

# Nitrogen and Sulphur Fertilization on Yield and Nutrient under North India condition

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## ABSTRACT

A field experiment was conducted during the winter (rabi) seasons of 2014-15 and 2015-16 at Janta Vedic College, Baraut (Baghpat), Uttarpradesh to study the effect of nitrogen and sulphur fertilizer on yield and nutrient uptake pattern of 'RGN73' Indian mustard (*Brassica juncea* L.). The experiment was laid out in factorial randomized block design with two factors. A (Nitrogen 80,120,160 kg/ha) and B (Sulphur 0, 20, 40, 60 kg/ha). Each replication 12 treatment combination of different levels of nitrogen and Sulphur and three replication application of 120 kg N/ha in combination with 40 kg S/ha resulted in increased siliqua length, higher seed/siliqua, 1000-seed weight and ultimately the seed yield over the control (80 kg/ha N, and 0 kg/ha S) but was found at par with 160 kg/ha significantly increased uptake of nitrogen (65.49, 39.68 kg/ha), phosphorus (14.29, 20.56 kg/ha), potassium (19.59, 97.44 kg/ha), Sulphur (9.46, 14.07 kg/ha) and Carbon (248.2, 865 kg/ha) during both the year in the seed and stover of the crop compared the control (80 kg N/ha). Among the different Sulphur levels 60 kg S/ha resulted in achieving significantly higher nutrient uptake in Indian mustard in 2014-15 and 2015-16. The cost of cultivation was found to be 2.10% and 2.17% lower with the combination 120 kg N/ha and 40 kg S/ha compared to 160 kg N/ha and 60 kg S/ha, hence it could be achieving higher yield levels and nutrient uptake in Indian mustard under North India condition.

**Keywords:** Indian mustard, Nitrogen, Nutrient uptake, Sulphur

## Article Publication

Published Online: 14-Feb-2021

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## 1. Introduction

Rapeseed-mustard a group of oilseed crop in India accounts for approximately 20-22% of total oil seed production in the country. out of 7 cultivated oilseeds specie of genus Brassica, more than 80% of total area in occupied by Indian mustard alone (Chandrashekar et al., 2013). The imperfect integration of essential plant nutrients and their poor supply are among the major causes of low seed and oil yield in Indian mustard. Among the various nutrients, a strong interaction of Nitrogen and Sulphur for enhancing the total seed yield as well as the Nitrogen and Sulphur for enhancing the total seed yield as well as the nutrient uptake has been found significant in Indian mustard. The assimilatory pathways of nitrogen and sulphur are considered to be functionally convergent and the availability of one nutrient, in addition to its direct role in promoting growth and yield, regulates the activity of another. There is greater synergistic influence of nitrogen and sulphur on growth, yield, nutrient uptake protein and oil production in oilseed rape. Due to metabolic coupling between nitrogen-sulphur metabolism, sulphur deficiency in plant leads to nitrogen deficiency as well (Akmal et al., 2014). Thus the combined application of nitrogen and sulphur had the largest effect on the concentration and uptake of nitrogen and sulphur on yield attributes, yield as well as uptake of the nutrient in Indian mustard (*Brassica juncea* L.). Hence, a field experiment was conducted to access the effect of varying levels of nitrogen and sulphur fertilization on yield nutrient uptake pattern of Indian mustard under North India condition.

## 2. Materials and Methods

The experiment was conducted during the winter seasons of 2014-15 and 2015-16 at the R.M.P. (P.G.) College, Gurukul Narsan (Haridwar), U.K. The soil of experimental site was sandy clay loam with pH 7.5, organic carbon 0.81%, available nitrogen

220 kg/ha, available phosphorus 22 kg/ha and potassium 192 kg/ha. The experiment was laid out in factorial randomized block design with two factors, factors A nitrogen levels, factors B sulphur levels. Each replication comprise 12 treatments combinations of different levels of nitrogen and sulphur and replicated thrice. A pre-sowing irrigation was applied and when soil reached proper moisture level and seed bed was prepared. Mustard variety 'RGN73' was sown manually with lines at 30 cm spaced rows using seed rate of 4 kg/ha and an plant to plant distance 20 cm was maintained by thinning at 4-5 leaf stage. The seed was sown on mid october and the crop harvest on 30 February in 2014-15 and 2015-16 respectively. The amount of different fertilizers required to supply the needed quantities of nutrients were calculated on per plot basis. Sulphur was applied through gypsum as basal, while the requirement of nitrogen was met by application of NPK mixture (12:32:16) along with urea as basal dose (50%) and top-dressing of urea (50%) was done at 30 DAS. The required quantity of phosphorus and potassium were applied through NPK mixture (12:32:16) itself as basal dose. All other agronomic practices were kept normal and uniform for all the treatments. Plant protection measures were adopted to keep the crop free from weeds, insect-pests and diseases. Crop was harvest manually when it was fully matured. Sun-dried crop was threshed manually after the harvesting. Seed and biomass yield from the whole plots were measured and converted into kg/ha. The processed samples were used for different chemical studies for uptake of the nutrients, viz. nitrogen, phosphorus, potassium, sulphur and carbon in both seed and stover at harvest stage of the crop.

### 3. Results and Discussion

#### Yield attributes and yield

Application of 160 kg N/ha increased the length of siliqua and seed/siliqua 11.36% and 15.07% respectively, over 80 kg N/ha but was found to be at par with 120 kg N/ha on pooled data basis (Table 1). The 1,000 seed weight increased with the increasing levels of nitrogen but did varied significantly. The successive increase in the rate of nitrogen resulted in increased seed yield of Indian mustard seed yield increased significantly being the maximum with the application of 160 kg N/ha but was at par with 120 kg N/ha. The increase in the yield was to the tune of 17.72% with the application of 160 kg N/ha over 80 kg N/ha.

Yield attributes have cumulative response in seed yield of Indian mustard. Length of siliqua seed/siliqua and 1,000-seed weight increased with the successive increase in N levels, as it results in increased translocation of the food material for seed formation in the crop. Increase in the seed yield owing to the fact that N acts as an important constituent for the synthesis of chlorophyll and various amino acids which act as the building blocks of protein. It also influences the source-sink relationship through production of photosynthates and its increased translocation to the reproductive parts that finally boosts the seed yield of Indian mustard (Kumar et. al., 2012, Hashim, 2014).

Increase in the doses of sulphur from 0 to 60 kg/ha resulted in increase in the yield attributes viz. length of siliqua, seed/siliqua, 1,000-seed weight and ultimately the seed yield to tune of 15.04% over no-sulphur application, while the 2 higher levels, i.e. 40 kg S/ha and 60 kg S/ha, were found to be at par significant improvement in seed yield might be a consequence of the initially increased branching of the crop which increased length of siliqua, seed/siliqua, 1,000 seed weight which finally increased the seed yield of mustard. The finding are in corroboration with Khalid et. al. (2009) and Yadav et. al. (2017).

#### Nutrient uptake

Effect of increasing nitrogen application showed a statistically significant increase for the uptake of N,P,K, S and C in mustard (Table 2). Application of 160 kg N/ha significant increased in the uptake of nitrogen (65.49, 39.68 kg/ha), phosphorus (14.29, 20.56 kg/ha), potassium (19.59, 97.44 kg/ha) in sulphur (9.46, 14.07 kg/ha) and carbon except for potassium and i.e. 120 kg N/ha and 160 kg N/ha were found to be at par. Lowest uptake of the nutrients was recorded with 80 kg N/ha. Higher doses of N (160 kg/ha) increased the uptake of N,P,K, S and carbon 24.87%, 18.68%, 21.28%, 20.40% and 24.73% higher in the seed, respectively, compared with the control (80 kg N/ha).

Applying higher doses of N increased the initial crop growth which in turn results in more photosynthetic rate of the crop. Thus resulting in more uptake of nutrients by the crop. Higher rate of N also enhances the root cation-exchange capacity and root proliferation that ultimately increase nutrient absorption by the crop (Tomas and Singh, 2007; Parmar et. al., 2011).

The nutrient uptake in seed and stover of the crop increased significantly with the successive increase in the doses of sulphur. The application of 60 kg s/ha increased the uptake of N (18.90% and 25.79%), P (16.25% and 20.46%), K (23.46 and 21.09%), S (22.40% & 25.96%) & C (20.27% & 16.37%) in seed and stover compared to no-sulphur application. The highest doses of sulphur resulted in significantly higher uptake of all the nutrients by the crop for N,P,K uptake in stover where 60 kg S/ha was found to be at par with 40 kg S/ha (Table 2).

Increase in the uptake of the nutrients by the S fertilization might be due to the profused vegetative growth by the crop, as S regulates the synthesis of chlorophyll and coenzyme A and also causes profuse root development which in turn increases the absorption of nutrients from the soil (Parmar et. al., 2011).

### Economics

The maximum gross return (68,530 Rs/ha), net return (44,107 Rs/ha) as well as benefit cost ratio (1.81) were fetched with the application of 160 kg N/ha, followed by 120 kg N/ha, while the least with 80kg N/ha (Table 3) on pooled data. The cost of cultivation was 160 kg N/ha, thus making it more economical over 160 Kg N/ha from farmers point of view.

Similarly higher doses of S (60 kg/ha) recorded the highest gross return (67,407 Rs/ha), Net return (42,695 Rs/ha) while the benefit : cost ratio (1.75) was found to be highest with 40 kg S/ha. The cost of cultivation was found to be 2.17% lower with 40 kg S/ha compared to 60 kg S/ha.

Nitrogen and sulphur plays a key role in synthesis of protein and amino acid therefore plays an important role in improving nutrient uptake and the yield of mustard. Thus, on the basis of aforesaid findings, it could be concluded that the combination of 120 kg N/ha with 40 kg S/ha is more economical and resulted in increased the N,P,K, S & C uptake and finally achieving higher yield levels in mustard thus, could be recommended under North India condition for better yield and productivity of Indian Mustard.

**Table 1. Length of siliqua, seeds/siliqua, 1,000-seed weight and seed yield as influenced by varying levels of nitrogen and sulphur fertilizer in mustard (pooled data).**

Treatment	Length of siliqua (cm)	Seeds/siliqua	1,000-seed weight (g)	Seed yield (t/ha)
N (Kg/ha)				
80	3.90	10.70	3.70	1.57
120	4.30	12.10	3.80	1.84
160	4.40	12.60	3.90	1.91
<b>SEm±</b>	<b>0.05</b>	<b>0.20</b>	<b>NS</b>	<b>0.025</b>
<b>CD (P=0.05)</b>	<b>0.10</b>	<b>0.60</b>	<b>0.20</b>	<b>0.074</b>
S (kg/ha)				
0	4.00	10.80	3.60	1.59
20	4.20	11.60	3.70	1.77
40	4.30	12.20	3.80	1.86
60	4.30	12.60	4.00	1.88
<b>SEm±</b>	<b>0.06</b>	<b>0.20</b>	<b>NS</b>	<b>0.029</b>
<b>CD (P=0.05)</b>	<b>0.20</b>	<b>0.70</b>	<b>0.20</b>	<b>0.085</b>

**Table 2. Nitrogen phosphorus and potassium, sulphur and carbon uptake at harvest as influenced by varying levels of nitrogen and sulphur fertilizer (Pooled data).**

Treatment	Nutrient uptake (Kg/ha)									
	N uptake		P uptake		K uptake		S uptake		C uptake	
	Seed	Stover	Seed	Stover	Seed	Stover	Seed	Stover	Seed	Stover
N (Kg/ha)										
80	45.20	23.66	11.62	15.26	15.42	75.24	7.53	9.93	1868	685
120	60.33	34.75	13.62	19.46	18.59	94.62	8.74	13.34	2380	820
160	65.49	39.68	14.29	20.56	19.59	97.44	9.46	14.07	2482	865
<b>SEm±</b>	<b>0.36</b>	<b>0.43</b>	<b>0.07</b>	<b>0.29</b>	<b>0.15</b>	<b>1.45</b>	<b>0.04</b>	<b>0.17</b>	<b>255.8</b>	<b>33.4</b>
<b>CD (P=0.05)</b>	<b>1.07</b>	<b>1.27</b>	<b>0.23</b>	<b>0.85</b>	<b>0.45</b>	<b>4.27</b>	<b>0.12</b>	<b>0.50</b>	<b>NS</b>	<b>98.7</b>
S (Kg/ha)										
0	51.35	27.15	11.75	15.93	15.46	76.96	7.41	10.35	1938	705
20	57.43	31.64	13.07	18.17	17.24	87.57	8.38	12.12	2222	785
40	61.27	35.39	13.76	19.57	18.69	94.34	9.03	13.34	2382	824
60	63.32	36.59	14.03	20.03	20.09	97.53	9.55	13.98	2431	843
<b>SEm±</b>	<b>0.42</b>	<b>0.50</b>	<b>0.09</b>	<b>0.33</b>	<b>0.18</b>	<b>1.67</b>	<b>0.05</b>	<b>0.19</b>	<b>295.4</b>	<b>38.6</b>
<b>CD (P=0.05)</b>	<b>1.23</b>	<b>1.50</b>	<b>0.26</b>	<b>0.99</b>	<b>0.52</b>	<b>4.93</b>	<b>0.14</b>	<b>0.14</b>	<b>NS</b>	<b>NS</b>

**Table 3. Cost of cultivation, gross return, net return, benefit cost ratio as influenced by varying levels of nitrogen and sulphur fertilizer (Pooled data).**

Treatment	Cost of cultivation (x10 <sup>3</sup> Rs/ha)	Gross return (x10 <sup>3</sup> Rs/ha)	Net returns (x10 <sup>3</sup> Rs/ha)	Benfit : cost ratio
N (Kg/ha)				
80	23.40	56.50	33.10	1.42
120	23.90	65.90	42.00	1.76
160	24.40	68.50	44.10	1.81
S (Kg/ha)				
0	23.10	57.40	34.30	1.48
20	23.60	63.30	39.70	1.68
40	24.20	66.50	42.30	1.75
60	24.70	67.40	42.70	1.73

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