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Effect of integrated nutrient management on Indian mustard yield attributes and yield

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Abstract
A field experiment was laid out during *rabi*–season 2019-2020 at Institute of Agriculture Sciences, SAGE university Indore (Madhya Pradesh) to the effect of two levels of RDF (100% and 75%) with two organic manure (poultry manure and vermicompost) and two biofertilizer (Azotobacter and Azospirillium) on indian Hybrid Mustard NRCH B506 (*Brassica juncea* L.). the yield attributes like no. of siliqua per plant, No. of seed per plant, test weight of seed, and as well as stover yield significantly increased with the application of vermicompost over control. seed inoculation with using of microbial culture highly increased the stover and seed yield. Treatment T9 that is 75% RDF+S @ 40 kg ha^{-1}+Vermicompost @ 5 t ha^{-1}+Azotobacter+PSB was observed remarkable highest yield attributes and stover yield as well as seed yield followed by Treatment T8 75% RDF + S@ 40 kg ha^{-1} + Vermicompost @ 5t ha^{-1}. Maximum seed yield was obtained by using bio-fertilizer in treatment combination.

Keywords: Biofrtilizer, poultry manure, vermicompost, azotobacter, organic manure

Introduction
India is the third largest producer of rapeseed-mustard occupying 5.79 million hectares area with 6.31 million tonnes production, but the average yield of rapeseed-mustard in India is only 1089 kg ha^{-1}, due to the lack of optimum use of nutrients and improper management. Rapeseed -mustard are the major *Rabi* oilseed crops of India and stand next to groundnut in the oilseed economy. The contribution of rapeseed-mustard to the total oilseed production in India is 26.0 percent by Piri *et al.,* (2019) [6].

Rapeseed-mustard major *Rabi* oilseed crops of India stand next to groundnut. The contribution of rapeseed-mustard to the total oilseed production in India is 26.0 percent. Domestic productions of edible oils meet only 50% of the total requirements, while rest is imported. The huge gap between the consumption and domestic production of edible oils can be filled up by either increasing the area under oilseed crops like rapeseed and mustard, sunflower and soybean or increasing production per unit area. To produce the additional quantity of oilseed, the only option to enhance productivity under limited resource conditions. The imbalanced and inadequate supply of fertilizers accompanied by restricted use of organic manures not only leads to limit the yield potential but soils also get deficient in the nutrients which deteriorate the soil health with decline in crop response. In order to bring the soil well supplied with all the essential plant nutrients, the organic manures being cheaper and eco-friendly could be alternative to fertilizers for improving both crop productivity and sustainability of the systems. Integration of vermicompost with fertilizers, not only supply macronutrients but also meet the requirement of micronutrients, the productivity is quite lower due to sub-optimal application of fertilizers and cultivation on marginal lands under rain fed conditions. Further the quality of mustard oil and its cake is an important aspect affected greatly by mineral nutrition (Tripathi *et al*. 2010) [12]. Intensive cultivation and use of unbalanced and inadequate fertilizers accompanied by restricted use of organic manures have made the soils not only deficient in the nutrients, but also deteriorated the soil health resulting in decline in crop response to the recommended dose of NPK fertilizers in the region.

Use of chemical fertilizers in combination with organic manure is essentially required to improve the soil health (Prasad *et al.,* 2017) [7]. Chemical fertilizers alone cannot sustain the desired levels of crop production under continuous farming. Integrated nutrient management is very essential which is not only sustains high crop production over the years (Verma *et al.,* 2016) [13] but also improves soil health and ensures safer environment (Babu *et al.,* 2017) [1]. The nutrient supplied to crops through INM not only restoring the soil fertility but also sustain desired level of production over the years (Pal and Pathak, 2016) [5]. Rapeseed-mustard oils are of high-value agricultural commodity for use in refined edible oil products and as renewable industrial or fuel oils.

The various macro and micronutrients are required for quantitative and qualitative oilseed production. Sulphur and zinc have marked effect on mustard yield, oil content & oil quality and soil properties. The balanced nutrient management through conjunctive use of organic, inorganic and bio-fertilizers facilitate profitable and sustainable crop production it's also maintain soil quality (Singh and Sinsinwar, 2016) [10]. Keeping all the above facts in view, the present investigation was undertaken to study the "Effect of Integrated Nutrient Management on Indian Mustard

Method and Material

The field Experiment conducted at Institute of Agriculture sciences at SAGE University Indore (Madhya Pradesh) during the winter season of 2019-2020. The field experiment consisting 11 Treatment with combination of two organic manure application that is Vermicompost and Poultry Manure and two Bacterial culture that is PSB and Azotobacter with 2 level of RDF(Recommended dose of Fertilizer) that is 100 % RDF and 75% RDF laid out in RBD Design with 3 replication. Mustard NRCHB 506 hybrid was sown in 30 cm row to row distance and 10 cm Plant to plant distance using 5 kg/hac on 20 oct 2019. The seeds were cultured with PSB and azotobacter and dried under shade for half an hour before sowing. The crop was thinned 15 days after sowing. Application of Nutrients as a RDF in the ratio of 80:40:40, half dose of nitrogen applied as basal at the time of sowing and remaining half apply as top dreesed after 35 DAS as well as full dose of P2O5 @ 40 kg /hac, K2O @ 40 Kg/hac and Sulpher @ 40 Kg per hac were applied as basal dose. In the term of organic manure poultry manure and vermicompost used as a basal dose at the rate of 2t/hac and 5 t/hac repectivaly.

Result and Discussion

Response of INM on yield attributes

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 showed in (Table 1) revealed that the highest number of siliqua plant^{-1} (461.0), maximum no. of seeds siliqua^{-1} (14.93) and test weight of seed significantly increased were recorded in treatment T_9 (75% RDF+S@40kg ha^{-1}+Vermicompost @5t ha^{-1}+Azotobacter+PSB), followed by T_8 &T_{10}, whereas, the lowest number of siliqua plant^{-1} was recorded in T_1 (control). The chemical and organic fertilizers along with microbial inoculants applied in integrated pattern might be due to sufficient nutrients throughout the growth period. These results are in conformity with the finding of Pal *et al*, (2018) who obtained increased values of yield attributes and yield of mustard due to application of complete INM package along with 100% of recommended dose of fertilizers. The results is in conformity with the finding of Rundal *et al*, (2013) [8] and Bhati *et al*, (2014) [2]. 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. With the results of Malhi *et al*, (2017) and Sattar *et al*, (2018) who reported that Test weight of mustard increased with increasing level of sulphur up to 60 kg ha^{-1} corroborate.

Table 1: Effect of integrated nutrient management on yield attributes of Indian mustard

Treatment	No. of siliqua plant^{-1}	No. of seeds siliqua^{-1}	Test weight (gm)
T_1=Absolute Control	388.67	11.58	2.94
T_2=100% RDF(N,P,K) @ 80:40:40 + S@ 40 kg ha^{-1}	438.33	12.23	3.27
T_3=100% RDF + S@ 40 kg ha^{-1} + Vermicompost @ 5t ha^{-1}	483.33	12.67	3.40
T_4=100% RDF + S@ 40 kg ha^{-1} + Vermicompost @ 5t ha^{-1} + Azotobacter +PSB	489.33	13.49	3.51
T_5=100% RDF + S@ 40 kg ha^{-1} + Poultry manure @ 2t ha^{-1}	483.52	13.79	3.73
T_6=100% RDF + S@ 40 kg ha^{-1} + Poultry manure @ 2t ha^{-1} + Azotobacter +PSB	485.33	13.84	3.36
T_7=75% RDF + S@ 40 kg ha^{-1}	455.33	14.23	3.29
T_8=75% RDF + S@ 40 kg ha^{-1} + Vermicompost @ 5t ha^{-1}	487.67	14.29	3.34
T_9=75% RDF + S@ 40 kg ha^{-1} + Vermicompost @ 5t ha^{-1}+ Azotobacter +PSB	494.81	14.93	3.86
T_{10}=75% RDF + S@ 40 kg ha^{-1}+ Poultry manure @ 2t ha^{-1}	463.67	14.34	3.26
T_{11}=75% RDF + S@ 40 kg ha^{-1}+ Poultry manure @ 2t ha^{-1} + Azotobacter +PSB	475.67	14.45	3.39
SEm ±	6.85	0.52	0.12
C.D (P=0.05)	17.23	1.38	0.34

Response of INM on Mustard Yield

The grain yield, Stover yield and Harvest Index differed significantly due to addition of different combinations of organic and inorganic fertilizers treatments. It was observed that there was remarkable seed yield obtained against control. The data showed in (Table 2) confirmed that, Amongst the treatments, T_9 seems more effective than others with respect to seed yield., Stover yield and Harvest Index This improvement in seed yield is might be due to improvement of soil pH, properties of soil due to vermicompost and poultry manures and instant availability of nutrients from inorganic fertilizers. Lepcha *et al*, (2015) [3] evaluated the combined effect of organic and inorganic sources of N observed similar results in case of harvesting index.

The yield enhancement obtained in present study were also in agreement with the finding of Piri *et al.*, (2012) who stated that may be due to the effect of sulphur in increasing growth attributes. The beneficial effect of combined application of FYM and liming improving condition of the acid soil for achieving higher seed yield of mustard has been reported by Saha *et al*, (2010) [9], Rundal *et al.*, (2013) [8] also obtained similar results in case of straw yield.

Table 2: Effect of integrated nutrient management on seed & stover yield, and Harvest Index (%) of Indian mustard

Treatment	Seed yield (kg ha^{-1})	stover yield (kg ha^{-1})	Harvest Index (%)
T_1=Absolute Control	856.81	3269	17.35
T_2=100% RDF(N,P,K) @ 80:40:40 + S@ 40 kg ha^{-1}	1278.35	5303	18.12
T_3=100% RDF + S@ 40 kg ha^{-1} + Vermicompost @ 5t ha^{-1}	1375.34	5535	18.46

T_4=100% RDF + S@ 40 kg ha^{-1} + Vermicompost @ 5t ha^{-1} + Azotobacter +PSB	1416.45	5567	20.19
T_5=100% RDF + S@ 40 kg ha^{-1} + Poultry manure @ 2t ha^{-1}	1443.68	5540	20.35
T_6=100% RDF + S@ 40 kg ha^{-1} + Poultry manure @ 2t ha^{-1} + Azotobacter +PSB	1473.45	5433	19.95
T_7=75% RDF + S@ 40 kg ha^{-1}	1486.61	5645	20.04
T_8=75% RDF + S@ 40 kg ha^{-1} + Vermicompost @ 5t ha^{-1}	1504.56	5644	20.32
T_9=75% RDF + S@ 40 kg ha^{-1} + Vermicompost @ 5t ha^{-1}+ Azotobacter +PSB	1582.24	5916	20.97
T_{10}=75% RDF + S@ 40 kg ha^{-1}+ Poultry manure @ 2t ha^{-1}	1494.46	5675	20.25
T_{11}=75% RDF + S@ 40 kg ha^{-1}+ Poultry manure @ 2t ha^{-1} + Azotobacter +PSB	1468.34	5713	20.22
SEm ±	18.43	89.53	0.037
C.D (P=0.05)	52.27	262.83	0.125

Response to Nutrient content in seed and stover

The data showed in (Table 3) revealed that the application of recommended fertility level and its incorporation with organics and bio-fertilizers observed significantly higher concentration of N, P, K & S in seed and stover of mustard. The highest nitrogen, Phosphorus, Potash and Sulpher content in seed and stover (4.19 & 0.67 %) were observed with input applied through 75% RDF+S @ 40 kg ha^{-1}+Vermicompost @ 5 t ha^{-1}+Azotobacter+PSB at this dose nitrogen registering 29.32 and 36.73% increased numerically over control followed by T8.

Table 3: Effect of integrated nutrient management on N, P, K & S content (%) in seed & stover of Indian mustard

Treatments	N%		P%		K%		S%	
	Seed	stover	Seed	Stover	Seed	stover	Seed	stover
T_1	3.24	0.49	0.59	0.23	0.86	1.45	0.15	0.36
T_2	3.96	0.57	0.63	0.24	0.94	1.68	0.17	0.39
T_3	3.99	0.62	0.67	0.28	0.96	1.69	0.23	0.39
T_4	4.03	0.64	0.69	0.29	0.99	1.66	0.26	0.44
T_5	4.09	0.63	0.72	0.29	1.16	1.71	0.29	0.47
T_6	4.08	0.65	0.73	0.30	1.18	1.73	0.29	0.51
T_7	4.12	0.58	0.75	0.30	1.2	1.73	0.33	0.53
T_8	4.18	0.65	0.77	0.32	1.24	1.72	0.35	0.59
T_9	4.19	0.67	0.78	0.33	1.27	1.74	0.36	0.64
T_{10}	4.14	0.65	0.77	0.33	1.21	1.72	0.34	0.62
T_{11}	4.14	0.66	0.76	0.32	1.22	1.71	0.34	0.58
SEm±	0.21	0.034	0.031	0.01	0.013	0.024	0.01	0.01
C.D (P=0.05)	0.05	0.05	0.04	0.03	NS	0.071	0.02	0.02

Response to Nutrient uptake in seed and Stover

Nutrient uptake differed significantly due to application of different treatment presented in (Table 4). The utilization of nitrogen, Phosphorus, potash and Sulpher by mustard seed and Stover was showed significantly higher over the control. The maximum nitrogen, Phosphorus, potash and Sulpher utilization in seed and Stover was recorded in T_9 where applied 75% RDF+S@40kg ha^{-1}+Vermi@5t ha^{-1}+Azotobacter +PSB followed by T8. The seed of mustard utilized greater amount of N than those of strove. Devi *et al*, (2012) revealed that the highest nitrogen uptake was recorded with the application of 60 Kg S ha^{-1} at all the growth staged and by seeds. The interaction between N and S was synergistic and hence application of S increases the concentration and uptake of nitrogen.

The highest percentage of P uptake in seed and stover (144%) and (164%) over the control and increase of nutrient concentration and uptake with application of chemical fertilizers along with vermicompost and poultry manure inoculated with Azotobactor and PSB might be due to gradual mineralization and availability of nutrients and improving the physical condition of soil. The finding was supported by Sukhmal *et al*, (2004). This may be due to favourable effect of physical and chemical environment of soil with FYM application which causes continuous supply of nutrients (Mandal and Sinha, 2002) [4]. Sulphur application with organics has a positive influence of availability of sulphur. (Singh *et al*, 2013) [11].

Table 4: Effect of integrated nutrient management on uptake of N, P, K and S (kg ha^{-1}) in seed and Stover of Indian mustard

Treatments	N uptake		P uptake		K uptake		S uptake	
	Seed	Stover	Seed	Stover	Seed	Stover	Seed	Stover
T_1	27.761	4.1984	5.055	1.971	7.369	12.424	1.2852	3.085
T_2	50.623	7.2866	8.054	3.068	12.016	21.476	2.1732	4.986
T_3	54.876	8.5271	9.215	3.851	13.203	23.243	3.1633	5.364
T_4	57.083	9.0653	9.774	4.108	14.023	23.513	3.6828	6.232
T_5	59.047	9.0952	10.394	4.187	16.747	24.687	4.1867	6.785
T_6	60.117	9.5774	10.756	4.420	17.387	25.491	4.2730	7.515
T_7	61.248	8.6223	11.150	4.460	17.839	25.718	4.9058	7.879
T_8	62.891	9.7796	11.585	4.815	18.657	25.878	5.2660	8.877
T_9	66.296	10.6010	12.341	5.221	20.094	27.531	5.6961	10.126
T_{10}	61.871	9.7140	11.507	4.932	18.083	25.705	5.0812	9.266
T_{11}	60.789	9.6910	11.159	4.699	17.914	25.109	4.9924	8.516
SEm±	0.718	0.5713	0.295	0.279	0.313	0.479	0.2343	0.395
C.D (P=0.05)	1.936	1.6135	1.000	0.968	NS	1.839	0.6163	1.136

Conclusion

The findings of present investigation revealed that impact of integrated use of nutrients on the soil, the plant height, length of siliqua (cm), No. of siliqua plant^{-1}, No. of seeds siliqua^{-1} test weight, seed and Stover yield of the mustard. Among the different treatment combinations with chemical fertilizers, organic manures and bio-fertilizers, T_9(75%RDF+ S@40 kg ha^{-1}+Vermicompost @5t ha^{-1} + Azotobacter + PSB) registered the maximum in most of the studied parameters like growth attribution and nitrogen, phosphorus and potassium content (%) in seed and Stover with uptake of N, P, & K (kg ha^{-1}) by seeds and Stover of mustard crop was noticed in higher in T_9 (75%RDF+S@40kg ha^{-1}+Vermicompost @ 5t ha^{-1}+Azotobacter+PSB) over the control. The best treatment combinations on T_9 (75%RDF+S@40kg ha^{-1}+Vermicompost @ 5t ha^{-1}+Azotobacter+PSB) is improvement soil property with significant effect on all growth parameter on mustard crop. The application of T_9 (75%RDF+S@40kg ha^{-1}+ Vermicompost@5t ha^{-1}+Azotobacter+PSB) treatment combinations is best combinations of integrated nutrient management in mustard crop is farmer future significant effected on growth of mustard, integrated nutrient management was benefited effect on all soil property. However, the results are of one season. Further experimentation is needed to have the right recommendation of sulphur source for mustard for a particular soil and climatic situation at SAGE University, Indore Madhya Pradesh.

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