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Effect of fertility levels on growth, yield and economics of Indian mustard (*Brassica juncea* L.) under north Gujarat region

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Abstract
A field experiment was conducted at Castor-Mustard Research Station, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar in the north-Gujarat agro-climatic region during *rabi* season of 2016-17. Number of branches/plant, number of siliquae/plant and seed yield of Indian mustard was recorded significantly higher with the application of 120 kg N/ha. Net returns and benefit: cost ratio was also recorded higher with application of 120 kg N/ha and it was gained ₹ 9412/ha and ₹ 6491/ha higher net returns over application of 80 kg and 100 kg N/ha

Keywords: Indian mustard, economics, nitrogen, phosphorus, potassium and oil content

Introduction
Mustard is second most important edible oilseed crop in India after soybean and it occupies prominent position in the country. In India, the productivity of Rapeseed-Mustard seed has been increased from 936 kg/ha in 2000-01 to 1184 kg/ha in 2015-16. In Gujarat, the crop is grown in 0.19 million hectare of area with 0.31 million tonnes of total production and productivity of 1611 kg/ha (Anonymous, 2016). Exploitation of full yield potentiality of newly developed variety of crop depends on the extent of fertilizer levels of all primary and secondary nutrients are must to obtain higher yield and enhance fertilizer use efficiency. Balanced fertilization is critically required for achieving higher yield from improved variety of mustard. The response of nitrogen to mustard has been reported from 60-120 kg/ha in different parts of country in various experiments. Primary nutrients *i.e.* nitrogen, phosphorus and potassium play a pivotal role in crop yield. About 98% of the cultivated Indian soils required phosphorus fertilization for getting better yield (Bhari *et al*., 2000 and Singh *et al*., 2010) [2, 7]. Various studied indicated that the increasing levels of nutrient resulted concomitantly increasing yield of mustard. Therefore, this study was initiated to evaluate the various levels of nutrient on the productivity, profitability and quality of Indian mustard.

Materials and Methods
Experimental site and weather details
The field experiment was conducted during *rabi* season of 2016-17 at Castor-Mustard Research Station, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar (24°12' N latitude, 72°12' E longitude and at an altitude of 154.5 m above mean sea level), Gujarat, India. The soil of the experimental field was loamy sand in texture with p*H* 7.4, low in available nitrogen, medium in available phosphorus, high in available potassium and medium in organic carbon. The weekly mean maximum temperature varied from 24.2 to 37.7°C (average 31.7°C) along with minimum temperature ranged from 8.4 to 20.0°C (average 13.0°C) and average weekly sunshine hours was 8.8 hrs. The weekly mean maximum and minimum relative humidity was (82.5% and 43.0%) during crop period of *rabi* season 2016-17, respectively (Fig. 1).

Treatments details and crop management
The experiment was laid out in factorial randomized block design with comprising three levels of nitrogen *viz*. N_{80}, N_{100}, N_{120}; two levels phosphorus *viz*. P_{20}, P_{40} and two levels of potassium *viz*. K_0, K_{30} kg/ha with replicated thrice. The mustard variety 'GM-3' was sown on 21st October, 2016 at a distance of 45 cm x 15 cm by using 3.5 kg/ha seed rate. Full dose of phosphorus and potassium along with half dose of nitrogen fertilizers were applied just before the sowing through urea, DAP and MOP and remaining half dose of nitrogen was applied after 25-30 DAS in earmarked plots. 40 kg sulphur/ha was also applied uniformly to all plots

as basal application. The remaining crop management practices were followed as per package of practices. Various growth parameters, yield attributes and yield were recorded at harvest. Oil content was analyzed by standard procedures of Nuclear Magnetic Resonance method. The cost of cultivation and net returns were calculated by taking into account the prevailing market cost of inputs and minimum support price of mustard. The standard analysis of variance (Gomez and Gomez, 1984) [5] technique prescribed for the randomized block design with factorial concept was performed to compare the treatment means at 5% level of significance (P=0.05) using least significant difference (LSD).

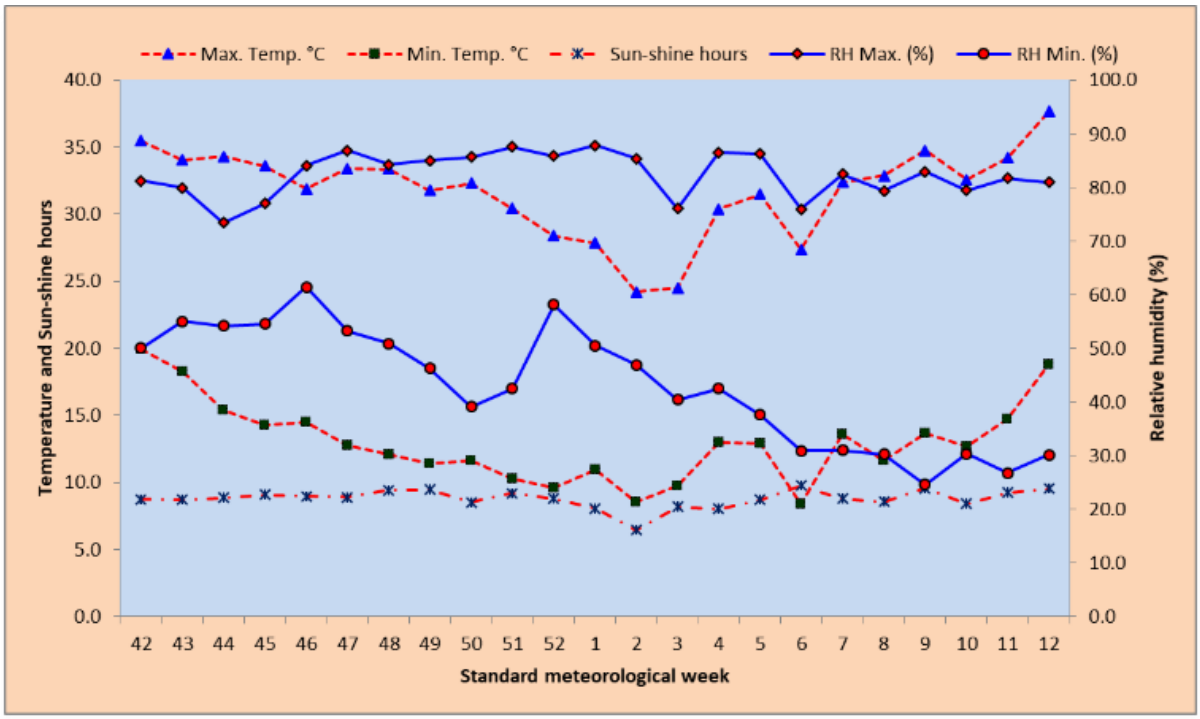

Fig 1: Mean weekly standard meteorological parameter during crop period during *rabi* 2016-17.

Results and Discussions

Crop growth, yield attributes and yield

Plant height, number of primary branches/plant, number of seeds/siliqua and length of siliqua were failed to showed significant variation due to various levels of nitrogen, phosphorus and potassium, only slightly marginal increment was noted on those parameters with increasing levels of fertility. However, number of secondary branches/plant and number of siliquae/plant was registered significantly higher with the application of 120 kg N/ha which was statistically on par with application 100 kg N/ha (Table 1). While, 1000-seed weight was recorded significantly higher under application of 80 kg N/ha and it's remained statistically at par with application of 100 kg N/ha but significantly superior over 120 kg N/ha. On other hand number of grains/siliquae of mustard were significantly influenced due to interaction effect of nitrogen and potassium levels. Application of 120 kg N/ha alone recorded significantly higher number of grains/siliquae as comparatively in conjunction with 30 kg/ha potassium (Table 3). These results are in close conformity with the findings of Singh *et al*. (2017) [8] and Jat *et al*. (2017) [6]. Seed yield of Indian mustard was concomitantly increased with increasing levels of nitrogen (Table 2). Application of 120 kg N/ha registered significantly higher seed yield (2510 kg/ha) and it was comparatively at par with 100 kg N/ha. The corresponding increases in seed yield due to application of 120 kg N/ha with the margin of 12.0 and 7.81% higher over 80 kg and 100 kg N/ha. Seed yield of mustard were also influenced significantly due to interactive effect of nitrogen and phosphorus. Mustard crop fertilized by 120 kg N/ha alongwith 20 kg P_2O_5 recorded higher seed yield (2595 kg/ha) as compared to other combinations (Table 4). Various levels of phosphorus and potassium were failed to showed significant variation in enhancing seed yield which were performed statistically at par with each other. This could be ascribed due to the more availability of nutrient in soil with increasing levels of fertility must have increased the proportion of nutrient in the crop plant which ultimately led to enhance yield. Beside this, the higher level of nutrient resulted in higher growth and yield attributes which led to contribute more seed yield. Similar increase in yield due to increasing levels of fertility has also been reported by Ghimire and Bana (2011) [4] & Jat *et al*. (2017) [6].

Table 1: Effect of fertility levels on growth and yield attributes of Indian mustard

Treatments	Plant height (cm)	No. of branches/plant		No. of siliquae per plant	No of Seeds/ siliqua	Length of siliqua (cm)	1000-seed weight (g)
		Primary	Secondary				
Nitrogen levels							
N_1: 80 kg/ha	179.42	3.88	12.80	298.3	12.68	3.98	5.85
N_2: 100 kg/ha	182.92	3.83	13.37	310.9	12.81	4.02	5.64
N_3: 120 kg/ha	180.00	3.87	14.33	327.1	13.28	4.27	5.32
SEm±	2.42	0.08	0.44	8.92	0.31	0.11	0.16
C D (P=0.05)	NS	NS	1.28	26.17	NS	NS	0.47

Phosphorus levels							
P_1: 20 kg/ha	181.06	3.80	13.49	309.3	12.79	4.14	5.56
P_2: 40 kg/ha	180.50	3.92	13.51	314.9	13.07	4.04	5.66
SEm±	2.97	0.10	0.54	10.93	0.38	0.14	0.20
C D (P=0.05)	NS	NS	NS	NS	NS	NS	NS
Potassium levels							
K_0: 0 kg/ha	179.50	3.92	13.77	317.5	13.11	4.10	5.56
K_1: 30 kg/ha	182.06	3.80	13.23	306.8	12.74	4.08	5.66
SEm±	2.97	0.10	0.54	10.93	0.38	0.14	0.20
C D (P=0.05)	NS	NS	NS	NS	NS	NS	NS

Table 2: Effect of fertility levels on yield and economics of Indian mustard

Treatments	Seed yield (kg/ha)	Oil Content (%)	Oil yield (kg/ha)	Net returns (₹/ha)	B: C ratio
Nitrogen levels					
N_1: 80 kg/ha	2241	36.23	813.4	57768	3.29
N_2: 100 kg/ha	2328	36.41	847.7	60689	3.39
N_3: 120 kg/ha	2510	36.23	909.7	67180	3.62
SEm±	66.61	0.16	25.51	2464.5	0.10
CD at 5%	195.36	NS	74.83	7228.2	0.29
Phosphorus levels					
P_1: 20 kg/ha	2301	36.26	835.0	60191	3.41
P_2: 40 kg/ha	2419	36.32	878.9	63567	3.45
SEm±	81.58	0.19	31.25	3018.4	0.12
CD at 5%	NS	NS	NS	NS	NS
Potassium levels					
K_0: 0 kg/ha	2302	36.16	833.4	60172	3.40
K_1: 30 kg/ha	2417	36.42	880.5	63586	3.46
SEm±	81.58	0.19	31.25	3018.4	0.12
CD at 5%	NS	NS	NS	NS	NS

Table 3: Interaction effect of different nitrogen and potassium levels on the number of grains/siliqua of Indian mustard

Nitrogen level (kg/ha)	Potassium levels (kg/ha)		
	K_0: 0 kg/ha	K_1: 30 kg/ha	Mean
N_1: 80 kg/ha	12.27	13.10	12.68
N_2: 100 kg/ha	13.33	12.23	12.78
N_3: 120 kg/ha	13.70	12.87	13.28
Mean	13.10	12.73	
SEm±	0.38		
CD (*P*=0.05)	1.11		

Table 4: Interaction effect of different nitrogen and phosphorus levels on the seed yield (kg/ha) of Indian mustard

Nitrogen level (kg/ha)	Phosphorus level (kg/ha)		
	P_1: 20 kg/ha	P_2: 40 kg/ha	Mean
N_1: 80 kg/ha	1961	2522	2241
N_2: 100 kg/ha	2348	2307	2328
N_3: 120 kg/ha	2595	2426	2511
Mean	2301	2419	
SEm±	81.61		
CD (*P*=0.05)	239.42		

Oil content and oil yield

The oil content was unaffected due to various levels of nitrogen, phosphorus and potassium (Table 2). However, oil yield was concomitantly increased with increasing levels of nitrogen up to 120 kg N/ha which was registered 11.84% and 7.31% higher oil yield over application of 80 and 100 kg N/ha. Various levels of phosphorus and potassium were equally effective to enhance oil yield. Similar trends were also observed by Jat *et al*. (2017) [6].

Economics

Significantly higher net returns (₹ 67180/ha) and B: C ratio (3.62) was recorded with application of 120 kg N/ha (Table 2). It gain ₹ 6491/ha and ₹ 9412/ha higher net income over the 100 kg and 80 kg N/ha. Application of higher dose of nitrogen i.e. 120 kg N/ha showed mark improvement in seed yields and thus gaining more profit in terms of net returns and benefit: cost ratio over rest of treatments. Application of phosphorus and potassium resulted marginally higher monetary returns with increasing levels as comparatively lower levels but it could not reach at the level of significance to showed marked variation. The findings have also been supported parallely by Daulagupu and Thakuria (2016) [3] and Jat *et al*. (2017) [6].

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