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Effect of nitrogen and zinc on the growth and yield of mustard (*Brassica juncea* L.)

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Abstract
A field experiment was conducted in the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University Agriculture, Technology and Sciences, Prayagraj, a field experiment was carried out during the *Rabi* season of 2024. to ascertain "The Impact of Zinc and Nitrogen on Mustard (*Brassica juncea* L.) Growth and Yield." Sandy loam in texture, the experimental field soil had a moderately basic reaction (p H 7.2), a medium organic carbon (0.49%) medium in available nitrogen (225.5 kg/ha), and very high levels of available potassium (233.4 kg/ha) and accessible phosphorus (18.6 kg/ha). Three levels of Zinc (4, 6 and 8 kg/ha) and Nitrogen (70, 80 and 90 kg/ha) along with recommended dose of fertilizers ((80:40:40 kg NPK/ha). Three replications and a two-factor Randomized Block Design (RBD) were used to set up the experiment. The outcome demonstrated that treatment 9 had noticeably greater growth characteristics, including plant height (144.93 cm), dry weight (28.93 g/plant), and number of branches/plant (19.01). In contrast, the treatment's test weight (5.78), number of siliqua/plant (209), number of seeds/p siliqua (19), yield qualities, and grain yield (3.5 t/ha) and stover yield (6.05 t/ha) were noted. These findings imply that the growth and yield of mustard were enhanced by the combination of 90 kg N/ha and 8 kg Zn/ha.

Keywords: Nitrogen, zinc, mustard, growth, yield

Introduction

Mustard (*Brassica juncea* L.) is important oilseed crop of family *Cruciferae*. It holds a significant position among oilseed crops, ranking second only to groundnuts. The current area, yield, and production of nine oilseeds in India are around 26.48 mha, 30.94 mt, and 1168 kg/ha, respectively. The area planted to rapeseed mustard in India is 6.36 mha, with an output of 8.03 mt. To ensure edible oil self-reliance, India's rapeseed-mustard production, which is currently just 1145 kg/ha on average, must be increased to 2562 kg/ha by 2030. After groundnuts and soybeans, mustard is one of the most significant oil seed crops in the world (FAO, 2004) [8]. The nation contributes roughly 23% of the global production of mustard and rapeseed. These crops are especially important in Rajasthan and Uttar Pradesh, which account for almost 80% of the nation's total land and production. In terms of both output and acreage, it is the most important oilseed crop cultivated in this nation (BBS, 2015).

Among the various oilseed crops grown in India, mustard seeds have an oil content of 35-48% and a protein content of 37-42% in cakes. The rapeseed-mustard group of crops is grown in 28 states across the country under a variety of agro-ecological conditions on an area of 6.51 million hectares, producing 8.18 million tons, indicating its significance in the nation's vegetable oil scenario. Haryana alone accounted for 10.2% of the nation's total rapeseed-mustard production, while the crop accounted for 20-22% of all oilseed production. It is grown on 6.70 million hectares in India, where in 2013-14 it produced 7.96 mt and had a productivity of 1188 kg/ha. Haryana is one of the major rapeseed and mustard growing state and crop occupied 5.4 lakh ha of area producing 8.8 lakh tonnes giving an average yield of 1639 kg/ha during 2017- 18.

A major nutrient that gives crops their lush green color (due to an increase in chlorophyll) is nitrogen. In arid and semi-arid regions, there is a significant lack of organic matter, which serves as the primary nitrogen reserve, and even if it were found, it would decompose quickly (Bani-saeedi, 2001) [20]. According to Siadat *et al*. (2010) [21], nearly all studies demonstrated that nitrogen fertilizers significantly increased seed production even under a variety of contradictory circumstances. However, depending on the soil type, climate, management techniques, timing of nitrogen treatment, cultivars, etc., the requirements for nitrogen fertilizer might vary significantly (Holmes and Ainsley, 1977) [22]. According to Bani-saeedi (2001) [20], nitrogen increased the number of siliquae per unit area, decreased the number of seeds per siliqua, and decreased flower abscission, which in turn affected thousand seed weight (TSW), resulting in a higher seed production per hectare. A considerable increase in crop yield was reported by Singh and Rathi (1985) [23]; they found that the highest yield was achieved with 160 kg of nitrogen per hectare.

Micronutrients have a key role in crop productivity and soil health maintenance. These are essentially unnecessary. In particular, plants require zinc for regular, healthy growth and reproduction. Zinc is vital to plants as a structural element or regulatory co-factor of several enzymes in many important metabolic pathways. Zinc is the main nutrient that links certain enzymes, including superoxide dismutase, alcohol dehydrogenase, and carbonic anhydrase (Ranjan *et al*., 2024) [24]. Zinc (Zn) is a micronutrient that is essential to several metabolic processes in plants' growth and development. It plays a role in hormone control, protein synthesis, and enzyme activity. It is particularly important for the generation of pollen, photosynthesis, and overall plant health. Zinc deficiency can cause stunted growth, reduced leaves, and poor reproductive development. Singh and associates (2016) [25].

Material and Methods

The field experiment was conducted on Cowpea during Kharif season of 2024 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj (U.P.). To study the Effect of Organic nutrition on growth and yield of Cowpea (Vigna unguiculata L.). The experimental field soil was sandy loam in texture, moderately basic in reaction (p H 7.2), available medium organic Carbon (0.49%) medium in available nitrogen (225.5 kg/ha), and very high accessible phosphorus (18.6 kg/ha) and available potassium (233.4 kg/ha). The treatments of the experiment was consisted of three levels of Nitrogen i.e., 70 kg N/ha, 80 kg N/ha, and 90 kg N/ha, three levels of Zinc i.e., 4 kg Zn/ha, 6 kg Zn/ha, 8 kg Zn/ha.Using a hand hoe, furrows 4-5 cm deep were fertilizers along the seed rows in order to apply as a spreading method. Once germination occurred, the gaps were closed by transplanting ten days following sowing. Seedlings were removed where needed to keep the space between plants at 30 cm by 10 cm. Ten days after sowing, the gaps were filled by transplanting after germination. In order to maintain a 30 cm by 10 cm gap between plants, seedlings were removed when necessary. To reduce crop density and weed competition, intercultural activities were carried out every 25 to 45 days. Crop growth rate (g/m2/day), relative growth rate (g/g/day), plant height (cm), number of branches/plant, plant dry weight (g), yield parameters, and yield Harvest index (%), test weight (g), seed yield (t/ha), soil yield (t/ha), and number of siliqua/plant and seeds/siliqua were statistically examined using Gomez and Gomez's (1976) [9] analysis of variance approach. Additionally, economics were computed. Benefit-cost ratio, net returns (INR/ha), gross returns (INR/ha), and cultivation cost (INR/ha). Prayagraj experiences both winter and Kharif temperatures, resulting in a semiarid and subtropical climate. It will be scorching, starting in February, and will cool off by the end of October. The Agro-meteorological Observatory of the Naini Agricultural Institute, SHUATS, records meteorological data, such as the weekly average of the highest and lowest temperatures, relative humidity, and rainfall.

Growth Parameters

Plant height (cm)

According to plant height statistics, plant height increased more quickly up to 60 DAS before slowing down at 80 DAS. At every stage of growth that was observed, the plant height data was determined to be significant. When 90 kg N/ha and 8 kg Zn/ha/ha are inoculated at 80 DAS, the plant height (146.93 cm) is significantly higher than the control (80:40:40 kg NPK/ha). The plant's increased height was caused by higher amounts of zinc and nitrogen, which aided in the creation of new cells and roots and made all the nutrients and water from the deeper soil layers available for increased photosynthetic activity. increasing the height of the plant by encouraging vegetative growth. Similar findings were also reported by Roy and Rahaman (1992) [26], Haque and Khan (2012) [27], Rasool and Singh (2016) [25].

Number of branches per plant

The number of branches per plant expanded quickly at 80 DAS, according to the data analysis. Co-inoculation with 90 kg of nitrogen per hectare and 8 kg of Zinc per hectare greatly boosted the number of branches per plant (19.1) compared to the control (80:40:40 kg NPK/ha). Nitrogen 90 kg/ha + Zinc 8 kg/ha seed inoculation resulted in more branches per plant than control. This outcome may be the consequence of zinc and nitrogen working together to improve nutrient availability during the crop growth phase. Rasool and Singh (2016) [25] and Haque and Khan (2012) [27] have reported similar results.

Plant Dry Weight (g/plant)

According to a critical analysis of the data, the inoculation of nitrogen 80 kg/ha + zinc 6 kg/ha resulted in a considerably higher dry weight per plant (29.60 g plant) than the control (80:40:40 kg NPK/ha) at harvest at 80 DAS. Significant zinc promotes plant vigor, accelerates leaf development, and stimulates the production of new cells, all of which aid in better nitrogen utilization and increased solar energy harvesting. As a result, growth characteristics rose as nitrogen dosages increased. Increased plant height and branch count may have contributed to the higher dry weight by increasing the amount of dry matter the plant produced. These results were deemed pertinent to Venkatarao *et al*. (2017) [28] and Mashi *et al*. (2020) [29].

Post-harvest observations

Number of siliquae per plant

The interaction between zinc and nitrogen significantly impacted the number of siliquae per plant, increasing the number of siliquae per plant (Table 2). Nitrogen 90 kg/ha + Zinc 8 kg/ha produced the largest number of siliquae per plant (209), while the lowest number of siliquae per plant (176) was shown to be statistically equivalent to the highest and lowest treatment.

Number of seeds per Siliquae

There was a notable difference in the number of seeds per siliquae between the N and Zn treatment combinations (Table 2). Nitrogen 90 kg/ha + Zinc 8 kg/ha produced the most siliquae per plant (19), while the control plots, which were shown to be statistically equivalent to the highest and lowest treatments, produced the seeds per siliquae (13) was reorded.

Test weight (g)

The thousand seed weight of mustard was significantly impacted by the administration of both zinc and nitrogen (Table 2). The nitrogen 90 kg/ha + zinc 8 kg/ha treatment combination, Control (RDF) 80:40:40 N:P:K kg/ha, had the highest thousand seed weight (5.78 g), while the control plots had the lowest (5.26 g), which was statistically comparable to the highest and lowest treatments**.**

Seed yield (t/ha)

There was a notable difference in seed yield across the N and Zn treatment combinations (Table 2). Nitrogen 90 kg/ha + Zinc 8 kg/ha produced the highest seed production (3.05 t/ha), while the control plots (RDF) 80:40:40 N:P:K kg/ha treatment combination produced the lowest seed yield (1.75 t/ha). By creating more vigorous growth and development through increased plant height, leaf area index, total plant weight, and seeds per plant, nitrogen influences growth parameters and boosts crop output (Allen and Morgan, 2009) [2].

Stover yield (t/ha)

Non-significant interaction effect was also obtained between nitrogen and zinc in consideration of stover yield under the present experiment. The maximum stover yield (6.05 t/ha) was obtained from the treatment combination Nitrogen 90 kg/ha + Zinc 8 kg/ha, while the minimum stover yield (3.39 t/ha) was obtained from Control (RDF) 80:40:40 N:P:K kg/ha found to be statistically on par with highest and lowest treatment in table. 2

Harvest index (%)

In the current experiment, a non-significant interaction effect between zinc and nitrogen was also seen when taking the harvest index into account. Nitrogen 90 kg/ha + Zinc 8 kg/ha produced the highest harvest index (39.03), whereas Control (RDF) 80:40:40 N:P:K kg/ha produced the lowest stover yield (28.12), which was statistically comparable to the highest and lowest treatments.

Conclusions

It has been determined that growing mustard with 90 kg of nitrogen per hectare and 8 kg of zinc per hectare produced higher seed yields, gross returns, net returns, and benefit-to-cost ratios. The findings from a single season of testing served as the basis for the conclusion. However, before giving a definitive suggestion to the farmers, more experimentation is needed for confirmation.

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Table 1: Effect of *Nitrogen and Zinc on* Growth Attributes *of Mustard.*

		Growth Attributes		
S. No	**Treatment Combination**	**Plant height (Cm) 80 DAS**	**Dry Weight(g) 80 DAS**	**No. of Branches/plant 60 DAS**
1.	Nitrogen 70 kg ha^{-1} + Zinc 4 kg ha^{-1}	136.86	27.74	17.4
2.	Nitrogen 70 kg ha^{-1} + Zinc 6 kg ha^{-1}	137.93	28.96	17.5
3.	Nitrogen 70 kg ha^{-1} + Zinc 8 kg ha^{-1}	137.73	27.47	18.6
4.	Nitrogen 80 kg ha^{-1} + Zinc 4 kg ha^{-1}	142.13	27.44	17.8
5.	Nitrogen 80 kg ha^{-1} + Zinc 6 kg ha^{-1}	141.26	29.60	18.8
6.	Nitrogen 80 kg ha^{-1} + Zinc 8 kg ha^{-1}	139.73	28.31	18.7
7.	Nitrogen 90 kg ha^{-1} + Zinc 4 kg ha^{-1}	143.13	29.48	17.8
8.	Nitrogen 90 kg ha^{-1} + Zinc 6 kg ha^{-1}	146.93	27.84	18.2
9.	Nitrogen 90 kg ha^{-1} + Zinc 8 kg ha^{-1}	144.93	28.93	19.1
10.	Control (RDF) 80:40:40 N:P:K kg ha^{-1}	133.33	27.55	16.6
F - test		S	S	S
S. Em (±)		2.59	0.54	0.43
CD (p = 0.05)		7.71	1.57	1.25

Table 2: Effect of Nitrogen and Zinc on yield and yield attributes of Mustard.

S. No	Treatments	Siliquae/Plant	Seeds/Siliquae	Test Weight (g)	Seed Yield (t/ha)	Stover Yield (t/ha)	Harvest Index (%)
	Nitrogen 70 kg ha^{-1} + Zinc 4 kg ha^{-1}	188	15	5.31	2.13	4.99	31.35
2	Nitrogen 70 kg ha^{-1} + Zinc 6 kg ha^{-1}	205	15	5.34	2.20	5.89	32.45
3	Nitrogen 70 kg ha^{-1} + Zinc 8 kg ha^{-1}	206	16	5.55	2.13	5.97	34.57
4	Nitrogen 80 kg ha^{-1} + Zinc 4 kg ha^{-1}	207	16	5.53	2.10	5.16	34.08
5	Nitrogen 80 kg ha^{-1} + Zinc 6 kg ha^{-1}	195	16	5.58	2.05	5.38	33.82
6	Nitrogen 80 kg ha^{-1} + Zinc 8 kg ha^{-1}	203	16	5.64	2.40	5.92	35.81
7	Nitrogen 90 kg ha^{-1} + Zinc 4 kg ha^{-1}	205	17	5.69	2.39	5.50	32.39
8	Nitrogen 90 kg ha^{-1} + Zinc 6 kg ha^{-1}	203	17	5.72	2.68	5.28	35.45
9	Nitrogen 90 kg ha^{-1} + Zinc 8 kg ha^{-1}	209	19	5.78	3.05	6.05	39.03
10	Control (RDF) 80:40:40 N:P:K kg ha^{-1}	176	13	5.26	1.75	3.39	28.12
F-Test		NS	NS	S	S	NS	NS
SE (m) ±		7.06	0.10	0.05	0.22	0.72	2.35
CD at 5%		-	-	0.14	0.67	-	-

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