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RESEARCH PAPER

Effect of sowing dates on growth, yield and economics of different varieties of Indian mustard (*Brassica juncea* L.)

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Abstract : The experiment comprised five varieties of Indian mustard and four dates of sowing was carried out during *Rabi* 2011-12 and 2012-13. Maximum plant height (175.1 cm), dry matter accumulation (53.4 g/plant) and secondary branches (4.58) were observed with PBR-375 which was significantly higher than other varieties. Sowing dates also significantly affect the growth parameters except primary branches and maximum plant height (175.1cm), dry matter accumulation (53.4 g/plant) and secondary branches (4.58) were recorded in 27 October sowing date which was significantly higher than other dates of sowing. PBR-375 resulted yield attributes, yield (2770.5 kg/ha), gross return (69264 Rs./ha), net return (38031 Rs./ha) and b: c ratio (1.49) significantly higher than other varieties of Indian mustard. Delay in sowing dates from 27 October to 10 December, decreases siliquae /plant, siliqua length, seed per siliqua and 1000-seed weight statistically. The best sowing dates in comparison of four sowing dates was appeared to be 27 October, as it produced significantly higher seed yield (2740.4kg/ha), gross return (68512 R.s/ha), net return (37383 Rs./ha) and b: c ratio (1.47) as compared to other sowing dates. The N, P K and S uptake were non-significantly affected by different varieties of Indian mustard. 27 October sowing date recorded significantly higher N, P, K and S uptake than other sowing dates of Indian mustard.

Key Words : Indian mustard varieties, PBR-375, Sowing dates, Yield, Economics

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INTRODUCTION

Indian mustard (*Brassica juncea* L.) belongs to Cruciferae family and genus *Brassica*. The production of rapeseed mustard in India was 6.8 million tones with productivity of 1145 kg/ha and area harvested 5.9 million hectare (Economic survey, 2012-13). It is cultivated in winter season and is a thermo as well as photosensitive crop (Ghosh and Chatterjee, 1998). Cultivation of low yielder varieties is the major causes for poor yield of mustard in Punjab. High yield potential of a variety is the prerequisite for increasing the production of a crop. In recent years, attempts have been made by developing new high yield varieties of mustard, which occupy a prominent position among oilseeds. Production potentiality of mustard can be fully-exploited with suitable agronomic practices. Among the different agronomic practices, optimum sowing time plays an important role to fully-exploit the genetic potentiality of a variety as it provides optimum growth conditions such as temperature, light,

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humidity and rainfall (Iraddi, 2008). Sowing at proper time allows sufficient growth and development of a crop to obtain a satisfactory yield and different sowing dates provide variable environmental conditions within the same location for growth and development of crop and yield stability (Pandey *et al*., 1981). If the mustard is sown late, duration is reduced due to the high temperature during the reproductive phase with concomitant reduction in yield (Radha Kumari *et al*., 2004). In late autumn sowing, seed germination is very slow and this leads to limited seedling development (Kondra *et al*. 1983; Christensen and Drabble, 1984). Keeping all this in view, the present investigation was taken up to find out suitable time of sowing in the agro-climatic conditions of south-western region of Punjab (semi-arid area) for realizing the maximum yield potential of five high yielding varieties of Indian mustard.

MATERIAL AND METHODS

This research was laid out with the aim of evaluating the agronomic traits of different varieties of Indian mustard (*Brassica juncea* L.) under different date of sowing in growing season of *Rabi* 2011-12 and 2012-13. The site is located at latitude of 30° 202 N, longitude of 74° 952 E and 201 meters above the sea level in semi-arid climate with having cold winters and hot and dry summer. The annual rainfall of Bathinda is between 20-40 mm. The summer temperature reaches upto 48°C and during winters, the minimum temperature reaches to 0°C. The experiment was carried out in split plot design with three replications in the research field of Punjab Agricultural University, Regional Research Station, Bathinda. The soil of experimental site was sandy loam in texture, medium in available N (271 kg/ha), P (15 kg/ha), K (220 kg/ha), medium in organic carbon content (0.65%) and slightly alkaline in reaction with pH 8.1. The treatments were combination of 5 varieties (PBR-375, PBR-210, RLM 619, RLC-1 and RLC-2) and 4 sowing dates (27-October, 12-November., 25- November. and10-December.). At the peak growing season (60 DAS), 5 plants were chosen randomly from each plot and were cut from the surface and dry matter accumulation per plant was recorded. Plant height, primary branches, secondary branches, number of siliquae per plant, siliqua length and number of seeds per siliqua, were measured at harvest stage. At physiological maturity stage, for determining the seed yield, the crop was harvested from net plot area from each plot and was left in the field for drying. In order to separate seeds form siliquae, manual threshing was done. The harvested seeds from each plot individually weighed with a precision scale and thereafter seed yield expressed as kg/ha. Finally 1000 seeds were taken from each seed lot of the experimental plots and then weighed and express as 1000-seed weight (g). N, P, K and S (kg/ha) uptake by mustard were estimated at harvest stage. The gross realization in terms of rupees per hectare was calculated from the realization received from seed yield at the prevailing market price. The cost of cultivation was worked out by considering the cost of all the inputs and cultural operations right from the land preparation to the harvesting of the crop. The net realization was worked out by deducting the cost of cultivation (variable cost) from the gross realization per hectare for each treatment. The benefit: cost ratio (B: C) was calculated by dividing the net returns with total expenditure by using following formula :

$$\text{BCR} = \frac{\text{Total net realization (Rs./ha)}}{\text{Total cost of cultivation (Rs./ha)}}$$

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Growth parameters :

The plant height, dry matter accumulation and secondary branches of Indian mustard were significantly affected by different varieties of Indian mustard (Table 1). The maximum plant height, dry matter accumulation and secondary branches of Indian mustard were observed with PBR-375 which was significantly higher than other varieties. The more number of primary branches were observed with PBR-375, although the difference was non-significant with respect to other varieties of Indian mustard. Growth parameters *viz.,* plant height, dry matter accumulation and secondary branches of Indian mustard were also significantly affected by different date of sowing. Delay in sowing dates from 27 October to 10 December, decreases plant height, dry matter accumulation, primary branches and secondary branches of mustard. Maximum plant height (175.1cm), dry matter accumulation (53.4 g/plant) and secondary branches (4.58) were recorded in 27 October sowing date which was significantly higher than other dates of sowing. Maximum use of the sources and appropriate

growth condition for increase in the number of leaves and internodes due to their long-term growth period in an early sowing date can be considered as the main factors for increasing the growth parameters. In contrast, in the late planting dates, especially in 27 January, because of the shortened growing season, the plant could not exploit the existing resources and environmental condition properly and this restriction was quiet evident as a decrease in the growth parameters (Rafiei *et al.*, 2011). These results were in well agreement with the finding of Shahidullah *et al*. (1997); Singh and Singh (2002) and Panda *et al*. (2004) who reported that, late sowing brings about a significance decrease in the growth parameters.

Yield attributes:

The silqua per plant were significantly affected by different varieties of Indian mustard (Table 1). Maximum silqua per plant were observed with PBR-375 which was significantly higher than other varieties of Indian mustard. The other yield attributes *viz.,* siliqa length, seed per siliqa and 1000-seed weight were non-significantly affect by different varieties of Indian mustard. The more siliqa length, seed per siliqua and 1000-seed weight were observed with PBR-375, although the difference was non-significant with respect to other varieties of Indian mustard. Yield attributing characters *viz.,* siliqua per plant, siliqa length, seeds per siliqa and 1000-seed weight were significantly affected by different date of sowing.

Delay in sowing dates from 27 October to 10 December, decreases siliquae /plant, siliqa length, seed per siliqa and 1000-seed weight statistically (Table 1). The highest number of siliquae per plant (175.2) was obtained from the plants of first sowing (27 October), which was significantly higher than other dates of sowing differing. This finding was in conformity with the findings of Mondal *et al*. (1999) who stated that the plants of early planting produced the highest number of siliquae / plant and reduced in the late sowings. In this regard, Norton *et al*. (1991) reported that in an early sowing condition, the survival chances of seed and siliqua on the upper part of main stem and top branches are high. The comparison of individual treatment means reflects that the highest number of seeds (12.3) per siliqua and siliqua length (4.3 cm) were recorded in 27 October sowing date which was significantly more than other date of sowing. The lowest seed number per siliqua and siliqua length were found in the plants of 10 December sowing date. These results were in agreement with the results of Mondal *et al*. (1999) and Shahidullah *et al*. (1997). Numerically maximum 1000-seed weight (11.1g) was recorded from the first sowing (27 October). The December 10 sowing was recorded the lowest weight of 1000-seed indicating reduced weight with each delay in sowing after October 27. Decrease in thousand seed

Table 1 : Effect of different dates of sowing on growth parameters and yield attributing characters of different varieties of Indian mustard (Pooled data)

Treatments	Plant height at harvest (cm)	Dry matter accumulation at 60 DAS (g/plant)	Primary branches/plant at harvest	Secondary branches/plant at harvest	Siliqa/ plant	Siliqa length (cm)	Seed/ Siliqa	1000-seed weight (g)
Varieties								
PBR-375	175.1	53.4	4.08	4.58	175.16	3.9	11.7	5.6
PBR-210	165.7	50.5	4.00	4.00	167.58	3.8	11.5	5.6
RLM 619	167.2	48.7	4.08	4.16	164.41	3.8	11.6	5.4
RLC-1	162.2	46.0	3.91	3.66	155.58	3.4	11.5	5.6
RLC-2	160.2	48.0	3.91	3.91	159.25	3.5	11.3	5.3
S.E±	1.89	1.57	0.30	0.19	4.03	0.64	0.45	0.39
C.D. (P=0.05)	3.09	2.56	NS	0.32	6.58	NS	NS	NS
Dates of sowings								
27-Oct.	182.8	58.0	4.46	4.86	195.40	4.3	12.3	6.1
12-Nov.	173.7	53.2	4.26	4.26	166.93	3.9	11.5	5.6
25-Nov.	165.4	46.6	3.73	3.73	155.73	3.3	11.3	5.4
10-Dec.	142.6	39.5	3.53	3.40	139.53	3.2	11.0	5.0
S.E±	1.71	2.60	0.33	0.41	3.02	0.32	0.33	0.36
C.D. (P=0.05)	2.21	3.46	NS	0.53	3.90	0.42	0.43	0.47

NS= Non-significant

weight as a result of delayed sowing of Indian mustard refers to the fact that, late sowing caused both siliqua formation and seed filling duration stages to encounter high temperature. In this condition, rate of respiration and assimilates consumption would increase and ultimately inadequate nutrients enters the seeds, so resulted hollow (unfilled) seeds (Whitfield, 1992). Robertson *et al*. (2004) and Bhuiyan *et al*. (2008) stated that 1000-seed weight reduced with the delayed sowing time.

Yield :

The highest seed yield was produced by the variety PBR-375 (2770.5 kg/ha) which was significantly followed by PBR-210 (2242.7 kg/ha) (Table 2). The lowest seed yield was recorded for RLC-1 (2017.9 kg/ha). Sowing date is an important determinant of yield in Indian mustard. Yield of Indian mustard was significantly affected by difference sowing dates. The best sowing dates in comparison of four sowing dates was appeared to be 27 October, as it produced higher yield of 3034 kg/ha as compared to other sowing dates. The higher seed yield (2740.4kg/ha) produced by 27 October sowing might be attributed to higher number of siliquae in individual plants, number of seeds per siliqua and 1000-seed weight. Sowing on December 10 yielded the second highest yield /the lowest yield (2057 kg/ha). The decline of seed yield with delay in sowing date could be largely explained by the decline in biomass at maturity. Likewise, Shahidullah *et al*. (1997) reported that late sowing mustard faced higher temperature during seed filling period and caused forced maturity which results reduced growth period of mustard. The findings of the present study about seed yield were fully supported by Mondal *et al*. (1999); Awasthi *et al.* (2007) and Yadav Yogesh *et al*. (2011).

Nutrients uptake :

The N, P K and S uptake by Indian mustard were non-significantly affected by different varieties of Indian mustard (Table 2). The variety, PBR-375 uptake maximum N, P, K and S as compared to other varieties of Indian mustard. Delay in sowing dates from 27 October to 10 December, decreases N, P K and S uptake statistically. The maximum N, P, K and S uptake was recorded with 27 October sowing date which was significantly higher than other sowing dates of Indian mustard. The lowest uptake of nutrients by Indian mustard occurred with 10 December sowing date.

Economics :

The cost of cultivation for different varieties of Indian mustard with different date of sowing was same (25400 Rs./ha) (Table 2). Maximum gross return (69264 Rs./ha), net return (38031 Rs./ha) and B:C ratio (1.49)

Table 2 : Effect of different dates of sowing on yield, economics and nutrients uptake of different varieties of Indian mustard (Pooled data)

Treatments	Yield/ha (Kg/ha)	Cost of cultivation (Rs./ha)	Gross return (Rs./ha)	Net return (Rs./ha)	B:C ratio	Nitrogen uptake (kg/ha)	Phosphorus uptake (kg/ha)	Potassium uptake (kg/ha)	Sulphur uptake (kg/ha)
Varieties									
PBR-375	2770.5	25400	69264	38031	1.49	91.2	25.0	33.0	14.4
PBR-210	2242.7	25400	56069	23088	0.90	91.5	24.5	34.2	15.5
RLM 619	2185.0	25400	54625	21651	0.85	88.7	24.0	34.2	13.4
RLC-1	2017.9	25400	50449	17079	0.67	89.2	24.2	33.0	14.4
RLC-2	2084.3	25400	52108	19150	0.75	89.5	24.2	33.0	15.0
SEm±	162.9	-	4074.5	3931.5	0.15	2.39	0.59	2.22	0.88
CD (P=0.05)	265.80	-	6645.4	6412.2	0.25	NS	NS	NS	NS
Dates of sowings									
27-Oct.	2740.4	25400	68512	37383	1.47	104.6	28.0	39.6	18.4
12-Nov.	2409.2	25400	60230	27989	1.10	93.4	26.2	34.4	14.8
25-Nov.	2120.7	25400	53018	19895	0.78	83.2	23.0	31.0	13.6
10-Dec.	1770.0	25400	44252	9932	0.39	79.0	20.4	28.9	11.4
S.E.±	94.2	-	2356.4	2653.6	0.10	1.89	1.03	2.81	1.02
C.D. (P=0.05)	121.7	-	3043.3	3427.2	0.13	2.44	1.80	3.62	1.95

NS= Non-significant

was recorded with variety, PBR-375, which was significantly higher than other varieties of Indian mustard. The lowest gross return, net return and B:C ratio was observed with variety RLC-1 due to its low yield. The best sowing dates in comparison of four sowing dates was appeared to be 27 October, as it produced significantly higher gross return (68512 Rs./ha), net return (37383 Rs./ha) and B:C ratio (1.47) as compared to other sowing dates. The higher seed yield (2740.4kg/ha) produced by 27 October was reason for higher monetary return. Awasthi *et al*. (2007) also recorded more monetary return with early sowing of Indian mustard.

It is concluded that PBR-375 was high yielding variety of Indian mustard. Through this study, 27 October, was the best sowing date of Indian mustard for obtaining maximum yield. The late planting of Indian mustard adversely affects the yield and yield components due to its adverse effect on growth parameters.

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