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Effect of Organic Manures and Micronutrient Fertilization on Growth, Yield and Productivity of Mustard (*Brassica juncea* L.)

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Abstract

A field experiment was conducted to evaluate the effect of organic manures and mineral nutrients on growth, physiological parameters, yield attributes and yield of mustard (*Brassica juncea* L.). The experiment consisted of four organic manure treatments viz., control, FYM @ 7.5 t ha^{-1}, vermicompost @ 1.5 t ha^{-1} and poultry manure @ 1.5 t ha^{-1} along with four mineral nutrient treatments involving sulphur, zinc and iron combinations. The results revealed that application of poultry manure @ 1.5 t ha^{-1} significantly improved plant height, fresh and dry matter accumulation, leaf area index (LAI), crop growth rate (CGR), relative growth rate (RGR), yield attributes and yield of mustard over control. Among mineral nutrient treatments, application of sulphur @ 50 kg ha^{-1} + $ZnSO_4$ @ 20 kg ha^{-1} + $FeSO_4$ @ 10 kg ha^{-1} recorded the highest plant height (159.20 cm), fresh weight (189.08 g plant^{-1}), dry weight (14.69 g plant^{-1}), siliqua plant^{-1} (235.30), grain yield (1595.19 kg ha^{-1}) and stalk yield (6235.47 kg ha^{-1}). The study concluded that integrated application of poultry manure along with sulphur, zinc and iron significantly enhanced mustard productivity under semi-arid conditions.

Keywords: Mustard, Organic manures, Sulphur, Zinc, Iron, Poultry manure, Yield

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Introduction

Indian mustard (*Brassica juncea* L.) is one of the most important oilseed crops cultivated in India and contributes substantially to edible oil production. It occupies a prominent place in Indian agriculture due to its adaptability under diverse agro-climatic conditions and its high economic value. However, productivity of mustard in many regions remains low because of nutrient deficiencies, declining soil fertility and imbalanced fertilizer use.

Oilseed crops have comparatively higher nutrient requirements, particularly sulphur and micronutrients such as zinc and iron. Sulphur plays a crucial role in chlorophyll formation, synthesis of amino acids, protein metabolism and oil formation in mustard [1]. Zinc is involved in enzymatic activities, auxin synthesis and carbohydrate metabolism, whereas iron is essential for chlorophyll synthesis and electron transport during photosynthesis [2].

In recent years, integrated nutrient management involving organic manures and mineral nutrients has gained considerable importance for sustainable crop production. Organic manures such as farmyard manure, vermicompost and poultry manure improve soil structure, microbial activity, nutrient availability and water holding capacity [3]. Poultry manure is particularly rich in nitrogen, phosphorus and micronutrients and releases nutrients gradually throughout crop growth. Vermicompost also enhances soil enzymatic activity and nutrient mineralization.

Several researchers have reported that combined use of organic and inorganic nutrient sources improves growth, physiological efficiency, yield attributes and yield of mustard [4, 5]. Sulphur and micronutrient fertilization along with organic amendments significantly enhance nutrient uptake and seed quality in oilseed crops.

Keeping these facts in view, the present investigation was undertaken to evaluate the effect of organic manures and mineral nutrients on growth, physiological parameters, yield attributes and productivity of mustard.

Materials and Methods

A field experiment entitled was conducted during the Rabi season of 2025–26 at the Research Farm of Vivekananda Global University, Jaipur, Rajasthan, India. The experimental site is situated at 26°51′ N latitude and 75°47′ E longitude with an altitude of 390 m above mean sea level and falls under Agro-climatic Zone IIIa (Semi-Arid Eastern Plain Zone) of Rajasthan.

The climate of the region is semi-arid with hot summers and cold winters. The annual rainfall ranges from 500–700

mm, most of which is received during July to September. During the crop season, a total rainfall of 25.6 mm was recorded. The soil of the experimental field was loamy sand in texture, alkaline in reaction, low in organic carbon and available nitrogen, medium in available phosphorus and potassium, and deficient in zinc.

The experiment was laid out in a Factorial Randomized Block Design (FRBD) with three replications comprising sixteen treatment combinations. The treatments consisted of four organic manure treatments viz., control, FYM @ 7.5 t ha^{-1}, vermicompost @ 1.5 t ha^{-1} and poultry manure @ 1.5 t ha^{-1}, and four mineral nutrient treatments viz., sulphur @ 50 kg ha^{-1}, sulphur @ 50 kg ha^{-1} + $FeSO_4$ @ 10 kg ha^{-1}, sulphur @ 50 kg ha^{-1} + $ZnSO_4$ @ 20 kg ha^{-1}, and sulphur @ 50 kg ha^{-1} + $ZnSO_4$ @ 20 kg ha^{-1} + $FeSO_4$ @ 10 kg ha^{-1}. A total of 48 plots were maintained with a gross plot size of 3.6 m × 6.0 m and net plot size of 2.7 m × 6.0 m.

Mustard variety NRCHB-101 was used as the test crop. Seeds were sown on 16 October 2025 using the "pora" method with row spacing of 45 cm and plant spacing of 15 cm. The recommended agronomic practices were followed uniformly for all treatments. Organic manures and mineral nutrients were applied as per treatment specifications before sowing. Prior to sowing, the seeds were treated with Apron 35 SD @ 6 g kg^{-1} seed for protection against white rust disease.

The experimental field was prepared by one deep ploughing followed by harrowing and planking to obtain fine tilth. One thinning operation was carried out to maintain optimum plant population, while hoeing and weeding were done manually to minimize weed competition. Two irrigations were applied at flowering and pod development stages through sprinkler irrigation system.

Growth observations such as plant height, fresh and dry weight, leaf area index (LAI), crop growth rate (CGR), and relative growth rate (RGR) were recorded at different growth stages. Yield attributes including number of siliquae $plant^{-1}$, siliqua length, seeds $siliqua^{-1}$, and test weight were recorded from randomly selected plants. Seed yield, stalk yield, and harvest index were calculated at harvest.

The experimental data were statistically analyzed using analysis of variance (ANOVA) appropriate for Factorial Randomized Block Design as described by Fisher (1950). Treatment means were compared at 5% level of significance using critical difference (CD) values wherever the F-test was significant. The primary objective of the study was to evaluate the independent effects of organic manures and micronutrient fertilization on mustard growth and productivity. Interaction effects were statistically analyzed and found to be non-significant for most parameters. Therefore, only the main effects have been presented for clarity and brevity

Results and Discussion

Effect on Plant Height

Plant height increased progressively with crop age under all treatments (**Table 1**). Among organic manures, poultry manure @ 1.5 t ha^{-1} recorded significantly higher plant height at all growth stages, with maximum height at harvest (158.83 cm), followed by vermicompost @ 1.5 t ha^{-1} (149.32 cm). The increase in plant height due to poultry manure might be attributed to continuous nutrient release, improved soil aeration and enhanced microbial activity, resulting in better root growth and nutrient absorption. Among mineral nutrient treatments, application of sulphur @ 50 kg ha^{-1} + $ZnSO_4$ @ 20 kg ha^{-1} + $FeSO_4$ @ 10 kg ha^{-1} significantly increased plant height over other treatments and recorded the highest plant height at harvest (159.20 cm). Balanced supply of sulphur, zinc and iron improved chlorophyll synthesis, cell elongation and photosynthetic efficiency, thereby enhancing vegetative growth. The lowest plant height was observed under control treatment due to inadequate nutrient availability. Similar findings were reported by [4], [6] and [7].

Effect on Fresh and Dry Matter Accumulation

Fresh and dry matter accumulation differed significantly due to organic manures and mineral nutrients (**Table 2**). Poultry manure @ 1.5 t ha^{-1} recorded the highest fresh weight (186.41 g $plant^{-1}$) and dry weight (14.43 g $plant^{-1}$) at harvest. This might be due to improved nutrient availability and enhanced physiological activities leading to greater biomass accumulation. Similarly, combined application of sulphur + zinc + iron recorded significantly higher fresh weight (189.08 g $plant^{-1}$) and dry weight (14.69 g $plant^{-1}$) compared to sulphur alone. Sulphur enhances protein synthesis and oil formation, whereas zinc and iron improve photosynthetic efficiency and enzymatic activities. The lowest biomass accumulation under control treatment might be attributed to poor nutrient availability and restricted metabolic activities. Similar observations were also reported by [1] and [5].

Effect on Leaf Area Index, CGR and RGR

Application of poultry manure significantly enhanced LAI, CGR and RGR over control (**Table 3**). Maximum LAI at 90 DAS (7.46), CGR during 80 DAS to harvest (0.197 g m^{-2} day^{-1}) and RGR (0.043 g g^{-1} day^{-1}) were recorded under poultry manure treatment. Improved leaf area development under organic manure treatments may be attributed to enhanced nutrient mineralization and better moisture conservation. Higher CGR and RGR indicate efficient photosynthetic activity and greater assimilate production during active crop growth stages.

Table 1 Effect of organic manures and mineral nutrients on plant height of mustard

Treatments	At 30 DAS (cm)	At 60 DAS (cm)	At 90 DAS (cm)	At harvest (cm)
Organic manures				
Control	11.37	31.37	70.54	119.49
FYM 7.5 t ha^{-1}	12.75	32.77	72.75	131.72
Vermicompost 1.5 t ha^{-1}	15.84	35.84	75.84	149.32
Poultry manure 1.5 t ha^{-1}	16.79	36.80	76.79	158.83
SEm+	0.49	0.58	0.61	4.64
CD (P = 0.05)	1.43	1.67	1.76	13.41
Mineral nutrients				
Sulphur @ 50 kg ha^{-1}	12.162	32.162	71.332	122.542
Sulphur @ 50 kg ha^{-1}+ $FeSO_4$ @ 10 kg ha^{-1}	13.242	33.242	73.242	133.182
Sulphur @ 50 kg ha^{-1}+ $ZnSO_4$ @ 20 kg ha^{-1}	14.422	34.432	74.422	143.422
Sulphur @ 50 kg ha^{-1} + $ZnSO_4$ @ 20 kg ha^{-1} + $FeSO_4$ @ 10 kg ha^{-1}	15.92	35.95	75.92	159.20
SEm+	0.49	0.58	0.61	4.64
CD (P = 0.05)	1.43	1.67	1.76	13.41

Table 2 Effect of organic manures and mineral nutrients on fresh and dry weight of mustard

Treatments	Fresh and dry matter					
	40 DAS		80 DAS		At harvest	
	Fresh weight	Dry weight	Fresh weight	Dry weight	Fresh weight	Dry weight
Organic manures						
Control	12.54	1.26	70.95	7.03	170.46	12.64
FYM 7.5 t ha^{-1}	14.02	1.41	75.30	7.49	177.34	13.10
Vermicompost 1.5 t ha^{-1}	17.17	1.72	83.16	8.27	185.20	13.88
Poultry manure 1.5 t ha^{-1}	18.14	1.82	84.42	8.40	186.41	14.43
SEm+	0.51	0.05	2.69	0.26	2.66	0.38
CD (P = 0.05)	1.48	0.15	7.76	0.76	7.69	1.10
Mineral nutrients						
Sulphur @ 50 kg ha^{-1}	13.35	1.35	71.79	7.12	171.26	12.73
Sulphur @ 50 kg ha^{-1}+ $FeSO_4$ @ 10 kg ha^{-1}	14.52	1.45	75.80	7.53	177.88	13.14
Sulphur @ 50 kg ha^{-1}+ $ZnSO_4$ @ 20 kg ha^{-1}	15.72	1.57	79.15	7.88	181.19	13.49
Sulphur @ 50 kg ha^{-1} + $ZnSO_4$ @ 20 kg ha^{-1} + $FeSO_4$ @ 10 kg ha^{-1}	18.29	1.83	87.08	8.65	189.08	14.69
SEm+	0.51	0.05	2.69	0.26	2.66	0.38
CD (P = 0.05)	1.48	0.15	7.76	0.76	7.69	1.10

Among mineral nutrient treatments, combined application of sulphur + $ZnSO_4$ + $FeSO_4$ significantly improved physiological growth parameters. Sulphur plays an important role in chlorophyll formation and protein synthesis, while zinc and iron improve enzymatic activities and photosynthetic processes. These findings corroborate the reports of [2] and [3].

Effect on Yield Attributes

Organic manures and mineral nutrients significantly influenced yield attributes of mustard (**Table 4**). Poultry manure @ 1.5 t ha^{-1} produced the maximum siliqua length (6.76 cm), seeds $siliqua^{-1}$ (12.21), $siliqua\ plant^{-1}$ (237.33) and 1000-seed weight (4.72 g). The increase in yield attributes may be due to better translocation of photosynthates from source to sink under improved nutrient availability. Among mineral nutrients, sulphur @ 50 kg ha^{-1} + $ZnSO_4$ @ 20 kg ha^{-1} +

$FeSO_4$ @ 10 kg ha^{-1} recorded maximum siliqua length (6.73 cm), siliqua $plant^{-1}$ (235.30) and test weight (4.68 g). Adequate sulphur nutrition enhances reproductive development and oil synthesis, while zinc and iron improve pollination and grain filling processes. The findings are in close agreement with those reported by [1], [4] and [7].

Table 3 Effect of organic manures and mineral nutrients on leaf area index and on CGR and RGR of mustard

Treatments	Leaf area index			CGR		RGR	
	At 30 DAS	At 60 DAS	At 90 DAS	40-80 DAS	80-at harvest	40-80 DAS	80-at harvest
Organic manures							
Control	2.17	4.17	6.85	0.189	0.183	0.066	0.035
FYM 7.5 t ha^{-1}	2.61	4.61	7.11	0.199	0.183	0.067	0.039
Vermicompost 1.5 t ha^{-1}	2.77	4.77	7.35	0.214	0.183	0.071	0.042
Poultry manure 1.5 t ha^{-1}	2.94	4.96	7.46	0.215	0.197	0.072	0.043
SEm+	0.09	0.09	0.07	0.008	0.007	0.001	0.001
CD (P = 0.05)	0.27	0.26	0.20	0.027	0.019	0.004	0.002
Mineral nutrients							
Sulphur @ 50 kg ha^{-1}	2.33	4.33	6.84	0.189	0.183	0.065	0.034
Sulphur @ 50 kg ha^{-1}+ $FeSO_4$ @ 10 kg ha^{-1}	2.57	4.57	7.15	0.198	0.183	0.067	0.039
Sulphur @ 50 kg ha^{-1}+ $ZnSO_4$ @ 20 kg ha^{-1}	2.66	4.68	7.26	0.206	0.183	0.070	0.041
Sulphur @ 50 kg ha^{-1} + $ZnSO_4$ @ 20 kg ha^{-1} + $FeSO_4$ @ 10 kg ha^{-1}	2.33	4.33	6.84	0.223	0.197	0.072	0.042
SEm+	0.09	0.09	0.07	0.223	0.197	0.003	0.004
CD (P = 0.05)	0.27	0.26	0.20	0.667	0.582	0.009	0.012

Table 4 Effect of organic manures and mineral nutrients on yield attributes of mustard

Treatments	Length of siliqua (cm)	No. of seeds $siliqua^{-1}$	No. of siliqua $plant^{-1}$	1000 -seed weight (g)	Grain yield (kg/ha)	Stalk yield (kg/ha)	Harvest index (%)
Organic manures							
Control	5.84	11.18	221.39	4.23	1038.08	4036.07	20.45
FYM 7.5 t ha^{-1}	6.47	11.74	228.27	4.35	1176.35	4756.51	19.94
Vermicompost 1.5 t ha^{-1}	6.56	11.95	236.13	4.47	1485.97	5794.59	20.46
Poultry manure 1.5 t ha^{-1}	6.76	12.21	237.33	4.72	1573.15	6140.28	20.46
SEm+	0.26	0.30	2.66	0.23	49	214	0.31
CD (P = 0.05)	NS	NS	7.69	NS	141	618	NS
Mineral nutrients							
Sulphur @ 50 kg ha^{-1}	6.10	11.35	222.19	4.15	1117.23	4407.82	20.27
Sulphur @ 50 kg ha^{-1}+ $FeSO_4$ @ 10 kg ha^{-1}	6.24	11.63	228.81	4.42	1217.43	4866.73	20.11
Sulphur @ 50 kg ha^{-1}+ $ZnSO_4$ @ 20 kg ha^{-1}	6.43	12.01	232.12	4.43	1343.69	5218.44	20.52
Sulphur @ 50 kg ha^{-1} + $ZnSO_4$ @ 20 kg ha^{-1} + $FeSO_4$ @ 10 kg ha^{-1}	6.73	11.86	235.30	4.68	1595.19	6235.47	20.42
SEm+	0.26	0.30	2.66	0.23	49	214	0.31
CD (P = 0.05)	NS	NS	7.69	NS	141	618	NS

*NS = Non-significant

Effect on Grain and Stalk Yield

Among organic manures, poultry manure @ 1.5 t ha^{-1} recorded significantly higher grain yield (1573.15 kg ha^{-1}) and stalk yield (6140.28 kg ha^{-1}), followed by vermicompost treatment. The increase in yield might be attributed to improved growth parameters, higher dry matter accumulation and superior yield attributes.

Similarly, integrated application of sulphur + $ZnSO_4$ + $FeSO_4$ significantly enhanced grain yield (1595.19 kg ha^{-1}) and stalk yield (6235.47 kg ha^{-1}). Balanced nutrient supply improved nutrient uptake efficiency, photosynthetic activity and assimilate partitioning towards reproductive structures.

Lower yield under control treatment was due to nutrient deficiency and poor vegetative growth. Similar findings were reported by [3], [5] and [6].

Conclusion

The present investigation clearly demonstrated that application of organic manures and mineral nutrients significantly improved growth, physiological parameters, yield attributes and yield of mustard. Among organic manures, poultry manure @ 1.5 t ha^{-1} proved most effective in enhancing plant growth, dry matter accumulation and productivity. Among mineral nutrient treatments, combined application of sulphur @ 50 kg ha^{-1} + $ZnSO_4$ @ 20 kg ha^{-1} + $FeSO_4$ @ 10 kg ha^{-1} recorded superior growth and yield performance. Therefore, integrated use of poultry manure along with sulphur, zinc and iron may be recommended for sustainable mustard production and improved soil fertility under semi-arid conditions.

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