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Effect of sowing dates on growth and yield attributes of Indian mustard (*Brassica juncea* L.) varieties under late sown conditions

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Abstract
A field experiment was conducted during *rabi* season of 2019, at Crop Research Farm of Department of Agronomy at Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj with the objective to study the effect of sowing dates on growth and yield attributes of Indian mustard (*Brassica juncea* L.) varieties under late sown conditions. Experiment comprises of 9 treatments replicated thrice. With 3 different dates of sowing 5th December, 10th December, and 15th December; 3 *varieties* i.e., Varuna, Mahyco Bold, Pioneer. Maximum plant height (185.23 cm), No. of branches (9.41), No. of siliqua per plant (241.3), was recorded with the treatment no.1 Varuna + 5th December sowing. Highest no. of seeds per siliqua (15.5) was recorded with treatment no.1 Varuna + 5th December sowing, and maximum test weight was recorded with treatment no. 5 Mahyco bold+ 10th December.

Keywords: Mustard varieties, date of sowing, varuna, growth, yield

Introduction

Indian mustard (*Brassica juncea* L.) belonging to the family to the family Cruciferae is one of the chief winter oilseed with a major source of high quality of edible oil (37- 49%). Mustard is the third important oilseed crop in the world after soybean (*Glycine max* L.*)* and palm (*Elaeis guineensis)* oil. It is grown in subtropical and tropical countries in the world. Oilseed cultivation is undertaken across the country in about 26.00 million ha, covering 72% under rain fed areas and producing around 30.00 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. Indian mustard is mainly cultivated in Uttar Pradesh, Madhya Pradesh, Rajasthan, Haryana, and Gujarat. Mustard contains 17-25% of proteins, 8-10% of fibers, 6-10% of moisture and 10-12% of extractable substances. The oil of mustard possesses a sizable amount of erucic acid (38- 57%). But the presence of toxic glucosinolatesin the mustard cake renders it unsuitable as a source of human protein and is at present as manure and as cattle feed.

In India, these crops are grown in *rabi* season from September-October to February- March. However, production potentiality of Indian mustard can be varied with the genotypes. It is a fact that specified genotypes does not exhibit same phenotypic characteristics in all environmental conditions. The genotypes growth response varies to environment and their relative ranking differs and ultimately decides selection of genotypes for stabilizing the higher yield. Time is one of the major input factors affecting growth and yield of crops. It affects duration of vegetative, reproductive and maturity period of mustard. Optimum planting time of mustard may vary from one variety to another and from a region to another because of variation of agro-ecological conditions Sarkar *et al*., (2004) [24]. The sowing date enables complete synchronization between the vegetative and reproductive phase, on the other side and climatic rhythm, on other hand, which enable in assessing the potential yield of the crop. In considerable areas, sowing of mustard gets delayed due to late harvesting of long duration rice as well as in areas where moisture from rice field cannot be receded out in time.

In recent years, the development of a number of mustard varieties suitable for the late planting and their introduction in these areas have opened the avenues of these crop cultivation in late planting condition. Exposure to high temperature during reproductive phase besides with reduced growing season by delayed sowing and eventually, results in reducing the productivity of the crop. Hence, selection of proper early maturing high yielding mustard varieties under late sown condition may play an important role in enhancing the crop productivity Singh *et al*., (2010) [27]. Climate change has increased the intensity of heat stress and heat stress due to increased temperature is an agricultural problem in many areas in the world as well as in India. There is an exact time for the sowing of particular variety of a crop on precise area. Time of sowing is very important for crop production as different sowing dates provide variable environmental conditions within the same location for growth & development of crop. The delay in sowing of mustard decreased grain yield by harmonization of siliqua filling period with elevated temperatures, the diminish in assimilates production, drought stress incidence, concise siliqua filling period and increase in speed of plant maturity since it is a thermo-sensitive crop.

Rapeseed - mustard is considerably sensitive to weather as evidenced from the variable response to different dates of sowing (Kumar *et al.*, 2007) [8]. Temperature based agro meteorological indices such as growing degree days (GDD), heliothermal units (HTU) and photo thermal units (PTU) are based on the perception that real time to accomplish the phenological stage is linearly associated to temperature in the range amid base temperature and optimum temperature (Monteith, 1981) [14]. About 10 to 50 per cent decrease in grain yield in different canola cultivars is observed by the one month delay in sowing Shargi *et al.*, (2011) [25].

Therefore, higher productivity of mustard is dependent on the adjustment of sowing with optimum thermal and radiation environment. Sowing at accurate period allows ample growth and development of a crop to attain adequate yield and different sowing dates offer erratic environmental conditions within the same location for growth and development of the crop and yield stability (Pandey *et al*., 1981) [18]. If the mustard sown late, duration is reduced due to high temperature during the reproductive phase with concomitant reduction in yield (Kumari *et al*., 2004) [10]. High temperature stress negatively affects plant growth development and crop yield (Boyer, 1982) [2]. Each degree centigrade increases in average growing season temperature reduce crop yield 17%. Keeping in view of the above facts, a field experiment entitled, "Effect of sowing dates on growth and yield attributes of different Indian mustard (*Brassica juncea* L.) varieties under late sown conditions" was conducted during *Rabi* 2019.

Materials and Methods

A field experiment was conducted during *Kharif* season of 2019, at Crop Research Farm of Department of Agronomy at Sam Higginbottom University of Agriculture, Technology, and Sciences, Prayagraj which is located at 25° 24' 42" N latitude, 81° 50' 56" E longitude and 98 m altitude above the mean sea level (MSL). To assess the effect of sowing dates on growth and yield of various Indian mustard (*Brassica juncea* L.) varieties under late sown conditions. The experiment was laid out in Randomized Block Design comprising of 9 treatments which are replicated thrice. Each treatment net plot size is 3m x 3m. Consisting of 2 factors i.e., Factor-1: Different dates of sowing; at 5th December, 10th December, and 15th December and Factor-2: Different varieties of mustard i.e., Varuna, Mahycobold, pioneer; both factors were combined to form 9 treatments T1: Varuna + 5th December, T2: Mahyco bold + 5th December, T3: Pioneer + 5th December, T4: Varuna + 10th December, T5: Mahycobold + 10th December, T6: Pioneer + 10th December, T7: Varuna + 15th December, T8: Mahycobold + 15th December, T9: Pioneer + 15th December. During sowing as per the treatment combination, nitrogen fertilizer was applied at three split doses half of the nitrogen fertilizer was applied as basal dose and rest parts are divided equally and applied 45 and 60 days after sowing.

The mustard crop was harvested treatment wise at harvesting maturity stage. After harvesting, grains were separated from each net plot and were dried under sun for three days. Later winnowed, cleaned and weight of the grain per net plot value, the grain yield per ha was computed and expressed in tonnes per hectare. After complete drying under sun for 10 days straw yield from each net plot was recorded and expressed in tonnes per hectare. The benefit: cost ratio was worked out after price value of grain with straw and total cost included in crop cultivation. After thorough field preparation initial soil samples were taken to analyze for available major nutrients. Nitrogen (N), phosphorous (P), potassium (K), sulphur (S), Organic Carbon (OC), pH and soluble salts. The type of soil in experimental field is sandy clay. The pH of the experimental field was 7.6, EC of 0.30 dS/m, organic carbon was 0.47%. The N status of the experimental field was low (215 kg ha^{-1}), medium in available P (13 kg ha^{-1}) while available K status was in higher range (233 kg ha^{-1}). The oxidizable organic carbon was determined by Walkley and Black (1934) [31], pH by pH meter and ECe by electrical conductivity bridge with glass electrode in a 1:2.5 soil water suspension (Jackson 1973) [4]. Soil texture by the Bouyoucos Hydrometer Method (Gee and Baudev, 1986). Available nitrogen was determined by Subbiah and Asija (1956) [28], Available phosphorus was determined by Olsen *et al*. (1954) [17] and available potash was determined by Flame photometric method, Jackson (1973) [4].

Results and Discussions

Effect on growth parameters

i) Plant height

At harvest highest plant height of 185.23 cm was recorded with the T1Varuna + 5th December sowing, whereas T4 Varuna + 10th December sowing was found statistically at par to maximum this might be due to the early sown date which might be due to the rapid drop in temperatures in late sowing in winter season i.e., Delay the sowing, lower the plant height similar findings were recorded by researches carried out by Kumari (Kumai, 2002) [11] along with due to their own genetic characteristics might have helped varunain recording significantly higher plant height at as compared to Mahycobold and pioneer this statement is in accordance with Jain *et al.*, (1986) [5] and Nandlal Patel (2013) [16].

ii) No. of branches per plant

At harvest maximum no. of branches (9.41) were recorded with the T1 Varuna + 5th December sowing, however T3 Pioneer 45S46 + 5th December sowing has shared statistical parity with T1. The crop sown early will have temperature advantage over the crop sown lately, which might have resulted in the more no. of branches in early sown crop and also early sowing i.e., 5th December will be more or less near to the optimum sowing time when compared to late sowing i.e., 10th December, 15th December this finding is in accordance to the Bhuiyan *et al.*, (2008) [1]; Kumar *et al.*, (2008) [7]; M.A. Aziz *et al.*, (2011) [12]. This is because of variation in different genotypes in their genetic makeup. Similar findings were found by Tyagi and Rana (1992) [30].

iii) Plant dry weight (g/plant)

At harvesting stage highest dry weight was gained by the T1 Varuna + 5th December sowing and Pioneer 45S46 + 5th December sowing was statistically at par to maximum. The early sown crop (5th December) when compared to late sown (10th December and 15th December) it might be due to prevailing high temperature at flowering stage that increased photo-respiration and reduced net photosynthesis resulted in lower dry matter in case of late sown crop Sage and Sharkey, (1987); M. S. A. Khan and M. A. Aziz (2015) [13]. Varuna as compared to Mahycobold and Pioneer respectively and its probable reason might be attributed to genetic characters and superiority of Varuna was primarily due to its good growth which might have higher capacity to utilized the photosynthates more efficiently for maximum leaf area index, number of branches per plant, Number of siliquae/ plant and ultimately the dry matter production,); Roy (2015); Krishnamurthy *et al.*, (2018) [6].

Effect onyield attributing parameters

iv) No. of siliqua per plant

Maximum no. of siliqua (226.89) was recorded with the T1Varuna + 5th December sowing, however T3 Pioneer 45S46 + 5th December sowing was at par to T1. No. of siliqua/ plant at late sowings might have reduced due could be due to floral sterility caused by high temperature at the reproductive stage Morrisons and Tewart (2002) [15]. High temperature at flowering and siliquae formation stages enhanced flower and siliquae abscissions that reduced the number of siliquae as supported by Sinaki *et al.*, (2007) [26]

v) Number of seeds per Siliqua

Non-significant effect was observed by the statistical analysis of number of seeds per siliqua. Treatment Varuna T-59 sown during 5thDecember recorded highest number of seeds per siliqua.

iii) Test weight (1000 grains wt)

Highest test weight of g was recorded with the T5 Mahycobold + 10th December and T2 Mahycobold + 5th December and T8 Mahycobold + 15th December. Being Mahyco bold, a bold seeded variety might have gained the more test weight compared to Varuna and Pioneer.

Table 1: Effect of sowing dates on growth of different Indian mustard (*Brassica juncea* L.) varieties under late sown conditions (At Harvest)

Treatment Combinations	Plant height (cm)	No. of branches /plant	Dry weight (g/plant)
T_1-Varuna T-59 + December 5	185.23	9.41	22.10
T_2-Mahycobold + December 5	158.93	8.71	20.85
T_3-Pioneer 45S46 + December 5	162.70	9.07	22.21
T_4-Varuna T-59 + December 10	180.33	8.54	20.37
T_5-Mahycobold + December 10	154.87	8.17	19.85
T_6-Pioneer 45S46 + December 10	155.60	8.32	18.84
T_7-Varuna T-59 + December 15	172.83	7.86	19.86
T_8-Mahycobold + December 15	149.93	7.38	19.98
T_9-Pioneer 45S46 + December 15	151.07	7.42	19.08
SEm (±)	1.21	0.13	1.21
CD (P=0.05)	0.40	0.39	0.40

Table 2: Effect of sowing dates on yield attributes of different Indian mustard (Brassica juncea L.) varieties under late sown conditions (At Harvest)

Treatment Combinations	Siliqua /plant(No.)	Seeds/Siliqua (No.)	Test weight (gm)
T_1-Varuna T-59 + December 5	241.3	15.5	5.75
T_2-Mahycobold + December 5	213.5	15.2	6.47
T_3-Pioneer 45S46 + December 5	234.3	13.6	5.38
T_4-Varuna T-59 + December 10	204.5	15.4	5.61
T_5-Mahycobold + December 10	187.5	13.7	6.54
T_6-Pioneer 45S46 + December 10	194.7	15.2	5.40
T_7-Varuna T-59 + December 15	187.1	14.5	5.59
T_8-Mahycobold + December 15	186.2	14.9	6.44
T_9-Pioneer 45S46 + December 15	187.2	14.0	5.42
SEm (±)	4.81	NS	0.06
CD (P=0.05)	14.41	0.56	0.19

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