



Optimizing yield and physiological performance of Indian mustard (*Brassica juncea* L.) varieties through sowing dates and nitrogen management

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Abstract

Field experiment was conducted during *rabi* 2022-23 to study the effect of dates of sowing and nitrogen treatments on yield and physiological performance of Indian mustard varieties at research farm, CCS Haryana Agricultural University, Hisar (Haryana). The experiment was laid out in split plot design with three replications consisted two dates of sowing and two varieties *viz.*, timely sown (Oct 20) and late sown (30 Oct) with 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. Results revealed that delay in sowing of Indian mustard varieties RH 1424 and RH 725 significantly decrease growth and yield of the crop. Among the plant water relations, chlorophyll index, decreased significantly with delay in sowing in both the varieties, whereas, canopy temperature, and canopy temperature depression (CTD) increased with delay in sowing significantly. 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. Among the doses of nitrogen, maximum seed yield (26.21 q/ha), biological yield (115 q/ha) was obtained with 100 kg N/ha.

Keywords: Indian mustard, nitrogen levels, physiological parameters, sowing date, yield

Introduction

Rapeseed-mustard (*Brassica* spp.) is a major group of oilseed crop in the world after soybean (*Glycine max*) and palm (*Elaeis guineensis* Jacq.) oil. In India, it is the second most important edible oilseed after groundnut sharing 27.8% in the India's oilseed economy. The Indian mustard (*Brassica juncea*) is highly responsive to the inputs than other mustard spp. under varied climatic conditions (Mandal and Sinha, 2011). In present conditions, the climatic trend has moderately changed in many agricultural regions, and this changing trend is expected to continue in the future. This raises many questions related to growing crops according to environmental variables (rainfall and temperature) and adjusting the sowing time of crops accordingly (Gouri *et al.*, 2005). Production efficiency of different genotypes greatly differs under different planting dates. Sowing at optimum time gives higher yields due to suitable environment that prevails at all the growth stages. Since, there is a vast variability in the climatic and edaphic conditions in the mustard growing areas of India, the selection of appropriate cultivar and time of sowing is important as it helps in increasing the productivity. Though different varieties have a differential response to date of sowing, adequate nutrient supply increases the seed and oil yields by improving the setting pattern of siliquae on branches, number of siliquae/plant, and other yield attributes

(Kapila Shekhawat *et al.*, 2012). Problem of low yield is associated mainly with depletion of nutrients from the soil (Thaneshwar *et al.*, 2017). Among the major nutrient elements, nitrogen which is insufficient in most of the Indian soils plays an important role in *Brassica* crops. Nitrogen is considered to be the most important nutrient for the crop to activate the metabolic activity and transformation of energy, chlorophyll and protein synthesis. Nitrogen also affects uptake of other essential nutrients and it helps in the better partitioning of photosynthates to reproductive parts which increase the seed to stover ratio (Keerthi *et al.*, 2018). Considering these facts in view the present investigation was proposed with the objective that finds out a suitable combination of sowing date and variety and nitrogen dose to enhance the productivity of the crop.

Materials and Methods

A field research trial was carried out at the research farm of Chaudhary Charan Singh Haryana Agricultural University, Hisar (India) during *rabi* season of 2022-23. The soil of the field was sandy loam, having pH 8.63 and low in organic carbon (0.53%). It was low in available N (155 kg/ha), medium in available P₂O₅ (23.2 kg/ha) and rich in available K₂O (395.6 kg/ha). The experiment consisting of two dates of sowing and varieties *viz.* timely sown RH 1425 (Oct 20), timely sown RH 725 (Oct 20), late

sown RH 1424 (30 Oct) and late sown RH 725 (Oct 30) in main plots and four nitrogen levels viz. 0 kg N/ha (Control), 60 kg N/ha, 80 kg N/ha and 100 kg N/ha in sub plots was laid out in split plot design with three replications. The doses of nitrogen were applied in the form of urea. Half dose of the nitrogen was applied as basal dose and remaining half as top dressing after first irrigation. Crop was sown with spacing of 30 cm x 10 cm at the seed rate of 5 kg /ha. All the agronomic operations were kept uniform in all the plots. The weeds were removed by long tine hoe at 30 and 60 days after sowing (DAS). The plant physiological parameters viz., relative water content, canopy temperature, and canopy temperature depression and chlorophyll index were studied by taking third leaf from top at full bloom stage under different dates of sowing and nitrogen levels. Plant water status, relative water content was calculated as described by Weatherly (1950). Canopy temperature and canopy temperature depression (CTD) of the crop in different treatments were measured from a distance of about one meter with infrared thermometer (Teletemp AG) during noon hours. Yield attributes were recorded from the five plants sample collected at the time of harvest. The crop harvested from net plot area was converted into seed yield (kg ha⁻¹) and biological yield (kg ha⁻¹). The data were analyzed as per the standard procedure for "Analysis of Variance" (ANOVA) (Gomez and Gomez, 1976).

Results and Discussion

Growth and physiological parameters

The perusal of data in Table 1 shows that plant height of both the varieties was not influenced with sowing time. The results on plant water relations of Indian mustard varieties viz., relative water content, canopy temperature

and canopy temperature depression and chlorophyll index was influenced by dates of sowing significantly. Relative water content (RWC) shows non-significant with dates of sowing and varieties. Canopy temperature and canopy temperature difference (CTD) increased significantly with delay in sowing. However, difference between late sown RH 1424 and late sown RH 725 sowings were found non-significant. Chlorophyll index decreased with delay in sowing. Highest chlorophyll index (32.96) was recorded with timely sown RH 1424 (Table 1).

Plant height was significantly increased with increased dose of nitrogen. Increase in each level of N doses increased the relative water content and chlorophyll index significantly (Table 1). This significantly higher RWC and chlorophyll index in 100 kg N/ha (85.5% and 33.1%, respectively) than control treatment indicated that for better plant water status maintenance, plant require higher amount of available nutrients as this fact is quite clear with lowest RWC and chlorophyll index in control i.e. 0 kg N/ha, which was significantly lower than 100 kg N/ha. Canopy temperature was decreased significantly with an increase in the doses of nitrogen from 0 to 100 kg N/ha. The canopy was also cooler in treatment where nitrogen was applied. But CTD was found non-significant. This more cooling of canopy might be due to better plant water status maintenance and higher regulation of stomata, which has transpired more water because of synergistic interaction between nutrient availability and stomatal regulation (Waraich and Ahmad, 2010).

Yield attributes and yield

Yield attributes and yield of Indian mustard varieties were significantly influenced due to different crop growing

Table 1: Effect of sowing dates and nitrogen levels on growth and physiology of Indian mustard varieties

Treatments	Plant height (cm)	RWC (%)	Canopy temperature (°C)	CTD (°C)	Chl index
Date of sowing x varieties					
Timely sown RH1424	187	83.4	20.1	-2.05	32.9
Timely sown RH 725	195	82.1	19.5	-3.03	30.4
Late sown RH1424	181	78.2	21.8	-2.93	24.9
Late sown RH 725	185	77.2	21.5	-3.04	23.8
SEm±	5.38	3.14	0.12	0.11	1.3
LSD (p=0.05)	NS	NS	0.42	0.39	4.6
Nitrogen levels (kg/ha)					
0	177	74.3	21.1	-2.83	22.3
60	184	79.1	20.7	-2.78	25.9
80	190	82.0	20.8	-2.77	30.8
100	197	85.5	20.4	-2.66	33.1
SEm±	2.81	1.06	0.2	0.17	1.5
LSD (p=0.05)	8.3	3.10	0.5	NS	4.4

Table 2: Effect of sowing dates and nitrogen levels on yield attributes and yields of Indian mustard varieties

Treatments	Primary branches (no.)	Sec. branches (no.)	Siliquae length (cm)	Seeds/siliquae (no.)	Test weight (g)	Siliquae/plant (no.)	Seed yield (q/ha)	Biological yield (q/ha)	Harvest index (%)
Date of sowing x varieties									
Timely sown RH1424	7.2	19.08	5.38	13.86	6.11	542	26.13	124.9	20.66
Timely sown RH 725	6.6	12.33	5.26	13.68	5.67	537	23.23	116.9	19.56
Late sown RH1424	5.3	15.00	5.02	12.08	5.39	230	18.93	96.9	19.42
Late sown RH725	5.0	9.33	5.18	10.94	4.83	189	17.51	74.3	23.20
SEm±	0.22	1.0	0.083	0.29	0.24	22.55	1.33	1.94	1.21
LSD (p=0.05)	0.79	3.53	NS	1.03	0.86	79.5	4.66	6.86	NS
Nitrogen levels (kg/ha)									
0	5.6	9.80	4.89	11.25	5.17	324	13.10	80.05	16.40
60	5.9	11.6	5.20	12.50	5.52	363	21.84	105.9	20.87
80	6.1	12.8	5.25	13.24	5.57	381	24.56	112.2	22.28
100	6.4	13.9	5.51	13.58	5.74	429	26.29	115.0	23.29
SEm±	0.12	0.50	0.105	0.24	0.13	17.71	1.34	1.60	1.36
LSD (p=0.05)	0.35	1.46	0.308	0.71	0.38	52.02	3.94	4.69	4.00

environments (Table 2). Timely sown RH 1424 produced highest number of siliquae plant⁻¹, seeds siliqua⁻¹, test weight (g), higher seed yield (kg ha⁻¹) and biological yield (kg ha⁻¹) as compared timely sown RH 725, late sown RH 1424 and late sown RH 725. However, primary branches, seeds per siliqua, test weight and number of siliquae per plant statically at par with timely sown RH 725. There was a significant decrease in seed and biological yield of Indian mustard varieties with delay in sowing. The delay in sowing from timely sown RH 1424 to timely sown RH 725, late sown RH 1424 and late sown RH 725 decreased the seed yield of mustard by about 11.09, 27.55 and 32.98%, respectively. This decrease was because of decreased number of siliquae per plant by 0.92, 57.6 and 65.12% respectively. The stronger source is required for the stronger sink.

The higher biological yield was found significantly associated with higher seed yield of mustard ($r=0.90$). This clearly shows the biological yield increased by any input or management practice will automatically increase the seed yield of mustard. The seed yield of mustard can also be estimated through biological yield with the regression equation (Fig 1, Seed yield = $-243.95 + 0.2313 \times$ biological yield, $r^2 = 0.82$). Timely sown crop received the optimum environment conditions required for better crop growth in terms plant height, no of branches per plant. The significantly positive association between biological yield with growth parameters plant height ($r = 0.75$). Timely sown RH 1424 and RH 725 maintained better water relations in terms of CT, CTD, RWC, and chlorophyll index which helped in opening of stomata and increased rate of photosynthesis which ultimately increased the biological and seed yield. This fact can be supported by significant association between seed yield and canopy temperature ($r = -0.63$), seed yield and RWC ($r = 0.95$), seed yield and chlorophyll index ($r = 0.93$) (Table 3).

Nitrogen application had significant effects on yield. Seed

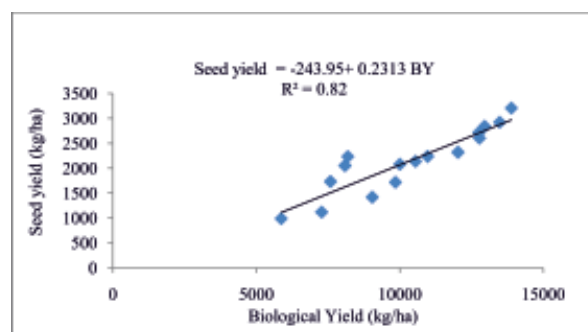


Fig. 1: Regression line showing the relationship of biological yield with seed yield

Table 3: Correlation coefficient (r) between seed yield and growth and physiology parameters

	Seed yield	Biological yield	Plant height	RWC	CT	Chlorophyll index
Seed yield	1					
Biological yield	0.904756	1				
Plant height	0.774469	0.647929	1			
RWC	0.953276	0.857809	0.825014	1		
CT	-0.62982	-0.72451	-0.65851	-0.62834	1	
Chlorophyll index	0.938615	0.888352	0.806982	0.96622	-0.6939	1

yield and biological yield increased significantly with increase in doses of nitrogen from 0 to 100 kg N/ha, however, seed and biological yield remained at par with 80 kg N/ha. The significantly higher seed yield (100.6%) and biological yield (43.6%) in 100 kg N/ha over control were because of more availability of nutrients for their growth and development of better yield attributes and yield. The poor nutrition in control affected the seed yield more than biological yield which ultimately resulted in significant reduction in harvest index. Similar trend have been reported by Keivendra *et al.* (2012) and Keerthi *et al.* (2018).

Conclusion

The present study concluded that timely sown RH1424 of Indian mustard variety exhibited significantly higher growth and yield followed by timely sown RH 725 due to better plant water relations for various plant processes. Among the doses of nitrogen, 100 kg N ha⁻¹ had higher growth and yield because of increase in crop duration by two days in well fertilized crop over control.

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