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Response of Indian mustard cultivar RH 749 to different fertility levels under *tarai* conditions of Uttarakhand

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Abstract
A field experiment entitled "Response of Indian mustard cultivar RH 749 to different fertlility levels under *tarai* condtions of Uttarkhand" was conducted at N. E. Borlaug Crop Research Centre of Govind Ballabh Pant University of Agriculture and Technology, Pantnagar (Uttarakhand) during *rabi* season of 2016-17. The experiment was laid out in factorial randomized block design comprising twelve treatments with three replications. The nitrogen, phosphorous and potassium were applied through urea, SSP and MOP, respectively. The results revealed that significantly higher seed yield (2135 kg ha-1) was obtained with the application of 120 kg nitrogen per hectare which was 17.5% and 29.2% higher over application of 100 kg and 80 kg nitrogen per hectare. This increase is due to higher values of yield attributing characters *viz.* number of siliquae per plant (326.7), number of seeds per siliquae (15.4), length of siliqua (4.3 cm), 1000-seed weight (4.3 g). Significantly higher oil yield (793.2 kg ha-1) was also recorded with the application of 120 kg nitrogen per hectare. Therefore, it can be concluded that Indian mustard RH 749 performed well with the application of 120 kg nitrogen along with 40 kg phosphorous under *tarai* conditions of Uttarakhand.

Keywords: RH 749, urea, SSP, MOP, siliqua

Introduction
Indian agriculture needs to be more knowledge intensive in order to keep pace with increased pressure due to growing population and reduction in land and energy resources. India holds a premier position in oilseed production in the world not only in terms of rich diversity but in terms of area as well. Mustard is an important *rabi* oilseed crop of India. Its area, production and productivity in the country is 5.8 million hectare, 6.2 million tonnes and 1083 kg/ha, respectively. In India, Rajasthan is the leading state in mustard cultivation with an area of 2.4 million ha with estimated production of 2.9 million tonnes and productivity of 1170 kg/ha (Directorate of Economics and Statistics, Department of Agriculture and Cooperation, 2014-15). There is a huge gap between the production and demand of oilseed crop and this gap is progressively widening, therefore, the production of oilseeds needs to be increased for self-sufficiency. Amongst various agronomic factors known to augment the crop production, fertilizers stand at top and are considered as one of the most productive inputs in its cultivation. The fertilizer application in right amount and at right time enhanced the yield of mustard remarkably as this crop is exhaustive in nature and requires more energy (Sharma, 1986) [6]. Researches done in the country have indicated that lower rates of fertilizer application may result in substantial reduction in seed and oil yields of mustard crop, the higher application rates may be uneconomical and ecologically unsound. Macro nutrients i.e. nitrogen, phosphorus and potassium plays an important role in enhancing the crop yield. Adequate supply of nutrients (NPK) increases the seed and oil yields by improving the setting pattern of siliquae on branches, number of siliquae/plant and other yield attributes. The balanced fertilization at proper time through an appropriate method of application increases nutrient use efficiency of mustard. Therefore, the present study was initiated with objective to evaluate the response of varying levels of N, P and K on the productivity, quality and profitability of Indian mustard.

Materials and Methods
A field experiment was conducted during *rabi* season of 2016-17 at G.B. Pant University of Agriculture and Technology, Pantnagar (29ºN latitude, 79.5º E longitude, at an altitude of 243.8 m above mean sea level), U.S. Nagar, Uttarakhand, India. The climate of Pantnagar is sub humid to subtropical with hot summers, heavy rains in monsoon period and extreme cold in winters. The soil of the experimental site was silty clay loam in texture having organic

carbon (0.82%), medium available nitrogen (264.6 kg/ha), medium available phosphorus (20.5 kg/ha) and medium available potassium (256 kg/ha) contents with slightly alkaline in reaction (pH 7.6). The experiment was laid out in Factorial Randomized Block Design, comprising three levels of nitrogen, two levels phosphorus and two levels of potassium with three replications. The mustard variety 'RH 749' was sown on 15 October, 2016 at spacing of 30 cm x 10cm by using 4 kg/ha seed rate. Half dose of nitrogen along with full doses of phosphorus and potassium fertilizers was applied as basal in furrows and remaining dose of nitrogen was top dressed at 30-35 DAS and at pre-flowering stage equally. Crop growth and yield parameters were recorded with standard procedure. The oil content in seed was extracted by using soxhlet's extraction method, taking petroleum ether as a solvent. The experimental data were analyzed by using STPR-15 programme, developed by the Department of Mathematics and Statistics, College of Basic Science and Humanities (CBSH), GBPUA&T Pantnagar.

Results and Discussion

Yield attributes

The data pertaining to all yield attributing characters *viz.*, the length of siliqua, 1000-seed weight, number of siliquae per plant and number of seeds per siliqua have been presented in Table 1. Amongst nitrogen levels, 1000-seed weight and the number of seeds per siliqua increased significantly with increasing level of nitrogen and were found maximum at 120 kg nitrogen followed by 100 kg and 80 kg nitrogen. Length of siliqua was found highest with 120 kg nitrogen application, whereas, 1000-seed weight and number of seeds per siliqua remained at par with 100 kg and 80 kg nitrogen. Application of 120 kg nitrogen and 100 kg nitrogen per hectare was also found to be at par with respect to number of siliquae/plant. However, non-significant results were obtained with the application of phosphorous and potassium.

Nitrogen being a major nutrient for most of the metabolic activities in plant, therefore, it could influence the siliqua length. The increase in test weight might be due to more accumulation of photosynthates and more number of seeds per siliqua in the treatment. These results are in conformity with Khan *et al.* (2004) [3] and Tripathi *et al.* (2010) [8]. Increased number of siliquae per plant and number of seeds per siliqua might be attributed due to more number of primary and secondary branches per plant as well as due to increase in number of seeds per siliqua due to adequate supply of fertilizers which might have resulted from optimum fertilization of flowers as well as increased pollen grain viability and thereby increased number of seeds per siliqua. Similar results were also quoted by Kumar *et al.* (2000) [4], Akter *et al.* (2007) [1].

Yield and quality

Nitrogen application significantly increased the seed yield as well as oil yield. The seed yield and oil yield increased significantly with the application of 100 kg nitrogen over 80 kg nitrogen per hectare application. However, the highest and significantly superior results were obtained with the application of 120 kg nitrogen per hectare over other doses of nitrogen. Application of 120 kg nitrogen remained on par with 100 kg nitrogen application. Application of 100 kg nitrogen resulted in significantly higher oil content as compared to 80 kg and 120 kg nitrogen application, whereas, values of oil content obtained at 80 and 120 kg nitrogen application remained on par. However, non-significant results were obtained with the application of phosphorous and potassium except for seed yield, where, 40 kg phosphorous was significantly higher over 20 kg phosphorous application.

The increase in seed yield due to adequate nutrients supply might be due to the combined effect of more plant height, more primary and secondary branches/plant, number of siliqua/plant, more number of seeds/siliqua and higher 1000-seed weight, which was the result of better translocation of photosynthates from source to sink. Similar results were observed by Rana *et al.* (2005) [5]. The application of higher dose of nitrogen (120 kg/ha), by preventing flower and siliqua abscission, it helps in increasing the number of siliquae per plant and affecting 1000-seed weight resulting in more seed yield. The increase in stover yield might be due to nitrogen on sink component which could be attributed to better growth and development of the plant in terms of plant height and dry matter accumulation. The low oil content in seeds on increasing nitrogen levels was due to increased availability of nitrogen which increased the proportion of protein in seeds. Due to high nitrogen supply, a large proportion of photosynthates may have diverted towards protein formation leaving a potential deficiency of carbohydrates to be degraded to 'acetyl co-enzyme A' for fatty acids synthesis. The amount of carbohydrates to be converted into fats is too low in comparision to other low nitrogen treated plants. Similar findings were also reported by Tigga *et al.* (2004) [7] who found that with increase in fertility levels results in decreasing in oil content in seeds and increased protein content in seed. At higher nitrogen levels, due to vigorous growth, more production of photosynthates and their translocation towards reproductive parts might led to increase in seed yield and subsequently resulted into higher oil yield.

The interaction effect between levels of phosphorous and potassium on seed yield was found to be significant (Table 3). The interaction of phosphorous and potassium was found significant in terms of the relative doses. The application of 40 kg phosphorous gave significantly higher seed yield over 20 kg phosphorous application along with no potassium application. However, the higher doses of potassium (30 kg/ha) did not give any significant increase in seed yield with increased dose of phosphorous. Increase in seed yield with phosphorous application might be due to role of phosphorous in lying down the primordial for reproductive parts of the plants.

There was significant interaction between the levels of phosphorous and potassium fertilization on oil yield (Table 19). The interaction between levels of phosphorous and potassium fertilization revealed that without potassium application increased levels of phosphorous (40 kg/ha) significantly increased the oil yield, whereas, increased potassium levels (30 kg/ha) along with increased phosphorous levels remained on par with respect to oil yield (kg/ha). Phosphorous and potassium both are essential for photosynthesis, energy/ enzyme driven reactions, seed formation and quality etc.

Conclusion

With the results obtained it could be concluded that among different levels of nitrogen, phosphorous and potassium fertilizer application, Indian mustard RH 749 performed well under nitrogen @ 120 kg/ha, phosphorous@ 40 kg/ha along with no potassium application under *tarai* region of Uttarakhand.

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Table 1: Effect of rates of nitrogen, phosphorous and potassium fertilization on length of siliqua, 1000-seed weight, Number of siliquae/plant and number of seeds/siliqua at harvest

Treatments	Length of siliqua (cm)	1000-seed weight (g)	Number of siliquae/plant	Number of seeds/siliqua
Rate of Nitrogen (A)				
80	3.8	3.2	286.2	12.6
100	4.0	3.7	308.4	13.9
120	4.3	4.3	326.7	15.4
S. Em.±	0.06	0.05	10.45	0.34
C.D.(P=0.05)	0.2	0.2	30.6	1.0
Rate of Phosphorous (B)				
20	3.9	3.7	303.4	13.8
40	4.1	3.8	310.8	14.2
S. Em.±	0.05	0.04	8.53	0.28
C.D.(P=0.05)	NS	0.1	NS	NS
Rate of Potassium (C)				
0	4.0	3.7	305.6	13.9
30	4.0	3.7	308.6	14.1
S. Em.±	0.04	0.04	8.1	0.24
C.D.(P=0.05)	NS	NS	NS	NS

Table 2: Effect of rates of nitrogen, phosphorous and potassium fertilization on seed yield, straw yield, oil content and oil yield at harvest

Treatments	Seed yield (Kg/ha)	Stover yield (Kg/ha)	Oil content (%)	Oil yield (Kg/ha)
Rate of Nitrogen (A)				
80	1510	5059	36.9	557.3
100	1761	5252	38.1	672.2
120	2135	5446	37.1	793.2
S. Em.±	36.0	92.8	0.07	13.48
C.D.(P=0.05)	106	272.3	0.2	39.5
Rate of Phosphorous (B)				
20	1758	5224	37.4	658.4
40	1846	5280	37.3	690.0
S. Em.±	29.4	75.8	0.06	11.01
C.D.(P=0.05)	86.4	NS	NS	NS
Rate of Potassium (C)				
0	1777	5256	37.3	664.1
30	1827	5248	37.4	684.3
S. Em.±	29.4	74.5	0.06	11.20
C.D.(P=0.05)	NS	NS	NS	NS

Table 3: Interaction between levels of phosphorous and potassium fertilization on seed yield at harvest

→ K / ↓ P	K_0	K_{30}
P_{20}	1689	1828
P_{40}	1864	1827
S. Em.±	41.7	
C.D. (P=0.05)	122.2	

Table 4: Interaction between levels of phosphorous and potassium fertilization on oil yield (kg/ha) at harvest

→ K / ↓ P	K_0	K_{30}
P_{20}	630.7	686.2
P_{40}	697.6	682.4
S. Em. ±	15.5	
C.D. (P=0.05)	45.6	

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