*International Journal of Environment and Climate Change*

***Volume 13, Issue 8, Page 1913-1918, 2023; Article no.IJECC.100783***
***ISSN: 2581-8627***
*(Past name: British Journal of Environment & Climate Change, Past ISSN: 2231–4784)*

# Effect of Potassium & Zinc on the Growth and Yield of Mustard (*Brassica juncea* L.)

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***Authors' contributions***

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

***Article Information***

DOI: 10.9734/IJECC/2023/v13i82147

**Open Peer Review History:**
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/100783

***Original Research Article***

***Received: 02/04/2023***
***Accepted: 06/06/2023***
***Published: 19/06/2023***

## ABSTRACT

A field experiment was carried out at an agricultural research farm in the Rabi season 2022, at the department of Agronomy at Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj in North Eastern plains of Eastern Uttar Pradesh to study the growth and yield of Mustard (*Brassica juncea* L.) Var. with the effect of potassium and zinc, under Randomized block design comprising 10 treatments of which treatment ($T_1$-$T_9$), Using three replications of nitrogen, phosphorus, potassium, and zinc with different combinations T1 – 30 kg K/ha + 5 kg Zn/ha, T2 – 30 kg K/ha + 10 kg Zn/ha, T3 – 30 kg K/ha + 15 kg Zn/ha, T4 – 40 kg K/ha + 5 kg Zn/ha, T5 – 40 kg K/ha + 10 kg Zn/ha, T6 – 40 kg K/ha + 15 kg Zn/ha, T7 – 50 kg K/ha + 5 kg Zn/ha, T8- 50 kg K/ha + 10 kg Zn/ha, T9 – 50 kg K/ha + 15 kg Zn/ha and T10 – Control. The exploratory plot's soil had a sandy loam texture, a (pH 7.2) that was natural with EC - 0.26 (dS/m), a low organic carbon (0.48 %), the available N (225 kg/ha), the available P (13.60 kg/ha) and the available K (215.4

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kg/ha). The experimental results revealed that 50 kg K/ha + 15 kg Zn/ha recorded Maximum plant height (193.45 cm), The highest plant dry weight (35.25 gm), number of siliqua/plant (302.20), number of seeds/siliqua (17.60), Seed yield (2685 kg/ha), Stover yield (6143 kg/ha) when compared with other treatment combinations.

*Keywords: Mustard; potassium; zinc; growth; yield.*

## 1. INTRODUCTION

India is an important rapeseed-mustard producing nation in the world, occupying the second highest production behind China with largest area. The name mustard is derived from the Latin word 'mustum', which implies aged wine blended with crushed seeds. In India, rape seed mustard is cultivated on 5.74 million hectares in a variety of agro-ecological conditions with the production of 6.79 million tonnes and has a productivity of 1,186 kg/ha [1]. In the recent past, the area covered under brown mustard has increased at the cost of other *Brassicas* because of its increased production and resistance to biotic and abiotic stresses.

Mustard oil is used primarily for cooking and is valued for vegetables, fodder, condiments and medicinal purposes. Mustard has a high nutritious value and an oil content that ranges from 37 to 49%. Due to its abundance in unsaturated fatty acids, Indian mustard oil is largely utilised as a desired edible oil for human consumption. Rapeseed-mustard oil has a high content of unsaturated and a low content of saturated fatty acids. The seed and oil of mustard have peculiar pungency due to glycoside "Sinigrin" ($C_{10}H_{16}O_9NS_2K$) thus making it suitable for condiments and can be used for the preparation of curries and pickels. Soxhlet method was used to extract the oil from mustard seeds. Grain and straw K values were calculated by flame photometry following nitric and perchloric acid digestion of the samples [2].

Among the mineral cations that the plant needs, potassium is one of the key nutrients in the soil. 2.4% of the earth's crust is potassium. Potassium is mostly found in complex silicate components, while some of it is also found in soil's organic matter and clay fraction. The amount of potassium in soil can range from 0.1% to 3.0% or even higher. In instances of insufficient soil moisture, potash is also necessary for the root system to absorb water [3].

Micronutrients are as crucial to plant nutrition as primary and secondary nutrients, though plants do not need as much of them. Even when all other nutrients are present in sufficient quantities, growth might be restricted by the absence of any one of the micronutrients in the soil. The removal of more micronutrients from the soil by high-yielding mustard crops cannot be made up by the use of high-analysis NPK fertilizers with lower levels of micronutrient pollutants. Therefore, micronutrient applications are required to obtain balanced nutrition. Thus, there is an urgent need for stepping up the use of micronutrient in growing field crops. To enhance the productivity of crops, micronutrients like Fe, Mn, Cu and Zn need to be supplemented along with NPK fertilizers [4].

Hence, nutrient management plays an important role in enhancing the production of mustard. One of the fundamental micronutrient components that plants need is zinc. Auxin and protein synthesis, seed production, maturation pace, and membrane integrity are all critically dependent on zinc. It encourages RNA synthesis in the absence of it, the metabolism of carbohydrates is severely hindered. In addition, it supports the growth of cells, respiration, photosynthesis, chlorophyll production, 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 [5].

## 2. MATERIALS AND METHODS

A field experiment was conducted during the Rabi season of 2022, at the Crop research farm of the Department of Agronomy at Sam Higginbottom University of Agriculture, Technology, and Sciences, Prayagraj, U.P, which is located at $25^{o}$ 24' 42" N latitude, $81^{o}$ 50' 56" E longitude and 98 m altitude above the mean sea level (MSL). To evaluate how potassium and zinc effect the Mustard's (*Brassica juncea* L.) growth and yield. The research was laid out in Randomized Block Design with 10 treatments which are replicated thrice. Each treatment net plot size is 3m × 3m. The recommended dose of potassium and zinc when used together with urea and DAP, which are included in the treatment combinations are as follows, ($T_1$) 30 kg K/ha + 5 kg Zn/ha, ($T_2$) 30 kg K/ha + 10 kg Zn/ha, ($T_3$) 30 kg K/ha + 15 kg Zn/ha, ($T_4$) 40 kg K/ha + 5 kg Zn/ha, ($T_5$) 40 kg K/ha + 10 kg Zn/ha, ($T_6$) 40 kg K/ha + 15 kg Zn/ha, ($T_7$) 50 kg K/ha + 5 kg Zn/ha, ($T_8$) 50 kg K/ha + 10 kg Zn/ha, ($T_9$) 50 kg K/ha + 15 kg Zn/ha and ($T_{10}$) Control. At the stage of harvesting maturity, the mustard crop was harvested treatment wise. Growth parameters viz. plant height (cm) and dry matter accumulation g/plant were recorded manually on five randomly selected representative plants from each plot of each replication separately and after harvesting, seeds were separated from each net plot and were dried under the sun for three days. Later winnowed, cleaned and seed yield per hectare was computed and expressed in kilogram per hectare. Stover production from each net plot was recorded and reported in kilogram per hectare after full drying under the sun for 10 days. The Gomez and Gomez [6] statistical approach was used to compute and analyse the data. After calculating the market value of seed with straw and the entire cost associated with crop production, the benefit to cost ratio was calculated.

## 3. RESULTS AND DISCUSSION

## 3.1 Effect on Growth Parameters

### 3.1.1 Plant height

Five plants were selected randomly from each plot and tagged. The heights (cm) of these plants were measured from the ground level up to tip of the plant. Plant height was recorded at 20, 40, 60, 80, 100 DAS and at harvest.

Here, Table 1, clearly shows that plant height measured increased as crop development progressed. At Harvest maximum plant height 193.45 cm was recorded with 50 kg K/ha + 15 kg Zn/ha, whereas treatment 50 kg K/ha + 10 kg Zn/ha was found to be statistically at par with treatment 50 kg K/ha + 15 kg Zn/ha. The plant height of mustard was influenced by the application of both potassium and zinc. Potassium and zinc concentrations were shown to boost plant height. Among potassium levels, application of 50 kg K/ha was recorded to significantly higher plant height. The increased plant height was attributed to the proper establishment of the crop as it gives strength to the plant tissues besides the activation of numerous enzymes in the plant system. The same outcomes were also reported by Farhad et al. [7]. An increase in plant height due to appropriate zinc availability may be attributed to the extensive root system, which promotes cell division and hence boosts plant development by stimulating plant growth hormones like IAA. The same outcomes were also reported by [8].

### 3.1.2 Dry matter accumulation

Three plants were uprooted from destructive sampling zone from each plot at 20, 40, 60, 80, 100 DAS and at harvest. The roots were removed, thereafter the samples were air dried and then kept in oven for 72 hours at $70^0$ C and their dry weight was determined by electronic balance (Model No. CB-50), and the average dry weight (g/plant) was calculated.

Here, the highest plant dry weight at harvest (35.25 g) was recorded with treatment 50 kg K/ha + 15 kg Zn/ha. However, treatment 50 kg K/ha + 5 kg Zn/ha and 50 kg K/ha + 10 kg Zn/ha were found to be statistically at par with 50 kg K/ha + 15 kg Zn/ha. Significantly higher dry matter production was recorded with the application of 50 kg K/ha. This was due to the favourable effect of higher dry matter distribution in leaf and siliqua. Application of potassium recorded higher LAI at all growth stages. It is because of the role of potassium in the translocation of photosynthates from source to sink. Similar results were reported by Singh et al. [9] in mustard. The amount of dry matter produced by plants was highly associated with their leaf area and leaf area index. The supplementation of zinc increased dry matter production. The addition of zinc to the mustard crop led to more leaves, thus more photosynthetic area was available for the light interception, which resulted in dry matter accumulation Similar outcomes were also reported by Kumar (2006).

**Table 1. Effect of Potassium and Zinc on growth parameters of mustard var. at harvest**

| Treatments | Plant height (cm) | Dry matter accumulation (g/plant) |
|---|---|---|
| K 30 kg/ha + Zn 5 kg/ha | 164.74 | 32.00 |
| K 30 kg/ha + Zn 10 kg/ha | 171.07 | 32.32 |
| K 30 kg/ha + Zn 15 kg/ha | 175.77 | 32.71 |
| K 40 kg /ha + Zn 5 kg/ha | 170.29 | 33.25 |
| K 40 kg/ha + Zn 10 kg/ha | 181.33 | 33.75 |
| K 40 kg/ha + Zn 15 kg/ha | 184.43 | 34.13 |
| K 50 kg/ha + Zn 5 kg/ha | 188.01 | 34.29 |
| K 50 kg/ha + Zn 10 kg/ha | 190.13 | 34.80 |
| K 50 kg/ha + Zn 15 kg/ha | 193.45 | 35.25 |
| Control (RDF) | 162.89 | 31.87 |
| SEm (±) | 1.33 | 0.33 |
| CD (P 0.05) | 3.94 | 0.97 |

**Table 2. Effect of Potassium and Zinc on yield and qualities that attribute yield of mustard var**

| Treatments | No. of siliqua/plant | No. of seeds/siliqua | Seed Yield (Kg/ha) | Stover Yield (Kg/ha) |
|---|---|---|---|---|
| K 30 kg/ha + Zn 5 kg/ha | 274.27 | 14.30 | 2175 | 5653 |
| K 30 kg/ha + Zn 10 kg/ha | 277.53 | 14.43 | 2226 | 5622 |
| K 30 kg/ha + Zn 15 kg/ha | 279.27 | 14.67 | 2268 | 5701 |
| K 40 kg /ha + Zn 5 kg/ha | 283.47 | 15.33 | 2335 | 5765 |
| K 40 kg/ha + Zn 10 kg/ha | 287.47 | 15.67 | 2387 | 5710 |
| K 40 kg/ha + Zn 15 kg/ha | 290.93 | 16.33 | 2466 | 5816 |
| K 50 kg/ha + Zn 5 kg/ha | 291.60 | 16.73 | 2523 | 5845 |
| K 50 kg/ha + Zn 10 kg/ha | 297.20 | 17.00 | 2611 | 6001 |
| K 50 kg/ha + Zn 15 kg/ha | 302.20 | 17.60 | 2685 | 6143 |
| Control (RDF) | 266.53 | 13.87 | 2081 | 5591 |
| SEm (±) | 2.63 | 0.40 | 26.73 | 75.62 |
| CD (P 0.05) | 7.82 | 1.20 | 79.41 | 224.67 |

## 3.2 Yield and Yield Attributes

### 3.2.1 Number of siliqua/plant

The siliqua present on five randomly selected plants were separated and counted, average value was reported a number of siliqua per plant.

Here, a significant effect was observed by the statistical analysis of the number of siliqua per plant. Treatment 50 kg K/ha + 15 kg Zn/ha resulted in a significantly higher number of siliqua/plant (302.20). However, 50 kg K/ha + 10 kg Zn/ha was found to be statistically on par with 50 kg K/ha + 15 kg Zn/ha. The number of siliqua/plants has increased due to higher doses of potassium and zinc. Potassium is reported to enhance the absorption of native as well as added major nutrients and thereby improves the number of siliqua/plant. In addition potassium application may be attributed to its role in various enzymatic reactions, growth processes, hormone production and protein synthesis and also translocation of photosynthates to reproductive parts there by leading to higher siliqua per plant. Similar findings were also reported by Bhati et al. [10]. This might be due to optimum availability of Zn which might have resulted in balanced nutrition. Similar findings were also reported by Kaur et al. [11].

### 3.2.2 Number of seeds/siliqua

Twenty selected siliqua taken from respective plant were threshed, seeds were counted and average number of seed was reported as number of seeds per siliqua.

Here, the statistical examination of the number of seeds/siliqua revealed a substantial influence. Treatment 50 kg K/ha + 15 kg Zn/ha recorded a significant and highest number of seeds/siliqua (17.60). However, 50 kg K/ha + 5 kg Zn/ha and 50 kg K/ha + 10 kg Zn/ha recorded statistical parity with 50 kg K/ha + 15 kg Zn/ha. The number of seeds/siliqua has increased due to higher doses of potassium and zinc. Potassium is reported to improves the absorption of native as well as added major nutrients. Additionally, potassium's use may be explained by its function in a number of enzymatic activities, growth processes, hormone production, protein synthesis, and the transfer of photosynthates to reproductive parts, which increases the number of seeds produced per siliqua. Similar findings were reported by Bhati et al. [10]. This might be due to optimum availability of Zn which might have resulted in balanced nutrition. The same results were also reported by Kaur et al. [11].

#### 3.2.3 Seed yield

Grains from harvest area (1 $m^2$) were dried in sun, cleaned and the filled grains were weighed separately from each plot for calculating the grain yield in kilogram/hectare.

Here, Seed yield was significantly influenced by different potassic, zinc, nitrogen, and phosphorus combinations. The seed yield showed an increasing trend with the application of potassium and zinc in mustard. It rose from 2081 kg/ha under control to 2685 kg/ha with the application of 50 kg K/ha + 15 kg Zn/ha. The significant and highest seed yield (2685 kg/ha) was observed under 50 kg K/ha + 15 kg Zn/ha. However, 50 kg K/ha + 10 kg Zn/ha was found to be statistically on par with 50 kg K/ha + 15 kg Zn/ha. The application of different levels of potassium influenced the seed yield. Due to improved vegetative development, as seen by increased dry matter production, the higher seed yield was linked to higher potassium dosages. The same results were also reported by Yadav et al. [12], Abha et al. [13] and Singh et al. [9]. The increase in seed yield of mustard under higher zinc supply might be ascribed mainly due to the combined effect of the higher number of siliqua/plant and number of seeds/siliqua, which was the result of better translocation of photosynthesis from source to sink. The same results were also reported by Chandra and Khandelwal [14] and Meena et al. [15].

#### 3.2.4 Stover yield

Stover from harvest area (1 $m^2$) was dried in sun, bundled, tagged and weighed separately from each plot for calculating the Stover yield in kilogram/hectare.

Here, Application of potassium and zinc had an impact on the mustard's ability to produce more stover yield, it varied from 5591 kg/ha under control to 6143 kg/ha with the application of 50 kg K/ha + 15 kg Zn/ha. The highest stover yield (6143 kg/ha) was recorded with 50 kg K/ha + 15 kg Zn/ha, however, 50 kg K/ha + 10 kg Zn/ha was found to be statistically on par with 50 kg K/ha + 15 kg Zn/ha. The application different levels of potassium influenced the seed and stover yield. Due to increase in vegetative development, as shown by increased dry matter production, the higher stover yield was linked to higher potassium dosages. Similar results were also reported by Yadav et al. [12], Abha et al. [13] and Singh et al. [9]. The increase in stover yield of mustard under higher zinc supply might be ascribed mainly due to the combined effect of the higher number of siliqua/plant and number of seeds/siliqua, which was the result of better translocation of photosynthesis from source to sink. The same results were also reported by Chandra and Khandelwal [14] and Meena et al. [15,16].

## 4. CONCLUSION

Based on the above results, it is concluded that applying potassium (50 kg/ha) and zinc (15 kg/ha) increases the growth parameters and yield characteristics of mustard. Further tests might be necessary to corroborate the findings as they are based on only one season.


## ACKNOWLEDGEMENTS

I express my gratitude to my advisor Dr. RAJESH SINGH for constant support, guidance and for his valuable suggestions for improving the quality of this research. I am indebted to Ph.D Scholar. AKANSHYA PRADHAN mam, who has been a constant source of inspiration and I am thankful to all the faculty members of Department of Agronomy, SHUATS, Prayagraj, Uttar Pradesh (U.P), India for providing necessary facilities and support. My words always fell short to thank my Parents, PADMA V & SATYANARAYANA K, for their constant encouragement & emotional support to complete my research, without them my research work would not be possible.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.


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*The peer review history for this paper can be accessed here:*
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