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RESEARCH

YIELD, ECONOMICS AND NUTRIENT UPTAKE PATTERN OF INDIAN MUSTARD (*BRASSICA JUNCEA* L.) VARIETIES AS AFFECTED BY SOWING TIME AND NITROGEN FERTILIZATION UNDER WESTERN HARYANA

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Abstract: A Field experiment was conducted during *rabi*2022-23 to study the effect of sowing time and nitrogen fertilization on yield, economics and nutrient uptake of Indian mustard varieties at research farm, College of Agriculture, Hisar, Haryana. The experiment was laid out in split plot design with three replications comprising two sowing dates viz., timely sown (Oct 20) and late sown (30 Oct) with two varieties RH 1424 and RH 725 and four nitrogen levels *viz*., 0 (control), 60, 80 and 100 kg N/ha as main plots and sub plots treatments, respectively. The maximum seed yield was obtained with timely sown crop with RH 1424 (26.13 q/ha) which was statically at par with timely sown RH 725 (23.13 q/ha), thereafter the yield decreased with delay in sowing. However, the yield obtained in late sown crop with RH 1424 is statically at par with late sown RH 725. Maximum uptake of nitrogen was recorded with timely sown RH 1424 (82 kg/ha) and 100 kg N/ha (78.4 kg /ha) compared to other treatments. The mustard yield was increased significantly with increased dose of nitrogen. Maximum seed yield (26.21 q/ha), biological yield (175 q/ha) and highest benefit cost ratio of 2.18 was obtained with 100 kg N/ha. However, the seed yield obtained with 100 kg N/ha is statically at par with 80 kg N/ha. The uptake of nitrogen was higher under 100 kg N/ha by 75% over the control.

Keywords: *Brassica juncea*, Nitrogen, Fertilization, Oilseed crops

INTRODUCTION

India is the world's fourth-largest cultivator and producer of oilseed crops, after USA, China and Brazil contributing around 19% of the global acreage but only about 2.7% of total production. Among oilseed crops, rapeseed-mustard (*Brassica* spp.) ranks third globally after soybean and palm oil (Choudhary *et al*., 2023). India stands as the second-largest cultivator of rapeseed-mustard, accounting for 21.1% of the global area, following Canada, and ranks third in production next to Canada and China contributing approximately 32% to the country's total oilseed output (Jat *et al*.,2019). The key factor behind India's imbalance between the demand and supply of vegetable oils is the relatively low productivity of its oilseed crops. Rapeseed-mustard is the third most widely produced oilseed crop in India, over the past decade, mustard productivity in India has shown significant improvement increasing from 1185 kg/ha in 2008–09 to 1524 kg/ha in 2020-21, with a production increase from 7.20 million tonnes to 10.21 million tonnes during the same period (Anonymous, 2021).The Indian mustard (*Brassica juncea*) is highly responsive to the inputs than other mustard spp. under varied climatic conditions (Mandal and Sinha 2011). Among the various agronomic practices, the time of sowing stands out as an important non-monetary input. Variations in sowing date, day length, and temperature interact to significantly influence the growth, yield, and quality of a crop. Choosing the optimal sowing time ensures favourable conditions for maximum light interception and efficient utilization of moisture and nutrients from the early growth stages through to seed filling. For mustard cultivation in particular, timely sowing is critical to achieving high productivity and superior crop performance.

Nitrogen enhances crop yield by positively affecting various growth parameters, leading to more vigorous development. This is evident in increased plant height, number of branches, total biomass, leaf area index and the number and weight of siliquae and seeds per plant (Alien and Morgan, 1972). As a key nutrient, nitrogen promotes a lush green colour in crops by boosting chlorophyll production. Nitrogen also affects uptake of other essential nutrients and it helps in the better partitioning of photosynthates to reproductive parts which increase the seed: Stover ratio (Keerthi *et al*., 2018). Numerous studies have confirmed that nitrogen fertilizers significantly increase seed yield, even under varying and challenging environmental conditions (Siadat *et al*., 2010).

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MATERIALS AND METHODS

Data on the growth and yield attributes of Indian mustard were collected during the *rabi* season of 2022-23 from a field experiment conducted at the Agronomy Research Farm, CCSHAU, Hisar. The site is located in the Indo-Gangetic plains of North-West India at an elevation of 215.2 meters above mean sea level with coordinates 29°10′ N latitude and 75°46′ E longitude. The experiment conducted in split plot design, incorporating two sowing dates and two mustard varieties in main plot namely timely sown RH 1425 (October 20), timely sown RH 725 (October 20), late sown RH 1424 (October 30) and late sown RH 725 (October 30) with four nitrogen levels in sub plots viz0 kg N/ha (control), 60 kg N/ha, 80 kg N/ha, and 100 kg N/ha. Nitrogen was applied as urea, with half the dose given as a basal application and the remainder as top dressing after the first irrigation. The soil of the experimental field is sandy loam with a pH of 8.63 and low organic carbon content (0.53%). It was low in available nitrogen (155 kg/ha), medium in available phosphorus (P_2O_5, 23.2 kg/ha), and high in available potassium (K_2O, 395.6 kg/ha). Mustard was sown at a spacing of 30 cm × 10 cm using a seed rate of 5 kg/ha. Two irrigations were applied, one at 30 days after sowing and another at the siliqua formation stage. All recommended agronomic practices were followed. Harvesting was done when over 85% of the siliquae turned brown. Observations recorded at harvest included plant height, yield attributes, seed yield, and economic analysis. Nitrogen content in seed and straw was determined at harvest. For this, oven-dried samples from each plot were ground separately and nitrogen content was estimated using the Nessler's reagent method (Linder, 1944). Nutrient uptake was calculated in kg/ha by multiplying nitrogen content with the corresponding seed and straw yields. Economic analysis was performed considering the market price of mustard and the cost of cultivation during the 2022-23 season. Data collected on various crop parameters were subjected to statistical analysis for valid interpretation and conclusions.

Table 1. Effect of sowing dates and nitrogen levels on yield attributes and yields of Indian mustard varieties

Treatments	Plant height (cm)	Siliqua length (cm)	Seeds/silique (No.)	Siliquae/ plant (No.)	Test weight (g)	Seed yield (q/ha)	Biological yield (q/ha)	Harvest index (%)
Date of sowing X varieties								
Timely sown RH1424	187	5.38	13.86	542	6.11	26.13	125	20.66
Timely sown RH 725	195	5.26	13.68	537	5.67	23.23	117	19.56
Late sown RH1424	181	5.02	12.08	230	5.39	18.93	97	19.42
Late sown RH725	185	5.18	10.94	189	4.83	17.51	74	23.20
CD (p=0.05)	**NS**	**NS**	**1.03**	**79.5**	**0.86**	**4.66**	**6.86**	**NS**
Nitrogen levels (kg/ha)								
0	177	4.89	11.25	324	5.17	13.10	80.	16.40
60	184	5.20	12.50	363	5.52	21.84	106	20.87
80	190	5.25	13.24	381	5.57	24.56	112	22.28
100	197	5.51	13.58	429	5.74	26.29	115	23.29
CD (p=0.05)	**8.3**	**0.308**	**0.71**	**52.02**	**0.38**	**3.94**	**4.69**	**4.00**

Table 2. Effect of sowing dates and nitrogen levels on Nitrogen content and total Nitrogen uptake of Indian mustard varieties

Treatments	N content (%)		N Uptake (kg/ha)		Total N Uptake (kg/ha)
	Seed	**Stover**	**Seed**	**Stover**	
Date of sowing X varieties					
Timely sown RH1424	1.40	0.45	37.0	45.0	82.0
Timely sown RH 725	1.36	0.44	31.8	41.7	73.5

Late sown RH1424	1.31	0.43	24.9	33.6	58.6
Late sown RH725	1.31	0.45	23.2	25.6	48.8
CD (p=0.05)	**0.032**	**0.012**	**6.84**	**6.84**	**7.06**
Nitrogen levels (kg/ha)					
0	1.26	0.42	16.56	28.3	44.8
60	1.36	0.44	29.75	36.5	66.3
80	1.37	0.45	33.97	39.4	73.3
100	1.39	0.47	36.71	41.7	78.4
CD (p=0.05)	**0.017**	**0.01**	**5.44**	**5.44**	**3.65**

Table 3. Cost of cultivation, gross return, net return, and benefit cost ratio as influenced sowing dates and nitrogen levels in Indian mustard varieties

Treatments	**Cost of cultivation (Rs/ha)**	**Gross returns (Rs/ha)**	**Net returns (Rs/ha)**	**B:C**
Date of sowing X varieties				
Timely sown RH1424	62783	132013	74480	2.18
Timely sown RH 725	62783	117366	59834	1.95
Late sown RH1424	62783	95618	38085	1.61
Late sown RH 725	62783	88461	30936	1.49
Nitrogen levels (kg/ha)				
0	61988	71444	9456	1.15
60	62782	115581	52799	1.84
80	63045	129348	66303	2.05
100	63308	138084	74776	2.18

Table 4. Correlation coefficient (r) between seed yield and growth and Yield attributes parameters

	Seed Yield	*Plant Height*	*Siliqua Length*	*No. of Seeds/Siliqua*	*Siliquae/Plant*	*test weight*
Seed Yield	1					
Plant Height	0.77	1.00				
Siliqua Length	0.83	0.70	1.00			
No. of Seeds/Siliqua	0.90	0.69	0.68	1.00		
No. Siliquae/Plant	0.70	0.62	0.55	0.86	1.00	
Test Weight	0.81	0.47	0.56	0.92	0.85	1

RESULTS AND DISCUSSIONS

Growth and yield attributes

The growth and yield attributes of Indian mustard varieties were significantly influenced by delayed sowing and increasing levels of nitrogen application. A perusal of data in Table 1 clearly indicates that the number of seeds per siliqua, siliquae per plant (no.) and test weight was significantly decreased with delay in sowing. Plant height and siliqua length was not influenced by the different dates of sowing. Maximum number of seeds/siliquae, siliquae per plant and higher test weight were recorded at timely sown RH 1424followed by timely sown RH 725 significantly higher over delay in sowing with both the varieties. There was 3.7, 21.7, 65 and 20.94 % decrease in siliqua length, seeds per siliqua, number of siliquae per plant and test weight in late sown RH 725 over timely sown RH 1424, respectively. This might be timely sown crop (Oct 20) faced favourable soil moisture condition and relatively warmer temperature during vegetative phase and conducive temperature during 50% flowering and pod formation stage and might be maintained better plant relations which led to higher rate of photosynthesis due to more opening of stomata for longer period of time. This has also increased for faster cell division and enlargement, which led to higher growth and yield attributes (Keerthi *et al*., 2018). All the growth and yield attributes of Indian mustard varieties increased significantly with increasing levels of nitrogen up to 100 kg N/h, however, it remained at par with 80 kg N/ha. The increase in plant height, siliqua length, number of seeds per silique, number of siliquae per plant and test weight under 100 kg N/ha by 11.29,12.67,20.7,32.4 and 11.02 % over the control, respectively. This might be due to the nitrogen being the basic constituent of chlorophyll, protein and cellulose required for the process of photosynthesis and tissue formation for proper growth and thereby increasing the yield attributes. These results are in line with those of Singh R.K. and Singh C.V. (2017) and Yadav *et al*. (2017).

Seed and Biological yield

Seed yield and biological yield decreased progressively with delay in sowing. However, the difference between timely sown RH 1424 and timely sown RH 725 were at par for seed yield. The delay in sowing with mustard varieties from timely sown RH 1424 to timely sown RH 725,timely sown RH 1424 to late sown RH 1424, timely sown RH 1424 to late sown RH725 decreased the seed yield of mustard by about 12.4, 28.2 and 33.63 % respectively. The might be, due to decrease in biological yield by 6.422.4 and 40.8 %, respectively. Timely sown crop with both the varieties received the optimum environment conditions required for better crop growth. The significant positive association between seed yield with plant height (r=0.77) siliqua length (0.83), no. of seeds/ per siliqua (0.90), no. of siliquae per plant (0.70) and test weight (0.81) (Table 4). Application of 100 kg N/ha recorded significantly higher seed and biological yield but seed yield was at par with 80 kg N/ha. Significantly higher seed yield (100.6%) and biological yield (42.8 %) in 100 kg N/ha over manage were because of more availability of nutrients for their growth and development of better yield attributes and yield. Trend has been reported by Keerthi *et al*. (2018).

Nitrogen content and uptake

The nitrogen content in seed was 3.1 times higher than in stover of Indian mustard crop. Maximum nitrogen content in seed (1.40 %) and stover (0.45%) was observed in timely sown RH 1424 which was significantly higher than late sown varieties. N content increased significantly with increased dose of nitrogen. Higher nitrogen content in seed (1.39 %) and stover (0.45 %) was observed with highest dose of nitrogen *i.e*. 100 kg N/ha which was significantly higher than over 80, 60 40 kg and 0 kg N/ha. The data on uptake of nitrogen in Table 2 reveals that nitrogen uptake in seed and stover decreased significantly with delay in sowing in both the varieties. Maximum nitrogen uptake by seed and stover and total uptake was recorded with timely sown RH 1424 which significantly differed with late sown varieties. The uptake of nitrogen was higher with timely sown RH 1424 was 68.03 % over late sown RH 725. The minimum nitrogen uptake by the seed and stover was in control treatment, *i.e*0 kg N/ha which was significantly lower as compared to other doses of nitrogen. Fertilization of 100 kg N/ha recorded highest nitrogen uptake by the seed (36.71 kg/ ha) and stover (41.7 kg/ha) and total uptake (78.4 kg /ha) compared to other treatments. The uptake of nitrogen was higher under 100 kg N/ha by 75% over the control (Table 2). The higher uptake of nitrogen under higher dose of N was because of more availability of these nutrients, which encouraged the crop growth and finally higher seed yields The nutrient status of plant tissue being the genetic character was affected less by the environment but, higher growth require higher uptake. Similar results have been reported by Parmar *et al*., (2011).

Economics

The economics of Indian mustard varieties affected by dates of sowing and nitrogen levels is given in (Table 3). The cost of cultivation Indian mustard varieties under different dates of sowing (₹ 62783) was observed same. The cost of cultivation increased with increase in dose of nitrogen. Among the different nitrogen levels, the cost of cultivation was highest at 100 kg N/ha and it was lowest at 0 kg N/ha. The net profit and B:C ratio was recorded highest at timely sown RH 1424 followed by timely sown RH 725 and lowest at late sown crop in both the varieties, but it increased with increase in nitrogen doses. Maximum net profit (₹ 74776) and B: C ratio (2.18) was recorded in application of 100 kg N/ha it was lowest in 0 kg N/ha ₹9456 and 1.15, respectively.

Thus, on the basis of aforesaid findings, it could be concluded that timely sown with RH 1424 and RH 725 (Oct 20) along with 100 kg N/ha performed significantly better growth, yield, nutrient uptake and higher economics under western Haryana.

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