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Effect of nitrogen and boron levels on growth yield of mustard(*Brassica Juncea L.*)

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Abstract
A field experiment was conducted at Department of Agronomy, Vivekanand Global University, Jaipur during *rabi* season 2024-2025, to study the "Effect of Nitrogen and Boron Levels on Growth Yield of Indian Mustard (*Brassica juncea L.*)**"**. The experiment was laid out according to randomized block design with three replications. The treatments consisting of four level of nitrogen (Control, 40 kg/ha, 80 kg/ha and 120 kg/ha) and four boron level (Control, 0.5 kg/ha, 1.0 kg/ha and 1.5 kg/ha) were applied to the mustard. Results showed that the highest plant height, dry matter accumulation, number of branches per plant, number of siliqua per plant, number of seeds per siliqua, test weight, seed yield, stover yield and biological yield, nitrogen, phosphorus and potassium content and uptake in seed and stover, oil content and oil yield of mustard was significantly increased with the application of nitrogen level 120 kg (N_4) which was remained at par with nitrogen level 80 kg/ha over control.

Keywords: Nitrogen, boron, mustard

Introduction
Indian mustard (*Brassica juncea*L.) is commonly known as rai or laha. Crop is grown under a wide range of agro climatic conditions. Indian mustard is the most important member of the brassica group. Mustard group of plants are grown both on sandy and heavy soils under irrigated as well as rainfed conditions. Crop is commonly cultivated in areas of marginal and sub-marginal productivity, either mixed or intercropped with wheat, barley, gram, pea, sugarcane, lentil etc. In areas of advanced agronomy, they are chiefly grown as pure crop.

The oil content of Indian mustard varying between 30 to 45.7%. The seed and oil are used as condiment in the preparation of pickles and for flavouring curries and vegetables. The oil is utilized for human consumption throughout the northern India, in cooking and frying purposes. It is also used in the preparation of hair oils and medicines. It is used in the manufacture of greases. The oil cake is used as feed and manure. Green stems and leaves are a good source of green fodder for cattle. The fresh leaves of young plants are used as green vegetable which serve as a good source of nitrogen and minerals in the human diet. In the industry, mustard oil is used for softening the leather. Besides, the production of rapeseed and mustard provide substantial jobs to the working force in the primary, secondary and tertiary sectors of the economy.

Rapeseed-mustard is the third important oilseed crop in the world after soybean (*Glycine max*) and palm (*Elaeisguineensis Jacq*.). Among the seven edible oilseed cultivated in India, rapeseedmustard (*Brassica* spp.) contributes 28.6% in the total production of oilseeds. In India, it is the second most important edible oilseed after groundnut sharing 27.8% in the India's oilseed economy (Shekhawat *et al.,* 2012) [12]. The share of oilseeds is 14.1% out of the total cropped area in India, rapeseed-mustard accounts for 3% of it. Globallytheestimated area, production and productivity of rapeseed-mustard in the world is 36.52 m ha, 72.78 m t and 1,994 kg ha^{-1}, respectively (FAO, 2023) [6]. India is the fourth largest rapeseed-mustard growing country in the world, occupying the fourth position in area and production after Canada, China and European Union. In India, among all the oilseed crops rapeseed-mustard occupying 5.74 million ha area and production of 8.0 million tonnes with average productivity of 11.13 q ha^{-1} (Ministry of Agriculture, 2023) [15].

Nitrogen is the most important nutrient, which determines the growth of the mustard crop and increases the amount of protein and the yield. Nitrogen is a major nutrient element that provides lush green color in crop (due to increase in chlorophyll) and its deficiency in arid and semi-arid regions is considerable because the amount of organic matters, which are the main nitrogen reserves, is very low in these regions and even if they were found, they would be quickly decomposed (Bani-saeedi, 2001) [1]. Almost all investigations showed that nitrogen fertilizers gave substantial seed yield increase even in diverse and contradicting conditions (Siadat*et al.,* 2010) [19]. Rapeseed-mustard group of crops have relatively high demand for N than many other crops owing to larger N content in seeds and plant tissues (Malagoli*et al.,* 2005) [13]. Poor translocation of N from vegetative parts to seed during reproductive growth results in low nitrogen use efficiency. Increasing N application also reduces oil content (Singh and Singh, 2005 and Singh *et al.,* 2008) [20, 21].

Boron is closely associated with the growth of plants and plays a vital role in cell division. Boron is involved in synthesis of oil and protein. Reproductive growth, especially flowering, fruit and seed set ismore sensitive to B deficiency than vegetative growth (Dear and Lipsett, 1987) [4]. Boron requirement for root growth in B-in efficient rapeseed cultivars was higher than that in B efficient cultivars (Hu *et al*., 1994 and Xioug*etal.,* 1995) [9]. Fruit development and flowering were restricted by shortage of boron. Availability of B to plants is affected by a variety of soil factors including soil solution, pH, texture, moisture, temperature, oxide content, carbonate content, organic matter content, and clay mineralogy (Goldberg *et al.,* 2000) [8]. Boron is generally less available in high pH soil. Increasing pH favours its retention by soils or soil constituents (Mezuman and Karen, 1981; Bloesch *et al.,* 1987 and Goldberg, 1997)

[3, 7, 14]. Moreover, requirement of boron varies with the species, crops and stages, *i.e.* reproduction and vegetative.

Materials and methods

A field experiment entitled " effect of nitrogen and boron levels on growth, yield and quality of mustard " was conducted at Agronomy farm, Vivekananda Global University, Jaipur during *Kharif* seasons of the years 2024-25. The experiment was laid out at Agronomy Farm, Vevakananda Global University, Jaipur during *Kharif* seasons of 2024. Jaipur is situated at 26^0 5" North latitude and 75^0 28" East longitudes at an altitude of 427 meters above mean sea level. In Rajasthan, this region falls under Agro-climatic zone-IIIA (Semi-Arid Eastern Plains). The climate of this region is a typically semi-arid, characterized by extremes of temperature during both summers and winters. The average annual rainfall of this tract varies from 450 mm to 500 mm most of which is received during the period of July to September. There is hardly any rain during winter. As the climate affects the growth, yield and quality of agricultural product, it is necessary to present climatic variables in this chapter. The data revealed that *crop* season witnessed a rainfall of 396 mm. The mean daily maximum and minimum temperatures during the growing season of groundnut fluctuated between 28.2 to 37.9^{0}C and 14.6 to 26.2^{0}C, respectively. Similarly, mean daily relative humidity ranged between 41 to 91 per cent. The average sunshine hours per day ranged between 5.0 to 9.8.

Results

Plant height (cm) Nitrogen level

The data pertaining to plant height recorded at different growth stages has been presented in table 1. It is evident from the data that nitrogen levels had non significant effect on plant height at 30 (DAS) of crop growth. Maximum plant height was recorded at higher 120 kg N ha^{-1}, which was *at par* with 80 kg N ha^{-1}, 40 kg N ha^{-1}, while significantly superior over rest of the N levels. Plant height of mustard increased due to nitrogen level of 120 kg/ha (N_4), to the tune of 2.94, 11.82, 11.83 and 2.39, 7.23, 7.22 per cent over control, respectively at 30, 60 DAS and at harvest of mustard.

Boron level

Boron levels had significant effect on plant height at all stages except, 30 DAS. Plant height increases significantly with increases in Boron doses up to 1.5 kg B ha^{-1}. Higher plant height was recorded under 1.5 kg B ha^{-1},which was at par with 1.0 kg ha^{-1} and 0.5 kg B ha^{-1}, while significantly superior over rest of the treatments at all stages of crop growth. Plant height of mustard increased due to boron level of 1.5 kg/ha (B_4), to the tune of 3.28, 15.37, 15.39 and 2.00, 9.37, 9.38 per cent over control, respectively at 30, 60 DAS and at harvest of mustard.

Table 4.1: Effect of different nitrogen and boron levels on plant height (cm) of mustard crop

Treatments	Plant height (cm)			Branches per plant	
	30 DAS	60 DAS	At harvest	60 DAS	At harvest
Nitrogen level (kg ha^{-1})					
0 kg	22.48	63.43	145.73	17.25	18.15
40 kg	22.60	66.15	152.00	18.20	19.15
80 kg	22.72	68.88	158.27	19.34	20.34
120 kg	23.14	70.93	162.97	19.91	20.94
SEm±	0.39	1.28	2.62	0.26	0.36
CD (p=0.05)	NS	3.66	7.46	0.74	1.01
Boron level (kg/ha)					
0 kg	22.25	61.29	140.81	17.86	18.78
0.5 kg	22.53	64.65	148.55	18.62	19.59
1.0 kg	22.83	68.69	157.84	19.39	20.40
1.5 kg	22.98	70.71	162.48	19.97	21.00
SEm±	0.39	1.28	2.62	0.26	0.36
CD (p=0.05)	NS	3.66	7.46	0.74	1.01

Branches per plant

Nitrogen level

The data pertaining to branches per plant recorded at different growth stages has been presented in table 4.1. It is evident from the data that nitrogen levels on branches per plant at 60 (DAS) and at harvest of crop growth. Maximum number of branches per plant (19.91 and 20.94) was recorded at higher 120 kg N ha^{-1}, which was at par with 80 kg N ha^{-1}, 40 kg N ha^{-1}, while significantly superior over rest of the N levels. Branches per plant of mustard increased due to nitrogen level of 120 kg/ha (N_4), to the tune of 15.42 and 15.37 per cent over control, respectively at 60 DAS and at harvest of mustard.

Boron level

Boron levels had significant effect on branches per plant at all stages except, 60 DAS and at harvest. Branches per plant increases significantly with increases in boron doses up to 1.5 kg B ha^{-1}. Higher number of branches per plant (19.97 and 21.00) was recorded under 1.5 kg B ha^{-1},which was at par with 1.0 kg ha^{-1} and 0.5 kg B ha^{-1}, while significantly superior over rest of the treatments at all stages of crop growth. Number of branches per plant of mustard increased due to boron level of 1.5 kg/ha (B_4), to the tune of 11.81 and 11.82 per cent over control, respectively at 60 DAS and at harvest of mustard.

Dry matter Accumulation (g $plant^{-1}$)

Nitrogen level

Data pertaining to dry matter accumulation as influenced by different nitrogen level have been represented in table 4.2. Dry matter accumulation increased with increased in nitrogen levels up to 120 kg N ha^{-1}, which was at par with 80 kg N ha^{-1} and 40 kg N ha^{-1}, while it is significant over rest of the treatments.

Boron level

Higher dry matter accumulation recorded under 1.5 kg B ha^{-1} which was at par with 1.0 kg S ha^{-1} and 0.5 kg S ha^{-1}, while significantly superior over rest of the treatments. Dry matter production successively increased till maturity due to favourable effect of nitrogen on the growth and development of plants. Increase in number of primary and secondary branches $plant^{-1}$, plant height and number of leaves $plant^{-1}$ were directly responsible for increasing the dry matter accumulation in plants with increasing the levels of Boron.

Table 2: Effect of different nitrogen and boron levels on dry matter accumulation (g) of mustard crop

Treatments	Dry matter accumulation (g)		
	30 DAS	60 DAS	At harvest
Nitrogen level (kg ha^{-1})			
0 kg	1.70	11.92	30.97
40 kg	1.74	14.30	37.16
80 kg	1.78	15.49	40.26
120 kg	1.80	16.53	42.19
SEm±	0.39	0.03	0.62
CD (p=0.05)	NS	0.08	1.76
Boron level (kg/ha)			
0 kg	1.72	13.38	34.76
0.5 kg	1.75	14.74	38.32
1.0 kg	1.79	15.35	39.90
1.5 kg	1.79	16.11	41.87
SEm±	0.39	0.03	0.62
CD (p=0.05)	NS	0.08	1.76

Number of siliqua/plant

Nitrogen level

Data presented in table 4.3 showed that effect of nitrogen on number of siliqua /plant of mustard was found significant. Nitrogen level of 0 kg/ha (N_1), 40 kg/ha (N_2), being at par with 80 kg/ha (N_3) and 120 kg/ha (N_4) recorded significantly maximum number of siliqua /plant as compared to control. Application of 120 kg/ha recorded 31.71 per cent higher number of siliqua /plant of mustard over 80 kg/ha (N_3). Further, 40 kg/ha (N_2) also registered an increase of 11.34 cent in number of siliqua /plant over control.

Boron level

The experimental findings presented in table 4.3 indicated that successive increase in levels of boron @ 1.5 kg /ha significantly increased the number of siliqua /plant of mustard over boron @ 1.0 kg/ha and control. The per cent increase in number of siliqua /plant of mustard due to application of boron @ 1.5 kg /ha was of the order of 10.08 and 25.46 per cent over boron at 1.0 kg /ha and boron @ 1.5 kg over boron @ 0.5 kg, respectively.

Siliqua length (cm)

Nitrogen level

Data presented in table 4.3 showed that effect of nitrogen on siliqua length of mustard was found significant. Nitrogen level of 0 kg/ha (N_1), 40 kg/ha (N_2), being at par with 80 kg/ha (N_3) and 120 kg/ha (N_4) recorded significantly maximum siliqua length as compared to control. Application of 120 kg/ha recorded 9.73 per cent higher siliqua length of mustard over 80 kg/ha (N_3). Further, 40 kg/ha (N_2) also registered an increase of 5.11 cent in siliqua length over control, respectively.

Table 3: Effect of different nitrogen and boron levels on yield attributes (cm) of mustard crop.

Treatments	Number of siliqua $plant^{-1}$	Siliqua length (cm)	Number of seeds $siliqua^{-1}$	Test weight (g)
Nitrogen level (kg ha^{-1})				
0 kg	223.97	7.50	10.70	4.74
40 kg	264.94	7.83	11.24	4.80
80 kg	284.06	8.23	11.68	4.85
120 kg	294.99	8.23	12.13	4.89
SEm±	4.98	0.14	0.21	0.08
CD (p=0.05)	14.16	0.39	0.61	0.22
Boron level (kg/ha)				
0 kg	247.42	7.78	11.08	4.76
0.5 kg	269.66	7.88	11.30	4.81
1.0 kg	280.78	8.08	11.52	4.86
1.5 kg	294.68	8.62	12.60	4.92
SEm±	4.98	0.14	0.21	0.08
CD (p=0.05)	14.16	0.39	0.61	0.22

Boron level

The experimental findings presented in table 3 indicated that successive increase in levels of boron @ 1.0 kg/ha significantly increased the siliqua length of mustard over boron 1.0 kg/ha and control. The per cent increase in siliqua length of mustard due to application of boron @ 1.5 kg /ha was of the order of 10.80 and 9.39 per cent over boron at 1.0 kg /ha over control, respectively.

Number of seeds Siliqua/plant

Nitrogen level

Data presented in table 3 showed that effect of nitrogen on number of seeds siliqua/plant of mustard was found significant. Nitrogen level of 0 kg/ha (N_1), 40 kg/ha (N_2), being at par with 80 kg/ha (N_3) and 120 kg/ha (N_4) recorded significantly maximum number of seeds siliqua / plant as compared to control. Application of 120 kg/ha recorded 13.36 per cent higher number of seeds siliqua per plant of mustard over 80 kg/ha (N_3). Further, 40 kg/ha (N_2) also registered an increase of 7.92 cent in number of seeds siliqua per plant over control, respectively.

Boron level

The experimental findings presented in table 4.4 indicated that successive increase in levels of boron @ 1.5 kg/ha significantly increased the number of seeds siliqua per plant of mustard over boron 1.5 kg/ha and control. The per cent increase in number of seeds siliqua per plant of mustard due to application of boron @ 1.5 kg /ha, 1.0 kg/ha was of the order of 13.72 and 11.50 per cent over control, respectively.

Test weight (g)
Nitrogen level
Data presented in table 3 showed that effect of nitrogen on test weight of mustard was found significant. The maximum test weight (4.89 g) was observed with the application of 120 kg nitrogen ha^{-1} (N_4) as compared to N_1, N_2 and N_3 but this treatment statistically remained at par with N_3 and N_2. However, the minimum nitrogen level of mustard was observed with the application of control (N_1) (4.74 g), respectively.

Boron level
The experimental findings presented in table 4.4 indicated that successive increase in levels of boron @ 1.5 kg/ha significantly increased the test weight of mustard over boron 1.5 kg/ha and control. The maximum test weight (4.92 g) was observed with the application of 1.5 kg boron ha^{-1} (B_4) as compared to B_1, B_2 and B_3 but this treatment statistically remained at par with B_3 and B_2. However, the minimum boron level of mustard was observed with the application of control (B_1) (4.76 g), respectively.

Discussion
The increase in plant height, dry matter accumulation and number of branches with the application of nitrogen might be due to improved photo synthetically active leaf area and their importance for longer period during vegetative and reproductive phases, led to more absorption and utilization of radiant energy which ultimately resulted in higher dry matter accumulation and significant increase in plant height. It is an established fact that nitrogen level improves the physical, chemical and biological properties of soil and supplies almost all the essential plant nutrients for growth and development of plants along with growth hormones and beneficial microbes which might have developed more favorable nutritional environment in soil for longer period resulted in increased plant height, new shoots and increased dry matter accumulation. Nitrogen level acts as a chelate for nutrients and soluble chelates probably increase their availability and uptake to plants and mobility in soils. Thus, increased availability of macro and micro nutrients might also be the reason of improved growth parameters of the crop.
The faster availability of nutrients from adequate supply of nitrogen level through-out the cropping period enhances the nutrient requirement of the crop and production of greater number of photo-synthetically active leaves which might have lead to higher production of carbohydrates and phytohormones which resulted in increased dry matter accumulation and number of branches. The results of the present investigation are in close conformity with those of Dhruw *et al.* (2017) [5], Kumar *et al.* (2017a) [10], Saini *et al.* (2017), Kumar *et al.* (2018a) [11, 12], Murali *et al.* (2018) [16], Singh *et al.*, (2018) and Yadav *et al.* (2018) [22] in mustard crop.
The beneficial response of nitrogen and boron on yield attributes and yield of mustard might be due to the availability of sufficient amount of plant nutrients throughout the growth period of crop resulting in better uptake of nutrients maintenance of, plant vigour and improved yield. Nitrogen a source of energy for soil micro-flora, which brings about the transformation of nitrogen form of nutrients present in soil, into available form. The increase in the yield attributes with the application of vermicompost ascribed to direct addition of plant nutrients (macro and micro) and growth regulators and also due to increased microbial population of soil, which accelerated the process of humification, removal of obnoxious smell and also the detoxification of soil pollutants. The results of the present study are in close conformity with findings of Brar *et al.* (2016), Bijarnia *et al.* (2017) [2], Bisht *et al.* (2018), Murali *et al.* (2018) [16], Reddy and Singh (2018) and Sahoo *et al.* (2018) in mustard crop.

Conclusion
Nitrogen level 120 kg/ha being at par with nitrogen 80 kg/ha recorded significantly the highest plant height and dry matter accumulation of mustard at 30, 60, 90 DAS and at harvest over control.
The highest number of branches at harvest was recorded with nitrogen 120 kg/ha over control.
Significant improvement was noted in with nitrogen 120 kg/ha, being at par with nitrogen 80 kg/ha and recorded significantly maximum number of siliqua/plant, seeds/siliqua and test weight of mustard as compared to control.
The significantly higher plant height and dry mater accumulation at 30, 60, 90 DAS and at harvest of mustard was recorded with the application of boron at 1.5 kg/ha over lower boron level.
Successive increase in boron level up to 1.5 kg/ha, increased number of branches per plant of mustard significantly over control and boron at 1.0 kg /ha and control.
Number of siliqua/plant, seeds /siliqua and test weight of mustard significantly increased with application of boron up to 1.5 kg/ha over boron at 1.0 kg/ha and control.

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