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Study of RDF levels of NPK and micronutrient on growth and yield of mustard [*Brassica juncea* (L.)]

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Abstract
A field experiment was conducted at Research Farm of Mewar University, Chittorgarh (Rajasthan) during *rabi* season of 2024-25 on loamy sand soil, which consisted ten treatments *viz*., Cntrol-T_0, 50% RDF + $ZnSo_4$ @ 5 kg/ha -T_1, 50% RDF + Boron @ 1 kg/ha-T_2, 50% RDF + $ZnSO_4$ @ 5 kg/ha + Boron @ 1 kg/ha- T_3, 75% RDF + $ZnSO_4$ @ 5 kg/ha-T_4, 75% RDF + Boron @ 1 kg/ha-T_5, 75% RDF + $ZnSO_4$ @ 5 kg/ha + Boron @ 1 kg/ha-T_6, 100% RDF + $ZnSO_4$ @ 5kg/ha-T_7, 100% RDF + Boron @ 1kg/ha-T_8, 100% RDF +$ZnSO_4$ @ 5 kg/ha + Boron @ 1 kg/ha-T_9 were applied to the musterd *var*. BIO-902 with randomized block design (RBD).
The results of one year study clearly showed that the application of fertilizers (RDF level of NPK) and micronutrients brought significantly increased growth, yield and quality attributes of mustard. The growth and yield characters like plant height, number of dry matter accumulation, number of silique plant^{-1} and seed yield was significantly improved under 100% RDF +$ZnSO_4$ @ 5 kg/ha + Boron @ 1 kg/ha T_9 which was statistically remained at par with 100% RDF +$ZnSO_4$ @ 5 kg/ha-T_7.

Keywords: Mustard, RDF, zinc, yield

Introduction
Oilseed crops occupy an important place in Indian agricultural economy as well as in human life. India is the 4th largest oilseed producing country in the world after USA, China and Brazil (DVVOF, 2017). Among the oilseeds, Indian mustard (*Brassica juncea* L.) is the principal winter edible oilseed crop. It has been grown for oilseed, green leaves and as a spice. India is an important rapeseed mustard growing country in the world, which occupying the third position in its production after Canada and China of the seven edible oilseeds Cultivated in India, In India, it is the second most important edible oilseed after soybean which shares 27.8% in the India's oilseed economy (Anonymous, 2024) [1]. Rapeseed-mustard (*Brassica spp*.) is one of the most important oilseed crops of the world where India is ranking third in area and production in the world (DRMR, 2024). The genus Brassica of family *Cruciferae* (*Brassicaceae*) is consisted of several multipurpose species which yield edible leaves, roots, stems and seeds as spice. Brassicas are also extensively cultivated as cash crop, vegetables and fodder. Indian mustard [*Brassica juncea* (L.) is the most important rabi season oilseed crop, which thrives best in light to heavy loam soil in areas having 25-40 cm rainfall.
The application of the Recommended Dose of Fertilizers (RDF) is crucial in optimizing the growth, yield, and quality of mustard (*Brassica juncea* L.). Mustard is a nutrient-exhaustive crop, and its response to balanced nutrient application is well-documented. RDF, typically comprising nitrogen (N), phosphorus (P), and potassium (K), ensures that the crop receives essential nutrients in appropriate proportions, tailored to regional soil and climatic conditions. Zinc is one of the first micronutrients recognized as essential for plants that transported to plant root surface through diffusion. Zinc deficiency is the most pervasive micronutrient deficiency in the world. It is, therefore considered as the most serious cause of hidden hunger in plants. It not only reduces the productivity but also the nutritional quality of the crop (Graham *et al*., 1992) [5].

Materials and Methods

The field experiments were carried out during *summer* season (2025) to study the "Study of RDF levels of NPK and micronutrient on growth and yield of mustard [*Brassica juncea* (L.) in randomized block design (RBD) with consisted nine treatments *viz*., Cntrol-T_0, 50% RDF + $ZnSo_4$ @ 5 kg/ha -T_1, 50% RDF + Boron @ 1 kg/ha-T_2, 50% RDF + $ZnSO_4$ @ 5 kg/ha + Boron @ 1 kg/ha- T_3, 75% RDF + $ZnSO_4$ @ 5 kg/ha-T_4, 75% RDF + Boron @ 1 kg/ha-T_5, 75% RDF + $ZnSO_4$ @ 5 kg/ha + Boron @ 1 kg/ha-T_6, 100% RDF + $ZnSO_4$ @ 5kg/ha-T_7, 100% RDF + Boron @ 1kg/ha-T_8, 100% RDF +$ZnSO_4$ @ 5 kg/ha + Boron @ 1 kg/ha-T_9 at Research Farm, Mewar University, Chittorgarh (Rajasthan). The experimental farm is geographically located at 075°88'99" E longitude and 26°81'17" N latitude and this region falls under agro-climatic zone IV A of Rajasthan. The experimental fields were clay loam and the soil fertility status contained available nitrogen (137.8 kg ha^{-1}) by Subia and Asija 1996, available phosphorus (16.3 kg ha^{-1}) by Olsen *et al*. 1954 and available potassium (250.12 kg ha^{-1}). The organic carbon content was from 0.34-0.38 percent. The weekly mean maximum and minimum temperatures were of temperature during both summers (40.6°C) and winters (2.7°C). The mean relative humidity fluctuated from 63.50 to 91 percent during the crop season. The average rainfall is 557 mm per annum, which is mostly received during July to september. The sporadic showers during winters are also common, which are probably observed during this period. The observation were recorded at harvest was analysed by statistical methods (Fisher, R.A. 1950) [4].

Results and Discussion

It is clear from the result of present study that, The growth characters like plant height (46.68 cm), number of dry matter accumulation (35.22 g $plant^{-1}$) was significantly improved under 100% RDF+$ZnSO_4$ @ 5 kg/ha + Boron @ 1 kg/ha T_9 which was statistically remained at par with 100% RDF +$ZnSO_4$ @ 5 kg/ha-T_7 over control (Table-1). The enhancement in plant height and biomass accumulation under T_9 may be attributed to the balanced and adequate supply of both macro- and micronutrients during the critical growth stages of the mustard crop. The application of zinc and boron in addition to the RDF likely played a vital role in promoting cell division, elongation, enzymatic activity, and chlorophyll synthesis-all contributing to improved vegetative growth. Zinc is an essential micronutrient that enhances auxin metabolism and root development, leading to better nutrient absorption. Boron, on the other hand, is crucial for meristematic tissue development, pollen germination, and translocation of sugars and other metabolites, which collectively improve overall plant vigor and biomass accumulation. These results are consistent with the findings of Meena *et al*. (2015) [8] and Kumar *et al*. (2018) [7], who reported that the integrated use of NPK with micronutrients like Zn and B significantly improved the growth and physiological parameters in mustard. Furthermore, Sharma and Chauhan (2017) [10] emphasized the role of boron and zinc in enhancing mustard growth, especially when applied in conjunction with recommended macronutrient levels. The improvement in dry matter accumulation under T_9 suggests enhanced photosynthetic efficiency and nutrient use efficiency, ultimately supporting better crop stand and productivity. The results also confirm that integrated nutrient management involving micronutrients is more effective than macronutrients alone, highlighting the need to include zinc and boron in mustard fertilization strategies, especially in micronutrient-deficient soils.

Further yield attributes and yields like number of siliquae/plant (25.53) and seed yield (1855 kg/ha) also recorded under 100% RDF +$ZnSO_4$ @ 5 kg/ha + Boron @ 1 kg/ha T_9 which was statistically remained at par with 100% RDF +$ZnSO_4$ @ 5 kg/ha-T7 and superior to the rest of the treatments. The higher number of siliquae per plant under T_9 can be attributed to improved reproductive efficiency due to the combined role of boron and zinc. Boron plays a crucial role in flower initiation, pollen viability, and fertilization, leading to better pod setting. Zinc, on the other hand, is involved in hormonal regulation and enzyme activation, which supports overall plant health and reproductive success. The synergy between these two micronutrients, along with adequate macronutrient supply (NPK), likely created a favorable physiological condition for increased siliquae development. Similarly, the enhanced seed yield under T_9 is a cumulative result of improved growth parameters (such as plant height and dry matter accumulation) and superior yield components like siliquae count and possibly seed weight. These results align with the findings of Verma *et al*. (2016) [12] and Meena *et al*. (2015) [8], who also reported significant yield gains in mustard with the combined application of RDF and micronutrients.In particular, Kumar *et al*. (2018) [7] reported that boron supplementation improved seed set and translocation of assimilates toward reproductive structures, contributing to higher yields. The finding that T_7 (RDF + Zn only) was statistically at par but slightly inferior to T_9 also reinforces the vital role of boron in yield maximization, especially when combined with zinc and a full NPK dose.

Table 1: Effect of fertilizer levels and micronutrient application on growth of mustard

Treatments	Plant height (cm)	Dry matter accumulation (g $plant^{-1}$)
T_0 : Control	29.58	27.32
T_1 : 50% RDF + $ZnSO_4$ @ 5 kg/ha	36.72	29.81
T_2 : 50% RDF + Boron @ 1 kg/ha	34.27	28.54
T_3 : 50% RDF + $ZnSO_4$ @ 5 kg/ha + Boron @ 1 kg/h	37.19	29.93
T_4 : 75% RDF + $ZnSO_4$ @ 5 kg/ha	38.56	32.87
T_5 : 75% RDF + Boron @ 1 kg/ha	37.96	30.83
T_6 : 75% RDF + $ZnSO_4$ @ 5 kg/ha + Boron @ 1 kg/h	39.29	33.02
T_7 : 100% RDF + $ZnSO_4$ @ 5 kg/ha	46.29	34.97
T_8 : 100% RDF + Boron @ 1 kg/ha	45.64	34.08
T_9 : 100% RDF + $ZnSO_4$ @ 5 kg/ha + Boron @ 1 kg/ha	46.68	35.22
SEm±	0.61	0.29
CD (P = 0.0 5)	1.88	0.87
CV (%)	9.02	9.41

Table 2: Effect of fertilizer levels and micronutrient application on yield of mustard

Treatments	Number of silique/plant	Seed yield (kg ha^{-1})
T_0 : Control	17.21	865
T_1 : 50% RDF + $ZnSO_4$ @ 5 kg/ha	18.25	1245
T_2 : 50% RDF + Boron @ 1 kg/ha	21.51	1093
T_3 : 50% RDF + $ZnSO_4$ @ 5 kg/ha + Boron @ 1 kg/h	25.63	1332
T_4 : 75% RDF + $ZnSO_4$ @ 5 kg/ha	28.49	1562
T_5 : 75% RDF + Boron @ 1 kg/ha	29.67	1336
T_6 : 75% RDF + $ZnSO_4$ @ 5 kg/ha + Boron @ 1 kg/h	19.91	1586
T_7 : 100% RDF + $ZnSO_4$ @ 5 kg/ha	21.76	1841
T_8 : 100% RDF + Boron @ 1 kg/ha	25.26	1601
T_9 : 100% RDF + $ZnSO_4$ @ 5 kg/ha + Boron @ 1 kg/ha	25.53	1855
SEm±	1.03	69
CD (P = 0.0 5)	3.17	212
CV (%)	7.15	7.66

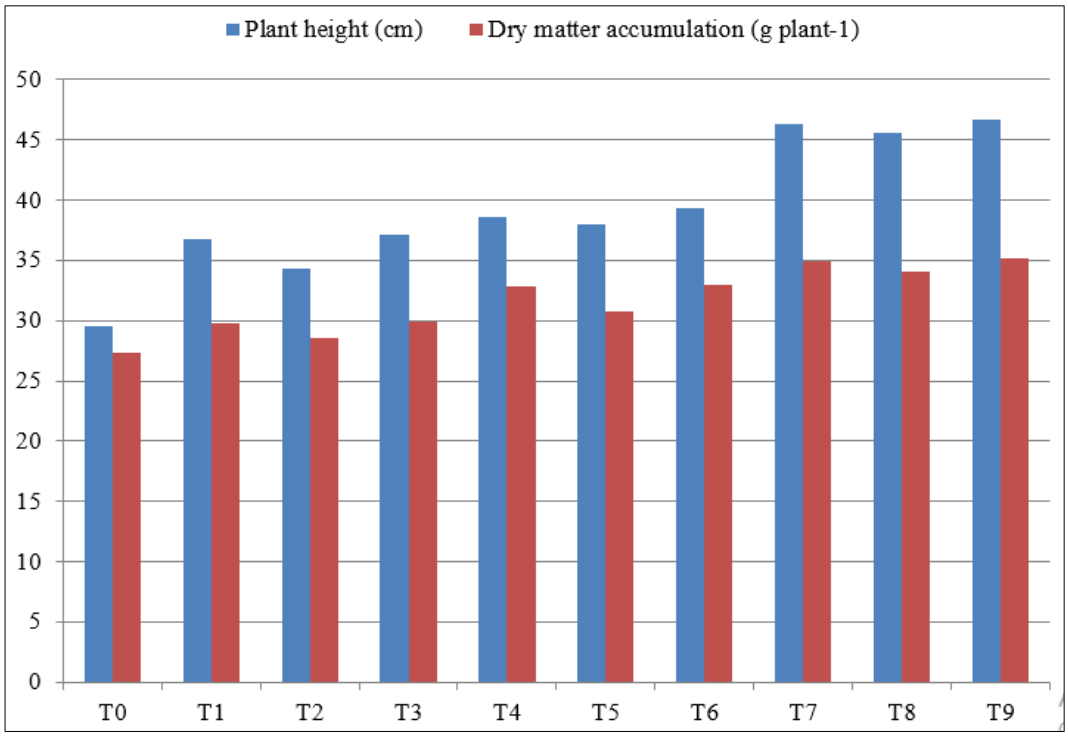

Fig 1: Effect of fertilizer levels and micronutrient application on growth of mustard

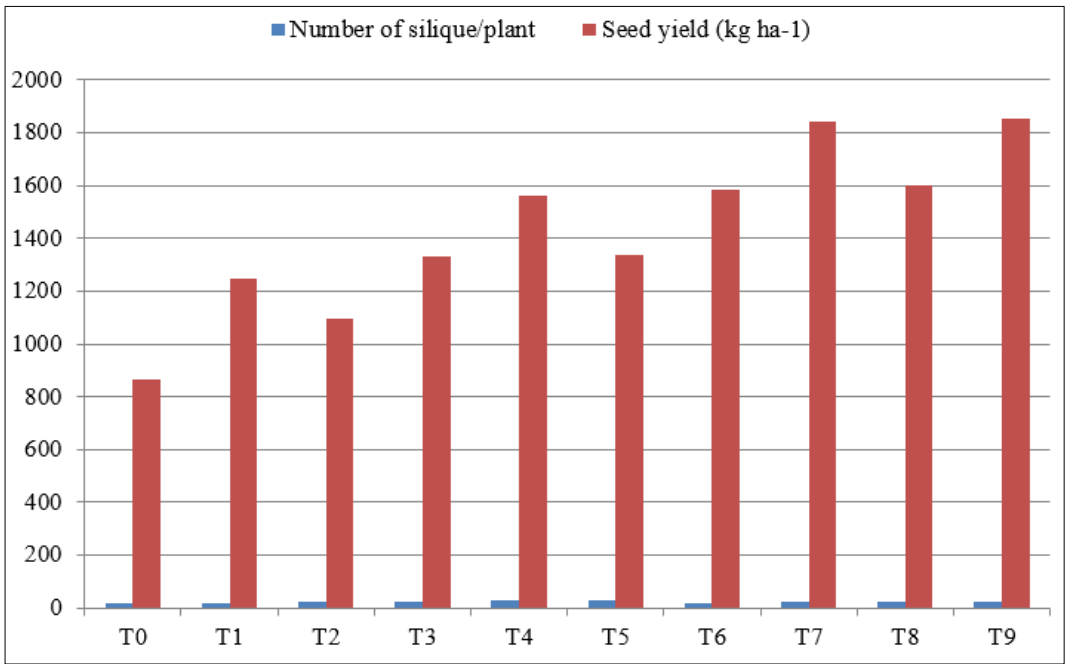

Fig 2: Effect of fertilizer levels and micronutrient application on yield of mustard

Conclusion

Based on the results of one year experimentation, it may be concluded that the Application of 40 kg nitrogen and 80 kg phosphorus ha^{-1} found suitable to produce good yield of mustard.

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