Original Research Article

Studies on the Growth andYield of Mustard (*Brassica juncea* L.)var.as influenced by Potassium and Zinc

ABSTRACT

A field experiment was conducted during *the Rabi season* of 2022, at a crop research farm, Department of Agronomy at Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj in North Eastern plains of Eastern Uttar Pradesh ~~with the objective~~ to study the effect of potassium and zinc on growth and yield of Mustard (*Brassica juncea*L.)Var. under Randomized block design comprising ~~of~~ 10 treatments of which treatments (T_1-T_9) withdifferentcombinations of nitrogenand phosphorus along withpotassium and zinc which are replicated thrice.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 ~~in~~ organic carbon (0.48 %), available N (225 kg/ha), available P (13.60 kg/ha) and available K (215.4 kg/ha).The experimental results revealed that 25 kg N/ha+ 50 kg P/ha recorded Maximum plant height (193.45 cm),Highest plant dry weight (35.25 gm),number of siliqua/plant (302.20), number of seeds/siliqua (17.60), Seed yield (2685kg/ha), Stover yield (6143 kg/ha).

Keywords-Mustard,Potassium, Zinc,Growth, Yield

Comment [Ma1]: It would be beneficial to include a clear statement of the research objectives in the abstract.

Comment [Ma2]: The abstract does not explicitly mention the study's conclusion or its implications. It would be valuable to include a brief statement summarizing the main findings and their significance in the context of mustard cultivation.

INTRODUCTION

India is an important rapeseed-mustard growing country in the world, occupying the largest area and ~~has~~ havingthe second position in production after China. The name mustard is derived from the Latin word 'mustum', which means old wine mixed with crushed seed. In India, rape seed mustard is cultivated ~~in~~ on 5.74 million hectares in a wide range of agro-ecological conditions with the production of 6.79 million tonnes of rapeseed mustard has a productivity of 1,186 kg/ha (**Anon., 2017)**. In the recent past, the area under brown mustard is increased at the cost of other *Brassicas* due to its higher productivity and tolerance to biotic and abiotic stresses.

Mustard oil is used primarily for cooking and is valued for vegetables, fodder, condiments, and medicinal purposes. Mustard is nutritionally very rich and its oil content varies from 37 – 49 percent. Indian mustard oil being a rich source of ~~the~~ unsaturated fatty acids is primarily used for human consumption as desirable edible oil. The oil obtained from rapeseed-mustard is rich in unsaturated and low in 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 pickles, and curries. Oil in mustard seed was extracted by the soxhlet method. Grain and straw K contents were estimated by flame photometry following nitric and perchloric acid digestion of the samples **(Jackson, 1973)**.

Potassium is one of the major nutrients in the soil, amongst the mineral cations required by the plant. The earth's crust contains 2.4% potassium. It is largely present in complex silicate components; some potassium is associated with organic matter and clay fraction of soil. The potassium content in the soil varies from 0.1% to 3.0 % or even more. Potash is also essential for absorbing water through the root system in conditions of soil moisture deficiency **(Umar, 2006)**.

Micronutrients are as important to plant nutrition as primary and secondary nutrients, though plants don't require as much of them. Lack of any one of the micronutrients in the soil can limit growth, even when all other nutrients are present in adequate amounts. ~~High~~ High-yielding mustard crop removes more micronutrients from the soil which cannot be replenished from the use of ~~high~~ high-analysis NPK fertilizers containing lower quantities of micronutrient contaminants. So, there is a need for micronutrient~~s~~ application ~~in order~~ to achieve balanced nutrition. Thus, there is an urgent need for stepping up the use of micronutrients 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 **(Kumar et al. 2012).**

Hence, nutrient management plays an important role in enhancing the production of mustard. Zinc is one of the essential micronutrient elements required by plants. Zinc has a pivotal role in auxin and protein synthesis, seed production, rate of maturity, and membrane integrity. It promotes RNA synthesis in the 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).**

Comment [Ma3]: The introduction mentions a few references (Anon., 2017; Jackson, 1973; Umar, 2006; Kumar et al., 2012; Bartaria et al., 2002), but it would be helpful to provide in-text citations within the text, where appropriate, to support the information presented.

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, Prayagrajwhich is located at 25°24' 42" N latitude, 81°50' 56" E longitude and 98 m altitude above the mean sea level (MSL). To assess the effect of potassium and zinc on the growth and yield of Mustard (*Brassica juncea*L.). The experiment was laid out in Randomized Block Design comprising ~~of~~ 10 treatments which are replicated thrice. Each treatment net plot size is 3m × 3m. The treatment ~~are~~iscategorized aswith recommended dose of nitrogen through urea andphosphorus through DAP, in addition ~~with~~ toPotassium and zincwhen applied in combinations 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. The mustard crop washarvested ~~treatment~~ treatment-wise at the harvesting maturity stage.Growth parameters viz. plant height (cm),and dry matter accumulation g/plantwere recorded manually on five randomly selected representative plants from each plot of each replication separately andafter harvesting, seeds were separated from each netplot and were dried under the sun for three days. Laterwinnowed, cleaned and seed yield per ha was computed and expressedin tonnes per hectare. After complete drying under the sun for 10 days stover yield from each net plot was recorded and expressed in tonnes per hectare. Thedata was computed and ~~analysed~~ analyzedby following the statisticalmethod of Gomez and Gomez (1984). The benefit: costratio was worked out after the price value of seed with strawand the total cost included in crop cultivation.

RESULTS AND ~~DISSCUSIONS~~DISCUSSIONS

Effect on growth parameters:

Comment [Ma4]: To enhance the clarity of the discussion, it would be beneficial to provide a concise summary of the key findings before delving into specific details.

Plant height

It is evident from Table1.that plant height measured increased with the advancement in crop growth. 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 + 5 kg Zn/ha, 50 kg K/ha + 10 kg Zn/ha were found to be statistically at par with treatment 50 kg K/ha + 15 kg Zn/ha. ~~Plant~~ The plant height of mustard was influenced by the application of both potassium and zinc. Plant height was found to be increased with increased levels of Potassium and Zinc. 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 ~~the~~ strength to the plant tissues besides the activation of numerous enzymes in the plant system. Similar results were also reported by Farhad *et al.* (2010). ~~Increase~~ An increase in plant height due to adequate availability of zinc might be attributed to the profuse root system which increases the plant growth by the enhancement in cell division because it influenced the formation of several growth hormones like IAA in plants. Similar results were also reported by **(Husain and Kumar 2006).**

Dry matter accumulation

At Harvest highest plant dry weight (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 favorable 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.* (2013)** in mustard. Dry matter production was significantly correlated to the leaf area and leaf area index of plants. The supplementation of zinc ~~resulted in increase in~~increased dry matter production. The addition of zinc to the mustard crop led to more ~~leaf~~leaves, thus more photosynthetic area was available for the light interception, ~~this~~ whichresulted in dry matter accumulation Similar results were also reported by **Kumar (2006).**

Yield and Yield Attributes:

Number of siliqua/plant

~~Significant~~ 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~~were~~ wasfound to be statistically on par with 50 kg K/ha + 15 kg Zn/ha. ~~Number~~ The number of siliqua/plants~~have~~ hasincreased 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 thereby leading to higher siliqua per plant.Similar findings were also reported by **Bhati *et al.*, (2014).** 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.*, (2017).**

Number ofseeds/siliqua

~~Significant~~ A significant effect was observed by the statistical analysis of the number of seeds/siliqua. 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. ~~Number~~ The number of seeds/siliqua~~have~~

hasincreased due to higher doses of potassium and zinc. Potassium is reported to enhance the absorption of native as well as added major nutrients. 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 thereby leading higher seeds per siliqua.Similar findings were also reported by **Bhati *et al.*, (2014).** 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.*, (2017).**

Seed yield

Seed yield was significantly influenced ~~with~~ bydifferent combinations of Potassium and Zinc with Nitrogen andPhosphorus.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. ~~Significant~~ 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. ~~Application~~ The application of different levels of potassium influenced the seed yield. The higher seed yield was associated with higher doses of potassium due to better vegetative growth as indicated by more dry matter production. Similar results were also reported by **Yadav *et al.*, (2013), Abha *et al.*, (2015), and Singh *et al.*, (2013).** 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. Similar results were also reported **by Chandra and Khandelwal (2009)** and **Meena *et al.* (2006).**

Stover yield

The stover yield of mustard was also influenced by the application of potassium and zinc, it varied from 5591 kg/ha under control to 6143 kg/ha with the application of 50 kg K/ha + 15 kg Zn/ha. ~~Highest~~ 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. ~~Application~~ The application different levels of potassium influenced the seed and stover yield. The higher stover yield was associated with higher doses of potassium due to better vegetative growth as indicated by more dry matter production. Similar results were also reported **by Yadav *et al.*, (2013), Abha *et al.*, (2015) and Singh *et al.*, (2013)**. 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. Similar results were also **reported by Chandra and Khandelwal (2009) and Meena *et al.* (2006).**

CONCLUSION

Based on the above findings it is concluded that with the application of Potassium (50 kg/ha) along with Zinc (15 kg/ha) performs positively and improves the growth parameters, and yield attributes of Mustard. Since the findings are based on one season, further ~~trails~~ trials may be required for further confirmation.

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

T.No.	Treatments	Plant height (cm)	Dry matter accumulation (g/plant)
T_1	30 kg K/ha + 5 kg Zn/ha	164.74	32.00
T_2	30 kg K/ha + 10 kg Zn/ha	171.07	32.32
T_3	30 kg K/ha + 15 kg Zn/ha	175.77	32.71
T_4	40 kg K/ha + 5 kg Zn/ha	170.29	33.25
T_5	40 kg K/ha + 10 kg Zn/ha	181.33	33.75
T_6	40 kg K/ha + 15 kg Zn/ha	184.43	34.13
T_7	50 kg K/ha + 5 kg Zn/ha	188.01	34.29
T_8	50 kg K/ha + 10 kg Zn/ha	190.13	34.80
T_9	50 kg K/ha + 15 kg Zn/ha	193.45	35.25
T_{10}	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 Zincon yield and yield attributing characters of mustard var. ‘’

T. No	Treatments	No. of siliqua/plant	No. of seeds/siliqua	Seed Yield (Kg/ha)	Stover Yield (Kg/ha)
T_1	30 kg K/ha + 5 kg Zn/ha	274.27	14.30	2175	5653
T_2	30 kg K/ha + 10 kg Zn/ha	277.53	14.43	2226	5622
T_3	30 kg K/ha + 15 kg Zn/ha	279.27	14.67	2268	5701
T_4	40 kg K/ha + 5 kg Zn/ha	283.47	15.33	2335	5765
T_5	40 kg K/ha + 10 kg Zn/ha	287.47	15.67	2387	5710
T_6	40 kg K/ha + 15 kg Zn/ha	290.93	16.33	2466	5816
T_7	50 kg K/ha + 5 kg Zn/ha	291.60	16.73	2523	5845
T_8	50 kg K/ha + 10 kg Zn/ha	297.20	17.00	2611	6001
T_9	50 kg K/ha + 15 kg Zn/ha	302.20	17.60	2685	6143
T_{10}	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