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Influence of different nutrient combinations of N, P, K, sulphur and zinc on growth and yield attributes of Indian mustard (*Brassica juncea* L.)

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Abstract
A field experiment was conducted at the Crop Research Farm, Centre of Agricultural Education, Faculty of Agricultural Sciences, Aligarh Muslim University, Aligarh, Uttar Pradesh during *rabi* season of 2024-25 to study the effect of different levels of nitrogen, phosphorus, potassium, sulphur and zinc on growth, yield and economics of mustard (*Brassica juncea* L.). The soil of the experimental site was silty clay loam, moderately alkaline in reaction (pH 7.8), with 0.36 dS/m EC, 0.39% organic carbon, and medium in available N (178 kg/ha), low in P (15 kg/ha), high in K (290 kg/ha), deficient in sulphur (7.38 mg/kg) and zinc (0.70 mg/kg). The experiment was laid out in a randomized block design with nine treatments (T_1-T_9) consisting of varying combinations of N, P, K, S and Zn. Growth attributes such as plant height, dry matter accumulation, and branching were significantly influenced by nutrient management. The treatment T_7 (120:60:40:30:9 kg N:P:K:S:Zn ha^{-1}) recorded the tallest plants (195.19 cm) and the highest dry matter accumulation (34.87 g $plant^{-1}$), closely followed by T_6 and T_3. Yield attributes *viz*., siliquae $plant^{-1}$, seeds $siliqua^{-1}$, siliqua length, and test weight also showed marked improvement under higher levels of S and Zn. Among treatments, T_6 (120:60:40:30:7 kg N:P:K:S:Zn ha^{-1}) produced the maximum seed yield (2174.07 kg ha^{-1}) and oil yield (927.41 kg ha^{-1}) along with the highest net return (₹93,353.98 ha^{-1}) and B:C ratio (2.84). The control consistently remained inferior across all parameters. The results suggest that the combined application of 120:60:40 kg N:P:K ha^{-1} with 30 kg S and 7 kg Zn ha^{-1} proved most effective in enhancing growth, productivity and profitability of mustard.

Keywords: Mustard, nutrient management, sulphur, zinc, yield attributes, economic

Introduction
Indian mustard (*Brassica juncea* L. Czern. & Coss.), a member of the family Brassicaceae, is one of the most important oilseed crops cultivated during the *rabi* season (2024-2025) in India. It is valued for its high oil content (30-38%) and protein-rich seed meal, which is used as cattle feed, while its leaves are consumed as a leafy vegetable. Mustard oil contains 37-49% oil, comprising erucic acid, oleic acid, and linolenic acid, making it nutritionally and industrially significant (Bhowmik *et al*., 2014) [1].

During 2023-24, in India it was cultivated on an area of about 9.30 million hectares with a production of nearly 11.90 million tonnes, recording an average productivity of 1.28 t ha^{-1}, which remains lower than the world average (USDA-FAS, 2024).

The self-sufficiency in oilseeds achieved during the "Yellow Revolution" of the early 1990s could not be sustained. At present, India ranks among the leading producers of oilseeds globally, yet it remains one of the largest importers of edible oils. The demand for vegetable oils has increased markedly in recent decades, driven by both industrial use and household consumption. The principal oilseeds grown in India are soybean, rapeseed-mustard, groundnut, sunflower, sesame, Niger, castor, safflower and linseed, cultivated predominantly under rainfed conditions on about 26 million hectares. Soybean (34%), groundnut (27%) and rapeseed-mustard (27%) together contribute over 88% of the total oilseed output, with mustard alone accounting for the largest share of vegetable oil production (35%), followed by soybean (23%) and groundnut (25%).

Oilseed production has increased from 27.38 million tonnes in 2014-15 to nearly 40 million tonnes in 2022-23 (Ministry of Agriculture and Farmers' Welfare, 2023). According to the Indian Council of Medical Research (ICMR), the per capita dietary requirement of edible oil is about 19 kg $year^{-1}$; however, the domestic supply falls short of this demand, necessitating large-scale imports. This imbalance underscores the importance of enhancing oilseed productivity and expanding domestic production.

Despite its importance, national productivity remains lower than the global average due to nutrient deficiencies, poor management, and predominance of rainfed cultivation.

Nutrient management plays a critical role in realizing the yield potential of mustard. Nitrogen (N) is the most limiting nutrient in mustard-based systems, contributing directly to vegetative growth, siliqua development, and seed yield. Phosphorus (P) is essential for energy transfer, root proliferation, and flowering, while potassium (K) enhances photosynthesis, water use efficiency, and tolerance to biotic and abiotic stresses (Singh *et al*., 2010) [13].

Among secondary and micronutrients, sulphur (S) and zinc (Zn) are particularly important for mustard. Sulphur is regarded as the "fourth major nutrient" after N, P, and K, being vital for the synthesis of amino acids (methionine, cysteine), proteins, oils, chlorophyll, vitamins, and glucosinolates (Saini *et al*., 2024) [12]. Brassica crops have a relatively high sulphur requirement, and deficiency leads to chlorosis, poor growth, and reduced oil content. Sulphur application in oilseeds has been reported to enhance yield by 12-48% under irrigated and 17-124% under rainfed conditions (Katyal *et al*., 1997) [4].

Zinc is another critical micronutrient required for enzyme activation, hormone regulation, protein synthesis, seed development, and photosynthesis (Nandal and Solanki, 2021) [9]. Its deficiency, common in calcareous and alkaline soils, results in stunted growth, chlorosis, and low seed yield. Application of zinc fertilizers has been reported to increase mustard yield by 11-40% depending on soil and climatic conditions (Mandal *et al*., 2002) [8].

In Uttar Pradesh, widespread deficiencies of S and Zn have been reported due to intensive cropping and limited fertilizer diversification (Verma *et al*., 2023) [15]. Considering the importance of balanced nutrition in mustard, the present investigation was undertaken to study the effect of different levels of NPK, sulphur, and zinc on growth and yield of Indian mustard under the agro-ecological conditions of Aligarh.

Materials and Methods

The field investigation was carried out during the *rabi* season of 2024-25 at the Crop Research Farm, Centre of Agricultural Education, Faculty of Agricultural Sciences, Aligarh Muslim University, Aligarh, Uttar Pradesh. The soil of the experimental site was silty clay loam, moderately alkaline in reaction (pH 7.8), with 0.36 dS/m EC, 0.39% organic carbon, and medium in available N (178 kg/ha), low in P (15 kg/ha), high in K (290 kg/ha), deficient in sulphur (7.38 mg/kg) and zinc (0.70 mg/kg). The experiment was laid out in a Randomized Block Design (RBD) with nine treatments and three replications. Treatments comprised two levels of nitrogen (120 and 90 kg/ha), two levels of sulphur (20 and 30 kg/ha) and two levels of zinc (7 and 9 kg/ha), along with a control. All plots received a uniform basal dose of 60 kg P_2O_5 and 40 kg K_2O/ha. The mustard hybrid 'Shriram 1666' was sown manually on 13 November 2024 using a seed rate of 3.5 kg/ha at a spacing of 45 cm × 20 cm. Each gross plot measured 3.5 × 5.5 m^2, while the net plot size was 3 × 4.5 m^2. Fertilizers were applied as per treatments (T_1: Control, T_2: 120:60:40:20:7 $kgha^{-1}$ of N:P:K:S:Zn, T_3: 120:60:40:20:9 $kgha^{-1}$ of N:P:K:S:Zn, T_4: 90:60:40:20:7 $kgha^{-1}$ of N:P:K:S:Zn, T_5: 90:60:40:20:9 $kgha^{-1}$ of N:P:K:S:Zn, T_6:120:60:40:30:7 $kgha^{-1}$ of N:P:K:S:Zn, T_7: 120:60:40:30:9 $kgha^{-1}$ of N:P:K:S:Zn, T_8: 90:60:40:30:7 $kgha^{-1}$ of N:P:K:S:Zn, T_9: 90:60:40:30:9 $kgha^{-1}$ of N:P:K:S:Zn). Half of the nitrogen and the full dose of P and K were incorporated as basal, whereas sulphur and zinc were applied at 21-27 DAS. The remaining nitrogen was top-dressed in two equal splits at 25-30 DAS and pre-flowering. Crop management practices, including two irrigations (at 30 and 50 DAS), thinning, and intercultural operations, were undertaken following recommended package of practices. To manage pests and diseases, monocrotophos (1 ml/litre) was applied against sawfly (*Athalia lugens)* and aphid (*Lipaphis erysimi)*, while mancozeb (0.2%) was sprayed for disease control. The crop was harvested manually at the maturity dated on 27^{th} march 2024 and seed and stover data were recorded. Observations on growth and yield attributes were recorded from five randomly tagged plants in each plot. Data were statistically analysed using the standard procedure for RBD as suggested by Gomez and Gomez (1984), with treatment means compared at 5% level of significance.

Results and Discussion

Growth Attributes

Data pertaining to plant height and dry matter accumulation of mustard as influenced by different treatments are presented in Table 1. The results clearly indicated that plant height increased with advancement of growth and reached maximum at harvest. Significantly taller plants were observed with 120:60:40:30:9 kg N-P-K-S-Zn ha^{-1} (T_7), (195.19 cm), which was at par with T_6 (193.13 cm) and T_3 (191.58 cm). The minimum plant height (176.70 cm) was recorded under T_1. At 60 DAS, plant height under T_6 and T_7 remained significantly superior, while at 90 DAS, T_7 was at par with T_6 and T_3. The magnitude of increase in plant height due to T_7 was 10.47% at harvest over T_1.

Dry matter accumulation also exhibited a similar trend. The highest dry matter accumulation at harvest was obtained in T_7 (34.87 g $plant^{-1}$), which was statistically at par with T_6 (33.00 g $plant^{-1}$) and T_3 (32.92 g $plant^{-1}$). The lowest value (23.73 g $plant^{-1}$) was observed in T_1. At 90 DAS, T_7 recorded 62.65% higher dry matter over T_1, while the increase at harvest was 46.91% over control. Treatments T_6 and T_3 also showed substantial improvement in dry matter accumulation compared to T_1. The higher accumulation of dry matter with T_7 and T_6 may be attributed to the synergistic role of nitrogen and sulphur in enhancing photosynthetic efficiency and protein synthesis, coupled with the beneficial effect of zinc in promoting auxin metabolism and assimilate translocation. Similar beneficial effects of sulphur and zinc fertilization on dry matter production in mustard have been reported by Jaiswal *et al.* (2025) [3] Adequate supply of sulphur ensures efficient utilization of nitrogen for synthesis of sulphur-containing amino acids, while zinc enhances enzymatic activities and improves chlorophyll stability, resulting in higher biomass production. The relatively lower accumulation in control treatment may be ascribed to sub-optimal nutrient availability restricting photosynthate production and partitioning.

The significant improvement in plant height and dry matter accumulation under higher levels of sulphur and zinc observed in the present study is in close agreement with the findings of Patel *et al*. (2023) [11], who reported that application of 40-60 kg S ha^{-1} along with 2.5-5 kg Zn ha^{-1} and FYM (10 t ha^{-1}) markedly enhanced vegetative growth attributes such as plant height, number of branches, siliquae number, and ultimately yield of mustard over control. The positive response of sulphur may be ascribed to its critical role in the synthesis of amino acids, proteins, and chlorophyll, thereby promoting vigorous vegetative growth and biomass accumulation. Similarly, zinc application contributed to enhanced growth performance by regulating auxin metabolism, improving enzyme activation, and facilitating better utilization of assimilates, which together resulted in improved plant vigour and dry matter production. The synergistic effect of S and Zn thus ensured superior nutrient uptake and physiological efficiency, leading to significant improvement in growth attributes compared to their individual application.

Besides plant height and dry matter accumulation, the number of branches per plant was also significantly influenced by the nutrient management practices. The number of primary branches showed a progressive increase with the advancement of crop growth up to harvest. At 30 DAS, the treatment T_7 recorded the maximum number of primary branches (2.65 plant^{-1}), which was at par with T_6 (2.57 plant^{-1}) and T_3 (2.43 plant^{-1}), whereas the minimum value (1.83 plant^{-1}) was observed under T_1. At 60 DAS, the differences among the treatments were found to be non-significant; however, significant variation was evident at later stages. At 90 DAS and harvest, T_7 maintained its superiority with 5.74 and 6.14 primary branches plant^{-1}, respectively, followed by T_6 (5.30 and 5.87 plant^{-1}) and T_3 (5.25 and 5.79 plant^{-1}), while the lowest values were recorded in T_1 (4.33 and 4.67 plant^{-1}).

The number of secondary branches also increased consistently with the advancement of crop growth. At 60 DAS, the highest number of secondary branches (4.93 plant^{-1}) was obtained with T_7, which was significantly superior to all other treatments except T_6 (4.20 plant^{-1}) and T_3 (4.01 plant^{-1}). This trend continued at later stages, where T_7 recorded the maximum number of secondary branches at 90 DAS (8.67 plant^{-1}) and harvest (9.85 plant^{-1}), closely followed by T_6 (8.33 and 9.28 plant^{-1}) and T_3 (8.00 and 9.11 plant^{-1}). The lowest values were consistently observed under T_1 (5.67, 6.82 and 7.09 plant^{-1} at 60 DAS, 90 DAS and harvest, respectively).

It may thus be inferred that treatments T_7 and T_6 were most effective in enhancing plant height, dry matter accumulation, as well as primary and secondary branching in mustard, whereas T_1 remained consistently inferior throughout the crop growth period.

Yield attributes and yield

Data presented in Table 2 clearly revealed that the application of varying levels of N, P, K, S, and Zn significantly influenced oil yield, oil content, siliqua formation, seed characteristics, and overall productivity of mustard. The highest oil yield (927.41 kg ha^{-1}) was recorded with the application of 120:60:40:30:7 kg ha^{-1} of N:P:K:S:Zn (T_6), which was statistically comparable with T_7 (848.8 kg ha^{-1}) and T_3 (829.73 kg ha^{-1}). In contrast, the lowest oil yield (606.3 kg ha^{-1}) was obtained under control (T_1). Oil content exhibited a marked improvement with nutrient application, where the maximum value (37.78%) was observed in T_7, while the minimum (32.86%) was noted in control.

Yield attributes such as number of siliqua plant^{-1}, seeds siliqua^{-1}, and siliqua length followed a similar trend. The maximum siliqua per plant (201.58) and seeds per siliqua (16.52) were obtained in T_6, accompanied by the longest siliqua (4.07 cm). Control recorded the lowest values across these parameters. Test weight also increased significantly with balanced fertilization, with the highest test weight (8.80 g) under T_6 and the lowest (7.09 g) in T_1.

Regarding yield, seed yield was maximum (2174.07 kg ha^{-1}) in T_6, which showed superiority over other treatments, followed by T_5 (2050.74 kg ha^{-1}) and T_2 (2082.96 kg ha^{-1}). Similarly, biological yield was the highest (9459.55 kg ha^{-1}) in T_8, closely followed by T_6 (8826.56 kg ha^{-1}). Control registered the lowest biological yield (8166.28 kg ha^{-1}).

Overall, the results indicated that higher levels of S (30 kg ha^{-1}) in combination with 120:60:40 NPK and Zn @ 7 kg ha^{-1} (T_6) proved most effective in improving both oil yield and yield-attributing characters, thereby enhancing the productivity of mustard.

The improvement in oil yield and yield-attributing traits such as siliqua plant^{-1}, seeds siliqua^{-1}, siliqua length, and test weight under higher levels of S and Zn along with NPK could be attributed to their synergistic role in enhancing metabolic activities, chlorophyll synthesis, and translocation of assimilates. Sulphur is essential for the synthesis of oil and sulphur-containing amino acids, while Zn plays a crucial role in auxin metabolism and enzymatic activation, which ultimately enhances reproductive efficiency and seed filling.

Similar results were reported by Jaiswal *et al.* (2025) [3], who observed that application of 55 kg S ha^{-1} and 15 kg Zn ha^{-1} significantly improved siliqua plant^{-1}, seeds siliqua^{-1}, seed yield, and oil content of mustard. Kumar *et al.* (2024) [5] also highlighted that the combined application of 40 kg S and 7.5 kg Zn ha^{-1} enhanced siliqua length and seed yield over control. In another study, Verma *et al.* (2018) [16] demonstrated that foliar and soil-applied Zn increased siliqua length and seeds siliqua^{-1}, which corroborates the present findings. Further, Anil Kumar *et al.* (2024) [5] emphasized that adequate sulphur supply (40 kg S ha^{-1}) coupled with Zn markedly increased oil yield due to improved partitioning of assimilates towards reproductive structures. Similarly, Mahak *et al.* (2024) [7] found that NP + 30 kg S + 5 kg Zn increased oil content by nearly 25% over control, attributing it to enhanced physiological efficiency and nutrient uptake.

The improvement in seed yield and biological yield (Table3) in the present investigation with 120:60:40:30:7 kg ha^{-1} of N:P:K:S:Zn (T_6) might thus be due to balanced nutrition, which ensures optimum source-sink relationship and efficient nutrient utilization. This confirms the findings of ND Publisher (2023), where nutrient combinations of NPK + S + Zn were reported to be more effective than NPK alone in increasing seed and oil yield of mustard.

Economics

The economic analysis of mustard as affected by different levels of primary and secondary nutrients is presented in Table 3. The cost of cultivation varied among treatments, primarily due to additional input of fertilizers. The maximum cost of cultivation (₹33,235.95 ha^{-1}) was recorded with 120:60:40:30:9 kg N-P-K-S-Zn ha^{-1} (T_7), while the lowest cost (₹27,054 ha^{-1}) was observed in the control (T_1).

Gross return was markedly enhanced with higher nutrient application. The treatment 120:60:40: 30:7 kg N-P-K-S-Zn ha^{-1} (T_6) registered the highest gross return (₹1,26,226.33 ha^{-1}), followed by 120:60:40:20:9 kg N-P-K-S-Zn ha^{-1} (T_3), whereas the control treatment resulted in the lowest gross return (₹90,961.85 ha^{-1}).

Net return, being the difference between gross return and cost of cultivation, also varied significantly. Application of 120:60:40:30:7 kg N-P-K-S-Zn ha^{-1} (T_6) gave the maximum net return (₹93,353.98 ha^{-1}), while the lowest was observed under

90:60:40:30:7 kg N-P-K-S-Zn ha⁻¹ (T_8) with ₹60,432.67 ha⁻¹.

The benefit: cost (B:C) ratio, an important measure of profitability, was found highest with 120:60:40:30:7 kg N-P-K-S-Zn ha⁻¹ (2.84), closely followed by 120:60:40:20:9 kg N-P-K-S-Zn ha⁻¹ (2.71). The minimum B:C ratio (1.86) was recorded in 90:60:40:30:7 kg N-P-K-S-Zn ha⁻¹ (T_8).

These results clearly indicated that the application of sulphur and zinc not only improved yield but also enhanced the economic feasibility of mustard cultivation. The treatment combination 120:60:40:30:7 kg N-P-K-S-Zn ha⁻¹ proved to be the most remunerative, giving the highest net return and profitability.

Table 1: Effect of Different Fertility Levels on Growth attributess in Mustard.

	Plant height(cm)				Dry matter accumulation(g plant⁻¹)				No of primary branches				No of secondary branches		
Treatments	**30 DAS**	**60 DAS**	**90 DAS**	**At harvest**	**30 DAS**	**60 DAS**	**90 DAS**	**At harvest**	**30 DAS**	**60 DAS**	**90 DAS**	**At harvest**	**60 DAS**	**90 DAS**	**At harvest**
T_1	13.55	77.86	147.05	176.7	2.14	7.27	14.52	23.73	1.83	3.27	4.33	4.67	3.6	5.67	6.82
T_2	19.46	86.56	164.56	189.33	2.77	8.27	19.46	31.27	2.38	3.83	5.21	5.37	3.99	7	8.92
T_3	20.92	87.12	167.03	191.58	2.84	8.4	20.92	32.92	2.43	3.89	5.25	5.79	4.01	8	9.11
T_4	15.65	78.8	154.12	177.83	2.39	7.53	15.65	27.69	2.12	3.33	4.56	4.91	3.67	6.33	7.56
T_5	16.67	80.86	158.13	181.8	2.61	7.73	16.67	29.24	2.19	3.67	4.65	4.93	3.82	6.67	7.88
T_6	21.16	89.89	167.92	193.13	3.09	8.8	21.16	33	2.57	3.93	5.3	5.87	4.2	8.33	9.28
T_7	23.62	90.53	169.49	195.19	3.22	8.93	23.62	34.87	2.65	3.99	5.74	6.14	4.93	8.67	9.85
T_8	18.36	81.21	161.38	185.11	2.67	8	18.36	29.83	2.24	3.7	4.76	5.03	3.89	6.7	8.51
T_9	19.17	86.79	163.57	187.12	2.75	8.07	19.46	30.98	2.24	3.82	4.9	5.11	3.93	6.83	8.89
SEm(±)	1.08	2.93	3.65	3.9	0.14	0.32	1.08	1.29	0.099	0.216	0.165	0.205	0.23	0.44	0.52
CD (P=0.05)	3.24	8.81	10.94	11.69	0.44	0.97	3.24	3.86	0.29	N/S	0.49	0.61	0.7	1.34	1.58

T_1: Control, T_2: 120:60:40:20:7 kgha⁻¹ of N:P:K:S:Zn, T_3: 120:60:40:20:9 kgha⁻¹ of N:P:K:S:Zn, T_4: 90:60:40:20:7 kgha⁻¹ of N:P:K:S:Zn, T_5: 90:60:40:20:9 kgha⁻¹ of N:P:K:S:Zn, T_6:120:60:40:30:7 kgha⁻¹ of N:P:K:S:Zn, T_7: 120:60:40:30:9 kgha⁻¹ of N:P:K:S:Zn, T_8: 90:60:40:30:7 kgha⁻¹ of N:P:K:S:Zn, T_9: 90:60:40:30:9 kgha⁻¹ of N:P:K:S:Zn

Table 2: Effect of Different Fertility Levels on Yield attributes and yield in Mustard.

Treatments	No of silique plant⁻¹	No of seeds siliqua⁻¹	Length of silique (cm)	Test weight (g)	Stover yield (kg ha⁻¹)	Seed yield (kg ha⁻¹)	Biological yield (kg ha⁻¹)	Oil yield (kg ha⁻¹)	Oil %
T_1	176.7	13.54	3.33	7.09	6367.02	1799.26	8166.28	606.3	32.86
T_2	194	15.35	3.8	8.27	6418.95	2082.96	8501.91	812.48	35.35
T_3	194.35	15.43	3.87	8.27	6393.59	1974.07	8367.67	829.73	36.46
T_4	177.83	13.83	3.37	7.27	6412.66	1675.19	8087.84	638.89	36.93
T_5	181.8	14.7	3.45	7.53	6625.26	2050.74	8676	713.06	34.73
T_6	201.58	16.52	4.07	8.8	6652.48	2174.07	8826.56	927.41	36.98
T_7	197.58	16.2	4	8.4	7076.4	1525.19	8601.58	848.8	37.78
T_8	185.11	14.83	3.62	7.73	7886.59	1572.96	9459.55	740.74	36.87
T_9	187.17	14.88	3.72	8.07	6033.04	1832.59	7865.63	788.52	35.6
SEm(±)	3.97	0.94	0.25	0.09	204.86	72.86	208.26	49.26	1.85
CD (P=0.05)	11.9	N/S	N/S	0.29	614.17	218.45	624.36	147.69	5.55

T_1: Control, T_2: 120:60:40:20:7 kgha⁻¹ of N:P:K:S:Zn, T_3: 120:60:40:20:9 kgha⁻¹ of N:P:K:S:Zn, T_4: 90:60:40:20:7 kgha⁻¹ of N:P:K:S:Zn, T_5: 90:60:40:20:9 kgha⁻¹ of N:P:K:S:Zn, T_6:120:60:40:30:7 kgha⁻¹ of N:P:K:S:Zn, T_7: 120:60:40:30:9 kgha⁻¹ of N:P:K:S:Zn, T_8: 90:60:40:30:7 kgha⁻¹ of N:P:K:S:Zn, T_9: 90:60:40:30:9 kgha⁻¹ of N:P:K:S:Zn

Table 3: Effect of treatments on economics in Mustard

Treatments	Cost of Cultivation (Rs/ha)	Gross Return (Rs/ha)	Net Return (Rs/ha)	B:C (Benefict-cost ratio)
T_1	27054	90961.85	63907.85	2.36
T_2	31816.9	114967.44	83150.54	2.61
T_3	32180.5	119415.96	87235.46	2.71
T_4	31391.86	94399.39	63007.53	2.01
T_5	31755.46	98548.11	66792.65	2.1
T_6	32872.35	126226.33	93353.98	2.84
T_7	33235.95	120981.75	87745.8	2.64
T_8	32447.31	92879.98	60432.67	1.86
T_9	32810.91	106825.63	74014.72	2.26

T_1: Control, T_2: 120:60:40:20:7 kgha⁻¹ of N:P:K:S:Zn, T_3: 120:60:40:20:9 kgha⁻¹ of N:P:K:S:Zn, T_4: 90:60:40:20:7 kgha⁻¹ of N:P:K:S:Zn, T_5: 90:60:40:20:9 kgha⁻¹ of N:P:K:S:Zn, T_6:120:60:40:30:7 kgha⁻¹ of N:P:K:S:Zn, T_7: 120:60:40:30:9 kgha⁻¹ of N:P:K:S:Zn, T_8: 90:60:40:30:7 kgha⁻¹ of N:P:K:S:Zn, T_9: 90:60:40:30:9 kgha⁻¹ of N:P:K:S:Zn

Conclusion

Among the different fertility levels, the application of 120:60:40:30:7 kg ha⁻¹ of $N:P_2O_5:K_2O:S:Zn$ proved most effective in enhancing seed yield, harvest index, and economic returns, while also improving growth parameters such as plant height, branching pattern, and dry matter accumulation. Although higher doses of sulphur and zinc (120:60:40:30:9 kg ha⁻¹) promoted vegetative growth, the balanced supply of 120:60:40:30:7 kg ha⁻¹ ensured better partitioning of assimilates towards reproductive development, thereby optimizing productivity and profitability.

It may be concluded that balanced fertilization with N, P, K, S, and Zn, particularly at the level of 120:60:40:30:7 kg ha⁻¹, is a viable strategy for realizing higher productivity and profitability of mustard in the Aligarh region.

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