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Impact of nutrient management system on growth, yield and quality of Indian mustard (*Brassica juncea* L.) cv. Rani variety

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Abstract
A field experiment was conducted at the central Research Field of Sam Higginbottom university of Agriculture, Technology and Sciences, Prayagraj during 2016-17 and 2017-18 to study the'' Impact of nutrient management system on the growth, yield and quality of Indian mustard (*Brassica juncea* L) cv. Rani variety'. The experiment was laid out in a factorial randomized block design with three replications along inorganic, organic and biofertilizers with 10 different treatment combinations. The result of the study revealed that the T_6 (50% N through vermicompost + Azotobacter) exhibited significantly higher in plant growth, yield, oil yield and quality parameters viz., Plant height, (cm), Number of primary branches/plant, Number of secondary branches/plant, First flower appearance, 50% flowering DAS and Flower appearance (DAS) Number of Siliquae/plant, Number of seeds/Siliquae 1000-seed weight (g), Seed yield (q/ha), Stover yield (q/ha), Harvest index (%), N content in seed (%), Protein content in seed (%), Protein yield (Kg/ha), Oil content (%), Oil yield (kg/ha), Palmitic acid (%), Stearic acid (%), Oleic acid (%), Linoleic acid (%), Linolenic acid and Arachidic acid. It was also evident from the results that the plant growth, yield, oil yield and quality parameters as recorded by different treatments during 2016-17 were comparatively lower than recorded during 2017-18.

Keywords: Mustard, vermicompost, azotobacter, biofertilizers, rani variety

Introduction
India is the third largest producer of oil seeds in the world. It accounts for 19% of world's area and 9% of the global production (Sinha, 2003) [1]. Mustard (*Brassica juncea* L.*)* is an important oil seed crop, next to sunflower. Application of chemical fertilizers has contributed significantly to the huge increase in the world food production.

Oilseed crops play the second important role in the Indian agricultural economy next to food grains in terms of area and production. Indian mustard (*Brassica juncea* L.) is the most popular one among different species of rapeseed and mustard in India. Nutrients management is one of the most important agronomic factors that affect the Indian mustard. But the adverse impacts of excessive inputs of chemical fertilizers in conventional agricultural practices are being well documented (Banerjee *et al*., 2011; Garai *et al*., 2014) [2, 3]. Chemical fertilizers also have contributed significantly toward the pollution of water, air and soil. In agro-ecosystems, the use of synthetic toxic chemical pesticides affects the soil fertility and growth of cultivated crops (Ignacimuthu and Vendan, 2007).

Bio-fertilizers offer an economically attractive and ecologically sound means of reducing external inputs and improving quality and quantity of crop. They contain microorganisms which are capable of mobilizing nutrient elements from unavailable form to available form through different biological processes. In our present investigation, phosphate solubilizing bacteria (PSB) and *Azotobacter* are used as biofertilizers. PSB secrete some organic acids which can solubilize P from insoluble and fixed forms to plant available forms, whereas *Azotobacter* can convert atmospheric N2 into plant available form of N in the soil. In the recent years, among the various sources of organic manure, efficacy of vermicompost was reported manifold. Mondal *et al*., (2017) [4].

Materials and methods
A field experiment was conducted at the research central field of Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad during Rabi seasons of 2016-17 and 2017-18 to study the impact of nutrient management system on vegetative growth parameters of Indian mustard (*Brassica juncea* L.) cv. Rani variety. The experiment consisted of 10 fertilizer treatments (T1 = control, T2 = RDF, T3 = 75% N through FYM, T4 = 75% N through Vermicompost, T5 = 50% N through FYM+ *Azotobacter*, T6 = 50%N through FYM+

PSB, T7 = 50% N through vermicompost + *Azotobacter*, T8 = 50% N through Vermicompost + PSB, T9 = 25% N through FYM + *Azotobacter* + PSB and T10 = 25% N through vermicompost + *Azotobacter* + PSB. The experiment was laid out in a randomized block design with replicated thrice, mustard seed at the rate of 25kg/ha was sown in lines at a row spacing of 30 cm as per treatment. After thinning twice the plant to plant, distance was maintained at 15 cm. At various stages of crop vegetative growth parameters was Plant height (cm), Number of primary branches/plant, Number of secondary branches/plant, first flower appearance, 50% flowering DAS and Flower appearance (DAS). The data collected on various parameters was analyzed by the method given by Cocharn (1963).

Table 1: Impact of Nutrient management system on vegetative growth parameters of Indian mustard (*Brassica juncea* L.) cv. Rani variety during *rabi* 2016-17 and 2017-2018

Treatment	Plant height (cm)		Number of primary branches/plant		Number of secondary branches/ plant		First flower appearance		50% flowering DAS		Flower appearance (DAS)	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
T0 = control	124.45	124.41	4.40	4.03	3.64	3.73	57.33	60.00	69.67	71.33	15.33	16.00
T1 = RDF	137.57	138.74	6.53	6.76	6.10	6.14	57.00	58.00	67.00	68.00	15.00	14.00
T2 = 75% N through FYM	129.15	130.34	5.22	4.62	4.13	4.30	55.67	57.67	64.00	61.33	13.33	14.00
T3 = 75% N through Vermicompost	129.37	130.72	4.63	4.83	4.24	4.42	56.67	57.33	64.00	62.67	15.00	14.00
T4 = 50% N through FYM+ *Azotobacter*	140.17	141.24	6.80	6.97	6.72	6.94	53.33	54.00	62.00	62.33	12.00	11.00
T5= 50%N Through FYM+ PSB	134.25	135.14	5.62	5.82	5.67	5.51	57.00	58.33	68.00	69.33	14.33	15.00
T6= 50% N through vermicompost + *Azotobacter*	142.14	143.34	6.16	7.16	6.41	6.85	55.67	55.00	66.33	64.00	14.33	13.33
T7 = 50% N Through Vermicompost + PSB	134.34	135.52	5.72	5.96	5.45	5.60	58.00	56.00	66.33	66.67	14.67	14.00
T8 = 25% N through FYM + *Azotobacter* + PSB	133.35	134.44	4.91	5.14	4.77	4.92	55.67	58.00	67.00	68.00	14.00	14.00
T9 = 25% N through vermicompost + *Azotobacter* + PSB	134.35	125.74	5.18	5.35	4.90	5.07	56.00	58.00	65.00	65.67	14.33	14.00
F-test	S	S	S	S	S	S	S	S	S	S	S	S
C. D. value 0.05%	0.893	0.020	0.740	0.028	0.423	0.047	1.876	2.106	1.674	3.020	1.487	1.304
SEd (±)	0.425	0.010	0.352	0.013	0.201	0.022	0.893	1.002	0.797	1.438	0.708	0.621

Table 2: Impact of Nutrient management system on yield parameters of Indian mustard (*Brassica juncea* L.) cv. Rani variety during *rabi* 2016-17 and 2017-2018

Treatment	Number of Silizuae/plant		Number of seeds/ Siliquae		1000-seed weight (g)		Seed yield (q/ha)		Stover yield (q/ha)		Harvest index (%)	
	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
T0 = control	117.44	118.82	8.72	8.86	3.53	3.51	9.08	9.39	24.78	25.67	26.71	26.94
T1 = RDF	137.43	138.74	9.64	9.80	4.40	4.41	11.84	10.80	31.57	32.36	27.31	27.49
T2 = 75% N through FYM	127.42	128.65	8.94	8.41	3.86	3.89	10.56	10.84	28.84	29.67	26.83	27.01
T3 = 75% N through Vermicompost	129.42	130.71	9.06	9.21	3.91	3.89	10.91	11.31	29.82	30.70	26.93	27.10
T4 = 50% N through FYM+ *Azotobacter*	146.24	147.84	9.78	10.04	4.42	4.46	12.08	12.36	31.72	31.22	27.56	27.71
T5 = 50%N Through FYM+ PSB	138.42	139.65	9.34	9.47	3.93	3.94	11.28	11.55	30.34	31.16	27.09	27.29
T6 = 50% N through vermicompost + *Azotobacter*	150.41	151.54	9.92	10.11	4.50	4.49	12.20	12.48	32.86	33.79	26.94	27.11
T7= 50% N Through Vermicompost + PSB	137.42	138.65	9.47	9.63	4.06	4.10	11.54	11.82	30.16	30.88	27.59	27.78
T8 = 25% N through FYM +*Azotobacter* + PSB	132.45	137.83	9.70	9.81	4.14	4.13	11.80	12.08	31.44	32.30	27.28	27.48
T9 = 25% N through vermicompost + *Azotobacter* + PSB	139.43	140.82	9.81	9.87	4.18	4.19	11.87	12.13	31.57	32.47	27.33	27.49
F-test	S	S	S	S	S	S	S	S	S	S	S	S
C. D. value 0.05%	0.090	0.029	0.077	0.0325	0.062	0.095	0.044	0.642	0.039	0.631	0.031	0.076
SEd (±)	0.043	0.014	0.037	0.155	0.029	0.045	0.021	0.305	0.028	0.300	0.015	0.036

Table 3: Impact of Nutrient management system on oil yield and quality parameters of Indian mustard (*Brassica juncea* L.) cv. Rani Variety during *rabi* 2016-17 and 2017-2018

Treatment	N content in seed (%)		Protein content in seed (%)		Protein yield (Kg/ha)		Oil content (%)		Oil yield (kg/ha)		Palmitic (%)	
	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
T0 = control	2.42	2.43	15.12	15.14	135.76	137.45	36.29	36.26	328.36	331.68	4.36	4.37
T1 = RDF	3.16	3.16	19.67	19.69	232.52	234.77	37.33	37.30	442.45	445.78	6.83	6.84
T2 = 75% N through FYM	2.73	2.72	16.89	16.87	179.14	180.50	37.71	37.66	399.11	402.63	5.31	5.32
T3 = 75% N through Vermicompost	2.74	2.74	17.11	17.09	186.83	188.19	37.90	37.83	416.64	419.39	5.36	5.37
T4 = 50% N through FYM+ *Azotobacter*	3.23	3.23	20.10	20.12	241.72	243.84	38.53	38.49	465.20	467.97	5.72	5.73
T5 = 50%N Through FYM+ PSB	2.84	3.17	17.63	17.63	198.43	200.19	37.56	37.52	422.30	425.67	5.68	5.69
T6 = 50% N through vermicompost + *Azotobacter*	2.93	2.92	20.30	20.28	246.25	247.96	38.66	38.64	470.14	473.63	5.75	5.75
T7= 50% N Through Vermicompost + PSB	2.87	2.87	17.72	17.74	203.43	205.44	37.62	37.60	473.51	463.51	5.68	5.70
T8 = 25% N through FYM + *Azotobacter* + PSB	2.92	2.92	20.06	20.08	235.63	227.73	38.06	38.05	448.16	451.55	5.46	5.47
T9 = 25% N through vermicompost + *Azotobacter* + PSB	3.25	3.25	20.09	20.11	237.53	239.71	38.09	38.08	450.63	454.14	5.53	5.54
F-test	S	S	S	S	S	S	S	S	S	S	S	S
C. D. value 0.05%	0.411	0.497	0.074	0.086	0.030	9.185	0.037	0.055	0.141	12.625	0.036	0.037
SEd (±)	0.196	0.235	0.035	0.041	0.041	4.672	0.017	0.026	0.067	6.009	0.372	0.018

Table 4: Impact of Nutrient management system on oil yield and quality parameters of Indian mustard (*Brassica juncea* L.) cv. Rani Variety during *rabi* 2016-17 and 2017-2018

Treatment	Stearic acid (%)		Oleic acid (%)		Linoleic acid (%)		Linolenic acid		Arachidic acid	
	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
T0 = control	3.08	3.09	34.23	34.23	42.64	42.64	0.32	0.32	0.87	0.88
T1 = RDF	4.52	4.54	37.12	37.14	45.85	45.87	0.34	0.34	0.87	0.84
T2 = 75% N through FYM	3.28	3.29	38.62	38.63	44.73	44.74	0.31	0.31	0.92	0.93
T3 = 75% N through Vermicompost	3.30	3.28	38.09	38.11	44.62	44.64	0.33	0.33	0.93	0.92
T4= 50% N through FYM+ *Azotobacter*	3.64	3.67	36.84	36.86	45.34	45.34	0.34	0.36	0.92	0.93
T5 = 50%N Through FYM+ PSB	3.62	3.62	36.73	36.74	45.15	45.18	0.31	0.32	0.91	0.92
T6 = 50% N through vermicompost + *Azotobacter*	3.78	3.78	36.90	36.91	45.35	45.38	0.34	0.38	0.94	0.94
T7 = 50% N Through Vermicompost + PSB	3.70	3.71	36.73	36.75	45.13	45.17	0.33	0.37	0.91	0.90
T8 = 25% N through FYM + *Azotobacter* + PSB	3.52	3.54	35.82	35.67	49.34	49.33	0.31	0.32	0.91	0.91
T9 = 25% N through vermicompost + *Azotobacter* + PSB	3.55	3.55	35.41	35.42	49.45	49.48	0.33	0.33	0.91	0.90
F-test	S	S	S	S	S	S	S	S	S	S
C. D. value 0.05%	0.050	0.066	0.604	0.634	0.066	0.061	0.023	0.026	0.036	0.042
SEd (±)	0.024	0.031	0.287	0.302	0.031	0.029	0.011	0.012	0.017	0.020

Result and discussion

As regards the effect of Nutrient management system results indicated that T_6 (50% N through Vermicomopst +Azotobacter) at par T_4 (50% N through FYM + Azotobacter and T_1 (RDF) recorded significantly taller plant height (142.14, 137.57 during 2016 and 2017 years respectively) than T_9, T_8, T_7, T_6, T_3,T_2 and T_0). The significantly lowest plant height was observed under T_0 (Control). Among the effect of fertilizers and biofertilizers treatment T_5(50% N through FYM+ Azotobacter at par with T_6, recorded significantly higher number of primary and secondary branches during both 2016-17 and 2017-18 years respectively. Over the rest of the treatment combination, the lower no of primary and secondary branches was seen in T_0 (control treatment). The beneficial effect of combined application of organic and biofertilizers uses singly or in combination, the data indicates that T_5 takes lesser number of days for the crop to produce first flower than T_6.The effect of nutrient management system applied singly or in combination results indicated that T_6 (50% N through Vermicompost + Azotobacter took more no of days on both of years respectively for the crop to reach 50% of flowering stage as compared to T_9,T_8 as they takes lesser no of days for the crop to attain 50% flowering stage during both years of experiment. As regards the effect of chemical, organic and biofertilizers used singly or in combinations, the result reveled that during 2016-2017 T_5 (50% N through FYM +Azotobacter) and T_6 (50% N through Vermicompost +Azotobacter)treatments were statistically at par with one another and recorded significantly highest flowering period over rest of the treatments. It was also found that application of 50% N through vermicompost along with Azotobacter inoculation produced highest protein content and protein yield. Indian mustard varieties did not show any significant variations in seed oil content, however highest seed oil content was recorded in Rani Variety with treatment combination T_6 (50% N through vermicompost + Azotobacter).

Conclusion

During 2 years study it has been observed that amongst different treatment using chemical fertilizers, organic manures alone or in combination with biofertilizers at different rates the treatment T_6 (50% N through vermicompost +Azotobacter

significantly produced the highest seed and Stover yield of mustard and improved quality characters *viz* protein yield, oil yield. combined applications of organic, inorganic fertilizers stimulated the accumulation of certain metabolites for optimum growth along with mechanism led to the growth and yield attributes of crop plant.

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