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Research Communication

Effect of integrated nutrient management on timely sown crop of Indian mustard *(Brassica juncea)*

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ABSTRACT

A study was conducted during the winter (*rabi)* season of 2020–21 at the Maharishi Markandeshwar University, Ambala, Haryana to assess the effect of integrated nutrient- management on timely sown crop of Indian mustard (*Brassica juncea* (L.) Czernj & Cosson). The experiment consisted of 8 treatments, viz. T_1, *Azotobacter* + 100% recommended dose of fertilizers (RDF); T_2, *Azotobacter* + FYM 5 t/ha + 50% RDF; T_3, 100% RDF; T_4 , control; T_5, *Azotobacter* + vermicompost 5 t/ha + 50% RDF; T_6, *Azotobacter* + phosphate solubilizing bacteria (PSB) + 100% RDF; T_7, *Azotobacter* + PSB + FYM 5 t/ha + 50% RDF; T_8, *Azotobacter* + PSB + vermicompost 5 t/ha + 50% RDF, which were replicated thrice and laid out in the randomized block design. The results depicted that the growth and yield attributes such as no. of primary branches/plant (9.40), no. of secondary branches/plant (19.03), dry-matter accumulation (99.10 g/plant), plant height (210.47 cm), seeds/siliqua (13.90), siliqua/plant (371.63), length of siliqua (5.17 cm), 1000-seed weight (6.00 g) and as well as seed yield (2.28 t/ha) and straw yield (2.03 t/ha) were found highest under T_8.

***Key words*:** *Azotobacter*, Farmyard manure, Phosphate solubilizing bacteria, Recommended Dose of Fertilizer, Seed yield, Straw yield[1], Vermicompost

Demand of oilseed crops is increasing owing to augmented need for human consumption and other industrial purposes. Hence, efforts to expand area and production of these crop at the national and state levels must be made. Low productivity of Indian mustard [*Brassica juncea* (L.) Czernj & Cosson] is widening the gap between production and consumption (Bisht *et al.,* 2018). In India, Indian mustard production accounts for more than 70% of the area under the rapeseed-mustard group of crops. However, the productivity level of Indian mustard is decreased due to the inefficient use of nutrients which is one of the major causes of its low yield (Namdeo *et al.*, 2021).

Although use of inorganic fertilizers and pesticides has emerged as an important tool to increase crop production, a major portion of the applied chemical fertilizers is lost through the leaching, run-off, emissions and volatilizations which cause economic losses and serious environmental problems (Jerin *et al*., 2013). Indiscriminate use of fertilizers has reduced soil productivity by degrading soil health in terms of soil fertility and microbial activity (Kumar *et al*., 2018). 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 fertilizers helps to supply all the essential nutrients to plants which play a critical role in maximizing the yield potential of Indian mustard. When farmyard manure (FYM), vermicompost (VC) and bio-fertilizers like *Azotobacter* are used in conjunction with fertilizers, these improve the physical, chemical and biological properties of the soil (Selim, 2018). Therefore, integrated nutrient management is the best practice for all these problems (Bisht *et al*., 2018). Therefore, current study was conducted to evaluate the effect of integrated nutrient management on timely sown crop of Indian mustard in Haryana conditions.

The experiment was conducted at the experimental field of the Maharishi Markandeshwar University, Ambala, Haryana, during the winter season (*rabi*) of 2020–21. The average maximum temperature ranges from 17°C in January to 45°C in June and the minimum 4°C to 25°C during January to June.

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The soil texture of the experimental area was sandy clay loam, with a moderate level of available nitrogen, phosphorus and potassium.

The experiment was laid out in the randomized block design, which included 8 treatments, viz. T_1, *Azotobacter* + 100% recommended dose of fertilizer (RDF); T_2, *Azotobacter* + FYM 5 t/ha + 50% RDF; T_3, 100% RDF; T_4, control; T_5, *Azotobacter* + vermicompost 5 t/ha + 50% RDF; T_6, *Azotobacter* + phosphate solublizing bacteria (PSB) + 100% RDF; T_7, *Azotobacter* + PSB + FYM 5 t/ha + 50% RDF; T_8, *Azotobacter* + PSB + vermicompost 5 t/ha + 50% RDF. The treatments were replicated thrice. The seed was sown on 20 October, 2020.

The recommended dose of 80 : 30 : 20 kg/ha of N : P_2O_5 : K_2O was applied in Indian mustard. As a basal dose, a half-dose of nitrogen and a full dose of P_2O_5 and K_2O were applied and the remaining nitrogen was top-dressed at 30 days after sowing (DAS). The seed was treated with *Azotobacter* and phosphorus solubilizing bacteria (PSB). The treatment-wise vermicompost and FYM were incorporated in the field before sowing. Nitrogen, phosphorus, potassium were applied through urea, single superphosphate and muriate of potash, respectively. The seed was sown at a rate of 2.5 kg/ha.

The data revealed that the plant height of Indian mustard at harvesting was influenced by various treatments (Table 1). The plant height increased significantly with the integrated application of fertilizers. The highest plant height at harvesting was observed in treatment T_8 (210.47 cm). However, it was at par with T_7. The lowest plant height was recorded in the control plot. Kumar *et al*. (2018) also found significantly highest plant height with the integrated application of organic, inorganic and biofertilizers seed treatment over single or no fertilizer application. The number of primary branches (Table 1) were maximum under treatment T_8 (9.40), followed by T_7, while the minimum (8.07) was recorded under treatment, where no fertilizer was applied. Bisht *et al.,* (2018) also reported an increase in the number of primary branches with balanced use of nitrogen.

The treatment T_8 also resulted in maximum number of secondary branches (19.03) followed by T_7, while the minimum was recorded under T_4 (control). Data revealed that, dry-matter accumulation significantly increased under T_6, T_7 and T_8 treatments, which were statistically at par. However, other treatments had no significant effect on dry-matter accumulation. These results confirm the findings of Singh *et al.,* (2018 a) and Mahato *et al.,* (2020). The available plant nutrients and growth-promoting substances in vermi-compost may have a good impact on plant growth, which helps to improve plant population as well as plant height, and resulted higher dry-matter accumulation. Apart from this, biofertilizers release many essential nutrients and growth-regulating substances, which improve translocation of solute, resulting in more accumulation of photosynthate, which was translocated from source to sink in Indian mustard.

Number of siliquae/plant was considerably affected by different combinations of organic and chemical fertilizers along with bio-fertilizers. The data given in Table 1 revealed that, all the treatments significantly increased the number of number of siliquae/plant over the control. The number of siliquae/plant (371.63) was the highest under treatment T_8, which was at par with T_7 (364.01), whereas the number of siliquae/plant was lowest under T_4 (control) followed by T_2 treatment.

The higher number of seeds/siliqua (13.90) was observed under T_8 followed by T_7 (13.10). The length of siliqua was significantly influenced by the addition of organic manures, inorganic fertilizers and bio-fertilizers. The ranged between the lengths of siliqua was 4.24–5.17 cm in

Table 1. Effect of integrated nutrient management on growth attributes

Treatment	Primary branches/ plant	Secondary branches/ plant	Dry-matter accumulation (g/plant)	Plant height at harvesting (cm)	Silique/ plant	Seeds/ siliqua	Length of siliqua (cm)	1,000-seed weight (g)
T_1	8.83	18.40	96.07	203.43	349.80	12.37	4.78	5.63
T_2	8.30	17.70	92.93	200.33	323.97	11.73	4.43	5.04
T_3	8.70	18.17	95.87	202.43	346.03	12.17	4.68	5.47
T_4	8.07	17.40	92.10	199.53	304.50	11.10	4.24	4.97
T_5	8.50	18.00	93.84	201.17	332.87	12.00	4.50	5.16
T_6	9.03	18.67	96.57	205.53	357.67	12.63	4.89	5.79
T_7	9.20	18.80	97.90	206.03	368.47	13.10	5.00	5.93
T_8	9.40	19.03	99.10	210.47	371.63	13.90	5.17	6.00
SEm±	0.05	0.03	1.33	1.17	2.51	0.14	0.04	0.07
CD (P=0.05)	0.16	0.10	4.04	3.55	7.62	0.41	0.12	0.20

T_1, *Azotobacter* + 100% recommended dose of fertilizer (RDF); T_2, *Azotobacter* + FYM 5 t/ha + 50% RDF; T_3, 100% RDF; T_4, control; T_5, *Azotobacter* + vermicompost 5 t/ha + 50% RDF; T_6, *Azotobacter* + phosphate solublising bacteria (PSB) + 100% RDF; T_7, *Azotobacter* + PSB + FYM 5 t/ha + 50% RDF; T_8, *Azotobacter* + PSB + VC 5 t/ha + 50% RDF different treatments. The treatment T_8 had the longest siliqua length (5.17 cm) followed by T_7.

All the treatments significantly increased 1,000-seed weight over control, except T_2 and T_5 treatments (Table 1). The maximum test weight (6.00 g) was recorded under T_8, which was found at par with T_7. Our results confirm the findings of Thaneshwar *et al.,* (2017). The integrated nutrient-management contains essential nutrients, which activate the metabolic activities in plants and helps to enhance the seed size.

The highest seed yield (2.28 t/ha) was obtained under T_8 treatment followed by T_7. Treatment T_7 and T_8 were significantly better in terms of seed yield than 100% RDF, whereas all the other treatments were at par with T_3. With application of organic amendments, biofertilizers and inorganic fertilizers, the availability of essential nutrients, their acquisition, mobilization and influx into the plant tissues increase and thus improves growth attributes, yield components and finally yield of Indian mustard. These results are in agreement with the findings of Singh and Sinsinwar (2006), Tripathi *et al.,* (2010) and De *et al.,* (2013). The enhanced seed yield owing to the application of organic and inorganic fertilizers could be due to adequate nutrient availability to the crop which improved growth and yield attributes that contributed to higher seed yield.

Table 2. Effect of integrated nutrient management on yield of Indian mustard

Treatment	Seed yield (t/ha)	Straw yield (t/ha)	Biological yield (t/ha)
T_1	1.85	2.79	4.64
T_2	1.64	2.56	4.20
T_3	1.76	2.69	4.45
T_4	1.15	2.14	3.28
T_5	1.70	2.62	4.32
T_6	1.92	2.86	4.77
T_7	2.04	3.02	5.06
T_8	2.28	3.21	5.50
SEm±	0.07	0.04	0.09
CD (P=0.05)	0.202	0.12	0.28

T_1, *Azotobacter* + 100% recommended dose of fertilizer (RDF); T_2, *Azotobacter* + FYM 5 t/ha + 50% RDF; T_3, 100% RDF; T_4, Control; T_5, *Azotobacter* + vermicompost 5 t/ha + 50% RDF; T_6, *Azotobacter* + phosphate solubilising bacteria (PSB) + 100% RDF; T_7, *Azotobacter* + PSB + FYM 5 t/ha + 50% RDF; T_8, *Azotobacter* + PSB + vermicompost 5 t/ha + 50% RDF

The straw yield of Indian mustard was improved significantly by all the treatments over control (Table 2). Treatment T_8 resulted in the maximum straw yield (3.21 t/ha) followed by T_7. However, control plots gave the minimum straw yield (2.14 t/ha). The results confirm the findings of Thaneshwar *et al*., (2017) and Singh *et al.* (2018 b).

The maximum biological yield (5.50 t/ha) was obtained under treatment T_8 followed by T_7, whereas the control gave the lowest. The application of organic and inorganic nutrient supply resulted in enhanced plant height, dry matter, and vegetative development, resulting in greater straw yield and grain yield, and eventually the largest total biomass production in Indian mustard.

Thus, integrated application of *Azotobacter* + PSB + vermicompost 5 t/ha + 50% RDF was best in respect of growth and yield parameters of Indian mustard followed by *Azotobacter* + PSB + FYM 5 t/ha + 50% RDF. Biofertilizers and organic manures supply all the essential macro and micronutrients to the plants, which helps to maintain the long term soil fertility and sustainability through nitrogen fixation by micro-organisms. Moreover, inorganic fertilizers enhance the yield of crop. It can be concluded that the integrated application of organic, inorganic and biofertilizers has a positive influence on the crop yield. A balanced and integrated nutrient management practice helps in increasing crop production.

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