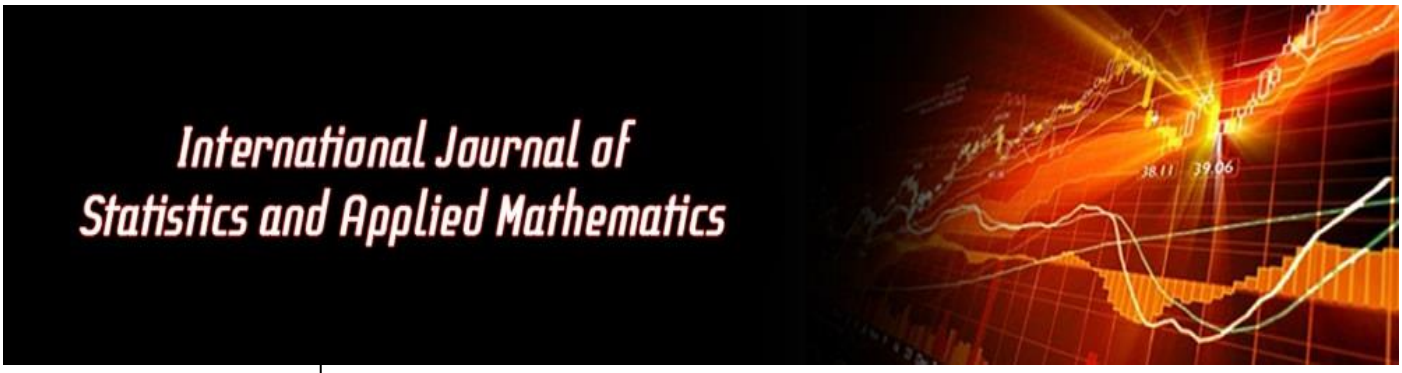

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Effect of vermicompost and inorganic nutrient on growth and yield of mustard (*Brassica juncea* L.)

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Abstract
The present experiment entitled "Effect of vermicompost and inorganic nutrient on growth and yield of mustard (*Brassica juncea* L.) under middle zone of U.P." was carried out at Shradheya Bhagwati Singh Agriculture Research Farm, Hajipur, Chandra Bhanu Gupta Krishi Snatkottar Mahavidyalaya, BKT, Lucknow (UP). The experiment was laid down in randomized block design with 15 treatment *viz* No Vermicompost + No nutrient management (T_1), No Vermicompost + S @ 40 kg/ha (T_2), No Vermicompost + S @ 40 kg/ha + Fe @ 9.5 kg/ha (T_3), No Vermicompost + S @ 40 kg/ha +ZN @ 5 kg/ha (T_4), No Vermicompost + S @ 40 kg/ha + Fe @ 9.5 kg/ha +ZN @ 5 kg/ha (T_5), Vermicompost @ 2 q/ha + No nutrient management (T_6), Vermicompost @ 2 q/ha + S @ 40 kg/ha (T_7), Vermicompost @ 2 q/ha + S @ 40 kg/ha + Fe @ 9.5 kg/ha (T_8), Vermicompost @ 2 q/ha + S @ 40 kg/ha +ZN @ 5 kg/ha (T_9), Vermicompost @ 2 q/ha + S @ 40 kg/ha + Fe @ 9.5 kg/ha +ZN @ 5 kg/ha (T_{10}), Vermicompost @ 4 q/ha + No nutrient management (T_{11}), Vermicompost @ 4 q/ha + S @ 40 kg/ha (T_{12}), Vermicompost @ 4 q/ha + S @ 40 kg/ha + Fe @ 9.5 kg/ha (T_{13}), Vermicompost @ 4 q/ha + S @ 40 kg/ha +ZN @ 5 kg/ha (T_{14}) and Vermicompost @ 4 q/ha + S @ 40 kg/ha + Fe @ 9.5 kg/ha +ZN @ 5 kg/ha (T_{15}) with three replications during rabi season of 2021-22. It is evident from summary of data that different treatments have their pronounced impact on all growth parameters *viz* plant height and number of branches per plant as well as yield attributes (No. of silique per plant, No. of seed per silique) and yield. Maximum and significantly higher values of these traits was noted with treatment T_{15} (Vermicompost @ 4 q/ha + S @ 40 kg/ha + Fe @ 9.5 kg/ha +ZN @ 5 kg/ha) as compared to rest treatments.

Keywords: Vermicompost, management, inorganic and evident

Introduction
Indian mustard is one of the most important winter oil seed crops grown in the northern part of India, *Brassica juncea* (L.) is used as a source of oil, vegetables, condiments and fodder. Green stems and leaves are a good source of cattle feed. The leaves of young plants are used as green vegetables as they supply enough Sulphur and minerals for diet. The seed has an oil content that varies from 38 to 46%. The standard cultivars of *Brassica juncea* (L.) are strong in glucosinolates and erucic acid (40-50%). (180-200 micromoles). Mustard seed is used in medicine for example mustard plasters, cattle feed and fertilizer and is also used as a lubricant and its defatted cakes are used in cosmetology. Mustard oil is an important part of the Indian diet and oil is used in the preparation of pickles, soap-making flavoring curries and vegetables. Apart from direct human and animal consumption, industrial use including the manufacture of rapeseed or use as a source of biodiesel fuel production has been developed in the recent year in the world Kansotia *et al*. (2013) [2].
Vermicomposting is faster than composting and the resulting earthworm casting is rich in microbial activity and plant growth regulators and fortified with pest repellence attributes as well. Vermicomposting reduces the C: N ratio and retains more N than the traditional method of preparing compost. It can improve seed germination, growth and yield of crops. Vermicompost application suppressed the incidence of diseases significantly reported by Sharma *et al*. (2017) [5] observed the influence of vermicompost and inorganic fertilizers on the yield and protein content of crops.

Materials and Methods

A field experiment on lentil entitled "Effect of vermicompost and inorganic nutrient on growth and yield of mustard (*Brassica juncea* L.)." was carried out at Shradheya Bhagwati Singh Agriculture Research Farm, Chandra Bhanu Gupta Agriculture PG college, (BKT, Lucknow) during the rabi season of 2021-22. The college is located 17 kilometers towards west from district headquarter Lucknow. The soil texture of experimental plot was silty-loam having organic carbon 0.74% available nitrogen 261 Kg/Ha, available Phosphorous 25.8 Kg/Ha, available Potassium 262.1 Kg/Ha with soil pH of 7.95. The experiment was laid down in randomized block design with 15 treatment *viz* No Vermicompost + No nutrient management (T_1), No Vermicompost + S @ 40 kg/ha (T_2), No Vermicompost + S @ 40 kg/ha + Fe @ 9.5 kg/ha (T_3), No Vermicompost + S @ 40 kg/ha +ZN @ 5 kg/ha (T_4), No Vermicompost + S @ 40 kg/ha + Fe @ 9.5 kg/ha +ZN @ 5 kg/ha (T_5), Vermicompost @ 2 q/ha + No nutrient management (T_6), Vermicompost @ 2 q/ha + S @ 40 kg/ha (T_7), Vermicompost @ 2 q/ha + S @ 40 kg/ha + Fe @ 9.5 kg/ha (T_8), Vermicompost @ 2 q/ha + S @ 40 kg/ha +ZN @ 5 kg/ha (T_9), Vermicompost @ 2 q/ha + S @ 40 kg/ha + Fe @ 9.5 kg/ha +ZN @ 5 kg/ha (T_{10}), Vermicompost @ 4 q/ha + No nutrient management (T_{11}), Vermicompost @ 4 q/ha + S @ 40 kg/ha (T_{12}), Vermicompost @ 4 q/ha + S @ 40 kg/ha + Fe @ 9.5 kg/ha (T_{13}), Vermicompost @ 4 q/ha + S @ 40 kg/ha +ZN @ 5 kg/ha (T_{14}) and Vermicompost @ 2 q/ha + S @ 40 kg/ha + Fe @ 9.5 kg/ha +ZN @ 5 kg/ha (T_{15}). Observations on Plant height, Number of branches per plant, Number of siliquae per plant, Number of seeds per siliquae, Seed yield and Stower yield and biological yield were recorded and subjected to statistical analysis to draw valid conclusions for the effect of treatments tested.

Results and Discussion

Plant Height

The plant height was progressively increased with increasing crop age and attended maximum at harvesting stage in all nutrient management treatments. A perusal of data recorded in Table-1 revealed that plant height was significantly influenced by different nutrient management treatment at all growth stages. Significantly maximum plant height (23.30 cm) at 30 DAS, (74.40 cm) at 60 DAS, (146.60 cm) at 90 DAS and 178.56 cm) at harvest stage was recorded with application of vermicompost @ 4 q ha¹ + sulphur @ 40 kg ha¹ + Fe @ 9.5 kg ha¹ and Zinc @ 5 kg ha¹ (Tis) over rest to the treatment however, being at par with T_{13} and T_{14} at 30 DAS and harvesting stage and T_{12}, T_{13} and T_{14} at 90 DAS. Result further revealed that application of sulphur, Fe and Zn with along vermicompost either 2 tha¹ or 4 t ha¹ increased the plant height at all stages of crop growth over vermicompost applied alone however, maximum increase in plant height was recorded with combination of vermicompost @ 4th /ha alongwith sulphur @ 40 kg ha¹ + Fe @ 9.5 kg ha¹ + Zinc @ 5 kg ha¹ at all stage to crop growth. The lowest height was noted under treatment T_1 (No Vermicompost + No nutrient management) at all the stages of growth. Beneficial effect of vermicompost and inorganic fertilizers on growth attributes of mustard was also noted by Kansotia *et al*. (2013) [2] and Kumar *et al*. (2010) [3].

Number of branches per plant

The number of branches per plants were significantly affected by different treatments (Table 2). The maximum increase in branches per plant was recorded in between 30 to 90 days and thereafter the rate of increase was slow from 90 days and slightly declined at harvesting stage. The maximum number of branches per plant 2.25 per plant at 30DAS, 19.40 per plant at 60 DAS, 24.25 per plant at 90 DAS and 26.84 per plant at harvest stage were recorded in treatment T I5 (Vermicompost @ 2 q/ha + S @ 40 kg/ha + Fe @ 9.5 kg/ha +ZN @ 5 kg/ha) respectively, which were significantly superior to rest of the treatments. However, it was on par with T 12, T_{13} and T_{14} at 60 and 90 DAS. The increase in growth attributes with integrated nutrient management may be due to adequate and continuous availability of macro and micro nutrients for plant growth at vegetative stages which enhance the cell elongation and cell expansion in the plant and increased plant height, number of branches, the leaf area index. The results of present investigation are in agreement with the finding of Dubey *et al.* (2013) [1] and Singh *et al.* (2011) [8].

Yield Attributes

Application of Vermicompost along with inorganic nutrients resulted significantly higher values of all yield attributes over no Vermicompost + no inorganic nutrient application. Data further revealed that application of Zn @5 kg/ha along with Sulphur @ 40 kg/ha with respected of vermicompost either 2 t/ha or 4t/ha produced significantly higher values of all yield attributes over Fe @ 9.5 kg ha along with Sulphur @ 40 kg/ha + vermicompost either 2 t or 4 t/ha. Application of Vermicompost @ 2 t/ha or 4 t/ha along with Sulphur @ 40 kg/ha + Fe @ 9.5 kg/ha + Zn @ 5 kg increased the all yield attributes significantly over rest of the treatment. However, the maximum values of yield attributes like number of siliquae per plant (332.72 per plant) and number of seed per siliqua (15.80 per siliqua) was significantly higher with vermicompost @ 4 t/ha + sulphur @ 40 kg/ha + Fe @ 9.5 kg/ha + Zn @ 5 kg/ha (Tis) over rest of the treatments except treatment (T_{12}, T_{13} and T_{14}) where non-significant difference was observed for all yield attributes. Application of vermicompost @4 t/ha along gave significantly higher values of all yield attributes over vermicompost @ 2 t/ha and no vermicompost. Sharma (2015) [6] and Singh and Kumar (2014) [7] also reported the similar results.

Yield

The grain, straw, and biological yield was affected statistically due to different nutrient management practices. Application of Vermicompost @2 t/ha or 4 t/ha + sulphur 40 kg/ha along with Zn @ 5 kg/ha produced significantly higher grain yield, straw yield and biological yield over vermicompost @ 2 t/ha or 4 t/ha + sulphur @ 40 kg/ha + Fe @ 9.5 kg/ha. Significantly maximum grain yield (22.80 q/ha), straw yield (78.35 q/ha) and total biological yield (101.15 q/ha) was recorded with vermicompost @ 4 t/ha - sulphur @ 40 kg/ha + Fe @ 9.5 kg/ha + Zn @ 5 kg/ha (T_{15}) over rest of the nutrient management treatment. The variation in biological yield, seed yield, stover yield and harvest index are the results of variation in various growth and yield contributing characters and hence productivity of mustard is collectively determined by vagueness in the vegetative growth and increase in value of various yields attributes. The higher number of siliqua plant, length of siliqua, number of seed siliqua and 1000-seed weight resulted into higher seed yield of mustard. The biological yield, seed yield, and stover yield of mustard were significantly increased with dose of vermicompost @ 4 q ha¹ + sulphur @ 40 kg ha¹+ iron @9.5 kg ha¹ + zinc @ 5 kg ha¹. The increase in seed yield under

inorganic fertilizer supply might be ascribed mainly due to the combined effect of higher number of siliqua plant, more number of seed siliqua and higher 1000-seed weight, which was the result of better translocation of photosynthesis from source to sink. zinc and iron stimulate the pod setting, seed formation and oil synthesis in the seeds of mustard and it increases the biological, seed and stover yields of mustard. Meena *et al*. (2006) [4] and Singh and Kumar (2014) [7] also reported the similar results.

Table 1: Effect of different nutrient management treatment on plant height of mustard at different growth stages

Treatments		Plant height (cm)			
		30 DAS	60 DAS	90 DAS	At har.
T_1	No Vermicompost + No nutrient management	18.00	60.00	115.30	140.34
T_2	No Vermicompost + S @ 40 kg/ha	18.23	60.76	118.90	142.89
T_3	No Vermicompost + S @ 40 kg/ha + Fe @ 9.5 kg/ha	18.45	60.78	121.90	145.89
T_4	No Vermicompost + S @ 40 kg/ha +ZN @ 5 kg/ha	19.00	63.98	123.56	157.90
T_5	No Vermicompost + S @ 40 kg/ha + Fe @ 9.5 kg/ha +ZN @ 5 kg/ha	19.50	64.56	125.89	160.90
T_6	Vermicompost @ 2 q/ha + No nutrient management	19.01	62.09	120.83	155.90
T_7	Vermicompost @ 2 q/ha + S @ 40 kg/ha	20.05	63.43	123.00	157.90
T_8	Vermicompost @ 2 q/ha + S @ 40 kg/ha + Fe @ 9.5 kg/ha	21.00	64.98	131.90	160.89
T_9	Vermicompost @ 2 q/ha + S @ 40 kg/ha +ZN @ 5 kg/ha	21.25	65.90	138.78	167.90
T_{10}	Vermicompost @ 2 q/ha + S @ 40 kg/ha + Fe @ 9.5 kg/ha +ZN @ 5 kg/ha	21.45	67.09	141.45	171.90
T_{11}	Vermicompost @ 4 q/ha + No nutrient management	20.50	63.90	135.90	164.25
T_{12}	Vermicompost @ 4 q/ha + S @ 40 kg/ha	21.40	67.87	140.89	169.90
T_{13}	Vermicompost @ 4 q/ha + S @ 40 kg/ha + Fe @ 9.5 kg/ha	22.77	69.56	142.90	173.90
T_{14}	Vermicompost @ 4 q/ha + S @ 40 kg/ha +ZN @ 5 kg/ha	23.00	71.00	143.09	175.87
T_{15}	Vermicompost @ 2 q/ha + S @ 40 kg/ha + Fe @ 9.5 kg/ha +ZN @ 5 kg/ha	23.30	74.40	146.60	178.56
S.Em ±		0.234	0.953	2.370	1.972
CD at 5%		0.678	2.76	6.866	5.713

Table 2: Effect of different nutrient management treatment on number of branch plant^{-1} at different growth stages

Treatments		Number of branch plant^{-1}			
		30 DAS	60 DAS	90 DAS	At har.
T_1	No Vermicompost + No nutrient management	2.00	13.20	16.60	17.45
T_2	No Vermicompost + S @ 40 kg/ha	2.00	13.40	17.00	18.24
T_3	No Vermicompost + S @ 40 kg/ha + Fe @ 9.5 kg/ha	2.05	14.40	17.80	18.68
T_4	No Vermicompost + S @ 40 kg/ha +ZN @ 5 kg/ha	2.05	14.45	18.80	19.84
T_5	No Vermicompost + S @ 40 kg/ha + Fe @ 9.5 kg/ha +ZN @ 5 kg/ha	2.10	15.00	19.20	20.74
T_6	Vermicompost @ 2 q/ha + No nutrient management	2.10	14.20	17.80	18.97
T_7	Vermicompost @ 2 q/ha + S @ 40 kg/ha	2.15	16.00	20.00	21.15
T_8	Vermicompost @ 2 q/ha + S @ 40 kg/ha + Fe @ 9.5 kg/ha	2.15	16.40	20.50	21.87
T_9	Vermicompost @ 2 q/ha + S @ 40 kg/ha +ZN @ 5 kg/ha	2.15	16.80	21.00	22.12
T_{10}	Vermicompost @ 2 q/ha + S @ 40 kg/ha + Fe @ 9.5 kg/ha +ZN @ 5 kg/ha	2.15	17.40	21.80	23.45
T_{11}	Vermicompost @ 4 q/ha + No nutrient management	2.10	14.45	18.08	19.15
T_{12}	Vermicompost @ 4 q/ha + S @ 40 kg/ha	2.15	17.80	22.20	23.45
T_{13}	Vermicompost @ 4 q/ha + S @ 40 kg/ha + Fe @ 9.5 kg/ha	2.15	18.10	22.61	23.97
T_{14}	Vermicompost @ 4 q/ha + S @ 40 kg/ha +ZN @ 5 kg/ha	2.20	18.80	23.50	25.05
T_{15}	Vermicompost @ 2 q/ha + S @ 40 kg/ha + Fe @ 9.5 kg/ha +ZN @ 5 kg/ha	2.25	19.40	24.25	26.84
S.Em ±		0.11	1.56	2.02	0.829
CD at 5%		NS	4.52	5.85	2.40

Table 3: Effect of different nutrient management treatment on number of Yield at different growth stages

Treatments		Yield attributes	
		No. of silique per plants	No. of seed per silique
T_1	No Vermicompost + No nutrient management	234.00	12.20
T_2	No Vermicompost + S @ 40 kg/ha	236.78	13.20
T_3	No Vermicompost + S @ 40 kg/ha + Fe @ 9.5 kg/ha	247.00	13.30
T_4	No Vermicompost + S @ 40 kg/ha +ZN @ 5 kg/ha	256.80	13.60
T_5	No Vermicompost + S @ 40 kg/ha + Fe @ 9.5 kg/ha +ZN @ 5 kg/ha	270.10	13.78
T_6	Vermicompost @ 2 q/ha + No nutrient management	247.00	13.50
T_7	Vermicompost @ 2 q/ha + S @ 40 kg/ha	285.27	14.00
T_8	Vermicompost @ 2 q/ha + S @ 40 kg/ha + Fe @ 9.5 kg/ha	293.60	14.20
T_9	Vermicompost @ 2 q/ha + S @ 40 kg/ha +ZN @ 5 kg/ha	296.60	14.60
T_{10}	Vermicompost @ 2 q/ha + S @ 40 kg/ha + Fe @ 9.5 kg/ha +ZN @ 5 kg/ha	300.00	14.63
T_{11}	Vermicompost @ 4 q/ha + No nutrient management	254.00	13.60
T_{12}	Vermicompost @ 4 q/ha + S @ 40 kg/ha	308.53	15.20
T_{13}	Vermicompost @ 4 q/ha + S @ 40 kg/ha + Fe @ 9.5 kg/ha	310.10	15.40
T_{14}	Vermicompost @ 4 q/ha + S @ 40 kg/ha +ZN @ 5 kg/ha	325.45	15.60
T_{15}	Vermicompost @ 2 q/ha + S @ 40 kg/ha + Fe @ 9.5 kg/ha +ZN @ 5 kg/ha	332.72	15.80
S.Em ±		1.02	0.261
CD at 5%		2.95	0.76

Table 4: Effect of different nutrient management treatment on number of Yield at different growth stages

Treatments		Yield (q/ha)		
		Seed Yield	**Stover Yield**	**Total biological Yield**
T_1	No Vermicompost + No nutrient management	10.50	38.15	48.65
T_2	No Vermicompost + S @ 40 kg/ha	14.10	49.54	63.64
T_3	No Vermicompost + S @ 40 kg/ha + Fe @ 9.5 kg/ha	15.50	52.41	67.91
T_4	No Vermicompost + S @ 40 kg/ha +ZN @ 5 kg/ha	18.30	64.14	82.44
T_5	No Vermicompost + S @ 40 kg/ha + Fe @ 9.5 kg/ha +ZN @ 5 kg/ha	18.40	64.85	83.25
T_6	Vermicompost @ 2 q/ha + No nutrient management	13.50	47.74	61.24
T_7	Vermicompost @ 2 q/ha + S @ 40 kg/ha	16.10	56.23	72.33
T_8	Vermicompost @ 2 q/ha + S @ 40 kg/ha + Fe @ 9.5 kg/ha	17.60	60.64	78.24
T_9	Vermicompost @ 2 q/ha + S @ 40 kg/ha +ZN @ 5 kg/ha	20.10	69.42	89.52
T_{10}	Vermicompost @ 2 q/ha + S @ 40 kg/ha + Fe @ 9.5 kg/ha +ZN @ 5 kg/ha	21.15	73.56	94.71
T_{11}	Vermicompost @ 4 q/ha + No nutrient management	14.50	50.24	64.74
T_{12}	Vermicompost @ 4 q/ha + S @ 40 kg/ha	16.90	58.53	75.43
T_{13}	Vermicompost @ 4 q/ha + S @ 40 kg/ha + Fe @ 9.5 kg/ha	18.10	63.37	81.47
T_{14}	Vermicompost @ 4 q/ha + S @ 40 kg/ha +ZN @ 5 kg/ha	19.90	69.12	89.02
T_{15}	Vermicompost @ 2 q/ha + S @ 40 kg/ha + Fe @ 9.5 kg/ha +ZN @ 5 kg/ha	22.80	78.35	101.15
S.Em $\pm$		1.15	1.86	2.35
CD at 5%		3.33	5.39	6.81

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