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YIELD AND YIELD ATTRIBUTES OF RAPESEED – MUSTARD (*Brassica*) GENOTYPES GROWN UNDER LATE SOWN CONDITION

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Abstract

A field experiment was conducted at the Central Research Station of BARI, Gazipur for two consecutive years 2010-11 and 2011-12 with 30 varieties/ genotypes of rapeseed-mustard under three dates of sowing viz., 25 November, 5 December, and 15 December to determine changes in crop phenology, growth and yield of mustard genotypes under late sown condition when the crop faced high temperature. Days to flowering and maturity were different at different planting times. Date of sowing significantly influenced plant height, siliquae/plant, seeds/siliqua, seed yield, and oil content of seed in both the years. The highest seed yield (1310 and 1535 kg/ha) was obtained from the first planting (25 November) in both the years, which was significantly different from two other dates of sowing. Yield and yield attributes of different varieties varied significantly. Among the varieties, BARI Sarisha-16 of *Brassica juncea* gave significantly the highest seed yield (1495 and 1415 kg/ha), which was statistically identical to BJDH-11, BJDH-12, BJDH-05, BJDH-20, and BARI Sarisha-6 and significantly different from all other varieties. Interaction effect of variety and sowing date significantly influenced plant height, number of siliquae per plant, number of seeds per siliqua, seed yield, and strover yield. The highest seed yield (1758 and 1825 kg/ha) were recorded from BJDH-11 and BARI Sarisha-16 of *Brassica juncea* at 25 November planting and BJDH-11 produced the highest yield at 15 December in both the years. The maximum strover yield (3758 and 3825 kg/ha) were obtained from BJDH-11 and BARI Sarisha-16 of *Brassica juncea* at 25 November planting during 2010-11 and 2011-12. The highest oil content of seeds (44.4 % and 45.9%) were obtained from the seed of BARI Sarisha-6 and BARI Sarisha-14 at 25 November planting in both the years.

Keywords: Late sowing time, genotype, and yield.

Introduction

Edible oil plays a very important role in human nutrition. As a high-energy component of food, edible oils are important for meeting the calorie requirements. Each gram of oil/fat supplies 9 kilocalories of energy, whereas each gram of carbohydrate/protein furnishes about 4 kilocalories of energy (Stryer, 1980). Fats and oils are also the sources of essential fatty acids. The main

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essential fatty acids of vegetable oils are linoleic and linolenic acids. Fats and oils are used to synthesize phospholipid, which are important components of active tissues viz., brain, nerve, and liver of human beings and other animals. Present dietary pattern of the people of Bangladesh is highly imbalanced due to excess consumption of carbohydrates in the form of cereal more than the body requirement. Carbohydrate contributes about 86% of the total calorie requirement; on the other hand, fats and oils contribute only about 5-15% (Ullah, 1989). The average availability of oils and fats in Bangladesh per capita per annum is 3.8 kg (10.55 g/head/day) against the requirement of 11 kg, while most developed countries consume about 20 kg. Bangladesh has been suffering from acute shortage of edible oil for last several decades. Internal production can meet only about 29% of our consumption (8 g/day /head). The rest 71 % is met from the import. To meet the annual requirement of edible oil and reduce the import, it is necessary to give immediate attention to increase its domestic production. Increased production of edible oil can come from expansion of cultivated area and in increase production or from both.

Rapeseed-Mustard is a principal oilseed crop, which plays a significant role in the national economy of Bangladesh. But seed yield/ha is very low compared to other rapeseed growing countries of the world, but the productivity of this crop is very low. The low average yield of mustard is due to cultivation of traditional varieties, non-availability of seeds of high yielding varieties and delayed sowing. The genotypes of any crop can express their potential only when grown under optimum management conditions with special emphasis to date of planting. About 20% yield of mustard reduced due to delayed sowing. There is an ever increasing demand of edible oil in the country and the local production can meet up only one third of the requirement. Every year, it needs to import oil and oilseeds to meet up the deficit. Climatic change may be the major cause for yield reduction in winter crops. Moreover, the rise of global temperatures as predicted between 1.1^0C and 6.4^0C during 21^{st} century might aggravate the situation. On the current trends, the average global temperature will rise by $2\text{-}3^0$C within next 50 years (Stern, 2006). Temperature is increasing day by day which hampers the growth of rapeseed - mustard and reduced yield. It is cultivated after harvesting of T.aman rice all over Bangladesh. In that case, sowing of mustard is delayed which affect growth and yield of mustard mainly due to rising temperature. Brassica grows well in cool and moist climate (Below 25^0C day temperature). In general, high temperatures (Higher than $24\text{-}25^0$C) cause a sharp decrease in oil content of most of the seeds. High temperature in *Brassica* enhanced plant development and caused flower abortion with appreciable loss in seed yield **(**Rao *et al*., 1992). Production potentiality of mustard can be fully exploited with suitable agronomic practices and genotypes. It is a fact that a specific genotypes does not exhibit the same phenotypic characteristics in all environmental conditions. The different genotypes varied in growth response to different environments and their relative ranking usually differ (Eberhort and Russel, 1966) and ultimately decides the selection of genotypes for a particular or different sowing dates for stabilizing higher yields (Finalay and Wilkinson, 1963; Eberhort and Russel, 1966 and Perkins and Jinks, 1968). Generally, the time of planting varies depending on the climatic condition of the region and the variety to be grown. Different varieties of mustard are sensitive to change in environmental conditions where the crop is being grown. Therefore, it is necessitated to study genotype × environment interaction to identify varieties stable in different environments (Sarma and Roy, 1993). In general, sowing time of mustard in Bangladesh is confined to a period ranging from mid–October to mid-November (Biswas, K.P. 1989 and Mondal *et al.*, 1999) but with the change of variety and location, various optimums have been suggested (Mondal *et al.*, 1992). Most of the time of a year, temperature is high. So, new varieties must be developed that can withstand adverse climatic condition, particularly high temperature in order to produce increased yield per unit area. Therefore, the present investigation is an attempt to analyze the effect of temperature on seed yield, its component and growth parameters and to identify varieties/genotypes against high temperature.

Materials and Method

The experiment was conducted at Oilseed Research Centre, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur during the rabi season of 2010-2011 and 2011-12. There were three planting dates (D_1=25 November, D_2=5 December, and D_3=15 December) and 30 varieties/genotypes of rapeseed/mustard i.e., 11 varieties/genotypes of *Brassica napus* (V_1= Nap-0559, V_2= Nap-0519, V_3= BARI Sarisha-8, V_4= Nap-0544, V_5= Nap-0538, V_6= Nap-0546, V_7= Nap- 0528, V_8= Nap- 0523, V_9= Nap- 0564, V_{10}= Nap- 0567and V_{11}= BARI Sarisha-13), 8 varieties/genotypes from *Brassica juncea (*V_{12}= BJDH-12, V_{13}= BJDH-05, V_{14}= BJDH-11, V_{15}= BJDH-01, V_{16}= BJDH-20, V_{17}= BJDH-17, V_{18}= BARI Sarisha-11, and V_{19}= BARI Sarisha-16) and 11 varieties/genotypes from *Brssica campestries* (V_{20}= JBC-5115, V_{21}= JBC-5118, V_{22}= BC-9921, V_{23}= BC-9917, V_{24}= BC-9922, V_{25}= BC-9909, V_{26}= BARI Sarisha -9, V_{27}= BARI Sarisha -15, V_{28}= BARI Sarisha -14, V_{29}= BARI Sarisha-6, and V_{30}= Tori-7were used in the experiment. Split plot design was followed in this experiment. The experiment was laid out in split plot design with seeding date in the main plots, and varieties/genotypes in sub-plots. Fertilizer were applied @ 120, 80, 60, 40, 4, 1 kg/ha of N, P, K, S, Zn, and B from Urea, TSP, MP, Gypsum, Zinc sulphate, and Boric acid, respectively. Seeds were sown in lines @ 7-8 kg/ha with 30 cm row spacing and continuous seeding in lines. Half of the nitrogen and full amount of other fertilizers were applied at the time of final land preparation. The remaining half of nitrogen fertilizer was applied as top dressing at 22 days after seedling emergence. Weeding cum thinning was done in the third week after sowing. Two irrigations were applied at 22 and 45 days after emergence and plant protection measures were taken whenever necessary. Data were collected on plant height, first flowering, days to maturity, seed yield, and yield attributing characters and oil content in seed. Data were analyzed statistically and treatment means were compared by Least Significant Difference (LSD) test. Weekly maximum and minimum temperature, total rainfall, relative humidity and sunshine hour have also been presented in Appendix (I). The meterological data were collected from Meterological Station at Joydebpur.

Results and Discussion

Effect of sowing time on yield and yield attributes of mustard

Different dates of sowing had significant effect on plant height, siliquae/plant, seeds/siliqua, 1000- seed weight. seed yield, stover yield, and oil content (Table 1). Plants of early sowing, flowered later due to prevalence of favourable environment, especially low temperature during vegetative growth phase which enhanced flower initiation in the varieties/lines. Saran and Giri, 1987 also reported that 11 November sowing gave earlier flower. At 25 November sowing, it took 29 days to flower and 87 days to mature and at 15 December sowing, it took 23 to 24 days to flower and 77 days to maturity, respectively (Table 1) in both the years. Delay sowing reduced to flowering and maturity due to higher temperature during late sowing causing reduction in days to flower plants of first planting during early vegetative period and of last planting during later part of the season faced high temperature. Hang and Gilliland (1984) also reported that days to flower and days to maturity varied year to year depending upon the temperature. The highest plant height (114.4cm and 106.8cm) were found at 25 November sowing time in both the years. The shortest plant (96.2cm and 91.1cm) were found at 15 December sowing time in both the years. In Bangladesh, the average daily temperatures during the third week of October to first week of November (24-27^{0}C) are quite favourable for quick seed germination and establishment of mustard and rape seedlings (Islam *et al*., 1994a). Moreover, the sharp fall of both the mean and minimum temperatures from the third week of November onwards shorten the period of inflorescence initiation in mustard and rapes (Islam *et al*., 1994b) . Mondal and Wright (1986) also found that a temperature range 5 - 15 ^{0}C is optimum for the normal growth and development of rapeseed plant. Above and below this range, temperatures reduced growth rate by reducing plant height and dry matter accumulation. The highest number of siliquae/plant (87.8 and 90.2) were found at 25 November sowing, which was significantly different from that of two other dates of sowing. The lowest number of siliquae/plant (56.3 and 57.3) were found at 15 December sowing. The highest seeds/siliqua (23 and 25), 1000-seed weight (3.4g), and seed yield (1310 and 1510 kg/ha) were obtained from 25 November sowing in both the years. Chakraborty *et al.* (1991) stated that early sowing produced 24% higher seed yield than that of later sowing. Delayed planting reduced seed yield drastically. It occured due to rapid inflorescence initiation, severe insect and diseases pest infestation. In late sowing condition, pod number also decreased. Due to high temperatures and long days, pod development phase accelerated rapid maturity of pods and lower yield (Tuteja *et al.*, 1996). The highest oil content in seed (42.8% and 43.0%) were recorded from when seeds sown on 25 November and it was lowest (41.3% and 40.6%) when seeds sown on 15 December (Table 1). Brar *et al*, (1998) also reported increased seed and oil yield from early planting.

Effect of varieties/genotypes on yield and yield attributes of mustard

Varieties/genotypes of mustard used in the experiment exerted significant influence on yield and yield attributes (Table 1). Among the 30 varieties/ genotypes, first flowering and maturity days were different and varied from 22 to 34 and 75 to 93 days, respectively. The highest plant height (165cm and 145cm) was found in BJDH -05, which was statistically identical to BJDH -11 and BARI Sarisha-16. Maximum number of siliquae/plant (108 and 90) was recorded in BJDH -05 which differed significantly from other varieties. This has contributed to higher yield. The lowest number of siliquae/plant (52.0 and 56.3) were found in BARI Sarisha-14. The maximum seeds per siliqua (24 and 25) were found from Nap-0538.The highest 1000- grain weight (3.87g and 3.58 g) were obtained from BJDH -17 which was identical to BJDH – 11, 12 and 20 and significantly different from all other varieties due to its bolder seeds. The highest seed yield/ha (1475 and 1415 kg/ha) was obtained from the variety BARI Sarisha -16 and it was due to higher number of siliqua/plant and 1000-seed weight. Similar results was also obtained by Mondal *et al*. (1992). Podder *et al.* (1996) also reported that the varieties Daulat and Rai-5 were highly responsive and stable under a wide range of sowing time. The highest oil content of seed (43.4% and 44.0%) were obtained from BC-9917 in 2010-11 and BARI Sarisha-14 in 2011-12, which was identical to BARI Sarisha-6, BARI Sarisha-15, BC-9909, BC-9921, and BC-9922. The lowest oil content (39.37% and 40.10%) was obtained from Nap-0519 and Nap- 0544 in both the years (Table 1).

Table 1. Effect of sowing date and variety/line on flowering, maturity, growth and yield contributing characters of rapeseed-mustard during rabi season of 2010-11 and 2011-12.

Sowing date/ Genotype	1st flower (day).		Maturity (days).		Plant height (cm)		Siliquae/plant (No.)	
	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12
November 25	29	29	87	87	114.4	106.8	87.8	90.2
December 5	26	27	82	82	103.9	98.1	70.8	71
December 15	23	24	77	77	96.2	91.1	56.3	57.3
CV (%)	-	-	-	-	7.21	5.31	11.33	9.23
LSD (.05)	-	-	-	-	10.21	8.01	8.60	5.30
Genotype								
Nap-0559	23	23.3	77	77.9	79	86.5	63	62.6
Nap-0519	24	23.2	79	78.3	74	87.7	52	63.1
BARISarisha-8	24	24.9	78	78.1	87	88.9	50	63.9
Nap-0544	23	23.7	78	78.3	82	84.7	47	62.2
Nap-0538	25	24.1	80	78.9	83	82.9	48	62.0
Nap-0546	26	25.0	79	78.7	86	86.2	53	63.3
Nap-0528	26	24.8	79	78.4	87	88.7	46	64.0
Nap-0523	24	24.2	79	78.8	86	88.2	56	63.7
Nap-0564	25	24.4	78	78.2	86	83.7	59	62.1
Nap-0567	25	24.4	77	77.3	86	83.4	55	61.7
BARI Sarisha-13	25	25.9	87	82.0	86	82.7	58	63.5
BJDH-12	33	33.2	94	91.8	144	138.7	73	87.9
BJDH-05	32	32.4	94	93.1	160	145.2	88	90.3

Table 1. Cont'd.

Sowing date/ Genotype	1st flower (day).		Maturity (days).		Plant height (cm)		Siliquae/plant (No.)	
	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12
BJDH-11	33	33.1	94	92.2	148	140.0	89	88.4
BJDH-01	31	31.8	92	93.0	146	136.2	82	87.0
BJDH-20	33	33.0	94	91.9	141	139.2	88	88.0
BJDH-17	33	32.7	93	92.0	146	134.4	99	86.3
BARISarisha-11	32	32.0	92	91.0	151	136.6	**108**	86.5
BARISarisha-16	33	33.7	95	93.3	165	141.3	99	89.4
JBC-05115	25	26.1	78	82.9	84	70.4	57	59.8
JBC-05118	26	27.0	77	77.9	87	73.8	47	59.5
BC-9921	24	24.1	79	78.1	99	86.2	93	62.8
BC-9917	22	22.8	78	78.1	97	83.8	84	61.6
BC-9922	23	22.8	77	77.1	93	86.9	94	62.3
BC-9909	23	23.0	77	77.2	91	88.9	97	63.0
BARI Sarisha-9	24	23.3	75	75.9	94	81.8	88	60.3
BARI Sarisha-15	26	24.6	76	75.9	99	82.7	72	61.0
BARI Sarisha-14	25	23.7	77	75.8	86	69.6	52	56.3
BARI Sarisha-6	24	26.4	81	79.1	107	94.9	60	66.8
Tori-7	22	22.0	75	74.8	88	85.0	93	60.6
CV(%)	-	-	-	-	5.79	4.58	11.33	9.33
LSD(.05)	-	-	-	-	12.06	11.03	9.38	7.56

Table 1. Cont'd.

Sowing date/ Genotype	Seeds/siliqua (No.)		1000-seed wt (g)		Seed yield (kg/ha)		Oil (%)	
	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12
November 25	23	83.0	3.4	3.40	1310	1535	42.8	43.0
December 5	20	77.8	3.02	2.98	1074	1201	42.0	41.8
December 15	11	110.1	2.82	2.82	816	895	41.3	40.6
CV (%)	8.0	7.40	8.02	6.03	14.71	12.61	3.00	2.95
LSD(.05)	7.7	6.20	0.63	0.57	103.5	99.5	1.09	1.02
Genotype								
Nap-0559	19	20.0	3.17	3.15	1157	1368	41.53	41.7
Nap-0519	15	16.8	3.17	3.13	1020	1146	39.37	41.1
BARI Sarisha-8	21	22.8	3.17	3.18	1078	1341	42.57	43.2
Nap-0544	18	19.9	3.27	3.26	995	1282	40.27	40.1
Nap-0538	24	25.1	2.97	2.94	1033	1306	42.13	42.9
Nap-0546	22	23.0	3.00	2.97	1080	1338	42.23	42.7
Nap-0528	23	24.0	3.27	3.29	1076	1377	42.23	42.5
Nap-0523	23	24.2	2.93	2.87	943	1262	42.03	42.0
Nap-0564	23	24.3	3.00	3.05	985	1274	41.67	42.0
Nap-0567	23	24.0	3.33	3.16	838	1125	41.60	41.7
BARI Sarisha--13	15	16.9	3.00	2.98	848	1011	41.03	42.5
BJDH-12	10	11.2	3.40	3.34	1187	1154	40.50	38.6
BJDH-05	10	11.6	3.47	3.38	1307	1268	40.90	38.8
BJDH-11	10	10.1	3.80	3.47	**1495**	1408	42.70	39.1

Table 1. Cont'd.

Sowing date/ Genotype	Seeds/siliqua (No.)		1000-seed wt (g)		Seed yield (kg/ha)		Oil (%)	
	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12
BJDH-01	10	11.4	3.30	3.45	1252	1191	42.23	40.3
BJDH-20	10	10.6	3.57	3.42	1320	1385	41.57	39.2
BJDH-17	11	11.2	3.70	3.58	1272	1265	41.73	39.0
BARI Sarisha-11	10	10.4	2.93	3.16	1086	1195	41.43	39.4
BARI Sarisha-16	11	12.5	3.73	3.31	1475	1415	42.30	39.3
JBC-05115	18	19.5	3.03	3.18	921	933	42.60	43.2
JBC-05118	20	21.9	3.13	3.15	757	749	42.20	43.2
BC-9921	17	18.9	2.40	2.70	985	1133	43.23	43.6
BC-9917	15	16.5	2.60	2.59	1071	1212	43.40	43.4
BC-9922	14	15.2	2.70	2.66	1106	1224	43.27	43.8
BC-9909	14	15.3	2.60	2.53	931	1114	43.33	43.8
BARI Sarisha-9	13	14.8	2.83	2.89	970	1092	42.33	43.1
BARI Sarisha-15	23	24.1	2.77	2.73	987	1188	43.30	43.6
BARI Sarisha-14	24	25.7	2.67	2.74	747	975	43.00	44.0
BARI Sarisha-6	16	17.7	3.37	3.07	1290	1423	43.27	43.8
Tori-7	16	17.3	2.53	2.73	788	1153	41.37	42.4
CV(%)	9.4	10.23	7.12	6.10	11.71	12.01	3.02	4.02
LSD(.05)	6.4	5.36	0.426	0.302	99.5	110.5	1.49	1.50

Table 2. Interaction Effect of sowing date and variety/line on flowering, maturity, growth and yield contributing characters of rapeseed-mustard during rabi season, 2010-11 and2011-12.

Variety/ Genotype	1st Flower(day).						Maturity(day).					
	25 Nov.		5 Dec.		15 Dec.		25 Nov.		5 Dec.		15 Dec.	
	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12
Nap-0559	25.5	25.3	23.0	23.7	20	21.0	84.5	86.7	76.0	76.0	71.0	71.0
Nap-0519	26.5	25.3	24.0	23.3	21	21.0	85.0	86.0	77.5	76.0	73.0	73.0
BARI Sarisha-8	27.0	28.3	24.0	24.7	21	21.7	85.0	84.7	77.0	77.5	72.0	72.0
Nap-0544	26.0	26.0	23.0	24.7	20	20.3	84.0	85.0	77.5	77.0	73.0	73.0
Nap-0538	27.5	26.7	25.0	23.3	22	22.3	86.0	85.7	78.5	77.0	74.0	74.0
Nap-0546	28.5	27.0	26.0	25.3	23	22.7	85.5	85.0	77.5	78.0	73.0	73.0
Nap-0528	28.5	26.3	26.0	25.3	23	22.7	85.5	85.3	77.5	77.0	73.0	73.0
Nap-0523	26.5	27.0	24.0	24.3	21	21.3	86.0	86.3	77.5	77.0	73.0	73.0
Nap-0564	28.0	26.3	25.0	24.7	22	22.3	84.5	85.7	76.5	77.0	72.0	72.0
Nap-0567	28.0	26.3	25.0	24.7	22	22.3	85.0	85.0	76.0	76.0	71.0	71.0
BARI Sarisha-13	28.0	28.3	25.0	26.3	22	23.0	87.0	85.0	89.5	76.0	85.0	85.0
BJDH-12	35.5	35.3	33.0	34.0	30	30.3	99.0	97.3	93.5	89.0	89.0	89.0
BJDH-05	35.0	34.7	32.0	32.7	29	30.0	99.0	97.3	93.5	93.0	89.0	89.0
BJDH-11	36.0	35.7	33.0	33.3	30	30.3	**99.5**	96.7	93.5	93.0	89.0	87.0
BJDH-01	34.0	34.7	31.0	32.3	28	28.3	97.5	96.0	92.0	93.0	87.0	90.0
BJDH-20	35.5	35.3	33.0	33.3	30	30.3	98.5	96.7	94.0	92.0	90.0	87.0
BJDH-17	35.5	35.0	33.0	32.7	30	30.3	98.5	97.0	92.5	94.0	87.0	85.0
BARI Sarisha-11	34.5	34.3	32.0	32.3	29	29.3	98.5	96.0	93.0	92.0	85.0	85.0

Table 2. Cont'd.

Variety/ Genotype	1st Flower(day).						Maturity(day).					
	25 Nov.		5 Dec.		15 Dec.		25 Nov.		5 Dec.		15 Dec.	
	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12
BARI Sarisha-16	36.0	36.7	33.0	34.0	30	30.3	99.5	97.0	94.0	93.0	90.0	90.0
JBC-5115	28.0	31.0	25.0	25.3	22	22.0	80.5	81.7	79.0	94.0	73.0	73.0
JBC-05118	29.0	32.7	26.0	25.7	23	22.7	81.0	81.7	78.0	79.0	73.0	73.0
BC-9921	27.0	26.7	24.0	24.3	21	21.3	84.0	83.3	79.0	78.0	73.0	73.0
BC-9917	25.0	26.0	22.0	22.3	19	20.0	82.5	82.3	78.5	79.0	73.0	73.0
BC-9922	25.5	25.3	23.0	23.3	20	19.7	81.0	81.3	78.0	78.0	72.0	72.0
BC-9909	25.5	26.0	23.0	22.7	20	20.3	81.0	81.7	77.5	78.0	72.0	72.0
BARI Sarisha-9	26.5	25.7	24.0	23.7	21	20.7	79.5	80.7	77.0	77.0	69.0	70.0
BARI Sarisha-15	29.0	26.7	26.0	24.7	23	22.3	81.5	80.7	77.5	77.0	69.0	70.0
BARI Sarisha-14	28.0	25.3	25.0	24.3	22	21.3	80.0	80.3	78.0	77.0	73.0	70.0
BARI Sarisha-6	27.0	30.7	24.0	27.3	21	21.3	80.0	83.3	88.0	78.0	76.0	76.0
Tori-7	24.5	24.3	22.0	22.3	19	19.3	77.0	77.3	76.0	76.0	71.0	71.0
CV(%)	-		-		-		-	86.0	-	76.0	-	73.0
LSD(0.05)	-		-		-		-	84.7	-	77.5	-	72.0

Table 2. Cont'd.

Variety/ Genotype	Plant height (cm)						Siliqua/plant (No.)					
	25 Nov.		5 Dec.		15 Dec.		25 Nov.		5 Dec.		15 Dec.	
	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12
Nap-0559	91.7	79.9	66.6	91.7	86.4	81.4	79.9	79.8	55.0	57.6	53.2	56.1
Nap-0519	82.1	71.7	69.6	95.3	85.7	82.1	71.6	80.0	49.5	56.7	33.4	42.0
BARISarisha-8	94.0	84.3	81.5	91.5	88.9	86.2	63.6	71.8	40.0	52.9	45.0	47.1
Nap-0544	86.9	84.2	73.6	92.0	85.3	76.9	56.1	75.5	49.1	46.3	35.4	36.0
Nap-0538	89.1	82.8	76.7	90.8	85.3	72.5	58.5	60.7	43.6	51.5	41.3	41.5
Nap-0546	100.0	84.3	72.6	96.3	87.1	75.2	61.6	61.3	56.1	48.7	42.2	41.7
Nap-0528	101.7	83.5	75.5	98.0	84.3	83.9	58.0	66.9	44.8	53.3	36.6	42.5
Nap-0523	89.6	84.7	82.4	90.7	90.5	83.5	63.9	59.9	56.5	49.7	48.5	47.5
Nap-0564	97.1	85.4	74.0	89.8	82.8	78.4	73.1	68.4	55.4	58.3	48.5	47.7
Nap-0567	90.2	85.4	81.1	87.0	86.1	77.2	58.1	74.8	58.9	57.2	47.5	51.7
BARISarisha-13	92.1	83.9	80.5	92.5	82.7	72.9	82.3	61.6	44.7	58.9	45.7	51.1
BJDH-12	153.5	146.9	131.1	150.1	132.1	133.8	76.8	83.7	78.4	66.3	64.5	49.1
BJDH-05	**174.9**	154.2	150.1	153.6	148.2	133.9	111.2	79.3	79.4	78.5	72.8	73.5
BJDH-11	156.0	147.8	139.1	148.1	139.5	132.3	111.5	111.1	87.8	81.6	68.0	65.1
BJDH-01	155.9	144.8	136.6	153.9	132.3	122.3	110.3	118.7	74.9	89.5	62.0	64.7
BJDH-20	160.9	139.1	124.4	144.6	141.7	131.2	107.8	112.8	87.2	77.7	68.8	70.6
BJDH-17	157.7	143.9	137.6	137.9	136.4	128.9	113.4	111.1	97.7	85.2	85.0	80.9
BARISarisha-11	156.2	152.1	144.1	149.8	131.5	128.5	**137.1**	114.6	98.5	97.5	89.2	90.7
BARISarisha-16	176.9	163.7	153.6	164.1	133.1	126.6	113.3	136.5	93.1	100.4	90.3	92.3

Table 2. Cont'd

Variety/ Genotype	Plant height (cm)						Siliqua/plant (No.)					
	25 Nov.		5 Dec.		15 Dec.		25 Nov.		5 Dec.		15 Dec.	
	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12
JBC-5115	90.8	81.9	80.3	82.1	66.1	62.9	69.9	114.0	55.6	94.6	45.1	46.9
JBC-05118	95.9	86.8	77.5	81.7	70.9	68.7	54.1	56.6	53.7	48.8	31.8	36.8
BC-9921	119.5	94.9	83.9	91.3	85.1	82.1	110.9	58.6	96.3	56.1	73.1	73.3
BC-9917	105.8	98.3	85.4	91.5	82.9	77.0	111.4	112.1	88.3	95.7	52.3	54.1
BC-9922	102.6	90.3	86.7	93.3	90.5	76.9	96.5	113.7	95.2	90.5	89.9	88.1
BC-9909	101.5	91.0	79.1	91.5	88.1	87.2	109.7	97.1	102.0	95.7	78.7	81.8
BARI Sarisha-9	101.6	95.6	85.4	85.9	82.3	77.2	117.7	113.9	85.0	103.1	61.3	64.1
BARI Sarisha-15	103.7	100.9	91.1	88.1	84.3	75.7	106.1	117.8	67.4	87.5	41.7	45.6
BARI Sarisha-14	89.5	85.1	84.3	82.5	65.9	60.3	63.1	107.3	59.0	64.7	34.1	33.9
BARI Sarisha-6	118.3	102.6	99.3	105.8	102.9	75.9	77.4	110.3	67.4	58.4	35.4	36.3
Tori-7	95.1	87.3	81.6	91.1	83.1	80.8	109.8	76.3	103.3	67.1	67.2	66.1
CV(%)	-	-	5.79	-	-	4.58	-	-	11.33	-	-	9.33
LSD(0.05)	-	-	12.06	-	-	11.03	-	-	9.38	-	-	7.56

Table 2. Cont'd.

Variety/ Genotype	1000-seed wt (g)						Seed yield (kg/ha)					
	25 November		5 December		15 December		25 November		5 December		15 December	
	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12
Nap-0559	3.5	3.46	3.1	3.07	2.9	2.90	1500	1626	1212	1222	758	956
Nap-0519	3.7	3.51	2.9	3.01	2.9	2.88	1182	1450	1076	1033	803	757
BARISarisha-8	3.7	3.63	3.0	2.97	2.8	2.93	1258	1740	1197	1327	779	956
Nap-0544	3.8	3.69	3.1	3.13	2.9	2.97	1417	1721	1130	1343	758	982
Nap-0538	3.2	3.29	2.9	2.78	2.8	2.76	1258	1662	985	1164	855	892
Nap-0546	3.4	3.42	2.8	2.79	2.8	2.71	1288	1743	1097	1333	855	937
Nap-0528	3.4	3.41	3.3	3.35	3.1	3.10	1242	1750	1061	1351	924	930
Nap-0523	3.3	3.04	2.9	2.99	2.6	2.57	1264	1591	818	1171	748	923
Nap-0564	3.4	3.54	2.9	2.89	2.7	2.71	1167	1687	1061	1293	727	842
Nap-0567	3.7	3.41	3.3	3.10	3.0	2.97	1121	1438	803	1011	591	727
BARISarisha-13	3.4	3.39	2.9	2.93	2.7	2.62	1121	1218	833	1177	591	638
BJDH-12	3.7	3.42	3.5	3.39	3.0	3.22	1742	1740	1242	1333	576	588
BJDH-05	3.7	3.53	3.4	3.43	3.3	3.17	1727	1720	1233	1407	961	976
BJDH-11	**4.0**	3.54	3.8	3.51	3.6	3.37	1758	1708	1458	1364	1268	1253
BJDH-01	3.5	3.86	3.3	3.37	3.1	3.14	1485	1471	1348	1160	924	941
BJDH-20	3.9	3.68	3.5	3.38	3.3	3.20	1697	1669	1152	1288	1112	1197
BJDH-17	3.9	3.83	3.7	3.50	3.5	3.41	1545	1663	1348	1290	924	941
BARI Sarisha-11	3.1	3.54	3.0	3.00	2.7	2.94	1561	1635	970	1197	727	753
BARI Sarisha-16	3.9	3.56	3.8	3.35	3.5	3.03	1742	1825	1424	1388	1258	1212

Table 2. Cont'd.

Variety/ Genotype	1000-seed wt (g)						Seed yield (kg/ha)					
	25 November		5 December		15 December		25 November		5 December		15 December	
	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12
JBC-5115	3.3	3.63	3.1	3.02	2.7	2.90	1142	1129	909	925	712	745
JBC-05118	3.4	3.34	3.1	3.15	2.9	2.95	1500	1626	848	712	515	579
BC-9921	2.7	3.41	2.3	2.41	2.2	2.28	1182	1450	909	1162	773	939
BC-9917	3.1	3.04	2.3	2.41	2.4	2.31	1258	1740	1076	1328	909	959
BC-9922	2.9	2.93	2.5	2.42	2.7	2.63	1417	1721	1152	1236	909	1073
BC-9909	3.1	2.84	2.5	2.50	2.2	2.25	1258	1662	985	1065	718	950
BARI Sarisha-9	3.0	3.07	2.9	2.96	2.6	2.64	1288	1743	955	1129	909	1022
BARI-15	3.1	3.11	2.7	2.59	2.5	2.50	1242	1750	1067	1100	818	891
BARI Sarisha-14	3.1	3.22	2.5	2.51	2.4	2.50	1264	1591	803	1094	530	636
BARI Sarisha-6	**4.0**	3.21	3.2	3.10	2.9	2.88	1167	1687	1364	1284	915	1038
Tori-7	2.9	3.45	2.5	2.52	2.2	2.23	1121	1438	818	1013	621	714
CV(%)			7.12			6.10			11.71			12.01
LSD (0.05)			0.426			0.302			99.5			110.5

Table 2. Interaction effect of sowing date and variety/line on yield contributing characters of rapeseed-mustard during rabi season, 2010-11 and 2011-12 .

Variety/ Genotype	Stover yield (kg/ha)						Oil (%)					
	25 November		5 December		15 December		25 November		5 December		15 December	
	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12
Nap-0559	3312	3626	3012	3022	1758	1956	42.2	43.1	41.5	41.5	40.9	40.4
Nap-0519	2882	3450	2576	2533	1803	1757	40.2	42.3	39.2	41.0	38.7	40.1
BARI Sarisha-8	3058	3740	2797	3227	1779	1956	42.6	43.4	43.1	43.1	42.0	42.9
Nap-0544	3417	3721	2730	3243	1758	1982	40.5	40.4	40.2	40.2	40.1	39.7
Nap-0538	3058	3662	2085	2864	1855	1892	42.6	43.2	42.3	42.9	41.5	42.5
Nap-0546	3027	3743	2597	3233	1855	1937	43.3	43.3	42.2	42.9	41.2	41.9
Nap-0528	3042	3750	2461	3351	1924	1930	43.1	44.1	42.2	42.0	41.4	41.5
Nap-0523	3064	3591	2018	2871	1748	1923	43.2	43.8	41.7	41.7	41.2	40.6
Nap-0564	2867	3687	2412	3093	1727	1842	42.3	42.5	41.7	41.8	41.0	41.6
Nap-0567	2821	3438	1803	2511	1591	1727	42.2	42.3	41.6	41.8	41.0	41.1
BARI Sarisha-13	2821	3118	1833	2977	1591	1638	41.8	43.8	41.0	42.4	40.3	41.4
BJDH-12	3742	3740	3042	3033	1576	1588	40.8	40.5	40.5	38.4	40.2	37.0
BJDH-05	3727	3720	3033	3207	1961	1976	41.4	40.6	40.7	38.1	40.6	37.7
BJDH-11	3758	3708	3258	3064	3068	3053	43.5	40.0	42.4	39.2	42.2	38.2
BJDH-01	3485	3471	3048	2960	1924	1941	42.7	41.1	41.9	40.6	42.1	39.2
BJDH-20	3697	3669	2552	3088	2512	2597	42.3	41.2	42.1	39.2	40.3	37.2
BJDH-17	3545	3663	3348	3090	1924	1941	42.8	40.2	41.7	39.2	40.7	37.6
BARI Sarisha-11	3561	3635	2170	2997	1727	1753	42.7	40.3	41.4	39.3	40.2	38.7

Table 2. Cont'd.

Variety/ Genotype	Stover yield (kg/ha)						Oil (%)					
	25 November		5 December		15 December		25 November		5 December		15 December	
	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12
BARI Sarisha-16	3742	3825	3224	3288	3058	3012	43.6	41.1	42.2	39.1	41.1	37.8
JBC-5115	2842	2929	2109	1925	1712	1745	43.4	44.2	42.8	43.8	41.6	41.7
JBC-05118	3000	3626	1848	1712	1515	1579	43.1	44.1	42.0	43.7	41.5	41.8
BC-9921	2882	3450	1909	2962	1773	1939	44.2	44.6	43.0	43.8	42.5	42.5
BC-9917	3058	3740	2476	3228	1909	1959	44.2	44.8	43.1	43.8	42.9	41.7
BC-9922	3417	3721	2852	3036	1909	2573	44.2	45.0	43.1	43.7	42.5	42.8
BC-9909	3058	3662	1985	2265	1718	1950	44.2	44.8	43.1	43.6	42.7	42.9
BARI Sarisha-9	3088	3743	1955	2529	1909	2722	43.0	44.5	42.2	43.3	41.8	41.5
BARI Sarisha-15	3042	3750	2867	2600	1818	1891	44.0	44.6	43.3	44.0	42.6	42.2
BARI Sarisha-14	3064	3591	1803	2294	1530	1636	44.0	45.9	43.1	44.3	41.9	41.7
BARI Sarisha-6	2867	3687	2964	3084	1915	2238	44.4	45.1	43.4	44.3	42.0	42.0
Tori-7	2621	3438	1818	2013	1621	1714	42.5	44.2	41.4	42.0	40.2	41.0
CV(%)	-	-	5.31	-	-	6.53	-	-	3.02	-	-	4.02
LSD(0.05)	-	-	302.5	-	-	412.3	-	-	1.49	-	-	1.50

Table 3. Interaction effect of sowing date and variety/line on insect infestation and disease index of rapseed-mustard during the rabi season, 2010-11 and 2011-12.

Variety/ Genotype	No.of aphids/plant						Disease score (PDI)					
	25 November		5 December		15 December		25 November		5 December		15 December	
	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12
Nap-0559	24	18	45	42	65	62	65	65	76	76	34	34
Nap-0519	26	20	38	35	61	60	65	65	83	83	38	38
BARI Sarisha-8	28	22	48	38	85	75	70	70	79	79	28	28
Nap-0544	29	24	52	42	78	80	84	84	72	72	42	42
Nap-0538	33	28	59	45	82	85	61	61	74	74	23	23
Nap-0546	31	25	45	35	75	78	70	70	76	76	37	37
Nap-0528	35	27	55	48	89	84	76	76	63	63	23	23
Nap-0523	27	21	60	55	92	94	71	71	80	80	56	56
Nap-0564	34	23	50	45	99	80	73	73	93	93	47	47
Nap-0567	23	17	42	40	83	75	82	82	92	92	63	63
BARI Sarisha-13	40	30	61	48	110	75	78	78	96	96	50	50
BJDH-12	35	40	65	58	220	200	29	29	18	18	22	22
BJDH-05	45	48	75	68	240	220	25	25	8	8	28	28
BJDH-11	39	42	62	55	205	230	43	43	8	8	45	45
BJDH-01	54	38	85	75	250	240	38	38	29	29	46	46
BJDH-20	50	52	79	72	220	245	28	28	14	14	32	32
BJDH-17	42	38	65	63	210	220	33	33	13	13	41	41
BARI Sarisha-11	50	45	81	78	230	75	55	55	20	20	37	37

Table 3. Cont'd.

Variety/ Genotype	No.of aphids/plant						Disease score (PDI)					
	25 November		5 December		15 December		25 November		5 December		15 December	
	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12
BARI Sarisha-16	61	55	92	85	180	165	30	30	7	7	27	27
JBC-5115	55	45	95	90	180	200	59	59	-	-	67	67
JBC-05118	51	45	87	86	225	235	78	78	-	-	76	76
BC-9921	65	42	92	100	245	185	43	43	-	-	50	50
BC-9917	50	50	85	98	190	200	50	50	-	-	44	44
BC-9922	62	42	92	92	210	185	66	66	-	-	66	66
BC-9909	54	38	85	82	195	200	38	38	-	-	86	86
BARI Sarisha-9	58	32	92	85	215	130	43	43	-	-	34	34
BARI Sarisha-15	41	44	72	65	140	120	37	37	-	-	23	23
BARI Sarisha-14	47	33	85	75	165	140	52	52	-	-	56	56
BARI Sarisha-6	55	45	97	85	175	140	39	39	31	31	22	22
Tori-7	62	55	114	110	280	200	49	49	-	-	26	26

Interaction between sowing dates and varieties/ genotypes

Phenological data of 30 genotypes during three sowing dates are presented in Fig. 1 and 2. Different dates of sowing and varieties/genotypes had significant effect on plant height, siliquae/ plant, seeds/siliqua,1000- seed weight. seed yield, strover yield, and oil content (Table 2).The highest plant height (176.7cm and 163.9cm) was found in BARI Sarisha-16 sown on 25 November. The shortest plant height (70.9cm and 68.7cm) was found from 15 December sowing with JBC-05118. On an average, at early sowing it took 26 days and 29 days to flower and 86 and 87 days to mature and at the later sowing, it took 22 and 23 days to flower and 76 days and77 days to maturity, respectively. This variation might have occurred due to rise in temperature. During the months of January and February, temperature started rising which may have been forced the plant to maturity. Hang and Gilliland (1984) reported that days to flower and days to maturity varied year to year depending upon the temperature. Delayed seeding reduced the number of days to flower and days to maturity. Mondal and Wright (1986) also found that a temperature range 5 - 15 ^{0} C is optimum for the normal growth and development of rapeseed plant. Above and below this range, temperatures reduced growth rate by reducing plant height and dry matter accumulation. Total dry matter weight (30.20 and 33.89g) produced by BJDH-20 genotypes at 25 November sowing (Fig. 1 and 2). The highest number of siliquae/plant (136 and 137) were obtained from 25 November sowing with BARI Sarisha-16 which differed significantly from that of other dates of sowing (Table 2). This happened probably due to comparatively good temperature and moisture received by the plants from 25 November sowing, but high temperature and stressed condition of both these factors was apparent in the later sowing. The lowest number of siliquae/plant (31and36) was found in plant sown at 15 December. The reduction in siliqua on main shoot and seeds/siliqua could be due to floral sterility as temperature>27^{0}C has been reported to induce floral sterility in canola (Morrison and Stewart, 2002) as well as development of flowers into seedless parthenocarpic fruits or flower abortion on the stem due to high temperature (Young *et al.,* 2004). Maximum 1000-seed weight (4.0g) was obtained from BARI Sarisha-6 and BJDH-11 in first year, which was significantly identical to BJDH-01 and BJDH-17 (Table 2) During second year, maximum 1000-seed weight (3.89g) was obtained from BJDH-01when plant sown on 25 November. Seed yield showed declining trend in all the varieties under late sown condition. The highest seed yield (1758 and 1825 kg/ha) was recorded from BJDH-11 and BARI Sarisha-16 at 25 November sowing which was identical to BJDH- 05, BJDH-12, BJDH-20, and BARI Sarisha-6 (Table 2). Higher seed yield of BJDH-11 and BARI Sarisha-16 than that of other varieties might be due to higher grain weight. Lowest seed yield (515 and 579 kg/ha) was obtained from JBC-05118 at 15 December sowing which might be due to shorter growing period and thereby less siliquae/plant, 1000-grain weight, and other yield contributing characters. The

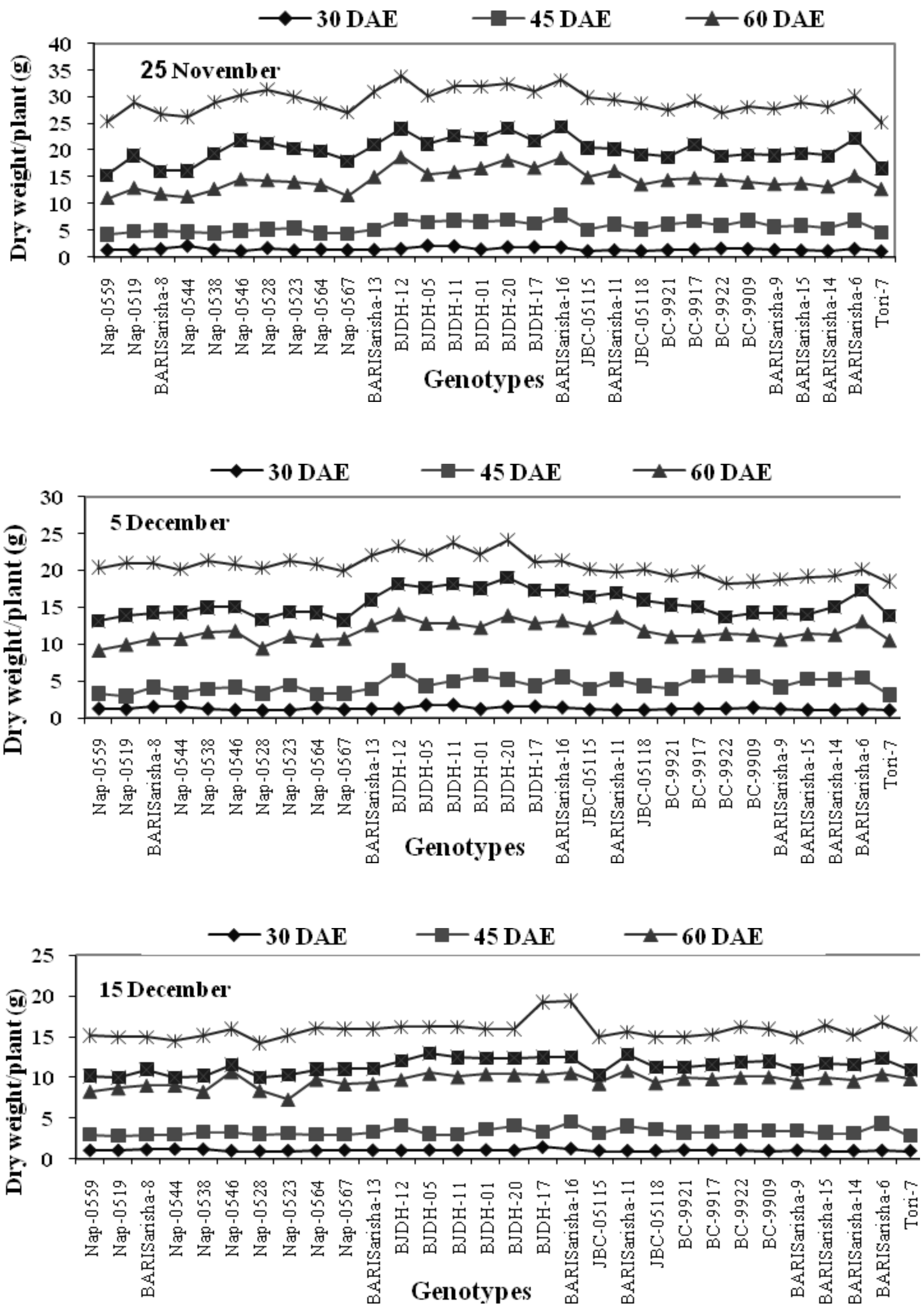

Fig. 1. Total dry matter weight of mustard varieties /genotypes under late sown condition during 2010-11.

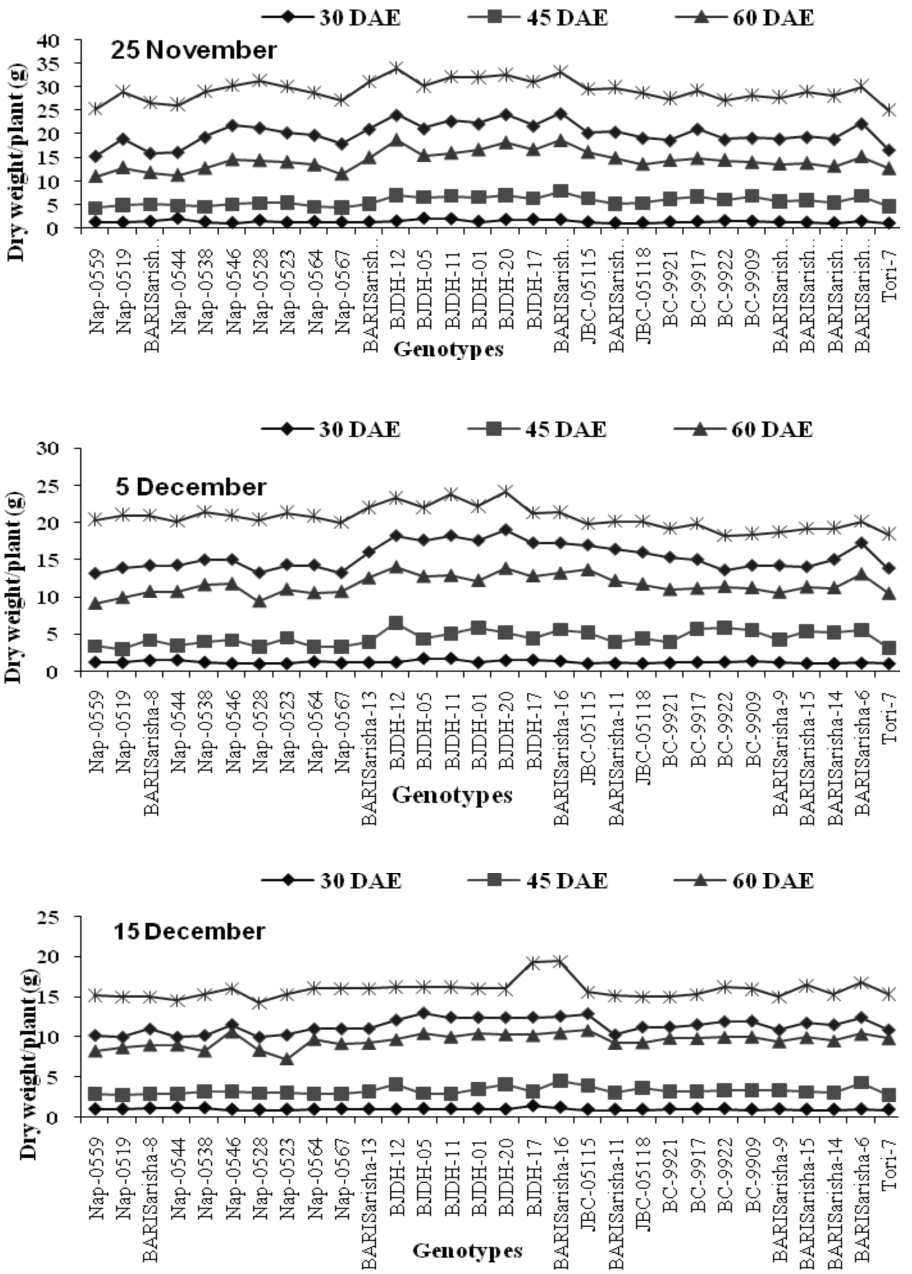

Fig. 2. Total dry matter weight of mustard varieties /genotypes under late sown condition during 2011-12.

results were in agreement with those of Subrahmanyam and Rathore (1994) who observed that high temperature during reproductive stage significantly inhibited the import of photosynthates by both upper and lower pods of terminal reaceme and thereby reduced sink strength. Heat stress also decreased oil content as both are negatively correlated. Under late sowing condition, siliqua number also decreased. High temperature and long days during pod development phase accelerated rapid maturity of pods causing lower yield. The maximum stover yield (3758 and 3825 kg/ha) was obtained from BJDH-11 and BARI Sarisha-16 of *Brassica juncea* from 25 November planting. The highest oil content in seed (44.4% and 45.1%) was recorded from BARI Sarisha-6 in 25 November sowing and the lowest oil content in seed (38.1% and 39.6%) was recorded from JBC-05118 at 15 December sowing. Insect infestation and disease index were increased with delayed sowing (Table 3). On an average, minimum insect infestation was obtained from first sowing. Maximum insect infestation was obtained from delay sowing due to high temperature which creates favourable condition for insect generation (Table 3). On an average, minimum disease score was found in seeds sown in 25 November and maximum disease score was found in seeds sown in 15 December (Table 3). *Brassica juncea* group and *B. napus* group showed better resistant performance against insect infestation and disease than *B. campestries group.* Under late sowing condition, yield performance of *B. juncea* group was better than *B. campestries* and *B. napus* groups. The five varieties/lines, namely BARI Sarisha -11, 16, BJDH-11, 12, 17, and 20 were adaptable in a wide range of sowing dates. Nap-0559 and Nap- 0546 lines of *B.napus* groups and BC-9921 and BARI Sarisha-6 of *B. campestries* were moderately adapted in a wide range of sowing time but *B. napus* groups and *B. campestries* were highly responsive and unstable under a wide range of sowing time. Therefore, these groups were suitable only under the most favourable date of sowing (25 November).

Conclusion

Form the above results, it may be concluded that the variety BARI Sarisha -11, BARI Sarisha -16, BJDH-11, 12, 17, and 20, Nap- 0559, BARI Sarisha-6, BC-9921, and BC-9922 performed better in 25 November sowing and a wide range of planting time for higher seed yield and delay in sowing reduces seed yield. BARI Sarisha -16, BJDH-11, 12, 17, and 20 , Nap-0559, BARI Sarisha-6 and BC-9922 performed better in 5 December sowing and BARI Sarisha -16, BJDH-11,12, and 20 performed better in 15 December sowing. The variety BARI Sarisha-16 may be recommended for late sowing condition after harvest of T. ama rice.

References

Brar, Z. S., D. S. Bal and A. S. Johi. 1998. Influence of sowing dates,nitrogen and planting geometry on the performance of gobhi sarson (*B. napus*). *Indian J. Agronomy* **43** (1) 133-137.

Biswas, K. P. 1989. Effect of sowing time on the yield and yield attributes of two mustard varieties. *Bangladesh J. Agric.* **14** (4): 317-320.

Chakraborty, P. K., A. Majumdar and B. N.Chatterjee. 1991. Physiological process in Indian mustard Brassica juncea)and yellow sarson (*Brassica napus* var Glauca) and their agronomic appraisal in mild and short winter prevailing in Gangetic plains of eastern India. *Indian J. Agric. Sci.* **61**(11): 851- 858.

Eberhort, S. A. and W. A., Russel.1966**.** Stability parameters for comparing varieties. *Crop Sci*. **6:** 36-40.

Finalay, K. W. and G. N.Wilkinson. 1963. The analysis of adaptation in plant breedingprogramme. *Aust. J. Agric. Res.* **4:** 742-754.

Hang, A.N. and G.C. Gilliland. 1984. Planting date effects on yield and quality of oilseed Brassica spp. Washington State University Agric. *Res. Centre Res. Bull*. **944:** 1-12.

Islam, N., O. M. Choudhury., N. A. Sarder and S.M.R. Karim. 1994a. Effects of sowing date on plant development, growth and yield of mustard and rapes-A review. *Bangladesh J. Agril Sci.* **21:** 311-322.

Islam, N., O.M. choudhury., N. A. Sarder and S.M.R. Karim. 1994b. Effects of sowing date on, growth and development of mustard and rapes. *Prog. Agric.* **5**(1): 23-29.

Mondal, M.R.I and M.J. Wright. 1989**.** Environmental effect on plant growth, morphological characters, yield, oil content and fatty acid composition of canola rapeseed. M.S. Thesis, Cornell University, Ithaca, New York, U.S.A

Mondal, M.R.I., M.A. Islam and M.A. Khaleque. 1992. Effect of variety and planting date on the yield performance of mustard / rapeseed. *Bangladesh J. Agril. Sci.* **19** (2): 181-186.

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

Mondal, M. R. I. and M.A.Wahhab. 2001. Production technology of oilcrops. Oilseed Research Centre, BARI, Joydebpur, Gazipur, Bangladesh. Pp. 4 -30.

Morrison, M.J. and D.W. Stewart. 2002**.** Heat stress during flowering in Summer Brasica. *Crop Science* **42:** 797-803.

Perkins, J. M. and J. L. Jinks.1968**.** Environmental and genotype environmental components of variability. *Heredity* **23:** 339-356.

Podder, P., .M. Kader., B.K.Biswas. , M.S. Alam and M.R.Amin 1996. Stability analysis for seed yield and yield components in mustard under different dates of sowing. *Bangladesh J. Agril. Sci.* **23**(2): 1-6.

Rao, G. U., A. Jain and K.T. Shivana. 1992. Effect of high temperature stress on Brassica pollan:viability, germination and ability to set fruits and seeds. *Ann. Bot.* (London) **69:** 193-198.

Sarma, R.N. and A. Roy. 1993. Phenotypic stability for seed yield and maturity in toria (*Brassica napus var. napus*) and Indian mustard (*Brassica juncea*). *Indian J. Agril. Sci.* **63**(12): 814-817.

Saran, G and G. Giri, 1987. Influence of dates sowing on Brassica species under semi-arid rainfed condition of north-east India. *Indian.J.Agric.Sci, Camb* **108:** 561-566.

Stern, M. 2006. Stern Review, the economics of climate change;United Kingdom. SCC. 2006. Addressing technical Assistance needs for adatation to climate change in vulnerable Commonwealth countries; SCC Data paper 1;26th Commonwealth Parliamentary Conference of Members from small countries; Abuja, Nigeria.

Stryer, L. 1980. Fatty acid metabolism in Biochemistry (2nd ed.) Stanford Univ. Freeman Co. New York, San Francisco. P. 385.

Subrahamanyam, D. and V. S. Rathore. 1994. Effect of high temperature on CO2 assimilation and partitioning in Indian mustard. *Journal Agronomy and Crop Science* **172:** 188-193.

Tuteja, S. S., Lakpale, R., Tripathi, R. S. 1996. Effect of date of sowing , nitrogen level and nitrogen splitting on mustard (*B. juncea*). Advances in Plant Sciences **9**(1) 167-168.

Ullah, A. 1989. Food consumption pattern of rice growing and rice mustard growing household of pabna district in Bangladesh: A comparative study. M.S. Thesis. Institute of Human Nutrition and Food. UPLB. Philippines.

Young, L. W., R. W. Wilen and P. C. Bonham-Smith. 2004**.** High temperature stress of *Brassica napus* during flowering reduces micro and megagametophyte fertility, induce fruit abortion and distrupts seed production. *Journal of Experimental Botany*. **55:** 485-495.

Appendix I. Weekly average minimum and maximum temperature and total rainfall at BARI, Joydebpur, Gazipur during the period from October to April (2010-11and 2011-12).

Month and Week	Temperature (^{0}C)				Rainfall (mm)	
	Maximum	Minimum	Maximum	Minimum		
October	2010-11		2011-12		2010-11	2011-12
1st week	32.8	25.8	29.53	27.14	10	5
2nd week	31.4	23.8	30.08	25.55	11.14	13
3rd week	33.6	25.2	28.54	24.91	6.14	0
4th week	31.9	22.3	26.94	21.95	0	0
November						
1st week	31.72	21.15	25.96	20.59	0.14	0
2nd week	31.35	19.31	26.79	19.80	0	0
3rd week	30.0	19.12	24.54	19.30	0	0
4th week	29.00	17.68	24.53	17.74	0	0
December						
1st week	27.95	14.17	24.41	17.60	0	0
2nd week	26.06	16.7	23.33	15.81	7.57	0
3rd week	25.56	12.20	15.54	12.73	0	0
4th week	25.48	11.21	22.76	13.15	0	0
January						
1st week	20.67	12.43	24.13	14.51	0	4
2nd week	20.07	10.8	23.16	12.46	0	6
3rd week	19.32	9.22	23.85	11.91	0	2
4th week	25.51	12.09	25.64	10.58	0	0
February						
1st week	27.68	12.87	27.71	11.96	0	0
2nd week	28.85	12.48	27.09	12.53	0	0
3rd week	27.22	17.41	28.87	13.79	0	0
4th week	29.25	14.6	31.01	14.34	0	0
March						
1st week	31.9	15	31.99	18.61	0	0
2nd week	32.1	17.8	32.68	18.84	2.75	0
3rd week	32.13	22.2	32.81	20.09	0	0
4th week	29.88	20.9	34.65	22.19	6.37	0
April						
1st week	31.37	20.76	32.26	21.99	9.25	7
2nd week	34.01	21.85	30.53	22.10	0.1	62
3rd week	33.17	21.43	34.78	22.10	3.5	80
4th week	32.88	21.9	34.43	22.10	8.12	14
May						
1st week	32.78	22.5	33.01	20.74	6.85	57
2nd week	33.34	23.21	34.61	25.33	5.71	16
3rd week	33.07	22.91	34.79	22.99	10.0	40
4th week	33.11	24.42	34.44	26.68	8.2	36