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Effect of nitrogen and sulphur levels on mustard (*Brassica juncea* L.) yield and post-harvest soil fertility

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Abstract

Indian mustard (*Brassica juncea* L.) is an important rabi oilseed crop whose productivity is strongly affected by balanced nitrogen (N) and sulphur (*S*) nutrition. A field experiment was conducted during rabi 2025–26 at the AICRP Mustard Research Farm, College of Agriculture, Nagpur, Maharashtra, on black cotton soil to evaluate three nitrogen levels (50, 65 and 80 kg N ha^{-1}) and three sulphur levels (15, 30 and 45 kg S ha^{-1}) in a factorial randomized block design with three replications. Mustard variety TAM-108-1 was grown at 45 × 10 cm spacing. Growth and yield observations included plant height and days to 50% flowering, number and weight of siliquae plant^{-1}, seed yield and stover yield. Post-harvest soil was assessed for pH, electrical conductivity (EC), organic carbon, calcium carbonate, available N, P and K, and DTPA-extractable Fe, Mn, Zn and Cu. Nitrogen increased plant height, siliqua number, siliqua weight and seed yield, while sulphur generally improved these traits. Plant height at 50% flowering reached 137.42 cm with 80 kg N ha^{-1} and 130.94 cm with 45 kg S ha^{-1}. The highest seed yield among individual N levels was 18.27 q ha^{-1} at 80 kg N ha^{-1}, while 45 kg S ha^{-1} produced 18.51 q ha^{-1}. The N × S interaction produced the highest seed yield (18.97 q ha^{-1}) and stover yield (55.28 q ha^{-1}) with 80 kg N + 45 kg S ha^{-1}. Post-harvest pH and EC were not significantly altered. Organic carbon, available N and P and several micronutrients increased with higher nutrient levels. Overall, balanced N and S nutrition improved mustard productivity and maintained a favorable post-harvest soil fertility status.

Keywords: *Brassica juncea* L., Nitrogen, Sulphur, Seed yield, Post-harvest soil fertility

1. Introduction

Indian mustard is a major rabi oilseed crop and an important component of Indian agricultural systems. The crop responds strongly to balanced nutrient supply because nitrogen is central to vegetative growth, chlorophyll and protein synthesis, whereas sulphur is required for sulphur-containing amino acids, enzymes and oil formation. The uploaded thesis notes that inadequate N and S nutrition can restrict the yield potential of mustard and that the two nutrients interact at plant and soil levels. Sulphur is particularly important for oilseed crops because of their comparatively high S requirement. The study therefore evaluated the individual and combined effects of N and S levels on growth, yield attributes, seed and stover yield, and selected post-harvest soil fertility indicators.

2. Materials and Methods

The experiment was conducted during 2025–26 at the AICRP Mustard Research Farm, College of Agriculture, Nagpur. The experimental soil was black cotton soil, clayey in texture, alkaline in reaction (initial pH 8.10), with organic carbon 5.2 g kg^{-1}, available N 267.56 kg ha^{-1}, available P 18.97 kg ha^{-1} and available K 345.69 kg ha^{-1}. The experiment followed a factorial randomized block design with three levels of N (N_1 = 50, N_2 = 65 and N_3 = 80 kg N ha^{-1}) and three levels of S (S_1 = 15, S_2 = 30 and S_3 = 45 kg S ha^{-1}), giving nine treatment combinations and three replications. Mustard variety TAM-108-1 was sown by drilling at 45 × 10 cm on 18 November 2025 and harvested on 14 March 2026. FYM @ 3 t ha^{-1} was common to all treatments. Nitrogen was applied in two split doses, while the full doses of phosphorus and sulphur were applied at sowing; sulphur was supplied through bentonite-S. Siliquae number and siliquae weight were recorded from five randomly selected plants. Seed and stover yields were converted to q ha^{-1}. Post-harvest soil samples were collected from 0–20 cm and analyzed for different soil fertility parameters adopting standard methods of analysis.

3. Result and Discussion

3.1 Seed and stover yield

Seed and stover yields were significantly influenced by N and S. Seed yield increased from 16.86 q ha^{-1} at 50 kg N ha^{-1} to 18.27 q ha^{-1} at 80 kg N ha^{-1}; the latter was statistically at par with 65 kg N ha^{-1} (18.04 q ha^{-1}). Sulphur increased seed yield from 16.57 q ha^{-1} at 15 kg S ha^{-1} to 18.51 q ha^{-1} at 45 kg S ha^{-1}. The interaction was significant, with N_3S_3 recording the highest seed yield (18.97 q ha^{-1}), at par with N_3S_2 (18.91), N_2S_3 (18.91) and N_2S_2 (18.59 q ha^{-1}). Stover yield was 49.88 q ha^{-1} at 50 kg N ha^{-1} and reached 54.09 q ha^{-1} at 65 kg N ha^{-1}, which was at par with 80 kg N ha^{-1} (53.95 q ha^{-1}). Sulphur increased stover yield from 50.67 q ha^{-1} at 15 kg S ha^{-1} to 54.03 q ha^{-1} at 45 kg S ha^{-1}. The N × *S* interaction was significant, and the highest stover yield was 55.28 q ha^{-1} under N_3S_3. Kumar *et al.* (2017) [1] reported significant increases in biological, seed and stover yield with increasing N and S levels in Indian mustard, with maximum yield obtained at 120 kg N + 40 kg S ha^{-1}. Mohiuddin *et al.* (2011) [2] also reported significant *N* × *S* effects on seed and shoot yield, with the highest seed yield under combined N and S application. The complementary response of N and S suggests that adequate N supports biomass formation while S supports protein synthesis, enzyme activity and efficient partitioning towards reproductive sinks.

Table 1. Interaction effect on seed yield

	N_1	N_2	N_3	Average
S_1	16.17	16.61	16.94	16.57
S_2	16.74	18.59	18.91	18.08
S_3	17.67	18.91	18.97	18.51
Average	16.86	18.04	18.27	
SE (m)±	0.21			
CD at 5%	0.61			

3.2 Post-harvest soil fertility

Post-harvest soil reaction and conductivity were not significantly affected by either nutrient or their interaction. Mean pH under N ranged from 7.92 to 7.96 and under S from 7.88 to 7.99; EC ranged from 0.28 to 0.32 dS m^{-1} under N and 0.29 to 0.30 dS m^{-1} under S. Organic carbon responded significantly: it increased from 5.46 g kg^{-1} at 50 kg N ha^{-1} to 5.60 g kg^{-1} at 80 kg N ha^{-1} and from 5.42 g kg^{-1} at 15 kg S ha^{-1} to 5.58 g kg^{-1} at 45 kg S ha^{-1}. The interaction was significant, with the highest organic carbon (5.61 g kg^{-1}) under N_3S_3 and the lowest (5.33 g kg^{-1}) under N_1S_1. Yadav *et al.* (2010) [3] indicated that the use of sulphur enhanced soil organic carbon following the harvest of Indian mustard. A notable increase in the organic carbon percentage was observed at the S_{40} level (0.39%) compared to the S_0 level of sulphur (0.34%), and this result was significant. Calcium carbonate varied only within a narrow range; the N effect was significant, with 4.24% under 65 kg N ha^{-1}, whereas S and *N* × *S* were non-significant.

Table 2. Interaction effect on stover yield

	N_1	N_2	N_3	Average
S_1	46.42	52.75	52.85	50.67
S_2	51.16	54.78	53.72	53.22
S_3	52.07	54.75	55.28	54.04
Average	49.88	54.09	53.95	
SE (m)±	0.82			
CD at 5%	2.47			

Available nitrogen showed a significant response to nitrogen and sulphur fertilization. Under nitrogen levels, available N increased from 293.27 kg ha^{-1} at 50 kg N ha^{-1} to 296.94 kg ha^{-1} at 80 kg N ha^{-1}. Similarly, under sulphur levels, available N increased from 293.14 kg ha^{-1} at 15 kg S ha^{-1} to 295.84 kg ha^{-1} at 45 kg S ha^{-1}. The *N* × *S* interaction was significant, with the maximum available N (300.13 kg ha^{-1}) recorded under N_3S_2. The increase in available N with higher nitrogen application may be attributed to the addition of nitrogen through fertilizer and the residual availability of applied nitrogen in soil. Prasad *et al.* (2018) [4] reported that the combination of 40 kg P ha^{-1} and 30 kg S ha^{-1} was optimal for available nitrogen (kg ha^{-1}), phosphorus (kg ha^{-1}), potassium (kg ha^{-1}), and sulphur (ppm), yielding results of 245.22, 23.14, 201.10, and 14.88, respectively. The soil's chemical properties, including available nitrogen, phosphorus, and sulphur, were found to be significant. Available phosphorus increased from 18.83 kg ha^{-1} at 50 kg N ha^{-1} to 19.07 kg ha^{-1} at 80 kg N ha^{-1} and from 18.93 kg ha^{-1} at 15 kg S ha^{-1} to 19.02 kg ha^{-1} at 45 kg S ha^{-1}. The *N* × *S* interaction was significant, with the highest available P (19.10 kg ha^{-1}) under N_3S_3. Jadav *et al.* (2016) [5] reported improvement in post-harvest available phosphorus with phosphorus and sulphur application in mustard. Available K was highest at 351.57 kg ha^{-1} under N_1 and 351.97 kg ha^{-1} under S_3, while the *N* × *S* interaction was non-significant. Overall, the application of nitrogen and sulphur maintained or improved the post-harvest availability of major nutrients without causing significant changes in soil pH and EC. Dighe (2014) [6] noted that the available nitrogen after the harvest of mustard was significantly affected by the application of sulphur, which notably increased the available nitrogen in the soil post-harvest. The highest recorded levels of available potassium and sulphur were associated with the application of 20 kg sulphur ha^{-1}, yielding 407.85 kg ha^{-1} and 9.10 mg kg^{-1}, respectively. The increased availability of potassium can be attributed in part to the dissolution of potassium containing minerals in the soil and in part to the decomposition of biomass and acidification with mineral potassium.

4. Conclusion

Under the conditions of the present field experiment, nitrogen and sulphur exerted complementary effects on mustard growth, yield attributes and productivity. Increasing N from 50 to 80 kg ha^{-1} and S from 15 to 45 kg ha^{-1} generally improved plant height, siliquae number and siliqua weight. The highest seed yield (18.97 q ha^{-1}) and stover yield (55.28 q ha^{-1}) were recorded with 80 kg N + 45 kg S ha^{-1}. Post-harvest soil pH and EC remained statistically stable, while organic carbon and available N and P improved with higher nutrient

levels; micronutrient availability also showed generally favourable responses. The results support balanced N and S management for higher mustard productivity while maintaining post-harvest soil fertility. Because the study represents one season and one experimental site, multi-season and multi-location validation is desirable before making a generalized fertilizer recommendation.

Table 3. Effect on post-harvest soil fertility

Treatment	Soil chemical properties						
	pH	EC (dS m^{-1})	OC (g kg^{-1})	$CaCO_3$	Nitrogen (kg ha^{-1})	Phosphorus (kg ha^{-1})	Potassium (kg ha^{-1})
Levels of Nitrogen							
N_1 (50 kg Nitrogen ha^{-1})	7.96	0.28	5.46	4.19	293.27	18.83	351.57
N_2 (65 kg Nitrogen ha^{-1})	7.92	0.29	5.55	4.24	294.03	19.04	349.29
N_3 (80 kg Nitrogen ha^{-1})	7.92	0.32	5.60	4.19	296.94	19.07	350.61
SE (m)±	0.05	0.01	0.02	0.08	0.66	0.014	1.86
CD at 5%	-	-	0.05	-	1.98	0.042	-
Levels of Sulphur							
S_1 (15 kg Sulphur ha^{-1})	7.99	0.30	5.42	4.17	293.14	18.93	351.27
S_2 (30 kg Sulphur ha^{-1})	7.88	0.30	5.56	4.16	295.26	18.99	347.24
S_3 (45 kg Sulphur ha^{-1})	7.95	0.29	5.58	4.30	295.84	19.02	351.97
SE (m)±	0.05	0.01	0.02	0.08	0.66	0.014	1.86
CD at 5%	-	-	0.05	-	1.98	0.042	-
Interaction (Nitrogen X Sulphur)							
SE (m)±	0.08	0.02	0.03	0.14	1.14	0.024	3.23
CD at 5%	-	-	0.08	-	3.43	0.072	-

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