

**EFFECT OF PLANTING DATE ON PHENOTYPIC CHARACTERS,  
HARVESTED LEAVES AND SEED YIELD OF MUSTARD GREEN  
(LAI SHAK) IN SYLHET REGION**

M. I. NAZRUL<sup>1</sup> AND S. T. ZANNAT<sup>2</sup>

**Abstract**

A field trial was conducted at farming system research and development (FSRD) site, South Surmain Sylhet under AEZ-20 during two consecutive years of 2017-18 and 2018-19 to find out the suitable planting date for successful and economic production of leaves and seed yield of mustard green (*Brassica juncea*). The experiment was laid out in randomized complete block design having five different dates of seedling transplant viz. 15 October, 30 October, 15 November, 30 November and 15 December with four dispersed replications. The seedlings transplanted on 15 November recorded significantly the highest number of harvested leaves plant<sup>-1</sup>, weight of single leaf, harvested leaf yield (35.07 t ha<sup>-1</sup>), siliqua plant<sup>-1</sup> and weight of 1000-seed and seed yield (1.38 t ha<sup>-1</sup>) of mustard green. The highest gross return (Tk. 862800 ha<sup>-1</sup>) and net return (Tk. 627300 ha<sup>-1</sup>) with benefit cost ratio (BCR) of 3.66 was obtained from 15 November planting followed by 30 October planting. Conversely, the lowest gross return (Tk. 611620 ha<sup>-1</sup>), net return (Tk. 376120 ha<sup>-1</sup>) and BCR (2.59) were recorded from 15 December planting. So, last October to mid-November planting would be suitable for economic production of leaves and seed yield of brown mustard in Sylhet region of Bangladesh.

Keywords: Mustard, Indian mustard, leaf mustard, planting date, seed yield.

**Introduction**

Brown mustard (*Brassica juncea* L.) belonging to the family Cruciferae is a variable species cultivated for centuries as a vegetable and oil crop and is also a widespread weed. It is known by diverse common names, which include Indian mustard, leaf mustard and brown mustard among many others (Grubben and Denton, 2004). In Bangladesh, it is also known as Lai Shak. The leaves, seed and stem of this mustard variety are used as edible. Traditionally, it is very popular vegetable for the people of north east region of our country. The leaves are used in African (Grubben and Denton, 2004); also used in many Indian dishes in Gujarati and Northern province of Vietnam, mustard greens is regarded as one of the main vegetable crops being consumed in large volume (Ha, 2011). It is nutritionally rich in protein, fat, vitamin and minerals; especially high in vitamin A and vitamin K (USDA Nutrient Database). Normally, it is growing as vegetable over the winter season in Sylhet region. Occasionally, early and late sowing may or may not provide maximum profit to the farmers. Timely sowing

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<sup>1</sup>Principal Scientific Officer, <sup>2</sup>Scientific Officer, Bangladesh Agricultural Research Institute (BARI), Gazipur, Bangladesh.

may allow sufficient growth and development of a crop to obtain a satisfactory yield. The seed yield and maturity of mustard plants are greatly influenced by environmental conditions regardless of proper sowing of times. Mustard sowing at optimum time gives higher yields due to suitable environment that prevails at all the growth stages (Kumar *et al.*, 2018). The growth and yield of mustard are profoundly affected by sowing time (Mondal and Islam, 1993; Shivani and Kumar, 2002; Alam *et al.*, 2014). Mustard green (Lai Shak) also one of the vegetable crops to be considered for optimum planting time to get more yields and economic return. Very early planting often works well but can be risky to the growers due to unpredictable weather. On the contrary, late planting also may hamper the production potential mainly due to temperature or variation for particular crops. The optimum time of transplant may help plants to expose in to the most favorable environment for better growth and good yield, as well as escape the insect and disease infestation. Keeping this view in mind, the present study was undertaken to finding out optimum planting date for maximum yield of leaves and seed of mustard green.

### Materials and Methods

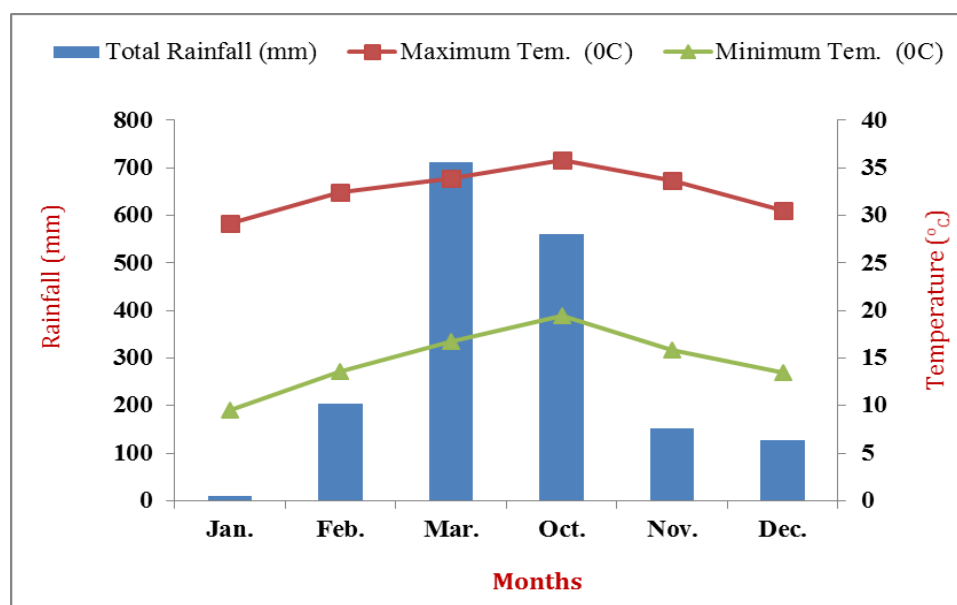
The experiment was conducted at farming system research and development (FSRD site, South Surma, Sylhet during *rabi* seasons of two consecutive years 2017-18 and 2018-19, experimental site located at 24°6' N latitude and 91°36' E longitude in Bangladesh. The site belongs to the Eastern Surma-Kushiyara Floodplain soil under Agro Ecological Zone (AEZ-20), which falls into grey heavy silty clay loams on the ridges and clay in the basins. General fertility status is moderate; having organic matter content of soil is low to medium (1.05-1.82%). The soil was clay loam in texture and acidic in nature pH ranges 5.4-6.24. The experimental field was also a piece of well drained high land with moderately even topography.

The monthly mean maximum and minimum air temperature and rainfall during the study period are presented in Figure 1. The mean annual minimum temperature is 9.15-24.05 °C and the mean annual maximum temperature is 29.70-37.65 °C. However, monthly mean maximum and minimum air temperature was 35.83 and 9.53 °C, during the crop growth period.

Rainfall of the area is uni-modal, usually occurring during April to October, and total annual rainfall reached to 4310mm; whereas in January no rain at all and lowest amount of rainfall occurs in November followed by December. The crop received monthly total rainfall 1766 mm during the crop growing period.

The experimental treatments consist of five different dates of seedling transplant viz. 15 October, 30 October, 15 November, 30 November and 15 December. The experiment was laid out in randomized complete block design with four dispersed replications. The brown mustard (Lai shak) seedlings were raised by following farmer's agronomic cultural practices. The unit plot size was 5 m x 4

m. Ten days old seedlings were transplanted by maintaining the spacing of 30 cm× 15 cm.



**Fig. 1.** Average of two years monthly mean air temperature (maxi & mini) and monthly total rainfall (mm) during crop growth period (Source: Metrological Department, Sylhet).

Fertilizer nutrients 170-96-140 kg ha<sup>-1</sup> of NPK along with cow dung (5 t ha<sup>-1</sup>) was applied. Full dose of cowdung, one third MoP and urea and rest of the fertilizers were applied during final land preparation. Remaining urea and MoP was applied in 2 splits at 10 and 25 days after transplant followed by earthingup and irrigation. Tilt and Bavistin @ 0.5 ml and 2 g/L was sprayed at seeding and siliquae development stage, respectively to control blight. Bioneem plus 1 EC (Azadiractin) @ 1 ml/L was sprayed to control aphid at the time of flowering. Ten plants were selected randomly from each plot to record data. Marketable green leaves harvesting was started at 20-25 days after transplant (DAT). During experimentation 5-7 harvests were done and average of 2-3 leaves were collected from each plant. On the contrary, the harvesting of mustard siliquae was started from 1<sup>st</sup> week of February to end of March in both years. Seed yield was weighted and convert it as t ha<sup>-1</sup> at 9-10 % moisture level. Data on yield and yield attributes of mustard green (Lai shak) for the two years were similar and therefore pooled. The data were analyzed statistically and the means were compared by using LSD test at 5 % level of probability. The gross economic return was also calculated on the basis of prevailing market price of the commodities.

## Results and Discussion

Planting time significantly influenced to the plant height of mustard green (Table 1). The tallest plant (187.97 cm) was measured from 15 November transplanting and it was significantly different from rest of the planting dates. The shortest plants (162.84 cm) were recorded from 15 December transplanting time. Prevailing weather conditions during the whole crop growing season have a direct association with the phenological developments in the crop plants, which modulate yield formation (Akhter *et al.*, 2016). Mondal and Wright (1989) reported that a temperature range 5-15 °C is optimum for the normal growth and development of mustard plant. Above and below this range, temperatures reduced growth rate by reducing plant height and dry matter accumulation. In Sylhet, the daily mean and minimum temperatures during October 25 °C and 18°C, respectively was quite favorable for quick seed germination and crop stand establishment of mustard. The crop received 531mm total rainfall during the crop period which hampered the normal growth and leaves production whereas in January no rain and lowest amount of rainfall (43 mm) occurs in November followed by February (175 mm). Moreover, the sharp fall of both the mean and minimum temperatures from the first week of November and onwards shorten the period of inflorescence initiation in mustard and rapeseed (Islam *et al.*, 1994). Number of branches plant<sup>-1</sup> was significantly affected by planting dates (Table 1). Maximum number of branches plant<sup>-1</sup> (12.28) was produced by 15 November planting which was statistically similar to that of 30 October planting. November 15 planted plants received comparatively low temperature (15.9 °C) during vegetative growth which probably influenced produced more branches.

Early (15 October) and late (15 December) planting gave the lowest number of branches plant<sup>-1</sup>. Early sowing of crop faced somewhat lower temperature at early growth stage which hampered the normal growth and development of crop. The crop sown on December 15 (Late) produced lower number of branches might be due to short growing period and lower temperature in vegetative growth stage. Similar trend was observed in case of the base girth of mustard green in different transplanting dates (Table 1). The highest base girth (4.68 cm) was recorded from 15 November planting. It might be due to favorable weather conditions mainly temperature help for the growth and development of plant.

The highest number of marketable harvested leaves plant<sup>-1</sup> (21.84) was obtained from the planting date 15 November. It was significantly different from all other planting dates (Table 1). The lowest number of harvested leaves plant<sup>-1</sup> (15.18) was recorded from 15 December sowing and it was statistically similar to 15 October planting. It might be due to variation in prevailing weather condition in delayed sowing which adversely affects the yield attributes. The results of present study are in agreement with the findings of Khaton (2004) in mustard. The size of mustard green leaves is important due to use as vegetable purpose. However, the leaf size at harvest was enhanced by different planting dates (Table 1). Maximum

leaf size (53.42 cm × 23.99 cm) was found at 15 November and 30 October (50.00 cm × 21.78 cm) planting, respectively. The late planting *i.e.* 15 December gave the smaller size of harvested leaves might be due to crop faced low temperature at the time of emergence as well as 50% flowering stage. The variation of single leaf weight at harvested was influenced by different transplanting time (Table 1). The highest weight (21.95 g) of single harvested leaf was recorded in 15 November which was statistically similar to those of 30 October (20.69 g) and 30 November (20.65 g) plantings. The lowest weight of single harvested leaf (19.35 g) was recorded when transplanting was done at 15 December.

Number of siliquae plant<sup>-1</sup> was significantly affected by planting dates (Table 2). The highest number of siliquae plant<sup>-1</sup> (838) was obtained from 30 October which was statistically similar to 15 November and 30 November plantings but dissimilar to 15 October and 15 December plantings. Earlier planting (15 October) crops received convenient soil moisture condition and relatively warmer temperature (18.45 °C) during vegetative growth and favorable temperature (20-25 °C) during 50% flowering. This finding was in conformity with the findings of Mondal *et al.* (1999) who stated that the 30 October planting produced the highest number of siliquae plant<sup>-1</sup> and reduced in the late (15 December) transplanting. Pandey *et al.* (2007) and Khavse *et al.*, (2014) reported that maximum temperature (>30°C) and lower temperature (<14°C) during flowering and pod development stage of the crop were favorable for mustard crop. Planting dates significantly influenced the number of seeds siliqua<sup>-1</sup> of mustard green (Table 2). The highest number of seeds (18) siliqua<sup>-1</sup> was produced in 15 November and it was significantly different from rest of the planting dates. October 30 and 30 November plantings gave statistically similar number of seeds siliqua<sup>-1</sup>. The lowest number of seeds (13) siliqua<sup>-1</sup> was recorded from 15 December transplant which was statistically identical with 15 October planting. These results are in agreement with the findings of Mondal *et al.* (1999).

Thousand seed weight also differed significantly among the planting dates (Table 2). The highest 1000-seed weight (1.43 g) was recorded in 15 November planting which was significantly different from all others planting dates. Transplanting dates 15 October, 30 October and 30 November gave statistically identical 1000-seed weight. In contrast, the lowest weight of 1000-seeds (1.19 g) was found in delaying of transplantation (15 December) which was statistically identical with 15 October and 30 October plantings. In delayed transplant crops faced low temperature (12.95 °C) at the time of emergence as well as 50 % flowering of the plants which hampered the growth. Moreover shorter growing period and higher temperature at the time of seed filling period caused reduction of seed size.

Mondal *et al.* (1992) stated that 1000-seed weight reduced with the delayed planting time after 15 November.

The brown mustard has 25-32 leaves at lower layers of plant; during experimentation 16-22 marketable leaves were harvested and rest of the leaves (8-10) remain attached to the plant for completing the seed production process. Hereafter, flowering branches with small leathery or curly leaves also appeared in plants. The harvested leaf yields ( $\text{g plant}^{-1}$  and  $\text{t ha}^{-1}$ ) were found significant with respect to dates of transplant (Table 2). Transplant in 15 November gave the maximum yield ( $426.12 \text{ g plant}^{-1}$ ,  $35.07 \text{ t ha}^{-1}$ ) of harvested leaves. The yield of harvested leaves increased up to 15 November planting and hereafter decreased. A significant variation was observed among the effect of transplanting time of mustard green in respect of seed yield (Table 2). The highest seed yield ( $1.38 \text{ t ha}^{-1}$ ) was recorded from 15 November transplant. This happened probably due to the phenological phase coincided with optimum temperature resulted in higher number of siliqua  $\text{plant}^{-1}$ , seeds  $\text{siliqua}^{-1}$  and 1000-seed weight. The lowest seed yield ( $1.13 \text{ t ha}^{-1}$ ) was recorded in late planting (15 December). This might be due to shorter growing period and higher temperature (Fig.1) at the time of seed filling caused reduction in yield components and thereby seed yield. The lowest seed yield was also obtained from crop sown on 15 October possibly due to adverse effect of high temperature (Fig. 1) at the vegetative phase.

There are many studies (Angadi *et al.*, 2000; Morrison and Stewart, 2002; Young *et al.*, 2004) related with thermo-tolerance in oilseed brassicas at the flowering stage, but little progress has been made so far in understanding the heat tolerance at seedling stage in *Brassica*. Weather data indicating that plants of 15 November planting were received congenial environment during crop period for growth and flowering. Lobell and Asner (2003) reported each degree centigrade increase in average growing season temperature may reduce crop yields up to 17%. Alam *et al.* (2014) mentioned that time of planting generally varies depending on the climatic condition of the region and the variety to be grown. In general, sowing time of mustard in Bangladesh is confined to a period ranging from mid-October to mid-November (Lakra *et al.*, 2018, Biswas, 1989 and Mondal *et al.*, 1999) but with the change of variety and location, various optimums have been suggested (Mondal *et al.*, 1992). Kalra *et al.* (1985) and Begna and Angadi (2016) also stated that delaying in planting dates reduced the seed yield of mustard. Stover yields of mustard green also affected by planting dates (Table 2). The maximum stover yield ( $4.80 \text{ t ha}^{-1}$ ) was recorded when crop was transplanted on 15 November followed by 30 October. It might be due to the cumulative effect of plant height and harvested leaf yield. The minimum stover yield ( $2.76 \text{ t ha}^{-1}$ ) was recorded when transplantation was done on 15 December.

**Table 1. Effect of different transplanting dates on phenotypic characters of brown mustard (Pooled of two years)**

Planting dates	Plant height at harvest (cm)	Branches plant <sup>-1</sup> (no.)	Base girth (cm)	Marketable harvested leaves plant <sup>-1</sup> (no.)	Leaf size at harvest		Weight of single leaf at harvest (g)
					length (cm)	width (cm)	
15 October	170.84	8.34	3.76	15.42	46.72	22.07	19.96
30 October	177.57	12.19	4.16	18.72	50.00	21.78	20.69
15 November	187.97	12.28	4.68	21.84	53.42	23.99	21.95
30 November	178.14	9.47	3.95	17.47	49.51	21.66	20.56
15 December	162.84	8.77	3.59	15.18	45.23	20.32	19.35
CV (%)	2.85	7.45	4.94	7.62	5.32	3.76	4.39
LSD <sub>(0.05)</sub>	9.35	1.44	0.49	2.55	3.21	1.49	1.36

**Table 2. Effect of different transplanting dates on yield and yield attributes of brown mustard (Pooled of two years)**

Planting dates	Siliquae plant <sup>-1</sup> (no.)	Seeds siliqua <sup>-1</sup> (no.)	1000-seed weight (g)	Harvested leaf yield		Seed yield (t ha <sup>-1</sup> )	Stover yield (t ha <sup>-1</sup> )
				Plant <sup>-1</sup> (g)	(t ha <sup>-1</sup> )		
15 October	766	15	1.22	328.53	26.04	1.16	3.68
30 October	838	16	1.21	383.49	32.14	1.30	4.05
15 November	819	18	1.43	426.12	35.07	1.38	4.80
30 November	814	15	1.27	351.58	28.09	1.24	3.64
15 December	744	13	1.19	305.96	24.09	1.13	2.76
CV (%)	15.84	5.55	3.38	7.65	4.56	5.00	5.57
LSD <sub>(0.05)</sub>	23.33	1.66	0.08	19.49	2.41	0.12	0.39

### Economics

Economic viability is an important indicator for selection of treatment to the end users. The gross return and gross margin were varied among the treatments, due to price variation of product in the market with the time of harvest (Table 3). Maximum total gross return (Tk. 862800 ha<sup>-1</sup>) was found from 15 November transplant followed by 30 October plantation. On the contrary, 15 December planting gave the lowest total gross return (Tk. 611620 ha<sup>-1</sup>). The net return

was also varied with five different transplanting time of brown mustard. The highest net return (Tk. 627300 ha<sup>-1</sup>) and benefit cost ratio (3.66) was obtained when planting was done on 15 November followed by 30 October (Tk. 558400 ha<sup>-1</sup> & 3.37). Conversely, the lowest net return (Tk. 376120 ha<sup>-1</sup>) and BCR (2.59) was noticed from 15 December planting.

**Table 3. Economic analysis of brown mustard at different transplanting dates (Pooled of two years)**

Treatments	Gross return (Tk. ha <sup>-1</sup> )				Total cost (Tk. ha <sup>-1</sup> )	Net return (Tk. ha <sup>-1</sup> )	Benefit cost ratio (BCR)
	Leaf as vegetable	Seed	Stover	Total			
15 October	520800	127600	7360	655760	235500	420260	2.78
30 October	642800	143000	8100	793900	235500	558400	3.37
15 November	701400	151800	9600	862800	235500	627300	3.66
30 November	561800	136400	7280	705480	235500	469980	3.00
15 December	481800	124300	5520	611620	235500	376120	2.59

*Price (Tk.kg<sup>-1</sup>):* brown mustard (Lai shak): 20.00; seed: 110.00, non-seed: 30.00, stover: 2.00

### Conclusion

From two years results it was revealed that last October to mid-November planting could be suitable for economic production for both leaves and seed of brown mustard in Sylhet region of Bangladesh.

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