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Effect of integrated nutrient management on agronomic traits and soil properties of Indian mustard (*Brassica juncea* L.)

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Abstract

A field experiment was conducted during *Rabi* season of 2024-25 at Research cum Instructional Farm, Pt. Shiv Kumar Shastri College of Agriculture & Research Station, Surgi, Rajnandgaon, (C.G.). To study the Effect of Integrated Nutrient Management on Agronomic Traits and Soil Properties of Indian Mustard (*Brassica juncea* L.). The experimental soil was characterized as Sandy loam in texture and was medium in Organic carbon (0.65%), low in available Nitrogen (213.46 kg ha⁻¹) and Phosphorus (11.08 kg ha⁻¹) and medium in available Potassium (252.06 kg ha⁻¹). The experiment was laid out in a Randomized Block Design (RBD) with nine treatments and replicated thrice. Among the different integrated nutrient management treatments application of 100% RDF + Vermicompost @ 5t ha⁻¹ + Azotobacter + PSB (T₅) recorded significantly higher mustard seed yield (15.70 q ha⁻¹) and straw yield (38.89 q ha⁻¹). Similarly higher plant height (190.51 cm), number of branches plant⁻¹ (20.88), total dry matter accumulation plant⁻¹ (61.23 g), number of siliqua plant⁻¹ (284.10), length of siliqua (6.93 cm) and number of seeds siliqua⁻¹ (15.54) were also recorded with same treatment which was remained at par with the treatments T₉- 75% RDF + Vermicompost @ 5t ha⁻¹ + Azotobacter + PSB, T₄- 100% RDF + Vermicompost @ 5t ha⁻¹ + Azotobacter and T₈- 75% RDF + Vermicompost @ 5t ha⁻¹ + Azotobacter.

Keywords: Indian Mustard, INM, Azotobacter, PSB, Vermicompost, RDF

Introduction

Indian mustard (*Brassica juncea* L.) is one of the major oilseed crops and has been cultivated in India since ancient times. Globally, India ranks as the third-largest producer of rapeseed-mustard, following China and Canada, highlighting its significant contribution to the world oilseed economy. This crop accounts for nearly one-third of the oil produced in India, making it the country's key edible oilseed crop (Kumar *et al.*, 2015). Indian mustard, belongs to the Cruciferae family and genus *Brassica*. Mustard has two centres of origin *i.e.*, (1) Middle East and India, where oldest forms are found, and (2) China. The term "Rapeseed- Mustard" is used for oilseed of genus *Brassica*, *Eruca* and *Sinapsis*. Within the rapeseed-mustard group, the genus *Brassica* is the most agronomically important, comprising five key cultivated species: *B. juncea*, *B. rapa*, *B. napus*, *B. carinata*, and *B. nigra*. Indian mustard (*Brassica juncea*) is predominantly cultivated under rainfed conditions. The crop performs best in well drained soils and shows moderate tolerance to soil acidity. In different regions of India, it is commonly referred to as Rai, Rayda, or Laha.

Mustard seed is used as spices in the preparation of pickle, flavouring curries and vegetables. It used as oil as well as prepared for ghee, hair oil, soaps, lubricating oil, medicines and in tanning industries. Oil content in mustard varies from 37% to 49% with 14-15% carbohydrate, 25-30% protein, 10-12% fibre, 1-1.5% minerals and vitamins, 2-3% glucosinolate. Mustard oil contains about 40-60% of erucic acid, 4.5 to 13% linolenic acid and 25-30% of oleic acid. The oil cake left after oil extraction is utilized as cattle feed and manure. Its oil cake contains 5.2%, 1.8%, 1.2% N, P, and K, respectively.

The estimated area, production and yield of rapeseed-mustard in the world is 36.59 million hectares (mha), 72.37 million tonnes (mt) and 1980 kg ha⁻¹. Globally, India accounts for 19.8% and 10% of the total acreage and production (USDA). India continues to be rank 2nd after Canada in acreage (9.18 mha) and ranks 4th after Canada, European Union and China in production (13.26 mt). As per the data given by DRMR 2023-24 of the total production under the nine oilseed crops grown in India, rapeseed- mustard alone contributes to 33.24% of the total oilseed production. Now in India rapeseed- mustard ranks 1st in oilseeds production ahead of soybean and groundnut with the production of 131.61 lakh tones (DRMR 2023-24). The major producing states of rapeseed- mustard in India are Rajasthan, Madhya Pradesh, Uttar Pradesh, Haryana, West Bengal, and Assam accounted for 86.72% of area and 89.53% of production in the country. Rajasthan alone contributes 41.44% to the total area and 45.03% to the production.

Chhattisgarh is a minor rapeseed-mustard producing state as compared to other larger states, i.e. RJ, MP, UP, HR, WB and Assam. The total area under rapeseed-mustard cultivation in Chhattisgarh is 188.25 thousand hectares with 26999 metric tonnes production and its productivity is 483 kg ha⁻¹ (Krishi darshika 2022-23).

It has been observed that during last 10 years at country level the acreage of rapeseed- mustard slightly decreased by -0.64. However, increase in yield by 11.0% and production by 10.36% but demand of oilseed crops for human needs and other industrial purpose is widening the gap between production and consumption (Bisht *et al.* 2018) [7]. The major constraints responsible for low yield of rapeseed mustard in India are lack of high yielding biotic stress resistant varieties and cultivation under rainfed situation with imbalanced use of nutrient. Apart from improved varieties and judicious irrigation, use of balanced fertilizers is critical for realizing higher yield.

Integrated nutrient management involves efficient and judicious use of all the major components of plant nutrient sources. INM is a comprehensive strategy that combines the use of organic and inorganic nutrient sources with other agronomic techniques to boost nutrient utilization efficiency and lessen environmental harm compared to using each component separately, combining chemical fertilizers and organic manures has been proven to be quite promising for maintaining both the productivity and health of the soil as well as stabilizing crop production. Plant nutrients from organic and inorganic sources, as well as bio-fertilizers, are used to maintain the soil's long-term fertility and productivity while simultaneously reducing pollution (Antil and Narwal, 2007) [4]. Inadequate use of organic manure and fertilizers as well as total reliance on chemical fertilizers has been recognized as major barriers to Indian mustard production. The appropriate application of nutrient sources helps to supply all the essential nutrients to plants which plays a critical role in maximizing the yield potential of Indian mustard.

Keeping the above facts in view the present investigation was initiated to study the effect of integrated nutrient management on agronomic traits and soil properties of Indian mustard (*Brassica juncea* L.).

Materials and Methods

The field experiment was conducted at at Research cum Instructional Farm, Pt. Shiv Kumar Shastri College of Agriculture & Research Station, Surgi, Rajnandgaon, (C.G.). during Rabi season in the year of 2024-25. The experiment was laid out in randomized block design (RBD) with three

replications and nine treatments viz., T₁- Absolute control, T₂- 100% RDF (N:P: K) @ 80:50:40 kg ha⁻¹, T₃- 100% RDF + Vermicompost @ 5 t ha⁻¹, T₄-100% RDF + Vermicompost @ 5t ha⁻¹ + Azotobacter, T₅- 100% RDF + Vermicompost @ 5t ha⁻¹ + Azotobacter + PSB, T₆- 75% RDF (N:P: K), T₇- 75% RDF + Vermicompost @ 5t ha⁻¹, T₈- 75% RDF + Vermicompost @ 5t ha⁻¹ + Azotobacter, T₉- 75% RDF + Vermicompost @ 5t ha⁻¹ + Azotobacter + PSB. The experimental soil was characterized as Sandy loam in texture with Soil pH (7.44), EC (0.43 dS m⁻¹), OC (0.65%) and BD (1.45 g cm⁻³) and low in available nitrogen (213.46 kg ha⁻¹), low in available phosphorus (11.08 kg ha⁻¹) and medium in available potassium (252.06 kg ha⁻¹). The Indian mustard variety DRMR 150-35 was sown as an experimental crop on dated 12th of November 2024 with the planting distance of 45×15 cm using seed rate of 5 kg ha⁻¹ and harvested on 23rd of February 2025.

The size of gross plot is 5 m×3 m which equals to 15m² while the size of net plot, where the actual experimentation occurred, was slightly smaller at 4.7 m×2.7 m equivalent to 12.69 m². To maintain the optimum distance between replications, a gap of 1 m was left between them, also a gap of 1 m for each separated individual plot was maintained.

The recommended dose of fertilizers @80 kg N, 50 kg P and 40 kg K was applied in mustard in the form of Urea, SSP and MOP at the time of sowing as basal dose. Half of nitrogen, full dose of phosphorus and full recommended dose of potassium was applied at the time of sowing. Remaining half dose of nitrogen was applied as top dressing at 35 DAS. Organic sources in the form of vermicompost were applied uniformly in plots as per the treatment using broadcasting method and mixed properly with soil before sowing of seeds. A total of two irrigations was applied uniformly in all the plots. The first irrigation was given just after sowing and second irrigation was done at 35-40 DAS after top dressing of urea followed by pre flowering stage of crop. The simultaneous thinning and weeding were done by manual labour during 15-20 DAS to maintain the optimum plant population and to keep the weeds under control. Recommended agronomic practices were followed to raise the experimental crop. The data recorded were statistically analyzed following standard statistical analysis of variance as outlined by Panse and Sukhatme 1967 [17].

Results and Discussion

Growth parameters

The data regarding the growth parameters presented in (Table. 1) viz., plant height, number of branches plant⁻¹ and total dry matter accumulation plant⁻¹ were noted to differ significantly difference by integrated nutrient management at harvest. Application of 100% RDF + Vermicompost @ 5t ha⁻¹ + Azotobacter + PSB (T₅) had reported significantly higher plant height (190.51 cm), maximum number of branches plant⁻¹ (20.88) and total dry matter accumulation plant⁻¹ (61.23 g) as compared to all other treatments, and was found at par with 75% RDF + Vermicompost @ 5t ha⁻¹ + Azotobacter + PSB (T₉), 100% RDF + Vermicompost @ 5t ha⁻¹ + Azotobacter (T₄) and 75% RDF + Vermicompost @ 5t ha⁻¹ + Azotobacter (T₈). While, the significantly lower value of all these parameters was recorded with the treatment T₁- Absolute control. The improvement in these parameters under integrated nutrient management treatments may be attributed to the balanced and continuous supply of nutrients throughout the crop growth period. The combined use of inorganic fertilizers and organic manures ensured immediate nutrient availability followed by sustained nutrient release, enhancing nutrient uptake efficiency.

This balanced nutrient supply promoted vigorous vegetative growth, increased branching and produced taller plants also improved photosynthetic activity which enhanced translocation of photosynthates ultimately resulted in higher biomass production and dry matter accumulation. These results were in accordance with the findings of Saini *et al.* (2017) ^[20], Singh *et al.* (2018) ^[21], Reddy *et al.* (2018) ^[18], Chavan *et al.* (2021) ^[9], Gora *et al.* (2023) ^[10] and Awasthi *et al.* (2024) ^[5].

Yield Attributes

In integrated nutrient management treatments, application of 100% RDF + Vermicompost @ 5t ha⁻¹ + Azotobacter + PSB (T₅) had resulted in significantly highest number of siliqua plant⁻¹ (284.10), maximum length of siliqua (6.93 cm) and maximum number of seeds siliqua⁻¹ (15.54) (Table.2) over rest of the treatments and it was statistically at par with 75% RDF + Vermicompost @ 5t ha⁻¹ + Azotobacter + PSB (T₉), 100% RDF + Vermicompost @ 5t ha⁻¹ + Azotobacter (T₄) and 75% RDF + Vermicompost @ 5t ha⁻¹ + Azotobacter (T₈). However, the minimum value of all these parameters was recorded in the treatment T₁- Absolute control. The improvement in yield attributes of Indian mustard may be attributed to integrated approach to supply nutrients, leading to vigorous plant growth, better photosynthetic activity and better translocation of assimilates towards reproductive structures, which leads to enhanced flowering and pod setting as well as improved seed development as a result of higher availability of macro and micro nutrients. Vermicompost and biofertilizers also improved soil health and moisture retention, thereby adding in supporting better siliqua development and seed filling. These results were in conformity with the findings of Nagdive *et al.* (2007) ^[16], Thaneshwar *et al.* (2017) ^[23], Chandan *et al.* (2018) ^[8], Bhanuwanti *et al.* (2022) ^[6], Goyal *et al.* (2023) ^[11] and Singh *et al.* (2023) ^[22].

Yield

The significantly higher seed yield (15.70 q ha⁻¹) and straw yield (38.89 q ha⁻¹) was produced by application of 100% RDF + Vermicompost @ 5t ha⁻¹ + Azotobacter + PSB (T₅) (Table. 2) over rest of the treatments and it was remained at par with the treatments 75% RDF + Vermicompost @ 5t ha⁻¹ + Azotobacter

+ PSB (T₉), 100% RDF + Vermicompost @ 5t ha⁻¹ + Azotobacter (T₄) and 75% RDF + Vermicompost @ 5t ha⁻¹ + Azotobacter (T₈). While the minimum seed and straw yield was recorded in the treatment T₁- Absolute control. The maximum seed and straw yield of Indian mustard under integrated nutrient management treatments may be attributed to improvement in yield attributing parameters such as number of siliqua plant⁻¹, length of siliqua and number of seeds siliqua⁻¹ along with better nutrient uptake and translocation efficiency. The combined application of organic and inorganic sources ensured continuous nutrient availability throughout the crop growth period which enhanced physiological efficiency, photosynthetic rate and ultimately increased the accumulation and translocation of assimilates towards both vegetative and reproductive structures. Vermicompost not only supplied macro and micronutrient but also improved soil fertility and microbial activity, whereas Azotobacter contributed through biological nitrogen fixation and PSB solubilizes insoluble phosphorus, ultimately resulting in better nutrient uptake and plant vigour, because of that the seed count must have risen and improved yield, which leads to maximum seed and straw yield of mustard. Corroborative results have also been reported by Sahoo *et al.* (2010) ^[19], Singh *et al.* (2018) ^[21], Mishra *et al.* (2020) ^[15], Jaiswal *et al.* (2021) ^[12] and Kumar *et al.* (2025) ^[13].

Conclusion

On the basis of experimental results application of 100% RDF + Vermicompost @5t ha⁻¹+ Azotobacter + PSB (T₅) attained significantly higher growth parameters, yield contributing characters and yield of Indian mustard and it was found at par with the treatments T₉, T₄ and T₈ and from the overall performance and association studies of all the parameters it can be concluded that the application of only RDF fertilizers is not capable of exploiting the potential of Indian mustard in sustainable manner. Therefore, in addition of supplementary nutrients like Vermicompost in combination with biofertilizers like Azotobacter and PSB are essential to get the higher production and productivity. Thus, the treatment T₅ (100% RDF + Vermicompost @5t ha⁻¹+ Azotobacter + PSB) seems to be more promising for boosting the productivity and better economic outcomes of mustard in sustainable way.

Table 1: Effect of Integrated nutrient management on growth parameters of Indian mustard

Treatments	Plant height (cm)	Number of branches plant ⁻¹	Dry matter accumulation g plant ⁻¹
T ₁ : Absolute Control	139.90	10.01	17.80
T ₂ : 100% RDF (N:P: K) @ 80:50:40 kg ha ⁻¹	166.48	15.96	40.08
T ₃ : 100% RDF + Vermicompost @ 5 t ha ⁻¹	171.21	17.05	46.39
T ₄ : 100% RDF + Vermicompost @ 5t ha ⁻¹ + Azotobacter	180.23	20.22	56.94
T ₅ : 100% RDF + Vermicompost @ 5t ha ⁻¹ + Azotobacter + PSB	190.51	20.88	61.23
T ₆ : 75% RDF (N:P: K)	162.02	14.96	37.92
T ₇ : 75% RDF + Vermicompost @ 5t ha ⁻¹	170.00	16.25	41.43
T ₈ : 75% RDF + Vermicompost @ 5t ha ⁻¹ + Azotobacter	178.08	18.85	56.78
T ₉ : 75% RDF + Vermicompost @ 5t ha ⁻¹ + Azotobacter + PSB	186.61	19.94	57.93
S.Em ±	5.85	1.02	1.49
CD = (0.5%)	17.68	3.09	4.51

Table 2: Effect of Integrated nutrient management on yield attributes and yield of Indian mustard

Treatments	Number of siliqua plant ⁻¹	Length of siliqua (cm)	Number of seeds siliqua ⁻¹	Seed yield (q ha ⁻¹)	Straw yield (q ha ⁻¹)
T ₁ : Absolute Control	210.47	5.43	11.69	8.93	26.60
T ₂ : 100% RDF (N:P: K) @ 80:50:40 kg ha ⁻¹	239.32	6.22	12.94	12.96	34.77
T ₃ : 100% RDF + Vermicompost @ 5 t ha ⁻¹	250.91	6.37	13.56	13.47	35.74
T ₄ : 100% RDF + Vermicompost @ 5t ha ⁻¹ + Azotobacter	274.62	6.66	14.66	14.29	36.42
T ₅ : 100% RDF + Vermicompost @ 5t ha ⁻¹ + Azotobacter + PSB	284.10	6.93	15.54	15.70	38.89
T ₆ : 75% RDF (N:P: K)	229.23	6.04	12.54	11.09	32.12
T ₇ : 75% RDF + Vermicompost @ 5t ha ⁻¹	241.07	6.34	13.33	13.28	35.65
T ₈ : 75% RDF + Vermicompost @ 5t ha ⁻¹ + Azotobacter	266.23	6.65	14.32	14.06	36.16
T ₉ : 75% RDF + Vermicompost @ 5t ha ⁻¹ + Azotobacter + PSB	277.88	6.73	15.06	14.87	37.79
S.Em ±	6.53	0.15	0.53	0.65	1.03
CD = (0.5%)	19.75	0.47	1.61	1.97	3.12

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