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Effect of foliar application of micronutrient on growth and seed yield in mustard (*Brassica juncea* L.) genotype NRCHB -101

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Abstract
The present investigation was carried out to know the effect of foliar application of micronutrients on mustard genotype NRCHB 101which was sown in farmer's field in 2nd week of November, during 2019 and 2020. The results revealed that there was a significant improvement in the growth and seed yield with application Zn, B, Mo and their combination. Treatment T7 ($ZnSO_4$ 0.5 per cent + Borax 1 per cent + Molybdenum 0.1 per cent) recorded significantly highest plant height (158.92 cm), chlorophyll content (41.10), number of primary branches (6.65), number of siliqua per plant (261.23), siliqua length (6.69 cm), number of seeds per siliqua (13.43) and seed yield per ha (2291.78 kg ha^{-1}). Similarly, lowest plant height (141.71 cm), chlorophyll content (33.82), number of primary branches (5.44), number of siliqua per plant (229.90), siliqua length (5.66), number of seeds per siliqua (10.38) and seed yield per ha (1727.90 kg ha^{-}1) was recorded at T_1 control treatment.

Keywords: Growth**,** seed yield, zinc, borax and molybdenum

Introduction

Indian mustard (*Brassica juncea* L.) is an important oil yielding crop belongs to the family Brassicaceae. Mustard having chromosome number 2n = 36, is a natural amphidiploid derived from interspecific cross between *B. nigra* and *B. campestris* (Nagaharu, 1935) [8]. Autogamy is the mode of pollination in mustard and certain amount (2 to 15%) of cross pollination occur due to insects, wind and other factors. Middle East has been considered as the primary centre of origin (Prakash and Hinata, 1980) [10]. Micronutrients hold a dominant and significant role in the growth and metabolic operations of oil seed crops. Among the micronutrients, occurrence of zinc deficiency is quite common and wide spread, followed by boron in soils of northern Karnataka (Vijayasekhar *et al*., 2000) [14]. Hence, nutrient management plays an important role in enhancing the seed production of mustard. Zinc is one of the essential micronutrient elements required by plants. Zinc has pivotal role in auxin and protein synthesis, seed production, rate of maturity and membrane integrity. It promotes RNA synthesis in absence of it, carbohydrate metabolism is greatly hampered. Apart from this, it helps in cell development, respiration, photosynthesis, chlorophyll formation and enzyme activity. Zinc application also influences the oil content in oil seed crops. Zinc is vital for vigorous growth and natural resistance to disease, pests and stress. Mustard plants absorb zinc in larger amounts than any other micronutrient (Bartaria *et al*., 2002) [1]. Boron is also an essential plant micronutrient and has emerged as the important plant nutrient to oilseed crops and plays a multiple role in their nutrition. It is involved in the calcium (Ca) metabolism and appears to be concerned to keep Ca in soluble form and increase its mobility in plants. The deficiencies of micronutrients *viz*., zinc and boron are increasing day by day due to imbalanced application of nutrients. The deficiency of zinc and boron are common in northern transition zone of Karnataka (Pulakeshi *et al*., 2012) [11].

Materials and Methods

The investigations were carried out during *rabi* 2019-2020 in farmer's field and laboratory experiment was conducted in the Department of Seed Science and Technology College of Agriculture Raichur and Department of Crop Physiology, University of Agriculture Sciences Raichur, (India) situated at 16° 28' north latitude and 77° 6' east longitude with an altitude of 389 m above the mean sea level. Investigation was carried out to know the effect of foliar application of micronutrients on mustard genotype NRCHB 101which was sown in farmer's field in 2nd week of November, during 2019 and 2020 laid out in Randomized block design with three replications under normal fertility conditions. Observations on the effect of sowing date on seed yield and quality parameters were recorded.

Treatment details

T_1- Control
T_2- $ZnSO_4$ (0.5 per cent)
T_3- Borax (1 per cent)
T_4- Molybdenum (0.1 per cent)
T_5- $ZnSO_4$ (0.5 per cent) + Borax (1 per cent)
T_6- $ZnSO_4$ (0.5 per cent) + Molybdenum (0.1 percent)
T_7- $ZnSO_4$ (0.5 per cent) + Borax (1per cent) + Molybdenum (0.1 per cent)
Spraying: Spraying of micronutrients at 30 and 40 DAS

Description of variety

NRCHB 101 (Indian mustard) is well known for variety suitable for late sown irrigated and rainfed Conditions it is largely grown in northen and central Indian states like M.P, U.P, Uttarakhand, Rajasthan, Bihar, JK, WB, Odisha, Asom, Chhattisgarh and Manipur. This variety was developed by ICAR-DRMR (Directorate of Rapeseed-Mustard Research) having tolerance to biotic (white rust, Alternaria blight, powdery mildew) and abiotic stresses (salinity, high temperature). Duration of the variety is 105- 135 days with average oil content of 34.6 to 41.1%.

Results and Discussion

Effect of foliar application micronutrients on mustard crop growth parameters

The application of micronutrients combination significantly influenced the growth of the plants. Plant height at vegetative stage, flowering stage and pod formation stage was recorded maximum in T_7 (26.30 cm, 153.62 cm and 158.92 cm, respectively) which was on par with T5 (25.87 cm, 149.89 cm and 157.29 cm, respectively) and the shortest plants were recorded in control T_1 (24.00 cm, 137.15 cm and 141.71 cm, respectively) Fig1. Increase in nutrient supply enhanced crop growth because of higher rate of photosynthesis, metabolic activity and cell division. Boron favourably stimulated crop growth by cell division in the meristematic region and by acting at the growing tip of the plants (Stangoulis *et al*. 2000, Mandal and Sinha 2002) [13, 6]. $ZnSO_4$ as a source of Zn and S enhanced crop growth probably by maintaining higher levels of auxin in the plant tissues and by synthesizing more food in the leaves with the help of S, which usually participated in the synthesis of proteins, vitamins, *etc.*

Significantly highest chlorophyll content at vegetative stage, flowering stage and at pod formation stage in T_7 (35.28, 44.43 and 41.10 respectively) which was on par with T_5 (33.90, 43.59 and 39.66 respectively) and the lowest number of primary branches were recorded in control T_1 (30.26, 36.74 and 33.82 respectively) Fig 2. SPAD values in the plant leaf tissue is specific to the age of plant, to plant species and to growing season, also had maximum stomatal conductance, photosynthetic rate and as well as the yield levels. At the same time, treatment T_1 observed with lower SPAD values with lower yield levels, low stomatal conductance and low photosynthetic rate. These present study results were in conformity with the earlier works of Kobraee *et al.* (2011) [4]

Number of primary branches at vegetative stage, flowering stage and pod formation stage recorded highest in T7 (1.41, 6.28 and 6.65 respectively) which was on par with T5 (1.34, 5.70 and 6.21 respectively) and the lowest number of primary branches were recorded in control T_1 (1.21, 4.60 and 5.44 respectively) Fig 3. Application of different combination micronutrients resulted significant increase in nutrient contents might be due to greater availability of N and P in soil supplied due to combined application of $ZnSO_4$, Borax and Molybdenum micronutrients and with balanced nutrient application, nutrient uptake increased as a function of biomass production and the nutrient content of that biomass in mustard. These results are in close conformity with findings of Bhagchand *et al*. (2013) [2].

Foliar application of micronutrients combination T7 (40.68 days in 2019 and 40.52 days in 2020) took less number of days to attain 50% flowering and more number of days in T4 (41.75 days in 2019 and 42.94 days in 2020) (Fig. 4). This is due to ratio of pollen grains increased when sprayed with Boron at different concentration. This might have better pollen viability compared to the other treatments. B is necessary for pollen viability in crops similar trend was observed by Padilla *et al*., (2017) [9].

Effect of foliar application micronutrients on mustard yield parameters

Highest number of siliqua per plant (253.39 in 2019 and 261.23 in 2020) was recorded in treatment, T7 and it was on par with T_5 (248.789 in 2019 and 256.48 in 2020), T_6 (242.38 in 2019 and 255.14 in 2020) and T_3 (241.08 in 2019 and 248.54 in 2020). While, minimum number of siliqua per plant was recorded in control T_1 (223.00 in 2019 and 229.90 in 2020) Fig5. This might be due to its role in the metabolism of starch as zinc affected the activity of aldolase in the plant tissue which is involved in the conversion of fructose 1-6 diphosphate to its subsequent compounds. These findings confirm the result of Singh *et al*. (2009) [12]. Also due to boron promotes the pollen-producing capacity of anthers and has an impact on the photosynthetic performance of plants by affecting the phosphorylation process, lowering the amount of assimilates utilized in respiration to get energy, and speeding up the removal of photosynthesis products and these findings confirm the result of Kumar *et al*. (2023) [5] in mustard.

Among all the treatments, foliar application of micronutrient, T7 was recorded highest number of seeds per siliqua (13.15 in 2019 and 13.43 in 2020) followed T5 (13.11 in 2019 and 12.37 in 2020) and T6 (11.68 in 2019 and 12.35 in 2020). Further, control T_1 recorded significantly lowest number of seeds per siliqua (10.17 in 2019, 10.59 in 2020 and 10.38 in pooled mean) Fig6. The higher performance of yield attributes might be due to the fact that, zinc is proved to increase pollen viability and significant effect on pollen formation and fertilization, hence higher seeds number are direct index of pollen viability, whereas the prolong nutrient supplied by the inorganic and inorganic sources led to better translocation of photosynthates into form of seed resulting in better yield attributes. Similar findings were reported by Kannan *et al*. (2013) [3].

Seed yield per ha^{-1} was recorded highest in T_7 (2252.56kg ha^{-1}) in 2019 and (2331.00 kg ha^{-1}) in 2020. However, it was on par with T_5 (2130.46 kg ha^{-1} in 2019 and 2175.60 kg ha^{-1} in 2020 respectively) and T_3 (2052.76 kg ha^{-1} in 2019 and 2175.60 kg ha^{-1} in 2020 respectively). While, control (T_1) recorded lower seed yield ha^{-1} (1790.80 kg ha^{-1} in 2019 and 1665.00 kg ha^{-1} in 2020 respectively) Fig7. The judicious use of micronutrients source has beneficial effect on physiological process of plant metabolism *viz.*, growth and yield there by leading to higher seed yield and similar findings were reported by Manojgowda, B.S. (2021) [7].

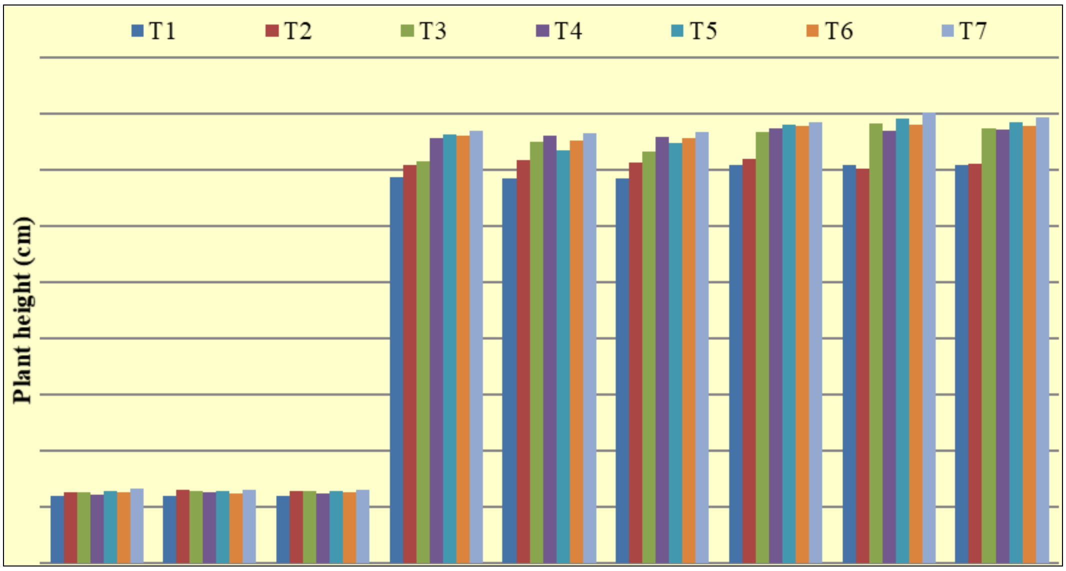

Fig 1: Effect of foliar application of micronutrients on plant height in mustard genotype NRCHB-101

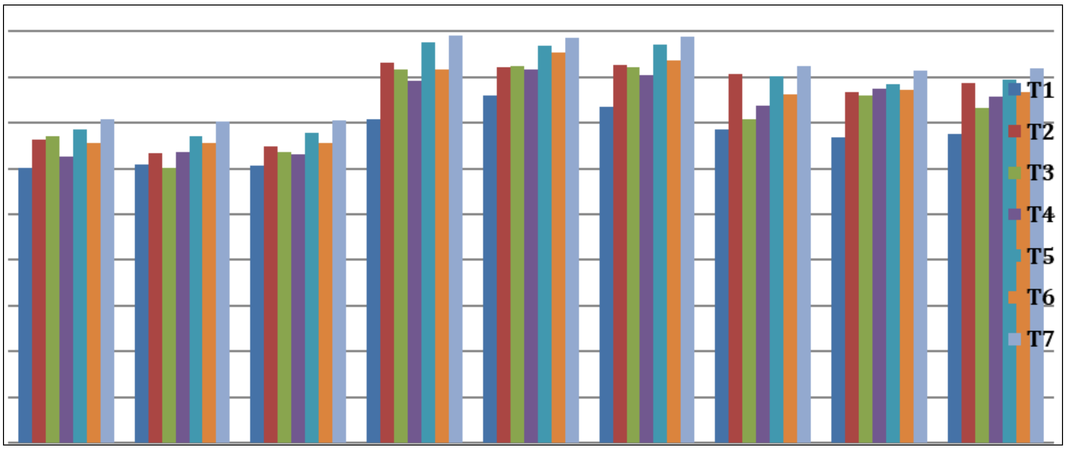

Fig 2: Effect of foliar application of micronutrients on chlorophyll content in mustard genotype NRCHB-101

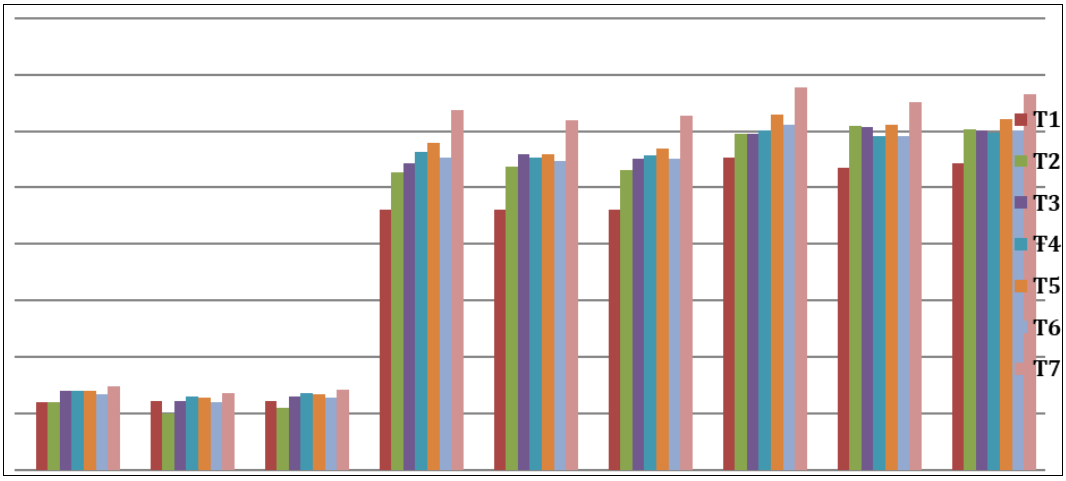

Fig 3: Effect of foliar application of micronutrients on chlorophyll content in mustard genotype NRCHB-101

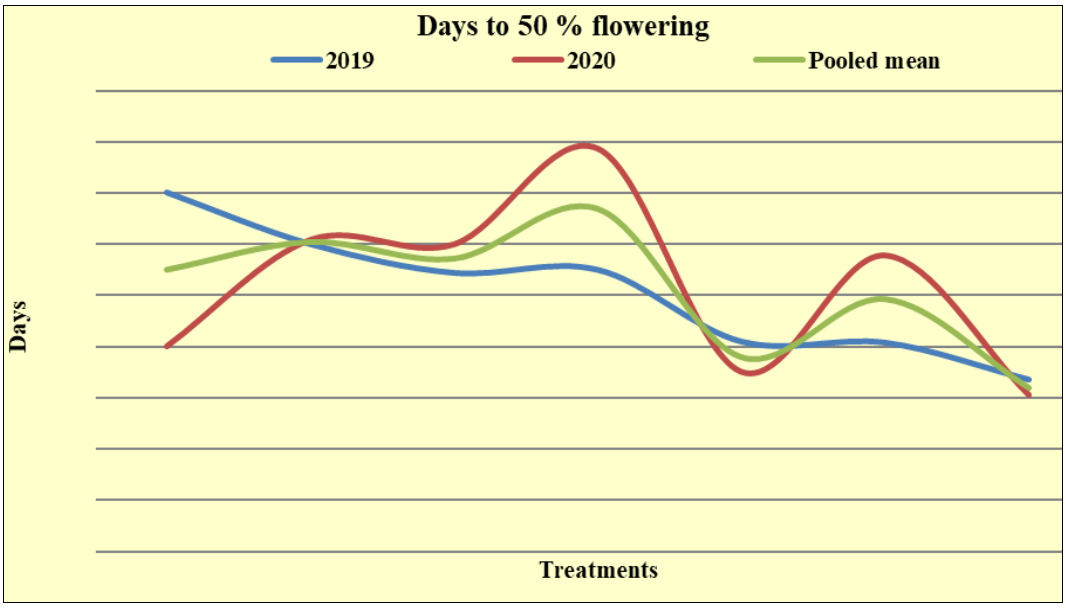

Fig 4: Effect of foliar application of micronutrients on days to 50% flowering in mustard genotype NRCHB-101

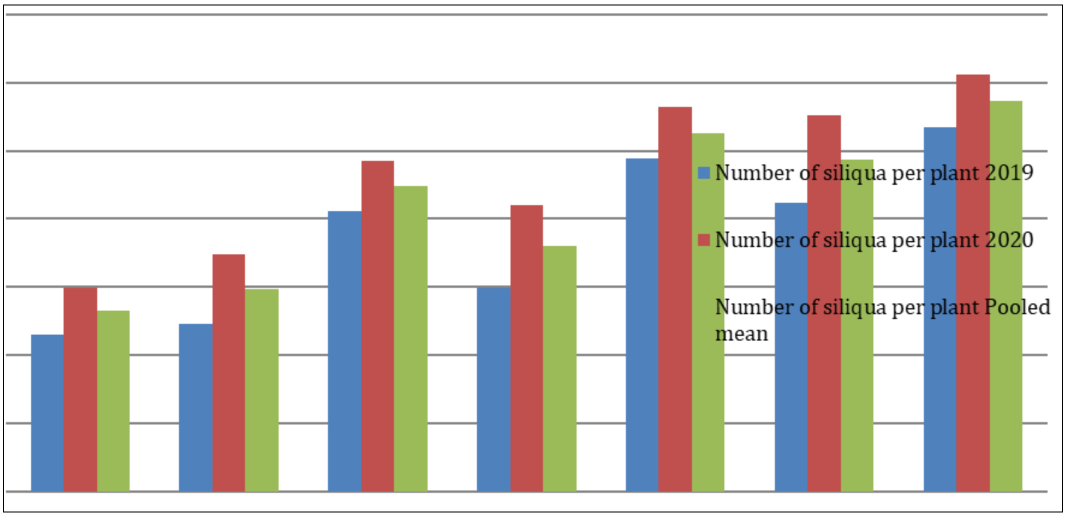

Fig 5: Effect of foliar application of micronutrients on number of siliqua per plant in mustard genotype NRCHB-101

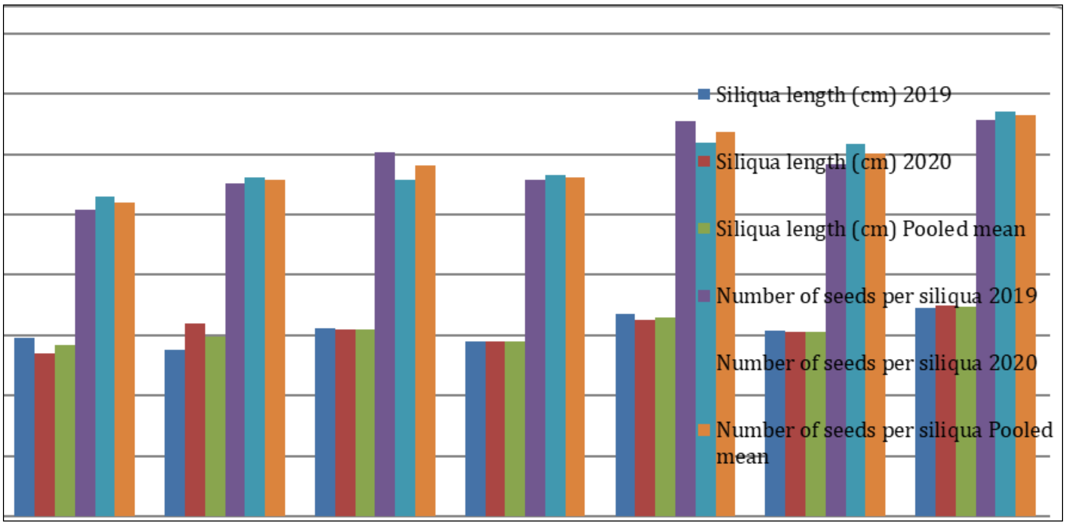

Fig 6: Effect of foliar application of micronutrients on siliqua length (cm) and number of seeds per siliqua in mustard genotype NRCHB-101

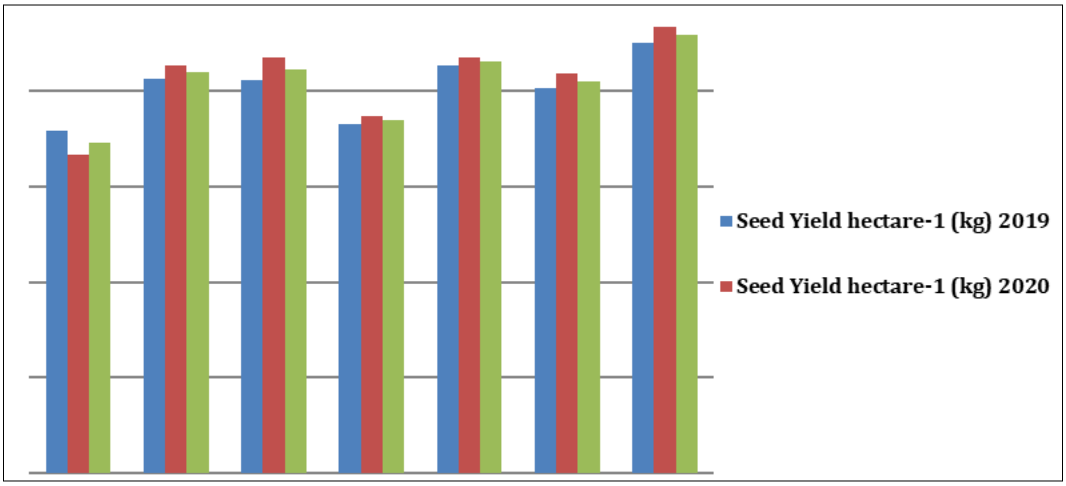

Fig 7: Effect of foliar application of micronutrients on seed yield hectare^{-1} (kg) in mustard genotype NRCHB-101

Conclusion

Among combinations foliar application micronutrients of Zinc, boron and molybdenum is best for producing high quality and quantity seeds in mustard. The judicious use of micronutrients source has beneficial effect on physiological process of plant metabolism *viz*., growth and yield there by leading to higher seed yield. $ZnSO_4$ (0.5 per cent) + Borax (1 per cent) + Molybdenum (0.1 per cent) at 30 and 40 days after sowings was found to be most effective combinations of micronutrients for increasing seed yield.

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