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INFLUENCE OF NITROGEN AND SULPHUR FERTILIZATION ON GROWTH AND YIELD OF INDIAN MUSTARD (*BRASSICA JUNCEA* L.)

Anjali Bhardwaj[1], Phool Chandra Singh[1], R.K. Singh[3], Priyanshi[2], Jitendra Yadav[1] and Saurav Chaurasiya[2*]

[1]Department of Agronomy, Sri Durga Ji Post Graduate College Chandeshwar, Azamgarh-276128 (U.P.), India

[2]Department of Agronomy, Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya, 224229, India

[3]Krishi Vigyan Kendra Amihit, Jaunpur-222142 (U.P.), India

*Corresponding author E-mail: chaurasiya8498@gmail.com

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ABSTRACT

Field experiment entitled"Evaluating the Influence of Nitrogen and Sulphur Fertilization on Growth and Yield of Indian Mustard (*Brassica juncea* L.)" was carried out at the Agronomy Research Farm of S.D.J. Post Graduate College Chandeshwar, Azamgarh affiliated with Veer Bahadur Singh Purvanchal University, Jaunpur (U.P.) during Rabi (winter) seasons of 2020-21 and 2021-22. The experiment comprised of four nitrogen levels (0, 40, 80 and 120 kg ha^{-1}) and four sulphur levels (0, 15,30 and 45 kg ha^{-1}) tested in Randomized Block Design and replication three times. The growth characters such as plant height,number of leaves plant^{-1} and number of branches plant^{-1}, fresh weight plant^{-1}, dry matter accumulation plant^{-1} and were maximum at 120 kg N ha^{-1} and 45 kg S ha^{-1}. The maximum seed yield (22.80 and 23.74 q ha^{-1}) and stover yield (77.73and 81.65 q ha^{-1}) was recorded at 120 kg N. In case of sulphur application, the maximum seed yield (21.40 and 22.29 q ha^{-1}) and stover yield (72.96 and 76.66 kg ha^{-1}) was recorded at 45kg S ha^{-1}.It may be concluded that 120 kg Nwith 45kg S ha^{-1} is possible to produce more yield in mustard crops.

Key words: Different levels of nitrogen, sulphur, Indian mustard, *Brassica juncea* (L.) Czern and Coss.

Introduction

Indian mustard (*Brassica juncea* L.) is an important oilseed crop, widely cultivated for its edible oil rich in essential fatty acids. The productivity and quality of mustard are closely linked to the availability of key nutrients, particularly nitrogen (N) and sulphur (S). Nitrogen is vital for plant growth, as it is a core component of amino acids, proteins, chlorophyll, and enzymes. It enhances vegetative growth and photosynthesis, but a deficiency leads to stunted growth and reduced yield, while excess nitrogen can cause issues like lodging and delayed maturation (Ladha*et al.*, 2005; Sharma *et al.*, 2013). Optimizing nitrogen application is crucial for high yield. Sulphur, although required in smaller amounts, is also essential for mustard. It is involved in the synthesis of amino acids, coenzymes, and vitamins, and contributes to plant growth and stress resistance. A deficiency in sulphur can cause poor growth, chlorosis, and reduced oil content in seeds, ultimately lowering both yield and quality (Saha *et al.*, 2022). Furthermore, sulphur plays a role in enhancing nitrogen uptake and reducing nitrogen leaching, making it critical for balanced fertilization (Rashid *et al.*, 2017). An optimal balance of nitrogen and sulphur is necessary to maximize mustard growth and oil quality. This study aims to investigate the effects of varying nitrogen and sulphur levels on mustard's growth, yield, and oil content. The objective is to identify the optimal nutrient combination to improve both productivity and seed

quality (Fageria*et al.*, 2010). The findings will provide valuable insights into nutrient management strategies that can enhance the sustainability and profitability of mustard cultivation.

Materials and Methods

A field experiment was carried out to "Evaluating the Influence of Nitrogen and Sulphur Fertilization on Growth and Yield of Indian Mustard (*Brassica juncea* L.)" was carried out at the Agronomy Research Farm of S.D.J. Post Graduate College Chandeshwar, Azamgarh affiliated with Veer Bahadur Singh Purvanchal University, Jaunpur (U.P.) during Rabi (winter) seasons of 2020-21 and 2021-22. The soil of experimental field was Clay loam in texture, and having pH (1:2.5) 8.20, EC 0.35 dS/m, organic carbon 3.7%, available nitrogen 194.25 kg/ha, available phosphorus 18.0 kg/ha., available potassium 250.25 kg/ha and available sulphur 10.50 kg/ha The experiment comprised of four nitrogen levels (0, 40, 80 and 120 kg ha^{-1}) and four sulphur levels (0, 40, 80 and 120 kg ha^{-1}) tested in Randomized Block Design with three replications.Nitrogen and sulphur were supplied through urea and gypsum respectively. As per treatment half dose of nitrogen and full dose sulphur was applied as basal dressing. The remaining half dose of nitrogen was applied after first irrigation. Full dose of P and K was applied at the time of sowing. The crop was timely sown. The growth attributes and yield were recorded at deferent crop growth stages (30, 45, 60, 120 DAS) and maturity.

Results and Discussion

The study investigated evaluating the influence of nitrogen and sulphur fertilization on growth and yield of Indian mustard over two experimental years (2020-21 and 2021-22) at the main experiment station, department of Agronomy.

Growth Attributes

Application of 120 kg N ha^{-1} resulted in the tallest plants across all stages, with a significant increase in plant height at 45, 60 days after sowing (DAS), and at harvest compared to lower nitrogen levels. Similarly, the highest plant height was observed at 45 kg S ha^{-1}, with a consistent increase at 45 and 60 DAS compared to lower sulphur doses. However, no significant interactions between N and S levels were observed for plant height at various growth stages. Singh and Kumar (2014) noted that nitrogen application significantly enhanced the height of mustard plants, with higher doses leading to taller plants at all growth stages.Nitrogen levels had a significant effect on leaf number from 45 DAS onward, with the highest leaf count recorded at 120 kg N ha^{-1}. Similarly, sulphur application increased leaf production, especially at 45 kg S ha^{-1}. The number of leaves was significantly higher at the higher sulphur levels compared to lower doses. However, the influence of sulphur on leaf number was not statistically significant at 30 DAS. Similar findings were observed by Kumar *et al.* (2002), who highlighted that nitrogen application increased leaf production, particularly at higher N levels, and that sulphur also played a role in enhancing leaf number, particularly at 45 kg S ha?¹.Nitrogen significantly influenced the number of branches at 45 and 60 DAS, with 120 kg N ha^{-1} producing the maximum number of branches. Similarly, sulphur application at 45 kg S ha^{-1} led to the highest number of branches per plant, with significant differences compared

Table 1: Effect of different levels of nitrogen and sulphur on different growth parameters of Indian mustard.

	Plant height (cm)								Number of green leaves $plant^{-1}$					
	30 DAS		45 DAS		60 DAS		At harvest		30 DAS		45 DAS		60 DAS	
	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22
Nitrogen levels (kg ha^{-1})														
0	21.48	22.23	40.32	42.33	57.60	60.48	135.03	141.75	5.40	5.70	14.55	15.30	18.20	19.10
40	21.70	22.80	43.47	45.66	62.10	65.23	144.00	151.20	5.50	5.80	17.90	18.83	22.40	23.53
80	22.40	23.53	4.5.76	48.07	65.38	68.68	151.00	158.55	5.70	6.00	21.28	22.33	26.63	27.93
120	22.90	24.03	47.65	50.05	68.08	71.50	157.00	164.85	5.80	6.10	22.73	23.88	28.43	29.83
SE(m)±	**0.42**	**0.48**	**0.80**	**0.84**	**1.15**	**1.13**	**2.44**	**2.56**	**0.10**	**0.11**	**0.32**	**0.36**	**0.45**	**0.47**
CD (p=0.05)	**NS**	**NS**	**2.30**	**2.44**	**3.32**	**3.26**	**7.04**	**7.38**	**NS**	**NS**	**0.91**	**1.03**	**1.30**	**1.35**
Sulphur levels (kg ha^{-1})														
0	21.40	22.38	40.93	43.02	58.48	61.45	138.00	144.90	5.40	5.70	15.50	16.30	19.43	20.38
15	21.70	22.68	44.45	46.67	63.50	66.68	142.60	149.73	5.60	5.90	18.08	19.00	22.63	23.73
30	22.35	23.40	45.36	47.64	64.80	68.05	150.43	157.95	5.70	6.00	21.03	22.10	26.30	27.60
45	23.03	24.13	46.46	48.79	66.38	69.70	156.00	163.78	5.70	6.00	21.85	22.93	27.30	28.68
SE(m)±	**0.42**	**0.48**	**1.03**	**1.09**	**1.48**	**1.46**	**3.15**	**3.30**	**0.12**	**0.14**	**0.41**	**0.46**	**0.58**	**0.60**
CD (p=0.05)	**NS**	**NS**	**2.97**	**3.15**	**4.28**	**4.21**	**9.08**	**9.53**	**NS**	**NS**	**1.18**	**1.33**	**1.68**	**1.74**

Table 2: Effect of different levels of nitrogen and sulphur on different growth parameters of Indian mustard.

	Number of branches plant^{-1}						Fresh weight of plant (g)					
	30 DAS		45 DAS		60 DAS		30 DAS		45 DAS		60 DAS	
	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22
Nitrogen levels (kg ha^{-1})												
0	1.65	1.70	8.25	8.66	15.00	15.72	5.40	5.70	14.55	15.30	18.20	19.10
40	1.65	1.75	9.28	9.73	16.81	17.64	5.50	5.80	17.90	18.83	22.40	23.53
80	1.68	1.78	9.48	9.94	17.23	18.07	5.70	6.00	21.28	22.33	26.63	27.93
120	1.75	1.80	9.70	10.18	17.59	18.49	5.80	6.10	22.73	23.88	28.43	29.83
SE(m)±	**0.03**	**0.03**	**0.17**	**0.13**	**0.23**	**0.19**	**0.10**	**0.11**	**0.32**	**0.36**	**0.45**	**0.47**
CD (p=0.05)	**NS**	**NS**	**0.49**	**0.36**	**0.65**	**0.55**	**NS**	**NS**	**0.91**	**1.03**	**1.30**	**1.35**
Sulphur levels (kg ha^{-1})												
0	1.63	1.73	8.50	8.90	15.40	16.15	5.40	5.70	15.50	16.30	19.43	20.38
15	1.65	1.75	9.20	9.64	16.73	17.54	5.60	5.90	18.08	19.00	22.63	23.73
30	1.73	1.78	9.43	9.91	17.11	17.94	5.70	6.00	21.03	22.10	26.30	27.60
45	1.73	1.78	9.58	10.06	17.40	18.30	5.70	6.00	21.85	22.93	27.30	28.68
SE(m)±	**0.04**	**0.04**	**0.22**	**0.16**	**0.29**	**0.25**	**0.12**	**0.14**	**0.41**	**0.46**	**0.58**	**0.60**
CD (p=0.05)	**NS**	**NS**	**0.64**	**0.47**	**0.84**	**0.71**	**NS**	**NS**	**1.18**	**1.33**	**1.68**	**1.74**

to the control (0 kg S ha^{-1}). The number of branches showed no significant response to either nitrogen or sulphur at 30 DAS. Studies by Arthanwar *et al.* (1996) demonstrated that nitrogen significantly increased the number of branches, and sulphur supplementation further enhanced branching in mustard plants.Fresh plant weight was significantly influenced by both nitrogen and sulphur levels. The maximum fresh weight was recorded at 120 kg N ha^{-1} and 45 kg S ha^{-1}, particularly at 60 DAS. However, the influence of sulphur on fresh weight was not significant at 30 DAS. The effects of nitrogen and sulphur on both fresh and dry weight were also documented by Singh *et al.* (1994), who found significant increases in biomass production with higher nitrogen and sulphur levels, particularly at 45 kg S ha^{-1}.Nitrogen levels significantly influenced the dry weight of the plant, with the maximum dry weight observed at 120 kg N ha^{-1}, especially at 45 and 60 DAS. Sulphur also showed a significant effect on dry weight at these stages, with the highest dry weight recorded at 45 kg S ha^{-1}. At 30 DAS, no significant differences in dry weight were observed due to nitrogen or sulphur application.

Yield Attributes

The highest mustard seed yield was observed with the application of 100 kg N ha^{-1}, which resulted in increases of 42.77%, 26.67%, and 9.09% compared to the control (0 kg N ha^{-1}), 40 kg N ha^{-1}, and 80 kg N ha^{-1}, respectively, in 2020–21. In 2021–22, seed yield increased by 42.67%, 26.61%, and 9.05%, respectively, under similar N treatments. Regarding sulphur application, 45 kg S ha^{-1} led to the highest seed production in both years, showing yield increases of 23.13%, 13.83%, and 6.47% compared to the control, 15 kg S ha^{-1}, and 30 kg S ha^{-1}, respectively, in 2020–21, and 23.15%, 13.84%, and 6.50% in 2021–22. However, no significant interaction between nitrogen and sulphur levels was observed for seed yield.For straw yield, the highest yield was also achieved with 100 kg N ha^{-1}, showing increases of 38.41%, 23.89%, and 8.46% in 2020–21, and 38.48%, 23.94%, and 8.50% in 2021–22, compared to the control, 40 kg N ha^{-1}, and 80 kg N ha^{-1}, respectively. The application of 45 kg S ha?¹ resulted in the highest straw yield, with increases of 20.04%, 11.76%, and 5.31% over the control, 15 kg S ha^{-1}, and 30 kg S ha^{-1} in 2020–21, and 20.16%, 11.78%, and 5.32% in 2021–22. No significant interaction between nitrogen and sulphur levels was noted for straw yield either. The findings regarding seed and straw yields being highest at 100 kg N ha^{-1} and 45 kg S ha^{-1} are consistent with the results of several studies. For example, Arthanwar *et al.,* (1996) and Kumar *et al.,* (2002) both reported enhanced seed and straw yields with increased nitrogen and sulphur application.

Effect of Nutrient Combinations

The combined application of 120 kg N, 60 kg P_2O_5, 40 kg K_2O, 40 kg S, 5 kg Zn, and 0.2% Boron spray resulted in the highest growth and yield attributes, including plant height, leaf number, branch number, fresh weight, and dry weight. This combination of nutrients was found to significantly enhance the physiological processes of the plant, improving photosynthesis, cell division, and vegetative growth, thereby increasing yield potential. These findings are consistent with earlier studies by Rana

Table 3: Effect of different levels of nitrogen and sulphur on different Yield of Indian mustard.

	Dry weight of plant (g)						Yield of mustard			
	30 DAS		45 DAS		60 DAS		Seed yield (q ha^{-1})		Straw yield (q ha^{-1})	
	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22
Nitrogen levels (kg ha^{-1})										
0	1.50	1.58	15.67	16.45	26.11	15.97	15.97	16.64	56.16	58.96
40	1.53	1.61	17.62	18.50	29.36	18.00	18.00	18.75	62.74	65.88
80	1.55	1.63	20.20	21.21	33.66	20.90	20.90	21.77	71.67	75.25
120	1.58	1.66	21.94	23.03	36.56	22.80	22.80	23.74	77.73	81.65
SE(m)±	**0.03**	**0.03**	**0.35**	**0.40**	**0.73**	**0.40**	**0.40**	**0.44**	**1.36**	**1.28**
CD (p=0.05)	**NS**	**NS**	**1.01**	**1.16**	**2.12**	**1.16**	**1.16**	**1.28**	**3.92**	**3.71**
Sulphur levels (kg ha^{-1})										
0	1.51	1.59	16.98	17.83	28.30	17.38	17.38	18.10	60.78	63.80
15	1.54	1.62	18.35	19.27	30.58	18.80	18.80	19.58	65.28	68.58
30	1.55	1.63	19.51	20.48	32.51	20.10	20.10	20.93	69.28	72.79
45	1.56	1.64	20.59	21.62	34.31	21.40	21.40	22.29	72.96	76.66
SE(m)±	**0.03**	**0.03**	**0.35**	**0.40**	**0.73**	**0.40**	**0.40**	**0.44**	**1.36**	**1.28**
CD (p=0.05)	**NS**	**NS**	**1.01**	**1.16**	**2.12**	**1.16**	**1.16**	**1.28**	**3.92**	**3.71**

et al. (2008), Singh and Singh (1998), and Chaplot*et al.* (2012), who reported similar results regarding nutrient interactions and their effects on mustard growth.

The results indicate that while the application of both nitrogen and sulphur individually contributed to higher yields, there was no significant interaction between these two factors that further enhanced the seed or straw yields. This suggests that the beneficial effects of nitrogen and sulphur on yield were additive rather than synergistic. This finding aligns with the studies of Arthanwar*et al.* (1996) and Kumar *et al.* (2002), which reported improved yields of mustard with increased nitrogen and sulphur levels, but without a significant interaction between the two nutrients.

Conclusion

The application of nitrogen and sulphur at optimal levels significantly enhanced various growth and yield parameters of mustard, with nitrogen having a more pronounced effect on plant height, leaf production, and dry matter accumulation, while sulphur primarily influenced branch number and dry weight. Both nitrogen and sulphur application significantly influenced mustard seed and straw yields, with 100 kg N ha^{-1} and 45 kg S ha^{-1} producing the highest yields. The increased nutrient supply likely enhanced plant growth and reproductive processes, leading to better seed and straw production. These findings are consistent with previous studies by Singh *et al.* (1994), Arthanwar*et al.* (1996), Kumar *et al.* (2002), and Singh and Kumar (2014), which highlighted the positive effects of nitrogen and sulphur on mustard yields. The optimal combination for higher yield and better quality was found to be 100 kg N ha^{-1} and 45 kg S ha^{-1}, supporting the importance of balanced nutrient management in mustard cultivation. The findings of this study underscore the importance of balanced nutrient management in optimizing mustard growth and yield.

Conflicts of Interest

The Author(s) declare that they have no competing interest or conflicts of interest to disclose.

Ethics approval

The proposed research study on the "Evaluating the influence of nitrogen and sulphur fertilization on growth and yield of Indian mustard (*Brassica juncea* L.)" adheres to all relevant ethical standards and guidelines applicable to agricultural and plant-based studies. The research aims to evaluate the effects of nitrogen and sulphur on mustard crops, with a focus on their impact on growth, productivity, and potential environmental effects. The primary aim of this study is to explore the role of nitrogen and sulphur on enhancing mustard growth and yield. The study seeks to assess their efficacy in comparison to traditional fertilizers, while also examining their safety, environmental impact, and overall potential to improve agricultural productivity. This study does not involve human participants. This study does not involve the use of animals. The study takes all necessary precautions to minimize any potential negative impact on the environment. The application of nitrogen and sulphur closely monitored to prevent unintended contamination of nearby water sources, soil ecosystems, or non-target plant species.

Consent for Publication:

Author and all co-author given the image, data or any other information to be published in any medium (e.g., books, online articles, reports).

Authors Contributions

- **Anjali Bhardwaj -** Author
- **Phool Chandra Singh-** Advisor
- **R.K. Singh-** Guidance
- **Priyanshi–** Formal analysis
- **Akhilesh Kumar Gupta–** Formal Analysis
- **Saurav Chaurasiya–** Guidance in directly this work and data analysis

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