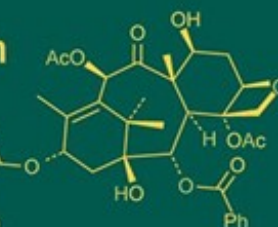


International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2026): 5.29
Indexing: Embase
IJABR 2026; SP-10(9): 2659-2662
www.biochemjournal.com
Received: 28-06-2026
Accepted: 13-08-2026
Published: 30-09-2026

The names and affiliations of all authors are provided below, following the references.

Influence of foliar applied micronutrients on seed quality characteristics of sesame (*Sesamum indicum* L.)

CL Sakhare¹, AM Misal², AH Rathod³, HS Pedhekar⁴, AR Gaikwad⁵, SD Gulwade⁶, PK Kharat⁷

DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i9Sag.10234>

ABSTRACT

A field experiment was conducted at the Quality Seed Production Unit, Khanapur-A, VNMKV, Parbhani, during the summer season of 2025–26 to evaluate the effect of foliar application of micronutrients on seed quality parameters of sesame (*Sesamum indicum* L.). The experiment comprised nine treatments laid out in a Randomized Block Design with three replications using the variety 'TLT-10'. The treatments were: T_1 – Control; T_2 – Boron (Borax) @ 0.3 g/L; T_3 – Zinc (ZnSO₄) @ 0.3 g/L; T_4 – Ferrous (FeSO₄) @ 0.4 g/L; T_5 – Manganese (MnSO₄) @ 0.2 g/L; T_6 – Boron + Ferrous; T_7 – Zinc + Ferrous; T_8 – Ferrous + Manganese; and T_9 – T_2 + T_3 + T_4 + T_5 . Foliar sprays were applied at 30 and 60 days after sowing (DAS). Four seed quality parameters, namely germination percentage, Seedling Vigour Index-I (SVI-I), Seedling Vigour Index-II (SVI-II) and oil content, were assessed. Analysis of variance revealed significant differences among the treatments for all seed quality parameters. The combined micronutrient treatment T_9 recorded the highest values for germination, SVI-I, SVI-II and oil content compared with the control. Among the individual micronutrients, manganese (T_5) and ferrous sulphate (T_4) were relatively more effective in enhancing oil content, whereas T_7 (Zinc + Ferrous), despite its high seed yield, recorded comparatively lower oil content. It is concluded that the combined foliar application of boron, zinc, ferrous sulphate and manganese (T_9) at 30 and 60 DAS resulted in the highest values for all the seed quality parameters studied in sesame.

Keywords: *Sesamum indicum* L., Foliar application, Micronutrients, Seed quality, Germination, Seedling vigour index, Oil content, Boron, Zinc, Ferrous, Manganese

Introduction

Sesame (*Sesamum indicum* L.) is known as the "Queen of Oilseeds" and is one of the oldest oilseed crops cultivated across tropical and subtropical regions. It is valued for its high oil content (45–50%), high-quality protein and natural antioxidants-sesamin, sesamol and sesamolins-which contribute to the stability and nutritional value of sesame oil (Namiki, 2007; Ashri, 2007) [2, 1]. Despite its significance, sesame productivity in India (400–450 kg ha⁻¹) remains considerably lower than its potential, partly due to inadequate micronutrient management (Anonymous, 2023) [3].

Seed quality is a critical determinant of crop establishment and ultimately of productivity. High-quality seeds are characterised by a high germination percentage, greater seedling vigour and high oil content-parameters that are significantly influenced by the nutritional status of the mother plant during seed development. Micronutrients such as zinc (Zn), boron (B), iron (Fe) and manganese (Mn) play pivotal roles in reproductive physiology, biochemical reserve deposition and membrane integrity of developing seeds. Zinc is essential for auxin synthesis, enzyme activation and protein metabolism; boron facilitates carbohydrate translocation and pollen viability; iron is required for chlorophyll synthesis and respiration; and manganese participates in photosynthetic electron transport and fatty acid synthesis (Marschner, 2012; Havlin et al., 2014) [5, 4]. Deficiency of any of these elements during seed development compromises the physiological quality of seeds.

Foliar application of micronutrients at critical growth stages has been shown to effectively improve seed quality. Parsaei et al. (2017) [6] reported that foliar application of zinc and boron significantly improved germination percentage and vigour indices in sesame. Dhaliwal et al. (2021) [7] found that foliar application of boron at 30 mg/L enhanced antioxidant activity and oil content of sesame seeds. Elayaraja et al. (2020) [8] recorded higher germination percentage and 1000-seed weight in sesame with zinc and manganese treatments. However, comprehensive information on the response of multiple seed quality parameters to the foliar application of micronutrients, particularly their combined application, is limited. The present study was therefore undertaken to evaluate the effect of foliar application of boron, zinc, ferrous and manganese-individually and in combination on germination percentage, Seedling Vigour Index-I, Seedling Vigour Index-II and oil content of sesame seeds.

Corresponding Author: CL Sakhare

M.Sc. Scholar Department of Seed Science and Technology, VNMKV, Parbhani, Maharashtra, India

Materials and Methods

Experimental site and design: The experiment was conducted at the Quality Seed Production Unit, Khanapur-A, VNMKV, Parbhani, Maharashtra, during the *summer* season of 2025–26 on uniform black cotton soil. The experiment was laid out in a RBD with 9 treatments and 3 replications using the sesame variety “TLT-10”. Foliar sprays were applied at 30 and 60 DAS. The plot size was 1.2 × 3.0 m (3.6 m²), with row-to-row spacing of 30 cm and plant-to-plant spacing of 15 cm. The treatments were: T₁- Control; T₂- Boron (Borax) @ 0.3 g/L; T₃- Zinc (ZnSO₄) @ 0.3 g/L; T₄- Ferrous (FeSO₄) @ 0.4 g/L; T₅- Manganese (MnSO₄) @ 0.2 g/L; T₆- Boron + Ferrous (0.3 + 0.4 g/L); T₇- Zinc + Ferrous (0.3 + 0.4 g/L); T₈- Ferrous + Manganese (0.4 + 0.2 g/L); and T₉ – T₂ + T₃ + T₄ + T₅.

Seed quality parameters assessed

(i) Germination percentage: Germination was assessed using the top-of-paper (TP) method as described by *ISTA (1985)* [9]. Four hundred pure seeds, comprising four replicates of 100 seeds each, were placed on moistened filter paper in Petri dishes and kept at 25 ± 1 °C for six days. Normal seedlings were counted on the final count day and germination percentage was calculated. (ii) Seedling Vigour Index-I (SVI-I): SVI-I was calculated as Germination (%) × Seedling length (cm), following *Abdul-Baki and anderson (1973)* [10]. (iii) Seedling Vigour Index-II (SVI-II): SVI-II was calculated as Germination (%) × Seedling dry weight (g). (iv) Oil content (%): Oil content was determined using approximately 25 g of clean seeds from each plot by the Nuclear Magnetic Resonance (NMR) method.

Results and Discussion

Analysis of variance revealed highly significant differences among the treatments for all four seed quality parameters studied, namely, germination percentage, Seedling Vigour Index-I, Seedling Vigour Index-II and oil content, indicating the differential influence of foliar micronutrient application on seed physiological quality in sesame. The results are presented and discussed below.

Germination percentage

Germination percentage differed significantly among the treatments. The highest germination percentage was recorded in T₉ (89.00%), followed by T₇ (88.00%) and T₈ (87.00%), while the minimum was recorded in T₁ (82.33%), followed by T₂ and T₅ (84.00% each). The grand mean for germination percentage was 85.78%, with treatment means ranging from 82.33 to 89.00%.

The superior germination under T₉ is attributable to the combined role of all four micronutrients in enhancing seed filling, metabolic reserve deposition and membrane integrity during seed development on the mother plant. Zinc promotes protein synthesis and enzymatic activity during seed maturation; boron facilitates carbohydrate translocation and ensures adequate starch deposition; iron supports chlorophyll synthesis, thereby improving the photosynthetic capacity of the mother plant; and manganese participates in superoxide dismutase activity, thereby reducing oxidative damage to developing seeds. Together, these functions result in physiologically mature seeds with higher germinability.

These findings are in conformity with *Parsaei et al. (2017)* [6], who reported that foliar application of zinc and boron, individually or in combination, significantly improved seed germination percentage in sesame under accelerated ageing conditions. *Elayaraja et al. (2020)* [8] also recorded higher germination percentage in sesame with combined zinc and manganese foliar treatments. The superior germination observed under combined micronutrient treatments reflects the synergistic benefits of balanced micronutrient nutrition on seed physiological quality.

Seedling vigour index-I

Significant differences were recorded among the treatments for Seedling Vigour Index-I (SVI-I). The maximum SVI-I was recorded in T₉ (1775.3), followed by T₃ (1687.2) and T₇ (1574.3), while the

minimum was recorded in T₁ (1183.0), followed by T₆ (1396.1) and T₅ (1491.2). The gr and mean for SVI-I was 1520.0.

SVI-I, calculated as the product of germination percentage and seedling length, reflects early growth vigour and seedling establishment potential. The higher SVI-I under T₉ is attributed to the combined effect of all four micronutrients in improving the biochemical reserves and hormonal status of seeds, resulting in rapid and uniform germination and vigorous seedling elongation. Zinc-mediated auxin synthesis is particularly important for seedling elongation, which may explain why T₃ (Zn alone) ranked second for SVI-I. These findings are consistent with *Parsaei et al. (2017)* [6], who documented that the combined foliar application of Zn and B produced sesame seeds with significantly higher vigour indices and improved germination. *Sonakamble et al. (2015)* [11] also reported a significantly higher vigour index with ZnSO₄ application through soil and foliar spray in soybean.

Seedling vigour index-II

Treatment T₉ recorded the highest Seedling Vigour Index-II (SVI-II) value of 304.39, followed by T₇ (289.51) and T₈ (282.75), while T₁ registered the lowest SVI-II value of 241.24, followed by T₅ (252.01) and T₂ (254.52). The gr and mean for SVI-II was 269.92.

SVI-II, calculated as the product of germination percentage and seedling dry weight, is considered a more sensitive indicator of seed vigour, as it quantifies the dry matter accumulation capacity of seedlings during early establishment. The higher SVI-II under T₉ reflects the greater accumulation of metabolic reserves—proteins, lipids and carbohydrates—in seeds during development under balanced micronutrient nutrition, enabling more vigorous seedling growth and greater dry matter accumulation. The strong performance of T₇ for SVI-II, ranking second, indicates that the zinc–iron combination is particularly effective in promoting seedling dry weight accumulation, possibly through the role of zinc in protein synthesis and iron in chlorophyll-dependent photosynthate production and supply to developing seeds.

These results are supported by *Parsaei et al. (2017)* [6], who found that the combined foliar application of Zn and B produced sesame seeds with superior physiological quality and enhanced antioxidant enzyme activities, thereby improving Seedling Vigour Index-II. *Sreepriya et al. (2019)* [12] similarly documented that manganese sulphate-primed sesame seeds produced significantly higher seedling vigour and field emergence compared with unprimed seeds.

Oil content (%)

Oil content differed significantly among the treatments. The maximum oil content was recorded in T₉ (46.99%), followed by T₅ (46.90%) and T₄ (46.50%), while the minimum was recorded in T₁ (45.00%), followed by T₇ (45.20%) and T₆ (45.30%). The gr and mean for oil content was 45.94%, with treatment means ranging from 45.00 to 46.99%.

An important observation from the oil content data is the combination-specific response of oil biosynthesis. While T₉ recorded the highest oil content overall, the individual treatments T₅ and T₄ ranked second and third, respectively, with notably higher oil content than the dual combinations T₇ and T₆. This pattern suggests that manganese and iron, when applied individually, may channel available photosynthates preferentially towards lipid biosynthesis, whereas in the zinc–iron combination (T₇), the strong vegetative growth and yield expression may redirect assimilates towards seed structural components rather than oil accumulation. The role of manganese in fatty acid biosynthesis—through its function as a cofactor of acetyl-CoA carboxylase and other lipid-metabolism enzymes—may explain the relatively higher oil content under T₅. Similarly, the involvement of iron in respiration and energy supply for lipid biosynthesis may account for the higher oil content under T₄.

These findings are consistent with *Habimana et al. (2016)* [13], who reported higher oil content and oil yield in sesame with manganese sulphate application and with *Dhaliwal et al. (2021)* [7], *Khuong et al.*

(2022) [14] and Dey *et al.* (2023) [15], who recorded significant increases in oil content following foliar boron application in sesame. Saudy *et al.* (2022) [16] similarly reported that a foliar nano-mixture of iron, zinc and manganese enhanced the oil content of sesame seeds. The observation that T₇ produced comparatively lower oil content despite its high seed yield is consistent with the findings of Rekani (2019) [17], who reported that the response of sesame to foliar appli-

cation of iron and manganese in terms of oil synthesis is dose- and combination-specific. Maheshwari *et al.* (2023) [18] further reported that combined foliar application of Zn + B + Fe resulted in maximum 1000-seed weight and oil content in sesame, supporting the beneficial role of combined micronutrient nutrition in improving seed biochemical quality.

Table 1. Influence of foliar applied micronutrients on seed quality parameters in sesame.

Treatment	Germination (%)	Seedling Vigour Index-I	Seedling Vigour Index-II	Oil Content (%)
T ₁ – Control	82.33	1183.0	241.24	45.00
T ₂ – Boron (Borax) @0.3 g/l	84.00	1494.7	254.52	46.10
T ₃ – Zinc (ZnSO ₄) @0.3 g/l	86.67	1687.2	273.01	45.80
T ₄ – Ferrous (FeSO ₄) @0.4 g/l	85.00	1509.1	261.79	46.50
T ₅ – Manganese (MnSO ₄) @0.2 g/l	84.00	1491.2	252.01	46.90
T ₆ – Boron + Ferrous	86.00	1396.1	270.03	45.30
T ₇ – Zinc + Ferrous	88.00	1574.3	289.51	45.20
T ₈ – Ferrous + Manganese	87.00	1568.9	282.75	45.70
T ₉ – T ₂ +T ₃ +T ₄ +T ₅	89.00	1775.3	304.39	46.99
General Mean	85.78	1520.0	269.92	45.94
S.Em.±	0.97	79.58	8.53	0.36
C.D. at 5%	2.91	238.58	25.57	1.09
C.V. (%)	1.96	9.07	5.47	1.38

Conclusion

The results of the present investigation clearly demonstrate that foliar application of micronutrients significantly improved all the seed quality parameters of sesame. The combined treatment T₉, applied at 30 and 60 DAS, was the most effective treatment, recording the highest germination percentage (89.00%), Seedling Vigour Index-I (1775.3), Seedling Vigour Index-II (304.39) and oil content (46.99%) compared with the control. The combined application of all four micronutrients improved photosynthetic efficiency, biochemical reserve deposition, membrane integrity and enzymatic antioxidant activity, collectively contributing to superior seed physiological quality. An important finding was the combination-specific response of oil biosynthesis, with individually applied manganese (T₅) and ferrous sulphate (T₄) being relatively more effective in enhancing oil content than certain dual combinations. On the basis of the present findings, combined foliar application of boron, zinc, ferrous sulphate and manganese (T₉) is recommended as an effective nutrient management strategy for improving seed quality parameters and producing high-quality sesame seed lots under the agro-climatic conditions of Marathwada, particularly in seed production programmes.

References

- Ashri A. Sesame (*Sesamum indicum* L.). In: Singh RJ, editor. Genetic resources, chromosome engineering, and crop improvement: Oilseed crops. Boca Raton, FL, USA: CRC Press, Taylor and Francis Group; 2007. p. 231–289.
- Namiki M. Nutritional functions of sesame: A review. Critical Reviews in Food Science and Nutrition. 2007;47(7):651–673.
- Anonymous. Agricultural statistics at a glance. Government of India; 2023.
- Havlin JL, Tisdale SL, Nelson WL, Beaton JD. Soil fertility and fertilizers: An introduction to nutrient management. 8th ed. Pearson; 2014.
- Marschner P, editor. Marschner's mineral nutrition of higher plants. 3rd ed. Academic Press; 2012.
- Parsaei A, Movahhedi Dehnavi M, Balouchi H. Effects of maternal plant foliar application of zinc and boron on germination, vigor, and antioxidant activity of sesame (*Sesamum indicum* L.) seeds under accelerated aging conditions. Journal of Seed Science. 2017;39(2):144–152.
- Dhaliwal SS, Sharma V, Shukla AK, Verma V, Behera SK, Sandhu PS, Kaur K, Gaber A, Althobaiti YS, Abdelhadi AA, Hossain A. Assessment of agro-economic indicators of *Sesamum indicum* L. as influenced by application of boron at different levels and plant growth stages. Molecules. 2021;26(21):6699.
- Elayaraja D, Singaravel R. Effect of foliar application of zinc and manganese on yield and quality of sesame (*Sesamum indicum* L.). Journal of Pharmacognosy and Phytochemistry. 2020;9(4):1565–1569.
- International Seed Testing Association (ISTA). International rules for seed testing. Seed Science and Technology. 1985;13(2):299–355.
- Abdul-Baki AA, Anderson JD. Vigor determination in soybean seed by multiple criteria. Crop Science. 1973;13(6):630–633.
- Sonakamble AM *et al.* Highest vigor index and seed recovery obtained from ZnSO₄ soil application and foliar spray. Karnataka Journal of Agricultural Sciences. 2015.
- Sreepriya S, Girija T. Seed invigoration—a technique for improving vigor and productivity of sesame (*Sesamum indicum* L.) variety Thilak. Journal of Tropical Agriculture. 2019;57(1):10–16.
- Habimana F, Stalin P, Muthumanickam D. Effect of manganese nutrition on growth, yield, manganese uptake and quality of sesame. Advances in Applied Research. 2016;8(1):14–18.
- Khuong N, Thuc L, Tran N, Huu T, Sakagami J. Foliar application of boron positively affects the growth, yield, and oil content of sesame (*Sesamum indicum* L.). Open Agriculture. 2022;7(1):30–38.
- Dey A, Begum M, Kabiraj MS, Rashid MH, Paul SK. Influence of foliar application of boron on the growth, yield and quality of sesame (cv. BARI Til-4). Turkish Journal of Agriculture – Food Science and Technology. 2023;11(12):2356–2364.

16. Saudy HS, Abd El-Samad GA, El-Temsah ME, El-Gabry YAE. Effect of iron, zinc and manganese nano-form mixture on micronutrient recovery efficiency and seed yield response index of sesame genotypes. *Journal of Soil Science and Plant Nutrition*. 2022;22:732–742.
17. Rekani SI. Effect of high concentration of Fe and Mn as foliar application on growth and yield of sesame grown in calcareous soil. *International Journal of Science and Research*. 2019;8(11):943–946.
18. Maheshwari B, Mehera B, Kumar P, Mondal S. Effect of foliar application of micronutrients on growth and yield of sesame (*Sesamum indicum* L.). *International Journal of Plant and Soil Science*. 2023;35(12):69–73.
19. Anonymous. FAO statistical database for global sesame production and area. Food and Agriculture Organization, Rome; 2023.
20. Oyinlola EY. Effect of boron fertilizer on yield and oil content of three sunflower cultivars in the Nigerian Savanna. *Journal of Agronomy*. 2007;6(3):421–426.

How to cite this article: Sakhare C, Misal A, Rathod A, Pedhekar H, Gaikwad A, Gulwade S, et al. Influence of foliar applied micronutrients on seed quality characteristics of sesame (*Sesamum indicum* L.). *International Journal of Advanced Biochemistry Research*. 2026;SP-10(9):2659-2662. doi: <https://www.doi.org/10.33545/26174693.2026.v10.i9Sag.10234>

Authors

CL Sakhare

M.Sc. Scholar Department of Seed Science and Technology, VNMKV, Parbhani, Maharashtra, India

AM Misal

Assistant Professor, Department of Agricultural Botany, College of Agriculture, Latur, Maharashtra, India

AH Rathod

Assistant Professor and Office Incharge BSP Unit, VNMKV, Parbhani, Maharashtra, India

HS Pedhekar

M.Sc. Scholar Department of Seed Science and Technology, VNMKV, Parbhani, Maharashtra, India

AR Gaikwad

Assistant Breeder, STR and QSP, VNMKV, Parbhani, Maharashtra, India

SD Gulwade

M.Sc. Scholar Department of Seed Science and Technology, VNMKV, Parbhani, Maharashtra, India

PK Kharat

M.Sc. Scholar Department of Dairy Science, VNMKV, Parbhani, Maharashtra, India