Journal of Oilseed Brassica, 13 (1) : 1-6, January 2022

Influence of sowing window, irrigation and fertilizer levels on growth and yield of late sown Indian mustard

Pramod Kumar[1]*, Suresh Kumar[1], VS Hooda[1], Ram Avtar[2], Sheilendra Kumar[3] and Kapil Malik[1]

[1]*Department of Agronomy, CCS Haryana Agricultural University, Hisar 125004, Haryana, India*
[2]*Departent of Genetics and Plant Breeding, CCS Haryana Agricultural University, Hisar 125004, Haryana, India*
[3]*Department of Agronomy, SK Rajasthan Agriculture University, Bikaner 334006, Rajasthan, India*
**Corresponding author: pramodthory70@gmail.com*
(Received: 17 June 2021; Revised: 11 September 2021; Accepted: 08 November 2021)

Abstract

A study was conducted in the *Rabi* seasons of 2018-19 and 2019-20 to assess the effect of date of sowing, irrigation and fertility levels on growth and productivity of Indian mustard (*Brassica juncea*) under late sown condition. Treatments imposed were sixteen combinations of two sowing dates viz. 2nd week of November and 4th week of November; two irrigation levels viz. no post-sown irrigation and one irrigation at flowering stage in main plots and four fertilizer levels viz. 87.5% RDF, 100% RDF, 112.5% RDF and 125% RDF in sub-plots with three replications. Sowing of mustard crop in 2nd week of November recorded significant increase in plant height, dry matter accumulation, number of primary and secondary branches over the 4th week of November sown crop. On an average, 2nd week of November sowing recorded significantly higher seed yield (75.63%) and stover yield (74.50%). Application of one irrigation at flowering stage recorded a significant increase in plant height, dry matter accumulation, number of primary and secondary branches over the no post-sown irrigation. Seed and stover yields were recorded significantly higher with one irrigation by 11.95 and 14.84%, respectively over the no post-sown irrigation. The increased doses of fertilizers also increased the growth, yield pamperers, and seed yield as well as stover yield responded significantly up to 125% RDF.

Keywords: *Fertilizer doses, growth, Indian mustard, irrigation, sowing dates, yield*

Introduction

Rapeseed-mustard is the third most important source of edible oil next to soybean and groundnut in India, and is grown in certain tropical and subtropical regions as a cold season crop (Shekhawat *et al*., 2012). Mustard seed in general, contains 30-33 % oil, 17-25 % proteins, 8-10 % fibres, 6-10 % moisture, and 10-12 % extractable substances (Sudhir *et al*., 2013). The estimated area, production and productivity of rapeseed-mustard in the world was 36.81 million ha, 72.99 million tonnes and 1983 kg/ha, respectively in 2018-19 (Anonymous, 2020). The area, production and productivity of rapeseed-mustard in India is 6.23 million ha, 9.26 million tonnes and 1511 kg/ha, respectively during the 2018-19 (Anonymous, 2019). Globally, India accounts 16.93% and 12.69% of the total acreage and production. Indian mustard accounts for about 75-80% of the 6.23 million ha under these crops in the country during 2018-19. Out of which Haryana, occupies 0.61 million ha area with 1.25 million tonnes production. The average productivity of rapeseed and mustard in Haryana was 2058 kg/ha during 2018-19 (Anonymous, 2019).

Optimum time of sowing is very important for higher mustard production. Different sowing dates provide variable environmental conditions within the same location for growth and development of crop (Panda *et al*., 2004). The late sowing of mustard decreases seed yield through synchronization of silique filling period with high temperatures, the decrease in assimilates production, drought stress occurrence, shortened silique filling period and acceleration of plant maturity because it is a thermo sensitive as well as photosensitive crop (Angrej *et al*., 2002). On the other hand, irrigation is also a prime requirement for crop production in Haryana. Generally, Indian mustard is grown in sub-marginal land under rainfed conditions. But with the availability of high yielding varieties and remunerative prices, cultivation of these crops started shifting to irrigated conditions. Scheduling irrigation to this crop is mostly based on physiological growth stages.

Among the commonly applied major nutrients, nitrogen is the key element in mustard production, which is structural component of protein molecules, amino acids, chlorophyll and other constituents. Its adequate supply promotes higher photosynthesis activity and vigorous

vegetative growth. About 98% of the cultivated soils of India need phosphorus fertilization for good yield (Ram and Pareek, 1999). Phosphorus plays an important role in improving water use efficiency due to its favorable effect on crop growth root development and high seed yield production per unit of water use. Though potassium is not a constituent of any organic compound but played vital role in metabolism as a co-factor for many enzymes and controls movement of stomata and maintains electro-neutrality of plant cells. Keeping these facts in mind, the present investigation was undertaken to assess the effect of date of sowing, irrigation and fertility levels on growth and productivity of Indian mustard under late sown condition.

Materials and Methods

A field experiment was conducted at the research farm of Chaudhary Charan Singh Haryana Agricultural University, Hisar during *Rabi* seasons of 2018-19 and 2019-20. This location is situated in the sub-tropical region at 29°10' N latitude and 75°46' E longitude with an elevation of 215.2 m above mean sea level in Haryana State of India. The climate of this region is semi-arid climate with severe cold during winter and hot dry and desiccating winds during summer. Weekly maximum and minimum temperature ranges were 16.8 – 35.6 ºC and 1.9 – 15.0ºC in 2018-19 and 11.9 – 31.0ºC and 2.6 – 15.0ºC in 2019-20, respectively. The weekly evening and morning relative humidity varied between 27-68 and 74-97% in 2018-19 and 37-82 and 80-99% in 2019-20 respectively. Total rainfall received during *Rabi* seasons was 35.9 mm in 5 rainy days during 2018-19 and 133.5 mm in 10 rainy days during 2019-20. Total evaporation from open pan evaporimeter Class A was 40.1 mm and 41.6 mm, during crop growing period of 2018-19 and 2019-20, respectively. Bright sunshine hours during crop growing seasons were 2.9 to 8.3 and 1.1 to 8.7 hrs, and wind velocity was 1.2 to 4.9 km/hr and 1.5 to 6.4 km/hr in 2018-19 and 2019-20, respectively. The experimental field soil was medium in organic carbon (0.53 and 0.55%) and available nitrogen (157.3 and 155.6 kg/ha), medium in available phosphorus (20.61 and 21.07 kg/ha) and rich in available potassium (296 and 94.7 kg/ha). Also, the soil was alkaline in reaction having pH (1:2 soil water suspensions) of 8.14 and 8.28 with electrical conductivity of 0.20 and 0.22 dS/m during 2018-19 and 2019-20, respectively.

The experiment was laid out in a split plot design with sixteen treatment combinations which were replicated thrice. Each plot sized 5.0 m × 3.5 m. The treatment combinations were comprised of two sowing dates viz. 2nd week of November and 4th week of November; two irrigation levels viz. no post-sown irrigation and one irrigation at flowering stage in main plots and four fertilizer levels viz. 87.5% RDF, 100% RDF (80 kg N, 30 kg P_2O_5, 20 kg K_2O), 112.5% RDF and 125% RDF in sub-plots. The Indian mustard variety PM-26 used for experimentation was sown using seed rate of 5 kg/ha. Sowing was done at 30 cm row interval by "pora" method on 14th and 27th Nov 2018 and 12th and 22nd Nov 2019. Fertilizer (kg/ha) applied as per treatments through urea, single super phosphate (SSP) and muriate of potash (MOP). Fertilizers were applied as per treatments. Full dose of nitrogen, phosphorus and potassium was applied as basal in plots with no post-sown irrigation, but in case of one irrigation at flowering, nitrogen was applied in two splits (half basal and half at irrigation). Intercultural operations viz. weeding, insect and pest management was done as and when required.

The crop was harvested after attaining full physiological maturity by manually with help of sickle and bundle of crop from different plots were kept in the field for sun drying. After complete drying, the produce was threshed, winnowed and the seeds were separated and their weight was recorded. The biometric observations were recorded on five randomly selected plants from net plot of each treatment.

All experimental data were statistically analyzed by the method of analysis of variance (ANOVA) as described by Panse and Sukhatme (1985). The significance of treatment effects was tested with the help of "F" (variance ratio) test. Appropriate standard errors along with critical differences (CD at 5%) were worked out for differentiating the treatment effects from those of change effects.

Results and Discussion

Growth characters

Data pertaining to growth characters viz. plant height, number of primary and secondary branches, dry matter accumulation at maturity stage as influenced by sowing dates, irrigation and fertility levels are presented in Table 1. In both the years plant height decreased with delay in sowing. Crop sown in 2nd week of November exhibited significantly greater plant height (160.4 and 163.8 cm) at maturity over 4th week of November sowing during 2018-19 and 2019-20, respectively. Similar results were obtained in case of number of primary and secondary branches and dry matter accumulation. An increase in number of primary branches per plant due to 2nd week of November sowing was to the extent of about 6.17 and 5.34% over 4th week of November sowing at maturity in 2018-19 and 2019-20, respectively. Similarly, number of secondary branches (5.53-5.76% higher) and dry matter accumulation (38.5-40.6 g per plant) were improved

significantly with sowing of crop in 2nd week of Nov as compared to sowing of crop in 4th week of Nov. The significant improvement in growth characters in 2nd week of November sowing may be on account of better growth of plants due to favorable growing environment. Similar findings have also been reported by Bhuiyan *et al*. (2008), Kumari *et al.* (2012) and Patel *et al.* (2013), which supports the findings of the present investigation. Among the irrigation treatment, one irrigation at flowering stage was found significantly better than no post-sown irrigation in increasing the plant height (153.3 and 157.2 cm), dry matter accumulation (11.01 and 11.65% higher), number of primary branches (7.82 and 7.49% higher) and secondary branches (6.41 and 6.53% higher) during 2018-19 and 2019-20, respectively. Adequate and timely supply of irrigation water at flowering stage ensured cell turgidity and consequently higher meristematic activity leading to more foliage development, greater photosynthetic rate, higher nutrient uptake and better growth of plant (Karoria, 2009). The increased turgidity in optimum irrigated condition results in higher stomatal conductance and photosynthesis which favoured improved morphological parameters like plant height, primary and secondary branches and better allocation of dry biomass in different plant parts. Similarly, all the growth characters were also influenced significantly due to application of different fertilizer doses. The plant height was increased with increasing fertilizer levels and maximum was recorded by application of 125% recommended dose of fertilizers at maturity (154.2 and 155.2 cm) in both the years. Similar results were also obtained in case of number of primary and secondary branches and dry matter accumulation. This increase in growth parameters with increased fertilizer doses might be due to the better nutrition to the plant resulted more plant height, number of primary and secondary branches, which resulted in better light interception and accumulation of more photosynthesis thus produced higher dry matter production. Similar results are reported by Ram *et al.* (2013) and Kumar and Swaroop (2015).

Table 1: Effect of date of sowing, irrigation and fertility levels on growth attributes of Indian mustard at maturity

Treatments	Plant height (cm)		No. of primary branches/plant		No. of secondary branches/plant		Dry matter accumulation (g/plant)	
	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20
Date of sowing								
2nd week of Nov	160.4	163.8	6.0	6.1	13.6	14.1	38.5	40.6
4th week of Nov	132.9	135.6	5.7	5.8	12.8	13.4	32.4	33.9
SEm±	2.3	2.5	0.07	0.07	0.16	0.19	0.6	0.7
CD (P=0.05)	7.9	8.6	0.23	0.23	0.56	0.67	2.1	2.4
Irrigation levels								
No irrigation	139.9	142.3	5.6	5.7	12.8	13.3	33.6	35.2
One irrigation	153.3	157.2	6.1	6.2	13.6	14.2	37.3	39.3
SEm±	2.3	2.5	0.07	0.07	0.16	0.19	0.6	0.7
CD (P=0.05)	7.9	8.6	0.23	0.23	0.56	0.67	2.1	2.4
Fertilizer levels								
87.5% RDF	135.7	140.4	5.6	5.8	13.0	13.5	32.7	34.7
100% RDF	145.6	149.6	5.9	6.0	13.2	13.8	35.1	37.0
112.5% RDF	150.9	153.8	5.9	6.0	13.3	13.8	36.7	38.3
125% RDF	154.2	155.2	6.0	6.1	13.3	13.9	37.2	38.9
SEm±	2.6	2.6	0.09	0.11	0.27	0.25	0.7	0.6
CD (P=0.05)	7.8	7.6	NS	NS	NS	NS	2.0	1.9

Yield attributes

The difference in yield attributes among the dates of sowing was observed to be significant (Table 2). Crop sown in 2nd week of November produced significantly higher number of siliquae/plant (265.3 and 275.1), number of seeds/siliqua (13.8 and 15.5) and 1000-seed weight (4.0 and 4.1 g) over 4th week of November sowing during both the years, respectively. Reduction in yield attributes was also reported by Singh *et al.* (2014) due to late sowing, owing to shorter reproductive phase in late sown Indian mustard. Dinda *et al.* (2015) also reported reduction in number of siliquae/plant, number of seeds/siliqua and 1000-seed weight due to late sowing of Indian mustard.

The irrigation levels had significant influence on different yield attributes of Indian mustard. One irrigation at flowering stage produced significantly higher number of

Table 2: Effect of date of sowing, irrigation and fertility levels on yield attributes of Indian mustard

Treatments	No. of siliquae/plant		No. of seeds/siliqua		1000-seed weight (g)	
	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20
Date of sowing						
2nd week of Nov	265.3	275.1	13.8	15.5	4.0	4.1
4th week of Nov	147.1	167.1	13.4	14.6	3.7	3.8
S.Em±	3.47	3.42	0.18	0.21	0.02	0.02
CD (P=0.05)	12.00	11.84	NS	0.71	0.05	0.06
Irrigation levels						
No irrigation	195.2	207.7	13.4	14.6	3.8	3.9
One irrigation	217.2	234.5	13.9	15.5	3.9	4.0
S.Em±	3.47	3.42	0.18	0.21	0.02	0.02
CD (P=0.05)	12.00	11.84	NS	0.71	0.05	0.06
Fertilizer levels						
87.5% RDF	186.3	200.4	12.9	13.7	3.7	3.8
100% RDF	202.8	219.4	13.7	15.1	3.9	4.0
112.5% RDF	213.3	229.0	13.8	15.4	3.9	4.0
125% RDF	222.5	235.7	14.1	15.9	4.0	4.1
S.Em±	3.68	3.66	0.27	0.27	0.03	0.03
CD (P=0.05)	10.74	10.70	0.80	0.79	0.07	0.08

siliquae/plant (217.2 and 234.5), number of seeds/siliqua (13.9 and 15.5) and 1000-seed weight (3.9 and 4.0 g) over no post-sown irrigation during both the years, respectively. Since the available soil moisture was maintained at optimum level with one irrigation at flowering stage, the late sown Indian mustard crop was not subjected to moisture stress, which might be beneficial for nutrient uptake resulting into higher values of yield attributes. Similar results were also noted by Ray *et al.* (2015) and Jagtap *et al.* (2020).

Number of siliquae/plant was increased with increasing fertilizer levels and maximum was recorded by application of 125% recommended dose of fertilizers (222.5 and 235.7) in both the years. Similar results were also obtained in case of number of seeds/siliqua and 1000-seed weight. This can be attributed to the fact that increase in fertilizer doses might have improved LAI and might have resulted in higher production of photosynthates and their translocation to sink (yield attributes), which resulted into the better yield attributes (Pattam *et al.*, 2017; Rathi *et al.*, 2019).

Seed and stover yield

The difference in seed and stover yield among the dates of sowing was observed to be significant (Table 3). The maximum seed yield of 2103 and 2200 kg/ha during 2018-19 and 2019-20, respectively was found with crop sown in 2nd week of November which was statistically significant over crop sown in 4th week of Nov (1119 and 1347 kg/ha) during first and second year, respectively. The response of stover yield of Indian mustard to dates of sowing showed the similar trend to that of seed yield. The maximum stover yield was produced when crop sown in 2nd week of November (4983 and 5082 kg/ha) which was statistically superior over crop sown in 4th week of November (2804 and 2967 kg/ha). These results suggest that pre-anthesis growth and development of mustard were adversely affected by cold frosty nights and reduced sunshine in the crop sown late. Singh *et al.* (2014) observed the similar trend and reported that late sown crop experienced sub-optimal temperature regime which retarded their growth compared to normal date or mid-sown crops. Also, post fertilization development suffered from forced maturity due to rapid rising in temperature (Singh and Singh, 2017).

The irrigation levels had significant influence on seed and stover yield of Indian mustard. One irrigation at flowering stage recorded significantly higher seed yield than no post-sown irrigation in both the years and in pooled basis. On an average, one irrigation produced 1685 and 1891 kg/ha of mustard seed during first and second season, respectively whereas no post-sown irrigation produced 1536 and 1656 kg/ha. One irrigation at flowering stage recorded significantly higher stover yield than no post-sown irrigation in both the seasons. No post-sown irrigation recorded 3624 and 3747 kg/ha of stover yield in first and second year, respectively. The corresponding yields in one irrigation treatment were 4163, 4301 kg/ha. No post-sown irrigation recorded 14.9 and 14.8% less stover yield than one irrigation at

Table 3: Effect of date of sowing, irrigation and fertility levels on yields of Indian mustard

Treatments	Seed yield (kg/ha)		Stover yield (kg/ha)	
	2018-19	2019-20	2018-19	2019-20
Date of sowing				
2nd week of Nov	2103	2200	4983	5082
4th week of Nov	1119	1347	2804	2967
SEm±	36	37	62	67
CD (P=0.05)	124	129	216	231
Irrigation levels				
No irrigation	1536	1656	3624	3747
One irrigation	1685	1891	4163	4301
SEm±	36	37	62	67
CD (P=0.05)	124	129	216	231
Fertilizer levels				
87.5% RDF (F_1)	1449	1592	3642	3740
100% RDF (F_2)	1619	1752	3856	3965
112.5% RDF (F_3)	1680	1853	3942	4127
125% RDF (F_4)	1695	1898	4134	4265
SEm±	39	41	69	76
CD (P=0.05)	114	119	202	222

flowering stage in 2018-19 and 2019-20, respectively. The significantly higher yield of Indian mustard in irrigated treatment was due to significantly improved yield attributes. These results corroborate the findings of Karoria (2009) and Choudhary *et al.* (2021). The better response of yield under irrigated treatment might be due to increased cell turgidity, higher stomatal conductance and photosynthesis which favoured improved morphological characters like leaf area, better allocation of dry biomass in different plant parts, therefore greater availability of assimilates to the developing seeds (Piri and Sharma, 2007).

In case of fertilizer levels, the mustard yield increased significantly with increased level of fertilizers. The minimum seed yield was found in 87.5% recommended dose of fertilizers (1449 and 1592 kg/ha) and increase in yield was significant up to 125% recommended dose of fertilizers. Maximum seed yield (1695 and 1898 kg/ha) was recorded with 125% recommended dose of fertilizers which was statistically at par with 112.5 (1680 and 1853 kg/ha) and 100% recommended dose of fertilizers (1619 and 1752 kg/ha) during 2018-19 and 2019-20, respectively except in 2019-20 where it was significantly superior over 100% recommended dose of fertilizers. Similarly, the maximum stover yield (4134 and 4265 kg/ha) was recorded with 125% recommended dose of fertilizers which was statistically at par with 112.5% recommended dose of fertilizers and was significantly superior over 100% and 87.5% recommended dose of fertilizers during both year. This can be attributed to increase in fertilizer doses which improved LAI and might have resulted in higher production of photosynthates and their translocation to sink (yield attributes), which results to the better yield attributes. The increase in seed yield and its attributes with increase in fertilizer doses have also been observed by Singh *et al.* (2014).

Conclusion

Mustard is a one of the important oilseeds crops in India. Its production is much influenced by the sowing time, irrigation and fertilizers. The maximum plant height, primary and secondary branches, dry matter accumulation, seed and stover yield were recorded with crop sown in 2nd week of November along with one irrigation at flowering stage and 125% RDF. Based on the findings, it can be concluded that sowing of crop in 2nd week of November with one irrigation and 125% recommended dose of fertilizers is advantageous to get the maximum yield of Indian mustard in the present ecosystem.

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