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Effect of Sowing Dates on Performance of Different Mustard Varieties (*Brassica juncea* L.) in Western Uttar Pradesh, India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

An experiment was conducted to study the "Effect of sowing dates on performance of different mustard varieties (*Brassica juncea* L.) in western Uttar Pradesh" during *rabi* season of 2021-22 at Crop Research Centre of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (U.P.). The experiment consisted of 12 treatment combinations with Date of sowing and Mustard varieties. The treatment consisted of three dates of sowing and four mustard varieties were tested in RCBD (Factorial) with three replications. Results revealed that the sowing of mustard on D_1 (7th October) gave higher plant height (190.2 cm), LAI (4.06), branches plant^{-1}, dry matter accumulation (69.40 g plant^{-1}), seed (21.11 q ha^{-1}), stover (71.76 q ha^{-1}) and biological yield (92.88 q ha^{-1}) of mustard crop. Similarly, the variety V_1 (Pusa Vijay) gave highest plant height (197.5 cm), LAI (4.22), branches plant^{-1}, dry matter accumulation (69.65 g plant^{-1}), seed (22.27 q ha^{-1}), stover (69.59 q ha^{-1}) and biological yield (91.87 q h^{-1}) of mustard crop. Thus, it may be concluded that the Pusa Vijay variety of mustard sown on 7th October gave significantly higher values of growth, yield attributes and yield of mustard.

Keywords: Sowing dates; mustard varieties; mustard crop; Pusa Vijay.

1. INTRODUCTION

Indian mustard (*Brassica juncea* L.) is a winter season crop grown in different agro-climatic conditions, ranging from northern hills to down south under irrigated and rainfed conditions under a vast range of temporal dimensions, namely early, timely and late-sown under irrigated and rainfed conditions. It is a member of the *Cruciferae* family and a vast source of high-quality edible oil (33-49 %). After groundnut (*Arachis hypogea* L.) oil and soybean (*Glycine max* L.) oil, mustard is the third most significant oilseed crop in the world. The world's tropical and subtropical regions are where it is grown. Globally, the total area under the Rapseed-Mustard crop is 35.95 Mha with 71.49 MT production and 1990 kg ha^{-1} productivity. However, India continues to be rank second after Canada in acreage 6.86 Mha (19.81%) and rank fourth after Canada, The European Union and China in production 9.12 MT (10.37%) with productivity of 1331 kg ha^{-1}. In India, Rajasthan have rank first with 2.84 Mha (41.44%) area and 4.10 MT (45.03%) production. Uttar Pradesh contributed 0.77 Mha (11.29%) to the total area and 0.98 MT (10.79%) to the production with 1090 kg ha^{-1} productivity. Anonymous [1].

Oilseeds cultivation is undertaken across the country in about 26 million ha, covering 72% under rain-fed areas and producing around 30 million tons of oil seed. Out of the nine major oilseed crops grown in India, soybean (39%), Groundnut (26 %) and Mustard (24%) add more than 88% of total oilseed production in the country. It has a protein content of 17–25%, a fiber content of 8-10%, a moisture content of 6-10%, and an extractable content of 10–12%. There is a significant level of erucic acid in mustard oil (38-57%). However, poisonous glucosinolates make mustard cake, which is also contained in manure and bovine feed, unsuitable as a source of human protein. The period of sowing seems crucial for crop production since different sowing dates offer varying climatic conditions for crop growth and development in the same location. Because mustard is a thermos-sensitive crop, the delayed seeding reduced grain yield by synchronizing the siliqua filling period with high temperatures, reducing assimilates production, increasing the rate of drought stress, and accelerating plant maturity.
These crops are cultivated in India during the *rabi* season, which runs from September to October through February to March. The genotypes of Indian mustard, however, might vary its output capacity. It is a reality that certain genotypes do not always display the same phenotypic traits depending on the environment. The choice of genotypes for sustaining the higher yield ultimately depends on the genotypes' growth responses to the environment and their relative ranking. One of the main input variables influencing the development and production of crops is time. It has an impact on the mustard plants vegetative, reproductive, and maturation periods. Because agro-ecological circumstances can vary from one place to another and from one variety to another, the best time to grow mustard may differ [2].

Selection of suitable sowing time with a suited varieties is equally important. Different sowing dates give various climatic conditions within the same area for crop growth and yield stability.

Sowing at the correct time allows a crop to grow and develop sufficiently to provide a reasonable amount [3]. “Late sowing of mustard reduces duration due to high temperatures during the reproductive phase, which also results in a decrease in yield” [4]. “Growth characters, yield attributes and yield of mustard were significantly influenced by 4 different sowing dates. Higher plant height, length of siliqua, seed/siliqua, and seed and stover yields were obtained when the crop was sown on 15 October than when it was sown on 30 October” [5].

“Some studies showed that mustard crops seeded in the second week of September produced considerably more yield than those sown in the first fortnight of October” [6]. “Generally, it was found that mustard crops planted after October 30th produced lesser yields” (Panwar *et al*., [7] Singh *et al*., [8] Sonani *et al*., [9] and Panda *et al*., [10] Bharat *et al*. [11] recorded that “sowing of mustard (15 October) significantly higher seed yield (1.30 t/ha) than 25 October (10.29 q/ha) and 4 November (0.86 t/ha). Similarly, during the *winter* season of 2015-16, again statistically higher seed yield was recorded by the crop sown on 15 October (1.32 t/ha) and was significantly higher than when crop was sown on 25 October (0.96 t/ha) and 4 November (0.80 t/ha)”. Awasthi *et al*. [5] reported that “various important growth characteristics and seed yield of mustard were significantly influenced by different varieties”. They found that the Variety ‘Vaibhav’ excelled over ‘Urwashi’ in terms of plant height, number of siliquae, length of siliqua, seeds/siliqua, seed yield and stover yield.

2. MATERIALS AND METHODS

The experiment was carried out at Crop Research Centre, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (U.P.) located in Indo-Gangnetic plains of Western Uttar Pradesh at 29 13’ 96” N latitude and the University is situated at 77 68’ 43” E longitudes with an elevation of 228 meters above the mean sea level. Meerut lies on National Highway 58 and is at a distance of 70 km from Delhi. Meerut predominantly enjoys semi-arid and sub-tropical climate with extremely hot summer and cold winter. Minimum and maximum temperatures both exhibit a gradual decrease starting from the first week of October and reach their minimum during December and January. An increase in the temperature is recorded with effect from first week of February and peak values were noticed during the end of May. Occasional frost is also experienced during the second fortnight of December and first fortnight of January. The mean weekly minimum temperature was records as low as 4.89 ^{0}C in last week of December, whereas the mean weekly maximum temperature reached 38.7^0 C in April. The area receives mean annual rainfall of 845 mm, of which more than 80% is in the month of July-September through Southwest monsoon. A few winter showers are also received. April and May are the driest months with mean relative humidity of 50 to 55%, Whereas the recorded of high humidity 92 % is in the month of August. Mean weekly temperature, relative humidity, sunshine hours, evaporation and rainfall as recorded at the nearby meteorological observatory of Indian Institute of Farming Systems Research, Meerut. The maximum and minimum temperatures recorded were 38.70°C and 4.7°C during the crop growth period. The upward trend was recorded in temperature, as the crop approached towards maturity. The Maximum temperature ranged from 16.6°C to 38.7°C during the maturity phase of the crop. Relative humidity varied from 28.4% to 92.6% during crop growth period.

The experiment comprised of 12 treatment combinations of three dates of sowing i.e., 7th October, 19th October, 31st October and four Mustard varieties i.e., Pusa Vijay, RH-0749, Pioneer-45S46 and Pro-Agro-5222 were tested in RCBD (Factorial) with three replications. The height of the mustard plant was measured from the base to the top of the plant at harvesting, with the help of meter scale. The mean of plant height was worked out based on total height of five randomly selected plants in each plot which was divided by the number of plants. The Number of primary and secondary branches per plant were counted from five plants selected randomly at harvest and their mean value was taken. Five plants were randomly selected from border rows at the harvest stage and after sun drying, materials were dried in oven (65 °C ±1) till the constant weight was attained. The average value obtained was recorded as the dry matter of the plant (g plant^{-1}). The samples were collected for dry matter estimation, leaves of five plants was packed at 90 DAS and leaf area was measured with the help of leaf area meter.

$$\text{Leaf Area Index} = \frac{\text{Leaf area (cm}^2\text{)}}{\text{Ground area (cm}^2\text{)}}$$

The number of primary and secondary branches per plant were counted from five plants selected

randomly at 60, 90 DAS and at the harvest and their mean value was taken. Similarly, five plants were randomly selected from border rows at 30, 60, 90 DAS and at harvest stage and after sun drying, materials were dried in oven (65±1 °C) till the constant weight was attained. The average value was recorded as the dry matter of the plant (g plant^{-1}). Mean crop growth rate (g m^{-2} day^{-1}) of a plant for a time "t" is defined us the increase in dry weight of plant material from a unit area per unit of time. It was calculated with the following formula Radford [12] from periodic dry matter recorded at different stages:

$$\text{Crop growth rate} = \frac{W_2 - W_1}{t_2 - t_1} \times \frac{1}{A}$$

Where,

W_1 = Total dry weight of plant at time t_1 (g), W_2= Total dry weight of plant at time t_2 (g), T_1= Time at first observation (days), T_2= Time at second observation (days), A= represents the ground area (m^2).

From the individual plot, the net plot area was harvested separately and produce was sun-dried. After sun drying, the crop was threshed and produce cleaned. The final weight was recorded in kg plot^{-1} and finally converted into q ha^{-1}. Stover yield of mustard was calculated with subtraction of seed yield from biological yield and reported in q ha^{-1}. After 3-4 days sun drying, all above-the-ground plant parts of the net plot were dried and weighed in kg plot-1 to represent the biological yield and finally converted into q ha^{-1}. The harvest index is an economic yield expressed as percentage of biological yield and calculated as formula given by Donald and Hamblin [13].

$$\text{HI (\%)} = \frac{\text{Economic yield (q/ha)}}{\text{Biological yield (q/ha)}} \times 100$$

Mustard seeds were sown in line at the distance of 45 cm row to row and plant to plant 15 cm with the help of Kudal. The seed rate was used @5 kg ha^{-1} and fertilizer nitrogen, phosphorus and potassium were applied in the forms of Urea, DAP and Muriate of potash @120:60:60:40 kg ha^{-1}, respectively. The full dose of phosphorus, potassium and half dose of nitrogen were applied as basal dressing at the time of sowing and rest half dose of nitrogen was applied as two split doses at the time of first irrigation and second irrigation.

3. RESULTS AND DISCUSSION

3.1 Growth and Yield Attributes

Growth and various yield attributes of mustard were significantly influenced by different sowing dates and varieties (Table 1). 7th October sown crop resulted in significantly higher plant height, number of primary and secondary branches at harvest over 19th October and 31st October. Plant height in 7th October sown crop was significantly higher (190.2 cm) over 19th October (180.9 cm) and 31st October (172.1 cm). Similarly, Plant height was significantly influenced by varieties. Among the varieties, 'Pusa Vijay' recorded the highest plant height (197.5 cm) which was significantly superior to RH-0749 (182.2 cm) and Pro-Agro-5222 (154.5 cm) but at par with Pioneer-45S46 (189.9 cm). Similar findings have also been reported by Chand *et al*. [14] Jadhav and Singh. [15] Yadav *et al*. [16] Gare *et al*. [17] and Surekha and Reddy. (1996) which supports the findings of the present investigation.

The highest number of primary branches plant^{-1} (9.80) was produced in 7th October sowing which got significantly reduced with delay in sowing i.e., 19th October (7.88) and 31st October (6.69). Similarly, the highest number of secondary branches plant^{-1} (15.76) was recorded in 7th October sown crop which got reduced by 14.36 in 19th October and 11.60 in 31st October sowing. Similar results were also obtained by Kumari *et al.* [18] Kumar *et al.* ([19]. In case of varieties the highest number of primary and secondary branches plant^{-1} was recorded in Pusa Vijay (9.63, 15.39) followed by Pioneer-45S46 (8.52, 14.39), RH-0749 (7.73,13.61) and Pro-Agro-5222 (6.62, 123.24), respectively which might be due to genotype response and capability of higher dry matter production. Similar results were also obtained by Awasthi *et al.* [5] Singh and Singh [20].

Higher dry matter accumulation (69.40 g plant^{-1}) was recorded under 7th October sowing over 19th October (66.05 g plant^{-1}) and 31st October (63.53 g plant^{-1}). Accumulation of dry matter in the plant is directly related to plant height, leaf area index and number of branches plant^{-1} which were appreciably reduced as sowing was delayed. Similar findings have been reported by Singh and Singh [20] and Lallu *et al*. [21]. Among the varieties Pusa Vijay recorded significantly higher dry matter accumulation (69.65 g plant^{-1}) over RH-0749 (65.29 g plant^{-1}), Pro-Agro-5222 (63.41 g plant^{-1}) but *at par* with Pioneer-45S46 (66.96 g

plant^{-1}) and its probable reason might be attributed to genetic characters of Pusa Vijay which has higher capacity to utilized the photosynthates more efficiently for maximum leaf area index, number of primary and secondary branches plant^{-1} and ultimately the dry matter accumulation. The increase in yield per unit area could be due to the efficient utilization of thermal energy by mustard which improves the early sowing and adoption of optimum plant population, whereas sufficient spacing recorded maximum utilization of photo and thermal units by the individual mustard plants thereby leading to significantly higher dry matter accumulation, yield attributes, yield and harvest index, but lower productivity due to lower plant population. Similar findings have been reported by Panda *et al.* [22] Patel *et al*. [23].

Crop sown on 7th October recorded significantly higher leaf area index (4.06) over 19th October (3.51) and 31st October (2.95) Similar trends were recorded at successive stages. Delayed, sowing by 36 days achieved lower leaf area index (2.95) at all the stages of mustard crop which might be due to less vegetative growth because of less favourable environmental conditions when crop was sown too late sowing conditions. Different varieties have no significant influence on the leaf area index. Among the varieties Pusa Vijay recorded maximum leaf area index (4.22) as compared to RH-0749 (3.32), Pro-Agro-5222 (2.82) and Pioneer-45S46 (3.65), respectively. Similar results were also obtained by Bhuiyan *et al.* ([24] Tyagi [25] and Kumar *et al.* [26].

Crop growth rate (g m^{-2} day^{-1}) was significantly influenced by various sowing dates and varieties. CGR increased with the advancement of crop age and reached to maximum between 60-90 DAS and thereafter decreased sharply. In the case of different dates of sowing, the maximum crop growth rate (4.26 g m^{-2} day^{-1}) was recorded in mustard sown on 7th October over 19th October (4.22 g m^{-2} day^{-1}) and minimum crop growth rate (4.17 g m^{-2} day^{-1}) was recorded in 31st October date of sowing. Similar findings have been reported by Lallu *et al*. [21]. Similarly, in case of different varieties, the maximum crop growth rate (4.26 g m^{-2} day^{-1}) was recorded in variety Pusa Vijay over RH-0749 (4.21 g m^{-2} day^{-1}), Pro-Agro-5222 (4.17 g m^{-2} day^{-1}) but *statistically at par* with Pioneer-45S46 (4.23 g m^{-2} day^{-1}) among these varieties at crop growth stages. Similar results were also obtained by Tyagi [25] and Kumar *et al.* [26].

3.2 Biological, Seed and Stover Yield

The data reveal that date of sowing and mustard varieties significantly influenced the seed, stover and biological yield (Table 2.) of mustard. Different dates of sowing under investigation brought significant influence on the seed yield. Crop sown on 7th October recorded significantly higher seed yield (21.11) over 31st October (17.51), while *at par* with 19th October (19.40) date of sowing. Seed yield was significantly influenced due to various varieties. Among the varieties Pusa Vijay recorded a significantly higher seed yield (22.27) as compared to Pro-Agro-5222, while which was *at par* with Pioneer-45S46 (21.02) and RH-0749 (19.65). Similar findings have been reported by Mondal *et al*. [2] and Kumari *et al*. [18].

The stover yield was also affected by sowing dates because it is depended on plant growth and dry matter accumulation. Crop sown on 7th October recorded significantly higher stover yield (71.76) over 19th October (65.61) and lowest 31st October (54.29) sowing of mustard. Similarly, among the varieties Pusa Vijay recorded a significantly higher stover yield (69.59) as compared to RH-0749 (62.75), Pro-Agro-5222 (56.87) and at par with Pioneer-45S46 (66.33). All the growth and yield attributes which determined the seed and stover yield of mustard crop, were adversely influenced when the sowing was done on too early and late sowing, which might have resulted in poor growth and translocation of photosynthates from source to sink and ultimately lower yield was recorded. Similar findings were reported by Panda *et al*. [22].

The biological yield of mustard a significantly influenced with the date of sowing and mustard varieties. The highest biological yield (92.88 q ha^{-1}) was recorded on the date of sowing 7th October, followed by 19th October (85.01 q ha^{-1}) and the lowest (71.80 q ha^{-1}) on 31st October. Similarly, the highest value of biological yield (91.87 q ha^{-1}) was recorded in variety Pusa Vijay which was *at par* with Pioneer-45S46 (87.36 q ha^{-1}) and the lowest biological yield (71.29 q ha^{-1}) in variety Pro-Agro-5222. Similar results were also obtained by Singh *et al.* [8] Kumar *et al.* 26] and Kumari *et al*. [18].

Table 1. Effect of different date of sowing and varieties on plant height (cm), primary branches plant^{-1}, secondary branches plant^{-1}, dry matter accumulation (g plant^{-1}), leaf area index and crop growth rate (g m^{-2} day^{-1}) of mustard at different growth stages

Treatments		Plant height (cm)	Primary branches plant^{-1}	Secondary branches plant^{-1}	DMA (g plant^{-1})	LAI	CGR (g m^{-2} day^{-1})
				Factor A (Date of sowing)			
D1	7th October	190.2	9.80	15.76	69.40	4.06	4.26
D2	19th October	180.9	7.88	14.36	66.05	3.51	4.22
D3	31st October	172.1	6.69	11.60	63.53	2.95	4.17
	SEm ±	*4.16*	*0.17*	*0.27*	*1.15*	*0.06*	*0.01*
	CD (P= 0.05)	*12.27*	*0.51*	*0.81*	*3.39*	*0.18*	*0.05*
				Factor B (Varieties)			
V1	Pusa Vijay	197.5	9.63	15.39	69.65	4.22	4.26
V2	RH-0749	182.2	7.73	13.61	65.29	3.32	4.21
V3	Pioneer-45S46	189.9	8.52	14.39	66.96	3.65	4.23
V4	Pro-Agro-5222	154.5	6.62	12.24	63.41	2.82	4.17
	SEm ±	*4.80*	*0.20*	*0.32*	*1.32*	*0.07*	*0.02*
	CD (P= 0.05)	*14.17*	*0.59*	*0.94*	*3.92*	*0.21*	*0.05*

Table 2. Effect of different date of sowing and varieties on seed, stover, biological yield (q ha^{-1}) and harvest index (%) of mustard

Treatments		Yield (q ha^{-1})			
		Seed yield	Stover yield	Biological yield	H.I. (%)
			Factor A (Date of sowing)		
D1	7th October	21.11	71.76	92.88	22.67
D2	19th October	19.40	65.61	85.01	22.51
D3	31st October	17.51	54.29	71.80	24.56
	SEm ±	*0.96*	*1.05*	*1.50*	*0.89*
	CD (P= 0.05)	*2.84*	*3.11*	*4.44*	*NS*
			Factor B (Varieties)		
V1	Pusa Vijay	22.27	69.59	91.87	24.06
V2	RH-0749	19.65	62.75	82.40	23.81
V3	Pioneer-45S46	21.02	66.33	87.36	24.01
V4	Pro-Agro-5222	14.42	56.87	71.29	21.11
	SEm ±	*1.11*	*1.21*	*1.73*	*1.02*
	CD (P= 0.05)	*3.28*	*3.60*	*5.13*	*NS*

3.2.1 Harvest index (%)

It is clear that with different dates of sowing, the higher value of the harvest index (24.56%) was recorded in 31st October because the ratio of seed and stover yield is less as compared to other dates of sowing therefore, the harvest index is higher of this date and the lowest (22.51%) in 19th October. Similarly, the different varieties of mustard did not bring any significant variation in harvest index. However, the maximum harvest index (24.06%) was recorded in variety Pusa Vijay and the minimum harvest index (21.11%) in variety Pro-Agro-5222. Data analysis revealed that the variety Pusa Vijay had a 1.04, 0.20 and 13.97% higher harvest index than the varieties RH-0749, Pioneer-45S46 and Pro-Agro-5222, respectively.

4. CONCLUSION

Thus, it may be concluded that sowing of mustard on 7th October with the introduction of variety 'Pusa Vijay' at a spacing of 45×10 cm can achieve higher productivity and better economic returns from mustard in Western Uttar Pradesh.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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