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Yield Performance and Nutrient Uptake of Indian Mustard (*Brassica juncea* L.) Varieties under Different Dates of Sowing and Planting Geometry

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Authors' contributions

This work was carried out in collaboration between all authors. Authors S. Khajuria and MCD designed the study. Author S. Khajuria performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors MCD and S. Kumar managed the analysis of the study. Author S. Kumar managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

An investigation was conducted at research farm of SKUAST–Jammu. The experiment was laid out in factorial randomized block design with 18 treatments and three replications. The treatments consisted of three dates of sowing (25th October, 5th November and 15th November), two varieties (RL-1359 and NRCDR-2) and three spacing (30 cm x 10 cm, 30 cm x 20 cm and 30 cm x 30 cm). The results revealed that the highest seed yield 1710 kg ha^{-1} was recorded with 25th October sown crop and significant reduction to the extent of 15.02 and 31.63 per cent was recorded when sowing was delayed to 5th November and 15th November, respectively. Among the varieties, yield attributes of varieties such as number of silliquae per plant, and 1000-seed weight were significantly higher with NRCDR-2 than RL-1359. However, seeds $siliqua^{-1}$ of both the varieties was at par. Variety NRCDR-2 also recorded significantly higher seed yield 1510 kg ha^{-1} which was about 9.57 per cent more in comparison to RL-1359 (1378 kg ha^{-1}). However, seeds $siliqua^{-1}$ and 1000-seed weight of

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30 cm x 30 cm and 30 cm x 20 cm was at par but significantly superior to 30 cm x 10 cm whereas, silliquae plant^{-1} was significantly higher with spacing of 30 cm x 30 cm as compared to 30 cm x 10 cm and 30 cm x 20 cm. Nutrient uptake in Indian mustard varieties was also significantly higher in October 25 sown crop along with the spacing of 30 cm x 10 cm at different dates of sowing and spacing. Among the varieties NRCDR-2 depicted significant higher nutrient uptake.

Keywords: Varieties; spacing; dates of sowing; Indian mustard.

1. INTRODUCTION

With the increasing consumer awareness and the establishment of World Trade Organization, internationally accepted norms for oil and meal quality more emphasized. The future crop with ideal oil quality with low erucic acid (2%), linolenic acid (< 3%) and high oleic acid (> 60%) linoleic acid (> 45%) and palmitic acid (> 6%) and meal with low glucosinolates (< 30 micro moles) would be rapeseed- mustard. One of the new vistas in the remunerative cultivation of oilseed *Brassica* in the non-traditional areas is to select appropriate species and variety suited to particular agro climatic situations which can yield more per unit of water and nutrients used [1].

Production potential of mustard can be fully exploited by growing suitable cultivars and improved agronomic practices. Among the different agronomic practices, optimum sowing time and suitable plant geometry plays an important role to fully exploit the genetic potential of a variety, provided optimum growth conditions such as temperature, light, humidity and rainfall etc. are favourable. Optimum sowing time is an important agronomic factor and non monetary input which plays a key role in achieving the potential yield of a crop by creating optimum environment for growth and development that results in better yield attributes [1]. The growth phases of the crop should synchronize with optimum environmental conditions for better expression of growth and yield. It is a fact that specified genotypes does not exhibit the same phenotypic characteristics in all environmental conditions. The response of different cultivars for growth varies to different environment and their relative ranking usually differ [2,3] and ultimately decides the selection of cultivars for a particular or different sowing dates for stabilized higher yields [4,5]. Optimal plant spacing provides favourable conditions for greater light interception from early crop growth stages. Further, it is more important that the plant spacing should be well defined to accommodate more number of plants per unit area. Planting geometry *i.e.* row to row and plant to plant distance plays a vital role in the production of rapeseed-mustard under irrigated conditions. Hence, keeping the above facts in the fore front for developing the hypothesis of the problem at hand, a study entitled yield performance and nutrient uptake of Indian mustard (*Brassica juncea* L.) varieties under different dates of sowing and planting geometry was undertaken with the objectives of to find out the effect of dates of sowing, varieties and spacing on yield attributes and nutrient uptake of Indian mustard.

2. MATERIALS AND METHODS

The field experiment was conducted at Agronomy Research Farm of Sher-e-Kashmir University of Agricultural Sciences & Technology of Jammu, Chatha (Jammu and Kashmir), India during *Rabi* 2014-2015. Geographically, the experimental site was located at 32^{o}-40^{o} North latitude and 74-58^{o} East longitude with an altitude of 332 meters above mean sea level in the Shiwalik foothills of North-Western Himalayas. The soil at the experimental site was sandy clay loam in texture with pH of 7.98, EC of 0.28 dS m^{-1}, organic carbon of 4.8 g/kg, available N of 239.40 kg ha^{-1}, P_2O_5 of 15.25 kg ha^{-1} and K_2O of 141.00 kg ha^{-1}. The experiment, replicated thrice, was laid out in factorial randomized block design with three dates of sowing *viz*. D_1: 25th October, D_2: 05th November and D_3: 15th November, two varieties *viz.* V_1: RL-1359 & V_2: NRCDR-2 and three planting geometry *viz.* S_1: 30 cm x 10 cm, S_2: 30 cm x 20 cm and S_3: 30 cm x 30 cm. The crops were sown in 13.5 m^2 plot size. The fertilizers were applied as 120:60:60 kg ha^{-1} N, P and K, respectively. Half dose of N and the entire dose of P and K were applied at the time of sowing through urea, di-ammonium phosphate and muriate of potash, respectively. Remaining half dose of N was applied in two equal splits at 30 DAS and 60 DAS according to dates of sowing. For all the growth and development studies during the crop growth period, five plants were selected randomly and tagged in each plot. Initially the growth parameters were recorded at 30 days after sowing and subsequent observations were

taken at an interval of 30 days. Yield and yield attributing characters were determined using standard procedures. Finally yield was expressed as kg ha^{-1}. Before sowing of the crop a composite soil sample is taken for determination of pH, EC, OC, available nitrogen, phosphorus and potassium and after harvesting of rice crop, individual soil samples from all the plots were taken from the surface for determination of same. Soil pH and EC was measured in a soil-water suspension using glass electrode pH meter and systronics conductivity meter, respectively [6]. Soil organic carbon was determined by the rapid titration method [7], available N by alkaline potassium permanganate method [8] available P by sodium bicarbonate method [9] and available K by ammonium acetate method [6]. The statistical analysis of factorial randomized block design was done by standard procedures suggested by [10].

3. RESULTS AND DISCUSSION

3.1 Yield and Yield Attributes

The data of yield attributes were presented in Table 1 revealed that sowing dates had significant impact on yield and yield attributes of mustard crop. Perusal of data makes it clear that dates of sowing registered non-significant effect as far as number of plants m^{-2} are concerned whereas other yield attributes *viz.* number of siliquae $plant^{-1}$, number of seeds $siliqua^{-1}$ and 1000-seed weight were appreciably influenced. Among sowing dates 25th October sown crop recorded significantly higher number of seeds $siliqua^{-1}$ and 1000-seed weight as compared to 5th and 15th November sown crop whereas siliquae $plant^{-1}$ though at par with 5th November sown crop but significantly higher than 15th November sown crop. Similarly, 5th November sown crop recorded significantly higher siliquae $plant^{-1}$ as compared to 15th November sown crop while number of seeds $siliqua^{-1}$ and 1000-seed weight was found to be at par for both November sown dates. This might be attributed to longer reproductive phase, suitable temperature and translocation of more photosynthetic product from source to sink in early sowing as compared to delayed sowing. These results substantiate the findings of [11,12]. The seed and stover yield was significantly higher in 25th October sown crop followed by 5th and 15th November sown crop and all the three sowing dates differed significantly from each other. Higher seed and stover yields were obtained in early sowing might be attributed to the fact that crop got sufficient time for growth under suitable climatic conditions than later sowing dates. Moreover, maximum and minimum temperature attained comparatively lower values under delayed sowing during various phases due to which duration of reproductive phase was markedly reduced, resulting in lower seed and stover yield. These findings are supported by similar results of [11,13].

Table 1. Effect of different treatments on yield and yield attributes of Indian mustard

Treatments	No. of plants m^{-2}	No. of siliquae $plant^{-1}$	No. of seeds $siliqua^{-1}$	1000-seed weight (g)	Seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Harvest index (%)
Dates of sowing							
25th October	19.33	182.39	14.36	4.11	1710	6868	19.96
5th November	19.28	173.43	13.05	3.95	1453	5906	19.83
15th November	19.17	155.57	12.17	3.85	1169	4737	19.84
SEm±	0.22	3.46	0.34	0.05	043	194	0.17
LSD (P=0.05)	NS	9.93	0.97	0.15	124	558	NS
Varieties							
RL-1359	19.22	164.43	12.81	3.88	1378	5515	20.05
NRCDR-2	19.30	176.50	13.57	4.07	1510	6160	19.70
SEm±	0.18	2.82	0.28	0.04	035	159	0.14
LSD (P=0.05)	N S	8.11	NS	0.13	101	456	0.39
Spacings							
30 cm x 10 cm	31.83	124.85	12.31	3.80	1733	7050	19.73
30 cm x 20 cm	15.33	182.51	13.30	3.99	1451	5837	19.95
30 cm x 30 cm	10.61	204.02	13.97	4.13	1149	4625	19.95
SEm±	0.22	3.46	0.34	0.05	043	194	0.17
LSD (P=0.05)	0.64	9.93	0.97	0.15	124	558	NS

Interactions: Non significant

Varieties were also found to be significant for number of primary and secondary branches, number of siliquae plant^{-1} and 1000-seed weight. From the data of Table 2 it is clear that variety NRCDR-2 registered itself appreciably superior than RL-1359 for number of primary and secondary branches, number of siliquae plant^{-1} and 1000-seed weight whereas number of seeds siliqua^{-1} was statistically at par with both the varieties. The varietal difference in several yield attributes may be attributed as inherent variation due to their genetic makeup. It has been also reported varietal difference in several yield attributes [14]. Significant differences were found in seed and stover yield of both the varieties. NRCDR-2 registered significant higher seed and stover yield over RL-1359. This might be due to higher nutrient uptake, greater vegetative growth, elevated yield attributes, higher dry matter partitioning towards economic part and better light interception. Yield variability among mustard cultivars also attributed to genetic characters and environmental effects. The varietal difference in seed and stover yield has also been reported by [15,16].

Spacing had significant influence on various yield attributes of Indian mustard. Number of seeds siliqua^{-1} and 1000-seed weight of 30 cm x 30 cm and 30 cm x 20 cm was at par but significantly higher than 30 cm x 10 cm. These results are in line with [17,18] and who attributed these results to the better soil moisture availability, decreased plant competition, increased light penetration through plant canopy at a lower plant population and higher translocation of assimilates for formation of seeds and higher siliqua length. Improvement in yield attributes with wider spacing was also reported by [11,19]. Sowing at spacing of 30 cm x 10 cm recorded significant higher seed and stover yield over wider spacing of 30 cm x 20 cm and 30 cm x 30 cm. The improvement in yield attributes with wider spacing failed to compensate for lower number of plants per unit area. However, lower value of various yield attributes under narrow spacing resulted in increased seed and stover yield which might be due to higher plant population that led to competition for nutrients and light and also increased the total nutrient uptake for plant and assimilates for seed development. Similar results were also obtained by [11,13].

Harvest index showed non-significant effect due to different sowing dates, varieties and plant geometry. This may be due to similar increment in seed and stover yield at different sowing dates and spacing.

3.2 Nutrient Uptake

Uptake of nutrients (N, P and K) by crop is a function of the nutrient content in plant and dry matter accumulation per unit area. The data presented in Table 2 revealed that N, P and K uptake in seed and stover was significantly influenced by sowing dates. A decreasing trend of N, P and K uptake was recorded with every delayed sowing date and followed the trend of seed and stover yield because of reduced growth and yield attributes of Indian mustard. It has been also reported that N, P and K uptake decreased with sowing dates although genotypes

Table 2. Effect of different treatments on nutrient uptake (kg ha-1) of Indian mustard at harvest

Treatments	Seed			Stalk			Total		
	N	P	K	N	P	K	N	P	K
Dates of sowing									
25th October	50.56	8.77	20.26	28.51	11.52	73.72	79.07	20.29	93.98
5th November	43.67	7.45	17.06	24.12	10.40	63.26	67.79	17.85	80.32
15th November	35.44	5.87	13.78	18.76	7.92	50.65	54.20	13.78	64.43
SEm±	1.45	0.24	0.58	0.86	0.35	1.77	2.41	0.55	2.25
LSD (P=0.05)	4.18	0.68	1.66	2.47	1.01	5.08	6.94	1.58	6.46
Varieties									
RL-1359	40.89	6.98	16.26	22.22	9.14	59.18	63.12	16.12	75.44
NRCDR-2	45.55	7.74	17.81	25.37	10.76	65.91	70.93	18.50	83.72
SEm±	1.19	0.19	0.47	0.70	0.29	1.44	1.97	0.45	1.83
LSD (P=0.05)	3.41	0.56	1.35	2.02	0.82	4.15	5.67	1.29	5.27
Spacing									
30 cm x 10 cm	51.90	8.93	20.45	29.12	12.19	75.51	81.02	21.13	95.95
30 cm x 20 cm	42.72	7.34	17.15	23.81	9.68	62.81	66.54	17.02	79.96
30 cm x 30 cm	35.05	5.82	13.50	18.46	7.96	49.32	53.51	13.78	62.82
SEm±	1.45	0.24	0.58	0.86	0.35	1.77	2.41	0.55	2.25
LSD (P=0.05)	4.18	0.68	1.66	2.47	1.01	5.08	6.94	1.58	6.46

Interactions: Non significant

were different [11]. Both the varieties were significantly differed for N, P and K uptake in seed and stover at harvest and significantly higher uptake was recorded in NRCDR-2 as compared to RL-1359. [20] also reported that nutrient uptake of rapeseed mustard was significantly affected by varieties. Sowing at spacing of 30 cm x 10 cm had significantly higher nutrient uptake by seed and stover over wider spacing of 30 cm x 20 cm and 30 cm x 30 cm due to increased growth and yield attributes which ultimately improves nutrient uptake as total uptake of nutrient is a function of dry matter accumulation and nutrient content. Nutrient uptake is the function of dry matter and nutrient content. Higher plant density led to higher plant dry matter and production which led to higher nutrient uptake by plants. Similar observations were also made by [11,16].

4. CONCLUSION

From the present study, it can be inferred that 25th October sown crop produced highest seed yield 1710 kg ha^{-1} and remained significant superior to 5th November and 15th November sown crop. Variety NRCDR-2 recorded significant higher yield attributes and nutrient uptake as compared to RL-1359. Closer spacing of 30 cm x 10 cm registered significant higher seed yield and nutrient uptake.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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