Original Research Article

Examining the Impact of Integrated Nutrient Management on Mustard Growth and Nutrient Composition

ABSTRACT

This study examines the impact of Integrated Nutrient Management (INM) on the growth attributes and nutrient composition of Indian mustard (*Brassica juncea* L.), a vital rabi season oilseed crop in India. Nine different treatment combinations were evaluated in a Randomized Block Design at Agronomy Research Farm. The treatments included various combinations of chemical fertilizers, vermicompost, sulfur, and zinc.The results indicate that the application of INM significantly influenced various growth parameters, including plant height and dry matter accumulation. Treatment T4 (75% RDF +Vermicompost@ 4t ha-1 + S @ 20kg ha-1) demonstrated the highest plant height and dry matter accumulation at different stages of growth. Additionally, seed yield, stover yield, and biological yield were positively impacted by INM, with T4 exhibiting the highest seed yield.Furthermore, the study highlights the importance of INM in enhancing the overall quality of Indian mustard. The application of these nutrient management practices not only led to increased seed yield but also improved the nutrient composition of the crop. The findings underscore the potential of INM as a sustainable approach to optimize crop productivity and improve food security in India.Overall, this research provides valuable insights for farmers, agricultural practitioners, and policymakers, offering a promising strategy for enhancing oilseed production and contributing to the agricultural economy of India. The positive outcomes of this study support the adoption of INM practices to ensure sustainable and productive mustard cultivation in the region.

Keywords:Integrated Nutrient Management, Stover yield, Vermicompost, Biological yield and Dry matter accumulation.

INTRODUCTION

India is the fourth largest oilseed producer in the world next to USA, China and Brazil. Hence, oilseeds play the second important role in the Indian agricultural economy, next only to food grains in terms of area and production. They occupy a distinct position after cereals constituting 14.87% gross cropped area of the country. They occupy an area of 27.86

m ha with 27.98 mt of production and registering the productivity level of 1004 kg ha-1.Indian mustard (*Brassica juncea*L.) is an important rabi season oilseed crop in India and occupies a prominent place being next in importance to soya bean and groundnut, both in area (5.83mha) and production (5.83mt), meeting the fat requirement of about 50% population in the state of Uttar Pradesh, Punjab, Rajasthan, Madhya Pradesh, Bihar, Orissa, West Bengal and Assam.

Indian mustard (*Brassica juncea* L.) is green tender plant is used for preparing vegetable. The oil is utilized for human consumption throughout northern India in cooking and frying purposes. The oil content in mustard seeds varies from 37-49 per cent. The oil cake is left after extraction is utilized as cattle feed and manure. Integrated nutrient management (INM) involves efficient and judicious use of all the major components of plant nutrient sources viz., chemical fertilizer in conjunction with animal manures, compost, green manures, legumes in cropping system, biofertilizer,crop residues or vegetable waste and other locally available nutrient sources for sustaining soil fertility, health and productivity.Sharma et al. (2013) reported that increase in the nitrogen level up to 60 kg N ha-1 consistently and significantly increased the number of primary branches per plant, number of seeds per siliqua and 1000 seed weight. Shah et al., (2004) reported that various nitrogen and phosphorus levels significantly influenced plant height and primary branches plant-1 in Indian mustard which significantly increased up to 80 kg N ha-1 while secondary branches plant-1 and dry matter plant-1 increased up to 120 kg N ha-1.

Nitrogen is the most important nutrient, which determines the growth of the mustard crop and increases the amount of protein and yield. Phosphorus and potash are known to be efficiently utilized in the presence of nitrogen. It promotes flowering, setting of siliquae and increase the size of siliquae and yield of mustard (Singh and Meena, 2004).

Sulphur is a crucial element for rapeseed-mustard in determining its seed yield, oil content, quality and resistance to various biotic and abiotic stresses.Zinc being one of the essential micronutrient, plays significant role in various enzymatic and physiological activities of the plant body. It is also essential for photosynthesis and nitrogen metabolism.Under such situation application of organic source of amendments like farm yard manure either alone or in combination with inorganic one like lime have been suggested for controlling acidity as well as nutrient (Mishra and Das, 2000).

MATERIAL AND METHODS

The present investigation entitled"Examining the Impact of Integrated Nutrient Management on Mustard Growth and Nutrient Composition"was carried out during Rabi season at

Agronomy Research Farm. The details of the materials used and methods used during the research of investigation are detailed as under:

Experiment details

Nine different treatments application were laid out in Randomized block design. Each treatment combination was allocated randomly in plots of each block. The details of treatments with their symbols have been presented in Table 1.

Table 1: List of Treatments laid out in Randomized block design

Treatments serial	Treatments Details
T_1	Control
T_2	100% RDF
T_3	100% RDF +Vermicompost@ 2t ha^{-1}
T_4	75% RDF +Vermicompost@ 4t ha^{-1} + S @ 20kg ha^{-1}
T_5	75% RDF +Vermicompost@ 4t ha^{-1} +Zn @ 5kg ha^{-1}
T_6	50% RDF+ Vermicompost@ 4t ha^{-1}
T_7	50% RDF +Vermicompost@ 4t ha^{-1}+S @ 20kg ha^{-1}
T_8	50% RDF +Vermicompost@ 4t ha^{-1}+ Zn @ 5kg ha^{-1}

Growth Studies

Plant height (cm)

Five plants were selected randomly from each plot and tagged. The heights of these plants were measured from base of plant to tip of the plant at 30, 60, 90, 120 DAS and at harvest. The height was measured from the base of the plant of tip of upper most expended leaf or foliage leaf. The height of the plant was recorded in centimeters.

Dry matter accumulation (g)

Plants of one meter row length of second rows were selected at five places randomly at 30, 60, 90, 120 DAS and at harvest and they were cut close to the ground surface. Then sun dried and collected individually in paper bags after cutting into small pieces. After sun drying, these samples were put in an electric oven at 65-700C till the constant dry weight.

Yield and Yield Studies

Grain yield

After taking the weight of total biomass, the produce of each net plot was threshed separately and clean grains were sun dried. The grain yield thus recorded in kg plot-1 was finally converted into kg ha-1.

Straw yield

Straw yield from net plot area was recorded by subtracting the grain yield from total harvested produce and converted into kg ha-1.

Biological yield

After working out grain yield and stover yield,biological yield was worked out by adding grain yield and stover yield.

Harvest Index

Harvest index is an indication of the physiological ability of a cultivar to convert the dry matter into economic yield. The harvest index was calculated by using the following formula:

Harvest index (%) = Economic yield/ Biological yield x 100

Test weight (g)

The samples of seeds were collected from each plot and then 1000 seed counted from the sample and weight were taken and expressed in mustard.

Siliquae length (cm)

Siliqua length was measured by taking five siliqua randomly from each plot and their mean values were worked out for presentation.

Number of siliqua Plant-1

Number of siliqua plant was recorded by taking three random plants at harvest by dividing the number of siliqua by number of plants.

Number of seed siliqua-1

Number of grain was counted by taking five siliqua randomly from each plot and their mean values were worked out for presentation.

RESULTS

To achieve the objectives, a field study was carried out, and the results obtained on aspect of these studies are presented under the following heads with the help of appropriate tables and suitable illustrations.

Growth parameters

Plant height (cm): The plant height is an important index of plant growth. It was recorded at harvest and subjected to statistical analysis. Perusal of the data (Table 2) revealed that the plant height significantly increased in different treatments compared with the control.

The data revealed that in Table 2 and combined application of different manures and mineral nutrient which one of treatment (T4) 75% RDF +Vermicompost@ 4t ha-1 + S @ 20kg ha-1 (29.96 cm) was significantly increased the plant height at 30 DAS over remaining treatments except treatment (T5) 75% RDF +Vermicompost@ 4t ha-1 +Zn @ 5kg ha-1 (24.33 cm).

It was also observed that maximum plant height (126.06cm) was recorded at (T4) and lowest plant height (83.73 cm) was recorded at (T1) at 60 DAS. The treatment(T4) 75% RDF +Vermicompost@ 4t ha-1 + S @ 20kg ha- 1 is significantly superior to (T1) Control, (T2)100% RDF and (T7) 50% RDF +Vermicompost@ 4t ha-1+S @ 20kg ha-1 was at par with rest of treatment.

Table: 2. Effect of integrated nutrient management on plant height (cm) at 30, 60, 90,120 and at harvest of mustard

Treatment	Plantheight(cm)			
	30 DAS	**60 DAS**	**90 DAS**	**Atharvest**
T_1:Control	15.93	83.73	124.86	129.20
T_2:100%RDF	23.53	120.50	177.40	179.20
T_3:100%RDF+Vermicompost@2tha^{-1}	22.89	113.53	172.66	176.30
T_4:75%RDF+Vermicompost@4tha^{-1}+S@20kgha^{-1}	28.93	126.06	187.13	189.50
T_5:75%RDF+Vermicompost@4tha^{-1}+Zn@5kgha^{-1}	24.33	119.70	182.33	183.80
T_6:50%RDF+Vermicompost@4tha^{-1}	23.30	117.00	171.80	173.50
T_7:50%RDF+Vermicompost@4tha^{-1}+S@20kgha^{-1}	26.80	125.60	188.50	192.20
T_8:50%RDF+Vermicompost@4tha^{-1}+Zn@5kgha^{-1}	22.53	122.93	178.53	183.20
SEm±	**0.51**	**1.47**	**1.48**	**1.28**
CD(P=0.05)	**1.45**	**4.19**	**4.21**	**3.66**

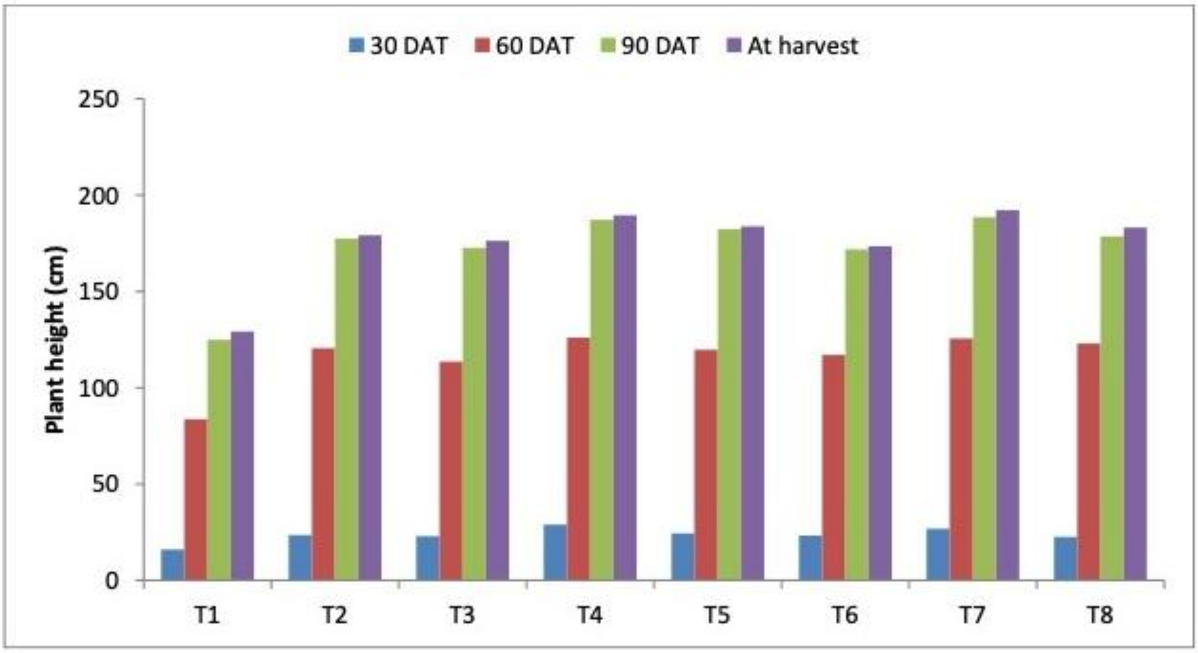

Fig:1. Effect of integrated nutrient management on plant height (cm) at 30, 60, 90 and at harvest of mustard

Maximum plant height (188.50cm) was recorded at (T7) and lowest plant height (124.86cm) was recorded at (T1) at 90 DAS. The treatment (T7) 50% RDF +Vermicompost@ 4t ha-1+S @ 20kg ha-1 was at par with (T5) 75% RDF +Vermicompost@ 4t ha-1 +Zn @ 5kg ha-1 and (T8) 50% RDF +Vermicompost@ 4t ha-1+ Zn @ 5kg ha-1 significantly superior with rest of treatment.

Maximum plant height (189.50cm) was recorded at (T4) and lowest plant height (129.20cm) was recorded at (T1) at harvest. The treatment (T4) 75% RDF +Vermicompost@ 4t ha-1 + S @ 20kg ha-1 was at par (T8)100% RDF + FYM @ 4t ha-1,(T5) 100% RDF + FYM @ 4t ha-1 +Zn @ 5kg ha-1 , (T8) 50% RDF +Vermicompost@ 4t ha-1+ Zn @ 5kg ha-1 significantly superior with rest of treatment.

Dry weight (g plant-1): The dry weight is an important index of plant growth. It was recorded at harvest and subjected to statistical analysis. Perusal of the data revealed (Table 3) that the dry weight significantly increased in different treatments compared with the control. The data revealed that in Table 3 and combined application of different manures and mineral nutrient which one of treatment (T2) 100% RDF was significantly increased the dry weight at 30 DAS over remaining treatments except treatment (T8) 50% RDF +Vermicompost@ 4t ha-1+S @ 20kg ha-1 (1.90g plant-1).

Table: 3. Effect of integrated nutrient management on dry weight (g plant^{-1}) at 30, 60, 90, and at harvest of mustard

Treatment	dryweight(gplant^{-1})			
	30DAS	60DAS	90DAS	Atharvest
T_1:Control	1.20	9.60	38.10	40.92
T_2:100%RDF	2.10	13.30	57.00	62.00
T_3:100%RDF+Vermicompost@2tha^{-1}	1.90	13.70	51.46	57.73
T_4:75%RDF+Vermicompost@4tha^{-1}+S@20kgha^{-1}	1.80	14.10	58.20	64.06
T_5:75%RDF+Vermicompost@4tha^{-1}+Zn@5kgha^{-1}	1.96	13.90	53.53	62.56
T_6:50%RDF+Vermicompost@4tha^{-1}	1.85	13.20	52.40	59.13
T_7:50%RDF+Vermicompost@4tha^{-1}+S @20kgha^{-1}	1.90	14.10	59.40	62.90
T_8:50%RDF+Vermicompost@4tha^{-1}+Zn@5kgha^{-1}	1.70	13.80	57.56	62.30
SEm±	**0.07**	**0.52**	**2.03**	**1.66**
CD(P=0.05)	**0.20**	**1.48**	**5.81**	**4.75**

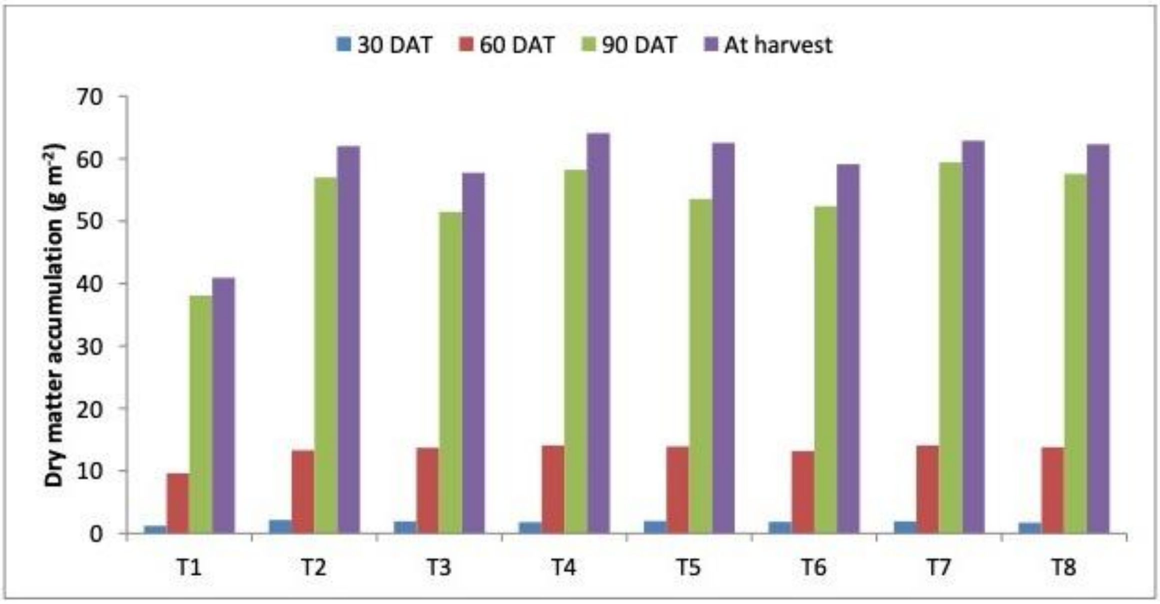

Fig: 2 Effect of integrated nutrient management on dry weight (g plant^{-1}) at 30, 60, 90, and at harvest of mustard

It was also observed that maximum dry weight (14.15g plant-1) was recorded at (T4) and lowest dry weight (9.60g plant-1) was recorded at (T1) at 60 DAS. The treatment (T4) is significantly superior to (T1) Control. Maximum dry weight (59.40g plant-1) was recorded at (T4) and lowest dry weight (38.10g plant-1) was recorded at (T1) at 90 DAS. The treatment (T4) 75% RDF +Vermicompost@ 4t ha-1 + S @ 20kg ha-1 was at par with (T3) 100% RDF +Vermicompost@ 2t ha-1 and (T5) 75% RDF +Vermicompost@ 4t ha-1 +Zn @ 5kg ha-1and significantly superior with rest of treatment. It was reported that maximum dry weight (64.06g plant-1) was recorded at (T4) and lowest dry weight (40.92g plant-1) was recorded at (T1) at harvest. The treatment (T3)100% RDF + FYM @ 4t ha-1 is significantly superior to (T1) Control, (T3) 100% RDF +Vermicompost@ 2t ha-1, (T7) 50% RDF+ Vermicompost@ 4t ha-1 while was at par with rest of treatment.

Yield attributes

Seed Siliquae-1

Perusal of the data on seed siliquae-1 revealed that application of (T4) 75% RDF +Vermicompost@ 4t ha-1 + S @ 20kg ha-1 significantly increased seed siliquae-1 over rest of treatments except treatment (T5) 75% RDF +Vermicompost@ 4t ha-1 +Zn @ 5kg ha-1 was statistically similar with T4 treatment.

Application of 75% RDF +Vermicompost@ 4t ha-1 + S @ 20kg ha-1 level increased the seed siliquae-1 of mustard significantly over that obtained in control level. Higher seed siliquae-1 (10.25) was noted in treatment (T4) 75% RDF +Vermicompost@ 4t ha-1 + S @ 20kg ha-1 which was significantly superior to all the treatments except treatment (T5) 75% RDF +Vermicompost@ 4t ha-1 +Zn @ 5kg ha-1, whereas minimum seed siliquae-1 (10.15) was obtained in control. It was also obtained that treatment (T7) 50% RDF +Vermicompost@ 4t ha-1+S @ 20kg ha-1.

Table: 4. Effect of integrated nutrient management on yield attributes of mustard

Treatment	**Seed Siliquae^{-1}**	**SiliquaePlant^{-1}**	**Test weight**
T_1:Control	7.60	175.50	4.15
T_2:100%RDF	10.10	295.50	4.80
T_3:100%RDF+Vermicompost@2tha^{-1}	10.00	290.50	4.69
T_4:75%RDF+Vermicompost@4tha^{-1}+S@20kgha^{-1}	10.25	309.80	4.94
T_5:75%RDF+Vermicompost@4tha^{-1}+Zn@5kgha^{-1}	10.15	296.50	4.90
T_6:50%RDF+Vermicompost@4tha^{-1}	9.95	292.10	4.75
T_7:50%RDF+Vermicompost@4tha^{-1}+S@20kgha^{-1}	10.11	285.75	4.83
T_8:50%RDF+Vermicompost@4tha^{-1}+Zn@5kgha^{-1}	9.96	282.50	4.69
SEm±	**0.36**	**7.56**	**0.11**
CD(P=0.05)	**1.06**	**22.57**	**0.30**

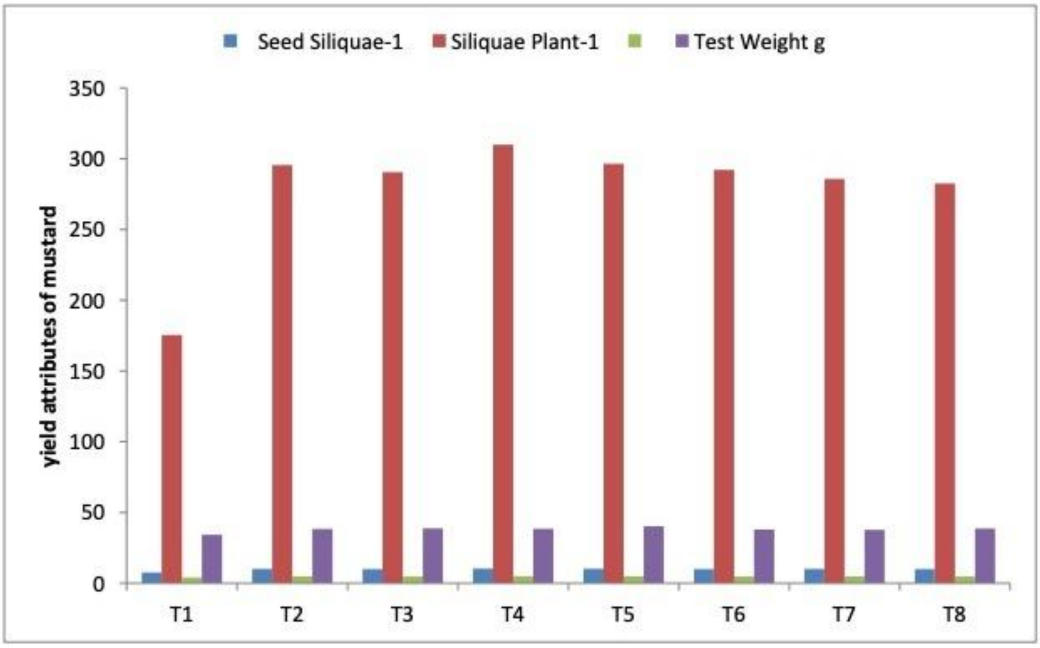

Fig:3.Effect of integrated nutrient management on yield attributes of mustard

Siliquae Plant-1

It is clearly evident from (Table 4), that siliquae Plant-1 was significantly affected by various treatments. The siliquae Plant-1 was obtained significantly highest with addition of treatment (T4) 75% RDF +Vermicompost@ 4t ha-1 + S @ 20kg ha-1 which statistically similar with the treatment (T5) 75% RDF +Vermicompost@ 4t ha-1 +Zn @ 5kg ha-1 treatment. Maximum siliquae Plant-1 (309.80) was observed at optimum levels of nutrients. It was also obtained that treatment (T4) 75% RDF +Vermicompost@ 4t ha-1 + S @ 20kg ha-1 was at par with treatments (T7) 50% RDF +Vermicompost@ 4t ha-1+S @ 20kg ha-1 and(T8) 50% RDF +Vermicompost@ 4t ha-1+ Zn @ 5kg ha-1

Test weight

It is an important yield attributing character which determines the seed size and quality of seed produced. It is inferred from the data given in table 4; that the different levels of nutrients applied alone or with organic manures were able to alter 1000 seed weight to some extent. The data revealed that the application of different manures and mineral nutrient was recorded non-significant variation in test weight of mustard.

Seed yield

It is clear from the results obtained (Table 4 and Fig. 3) from the investigation that there was a significant response in seed yield due to different treatments as compared to control. Application of 75% RDF +Vermicompost@ 4t ha-1 + S @ 20kg ha-1 level increased the seed yield of mustard significantly over that obtained in control level. Higher seed yield (19.92 q ha-1) was noted in treatment (T4) 75% RDF +Vermicompost@ 4t ha-1 + S @ 20kg ha-1 which was significantly superior to all the treatments except treatment (T5) 75% RDF +Vermicompost@ 4t ha-1 +Zn @ 5kg ha-1, whereas minimum yield was obtained in control.

Stover yield

It is clearly evident from (Table 4 and Fig. 3), that stover yield was significantly affected by various treatments. The stover yield (72.65q ha-1) was obtained significantly highest with the addition of treatment (T4) 75% RDF +Vermicompost@ 4t ha-1 + S @ 20kg ha-1 which was at par over (T6) 50% RDF+ Vermicompost@ 4t ha-1 treatment.

Biological yield

The data related to biological yield as affected by different treatments are presented in the Table 5 and their analysis of variance is placed. The data revealed that biological yield was affected significantly by different treatmentsand ranged from 34.59 to 92.57 q ha-1 under different treatments. Themaximum biological yield (92.57 q ha-1) was recorded in T4 (75% RDF +Vermicompost@ 4t ha-1 + S @ 20kg ha-1), which was followed by (75% RDF +Vermicompost@ 4t ha-1 +Zn @ 5kg ha-1) T5 treatments. Minimum biological yield 34.59 q ha-1 was found in T1 (control).

Table 5: Effect of integrated nutrient management on yield, test weight and harvest index of mustard

Treatment	**Seed Yield (q ha^{-1})**	**Stover yield (q ha^{-1})**	**Biological yield (q ha^{-1})**
T_1 :Control	7.90	26.69	34.59
T_2 :100% RDF	18.45	68.33	86.78
T_3: 100% RDF +Vermicompost@ 2t ha^{-1}	18.72	69.75	88.47
T_4: 75% RDF +Vermicompost@ 4t ha^{-1} + S @ 20kg ha^{-1}	19.92	72.65	92.57
T_5: 75% RDF +Vermicompost@ 4t ha^{-1} +Zn @ 5kg ha^{-1}	18.95	70.20	89.15
T_6: 50% RDF+ Vermicompost@ 4t ha^{-1}	18.32	68.05	86.37
T_7:50% RDF +Vermicompost@ 4t ha^{-1}+S @ 20kg ha^{-1}	18.85	70.05	88.90
T_8: 50% RDF +Vermicompost@ 4t ha^{-1}+ Zn @ 5kg ha^{-1}	18.65	69.65	88.30
SEm±	***0.67***	***1.55***	***2.25***
CD (P=0.05)	***1.96***	***4.50***	***6.66***

DISCUSSION

Maximum plant height (189.50cm) was recorded at (T4) and lowest plant height (129.20cm) was recorded at (T1) at harvest. The treatment (T4) 75% RDF +Vermicompost@ 4t ha-1 + S @ 20kg ha-1 was at par (T8)100% RDF + FYM @ 4t ha-1,(T5) 100% RDF + FYM @ 4t ha-1 +Zn @ 5kg ha-1 , (T8) 50% RDF +Vermicompost@ 4t ha-1+ Zn @ 5kg ha-1 significantly superior with rest of treatment. Panda *et al.* (2008), Pathak and Godika (2010) and Singh and Pal (2011) also reported increase in plant height of Indian mustard with application of varying doses. The enhancement in plant height may be attributed to the increased availability of nutrients to the plants, which in turn might have increased cell division and their expansion.

Maximum siliquae Plant-1 (309.80) was observed at optimum levels of nutrients. It was also obtained that treatment (T4) 75% RDF +Vermicompost@ 4t ha-1 + S @ 20kg ha-1 was at par with treatments (T7) 50% RDF +Vermicompost@ 4t ha-1+S @ 20kg ha-1 and(T8) 50% RDF +Vermicompost@ 4t ha-1+ Zn @ 5kg ha-1. Finding confirms the result Mandal and Sinha (2002), Kapur et al. (2010), Begumi et al. (2012) and Kumar et al. (2011).

The probable reason may be that the increasing resulted in (T4) 75% RDF +Vermicompost@ 4t ha-1 + S @ 20kg ha-1 greater accumulation of carbohydrates, protein and their translocation to the leaves and stem parts, which in turn, improved stover yield. The findings confirm the results of Jat and Mehra (2007) and Indra *et al.* (2008). Earlier Singh and Singh (2014), Singh and Pal (2011) also reported similar results.The results showed that the application of different manures and mineral nutrient was non- significant effect on harvest index among different sources at given in the Table 4. Earlier Kumar *et al.* (2011) and Pati *et al*. (2015) also reported similar results.

CONCLUSION

The study focused on evaluating the impact of integrated nutrient management on the growth attributes and nutrient composition of Indian mustard (Brassica juncea L.), an important rabi season oilseed crop in India.the study observed a positive effect on yield attributes, including seed yield, stover yield, and biological yield. The treatment (T4) of 75% RDF +Vermicompost@ 4t ha-1 + S @ 20kg ha-1 demonstrated the highest seed yield, highlighting the significance of integrated nutrient management in enhancing crop productivity. It is worth noting that the application of these nutrient management practices not only increased seed yield but also improved the overall quality of the crop.

In conclusion, the results of this study emphasize the importance of integrated nutrient management in optimizing the growth and nutrient composition of Indian mustard. By implementing these practices, farmers can achieve higher crop yields and improved nutritional quality, contributing to the sustainability of mustard cultivation and enhancing food security in India. This research provides valuable insights for agricultural practitioners and policymakers aiming to enhance oilseed production in the country.

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