5.79 g). The lowest dry weight of flower was with V_3 (2.56 g).

4.13.3 Effect of inflorescence top-cutting

Significant variation was observed for inflorescence top-cutting on dry weight of flower (Table 19). The significantly highest dry weight of flower was with C_1 (8.12g). The lowest dry weight of flower was with C_2 (6.22 g).

Table 19 Effect of sowing time, variety and inflorescence top-cutting on the Dry weight of mustard flower

Treatments*	Dry weight of flower (g)
Sowing time	
S_1	4.82 a
S_2	4.58 a
S_3	4.93 a
SE	**0.15**
CV	**17.14**
Variety	
V_1	5.79 a
V_2	5.98 a
V_3	2.56 b
SE	**0.11**
CV	**17.14**
Cutting	
$\mathbf{C_0}$	0.00 b
$\mathbf{C_1}$	8.12 a
$\mathbf{C_2}$	6.22 a
SE	**1.16**
CV	**17.14**

*S_1 = 01 November, S_2 = 15 November, S_3 = 30 November V_1 = Tori-7, V_2 = BARI Sarisha-9, V_3 = BARI Sarisha-15
C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut

4.13.4 Interaction of sowing time and variety

Interaction effect of sowing time and variety was significant on dry weight of flower (Table 20). The significantly highest dry weight of flower was with S_3V_2 (6.38 g) which was statistically similar with S_1V_1, S_1V_2, S_2V_2 and S_2V_3. The lowest fresh weight of flower was with S_2V_3 (2.02 g). Intermediate dry weight of flower was with S_3V_1, S_3V_3 and S_1V_3 which was significantly lower than that of S_3V_1.

4.13.5 Interaction of sowing time and inflorescence top-cutting

Interaction effect of sowing time and inflorescence top-cutting was significant on dry weight of flower (Table 20). The significantly highest dry weight of flower was with S_2C_1 (9.39 g), S_1C_1 (8.373 g), S_3C_2 (8.19 g) and S_3C_1 (6.60 g) which was statistically similar with S_1C_2 and S_2C_2.

4.13.6 Interaction of variety and inflorescence top-cutting

Interaction effect of variety and inflorescence top-cutting was significant on dry weight of flower (Table 20). The significantly highest dry weight of flower was with V_2C_1 (10.09 g) and V_1C_1 (10.07 g) which was statistically similar with V_1C_2, V_2C_2 and V_3C_1. The significantly lowest dry weight of flower was V_3C_2 (3.48 g).

Table 20 Interaction effect of sowing time, variety and inflorescence top-cutting on the Dry weight of mustard flower

Treatments*	Dry weight of flower (g)
S X V	
S_1V_1	5.92 ab
S_1V_2	5.87 ab
S_1V_3	2.68 c
S_2V_1	6.04 ab
S_2V_2	5.69 ab
S_2V_3	2.02 d
S_3V_1	5.43 b
S_3V_2	6.38 a
S_3V_3	2.98 c
SE	**0.20**
CV	**12.97**
S X C	
S_1C_0	0.00 b
S_1C_1	8.37 a
S_1C_2	6.10 ab
S_2C_0	0.00 b
S_2C_1	9.39 a
S_2C_2	4.37 ab
S_3C_0	0.00 b
S_3C_1	6.60 a
S_3C_2	8.19 a
SE	**2.01**
CV	**12.97**
V X C	
V_1C_0	0.00 c
V_1C_1	10.07 a
V_1C_2	7.32 ab
V_2C_0	0.00 c
V_2C_1	10.09 a
V_2C_2	7.86 ab
V_3C_0	0.00 c
V_3C_1	4.21 a-c
V_3C_2	3.48 bc
SE	**2.01**
CV	**12.97**

*S_1 = 01 November, S_2 = 15 November, S_3 = 30 November V_1 = Tori-7, V_2 = BARI Sarisha-9, V_3 = BARI Sarisha-15
C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut

4.13.7 Interaction of sowing time, variety and inflorescence top-cutting

Interaction of sowing time, variety and inflorescence top-cutting was significant on dry weight of flower (Table 21). The significantly highest dry weight of flower was with $S_2V_1C_1$ (13.21 g) which was statistically similar with $S_2V_2C_1$, $S_1V_1C_1$ and S3V_2C2. The significantly lowest fresh weight of flower were with $S_2V_3C_1$ (3.33 g), $S_2V_3C_2$ (2.74g), $S_1V_3C_2$ (2.69 g) and $S_3V_3C_1$ (3.95 g) which were identical with $S_3V_3C_2$, $S_1V_3C_1$, $S_2V_1C_2$ and $S_2V_2C_2$. The intermediate fresh weights of flower were $S_1V_1C_2$, $S_1V_2C_1$, $S_1V_2C_2$, $S_3V_1C_1$, $S_3V_1C_2$ and $S_3V_2C_1$ which were significantly lower than $S_2V_1C_1$.

Table 21 Interaction effect of sowing time, variety and inflorescence top-cutting on the Dry weight of mustard flower

Treatments*	Dry weight of flower (g)
S X V X C	
$S_1V_1C_0$	0.00 e
$S_1V_1C_1$	10.00 ab
$S_1V_1C_2$	7.75 b
$S_1V_2C_0$	0.00 e
$S_1V_2C_1$	9.76 b
$S_1V_2C_2$	7.85 b
$S_1V_3C_0$	0.00 e
$S_1V_3C_1$	5.35 cd
$S_1V_3C_2$	2.69 d
$S_2V_1C_0$	0.00 e
$S_2V_1C_1$	13.21 a
$S_2V_1C_2$	4.90 cd
$S_2V_2C_0$	0.00 e
$S_2V_2C_1$	11.63 ab
$S_2V_2C_2$	5.46 cd
$S_2V_3C_0$	0.00 e
$S_2V_3C_1$	3.33 d
$S_2V_3C_2$	2.74 d
$S_3V_1C_0$	0.00 e
$S_3V_1C_1$	6.99 c
$S_3V_1C_2$	9.31 b
$S_3V_2C_0$	0.00 e
$S_3V_2C_1$	8.88 b
$S_3V_2C_2$	10.26 ab
$S_3V_3C_0$	0.00 e
$S_3V_3C_1$	3.95 d
$S_3V_3C_2$	5.01 cd
SE	**3.48**
CV	**21.01**

*S_1 = 01 November, S_2 = 15 November, S_3 = 30 November V_1 = Tori-7, V_2 = BARI Sarisha-9, V_3 = BARI Sarisha-15
C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut

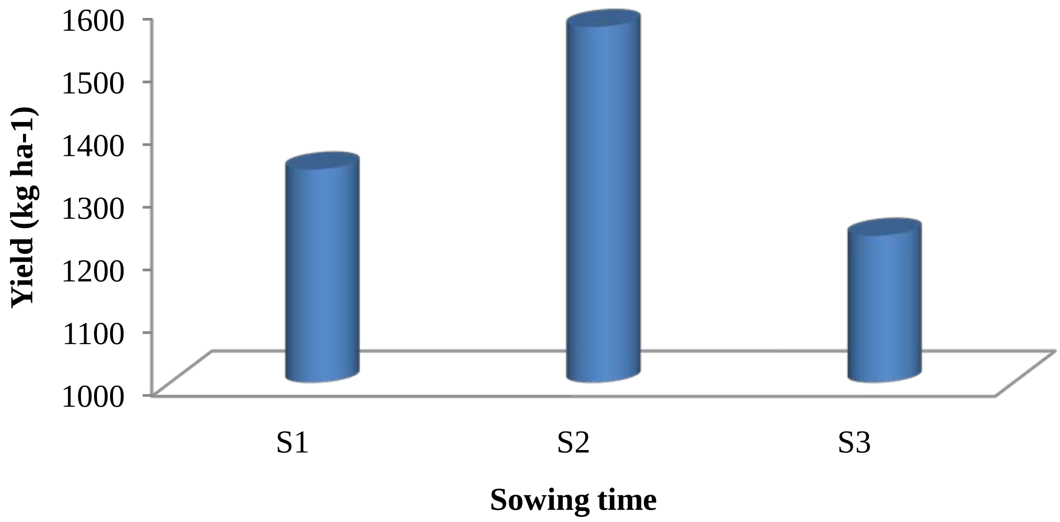
4.14 Seed yield (kg ha^{-1})

4.14.1 Effect of sowing time

Effect of sowing time was significant on seed yield (Fig.55). The significantly highest seed yield was with S_2 (1566.50 kg ha^{-1}).The yield of S_1 (1339 kg ha^{-1}) was significantly lower than that of S_2.The significantly lowest seed yield was with S_3 (1234.35 kg ha^{-1}).

The results were similar with those of Afroz *et al.* (2011) who observed that the highest seed yield was obtained by the BARI Sarisha-9 in 10 November sowing and lowest seed yield was achieved in 30 November sowing.

Mondal *et al*. (1992), Mondal and Islam (1993) and Uddin *et al.* (1987) reported that late sowing decreased the seed yield.

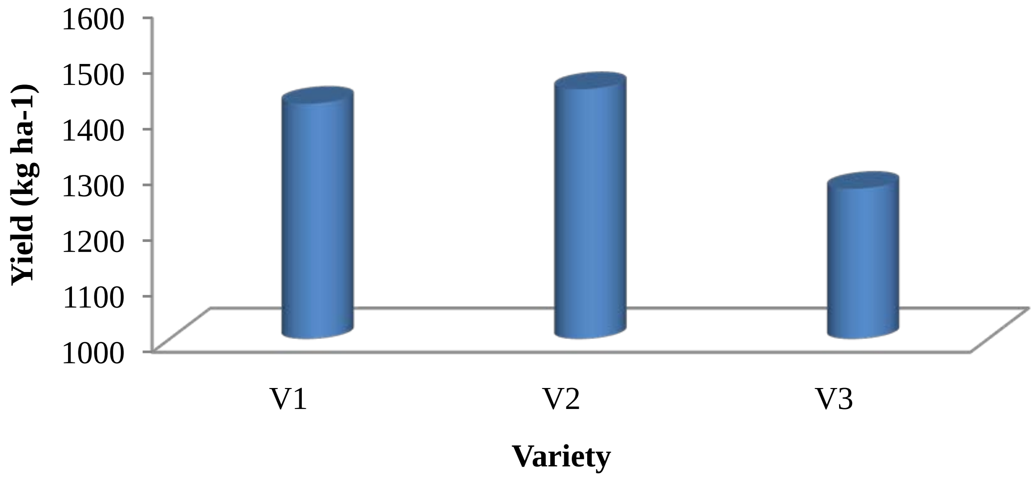


S_1 = 01 November, S_2 = 15 November, S_3 = 30 November

Figure 55 Seed yield of mustard as influenced by sowing time (SE=10.52)

4.14.2 Effect of variety

Significant varietal effect was found on seed yield (Fig.56). The significantly highest yield was showed by V_2 (1448.20 kg ha^{-1}) and V_1 (1422.20 kg ha^{-1}). The significantly lowest yield was with V_3 (1270.10 kg ha^{-1}). The findings is in conformity with the findings of Zaman *et al.* (1991), Chakrabarty *et al.* (1991) and Uddin *et al*. (1987) reported that yields were different among the varieties.



V_1 = Tori-7, V_2 = BARI Sharisha-9, V_3 = BARI Sharisha-15

Figure 56 Seed yield of mustard as influenced by variety (SE=6.55)

4.14.3 Effect of inflorescence top-cutting

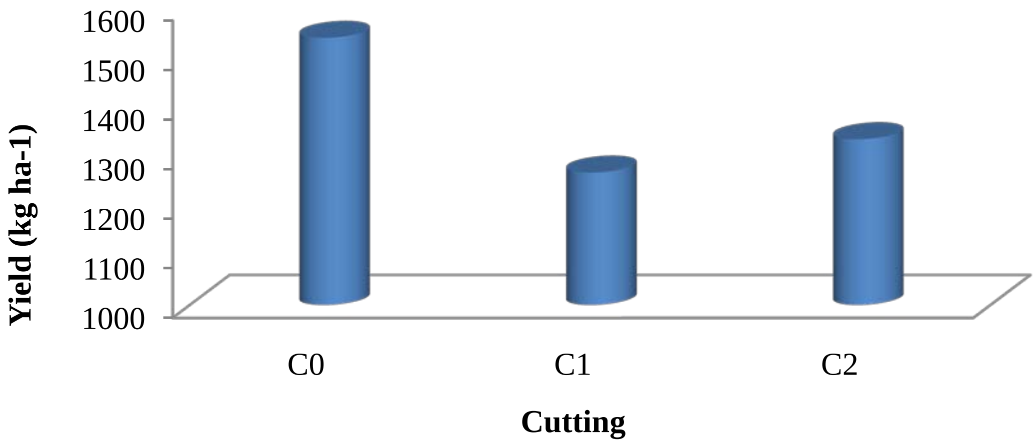
Effect of inflorescence top-cutting was also significant on seed yield (Fig.57). Highest yield was with C_0 (1538.55 kg ha^{-1}). The yield of C_2 (1334.45 kg ha^{-1}) and that of C_1 (1266.85 kg ha^{-1}) were statistically same and significantly lower than that of C_0. In this study, it was observed that inflorescence top cutting did not increase seed yield of mustard, rather decreased it due to the inflorescence removal, the photosynthetic ability of the source organ (leaf) may be changed.

Decreasing sink demand by removing fruit generally reduced leaf photosynthetic rate in many species, such as tomato (Walker and Ho, 1977), grape (Downton et al. 1987), kiwifruit (*Actinidia deliciosa* Liang et Ferguson) (Buwalda and Smith, 1990), and *Satsuma mandarin* (Citrus unshiu Marc.) (Iglesias *et al.,* 2002). Similarly, in peach trees, the photosynthetic rate was greater for leaves with a high crop load than a low crop load (Quilot *et al*., 2004). Li *et al.* (2005) reported that fruit removal resulted in a 50% to 56% reduction in net photosynthetic rate in ‘Okubo’ peach and a 22% to 39% reduction in ‘Yanfeng 1’peach, compared with fruit-bearing shoots. The responses of leaf photosynthetic rate to sink –source modification may be due to differences in genotypic factors or developmental stage and the number of removed fruit.

Although these are evidences that inflorescence removal increased the weight of the remaining organs of the plant.

Park *et al.* (2003) evaluated the effect of inflorescence removal on the photosynthesis, assimilation, and dry matter accumulation of buckwheat under both standard and increased fertilization. They observed that when inflorescence was removed, both the stomatal conduction and assimilation rate of most of the cultivar increased. The study also revealed that removal of inflorescence significantly increased the fresh weight of both leaf and stem under both standard and increased fertilization.

In this study although per hectare seed yield did not increase due to inflorescence top cutting, siliqua fresh weight was increased suggesting that inflorescence top cutting had effect on seed attributes.

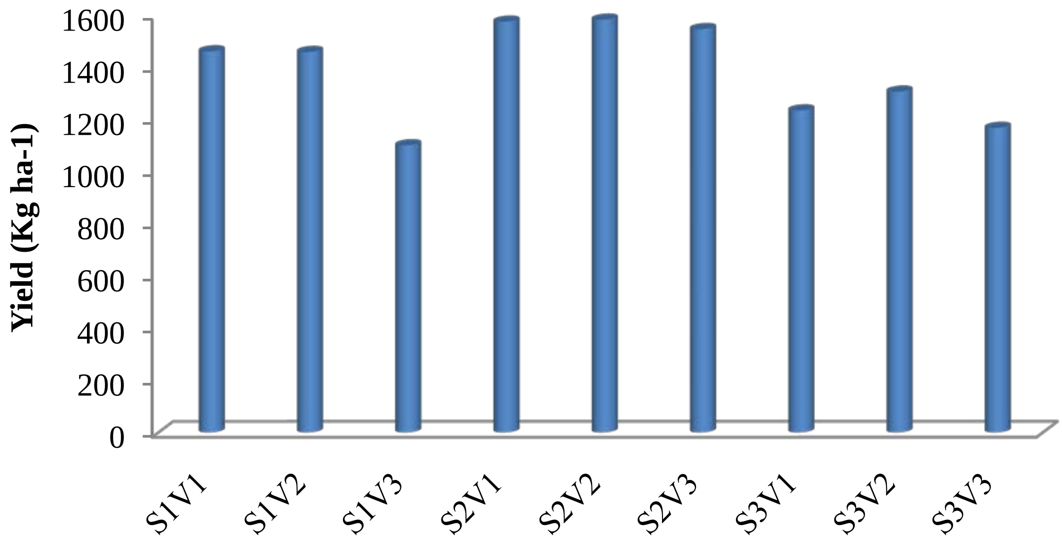


C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut

Figure 57 Seed yield of mustard as influenced by inflorescence top-cutting (SE=5.79)

4.14.4 Interaction effect of sowing time and variety

Significant variation was observed for seed yield of mustard due to interaction effect of sowing time and variety (Fig.58).The highest yield was with S_2V_2 (1581.45 kg ha^{-1}) and S_2V_1(1573.65 kg ha^{-1}) which were statistically similar with S_1V_1 , S_1V_2 and S_2V_3. The significantly lowest yield was with S_1V_3 (1099.15 kg ha^{-1}) which was statistically similar with S_3V_3, S_3V_1 and S_3V_2.

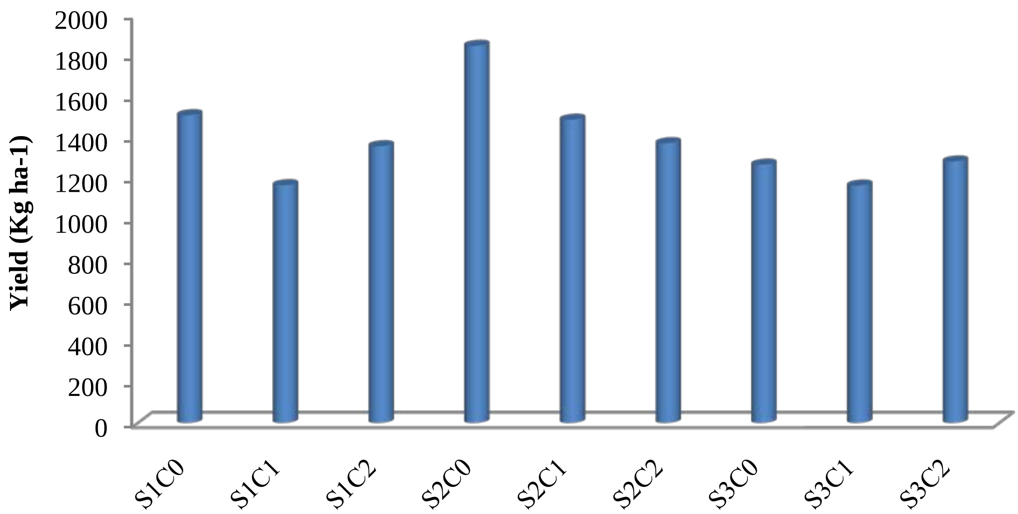


S_1 = 01 November, S_2 = 15 November, S_3 = 30 November, V_1 = Tori-7, V_2 = BARI Sarisha-9, V_3 = BARI Sarisha-15

Figure 58 Seed yield of mustard as influenced by sowing time and variety (SE=11.35)

4.14.5 Interaction effect of sowing time and inflorescence top-cutting

Interaction effect of sowing time and inflorescence top-cutting was significant on seed yield (Fig.59). The significantly highest yield was with S_2C_0 (1846.65 kg ha^{-1}). The significantly lowest yield was with S_3C_1 (1160.90 kg ha^{-1}) and S_1C_1 (1162.85 kg ha^{-1}), which was identical with S_1C_2, S_3C_0 and S_3C_2.The intermediate yield were withS_1C_0, S_2C_1 and S_2C_2.

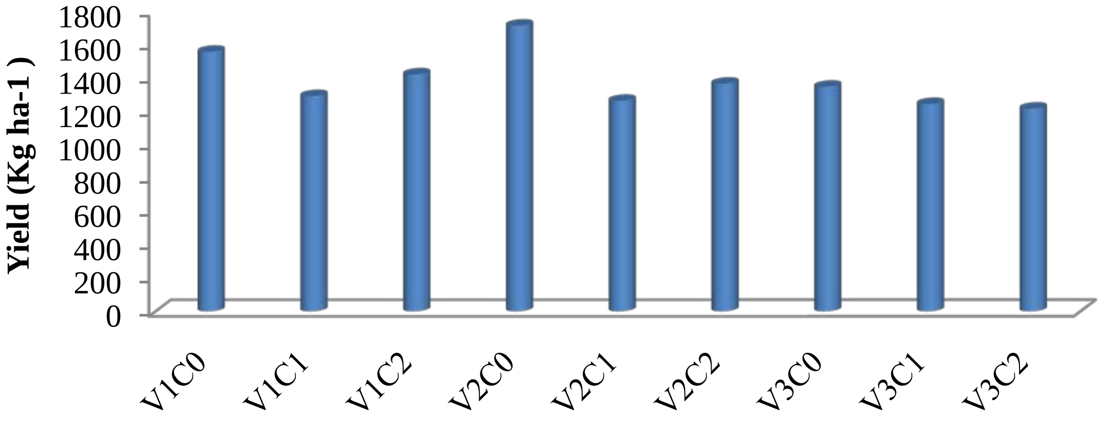


S_1 = 01 November, S_2 = 15 November, S_3 = 30 November, C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut

Figure 59 Seed yield of mustard as influenced by sowing time and inflorescence top-cutting (SE=10.03)

4.14.6 Interaction effect of variety and inflorescence top-cutting

Significant variation was observed for seed yield due to interaction effect of variety and inflorescence top-cutting. The significantly highest yield was with V_2C_0 (1712.75 kg ha^{-1}) which was statistically similar with V_1C_0 (1555.45 kg ha^{-1}). The significantly lowest yield was with V_3C_2 (1216.80 kg ha^{-1}), V_3C_1 (1244.75 kg ha^{-1}), V_2C_1 (1263.60 kg ha^{-1}), V_1C_1 (1292.20 kg ha^{-1}) and V_3C_0 (1348.75 kg ha^{-1}) which were statistically similar with V_1C_2 and V_2C_2.



V_1 = Tori-7, V_2 = BARI Sarisha-9, V_3 = BARI Sarisha-15, C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut

Figure 60 Seed yield of mustard as influenced by variety and inflorescence top-cutting (SE=10.03)

4.14.7 Interaction effect of sowing time, variety and inflorescence top-cutting

Interaction effect of sowing time, variety and inflorescence top-cutting was significant on seed yield (Table 22). The significantly highest yield was with $S_2V_2C_0$ (1996.15 kg ha^{-1}) which was identical with $S_1V_2C_0$, $S_2V_1C_0$ and $S_2V_3C_0$. The significantly lowest yield was with $S_1V_3C_2$ (1052.35 kg ha^{-1}) which was statistically similar with $S_3V_1C_1$, $S_3V_1C_0$, $S_3V_1C_2$, $S_3V_2C_0$, $S_3V_2C_1$, $S_3V_2C_2$, $S_3V_3C_0$, $S_3V_3C_1$, $S_3V_3C_2$, $S_2V_3C_1$, $S_2V_3C_2$, $S_1V_3C_1$, $S_1V_3C_0$, $S_1V_2C_1$ and $S_1V_1C_1$.The intermediate yield were with $S_1V_1C_0$, $S_1V_1C_2$, $S_1V_2C_2$, $S_2V_1C_1$, $S_2V_2C_1$ and $S_2V_3C_1$. In this study, seed yield per ha apparently did not increased. However, fresh siliqua weight (Table 5) and also 1000-seed weight of many treatments composed of inflorescence top cutting have increased. This indicated that inflorescence top cutting had positive effect on these reproductive parameters although this phenomena was not demonstrate in case of seed yield per ha. Inflorescence top cutting of S_2V_1 (in most cases of C_1) showed significantly higher values than most of the treatments of stem dry weight, the inflorescence dry weight and total dry weight. But this treatment had also higher chaff weight indicating that the diverted photosynthates was not enough and could not contribute to yield increase and it was consumed by chaff. But it was also observed that the same treatments increased 1000-seed weight but did not significantly increase the number of seed per siliqua (Table 3).this suggest that inflorescence top cutting should have been a bit contain.So that both the number and weight of seeds in a siliqua have increased which might have been helpful to increase the per hectare seed yield.

Table 22 Interaction effect of sowing time, variety and inflorescence top-cutting on the seed yield (kg ha^{-1}) of mustard

Treatments*	Yield (kg ha^{-1})
S X V X C	
$S_1V_1C_0$	1216.80 b-e
$S_1V_1C_1$	1593.80 e-i
$S_1V_1C_2$	1238.25 b-f
$S_1V_2C_0$	1547.65 a-c
$S_1V_2C_1$	1779.70 g-i
$S_1V_2C_2$	1129.70 b-h
$S_1V_3C_0$	1462.50 g-i
$S_1V_3C_1$	1143.35 hi
$S_1V_3C_2$	1102.40 i
$S_2V_1C_0$	1052.35 ab
$S_2V_1C_1$	1818.70 b-g
$S_2V_1C_2$	1508.65 d-i
$S_2V_2C_0$	1996.15 a
$S_2V_2C_1$	1470.30 b-h
$S_2V_2C_2$	1276.60 e-i
$S_2V_3C_0$	1725.75 a-d
$S_2V_3C_1$	1471.60 b-h
$S_2V_3C_2$	1437.80 c-i
$S_3V_1C_0$	1253.85 e-i
$S_3V_1C_1$	1129.70 g-i
$S_3V_1C_2$	1315.60 d-i
$S_3V_2C_0$	1361.75 d-i
$S_3V_2C_1$	1191.45 f-i
$S_3V_2C_2$	1361.75 d-i
$S_3V_3C_0$	1176.50 f-i
$S_3V_3C_1$	1160.90 f-i
$S_3V_3C_2$	1160.90 f-i
SE	**17.38**
CV	**14.18**

*S_1 = 01 November, S_2 = 15 November, S_3 = 30 November V_1 = Tori-7, V_2 = BARI Sarisha-9, V_3 = BARI Sarisha-15
C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut

4.15 Stover Yield

4.15.1 Effect of sowing time

Effect of sowing time was insignificant on Stover yield (Table 23). Though numerically highest Stover yield was with S_2 (2952.51 kg ha^{-1}). The lowest Stover yield was with S_3 (2724.49 kg ha^{-1}).

4.15.2 Effect of variety

Insignificant varietal effect was found on Stover yield (Table 23). The highest Stover yield was observed by V_3 (2873.41 kg ha^{-1}) and the lowest Stover yield was with V_1 (2842.29 kg ha^{-1}).

4.15.3 Effect of inflorescence top-cutting

Effect of inflorescence top-cutting was significant on Stover yield (Table 23). The significantly highest Stover yield was with C_2 (2909.69 kg ha^{-1}). The Stover yield of C_0 (2883.73 kg ha^{-1}) was statistically similar with C_2. The significantly lowest Stover yield was with C_1 (2770.24 kg ha^{-1}). There was a direct relationship between plants dry weight and fresh weight. Park *et al*. (2003) observed that when inflorescence was removed, both the stomatal conduction and assimilation rate of most of the cultivar increased. The study also revealed that removal of inflorescence significantly increased the fresh weight both leaf and stem under standard and increased fertilization

Table 23 Effect of sowing time, variety and inflorescence top-cutting on the Stover yield (kg ha^{-1}) of mustard

Treatments*	Stover Yield (kg ha^{-1})
Sowing time	
S_1	2886.66 a
S_2	2952.51 a
S_3	2724.49 a
SE	**178.6**
CV	**21.13**
Variety	
V_1	2842.29 a
V_2	2847.96 a
V_3	2873.41 a
SE	**164.5**
CV	**21.13**
Cutting	
C_0	2883.73 ab
C_1	2770.24 b
C_2	2909.69 a
SE	**70.83**
CV	**21.13**

*S_1 = 01 November, S_2 = 15 November, S_3 = 30 November V_1 = Tori-7, V_2 = BARI Sarisha-9, V_3 = BARI Sarisha-15
C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut

4.15.4 Interaction effect of sowing time and variety

Insignificant variation was observed for Stover yield of mustard due to interaction effect of sowing time and variety (Table 24).The highest yield was with S_2V_2 (3056.55 kg ha^{-1}) and the lowest yield was with S_3V_2 (2571.63 kg ha^{-1}).

4.15.5 Interaction effect of sowing time and inflorescence top-cutting

Interaction effect of sowing time and inflorescence top-cutting was significant on Stover yield (Table 24). The significantly highest yield was with S_2C_2 (3061.71 kg ha^{-1}), S_1C_0 and S_2C_0 which were statistically similar with S_1C_1, S_1C_2, S_2C_1 and S_3C_2. The significantly lowest yield was with S_3C_1 (2649.01 kg ha^{-1}) and S_3C_0 (2667.06 kg ha^{-1}).

4.15.6 Interaction effect of variety and inflorescence top-cutting

Insignificant variation was observed for Stover yield due to interaction effect of variety and inflorescence top-cutting (Table 24). The numerically highest Stover yield was with V_1C_2 (2963.17 kg ha^{-1}) and the lowest Stover yield was with V_1C_1 (2728.97 kg ha^{-1}).

Table 24 Interaction effect of sowing time, variety and inflorescence top-cutting on the Stover yield (kg ha^{-1}) of mustard

Treatments*	Stover Yield (kg ha^{-1})
S X V	
S_1V_1	2832.14 a
S_1V_2	2915.71 a
S_1V_3	2912.10 a
S_2V_1	2865.67 a
S_2V_2	3056.55 a
S_2V_3	2935.32 a
S_3V_1	2829.05 a
S_3V_2	2571.63 a
S_3V_3	2772.82 a
SE	**284.9**
CV	**19.46**
S X C	
S_1C_0	3038.49 a
S_1C_1	2811.51 ab
S_1C_2	2809.96 ab
S_2C_0	2945.64 a
S_2C_1	2850.20 ab
S_2C_2	3061.71 a
S_3C_0	2667.06 b
S_3C_1	2649.01 b
S_3C_2	2857.42 ab
SE	**122.7**
CV	**19.46**
V X C	
V_1C_0	2834.72 a
V_1C_1	2728.97 a
V_1C_2	2963.17 a
V_2C_0	2930.16 a
V_2C_1	2731.55 a
V_2C_2	2882.18 a
V_3C_0	2886.31 a
V_3C_1	2850.20 a
V_3C_2	2883.73 a
SE	**122.7**
CV	**19.46**

*S_1 = 01 November, S_2 = 15 November, S_3 = 30 November V_1 = Tori-7, V_2 = BARI Sarisha-9, V_3 = BARI Sarisha-15
C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut

4.15.7 Interaction effect of sowing time, variety and inflorescence top-cutting

Interaction effect of sowing time, variety and inflorescence top-cutting was significant on Stover yield (Table 25). The significantly highest Stover yield was with $S_2V_2C_0$ (3172.62 kg ha^{-1}) and $S_2V_2C_2$ (3172.62 kg ha^{-1}) which was identical with $S_1V_2C_0$, $S_2V_1C_0$, $S_1V_1C_0$, $S_1V_1C_2$, $S_1V_2C_0$, $S_1V_2C_1$, $S_1V_2C_2$, $S_1V_3C_0$, $S_1V_3C_1$, $S_1V_3C_2$, $S_2V_1C_0$, $S_2V_1C_1$, $S_2V_1C_2$, $S_3V_1C_2$ and $S_2V_3C_0$. The significantly lowest Stover yield was with $S_3V_2C_1$ (2522.62 kg ha^{-1}) which was statistically similar with $S_3V_2C_0$, $S_3V_1C_1$, $S_1V_1C_1$ and $S_3V_2C_2$.

Table 25 Interaction effect of sowing time, variety and inflorescence top-cutting on the Stover yield (kg ha^{-1}) of mustard

Treatments*	Stover Yield (kg ha^{-1})
S X V X C	
$S_1V_1C_0$	3048.81 a-c
$S_1V_1C_1$	2661.91 b-d
$S_1V_1C_2$	2785.71 a-d
$S_1V_2C_0$	3048.81 a-c
$S_1V_2C_1$	2847.62 a-d
$S_1V_2C_2$	2850.71 a-d
$S_1V_3C_0$	3017.86 a-c
$S_1V_3C_1$	2925.00 a-d
$S_1V_3C_2$	2793.45 a-d
$S_2V_1C_0$	2747.02 a-d
$S_2V_1C_1$	2863.09 a-d
$S_2V_1C_2$	2986.91 a-d
$S_2V_2C_0$	3172.62 a
$S_2V_2C_1$	2824.41 a-d
$S_2V_2C_2$	3172.62 a
$S_2V_3C_0$	2917.26 a-d
$S_2V_3C_1$	2863.09 a-d
$S_2V_3C_2$	3025.59 a-c
$S_3V_1C_0$	2708.34 a-d
$S_3V_1C_1$	2661.91 b-d
$S_3V_1C_2$	3116.91 ab
$S_3V_2C_0$	2569.05 cd
$S_3V_2C_1$	2522.62 d
$S_3V_2C_2$	2623.21 cd
$S_3V_3C_0$	2723.81 a-d
$S_3V_3C_1$	2762.50 a-d
$S_3V_3C_2$	2832.14 a-d
SE	**212.5**
CV	**8.38**

*S_1 = 01 November, S_2 = 15 November, S_3 = 30 November V_1 = Tori-7, V_2 = BARI Sarisha-9, V_3 = BARI Sarisha-15
C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut

4.16 Biological yield

4.16.1 Effect of sowing time

Effect of sowing time was insignificant on biological yield (sun dried) (Table 26). Though numerically highest biological yield was with S_1 (4385.78 kg ha^{-1}). The lowest biological yield was with S_3 (3950.34 kg ha^{-1}).

4.16.2 Effect of variety

Insignificant varietal effect was found on biological yield (Table 26).The highest biological yield was observed by V_2 (4295.84 kg ha^{-1}) and the lowest biological yield was with V_3 (4143.52 kg ha^{-1}).

4.16.3 Effect of inflorescence top-cutting

Effect of inflorescence top-cutting was significant on biological yield (Table 26).The significantly highest biological yield was with C_0 (4422.57 kg ha^{-1}).The biological yield of C_2 (4243.93 kg ha^{-1}) was statistically similar with C_0.The significantly lowest biological yield was with C_1 (4037.25 kg ha^{-1}).

Table 26 Effect of sowing time, variety and inflorescence top-cutting on the Biological yield (kg ha^{-1}) of mustard

Treatments*	**Biological Yield (kg ha^{-1})**
Sowing time	
S_1	4385.78 a
S_2	4367.64 a
S_3	3950.34 a
SE	**268.7**
CV	**21.43**
Variety	
V_1	4264.38 a
V_2	4295.84 a
V_3	4143.52 a
SE	**188.3**
CV	**21.43**
Cutting	
C_0	4422.57 a
C_1	4037.25 b
C_2	4243.93 a
SE	**110.8**
CV	**21.43**

*S_1 = 01 November, S_2 = 15 November, S_3 = 30 November V_1 = Tori-7, V_2 = BARI Sarisha-9, V_3 = BARI Sarisha-15
C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut

4.16.4 Interaction effect of sowing time and variety

Significant variation was observed for biological yield of mustard due to interaction effect of sowing time and variety (Table 27).The highest biological yield was with S_2V_2 (4550.00 kg ha^{-1}) and S_1V_2 (4471.07 kg ha^{-1}) which were statistically similar with S_1V_1 , S_2V_1, S_2V_3 and S_1V_3. The significantly lowest biological yield was with S_3V_2 (3866.47 kg ha^{-1}) which was statistically similar with S_3V_3 and S_3V_1.

4.16.5 Interaction effect of sowing time and inflorescence top-cutting

Interaction effect of sowing time and inflorescence top-cutting was significant on biological yield (Table 27). The significantly highest biological yield was with S_1C_0 (4726.19 kg ha^{-1}) which was identical with S_2C_0 and S_2C_2. The significantly lowest biological yield was with S_3C_1 (3831.83 kg ha^{-1}) which was identical with S_1C_1, S_2C_1, S_3C_0 and S_3C_2.The intermediate yield was with S_1C_2 (4257.92 kg ha^{-1}).

4.16.6 Interaction effect of variety and inflorescence top-cutting

Significant variation was observed for biological yield due to interaction effect of variety and inflorescence top-cutting (Table 27). The significantly highest biological yield was with V_2C_0 (4642.85 kg ha^{-1}) which was statistically similar with V_1C_0 and V_1C_2. The significantly lowest biological yield was with V_3C_1 (4095.08 kg ha^{-1}), V_2C_1 (3995.44 kg ha^{-1}), V_1C_1 (4021.23 kg ha^{-1}), V_3C_2 (4100.73 kg ha^{-1}) and V_3C_0 (4234.77 kg ha^{-1}) and V_2C_2 (4249.25 kg ha^{-1}).

Table 27 Interaction effect of sowing time, variety and inflorescence top-cutting on the Biological yield (kg ha^{-1}) of mustard

Treatments*	Biological Yield (kg ha^{-1})
S X V	
S_1V_1	4413.29 ab
S_1V_2	4471.07 a
S_1V_3	4272.98 a-c
S_2V_1	4323.01 a-c
S_2V_2	4550.00 a
S_2V_3	4229.89 a-d
S_3V_1	4056.83 b-d
S_3V_2	3866.47 d
S_3V_3	3927.70 cd
SE	**192.0**
CV	**15.02**
S X C	
S_1C_0	4726.19 a
S_1C_1	4173.24 c-e
S_1C_2	4257.92 b-d
S_2C_0	4585.87 ab
S_2C_1	4106.67 c-e
S_2C_2	4410.35 a-c
S_3C_0	3955.64 de
S_3C_1	3831.83 e
S_3C_2	4063.53 c-e
SE	**192.0**
CV	**15.02**
V X C	
V_1C_0	4390.08 ab
V_1C_1	4021.23 b
V_1C_2	4381.83 ab
V_2C_0	4642.85 a
V_2C_1	3995.44 b
V_2C_2	4249.25 b
V_3C_0	4234.77 b
V_3C_1	4095.08 b
V_3C_2	4100.73 b
SE	**192.0**
CV	**15.02**

*S_1 = 01 November, S_2 = 15 November, S_3 = 30 November V_1 = Tori-7, V_2 = BARI Sarisha-9, V_3 = BARI Sarisha-15
C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut

4.16.7 Interaction effect of sowing time, variety and inflorescence top-cutting

Interaction effect of sowing time, variety and inflorescence top-cutting was significant on biological yield (Table 28). The significantly highest biological yield was with $S_2V_2C_0$ (5014.28 kg ha^{-1}) which was identical with $S_1V_2C_0$, $S_1V_1C_0$, $S_2V_1C_0$, $S_2V_1C_2$, $S_2V_2C_2$, $S_2V_3C_0$, $S_3V_1C_2$, $S_1V_2C_2$ and $S_1V_3C_0$. The significantly lowest biological was with $S_3V_2C_1$ (3760.72 kg ha^{-1}), $S_3V_2C_2$ (3783.93 kg ha^{-1}) and $S_3V_3C_0$ (3865.72 kg ha^{-1}) which were statistically similar with $S_3V_1C_1$, $S_3V_1C_0$, $S_3V_2C_0$, $S_3V_3C_1$, $S_3V_3C_2$, $S_2V_3C_2$, $S_1V_3C_1$, $S_1V_2C_1$, $S_1V_1C_1$, $S_1V_1C_2$, $S_1V_2C_2$, $S_2V_1C_1$, $S_2V_2C_1$ and $S_2V_3C_1$.

Table 28 Interaction effect of sowing time, variety and inflorescence top-cutting on the Biological yield (kg ha^{-1}) of mustard

Treatments*	**Biological Yield (kg ha^{-1})**
S X V X C	
$S_1V_1C_0$	4890.48 ab
$S_1V_1C_1$	4093.45 de
$S_1V_1C_2$	4255.95 b-e
$S_1V_2C_0$	4859.52 a-c
$S_1V_2C_1$	4240.48 b-e
$S_1V_2C_2$	4313.21 a-e
$S_1V_3C_0$	4428.57 a-e
$S_1V_3C_1$	4185.80 b-e
$S_1V_3C_2$	4204.57 b-e
$S_2V_1C_0$	4333.34 a-e
$S_2V_1C_1$	4178.57 b-e
$S_2V_1C_2$	4457.14 a-e
$S_2V_2C_0$	5014.28 a
$S_2V_2C_1$	3985.12 de
$S_2V_2C_2$	4650.59 a-d
$S_2V_3C_0$	4410.00 a-e
$S_2V_3C_1$	4156.33 b-e
$S_2V_3C_2$	4123.32 c-e
$S_3V_1C_0$	3946.43 de
$S_3V_1C_1$	3791.67 e
$S_3V_1C_2$	4432.38 a-e
$S_3V_2C_0$	4054.76 de
$S_3V_2C_1$	3760.72 e
$S_3V_2C_2$	3783.93 e
$S_3V_3C_0$	3865.72 e
$S_3V_3C_1$	3943.10 de
$S_3V_3C_2$	3974.29 de
SE	**332.5**
CV	**8.84**

*S_1 = 01 November, S_2 = 15 November, S_3 = 30 November V_1 = Tori-7, V_2 = BARI Sarisha-9, V_3 = BARI Sarisha-15
C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut

4.17 Harvest Index (%)

4.17.1 Effect of sowing time

Effect of sowing time was significant on harvest index (Table 29). The significantly highest harvest index was with S_2 (35.87 %). The harvest index of S_3 (31.25 %) was significantly lower than that of S_2. The significantly lowest harvest index was with S_1 (30.53 %). The results are agreed with those of Hossen (2005) who reported that a reduction in harvest index in early and delay sowing.

4.17.2 Effect of variety

Insignificant varietal effect was found on harvest index (Table 29). The numerically highest harvest index was showed by V_2 (33.71 %) and lowest harvest index was with V_3 (30.65 %). The results are agreed with those of Islam et al. (1999) who observed that the harvest index varied markedly among varieties of different plant type of mustard. Mendham *et al.* (1981) stated that a low harvest index of rapeseed might be due to excessive pod and seed losses during flowering.

4.17.3 Effect of inflorescence top-cutting

Effect of inflorescence top-cutting was also significant on harvest index (Table 29). The significantly highest harvest index was with C_0 (34.79 %). The harvest index of C_1 (31.38 %) and that of C_2 (31.44 %) were statistically same and significantly lower than that of C_0.

Table 29 Effect of sowing time, variety and inflorescence top-cutting on the Harvest Index (%) of mustard

Treatments*	**Harvest Index (%)**
Sowing time	
S_1	30.53 b
S_2	35.87 a
S_3	31.25 ab
SE	**0.73**
CV (%)	**11.67**
Variety	
V_1	33.35 a
V_2	33.71 a
V_3	30.65 a
SE	**1.07**
CV (%)	**11.67**
Cutting	
$\mathbf{C_0}$	34.79 a
$\mathbf{C_1}$	31.38 b
$\mathbf{C_2}$	31.44 b
SE	**0.59**
CV (%)	**11.67**

*S_1 = 01 Nove ber, S_2 = 15 November, S_3 = 30 November V_1 = Tori-7, V_2 = BARI Sarisha-9, V_3 = BARI Sarisha-15
C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut

4.17.4 Interaction effect of sowing time and variety

Significant variation was observed for harvest index of mustard due to interaction effect of sowing time and variety (Table 30).The significantly highest harvest index was with S_2V_3 (36.53%) and lowest harvest index was with S_1V_3 (25.72 %).

4.17.5 Interaction effect of sowing time and inflorescence top-cutting

Interaction effect of sowing time and inflorescence top-cutting was significant on harvest index (Table 30). The significantly highest harvest index was with S_2C_0 (40.27 %) and S_2C_1 (36.14 %) which were identical with S_1C_0, S_2C_2, S_3C_1, S_3C_2 and S_3C_0.The significantly lowest harvest index was with S_1C_1 (27.86 %).

4.17.6 Interaction effect of variety and inflorescence top-cutting

Significant variation was observed for harvest index due to interaction effect of variety and inflorescence top-cutting (Table 30). The significantly highest harvest index was with V_2C_0 (36.89 %) which was statistically similar with V_1C_0 (35.43%). The significantly lowest harvest index was with V_3C_2 (29.67 %), V_3C_1 (30.40 %) and V_3C_0 (31.85 %) which were statistically similar with V_1C_1, V_1C_2 and V_2C_2.

Table 30 Interaction effect of sowing time, variety and inflorescence top-cutting on the Harvest Index (%) of mustard

Treatments*	Harvest Index (%)
S X V	
S_1V_1	33.08 a
S_1V_2	32.59 a
S_1V_3	25.72 b
S_2V_1	36.40 a
S_2V_2	34.76 a
S_2V_3	36.53 a
S_3V_1	30.39 ab
S_3V_2	33.76 a
S_3V_3	29.69 ab
SE	**1.86**
CV (%)	**17.18**
S X C	
S_1C_0	31.87 ab
S_1C_1	27.86 b
S_1C_2	31.80 ab
S_2C_0	40.27 a
S_2C_1	36.14 a
S_2C_2	31.04 ab
S_3C_0	31.94 ab
S_3C_1	30.30 ab
S_3C_2	31.48 ab
SE	**1.03**
CV (%)	**17.18**
V X C	
V_1C_0	35.43 ab
V_1C_1	32.13 bc
V_1C_2	32.38 bc
V_2C_0	36.89 a
V_2C_1	31.63 c
V_2C_2	32.17 bc
V_3C_0	31.85 c
V_3C_1	30.40 c
V_3C_2	29.67 c
SE	**1.03**
CV (%)	**17.18**

*S_1 = 01 November, S_2 = 15 November, S_3 = 30 November V_1 = Tori-7, V_2 = BARI Sarisha-9, V_3 = BARI Sarisha-15
C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut

4.17.7 Interaction effect of sowing time, variety and inflorescence top-cutting

Interaction effect of sowing time, variety and inflorescence top-cutting was significant on harvest index (Table 31). The significantly highest harvest index was with $S_2V_1C_0$ (41.97 %) which was identical with $S_3V_2C_0$, $S_1V_2C_0$, $S_2V_2C_0$, $S_3V_2C_1$, $S_2V_3C_1$, $S_2V_3C_2$, $S_1V_1C_2$, $S_1V_2C_2$, $S_2V_1C_1$, $S_2V_2C_1$, $S_1V_1C_0$, $S_2V_1C_2$ and $S_2V_3C_0$. The significantly lowest harvest index was with $S_1V_3C_2$ (25.03 %) which was statistically similar with $S_1V_1C_1$, $S_1V_2C_1$, $S_3V_1C_2$, $S_3V_1C_0$, $S_1V_3C_0$, $S_2V_2C_2$, $S_3V_3C_0$, $S_3V_1C_1$, $S_3V_1C_2$, $S_3V_3C_1$, $S_3V_3C_2$, $S_3V_3C_0$ and $S_1V_3C_1$.

Table 31 Interaction effect of sowing time, variety and inflorescence top-cutting on the Harvest Index (%) of mustard

Treatments*	Harvest Index (%)
S X V X C	
$S_1V_1C_0$	32.59 a-e
$S_1V_1C_1$	30.25 b-f
$S_1V_1C_2$	36.36 a-c
$S_1V_2C_0$	36.62 a-c
$S_1V_2C_1$	26.64 d-f
$S_1V_2C_2$	33.91 a-e
$S_1V_3C_0$	25.82 ef
$S_1V_3C_1$	26.34 d-f
$S_1V_3C_2$	25.03 f
$S_2V_1C_0$	41.97 a
$S_2V_1C_1$	36.10 a-c
$S_2V_1C_2$	31.25 a-e
$S_2V_2C_0$	39.81 ab
$S_2V_2C_1$	36.89 a-c
$S_2V_2C_2$	27.45 d-f
$S_2V_3C_0$	39.13 ab
$S_2V_3C_1$	35.41 a-d
$S_2V_3C_2$	34.87 a-e
$S_3V_1C_0$	31.77 b-f
$S_3V_1C_1$	29.79 e-f
$S_3V_1C_2$	29.68 c-f
$S_3V_2C_0$	33.58 a-e
$S_3V_2C_1$	31.68 a-f
$S_3V_2C_2$	35.99 a-d
$S_3V_3C_0$	30.43 b-f
$S_3V_3C_1$	29.44 c-f
$S_3V_3C_2$	29.21 c-f
SE	**1.79**
CV (%)	**9.56**

*S_1 = 01 November, S_2 = 15 November, S_3 = 30 November V_1 = Tori-7, V_2 = BARI Sarisha-9, V_3 = BARI Sarisha-15
C_0 = Control, C_1 = First cut (40 days after sowing), C_2 = 7 days after first cut

CHAPTER V

SUMMARY

The study was carried out to find out the effect of inflorescence-top cutting and sowing time for optimum yield of mustard varieties. The results are summarized below.

The 15 November sowing S_2 (109.61 cm) only produced the tallest plant. The maximum plant height was found from the treatment combination S_2V_1 (113.03 cm) and S_2V_2 (112.11cm). The significantly highest number of inflorescence both primary and secondary was produced by S1 (9.73) and S2 (9.11). The highest number of primary inflorescence was produced by the treatment combination S_1C_2 (10.26), V_1C_2 (9.81) and $S_1V_1C_2$ (12.00). S_2C_1 (7.14) and V_1C_1 (7.96) also produced highest number of secondary inflorescence. Treatment S_1 (15.32) and S_2 (15.87) gave the highest number of sterile siliqua. V_1 (200.56) gave the highest number of filled siliqua and V_2 (17.93, 15.06) gave the highest number of unfilled and sterile siliqua. Treatment combination S_2V_2 (229.48), S_1C_1 (192.70), S_1C_2 (191.44), V_1C_2 (216.07) and $S_2V_1C_1$ (254.11) gave the the highest number of filled siliqua. $S_1V_1C_0$ and $S_3V_1C_2$ (both 26.66) gave the highest number of unfilled siliqua and $S_1V_1C_1$ (26.55) gave the highest number of sterile siliqua.

Fresh weight was greatly influenced by cutting. S_2 produced the highest fresh weight of siliqua at the bottom of the inflorescence and S1 produced the highest fresh weight of siliqua at the top of the inflorescence. V_3 produced highest fresh weight in all position of the inflorescence. C_1 produced highest fresh weight at all top, mid and bottom position of the siliqua. In case of interaction effect the treatment combination S_2V_3, S_3V_3, $S_3V_3C_2$ and $S_3V_3C_1$ give the highest fresh weight of siliqua at the bottom of the inflorescence. S_1C_1, S_2C_1, S_2C_2, $S_2V_3C_1$, $S_1V_3C_1$ and $S_1V_3C_2$ gave the highest fresh weight of siliqua at the top of the inflorescence. $S_3V_3C_1$ gave the highest fresh weight of siliqua at the mid of the inflorescence.

Sowing time had significant effect on dry weight of chaff. S_2 gave the highest dry weight of chaff. Cutting showed significant effect. The treatment combination S_2C_2, V_1C_2 and S_2V_1 gave highest dry weight of chaff. The highest dry weight of chaff also obtained from $S_2V_1C_1$ and $S_2V_1C_2$.

The highest dry weight of seed was obtained from S_1, S_2, V_1, V_2, C_1 and C_2. In case of interaction effect the treatment combination S_1V_1, S_1C_2, V_1C_1, V_1C_2, $S_1V_1C_1$, $S_1V_1C_2$ and $S_2V_1C_1$ gave the highest dry weight of seed.

The highest dry weight of stem obtained from S_1, S_2, C_1 and C_2. In case of interaction effect the treatment combination S_2C_1, S_2C_2, V_1C_1, $S_2V_1C_1$, $S_2V_1C_2$ and $S_2V_2C_2$ gave the highest dry weight of stem.

The highest dry weight of inflorescence without siliqua was found in S_2 and V_1. In case of interaction effect the treatment combination S_2V_1, S_2C_0, S_2C_2 and $S_2V_1C_2$.

Above ground dry weight varied at all stages with different sowing times, varieties and cutting times. The highest above ground dry weight of plant was obtained from S_2, V_1, V_2, C_1 and C_2. The treatment combination S_2V_1, S_2C_2, $S_2V_1C_1$ and $S_2V_1C_2$ gave the highest above ground dry weight.

Cutting showed significant effect on thousand seed weight. The highest thousand seed weight was obtained from C_1 and C_2. In case of interaction treatment combination $S_2V_1C_2$ gave the highest result.

The highest fresh weight of flower was found in C_1. In case of interaction treatment combination S_1V_2, S_1C_1, S_2C_1, V_1C_1, V_2C_1, $S_2V_1C_1$ and $S_2V_2C_1$ gave the highest fresh weight of flower. The highest dry weight of flower was found in C_1. Treatment combination S_2V_1, S_3V_2, S_1C_1, S_2C_1, S_3C_2 and $S_2V_1C_1$ gave the highest dry weight of inflorescence.
Seed yield plant $^{-1}$ is a complex character which depends on the different yield contributing characters. Treatment S_2 (2410 kg ha^{-1}), V_2 (2228 kg ha^{-1}) and C_0 (2367 kg ha^{-1}) gave the highest seed yield. In case of interaction treatment combination S_2V_1, S_2V_2, S_2V_3, S_2C_0, V_2C_0, $S_2V_2C_0$, $S_1V_2C_0$, $S_2V_1C_0$ and $S_2V_3C_0$.

Treatment C_2 gave the highest Stover yield. In case of interaction $S_2V_2C_0$ and $S_2V_2C_2$ gave the highest Stover yield. The highest biological yield was obtained from C_0 (6803 kg ha^{-1}). Among the treatment combination S_2V_2, S_1C_0, V_2C_0 and $S_2V_2C_0$ gave the highest result.

The treatment S_1 and C_0 gave the highest harvest index. Treatment combination V_2C_0 and $S_1V_1C_0$ produced highest harvest index.

CHAPTER VI

CONCLUSION

Mustard is a cold season crop and one of the most important oil seed crop. Time of sowing is very important for growth and development of a crop. In mustard there are some varieties which produce a long inflorescence but cannot convert all its flowers especially at the top; and stop pod formation after reaching its potentials. As a result the remaining flower along with the pedicel remains for a while on the inflorescence and uses some portion of the current photosynthate and shed either after blossom or being unbloomed. These flowers certainly used some portions of post flowering photosynthate which ultimately get lost. If the non potential portion of the inflorescence is removed for edible purposes before using some extra photosynthate while on the inflorescence stalk, some portion of the photosynthates could the saved which would translocate downwards to supplying some extra photosynthate to the developing siliquas. This extra supply of photosynthate would be helpful to increase the weight of the grains and intern incrase the yield of mustard.

The present study was undertaken to find out the effect of inflorescence-top cutting of mustard genotypes under varying sowing times on the yield and yield attributes of mustard. The research was conducted at the Agronomy field of Sher-e-Bangla Agricultural University, Dhaka-1207, during the period from November 2011 to February 2012. Treatments were three sowing times viz. S_1 (01 November), S_2 (15 November) and S_3 (30 November), three varieties viz. V_1 (Tori-7), V_2 (BARI Sarisha-9) and V_3 (BARI Sarisha-15) and three cutting times viz. C_0 (control), C_1 (first cut) and C_2 (second cut).

The maximum plant height was found from the treatment combination S_2V_1 (113.03 cm). The highest number of primary and secondary inflorescence was produced by the treatment combination S_1C_2 and $V_1C_{1.}$ $S_2V_1C_1$ (254.11) gave the the highest number of filled siliqua. $S_1V_1C_0$ and $S_3V_1C_2$ (both 26.66) gave the highest number of unfilled siliqua and $S_1V_1C_1$ (26.55) gave the highest number of sterile siliqua. $S_3V_3C_2$ gave the highest fresh weight of siliqua at the bottom of the inflorescence. The highest dry weight of chaff, seed, stem and inflorescence were obtained from $S_2V_1C_2$, $S_2V_1C_1$, $S_2V_1C_1$ and $S_2V_1C_2$

respectively. $S_2V_1C_2$ gave the highest above ground dry weight per plant. Treatment combination $S_2V_1C_2$ gave the highest thousand seed weight. $S_2V_1C_1$ gave the highest fresh weight and dry weight of flower. $S_2V_2C_0$ gave the highest Seed yield, Stover yield and Biological yield per hectare. $S_1V_1C_0$ produced highest harvest index.

Although cutting treatment did not show yield increase, some of the cutting treatments in combination with the variety or sowing time showed high values in number of inflorescence, number of siliqua and 1000 seed weight. Chaff weight also increased due to inflorescence cutting indicating that photosynthate saves did not transport towards grain. So, further investigation is suggested involving earlier inflorescence cutting.

REFERENCE

Afroz, M. M., Sarkar, M. A. R., Bhuiya, M. S. U. and Roy, A. K. (2011). Effect of sowing date and seed rate on yield performance of two mustard varieties. *J. Bangladesh Agril. Univ*. **9**(1): 5-8.

Ahmed, F., Karim, M. R. and Rahman, M. A. (1999). Effect of different management practices on the productivity and profitability of mustard under late sowing condition. *Bangladesh J. Agril. Res.***211**(3):425-430.

Alados, L. C., Barroso, G. F. and Garcia, L. (1997). Effect of early season defoliation on above ground growth of *anthyllis cytosides* a Mediterranean browse species. *Journal of Arid Environments*. **37:**269-283.

Ali, M. H. and Rahman, M. A. (1998). Response of nitrogen in TS-72 (Kalyania) cultivar of *Brassica campestris. Bangladesh J. Agric.* **11**(3):83-86.

Ali, M. H. and Ullah, M. J. (1995). Effect of different levels and methods of nitrogen application on growth and yield of rapeseed (Brassica campestris L.) *Ann. Bangladesh j. Agric.* **5**(2):115-120

Ali, N., Shah, S. A. H. and Rashid, A. (1985). Effect of sowing dates on seed yield and yield components of Prorbi Raya. *Pakistan J. Agric. Res*. **6**: 97-100.

Andrahcnnadi, C. P., Wecrasena, L. A. and Abetyratne, M. D. R. S. (1991). Evaluation of brown mustard germplasm in Srilanka. *Cruciferae Newsl.* **14-15**:62-63.

Angrej, S., Dhingra, K. K., Jagroop, S., Singh. M. P. , Singh, J. and Singh , A. (2002) . Effect of sowing time and plant density on growth , yield and quality of Ethiopian mustard (Brassica carinata A. Br.) . *J. Res. Punjab Agril. Uni*. **39**(4): 471-475.

Ansari, A. H. , Qayyum , S. M. , Mirza, A. A. and N. A. Choudhury. (1990) . Effect of different sowing dates on the growth and yield of three varieties of mustard. *Pakistan J. Agric. Res*. **11**(4):234-348.

Aziz, M. A. (2009). Effect of date of sowing on the yield of mustard in the hilly areas. In: Dessemination of Technology Developed. Bangladesh Agricultural Research Council. Farmghate, Dhaka, Bangladesh.

Bali, A. S., Singh, T., Shah, M. H., Singh, K. N. and Nehvi, F. A. (1992). Response of Indian mustard (*Brassica juncea*) to sowing date and fertilizer application. *Indian J. Agric. Sci.* **62**(10):690-691.

BARI (2000). Annual report 1999-2000. Oilseed Research Centre. Bangladesh Agricultural Research Institute. Joydebpur, Gazipur.

BARI (2001). Annual report 2000-2001. Oilseed Research Centre. Bangladesh Agricultural Research Institute. Joydebpur, Gazipur.

BARI (2002). Annual report 2001-2002. Oilseed Research Centre. Bangladesh Agricultural Research Institute. Joydebpur, Gazipur.

BARI. (1992).Annual Report 1992-1993. Bangladesh Agricultural Research Institute, Joydebpur , Gazipur,pp. 231-298.

BBS. (2004). Monthly Statistical Bulletin of Bangladesh of Bureau Statistics (BBS) Statistics Division, Ministry of Planning, Government of People's Republic of Bangladesh

BBS. (2009). Monthly Statistical Bulletin of Bangladesh of Bureau Statistics (BBS) Statistics Division, Ministry of Planning, Government of People's Republic of Bangladesh.

BBS. (2012). Monthly Statistical Bulletin of Bangladesh of Bureau Statistics (BBS) Statistics Division, Ministry of Planning, Government of People's Republic of Bangladesh.

Beech, D.F. and Norman, M. J. T. (1964).The effect of time of planting and nitrogen fertilizer on yield attributes of Brassica oilseeds crops in the Ord river Valley, *Aust. J. Exptl. Agrivc and Ani. Hus* . **4**: 207-214

Begum, F., Hossain, F. and Mondal, M.R.I. (2012).Influence of Sulphur on morpho-physiological and yield parameters of rapeseed. *Bangladsh J. Agril. Res.* **37**(4): 645-652.

Bhagat, D. V. and Singh, S. (1989). Effect of sowing dates and varieties on seed quality, yield and aphid infestation of mustard. Bharatiya Krishi Anushandhana Patrika. **4:**4, 179-183.

Bishnoi, K. C. and Singh, K. (1979). Oil yield and quality parameters of three raya varieties as affected by sowing time and nitrogen levels. *Indian J. Agron.* **24:** 255-263.

Biswas, K. P. (1989).Performance evaluation of 18 genotypes of oleiferous Brassica. Proceeding of the 14th Annual Bangladesh Sci. Conf.p.70.

Biswas, K. P. and Zaman, M. W. (1990). 'Nap-3' a new genotype of rapeseed. Extended synopsis. 15th Bangladesh science conference. 5-8 March. BAAS. Atomic energy research establishment. Savar, Dhaka.

Brar, Z. S. , Bal, D. S. and John, A. S. (1998). Influence of sowing dates , nitrogen and planting geometry on the performance of Gobhi sarson (*Brassica napus* spp. *Olefera* var. annua). *Indian J. Agron.* **43**(1):133-137.

Bukhtiar, B. A. , Atta, M. and Habib, G. (1992). Effect of sowing dates on seed yield of rapeseed and mustard under rainfed condition. *J. Agric Res*. **3**. (4): 463-469.

Buttar, G. S. and Aulakh , C. S. (1999) . Effect of sowing date, nitrogen and row spacing on growth, yield attributes and yield of Indian mustard (*Brassica juncea*). *Indian J. Agron*. **44**(4):813-815.

Buwalda, J. G. and Smith. G. S. (1990). Effect of partial defoliation at various stages of the growing season on fruit yields, root growth, and return bloom of kiwifruit vines. *Scientia Hort.* **42**:29–44.

Byoung-Jae, PARK, Ju-Kyoung, LEE, Ki-Cheol, LEE, Kwang-Jin, CHANG, Sun-Lim, KIM and Cheol-Ho, PARK. (2003). Effects of fertilization and inflorescence removal on photosynthesis and hay yield of buckwheat. Fagopyrum. **20**: 43—46.

Campbell. D. C. and Kondra, Z. P. (1978). Relationship among growth patterns, yield components and yield of rapeseed, *Can.J.Plant Sci*. **58**:87-93.

Chakraborty, P. K., Majumder, A. and Chatterjee, B. N. (1991). Physiological process in Indian mustard (*Brassica juncea*) and Yellow sarson (*Brassica napus* var. glauca) and their their agronomic appraisal in mild and short winter prevailing in Gangetic Plains of Eastern India. *Indian J. Agril. Sci.* **61**(11): 851-861.

Chaterjee, B. N. , Ghosh, R. K. and Chakraborty. (1985). Response of mustard to sulphur and micronutrient . *Indian J. Agron.* **30** (1):75-80.

Chaudhary, A. K. and Sharma, J. C. (1986). Sulphur for better yield of mustard. *Indian Fmg.* **35**(11):12.

Chauhan, Y. S. and Bhargava, S. C. (1984). Physiological analysis of growth and yield variation, of rapeseed and mustard. *J. Agric. Sci*. Camb. **103**:249-252.

Chay, P. and Thurling , N. (1989). Variation in pod length in spring rape (Brassica napus) and its effect on seed yield components. *J. Agric. Sci.* Camb. **113**: 139-147.

Cheema, M. A., Malik, M. A., Hossain A., Shah. S. H. and Basra, S. M. A. (2001). Effects of time and rate of nitrogen and Phosphorus application on the growth and the seed and oil yields of canola (*Brassica napus* L.). *J. Agron. Crop Sci*. **186**: 103-110.

Choudhary, J. K. and Thakuria, R. K. (1994). Response of Indian mustard (*Brassica juncea*) and toria (*Brassica campestris subsp. Olifera var. toria*) to sowing date under rainfed condition. *Indian J. Agron.* **39**(4): 687-688.

Clifford, P. E., Neo, H. H. and Hew, C. S. (1995). Regulation of assimilate partitioning In: Flowering Plants of the Monopodial Orchid Aranda Noorah Alsagoff (pp. 381-389)

Degenhardt, D. F. and Kondra, Z. P. (1981). The influence of seeding date and seeding rate on seed yield and growth characters of five genotypes of Brassica napus . *Can. J. Plant Sci*. **61**:185-190.

Downton, W. J. S., Grant, W. J. R. and Loveys, B. R. (1987). Diurnal changes in the photosynthesis of field-grown grape vines. *New Phytol.* **105**:71–80.

Dudhade, D. D., Gare, B. N., Khade, K. K. and Ramshe, D. G. (1996). Effect of sowing date on growth, yield attributes and yield of Indian mustard (*Brassica juncea*). *Indian J. Agron.* **41**(3):445-447.

FAO (1998). Production year book. Food and Agriculture Organization of the United Nations. Roome 00100. Italy. P.113.

FAO. (2003). Production Year Book. Food and Agricultural Organization of The United Nations. Rome 00100. Italy. (57):122.

FAO. (2004). FAOSTAT database of Agriculture (Crops). http://www.fao.org.

Gaffer, M. A., Mohammad, H. (1988). Effect of different seed rates at different management levels on the performance of mustard. *Bangladesh J. Sci. Inds. Res.* **23** (1-4): 62-66).

Gangasaran. Patil. R. R. and Prasad, M. (1981). Multiple regression studies on brown sarson . *Indian J. Agron*. **26**:220-226.

Gfadakar, S. R., Morey, D. K. and Zilpe, Y. P. (1988). Effect of transplanting date on dry matter, yield and accumulation of photothermal units in rice (*Oryza sativa*) at Nagput. *Indian J. Agric. Sci*. **58**(5):339-341.

Ghosh, R. K. and Chaterjee, B. N. (1988). Effect of dates of sowing on oil content and fatty acid profiles of Indian mustard. *Indian J. Oilseed Res.* **5**(2):144-149.

Ghosh, R. K. and Chatterjee, B. N. (1988a). Effect of dates of sowing on oil content and fatty acid profiles on Indian mustard . *Indian J. Oilseed Res*. **5**(2): 144-149.

Ghosh, R. K. and Chatterjee, B. N. (1988b). Contribution of primary branches to grain yield of Indian mustard (*Brassica juncea* L.) *Acta. Agric. Scan.* **38**(1): 49-57.

Halbrecq, B. and Ledent, J. F. (2001).Evolution of flowering and ripening within inflorescences of buckwheat plants, effect of defoliation and sowing date Proc.8th IntI. Symp. Buckwheat at Chunchon :143-152.

Halva, S., Hirvi, T., Makinen, S. and Honkanen, E. (1986).Yield and glucosolates in mustard seeds and volatile oils in caraway seeds and coriander fruit. 1 .Yield and glucosinolate contents of mustard seeds. *J. Agril. Sci*. **58** (4): 157-162.

Hicks, D. R., Nelson, W. W. and Ford. J. H. (1977). Defoliation effects on corn hybrids adapted to the northern Corn Belt. *Agron. J*. **69**:387-390.

Hong, E. H., Park, E. H. and Chin, M. S. (1987). Alterationof vegetative and agronomic attributes of soybeans by terminal bud removal. *Korean J.Crop Sci*.**32**:431-35.

Hortensteiner, S. and Feller U. (2002). Nitrogen metabolism and remobilization during senescence. *J. Exp. Bot*. **53**: 927–937.

Hossain, M. A., Arabinda, S. and Abedin , M. J. (1984). Effect of seed rate and time of sowing on the yield of mustard under rainfed condition . *Bangladesh J. Agric. Res.***9**:54-57.

Hossen, M. A. (2005). Effect of sowing date on yield and yield components of rapeseed varieties. M.S.Thesis, Department of Agronomy. Sher-e-Bangla Agricultural University. Dhaka -1207.

Hussain, M. F., Zakaria, A. K. M.and Jahan, M. H. (1996). Technical report on variety screening, Adaptive research on oil seeds. Rural Development Academy, Bogra, Bangladesh, pp. 6-13

Hussain, S. Hazarika. G. N. and Bania, P. K. (1998). Genetic Variability, Heritability and genetic advance in Indian rapeseed (*Brassica campestris* L.) and mustard (*Brassica juncea*, Czern and Coss). *J. Agril. Sci*. North East India. **11**(2):260-261.

Iglesias, D. J., Lliso, I. Tadeo, F. R. and Talon, M. (2002). Regulation of photosynthesis through source:sink imbalance in citrus is mediated by carbohydrate content in leaves. *Physiol. Plant.* **116**:563–572.

Islam, N. and Razzaque, A. S. M. A. (1999). Accommodating mustard in the transplant aman rice mustard cropping pattern. I. Selection of mustard varieties to late sowing. Bangladesh Agricultural University Res. Prog. **10**:58.

Islam, N., Choudhury, M. and Karim, M. R. (1994). Effects of sowing date on growth and developmentof mustard and rapes . *Progress. Agric*. **59**:23-29.

Jadhav, S. N. and Singh, N. P. (1993). Effect of sowing date, insect pest-control measures and irrigation on oil content, seed and oil yields in mustard (*Brassica juncea*). *Indian J. Agron.* **38**(1):139-141.

Jahan, M. H., and Zakaria, A. K. M. (1997). Growth and yield performance of different varieties of rapeseed, mustard and canola IN Level Barind Tract. *Progress Agric.* **8**(1&2):144-152.

Jain, A. K., Tiwari, A. S. and Kushwah, V. S. (1988). Genetics of quantitative traits in Indian mustard. *Indian J. Gen. Plant Breed*. **48**(2):117-119.

Jain, V. K., Chauhan, Y. S. Khandekar, M. P. (1989). Effect of sowing dates and genotypes on yield and yield attributing traits in Indian mustard. *Madras Agril. J.* **76**(5):241-246.

Jansky, S. H. and Thomson, D. M. (2009). The effect of flower removal on potato tuber yield. *Can. J. Plant Sci*. **70**: 1223-1225.

Joshi, M. L., Ahuja, B. D. and Mathur, B. N. (1989). Loss in seed yield by insect pests and their occurrence on different dates of sowing in Indian mustard. (*B. juncea* sub sp. *juncea*) *Indian J. Agric. Sci.* **59**(3):166-168.

Kalra, A. A. (1983). Effect of sowing date on yield , aphid infestation on seed yield and its component traits in Indian mustard (*Brassica juncea* L.) . *Agric. Digest*. **3**(3/4): 177-178.

Kalra, U. K. , Yadava, T. P. and Bhola , A. L. (1985). Effect of sowing date, notrogen and row spacing on growyh , yield attibutes and yield of Indian mustard. Agricultural Science Digest (India) (3-4) : 177-178.

Kandil, A. A. (1983). Efect of sowing date on yield, yield components and some agronomic characters of oilseed rapes (Brassica napus L.) . In : 6th Intl. Rapeseed Conf. Paris , France, p.297.

Karim, M. R., Islam, F., Alumed. F. and Islam. M. R. (2000). Performance of some B. juncea varieties under on fame condition at Pabna. *Bangladesh J. Agril. Sci*. **27**(1): 157-158.

Khaleque, M. A. (1985). Rape and mustard. A guide Book on production of oil crops in Bangladesh, Dept. Agric. Ext., Ministry of Agriculture, Government of Peoples Republic of Bangladesh, Dhaka. Pp. (16-29).

Khan, N. A., Singh, S. Nazar, R. and Lone, P. M. (2007). The source-sink relationship in mustard. *Aust. J. Plant Sci.* **1**: 10-18.

Kolsarici, O. and Er, C. (1988). Investigation of the most suitable sowing time, variety and plant density in rape cultuivar in Amasaya. Doga, Turk Tarim vc Ormancilik Dergici, 12 (2): 161-177.

Kreft, 1. (1986). Physiology of buckwheat yield. Proc. 3rd IntI. Symp. Buckwheat at Pulawy, Part I: 37-51.

Krishi Dairy (2013). Agriculture Information Service (AIS), Department of Agriculture Extension, Khamarbari, Dhaka-1215. pp. 17-25.

Kudla, M. (1993). Comparative analysis of winter swede rape genotypes. *Biuletyn Instytutu Hodowlo Roslin*. **190**: 99-107.

Kumar, A. and Gangwar, K. S. (1985) . Analysis of growth development and yield of Indian rape seed (*Brassica campestris* var. toria) in relation to nitrogen and plant density. *Indian J. Agron.* **30**(3): 358-363.

Kumar, V. and Singh, D. (1994). Genetics of yields and its components Indian mustard (*B. juncea* L. Czern and Coss). *Crop Res.* **7**(2): 243-246.

Lebowitz, R. J. (1989). Image analysis Measurements and repeatedly estimates of pod morphology traits in *Brassica campestris* L. *Euphytica* **43**(1-2):113-116.

Li, W. D., Li, S. H., Yang, S. H., Yang, J. M., Zheng, X. B., Li, X. D. and Yao. H. M. (2005). Photosynthesis in responses to sink–source manipulations during different phenological stages of fruit development inpeach trees: Regulation by stomatal aperture and leaf temperature. *J. Hort. Sci. Biotechnol*. **80**:481–487.

Lutman, P. J. W. and Dixon, F. L. (1987). The effect of drilling date on the growth and yield of oilseed rape (*Brassica napus* L.). *J. Agric. Sci. Camb*. **108**:195-200.

Maini, N. S., Sandhu, I. J. S. and Johal, K. S. (1964). Effect of sowing date, spacing irrigation and nitrogen levels on the grain yield of toria (*Brassica campestris*). *Indian Oilseed J.* **8**:128-132.

Majumder, D. K. and Sandhu, A. S. (1964). Effect of time of sowing and fertilizers on the growth, development, quality characteristics and chemical composition of rapeseed (*Brassica campestris* var. Brown Sarson). *Indian Oilseed J.* **8**: 269-276.

Malik, R. S. (1989). Seed yield and oil contents of cultivated species of Brassica in relation to aphid and white rust infestation. *Ann. Agric. Res.* **10**(2): 178-181.

Masood, T., Giani, M. M. and khan, F. A. (1999). Path analysis of the major yield and quality characters in *Brassica campestris*. Japan. *J. Ani. P. Sci.* **9**(1): 69-72.McGregor, D. I. (1987). Effect of plant density on development and yield of rapeseed and its significance to recovery from hail injury. *Can. J. Plant Sci*. **67**: 50 -51.

Mehrotra, O. N., Saxena, H. K. and Mosa, M. (1976). Physiological analysis of varietal differences in seed yield of Indian mustard (*Brassica juncea* L. Czern and Cross). *Indian J. Plant Physiol.* **19**:139-146.

Mendham, N. J. and Scott, R. K. (1975). The limiting effect of plant size at inflorescence ignition on subsequent growth and yield of oilseed rape (*Brassica napus*). *J. Agric. Camb.* **84**:487-502.

Mendham, N. J. Russell, J. and Jarosz, N. K. (1990). Response to sowing time of three contrasting Australian cultivars of oilseed rape (*Brassica napus*). *J. Agric. Sci. Camb.* **114**(3):275-283.

Mendham, N. J., Samiullah, M. Afridi, M. R. K. (1981). The effect of delayed sowing and weather on growth, development and yield of oilseed rape (*Brassica napus*). *J. Agric. Camb*. **96**:389-416.

Mohammad, F., Samiullah, M. Afridi, M. R. K. and Khan, N. A. (1987). Morphology of musdtard variety to three sownng dates. I. Growth characteristics. *Bangladesh J. Agric. Res.* **14**(10): 66-71.

Mondal, M. R. I. (1995). Production Technologies for Oilseeds Crops: Recommendations and Future Plan. Proceedings of Workshop on Transfer of Technology of CDP Crops under Research-Extension Linkage Programme held on 22-27 October, 1994. (Edited by Ahmed, H.U., Islam, M. A., Ahmed, A., Alam, M. S. and Islam, M. A.). BARI, Gazipur. Bangladesh. pp. 5-19.

Mondal, M. R. I., and Islam, M. A. (1993). Effect of seed rate and date on yield and yield components of rapeseed. *Bangladesh J. Agril. Sci.* **20**(1):29-33.

Mondal, M. R. I., and Islam, M. A. and Khaleque, M. A. (1992). Effect of variety and planting date on the yield performance of mustard / Rape seed. *Bangladesh J. Agril. Sci.* **19**(2):181-188.

Mondal, M. R. I., and Wahhab, M. A (2001). Production technology oilseeds. Oilseed Res. Centre, Bangladesh Agril. Res. Inst. Joydebpur, Gazipur .pp.6-24.

Mondal, R. I. (1986). Environmental effects on plant growth, morphological characterts, yield, oil content and fatty acid composition of canola / rapeseed (*Brassica napus* L). M.S. Thesis, Faculty of Graduate School of Cornel Univ.. N. Y. USA. pp.123.

Mondal, R. I., B, M., Hydar-Ali, M. K. and Akbar, M. A. (1999).Response of rapeseed genotype Dhali to seed rate and seeding date. *Bangladesh J. Agril. Res.* **24**(1): 83-90.

Mondal. M. R., Islam, M. A. and Khaleque, M. A. (1992) . Effect of variety and planting date on the yield performance of mustard and rapeseed. *Bangladesh J. Agril. Sci.* **19**(92): 181-188.

Monir, M. and Mc Neily, T. (1987). Dry matter accumulation, height and seed yield in spring oilseed rape as affected by fertilizer and spacing. *Pak. J. Agric. Res.* **8**(2): 143-149.

Olsson, M. G. (1990). Rape yield production components .Pl. Br. Abs. **61**(5): 588(1991).

Patel, J. R., Parmnam, M. T. and Patel, J. C. (1980). Effect of different sowing dates, spacing and plant production on yield of mustard . *Indian. J. Agron.* **25**: 256-257.

Patel, J. R., Parmnam, M. T. and Patel, J. C. (1980). Effect of different sowing dates, spacing and plant population on yield of mustard. *Indian J. Agron,* **25**:256-257.

Patel, K. A., Parmar, M. T. and Patel, J. C. (1987). Response of mustard on different spacing and levels of nitrogen and phosphorus. *Indian J. Agron.* **25**(3): 524-525.

Paul, N. K., Joarder, O.I/. and Eunus , A. M. (1978). Correlation studies and the application of discriminate function selection in Indian mustard. *Acta Agronomica Academiae Scientiarium Hungaricae.* **27**(3-4): 421-428.

Pronay, B., Azad, A. K. and Hossain, M. F. (2011) Yield response of mustard to sowing date. *Libyan Agriculture Research Center Journal International*. **2** (3): 112-117.

Quilot, B., Genard, M. and Kervella, J. (2004). Leaf light-saturated photosynthesis for wild and cultivated peach genotypes and their hybrids: A simple mathematical modelling analysis. *J. Hort. Sci. Biotechnol.* **79**:546–553

Rahman, A. and Das M. L. (1991). Improvement of mustard through induced mutation. *Bangladesh J. Agril. Sci.* **18**(2):203-206.

Rahman, M. M, Hossain, S. M. A., Islam, N., Jalaluddin, M. and Salam, M. U. (1993). Effect of sowing date and Boron fertilizer on the yield and oil content of mustard and rapeseed. *Bangladesh Agron. J.* **15**(1&2): 73-78.

Rahman, M. M. (2002). Status of Oilseeds and Future Prospects in Bangladesh. Paper presented in Review Workshop on the Impact of Technology Transfer on Oil Crops, Held at BARI on 29 April, 2002.

Rahman, M. M. Uddin, M. M. and Khan, M. R. (1989). Influence of seeding date on the occurrence of aphids (*Lipaphis pseudobrassicae*) and seed yield of mustard and rapeseed. *Bangladesh J. Sci. Ind. Res*. **24**:1-4, 116-1222.

Rahman, M. M., Salam, M. U., Miah, M. G. and Islam, M. S. (1988). Effect of sowing time on the performance of mustard (SS-75). *Bangladesh. J. Agril. Res.* **13**(1): 47-51.

Robertson, M. J., Holland, J. F. and Bambach, R. (2004). Response of canola and Indian mustard to sowing date in the grain belt of north-eastern Australia. *Australian J. Experimental Agric.* **44**(1):43-52.

Ruszkowski, M. (1990). The phenomenon of dominance, competition compensation and overcompensation in buckwheat productivity.*Fagopyrum* **10**: 5-6.

Saran, G. and Giri, G. (1987). Influence of date of siwing on Brassica specis under semi arid rainfed conditions of North West. *Indian J. Agric., Sci. Camb*. **108**: 561-566.

Sarmah, P. C. (1996). Effect of sowing date and row spacing on rainfed mustard under late sown condition. *J. Oilseed Res.* **13**(1): 10-12.

Scarisbrick, D. H., Daniels, R. W. and Alcock, M. (1981). The effect of sowing date on the yield and yield components of spring oilseed rape. *J.Agric. Sci. Camb*. **97**:189-195.

Scott, R. K., gunremi, E. A., Ivind, J. D. and Mendham, N. J. (1973). The effect of sowing date and season on growth and yield of oilseed rape (*Brassica napus*). *J. Agric. Sci. Camb*. **81**: 277-285.

Sen, S. and Sur, S. C. (1964). Optimum time of sowing of Tai and Toria in West Benghal. *Indian oilseed J.* **8**(3):321-326.

Shah, M. A. R., Yousaff, M. A. and Sarder, N. A. (1985). The effects of different dates of sowing on the yield of three varieties of mustard. Research Report. RARS. Jessore.

Shahidullah, M. Islam, U. Karim, M. A. and Hussain, M. (1997). Effect of sowing dates and varieties on yield and yield attributes of mustard. *Bangladesh J. Agric. Sci. Ind. Res*. **32**:4, 515-516.

Shamsuddin, A. K. M. and Rahman, L. (1977). Studies on the performance of some exotic and indigenous varieties of mustard under Bangladesh conditions. *Bangladesh J. Agril. Sci. Res.* **3**:1-8.

Shamsuddin, A. M., Islam, M. A., and Asaduzzaman, S. M . (1987). Effect of nitrogen on yield and yield contributing characters of mustard at different levels. *Bangladesh J. Agril. Sci.* **14**(2): 165-167

Sharaan, A. N. and Gowad, K. I. A. (1986). Effect of cultivars and seeding rate on forage yield and crude protein in rape (*B. napus L.) Annals Agril. Sci*. **24**: 1857-1870.

Shivani, K., Sanjeeb and Kumar, S. (2002). Response of Indian mustard (*Brassica juncea*) to sowing date and row spacing in mid hills of Sikkim under rainfed conditions. *Indian J. Agron.* **47**(3): 405-410.

Sihag, J. S., Manohar, S. S. and Chaudhary, T. (2003). Combined effect of sulphur and time of sowing on yield attributes, yield and quality of mustard (*Brassica juncea* L. Czern and Coss). *J. Eco Physiol*. **6**(1/2):65-68.

Singh, C. (1988). Modern Techniques of raising field crops (3rd edition) Oxford and IBH Publishing Co. Ltd. Pp.301-313.

Singh, D. P., Singh, D. Singh, S. P. Singh, A. B. and Mishra, S. N. (1969). Relationship among some important agronomic characters in Indian mustard (*B. juncea*). *Indian J. Agric. Sci.* **39**:362-365.

Singh, H. (1986). Genetic variability, heritability and drought Induces analysis in *Brassica species*. *J. Oilseed Res.* **3**(2):170-177.

Singh, K. and Singh, D. (1987). Rersponse of mustaed to nitrogen and spacing . *Indian J. Agron*. **32**(1):15-17.

Singh, M., Swarankar, G. B. Prasad, L. and Rai, G. (2002). Genetic variability, heritability and genetic advance for quality traits in Indian mustard (*B. juncea* L. Czern and Coss). *Plant archives.* **2**(1): 27-31.

Singh, R. P., and K. P. P. Nair. (1975). Defoliation studies in hybrid maize - I. Grain yield, quality, and leaf chemical composition. *J. Agric. Sci. Camb*.

Singh, R., Bassi, G.and Singh, D. (2013). Influence of sowing time and leaf cuttings on the seed yield and quality components of palak (*Beta vulgaris* var bengalensis). *Indian J. Agric. Sci*. 83:4.

Tadesse, T. Yeshealem, B., Assefa, A. and Liben, M. (2012). Influence of seed rate and leaf topping on seed yield, oil content and economic returns of Ethiopian mustard (*brassica carinata*). *Pak. J. Agri. Sci*. Vol. **49**(3): 237-242.

Thomison, P. R. and Geyer, A. B. (2006). Impact of Defoliation on Grain and Stalk Quality in Corn. The Ohio State University Department of Horticulture and Crop Science 2021 Coffey Rd, Columbus, OH 43210. www.scisoc.confex.com/crops/responses.

Thomson, P. R., and E. D. Nafziger. 2003. Defoliation affects grain yield, protein, and oil of TopCross high-oil corn. Online Crop Management doi:10.1094/CM-2003-1027-01-RS.

Thurling, N. (1974). Morphophysiological determinants of yield in rapeseed (*Brassica campestris* and *Brassica napus*). II. Yield components. *Aust. J. Agric. Res.* **25**:711-721.

Tollenaar, M., and T. B. Daynard.1978. Effect of defoliation on kernel development in maize. *Can. J. Plant Sci*. **58**: 207-212.

Tomar, R. K. S. and Mishra, G. L. (1991). Influence of sowing dates and nitrogen on the yield of mustard (*B. juncea* L.). L. *Oilseeds. Res*. **8**(2): 210-214.

Tomar, S. S. and Namedo, K. N. (1989). Response of Indian mustard varieties to row spacing and nitrogen . *Indian J. Agron.* **34**(4):472-473.

Uddin, M. M., Samad, A., Khan, M. R., Begum, S. and Salam, M. A. (1986). Effect of sowing dates on the yield and some of its components of mustard and rapeseed. *Bangladesh J. Inds. Res*. **21**:159-166.

Uddin, M. M., Samad, A., Khan, M. R., Begum, S., Hossain, K. and Khaleda, S. (1987). Variety X sowing date interaction in mustard and rapeseed. *Bangladesh J. Agric. Res.* **12**(2):55-60.

Upasani, R. and Sharma, H. C. (1986). Effect of nitrogen and sulphur on some growth parameters, evapotranspiration and moisture use effency under dry land conditions. *Indian J.Agron.* **31**(3): 222-228.

Vacchani, M. V. (1952). The influence of sowing date on the yield of Oleferous *Brassica* crops. *Indian J. Agric. Sci*. **22**(40):397-409.

Walker, A. J. and Ho, L. C. (1977). Carbon translocation in the tomato,carbon import and fruit growth. *Ann. Bot. (Lond.)* **41**:813–823.

Wang, Z. Fu., He, J., Tian, M. Q. and Cao. H. (1997). Effect of source/ sink manipulation on net photosynthetic rate and photosynthate partitioning during grain filling in winter wheat. *Biologia plantarum.* **39** (3): 379 - 385.

Wu, B. H., Huang, H. Q., Fan, P. G. and Li., S. H. (2008) Photosynthetic Responses to Sink–Source Manipulation in Five Peach Cultivars Varying in Maturity Date. *J. Amer. Soc. Hort. Sci.* **133**(2):278–283.

Yadav, C. K. (1983). Studies on genetics of yield and its components in Indian mustard (*Brassica juncea* L. Czern & Cross). *Thesis Abs*. **9**(2):186-187.

Yadav, R. N., Bhan, S. and Uttam, S. K. (1996). Effect of sowing date, variety and plant population on growth and yield of rainfed Indian mustard (*Brassica Juncea*). *Indian J. Agron.* **39**(4):682-684.

Yadav, T. P., Yadava, A. K.and Singh. A (1978). A concept of plant ideotype. **In:** Indian mustard (*B. juncea* L.) 5th International rapeseed conference . Malmo, Sweden.

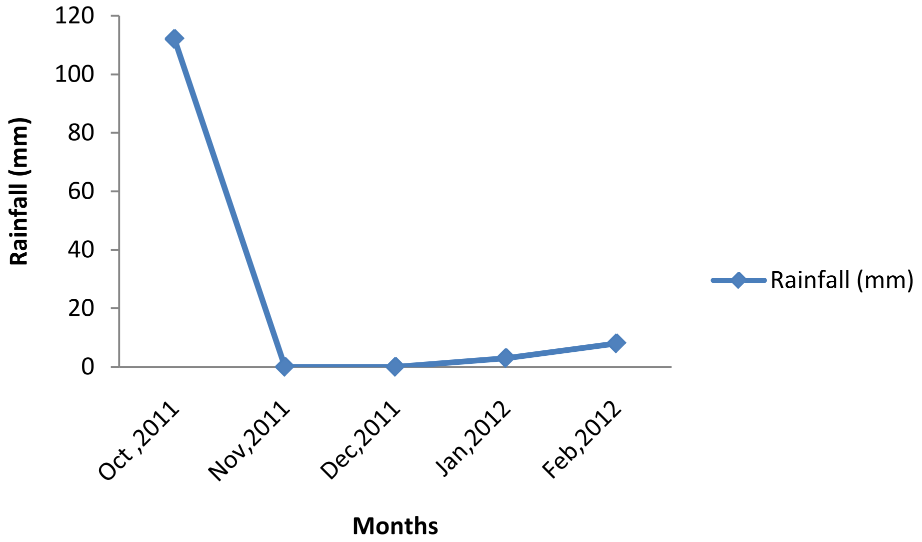
Yadav, Z., Schafferman, D. and Zur, M. (1994). Yield and moisture use efficiency of mustard in relation to sowing date, variety and spacing in rainfed lands of Central Uttar Pradesh. *Indian J. Soil Conservation.* **22**(3): 29-32.

Yadava, Y. P., Singh, H. and Singh, D. (1993). Gene action for seed yield and its attributes under two environments in Indian mustard. *Crop. Res.* **6**(1): 168-172.

Yin, J. C. (1989). Analysis of ecological, physiological and production characteristics of high quality rapeseed cultivars. *Agricultural Shanghai*. **5**(4): 25-31.

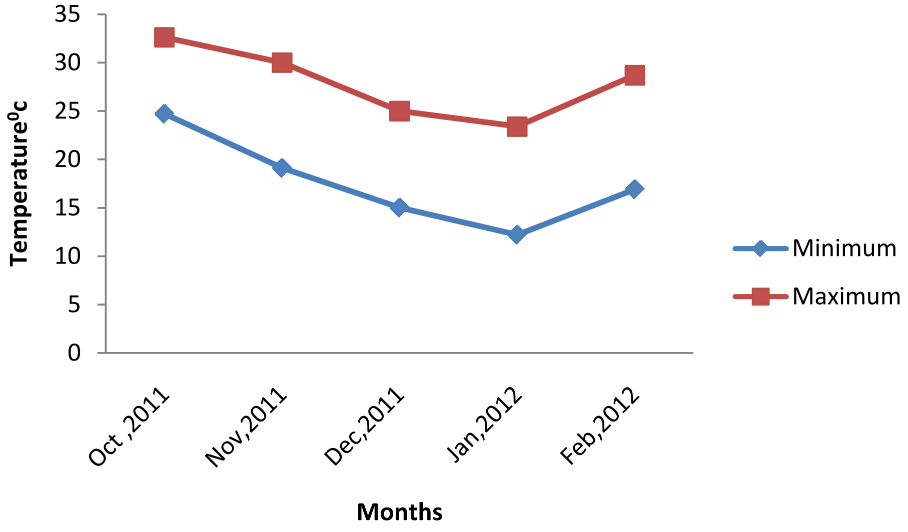
Zaman, S. M., Rahman, L. and Miah, M. A. J. (1991). Effect of sowing date on the performance of mustard under Zero tillage condition. *Bangladesh J. Agril. Sci.* **18**(2): 199-202.

Appendix 1. Monthly average total rainfall during the study period (October to February)



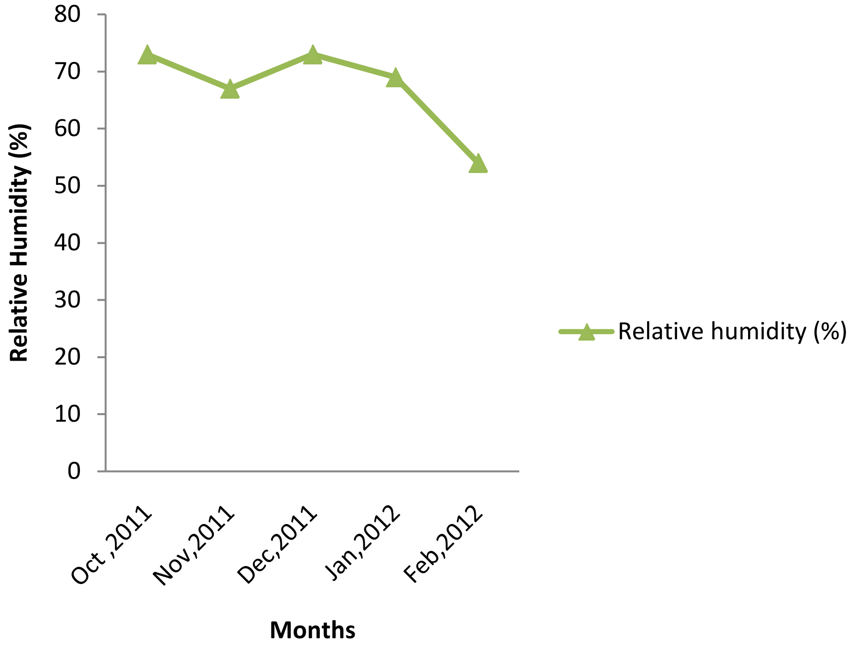
Source: Bangladesh Meterological Department (Climate division), Agargaon, Dhaka- 1212

Appendix 2. Monthly average air temperature during the study period (October to February)



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

Appendix 3. Monthly average relative humidity during the study period (October to February)



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