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Effects of nitrogen scheduling along with Zn and boron fertilization on growth and yield of Indian mustard (*Brassica juncea* L.)

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Abstract
Rapeseed and Mustard is the third most important oilseed crop in India after Soybean and Groundnut. In addition to this it produces one of the finest qualities of edible oil along with fodder and oil cake. Being a heavy feeder crop it is demands a RDF of 120:60:20 Kg/ha of N:P_2O_5: K_2O. AS the initial crop growth is very slow the 50% basal dose of N applied to is not utilized and lost by various means and hence the aim is to increase the fertilizer use efficiency by manipulating the nitrogen schedule. Also an attempt has been made to supplement the growth and yield by Zn and B application. The experiment was laid out in RBD design with 12 treatments and three replications, *i.e.*, different schedules of nitrogen fertilizer, combined with Zinc ($ZnSO_4$) and Boron (Borax) in half of the treatments and rest of the treatments without Zinc and Boron. Statistical analysis of experimental data T_8 that involves the application of N at 15, 30 and 45 DAS at the rate of 30, 60 and 30 kg/ha, along with Zn and B was found to be the best treatment in terms of grain and biological yield. T_7 that applied N at 15, 30 and 45 DAS at the rate of 30, 30 and 30 kg/ha, along with Zn and B was found to be the best one in terms of resource saving and economics.

Keywords: Indian mustard, nitrogen schedule, zinc, boron

Introduction
Rapeseed and mustard is the third most important oilseed crop of India nut unfortunately the average yield of Rapeseed-mustard is 1128 kg/ha in India, which is almost 57% of the world average yield *i.e.* 1980 kg/ha. More than 26 states and union territories cultivate this crop, with Rajasthan, Madhya Pradesh, Uttar Pradesh, Haryana and West Bengal having a lion's share in terms of area and production of rapeseed –mustard (DRMR, 2020). The main reason behind this poor yield of this crop is improper nutrient management. The Indian farmers indiscriminately use nitrogenous fertilizers but pay a little attention to micronutrients like Zn and B. Most of the nitrogen in ammonium form is incorporated into complex organic compounds in the roots as such, whereas nitrate is highly mobile in the xylem and also stored in the vacuoles of several cells of roots, shoots, and storage organs. The accumulation of nitrate in vacuoles is of considerable importance for ionic balance, osmoregulation etc. (Smirnoff and Stewart, 1985). Nitrogen is also used in the synthesis of other amides, peptides, ureides, amino acids, amines, and high molecular-weight peptides, like proteins. Zinc is a major component of various enzymes like alcohol dehydrogenase, carbonic anhydrase and Cu-Zn superoxide dismutase and hormone like Indole acetic acid. Boron is involved in sugar transport, cell wall synthesis; lignification; cell wall structure, carbohydrate metabolism; RNA metabolism, respiration, indole acetic acid (IAA) metabolism, phenol metabolism;, membranes (Parr and Loughman, 1983) [9]. Hence here the main focus is manipulation of the nitrogen schedule along with Zn and B fertilization.

Materials and Methods
A field experiment was conducted in the crop research centre of GB pant University of Agriculture and Technology, Pantnagar in 2020-21 and 2021-22 to study the effects of nitrogen schedules along with Zn and B fertilization on growth and yield of Indian mustard. Pantnagar is located at the foot hills of Himalayas in *tarai* region, at 29^0 N latitude, 79.29^0 E longitude and an altitude of 243.83 m above MSL. The soils of the experimental site have silty-clay loam structure, with EC, pH and organic carbon content of 0.38dS/m at 25 ^{0}C, 7.42 and 0.74% respectively.

The available N, P, K, S, Zn and B content of experimental site is 223 kg/ha, 20 kg/ha, 214 kg/ha, 13.8ppm, 8.3ppm, 11 ppm respectively. Indian mustard variety of NRCHB101 was sown with the seed rate of 5kg/ha at a spacing of 30×10 cm^2. Urea, SSP, MOP, $ZnSo_4.H_20$ and Borax was used as the source of N, P, K, Zn and B respectively. For other operations standard agronomic practices were followed.

The experiment was conducted in Randomized Block Design with 12 treatments and 3 replications. The treatments are as follows: T_1- N @30,30,30,30 Kg/ha at 15,30,45,60 DAS respectively, T_2- N @30,30,30Kg/ha at 15,30,45 DAS respectively, T_3- N @30,60,30Kg/ha at 15,30,45DAS respectively, T_4- N @30,30,30,30 Kg/ha at 0,15,30,45 DAS respectively, T_5- N @30,60,30Kg/ha at 0,15,30 DAS respectively, T_6- T1+Zn+B, T_7-T2+Zn+B, T_8- T3+Zn+B, T_9-T_4+Zn+B, T_{10}-T5+Zn+B, T_{11}-RDF(120:60:20 N:P_2O_5:K_2O), T_{12}-T_{11}+Zn+B. $ZnSO_4$ and Borax were applied at the rate of 25 and 10 Kg/ha according to the treatments. The plant height was measured by using a wooden scale. The per plant dry weight was measured by selecting five plants from each plot and then drying them in hot air over at 65± 5ºC till the attainment of a constant weight. Then their weight was measured in an electronic balance and the average was taken. The biological yield was taken from the net plot area. At the maturity stage the net plot was harvested manually and then dried in the field and the weight was taken. After manual threshing and cleaning of the seeds the seed weight was taken and converted in to per hectare basis.

The data were analysed by using statistical package STPR developed by college of basic science and humanities, GBPUA&T. the Cd was compared at 5% level of significance and presented in tabulated manner in the next section.

Results and Discussion

Plant height: The effect of nitrogen scheduling along with Zn and B application was found to be non-significant on plant height at 30DAS but there was significant difference at 60,90 DAS and at harvesting stage in both the years of study. The probable reason may be that at the initial crop growth stage the nitrogen requirement is very low which can be fulfilled from the soil itself. Hence there was no significant difference between the treatments which gets basal dose of N and that lacks it. But as the crop growth advances the nutrient requirement increases accordingly and significant difference is found in the later stages. From the bar diagram pertaining to plant height, it can be concluded that the increment in plant height was maximum between 30 and 60 DAS. In general, during both the years of experimentation, it can be said that the plant height is directly proportional to the amount of nitrogenous fertilizer applied. At 60 DAS, plant height was significantly influenced during both the years of experimentation. During both the years, maximum plant height at 60 DAS was observed in T_8 (127.3, 125.2 cm) which was statistically at par with T_3, T_4 and T_9, because all these treatments had received 120 kg N/ha till 60 DAS. At 90 DAS and harvest similar trend was found in both the years of study in terms of plant height. The treatments that received 120 kg N/ha were at par with each other and on the other hand significantly superior over treatments getting 90kg N/ha (T_2,T_5,T_7,T_{10}). Hence it can be concluded that nitrogen plays a key role in increasing the plant height. The total dose of nitrogen is more important than its schedule of application in terms of its influence on plant height. Zn and B has a little effect on plant height. Similar findings are also reported by Raghuvanshi *et al.* (2018) [10].

Table 1: Effect of nitrogen scheduling along with Zn and B on plant height (cm) of Indian mustard at various growth stages.

Treatment	Plant height (cm)							
	2020-21				2021-22			
	30 DAS	60 DAS	90 DAS	At Harvest	30 DAS	60 DAS	90 DAS	At Harvest
T_1	17.8	95.5	169.7	175.8	17.1	89.4	165.3	169.1
T_2	18.1	98.1	138.5	155.3	17.4	91.6	136.5	148.5
T_3	18.5	121.2	172.8	185.7	17.9	118.5	169.4	179.1
T_4	21.9	126.1	170.4	181.9	21.3	123.4	167.2	175.1
T_5	22.1	91.8	141.0	159.7	20.7	85.9	138.2	153.2
T_6	18.2	107.1	173.8	188.4	16.8	104.6	169.8	181.8
T_7	18.9	111.8	137.3	157.1	18.3	109.2	134.6	150.6
T_8	18.9	127.3	171.5	184.6	18.4	125.2	167.9	178.2
T_9	21.1	124.2	168.3	179.4	20.5	121.4	165.2	173.2
T_{10}	21.9	104.5	138.4	161.8	21.1	101.6	135.3	155.8
T_{11}	21.2	99.3	170.3	183.4	20.2	93.3	167.1	177.1
T_{12}	22.1	101.6	172.6	184.7	21.1	95.9	168.9	179.1
S.Em±	2.3	4.8	8.9	4.6	2.2	5.0	8.6	4.8
C D (P=0.05)	NS	14.1	26.3	13.6	NS	14.8	25.4	14.2

Total Dry matter accumulation (g/plant

The effect of nitrogen scheduling along with Zn and B application significantly affected per plant dry matter accumulation at all stages of observation during both the years of study. At 30DAS, T_{12} recorded highest dry matter accumulation (1.62, 1.59g/plant) in both the years of study. This is because this particular treatment received 60kg N/ha as basal dose along with Zn and B, which more than rest of the treatments. At 60DAS, maximum dry matter accumulation was in T_9, which was statistically at par with T_3, T_4 and T_8. The reason behind this is that these treatments had received 120kg N/ha up to 60DAS, where the rest of the treatments have received 9kh N/ha only. Similarly, at 90 DAS and harvest all the treatments were found to be at par with each other during both the years except T2, T5, T7, T10, because these treatments have received 90kg N/ha against 120kg N/ha in rest of the treatments. It is a general observation that the treatments getting Zn and B accumulated more biomass than those treatments which lack them. It is because Zn leads to the formation of IAA, which is a auxin and promotes branching in specifically and plant growth in general (Jat and Mehra, 2007) [5]. Boron also promotes biomass accumulation by maintaining a favorable balance between photosynthesis and respiration **(**Kumararajaa *et al.*, 2015) [6].

Table 2: Effect of nitrogen scheduling along with Zn and B on dry matter accumulation per plant (g) of Indian mustard at various growth stages

Treatment	Dry matter per plant (g)							
	2020-21				2021-22			
	30 DAS	60 DAS	90 DAS	At Harvest	30 DAS	60 DAS	90 DAS	At Harvest
T_1	0.85	2.88	16.96	41.83	0.79	2.80	16.89	40.98
T_2	0.79	2.57	12.47	31.27	0.75	2.54	12.40	30.80
T_3	0.88	5.57	15.16	40.11	0.85	5.51	14.68	39.49
T_4	1.42	5.48	16.55	41.11	1.39	5.44	15.85	40.45
T_5	1.47	3.01	12.24	28.89	1.43	2.94	11.70	28.05
T_6	0.75	2.94	16.71	40.84	0.72	2.86	15.97	40.18
T_7	0.78	2.81	11.87	30.82	0.75	2.76	11.54	30.06
T_8	0.81	5.76	16.64	39.64	0.78	5.70	15.91	38.99
T_9	1.36	5.84	14.80	38.41	1.33	5.78	14.36	37.76
T_{10}	1.49	2.58	12.12	29.88	1.45	2.52	12.02	29.17
T_{11}	1.55	2.51	16.42	42.22	1.51	2.46	15.75	41.51
T_{12}	1.62	2.54	16.77	42.45	1.59	2.48	16.15	41.91
S.Em±	0.03	0.08	0.51	1.16	0.03	0.08	0.57	1.15
C D (P=0.05)	0.1	0.25	1.51	3.42	0.1	0.24	1.69	3.39

Yield

Table 3: Effect of nitrogen scheduling along with Zn and B on yield of Indian mustard

Treatments	2020-21				2021-22			
	Seed yield(kg/ha)	Stover yield(kg/ha)	Biological yield(kg/ha)	H.I	Seed yield(kg/ha)	Stover yield(kg/ha)	Biological yield(kg/ha)	H.I
T_1	1404.3	5412.4	6816.9	20.6	1359.0	5383.2	6742.2	20.6
T_2	1378.3	5153.0	6531.3	21.1	1351.0	5118.4	6469.4	20.9
T_3	1461.7	4402.3	5864.0	24.7	1431.3	5048.8	6480.2	22.1
T_4	1284.0	5041.1	6325.3	20.3	1251.0	5023.8	6274.8	20.0
T_5	1077.3	4267.0	5344.6	20.2	1048.3	4213.3	5261.6	20.0
T_6	1728.0	6162.4	7890.4	21.9	1693.7	6132.3	7826.0	21.7
T_7	1604.0	5847.1	7451.3	21.7	1573.7	5659.6	7233.2	22.2
T_8	1875.7	6384.2	8259.8	23.0	1848.3	6341.7	8190.1	22.6
T_9	1618.7	5670.4	7289.1	22.2	1583.0	5644.8	7227.8	21.9
T_{10}	1546.0	5832.2	7378.2	21.5	1508.7	5816.3	7324.9	21.4
T_{11}	1072.7	4557.2	5763.3	20.6	1047.7	4648.9	5696.6	18.4
T_{12}	1523.0	6207.1	7730.1	19.7	1491.3	6181.2	7672.5	19.6
S.Em±	87.5	355.9	521.7	2.1	86.4	347	356.8	1.7
C D (P=0.05)	258.2	1048.5	1540.0	NS	255.0	1005	1053.3	NS

The effect of nitrogen schedules along with Zn and B application was found significant on grain yield, stover yield and biological yield, while their effect was non-significant on harvest index during both the years of experimentation.

During both the years of experimentation T_8 (1875.7, 1848.3 kg/ha) recorded highest grain yield, which is statistically at par with T_6 and T_9. Among all the treatments, the treatment that followed farmers practice with RDF (T_{11}) recorded lowest seed yield (1072.7, 1047.7 kg/ha). T_{12} (1523, 1491.3 kg/ha) that followed farmers practice along with Zn and Boron (120kg/ha N+ Zn+ B) recorded lower yield than T_7 (1604, 1573.7 kg/ha), which consumed only 90 kg N/ha in three splits at 15, 30 and 45 DAS at the rate of 30 Kg N/ha in each split along with Zn and B. Same type of relation is also found between T_{11} and T_{12}, where T_{11} recorded lower yield than T_2 by consuming 120 Kg N/ha against only 90 kg N/ha for T_2. The most probable reason behind maximum seed yield in T_8 is that, N was applied at 15, 30 and 45 DAS in three splits at the rate of 30, 60, 30 kg/ha respectively. This schedule of nitrogen application matched the sigmoidal pattern of crop growth and hence provided maximum fertilizer use efficiency and yield (Liu *et al*., 2018) [7]. In normal farmer's practice 50% N is applied as basal dose. But in that time the crop requirement is less and hence most of the applied N is lost in various means. A higher yield can be obtained by skipping the basal dose and applying at the rate of 30 Kg/ha at 15, 30 and 45 DAS. In this way higher yield and 25% saving of fertilizers can be achieved. Similar types of findings are also reported by Bhatnagar *et al.* (2019) [1].

Highest stover yield was obtained in T8 (6384.2, 6341.7 kg/ha) during both the years of study, which is at par with T_7, T_{10} and T_{12}. T8 (8259.8, 8190.1 kg/ha) also recorded highest biological yield during both years with is again statistically at par with T_1, T_6, T_7, T_9, T_{10} and T_{12}.

The effect of different treatments was non-significant on harvest index during both the years. In 2020-21, numerically T_3 (24.7) recorded highest HI, followed by T8 (23.0). But in 2021-22, numerically T8 (22.6) recorded highest HI followed by T3 (22.1).

The treatments that were applied with Zn and B fertilizers recorded highest grain and biological yield over the treatments that lack them. Because Zn helps in activation of enzymes such as triphosphatage, dehydrogenase, tryptophan synthetase, proteinage and peptidase etc. and better photosynthetic activity as well. These results are closely related with Singh and Yadav (1997) [11]. Zinc is also an essential component of enzymes responsible for assimilation of nitrogen, help in chlorophyll formation and plays an important role in nitrogen metabolism. Similar results were obtained by Islam *et al*. (1998) [3]. Boron promotes the pollen producing capacity of anthers and hence might have produced higher number of seeds per siliqua. It also had a positive effect on the photosynthetic performance of plants by influencing phosphorylation process, reducing the quantity of assimilates consumed by respiration to obtain energy and accelerating the removal of products of photosynthesis. The increase in seed yield is largely a function of improvement in the yield attributes. These results are in agreement with the finding of Mathew and George (2013) [8] in sesame. The positive influence of B in improving the seed yield of mustard was also reported by Jaiswal *et al*. (2015) [4].

Conclusion

T_8 that involves the application of N at 15, 30 and 45 DAS at the rate of 30, 60 and 30 kg/ha, along with Zn and B was found to be the best treatment in terms of grain and biological yield. T_7 that applied N at 15, 30 and 45 DAS at the rate of 30, 30 and 30 kg/ha, along with Zn and B was found to be the best one in terms of resource saving and economics.

References

1. Bhatnagar A, Singh G, Singh V. Optimization of nitrogen dose and application schedule for winter maize (*Zea mays* L.) in North-West plain of India. Maize Journal. 2019;8(1):1-7.
2. http://www.drmr.res.in/ Directorate of Rapeseed and Mustard Research, 2/1/21.
3. Islam MR, Islam MS, Jahiruddin M, Hoque MS. Effect of sulphur, zinc and boron on yield and nutrient uptake by wheat. Int. J of Trop. Agric. 1998;16:119-122.
4. Jaiswal AD, Singh SK, Singh YK, Singh S, Yadav SN. effect of sulphurand boron on yield and quality of mustard (*Brassica juncea* L.) grown in Vindhy red soil. J. Indian Soc. Soil Sci. 2015;63(3):362-364
5. Jat JR, Mehra RK. Effect of sulphur and zinc on yield, macronutrient content in and uptake by mustard on Haplustepts. J Indian Soc. Soil Sci. 2007;55:190-195.
6. Kumararajaa P, Premia OP, Kandpala BK. Application of boron enhances Indian mustard (*Brassica juncea*) productivity and quality under boron deficient calcareous soil in semi-arid environment Ecosystem. Env. & Cons. 2015;3:249-254.
7. Liu J, Yan Y, Ali A, Yu M, Xu Q, Shi P. Simulation of crop growth, time to maturity and yield by an improved sigmoidal model. Sci. Rep. 2018;8:1-5.
8. Mathew J, George S. Synergistic influence of sulphur and boron on enhancing the productivity of season (*Sesamum indicum* L.) grown in an Entisol of Kerala. J Indian Soc. Soil Sci. 2013;61:122-127.
9. Parr AJ, Loughman BC. Boron and membrane functions in plants. In: ‘DA. Robb and W. S. Pierpoint, (Eds) Metals and Micronutrients: Uptake and Utilization by Plants., Academic Press, London. 1983, 87-107.
10. Raghuvanshi N, Kumar V, Dev J. Effect of Nitrogen Levels on Mustard (Brassica juncea (L.) Cuzern and Coss.) Varieties under Late Sown Condition. Curr. Appl. Sci. Technol. 2018;30(2):1-8.
11. Singh U, Yadav DS. Studies on sulphur and zinc nutrition on green gram (*Phaseolus radia* L.) in relation to growth attributes, seed protein, yield and S, Zn uptake. Indian J Agric. Sci. 1997;20:224-226.
12. Smirnoff N, Stewart GR. Nitrate assimilation and translocation by higher plants: comparative physiology and ecological consequences. Physiol. Plant. 1985;64:133-140.