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Effect of nitrogen and boron on growth and yield of Mustard (*Brassica juncea* L.)

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Abstract
A field experiment was conducted during *Rabi* season of 2021 at experimental field of the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology & Sciences, Prayagraj, and Uttar Pradesh, India. The soil of experimental field is Sandy loam in texture, nearly neutral in soil reaction (pH 7.0). To determine the "Effect of nitrogen and boron on growth and yield of Mustard (*Brassica juncea* L.)" The treatments consisted of nitrogen and boron *viz.*, Nitrogen levels at 70 kg/ha, 80 kg/ha and 90 kg/ha and Soil application of Boron at 1 kg/ha, 1.5 kg/ha and 2 kg/ha whose effect is observed in Mustard. The Experiment was laid out in Randomized Block Design with Nine treatments Replicated thrice. The results obtained that the treatment 8 with (Nitrogen 90 kg/ha + 1.5 Boron kg/ha)was recorded significantly maximum plant height (181.90 cm), Number of Braches (11.17) dry weight (31.60 g/plant), number of siliqua per plant (242.00),number of seed per siliqua (11.33), Test weight (4.44), seed yield (1.97), stover yield (4.87 t/h), harvest index (28.81).The results obtained with the treatment of T8(Nitrogen 90 kg/ha + 1.5 Boron kg/ha) was recorded maximum crop growth rate (13.81g/m2/day) and relative growth rate (0.03g/g/day).The results obtained with the treatment of T8 recorded higher gross return (137900 INR/ha), net return (92999 INR/ha) and benefit cost ratio (B:C) (2.09). The results obtained with the treatment of T9 recorded higher cost of cultivation (47449 INR/ha).

Keywords: Mustard, nitrogen, boron, yield, economics

Introduction

Mustard (*Brassica compestris* L.) is important oilseed crop of family Cruciferae and occupies a prominent place among oilseed crops being next to groundnut in important. The present area, production and yield of nine oilseeds in India is around 26.48 mha, 30.94 mt and 1168 kg ha-1 respectively, and rapeseed mustard sown area in India is 6.36 mha which has a production of 8.03 mt. The average productivity of rapeseed mustard in India is 1262 kg ha-1 (Directorate of Economics and Statistics, Department of Agriculture and Cooperation, 2012-13). The average productivity of rapeseed-mustard in India is only 1145 kg ha-1, which needs to be enhanced up to 2562 kg/ha by 2030 for ensuring edible oil self-reliance. The country shares about 23% of the world production of rapeseed and mustard. These crops are of particular significance of Rajasthan and Uttar Pradesh, which shares about 80% of area and production of entire country. The oil content of the mustard seeds ranges from 35-48% and 37-42% protein in cake. In India it is cultivated on 6.70 million hectares with production of 7.96 mt and productivity of 1188 kg/ha in 2013-14. Haryana is one of the major rapeseed and mustard growing state and crop occupied 5.4 lakh ha of area producing 8.8 lakh tonnes giving an average yield of 1639 kg/ha during 2013-14 (Keerthi Pattam *et al*., 2017).

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 photosynthesis to reproductive parts which increase the seed: stover ratio. There is an ample scope for increasing the yield of Indian mustard through fertilizer use, especially nitrogen.

Boron plays an important role in cell differentiation and development, regulating membrane permeability, tissue differentiation, carbohydrate and protein metabolism, translocation of photosynthates and growth regulators from source to sink and growth of pollen grains thereby marked increase in seed yield of crops. Cell wall formation, Cell wall strength, cell division, fruit and seed development and sugar transport are plant functions related to boron (B). Under Boron deficiency, pollen viability and seed set of rape is greatly reduced and protein formation is also restricted. Flowering and fruit development were restricted by shortage of boron. It also makes up the calcium deficiency to some extent. Reproductive growth, especially flowering, fruit and seed set is more sensitive to Boron deficiency than vegetative growth. (Shamalaprashanthi and Umesha C. 2020)

Materials and Methods

The materials and methodology and techniques adopted in the present experiment entitled, Effect of Nitrogen and Boron on growth and yield of varieties of Mustard (*Brassica juncea* L.) with a brief description regarding site of experiment, soil properties, sampling techniques, climatic conditions during crop growing period, cropping history, calendar operations and statistical analysis are presented in this chapter with following headings.

In order to study the three levels nitrogen of and three levels of boron on the growth and yield characters of mustard. The experiment was conducted at during *Rabi* 2021 Crop Research Farm, Naini Agricultural Institute, SHUATS, Prayagraj. The experimental site of the study is geographically located at 25.28ºN latitude, 81.54ºE longitude and 98 m altitude above the mean sea level (MSL). The soil of the experimental field constituting a part of central Gangetic alluvium is neutral and deep. Pre- sowing soil samples were taken from a depth of 15 cm with the help of an auger. The composite samples were used for the chemical and mechanical analysis. The soil was sandy loam in texture, low in organic carbon (0.36%) and medium in available nitrogen (171.48 kg/ha), phosphorous (15.2 kg/ha) and low in potassium (232.5 kg/ha).The treatments consist of three levels of nitrogen (70, 80 and 90 kg/ha) soil application and four levels of boron (1, 1.5 and 2 kg/ha) respectively. The experiment was laid out in randomized block design with nine treatments each replicated thrice and control *i.e.*, recommended N, P and K (80:40:40 kg/ha) alone. The plots were prepared with dimension of 5 m × 3 m and seeds of variety G-1 were sown with a spacing of 30cm × 15 cm. At 4-5 leaf stage plants were thinned to appropriate density. Weeds were controlled manually at 5-leaf stage, stem elongation and flowering stage to maintain a uniform plant population. Growth characteristics plant height (cm), number of branches per plant, dry weight per plant (g), crop growth rate (g/m^2/day) and relative growth rate (g/g/day) were recorded, with following formulas (A & B). Irrigation were given uniformly and regularly to all plots as per requirement so as to prevent the crop from water stress at any stage. The crop was completely harvested at physiological maturity stage and their biometric observations such as number of capsules per plant, number of seeds per capsule, 1000 seed weight (g), seed yield (kg/ha), stalk yield (kg/ha) and were recorded. The data recorded for different characteristics were subjected to statistical analysis by adopting the method of analysis of variance (ANOVA) as described by Gomez (1984).

Result

Growth parameters

Table.1pertaining that details of influence of nitrogen and boron on mustard growth attributes.

Plant height (cm)

At 120 DAS, maximum plant height (181.90 cm) was recorded with application of Nitrogen 90 kg/ha + Boron 1.5 Kg/ha which was significantly superior over all other treatments and statistically at par with treatment of Nitrogen 90kg/ha + Boron 1 kg/ha (179.40cm).

Number of branches for plant

At 120 DAS, maximum No of Branches (11.17 cm) was recorded with application of Nitrogen 90 kg/ha + Boron 1.5 Kg/ha which was significantly superior over all other treatments and statistically at par with treatment of Nitrogen 90 kg/ha + Boron 1 Kg/ha (10.80 cm)

Dry Weight (g/plant)

At 120 DAS, maximum dry weight (31.60 cm) was recorded with application of Nitrogen 90 kg/ha + Boron 1.5 Kg/ha which was significantly superior over all other treatments and statistically at par with treatment of Nitrogen 80 kg/ha + Boron 1kg/ha(31.13g), Nitrogen 80 kg/ha + Boron 1.5kg/ha(31.17g), Nitrogen 90 kg/ha + Boron 1 Kg/ha (31.40 cm), Nitrogen 90 kg/ha + Boron 2kg/ha (31.23g)

Yield attributes

Table.2 pertaining that details of influence of nitrogen and boron on mustard yield attributes.

Number of siliqua/plants

Treatment with application of Nitrogen 90 kg/ha + Boron 1.5 Kg/ha was recorded maximum number of siliqua/plant (242.00) was significantly superior over all the treatments and statistically at par with treatment of Nitrogen 90 kg/ha + Boron 1 Kg/ha (239.00)

Number of seeds/siliqua

Treatment with application of Nitrogen 90 kg/ha + Boron 1.5 Kg/ha was recorded maximum number of seeds/siliqua (11.33) was significantly superior over all the treatments and statistically at par with treatment of 70 Nitrogen kg/ha + 1.5 Boron kg/ha (10.00), 80 Nitrogen kg/ha +1 Boron kg/ha (10.00), 80 Nitrogen kg/ha +1.5 Boron kg/ha (1034) and Nitrogen 90 kg/ha+ Boron 1 Kg/ha (10.67)

Test weight

Treatment with application of Nitrogen 90 kg/ha + Boron 1.5 Kg/ha was recorded maximum test weight (4.44g) was significantly superior over all the treatments and statistically at par with treatment of 80 Nitrogen kg/ha +1.5 Boron kg/ha (4.4g) and Nitrogen 90 kg/ha + Boron 1 Kg/ha (4.43g)

Seed yield (kg/ha)

Treatment with application of Nitrogen 90 kg/ha + Boron 1.5 Kg/ha was recorded maximum seed yield (1.97 kg/ha) which was significantly superior over all the treatments and statistically at par with treatment of Nitrogen 90 kg/ha + Boron 1 Kg/ha (1.85 kg/ha)

Straw yield (kg/ha)

Treatment with application of Nitrogen 90 kg/ha + Boron 1.5 Kg/ha was recorded maximum straw yield (4.87 kg/ha) which was significantly superior over all the treatments and statistically at par with treatment of 80 Nitrogen kg/ha +1.5 Boron kg/ha (4.80 kg/ha) and Nitrogen 90 kg/ha + Boron 1 Kg/ha (4.80 kg/ha)

Harvest index (%)

Treatment with application of Nitrogen 90 kg/ha + Boron 1.5 Kg/ha was recorded maximum harvest index (28.81%) which was significantly superior over all the treatments and statistically at par with treatment of Nitrogen 70 kg/ha + Boron 1 Kg/ha (28.27)

Discussion

Oil content of mustard seed and oil yield increased significantly due to sulphur application and found maximum at 40 kg S ha-1(Table-4.8). Sulphur plays an important role in the formation of more glycosides and glucocinolate and activation of enzymes, which as in biochemical reaction with the plant and on hydrolysis produce higher amount of oil as well as alkyl isothiocyanate, which is responsible for pungency. Oil yield is additive effect of oil content and seed yield which was noticed maximum at 40 kg S ha-1resulted in higher oil yield. Chaurasiya *et al.*, (2019) [3].

Plant height was significantly increased by the application of N-fertilizer (Table 1). Longest plant stature (79.3 cm) was recorded in the plant streated with 100 kg N ha", which is about 29.36% longer than that of control (61.3 cm). Optimum level of N application probably enhanced ana bioccellular activity of the plant, which encouraged the plant growth and plant height. The result is that plant height increased linearly with nitrogen application up to 120 kg N ha' Rahman *et al.*, (2005) [10].

The increase in number of branches might be due to the role of B in cell division, tissue differentiation, carbohydrate metabolism and maintenance of conducting tissue with regulatory effect on other element. The number of siliqua plant-1 significantly increased with varying levels of B (Table 2) being maximum of 242 and 245 in RDF+1.5 kg B ha-1during 2012-13 and 2013-14, respectively. The corresponding value showed 23.5 and 21.9 percent increase over control Yadav *et al.*, (2016) [12]

Application of nitrogen increased all the yield contributing characters *viz*., length of siliqua. Number of seed siliqua-1, 1000-seed weight significantly up to 160 kg ha-1 of N except number of siliqua plant-1significantly higher up to 120 kg ha-1of N. Application of 40 kg ha-1of N. resulted in significantly higher all the yield contributing characters over the control (0 kg ha-1 N). This might be due to the fact that nitrogen application increased the root development which enhanced the absorption of nutrients from soil which resulted in better development of source capacity Raghuvansh *et al.*, (2018) [9].

The growth attributes like plant height and number of branches/ plants increased significantly with every increasing in level of nitrogen up to 80 kg N/ha, (Reddy and Sinha 1987). Nitrogen has also increased for faster cell division and enlargement, which leads to higher growth rate, (Kumar *et al*. 2013) [4]. The nitrogen being the constituent of amino acids, proteins, chlorophyll and protoplast would directly influence the growth and yield attributing characteristics through better utilization of photosynthases and also reported increase in growth and yield attributes. plays an important role in the production phenology of mustard and this crop responds to applied Prashanthi *et al.*, (2021).

The uptake of boron by mustard seeds increased significantly with increasing doses of boron and it was highest with the application of 2kg B ha-1. The increase in boron uptake was in consonance with higher seed yield and increase in B content in seeds with increase in B levels. Yanthan *et al.*, (2021) [13].

Table 1: Influence of nitrogen and boron on growth of mustard crop

Treatment	Plant height (cm)	Number of branches/plant	Dry weight (g)
Nitrogen 70kg/ha + Boron 1 kg/ha	169.97	10.13	30.70
Nitrogen 70kg/ha + Boron 1.5kg/ha	170.30	9.83	30.63
Nitrogen70kg/ha +Boron 2 kg/ha	170.37	10.03	30.83
Nitrogen 80kg/ha + Boron 1kg/ha	164.63	10.00	31.13
Nitrogen 80kg/ha + Boron 1.5 kg/ha	169.50	10.00	31.17
Nitrogen 80kg/ha + Boron 2kg/ha	163.40	10.17	30.67
Nitrogen 90kg/ha + Boron 1kg/ha	179.40	10.80	31.40
Nitrogen 90kg/ha + Boron 1.5 kg/ha	181.90	11.17	31.60
Nitrogen 90kg/ha + Boron 2kg/ha	170.50	10.27	31.23
SEM (±)	3.67	0.20	0.21
CD (p=0.05)	10.99	0.60	0.63

Table 2: Influence of nitrogen and boron on yield and yield attributes of mustard crop.

Treatment	No. of siliqua/plant	No. of seeds/siliqua	Test weight (g)	Seed yield (kg/ha)	Stover yield (kg/ha)	Harvest index (%)
Nitrogen 70kg/ha + Boron 1 kg/ha	230.33	9.33	4.32	1.80	4.57	28.27
Nitrogen 70kg/ha + Boron 1.5kg/ha	232.33	10.00	4.39	1.83	4.70	28.01
Nitrogen 70kg/ha + Boron 2 kg/ha	227.00	9.00	4.37	1.68	4.50	27.63
Nitrogen 80kg/ha + Boron 1kg/ha	237.33	10.00	4.39	1.82	4.73	27.77
Nitrogen 80kg/ha + Boron 1.5 kg/ha	238.00	10.34	4.40	1.84	4.80	27.69
Nitrogen 80kg/ha + Boron 2kg/ha	228.00	9.00	4.38	1.70	4.40	27.87
Nitrogen 90kg/ha + Boron 1kg/ha	239.00	10.67	4.43	1.85	4.80	27.89
Nitrogen 90kg/ha + Boron 1.5 kg/ha	242.00	11.33	4.44	1.97	4.87	28.81
Nitrogen 90kg/ha + Boron 2kg/ha	229.33	9.00	4.31	1.72	4.40	27.64
SEM (±)	1.19	0.53	0.02	0.04	0.03	0.45
CD (p=0.05)	3.57	1.58	0.07	0.11	0.09	-

Table 3: Effect of nitrogen and boron on economics of mustard

Treatment	Cost of cultivation (INR/ha)	Gross return (INR/ha)	Net return (INR/ha)	B:C ratio
Nitrogen 70kg/ha + Boron 1 kg/ha	41924	1260000	84076	2.00
Nitrogen 70kg/ha + Boron 1.5kg/ha	44466	128100	83634	1.88
Nitrogen 70kg/ha + Boron 2 kg/ha	47014	117600	70586	1.50
Nitrogen 80kg/ha + Boron 1kg/ha	42142	127400	85258	2.02
Nitrogen 80kg/ha + Boron 1.5 kg/ha	44684	128800	84116	1.88
Nitrogen 80kg/ha + Boron 2kg/ha	47232	119000	71768	1.51
Nitrogen 90kg/ha + Boron 1kg/ha	42359	129500	87141	2.05
Nitrogen 90kg/ha + Boron 1.5 kg/ha	44901	137900	92999	2.07
Nitrogen 90kg/ha + Boron 2kg/ha	47449	120400	72951	1.53

Conclusion
It is concluded that Treatment 8 (90 Nitrogen kg/ha + 1.5 Boron kg/ha) recorded significantly Higher plant height, dry weight, crop growth rate, relative growth rate, siliqua/plant, seeds/siliqua, Test weight, seed yield, gross returns, net return, and benefit cost ratio.

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