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Integrated nutrient management in relation to yield and uptake of nutrients in mustard crop (*Brassica juncea* L.)

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Abstract
A field experiment was carried out during the winter (Rabi) season of 2021-22, at the student's instructional farm, Aks University, Shergunj, Satna (M.P.) to ascertain Integrated Nutrient Management in Relation to Yield and uptake of Nutrients in Mustard Crop (*Brassica juncea* L.).The experiment consisted of twelve treatments i.e. T_1-Control,T_2-50% RDF + FYM, T_3- 50% RDF + Azotobactor + PSB,T_4-50% RDF + S, T_5-50% RDF + FYM + Azotobactor + PSB,T_6-75% RDF + S, T_7-75% RDF + FYM,T_8 - 75% RDF + Vermicompost, T_9-75% RDF + Azotobactor,T_{10}-100% RDF,T_{11}-100% RDF + S,T_{12}-100% RDF + Vermicompost. The experiment was laid out in randomized block design with three replications. Growth parameters like Plant height and Number of Silique per plant were noted highest with treatment T_{12} (100% RDF + Vermicompost). Yield attributing characters such as Number of Seeds per Silique, 1000 Seed Weight and Grain yield were found significantly higher with increasing the level of NPK. Finally concluded that higher nutrient uptake (NPKS) was observed when FYM +Vermicompost +Sulphur was integrated with the inorganic fertilizer compared to the inorganic fertilizer applied alone. The combination of FYM and biofertilizer with inorganic fertilizers improved soil fertility compared to applying inorganic fertilizers alone.

Keywords: RDF, INM, mustard, FYM, vermicompost, sulphur

Introduction
Oil-seed crops are important in India's agricultural economy. The mustard plant is one of several plant species in the Brassicaceae family (the mustard family). Mustard oil can be made from the seeds, and the edible leaves can be consumed as mustard greens. Rapeseed and mustard [*Brassica juncea* (L) Czern and Coss] are important oilseed crops, but their productivity in the state is well below their potential yield, which can only be raised through balanced fertilization and other management measures, particularly Sulphur and zinc in semiarid soils. Organic manures, such as FYM, compost, and biofertilizers, are less expensive and more environmentally friendly than chemical fertilizers, and might be used to improve crop productivity and system sustainability. Using vermicompost in combination with fertilizers not only provides macronutrients, but also meets micronutrient requirements while maintaining soil physico-chemical characteristics. Nitrogen is a crucial plant nutrient as it is associated with vegetative growth. The quantity of N supplied to the crop and environmental factors may affect the amount of protein product, in addition to its role in the formation of proteins, it is an integral part of the chlorophyll molecule. Phosphorus is the second most important essential nutrient after nitrogen. When it comes to crop productivity and quality, phosphorus is known as "The Master Key" among the NPK elements. The most noticeable effect of Phosphorus has been seen on the root system of plants, as it promotes the production of lateral and fibrous roots. Potassium has been linked to photosynthesis, the maintenance of turgor in plant cells, the creation of oils, and the transmission of disease resistance. There have been instances of yield reductions despite the usage of NPK fertilizers on a regular basis. The loss in productivity is usually related to a lack of secondary nutrients and micronutrients, especially in oil seed crops. Sulphur fertilization not only increases grain output, but it also enhances crop quality, this is mainly due to its association with Sulphur containing amino acids like cystine, cystines, methionine and quality of protein.

Materials and Method

The experiment was conducted during Rabi season of 2021-22 at instructional farm, AKS University, Satna in clay loamy soil. Geographically it is situated in Gird zone at the latitude of 24°. 56' North and longitude 80°.79' east with an altitude of 315 meters above mean sea level. Soil of the experimental plot was clay loamy in texture with pH (7.8), EC (0.10) dS/ m, organic carbon (0.78%) soil. The soil was low in available Nitrogen (229.9 kg/ha), in available Phosphorus (8.937 kg / ha) and medium in available Potassium (179.8 kg / ha).The experiment was conducted in a randomized block design with three replications and twelve treatments *viz.* T_1-Control,T_2-50% RDF + FYM, T_3- 50% RDF + Azotobactor + PSB,T_4-50% RDF + S, T_5-50% RDF + FYM + Azotobactor + PSB,T_6-75% RDF + S, T_7-75% RDF + FYM,T_8 - 75% RDF + Vermicompost, T_9-75% RDF + Azotobactor,T_{10}-100% RDF,T_{11}-100% RDF + S,T_{12}-100% RDF + Vermicompost. The experimental field was prepared by one ploughing with tractor drawn plough and followed by harrowing and planking to achieve fine tilth. The mustard (Pusa Vijay) was sown @ 5kg/ha at a depth of 3 cm. Full dose of P and K while half dose of N was applied as basal dose at the time of sowing where rest of N was given in two split doses during experimentation. The data collected on growth, yield attributes and yields were statistically analyzed. (Panse and Sukhatme 1985) [1].

Result and Discussion

The plant height and number of silique per plant were significantly affected by different levels of INM. Increasing the level of fertilizers upto 100%RDF Significantly increased the plant height and the number of silique per plant (table 1). Application of FYM in the treatment T_{12} showed highest plant height and number of silique per plant. This increase in plant height of mustard might be due better availability of nutrient through both chemical and organic sources of the nutrient throughout the crop growth stages, where the chemical fertilizer supplied the nitrogen at initial growth stages of the crop and organic manures at later stages through slow and steady release of nitrogen. These results are in conformity with the findings of Rajput *et al.* (2018) [2].

It is observed that the Yield and yield attributes were significantly influenced by the application of different combinations of organic and chemical fertilizers along with bio-fertilizers. The data revealed in the (table 2) highest number of Seeds per Silique, was recorded when T_{12} (100% RDF + Vermicompost) was applied which was (13.07).1000 seed weight (5.06 g) and Seed yield (19.50 qha^{-1}) were recorded maximum in T_{11} (100% RDF + S) followed by T_{12} (100% RDF + Vermicompost) minimum was observed in T_1 (Control) plot where none of the fertilizer was applied.

The increase in no. of seeds/silique of Mustard with this treatment might be due better availability of nutrient through both chemical and organic sources of the nutrient throughout the crop growth stages. The increase in grain and straw yield of mustard with this treatment was due to significantly higher plant height, dry matter accumulation, number of Silique, test weight etc. which all these growth and yield attributing characters contributed to final yield of the mustard crop. These results are in conformity with the findings of Singh *et al.* (2015) Tripathi *et al.* (2011) Ghatei *et al.* (2013) and Pandey *et al.* (2018) [3, 4, 5, 6]. These findings clearly indicate that optimum supplied of fertilizers combined with organics which provide opportunity for seeds to grow their full potential, with an obvious increase in Test weight as observed in the study.

Nutrient uptake differed significantly due to application of different treatment presented in (Table 3). The utilization of nitrogen, Phosphorus, potash and Sulpher by mustard seed and Stover was showed significantly higher over the control. Maximum uptake of Nitrogen (kg/ha) by seed and straw was recorded when T_{12} (100% RDF + Vermicompost) followed by T_{11} (100% RDF + S). The higher nitrogen content and uptake of mustard with these treatments was due to higher availability of nitrogen in adequate amount, which was supplied through chemical fertilizer during active growth stages of the crop and steadily supplied through organic manures at development and reproductive stages of the crop. These results are in conformity with the findings of Ghatei *et al.* (2013) and Keerthi *et al.* (2017) [5, 7]. The interaction between N and S was synergistic and hence application of S increases the concentration and uptake of nitrogen.

Maximum uptake of Phosphorus (kg/ha), Potassium (kg/ha) and Sulphur (kg/ha) by straw and seed was recorded when T_{12} (100% RDF + Vermicompost) was applied which was followed by T_8 (75% RDF + Vermicompost). Application of higher recommended dose of chemical fertilizer in combination with organic manures and biofertilizers increased the uptake by grain and straw. Among all treatments the significantly higher uptake by grain and straw of mustard were recorded with application of 100% RDF + Vermicompost which was statistically at par with application of 75% RDF +Vermicompost. These results are in conformity with the findings of Tripathi *et al.* (2011), Sharma *et al.* (2017) and Mandal and Sinha (2002) [4, 8, 9].

Table 1: Effect of Integrated nutrients management on growth parameters such as plant height (cm) and number of silique per plant

Treatment	Plant Height (cm)			Number of Silique per Plant
	30 DAS	60 DAS	90 DAS	
T_1 – Control	28.92	69.77	141.66	129.07
T_2 - 50% RDF + FYM	30.59	72.35	147.69	161.93
T_3 - 50% RDF + Azotobactor + PSB	30.98	73.01	147.82	154.67
T_4 - 50% RDF + S	31.13	71.98	149.96	150.93
T_5 - 50% RDF + FYM + Azotobactor + PSB	31.44	75.07	152.09	163.47
T_6 - 75% RDF + S	33.48	76.51	157.85	164.87
T_7 - 75% RDF + FYM	35.07	79.62	167.35	173.07
T_8 - 75% RDF + Vermicompost	34.33	78.07	166.39	174.27
T_9 - 75% RDF + Azotobactor	35.02	78.65	159.09	168.53
T_{10} - 100% RDF	38.79	84.86	169.11	181.53
T_{11} - 100% RDF + S	40.30	88.84	179.99	178.40
T_{12} - 100% RDF + Vermicompost	40.26	91.87	180.98	185.07

SEm±	1.683	2.981	4.296	4.549
C.D. (P = 0.05)	4.968	8.8	12.682	13.427

Table 2: Effect of Integrated nutrients management on yield parameters such Number of Seed per Silique, 1000 seed weight (g) and seed yield (kg/ha)

Treatment	Number of Seed per Silique	1000 seed weight (g)	Seed Yield (q/ha)
T_1 – Control	9.20	3.60	12.02
T_2 - 50% RDF + FYM	10.73	4.20	13.55
T_3 - 50% RDF + Azotobactor + PSB	11.07	4.33	14.27
T_4 - 50% RDF + S	10.47	4.32	15.30
T_5 - 50% RDF + FYM + Azotobactor + PSB	11.13	4.40	14.39
T_6 - 75% RDF + S	11.40	4.61	15.55
T_7 - 75% RDF + FYM	11.20	4.49	14.52
T_8 - 75% RDF + Vermicompost	12.07	4.59	14.94
T_9 - 75% RDF + Azotobactor	12.20	4.60	14.50
T_{10} - 100% RDF	12.73	4.81	16.89
T_{11} - 100% RDF + S	12.60	5.06	19.50
T_{12} - 100% RDF + Vermicompost	13.07	4.91	18.25
SEm±	0.41	0.166	0.657
C.D. (P = 0.05)	1.211	0.491	1.939

Table 3: Effect of Integrated nutrients management on nutrients uptake such as nitrogen uptake, phosphorus uptake, potassium uptake and sulphur uptake in seed and straw of mustard

Treatments	Nitrogen (kg/ha)		Phosphorus(kg/ha)		Potassium (kg/ha)		Sulphur (kg/ha)	
	Seed	Straw	Seed	Straw	Seed	Straw	Seed	Straw
T_1 – Control	36.02	28.02	4.84	6.68	5.49	47.12	10.11	4.80
T_2 - 50% RDF + FYM	52.70	41.32	9.51	11.27	10.65	80.65	17.30	9.29
T_3 - 50% RDF + Azotobactor + PSB	49.84	41.84	10.40	11.50	10.58	86.75	15.87	10.41
T_4 - 50% RDF + S	45.55	35.21	8.42	9.86	9.71	76.14	13.74	8.65
T_5 - 50% RDF + FYM + Azotobactor + PSB	56.38	43.54	11.20	13.77	10.90	91.25	17.95	10.61
T_6 - 75% RDF + S	53.73	45.49	9.51	11.58	10.23	83.08	16.63	8.91
T_7 - 75% RDF + FYM	57.39	46.49	11.69	13.08	11.86	95.53	18.27	10.72
T_8 - 75% RDF + Vermicompost	57.69	49.69	11.73	13.83	12.16	100.78	18.65	11.13
T_9 - 75% RDF + Azotobactor	53.59	43.59	9.77	12.60	10.66	97.70	16.47	9.52
T_{10} - 100% RDF	56.51	48.51	9.57	12.37	9.24	77.82	15.14	9.30
T_{11} - 100% RDF + S	59.80	49.63	9.73	12.70	10.78	90.37	15.70	10.72
T_{12} - 100% RDF + Vermicompost	68.36	60.49	13.28	15.41	13.28	112.63	20.71	12.35
S Em ±	2.649	2.566	0.773	0.767	0.773	5.56	0.888	0.81
C.D. (P = 0.05)	7.891	7.574	2.283	2.236	2.283	16.293	2.621	2.392

Conclusion

Application of optimum levels of NPK (N_{80} P_{60} K_{40}) recorded significant higher yield by 28.1%, 25.4% over 50%NPK and 75% NPK respectively. Application of 100% NPK levels significantly increased mustard seed yields over those obtained at 50 and 75% NPK levels. The maximum seed yields (19.84 q/ha) observed with 100%NPK +S were effective as 100% of NPK levels. Adding Vermicompost containing 75% and 100% NPK increased the mustard seed yield. Higher nutrient uptake (NPKS) was observed when FYM +Vermicompost +Sulphur was integrated with the inorganic fertilizer compared to the inorganic fertilizer applied alone. The combination of FYM and bio-fertilizer with inorganic fertilizers improved soil fertility compared to applying inorganic fertilizers alone.

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