International Journal of Agriculture and Nutrition

ISSN Print: 2664-6064
ISSN Online: 2664-6072
NAAS Rating (2025): 4.69
IJAN 2025; 7(11): 158-160
www.agriculturejournal.net
Received: 05-10-2025
Accepted: 07-11-2025

Damini Karmakar
Department of Agronomic Sciences, Uttar Banga Krishi Viswavidyalaya, Cooch Behar, West Bengal, India

Devendra Adhikari
Department of Agronomic Sciences, Uttar Banga Krishi Viswavidyalaya, Cooch Behar, West Bengal, India

Charu Solanki
Department of Agronomic Sciences, Uttar Banga Krishi Viswavidyalaya, Cooch Behar, West Bengal, India

Madhuri Parikh
Department of Field Crops, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh, India

Corresponding Author:
Damini Karmakar
Department of Agronomic Sciences, Uttar Banga Krishi Viswavidyalaya, Cooch Behar, West Bengal, India

Effect of sulphur and boron application on yield and quality of rapeseed-mustard

Damini Karmakar, Devendra Adhikari, Charu Solanki and Madhuri Parikh

DOI: https://www.doi.org/10.33545/26646064.2025.v7.i11c.495

Abstract
Sulphur and boron deficiencies together limit rapeseed-mustard productivity more than any single nutrient gap. A two-year field trial was conducted during rabi 2021-22 and 2022-23 at Uttar Banga Krishi Viswavidyalaya, Cooch Behar, West Bengal, to assess combined effects of sulphur (0, 20, 40, 60 kg/ha) and boron (0, 1.0, 1.5 kg/ha) on yield and quality of Brassica juncea cv. NRCHB-101 in a factorial randomized block design with three replications. Application of 40 kg S/ha with 1.5 kg B/ha recorded the highest seed yield (17.1 q/ha), oil content (41.8%), and oil yield (714.8 kg/ha), which were 74.5%, 15.5%, and 101.4% higher than the control. Sulphur uptake peaked at 23.1 kg/ha with 39.5% apparent recovery. Beyond 40 kg S/ha, yield gains plateaued. These results point to 40 kg S/ha with 1.5 kg B/ha as the optimum dose for terai zone alluvial soils.

Keywords: Sulphur, boron, rapeseed-mustard, seed yield, oil content, nutrient uptake, quality parameters, Brassica juncea, factorial experiment, terai zone

Introduction
Rapeseed-mustard is the third largest oilseed crop globally, yet Indian average yields remain well below the world average because of nutrient imbalances. India cultivated roughly 8.5 million hectares during 2022-23 with a national average of 13.8 q/ha versus the global mean of about 20 q/ha [1]. A significant portion of this gap traces to inadequate sulphur and boron nutrition [2]. Sulphur is a structural component of cysteine and methionine and directly influences oil biosynthesis. Mustard removes 12-15 kg S per tonne of seed, yet sulphur application is routinely neglected [3]. The shift from ammonium sulphate to urea has worsened the sulphur balance, with deficiency documented in over 40% of Indian soils [4]. Boron plays a non-substitutable role in pollen germination and sugar transport; deficient plants show poor pod set and shriveled seeds [5]. The terai zone of West Bengal is prone to boron deficiency due to leaching and acidic soils [6]. While individual responses have been examined, their combined application under terai conditions has not been adequately explored [7]. This research determined the optimum combination for maximizing yield and quality.

Material and Methods
Material
The experiment was conducted during rabi 2021-22 and 2022-23 at the Instructional Farm of Uttar Banga Krishi Viswavidyalaya, Cooch Behar (26.32° N, 89.44° E, 43 m altitude). Soil was sandy loam (Typic Haplaquept), pH 5.7, organic carbon 0.82%, available S 8.6 mg/kg (deficient), and hot water-soluble B 0.31 mg/kg (deficient). Variety NRCHB-101 was sown at 5 kg/ha in 30 cm rows. Basal dose: 80 kg N, 40 kg P_2O_5, 40 kg K_2O per hectare [8].

Methods
A factorial RBD with four sulphur levels (0, 20, 40, 60 kg/ha as elemental S) and three boron levels (0, 1.0, 1.5 kg/ha as borax) gave 12 treatments × 3 replications. Plot size was 5 m × 3 m. Sulphur was basal; boron was split at sowing and flower initiation.

Observations: seed yield, oil content (Soxhlet), protein (micro-Kjeldahl), S uptake (turbidimetric), B uptake (azomethine-H) [9]. Apparent S recovery was computed. Data were pooled and analyzed at P = 0.05 [10].

Field Experimental Design

The 36 plots were arranged in three blocks perpendicular to field slope. A 1 m alley separated plots and 1.5 m separated blocks. Irrigation was provided at crown root initiation, flowering, and siliqua development stages. No sulphur- or boron-containing pesticides were used [11].

Results

Table 1: Effect of sulphur and boron on seed yield, oil content, and oil yield of rapeseed-mustard (pooled, 2022-2023)

Treatment	Seed Yield (q/ha)	Oil Content (%)	Oil Yield (kg/ha)	Protein (%)
S_0B_0 (Control)	9.8	36.2	354.8	19.4
$S_{20}B_0$	13.2	38.1	503.0	20.1
$S_{40}B_0$	15.6	39.7	619.3	20.8
$S_{60}B_0$	15.2	39.4	598.9	20.6
$S_0B_{1.0}$	11.4	37.3	425.2	19.8
$S_{40}B_{1.0}$	16.4	41.2	675.7	21.4
$S_{40}B_{1.5}$	17.1	41.8	714.8	21.7
$S_{60}B_{1.5}$	16.2	41.3	669.1	21.3
SEm(±)	0.54	0.41	28.3	0.23
CD (P=0.05)	1.62	1.23	84.9	0.69

Both nutrients significantly improved yield and quality (Table 1). Seed yield rose from 9.8 to 17.1 q/ha under $S_{40}B_{1.5}$ (74.5% gain). Oil content increased from 36.2% to 41.8%. Response to sulphur was strong up to 40 kg/ha then plateaued; boron showed a positive trend up to 1.5 kg/ha. The S × B interaction was significant for oil yield ($P < 0.05$).

Table 2: Nutrient uptake and sulphur recovery efficiency in rapeseed-mustard

Treatment	S Uptake (kg/ha)	B Uptake (g/ha)	S Recovery (%)	B:C Ratio
S_0B_0	7.3	42.1	-	1.00
$S_{20}B_0$	12.8	48.6	27.5	1.84
$S_{40}B_0$	18.4	52.3	27.8	2.31
$S_{40}B_{1.0}$	21.7	78.4	36.0	2.68
$S_{40}B_{1.5}$	23.1	91.6	39.5	2.79
$S_{60}B_{1.5}$	22.4	88.2	25.2	2.43
SEm(±)	1.12	4.37	2.14	-
CD (P=0.05)	3.36	13.11	6.42	-

Boron improved S recovery from 27.8% ($S_{40}B_0$) to 39.5% ($S_{40}B_{1.5}$), suggesting synergistic nutrient absorption (Table 2). B:C ratio peaked at 2.79 for $S_{40}B_{1.5}$ and declined at higher S doses.

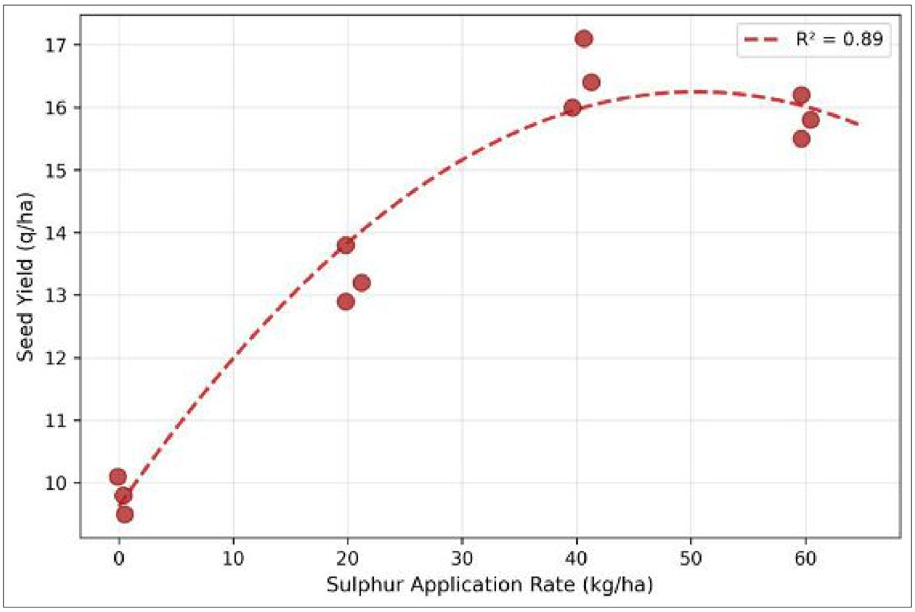

Fig 1: Relationship between sulphur rate and rapeseed-mustard seed yield showing quadratic response plateau

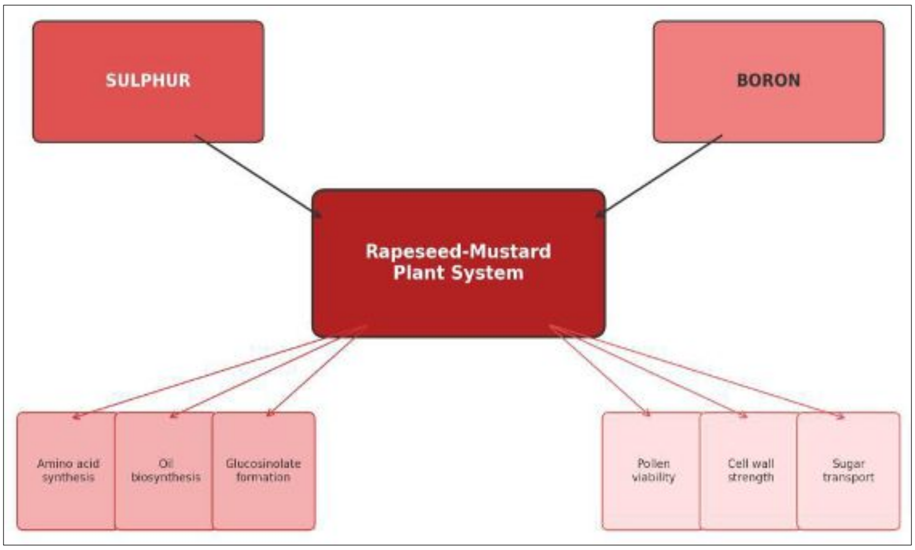

Fig 2: Roles of sulphur and boron in rapeseed-mustard growth and quality determination

Comprehensive Interpretation

The quadratic model ($R^2 = 0.89$) estimates a biological optimum at about 43 kg S/ha. Adding 1.5 kg B/ha shifted yield upward by 1.5 q/ha without changing the inflection point, implying boron removes a separate bottleneck. The strong correlation between oil content and S uptake ($r = 0.91$) supports the biochemical link between sulphur and fatty acid desaturation.

Discussion

The oil content increase of 5.6 percentage points is economically meaningful as oilseed pricing depends directly on extractable oil. Sulphur's role through acetyl-CoA carboxylase is well established [7]. The synergistic effect of boron on S recovery (27.8% vs. 39.5%) may relate to boron's influence on root cell wall elasticity and membrane transport, improving sulphate uptake [5]. The plateau beyond 40 kg S/ha matches patterns in other oilseed crops [3], and the declining B:C ratio at 60 kg S/ha confirms that exceeding the optimum is inadvisable.

Conclusion

The treatment of 40 kg S/ha with 1.5 kg B/ha gave the highest seed yield, oil content, oil yield, and economic return on sulphur- and boron-deficient alluvial soils. Beyond 40 kg S/ha, yield gains flattened. Boron at 1.5 kg/ha enhanced both yield and sulphur recovery. Farmers in the terai zone should adopt this combination as part of balanced nutrient management, with soil testing recommended to adjust doses based on residual nutrient status.

References

1. Directorate of Rapeseed-Mustard Research. Annual Progress Report 2022-23. ICAR-DRMR, Bharatpur. 2023;1-112.
2. Aulakh MS, Malhi SS. Interactions of nitrogen with other nutrients and water. Advances in Agronomy. 2005;86:341-409.
3. Tandon HLS. Sulphur research and agricultural production in India. Fertiliser Development and Consultation Organisation. 2011;4:1-160.
4. Shukla AK, Behera SK, Pakhre A. Micronutrient deficiencies vis-a-vis food and nutritional security. Indian Journal of Fertilisers. 2018;14(12):52-67.
5. Goldbach HE, Wimmer MA. Boron in plants and animals. Journal of Plant Nutrition and Soil Science. 2007;170(1):39-48.
6. Sarkar D, Mandal B, Kundu MC. Increasing use efficiency of boron fertilisers. Plant and Soil. 2007;301(1):77-85.
7. Malhi SS, Gan Y, Raney JP. Yield, seed quality, and sulphur uptake of Brassica oilseed crops. Agronomy Journal. 2007;99(2):570-577.
8. Ray K, Sengupta K, Pal AK. Effect of sulphur and boron nutrition on Indian mustard. Journal of Oilseed Brassica. 2014;5(2):122-128.
9. Tandon HLS. Methods of analysis of soils, plants, waters and fertilisers. Fertiliser Development and Consultation Organisation, New Delhi. 2005;2:1-204.
10. Fageria NK, Baligar VC, Jones CA. Growth and mineral nutrition of field crops. CRC Press. 2011;3:1-560.
11. Prasad R, Shivay YS, Kumar D. Current status of sulphur in Indian agriculture. Indian Journal of Agronomy. 2016;61(3):261-268.
12. Saha B, Saha S, Poddar P. Yield and quality of rapeseed as influenced by boron. Journal of the Indian Society of Soil Science. 2015;63(2):202-208.
13. Singh MV. Micronutrient nutritional problems in soils of India. Indian Journal of Fertilisers. 2009;5(4):11-26.
14. Saha R, Mishra VK. Effect of organic residue management on soil characteristics. Soil and Tillage Research. 2009;104(1):64-72.