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Effect of Different Levels of Fertilisers on Nutrient Uptake of Indian Mustard (*Brassica juncea* L.)

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ABSTRACT

The present study was carried out with the objectives to study the growth the effect of different levels of fertilisers on yield, nutrient uptake and economics of the Indian mustard variety NRCHB-101 under graded doses of fertilizer. The field experiment was conducted during 2016-17 at the Agronomy Main Research Station, OUAT, Bhubaneswar laid out in a Factorial Randomized Block Design with three replications and twelve treatments. The total N uptake by Indian mustard var. NRCHB-101 was highest at N3 (120 Kg ha^{-1}) and lowest at P1 (20 kg ha^{-1}) i.e., 64.08 kg ha^{-1} and 60.95 kg ha^{-1}, respectively. The total P uptake was highest at N3 (120 Kg ha^{-1}) and lowest at N1 (80 kg ha^{-1}) i.e., 27.32 kg ha^{-1} and 21.51 kg ha^{-1}, respectively. The total K uptake by Indian mustard var. NRCHB-101 was highest at N3 (120 Kg ha^{-1}) and lowest at N1 (80 kg ha^{-1}) i.e., 51.79 kg ha^{-1} and 45.60 kg ha^{-1}, respectively.

KEY WORDS: INDIAN MUSTARD, NUTRIENT INTERACTION, NUTRIENT UPTAKE

INTRODUCTION

Role of oilseeds in Indian agriculture needs hardly any emphasis. Oilseeds constitute an important group of crops next to cereals. India is a premier oilseed growing country. India is the fourth largest oilseed economy in the world. Among the seven edible oilseeds cultivated in India, rapeseed-mustard contributes 28.6 per cent of the total area. Presently, rapeseed-mustard is the third most important oilseed crop in India after groundnut and soybean. India is one of the largest producer, consumer and importer of oilseeds in the world. Out of nine major oilseeds grown in India, Indian mustard (Brassica juncea) is an important winter season Rabi crop. The gap between production and demand of rapeseed-mustard is progressively widening and therefore, the production is to be increased for self sufficiency. Indian mustard requires relatively larger amount of nutrients for realization of higher yield potential. Moreover, with increase in irrigated area and introduction of high yielding varieties, it becomes imperative to work out the response of Indian mustard to nitrogen, phosphorus and potassium in Odisha condition. The mustard growing areas in India are experiencing the vast diversity in the agro climatic conditions and different species of rapeseed-mustard are grown in some or other part of the country. Under marginal resource situation, cultivation of rapeseed-mustard becomes less remunerative to the farmers. This results in a big gap between requirement and production of mustard in India.

Therefore site-specific nutrient management through soil-test recommendation based should be adopted to improve upon the existing yield levels obtained at farmers field. Effective management of natural resources, integrated approach to plant-water, nutrient and pest management and extension of rapeseed-mustard cultivation to newer areas under different cropping systems will play a key role in further increasing and stabilizing the productivity and production of rapeseed-mustard. With this backdrop,

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the present paper on Indian mustard high yielding variety NRCHB-101 entitled "Effect of different levels of fertilisers on nutrient uptake of Indian mustard (Brassica juncea L.)" has been presented with the objectives to study the interaction effect of nutrients on the variety under different fertility levels.

MATERIAL AND METHODS

The field experiment was conducted during Rabi 2016-17 at the Agronomy Main Research Station, Odisha University of Agriculture and Technology, Bhubaneswar (20026'N, 85081'E, 25.9m above MSL), Odisha.The soil of the experimental sandy loam acidic (pH-5.4) medium in organic carbon (0.628%) and available nitrogen (1673.3kg/ha), phosphorus (64.5kg/ha) and potassium (123.4 kg/ha). The experiment was laid out in a factorial randomized block design with three replications. Twelve treatment combinations comprising 3 nitrogen levels (80, 100, 120 kg N/ha), two (20, 40 kg P205/ha) and two potassium levels (0, 30 kg K_2O/ha) were tested in the experiment. Indian mustard variety 'NRCHB-101' was sown 30 cm row distance.

Table 1. Nitrogen uptake by Indian mustard as influenced by nitrogen, phosphorus and potassium levels

Treatment	Nitrogen Uptake		
	Seed Yield (kg ha^{-1})	Stover Yield (kg ha^{-1})	Total (kg ha^{-1})
N-levels (kg ha^{-1})			
80	50.17	10.90	61.07
100	49.33	12.05	61.38
120	51.44	12.64	64.08
SE(m)±	2.26	0.56	2.82
CD(P=0.05)	NS	1.36	NS
P2O5 levels (kg ha^{-1})			
20	49.51	11.44	60.95
40	51.11	12.28	63.39
SE(m)±	1.84	0.46	2.30
CD(P=0.05)	NS	NS	NS
K2O levels (kg ha^{-1})			
0	49.82	11.62	61.44
30	52.12	11.80	63.92
SE(m)±	1.84	0.46	2.30
CD((P=0.05)	NS	NS	NS

Thinning was done as 15 DAS to maintain plant to plant distance of 10 cm. All the recommended agronomic practices are done throughout the crop season. The crop was sown on 20th November and harvesting was done manually during last week of February. The N,P and K uptake in seed and stover was estimated by following standard procedure described by Jackson(1973) and all the data were analysed as per standard statistical procedures.(Gomez and Gomez,1984).

RESULT AND DISCUSSION

The N uptake was significant for different levels of N, P and K. The N uptake increases as the doses of N, P and K increases. The seed uptake was highest at K_2 (30 Kg ha^{-1}) and lowest at N2 (100 kg ha^{-1}) i.e., 52.12 kg ha^{-1} and 49.33 kg ha-1, respectively. The stover N uptake was highest at N3 (120 Kg ha^{-1}) and lowest at N1 (80 kg ha^{-1}) i.e., 12.64 kg ha^{-1} and 10.90 kg ha^{-1}, respectively. The total N uptake in seed by Indian mustard var. NRCHB-101 is highest at N_3 (120 Kg ha^{-1}) and lowest at P_1 (20 kg ha^{-1}) i.e., 64.08 kg ha^{-1} and 60.95 kg ha^{-1}, respectively. The N uptake by both, seed and stover, was significant for all the interactions. The higher uptake at the increased doses of N was due to higher efficiency of the crop to make use of the increased levels of N because of increased growth and vigour. Similar results of N uptake with increasing levels of N have been reported by Kumawat et al. (2014) and Dabi et al. (2015).

Table 2 represents the interaction effect of NP, PK and NK levels on total uptake of N by seed and stover of Indian mustard var. NRCHB-101. As evident from the table, the highest N uptake by seed was at N_3K_2 i.e., 51.73 kg ha $^{-1}$ and the lowest was at N1K1 i.e., 49.58 kg ha^{-1}. The table revealed that the highest N uptake by stover was at N_3P_2 i.e., 12.90 kg ha^{-1} and the lowest was at N1P1 i.e., 10.30 kg ha^{-1}. The N uptake by both, seed and stover, was significant for all the interactions. The N-P-K interaction effect on total N uptake by seed and stover has been shown in Table 3. As depicted in the table, the total N uptake by both, seed and stover, is highest at N3 P_2 K_2 i.e., 52.10 kg ha^{-1} and 13.10 kg ha^{-1}, respectively. The N uptake by both, seed and stover, was significant for all the interactions.

The seed uptake was highest at P2 (40 Kg ha^{-1}) and lowest at N_1 (80 kg ha^{-1}). The stover P uptake was highest at N_3 (120 Kg ha^{-1}) i.e., 8.32 kg ha-1. The lowest stover P uptake was observed at N1 (80 kg ha^{-1}) and P_1 (20 kg ha^{-1}) i.e., 5.71 kg ha-1. The total P uptake in seed by Indian mustard var. NRCHB-101 is highest at N3 (120 Kg ha^{-1}) and lowest at N1 (80 kg ha^{-1}) i.e., 27.32 kg ha^{-1} and 21.51 kg ha-1, respectively. The P uptake was significant for different levels of N, P and K. The P uptake increases as the doses of N, P and K increases. The total P uptake by both, seed and stover, is highest at N3 P2 K2 i.e., 19.82 kg ha-1 and 8.83 kg ha^{-1}, respectively. The P uptake by both, seed and stover, was significant for all the interactions.These results for P uptake corroborated with the findings of Ghimire and Bana (2011). The higher removal of N and P might be due to synergistic effect chlorophyll content, cell division, photosynthetic rate and root activities of plants which has been reported.

Table 5 represents the interaction effect of NP, PK and NK levels on total uptake of P by seed and stover of Indian mustard var. NRCHB-101. As evident from the table, the highest N uptake by seed was at N3P2 i.e., 19.47 kg ha^{-1} and the lowest was at N_1P_1 i.e., 15.45 kg ha^{-1}. The table revealed that the highest P uptake by stover was at N_3P_2 i.e., 8.59 kg ha^{-1} and the lowest was

at 5.33 i.e., 10.30 kg ha^{-1}. The P uptake by both, seed and stover, was significant for all the interactions. The N-P-K interaction effect on total P uptake by seed and stover has been shown in Table 6. As depicted in the table, the total P uptake by both, seed and stover, was the highest at the interaction level of N3 P2 K2 i.e., 19.82 kg ha^{-1}and 8.83 kg ha^{-1}, respectively. The P uptake by both seed and stover was significant for all the interactions.

Table 2. Interaction effect of NP, PK and NK on total uptake of N by Indian mustard

	Seed (kg ha^{-1})		Stover (kg ha^{-1})	
N-levels (kg ha^{-1})	P-levels (kg ha^{-1})		P-levels (kg ha^{-1})	
	20	40	20	**40**
80	50.17	50.17	10.30	11.50
100	49.33	49.33	11.65	12.45
120	51.44	51.44	12.38	12.90
SE(m)±	3.19		0.79	
CD(P=0.05)	NS		1.92	
P_2O_5 levels (kg ha^{-1})	K-levels (kg ha^{-1})		K-levels (kg ha^{-1})	
	0	30	0	**30**
20	48.94	50.08	11.23	11.66
40	50.70	51.52	12.01	12.56
SE(m)±	2.60		0.64	
CD(P=0.05)	NS		NS	
N-levels (kg ha^{-1})	K-levels (kg ha^{-1})		K-levels (kg ha^{-1})	
	0	30	0	**30**
80	49.58	50.75	10.53	11.27
100	48.73	49.92	11.87	12.23
120	51.15	51.73	12.47	12.82
SE(m)±	3.19		0.79	
CD(P=0.05)	NS		1.92	

Table 3. Interaction effect of nitrogen, phosphorus and potassium on total uptake of N by mustard seed and stover

Total uptake of N by mustard seed				
Levels of N	**Levels of P & K**			
	P_1		**P_2**	
	K_1	K_2	K_1	K_2
N_1	48.23	50.30	50.93	51.20
N_2	47.93	48.57	49.53	51.27
N_3	50.67	51.37	51.63	52.10
	N×P	P×K	N×K	N×P×K
SE(m)±	3.19	2.60	3.19	4.51
CD(P=0.05)	NS	NS	NS	NS
Total uptake of N by mustard stover				
Levels of N	**Levels of P & K**			
	P_1		**P_2**	
	K_1	K_2	K_1	K_2
N_1	9.93	10.67	11.13	11.87
N_2	11.53	11.77	12.20	12.70
N_3	12.23	12.53	12.70	13.10
	N×P	P×K	N×K	N×P×K
SE(m)±	0.79	0.64	0.79	1.12
CD(P=0.05)	1.92	1.56	NS	NS

Table 3. Interaction effect of nitrogen, phosphorus and potassium on total uptake of N by mustard seed and stover

Phosphorus Uptake Treatment	Seed (kg ha^{-1})	Stover (kg ha^{-1})	Total (kg ha^{-1})
N-levels (kg ha^{-1})			
80	15.80	5.71	21.51
100	17.13	7.13	24.26
120	19.00	8.32	27.32
SE(m)±	0.49	0.35	0.84
CD(P=0.05)	1.19	0.86	2.05
P_2O_5 levels (kg ha^{-1})			
20	17.19	5.71	22.9
40	19.26	7.13	26.39
SE(m)±	0.40	0.29	0.69
CD(P=0.05)	0.97	0.70	1.67
K_2O levels (kg ha^{-1})			
0	16.92	6.73	23.65
30	17.69	7.38	25.07
SE(m)±	0.40	0.29	0.69
CD((P=0.05)	NS	NS	NS

Table 4. Phosphorus uptake by Indian mustard as influenced by nitrogen, phosphorus and potassium levels

Phosphorus Uptake Treatment	Seed (kg ha^{-1})	Stover (kg ha^{-1})	Total (kg ha^{-1})
N-levels (kg ha^{-1})			
80	15.80	5.71	21.51
100	17.13	7.13	24.26
120	19.00	8.32	27.32
SE(m)±	0.49	0.35	0.84
CD(P=0.05)	1.19	0.86	2.05
P_2O_5 levels (kg ha^{-1})			
20	17.19	5.71	22.9
40	19.26	7.13	26.39
SE(m)±	0.40	0.29	0.69
CD(P=0.05)	0.97	0.70	1.67
K_2O levels (kg ha^{-1})			
0	16.92	6.73	23.65
30	17.69	7.38	25.07
SE(m)±	0.40	0.29	0.69
CD((P=0.05)	NS	NS	NS

Table 5. Interaction effect of NP, PK and NK on total uptake of P by mustard seed and stover

	Seed (kg ha^{-1})		Stover (kg ha^{-1})	
N-levels (kg ha^{-1})	P-levels (kg ha^{-1})		P-levels (kg ha^{-1})	
	20	40	20	40
80	15.45	16.15	5.33	6.10
100	16.79	17.47	6.79	7.47
120	18.54	19.47	8.06	8.59
SE(m)±	0.69		0.50	
CD(P=0.05)	1.68		1.21	
P_2O_5 levels (kg ha^{-1})	K-levels (kg ha^{-1})		K-levels (kg ha^{-1})	
	0	30	0	30
20	16.75	17.10	6.60	6.85
40	17.40	17.98	7.11	7.65
SE(m)±	0.57		0.41	
CD(P=0.05)	NS		0.99	
N-levels (kg ha^{-1})	K-levels (kg ha^{-1})		K-levels (kg ha^{-1})	
	0	30	0	30
80	15.66	15.94	5.56	5.87
100	16.86	17.39	6.86	7.39
120	18.71	19.30	8.14	8.50
SE(m)±	0.69		0.50	
CD(P=0.05)	1.68		1.21	

Table 6. Interaction effect of N, P and K on total uptake of P by mustard seed and stover

Total uptake of P by mustard seed				
Levels of N	Levels of P & K			
	P_1		P_2	
	K_1	K_2	K_1	K_2
N_1	15.25	15.64	16.08	16.23
N_2	16.70	16.88	17.02	17.91
N_3	18.30	18.77	19.11	19.82
	N×P	P×K	N×K	N×P×K
SE(m)±	0.69	0.57	0.69	0.98
CD(P=0.05)	1.68	1.37	1.68	2.38
Total uptake of P by mustard stover				
Levels of N	Levels of P & K			
	P_1		P_2	
	K_1	K_2	K_1	K_2
N_1	5.15	5.51	5.97	6.23
N_2	6.70	6.88	7.02	7.91
N_3	7.94	8.18	8.34	8.83
	N×P	P×K	N×K	N×P×K
SE(m)±	0.50	0.41	0.50	0.71
CD(P=0.05)	1.21	0.99	1.21	1.72

Table 7. Potassium uptake by Indian mustard as influenced by nitrogen, phosphorus and potassium levels

Potassium Uptake	Seed (kg ha^{-1})	Stover (kg ha^{-1})	Total (kg ha^{-1})
N-levels (kg ha^{-1})			
80	10.24	35.26	45.60
100	11.51	36.13	47.64
120	13.42	38.37	51.79
SE(m)±	0.35	0.83	1.18
CD(P=0.05)	0.85	2.02	2.87
P_2O_5 levels (kg ha^{-1})			
20	11.11	36.22	47.33
40	13.02	38.75	51.77
SE(m)±	0.22	0.68	0.9
CD(P=0.05)	0.70	1.65	2.35
K_2O levels (kg ha^{-1})			
0	11.25	35.78	47.03
30	11.93	37.45	49.38
SE(m)±	0.29	0.68	0.97
CD((P=0.05)	0.69	1.65	2.45

The seed uptake was highest at N_3 (120 Kg ha^{-1}) and lowest at N1 (80 kg ha^{-1}) i.e., 13.42 kg ha^{-1} and 10.24 kg ha-1, respectively. The stover K uptake was highest at P_2 (40 Kg ha^{-1}) and lowest at K1 (0 kg ha^{-1}) i.e., 38.75 kg ha^{-1} and 35.26 kg ha^{-1}, respectively. The total K uptake in seed by Indian mustard var. NRCHB-101 is highest at N3 (120 Kg ha^{-1}) and lowest at N1 (80 kg ha^{-1}). The K uptake was significant for different levels of N, P and K. The K uptake increases as the doses of N, P and K increases. Similar results have been reported by Grewal et al. (2009).The highest K uptake by seed was at N3P2 i.e., 13.35 kg ha^{-1}. The highest K uptake by stover was at N3P2 i.e., 38.87 kg ha^{-1}.

The total K uptake by both, seed and stover, is highest at N_3 P_2 K_2 followed by N_3 P_2 K_1 in seed and stover, respectively. The K uptake by both, seed and stover, was significant for all the interactions.The stover yields of Indian mustard were significantly obtained under application of higher levels of N and P could be ascribed to better transformation of growth and yield attributes into yield which corroborated with findings of Dabi et al. (2015).

Table 8. Interaction effect of NP, PK and NK on total uptake of P by mustard seed and stover

	Seed (kg ha^{-1})		Stover (kg ha^{-1})	
N-levels (kg ha^{-1})	P-levels (kg ha^{-1})		P-levels (kg ha^{-1})	
	20	40	20	40
80	9.89	10.59	33.86	36.66
100	11.17	11.85	35.62	36.83
120	12.68	13.35	37.86	38.87
SE(m)±	0.50		1.18	
CD(P=0.05)	1.21		2.86	
P_2O_5 levels (kg ha^{-1})	K-levels (kg ha^{-1})		K-levels (kg ha^{-1})	
	0	30	0	30
20	11.10	11.40	35.47	36.08
40	11.75	12.12	37.20	37.71
SE(m)±	0.41		0.96	
CD(P=0.05)	0.98		2.32	
N-levels (kg ha^{-1})	K-levels (kg ha^{-1})		K-levels (kg ha^{-1})	
	0	30	0	30
80	10.08	10.40	34.83	35.69
100	11.38	11.64	36.05	36.39
120	12.81	13.22	38.13	38.60
SE(m)±	0.50		1.18	
CD(P=0.05)	1.21		2.86	

Table 9. Interaction effect of nitrogen, phosphorus and potassium on total uptake of K by mustard seed and stover

Uptake of K by mustard seed				
Levels of N	Levels of P & K			
	P_1		P_2	
	K_1	K_2	K_1	K_2
N_1	9.72	10.06	10.44	10.75
N_2	11.09	11.26	11.67	12.03
N_3	12.48	12.88	13.14	13.57
	N×P	P×K	N×K	N×P×K
SE(m)±	0.50	0.41	0.50	0.70
CD(P=0.05)	1.21	0.98	1.21	1.71
Uptake of K by mustard stover				
Levels of N	Levels of P & K			
	P_1		P_2	
	K_1	K_2	K_1	K_2
N_1	33.27	34.45	36.39	36.93
N_2	35.51	35.72	36.59	37.07
N_3	37.64	38.08	38.63	39.12
	N×P	P×K	N×K	N×P×K
SE(m)±	1.18	0.96	1.18	1.66
CD(P=0.05)	2.86	2.32	NS	NS

Table 8 represents the interaction effect of NP, PK and NK on total uptake of K by seed and stover of Indian mustard var. NRCHB-101. As evident from the table, the highest K uptake by seed was at N3P2 i.e., 13.35 kg ha $^{-1}$ and the lowest was at N1P1 i.e., 9.89 kg ha^{-1}. The table also showed that the highest K uptake by stover was at N3P2 i.e., 38.87 kg ha -1 and the lowest was at N_1P_1 i.e., 33.86 kg ha^{-1}.

The N uptake by both, seed and stover, was significant for all the interactions. The N-P-K interaction effect on total K uptake by seed and stover has been shown in Table 9. As depicted in the table, the total K uptake by both, seed and stover, was highest at N_3 P_2 K_2 i.e., 13.57 kg ha^{-1} and 39.12 kg ha^{-1}, respectively followed by N_3 P_2 K1 i.e., 13.14 kg ha^{-1} and 38.63 kg ha^{-1} in seed and stover, respectively. The K uptake by both, seed and stover, was significant for all the interactions.

CONCLUSION

The total N uptake by Indian mustard var. NRCHB-101 was highest at N3 (120 Kg ha^{-1}) and lowest at P1 (20 kg ha^{-1}) i.e., 64.08 kg ha^{-1} and 60.95 kg ha^{-1}, respectively. The total P uptake was highest at N3 (120 Kg ha^{-1}) and lowest at N1 (80 kg ha^{-1}) i.e., 27.32 kg ha-1 and 21.51 kg ha^{-1}, respectively. The total K uptake by Indian mustard var. NRCHB-101 was highest at N3 (120 Kg ha^{-1}) and lowest at N1 (80 kg ha^{-1}) i.e., 51.79 kg ha^{-1} and 45.60 kg ha^{-1}, respectively. The total N, P and K uptake by both, seed and stover, was highest at interaction N3 P2 K_2. The N, P and K uptake increased as the doses of N, P and K increased.

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