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Integrated nutrient management improves growth characters of summer mungbean (*Vigna radiata* L. Wilczek) under semi-arid conditions of Southern Rajasthan

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Abstract

A field experiment was conducted during summer seasons of 2022 and 2023 at Rajasthan College of Agriculture, MPUAT, Udaipur to study the effect of integrated nutrient management on growth characters of mungbean (*Vigna radiata* L. Wilczek). The experiment was conducted in Randomized Block Design with twelve treatments comprising inorganic fertilizers, FYM, vermicompost, *Rhizobium* and foliar ZnSO₄ application. Integrated nutrient management significantly improved plant height, number of branches and nodulation over the control. The treatment 75% RDF + 2.5 t vermicompost + *Rhizobium* + foliar spray of ZnSO₄ (T₁₁) recorded the highest plant height (58.13 cm), branches plant⁻¹ (9.20) and nodules plant⁻¹ (27.41) on pooled basis. The performance of T₁₁ was statistically at par with 75% RDF + 3 t FYM + *Rhizobium* + foliar spray of ZnSO₄ (T₇) and 125% RDF (T₃). The study concluded that integrated nutrient management enhanced vegetative growth and nodulation of mungbean through balanced nutrient supply, improved soil biological activity and better nutrient-use efficiency under the semi-arid conditions of southern Rajasthan.

Keywords: Integrated nutrient management, mungbean, vermicompost, FYM, *Rhizobium*, zinc sulphate, growth parameters, nodulation

1. Introduction

Mungbean [*Vigna radiata* (L.) Wilczek] is an important grain legume belonging to the family *Fabaceae*, sub-family *Papilionoideae*, and tribe *Phaseoleae* (Dixit *et al.*, 2025) [4]. Botanically, mungbean is an erect or semi-erect annual herb, typically attaining a height of 30-90 cm, depending on genotype and growing conditions (Mehandi *et al.*, 2019) [9]. It is widely cultivated in tropical and subtropical regions because of its short duration, high nutritional value and ability to fix atmospheric nitrogen through symbiotic association with *Rhizobium*. Mungbean is a nutrient-rich pulse crop, with seeds containing 24–28% protein, 1.0–1.5% fat, 3.5–4.5% fibre, 4.5–5.5% ash, and 59–65% carbohydrates on a dry weight basis (Tsou *et al.*, 1979) [13]. The seeds supply approximately 334–344 kcal of energy per 100 g (Srivastava and Ali, 2004) [12].

Despite its importance, the productivity of mungbean remains low due to poor soil fertility, imbalanced fertilizer application and deficiencies of essential nutrients, particularly under the semi-arid conditions of Rajasthan. These factors adversely affect plant growth, nodulation and biomass production, ultimately reducing crop yield.

INM as a strategy to overcome production constraints in mungbean (Choudhary *et al.*, 2025) [3]. INM refers to the optimization of all possible sources of plant nutrients in an ecologically sound manner to achieve sustainable crop production and maintain soil fertility (Asante *et al.*, 2025) [1]. It involves the balanced use of inorganic fertilizers in combination with organic sources such as farmyard manure (FYM), compost, vermicompost, green manures, crop residues, and biological inputs like *Rhizobium*, phosphate solubilizing bacteria (PSB), and arbuscular mycorrhizal fungi (Nanda *et al.*, 2025) [11].

Although several studies have reported the beneficial effects of integrated nutrient management on pulse crops, information on its influence on the growth characters of summer mungbean under the semi-arid agro-climatic conditions of southern Rajasthan is limited.

Therefore, the present investigation was undertaken to evaluate the effect of integrated nutrient management on the growth characters of summer mungbean.

2. Materials and Methods

A field experiment was conducted during the summer seasons of 2022 and 2023 at the Instructional Farm, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology (MPUAT), Udaipur, Rajasthan, India. The soil was clay loam in texture, slightly alkaline in reaction, low in available N, medium in available P and high in available K.

The twelve treatments were: T₁–Control, T₂–100% RDF, T₃–125% RDF, T₄–100% RDF + foliar spray of ZnSO₄, T₅–75% RDF + 3 t FYM ha⁻¹ + *Rhizobium*, T₆–50% RDF + 6 t FYM ha⁻¹ + *Rhizobium*, T₇–75% RDF + 3 t FYM ha⁻¹ + *Rhizobium* + foliar spray of ZnSO₄, T₈–50% RDF + 6 t FYM ha⁻¹ + *Rhizobium* + foliar spray of ZnSO₄, T₉–75% RDF + 2.5 t vermicompost ha⁻¹ + *Rhizobium*, T₁₀–50% RDF + 5 t vermicompost ha⁻¹ + *Rhizobium*, T₁₁–75% RDF + 2.5 t vermicompost ha⁻¹ + *Rhizobium* + foliar spray of ZnSO₄ and T₁₂–50% RDF + 5 t vermicompost ha⁻¹ + *Rhizobium* + foliar spray of ZnSO₄.

Growth parameters, namely plant height, number of branches plant⁻¹ and number of nodules plant⁻¹, were recorded following standard procedures. The pooled data of two years were analysed using analysis of variance (ANOVA) for a Randomized Block Design (Gomez and Gomez, 1984) [5]. Treatment means were compared using the critical difference (CD) test at the 5% level of significance.

3. Results and Discussion

3.1 Effect on Plant Height

The significantly higher plant height (57.70 and 58.56 cm during 2022 and 2023, respectively, with pooled mean of 58.13 cm) was recorded under 75% RDF + 2.5 t vermicompost + *Rhizobium* + FS of ZnSO₄ (T₁₁). This treatment remained statistically at par with 75% RDF + 3 t FYM + *Rhizobium* + FS of ZnSO₄ (T₇) and 125% RDF (T₃) individual and on pooled basis. The minimum plant height was observed under control (T₁) during both the years and in pooled analysis (Table 1).

The significant variation in plant height of mungbean observed under different integrated nutrient management treatments clearly indicates the positive role of balanced and integrated nutrient supply in enhancing vegetative growth. The maximum plant height recorded with T₁₁ during both years and on pooled basis suggests that adequate and readily available nutrients, particularly nitrogen and phosphorus, promoted cell division, cell elongation and overall vegetative vigor, resulting in taller plants. The statistical parity of this treatment with integrated combinations involving reduced RDF along with vermicompost or FYM, *Rhizobium* inoculation and foliar application of zinc sulphate highlights the efficiency of integrated nutrient management in sustaining crop growth even at lower levels of inorganic fertilizers. Organic manures likely improved soil physical condition and microbial activity, leading to better nutrient mineralization and sustained nutrient release, while *Rhizobium* inoculation enhanced biological nitrogen fixation and zinc application improved enzymatic activity and auxin synthesis, collectively contributing to increased plant height. In contrast, the lowest plant height under the control treatment may be attributed to poor nutrient availability and restricted physiological processes, emphasizing the necessity of integrated nutrient management for achieving optimum growth of mungbean under the agro-climatic conditions of southern Rajasthan.

This finding is also individually concluded by Mohit and Kumar (2022) [10], Kishor *et al.*, (2021) [7] and Choudary *et al.*, (2025)

who reported a significant increase in plant height of green gram under integrated nutrient management practices. This clearly indicates that integrated nutrient management has a positive impact on plant height in mungbean.

3.2 Effect on Number of Branches per Plant

The significant increase in number of branches per plant under different integrated nutrient management treatments. On pooled basis, number of branches per plant varied from 6.19 to 9.20. The significantly maximum number of branches per plant (9.00 and 9.39 during 2022 and 2023, respectively, with pooled mean of 9.20) was recorded under 75% RDF + 2.5 t vermicompost + *Rhizobium* + FS of ZnSO₄ (T₁₁), which was statistically at par with 75% RDF + 3 t FYM + *Rhizobium* + FS of ZnSO₄ (T₇) individual and on pooled basis. The lowest number of branches plant⁻¹ was observed under control (T₁) during both the years and in pooled analysis (Table 1).

Integrated nutrient sources effectively enhanced nutrient availability and uptake, thereby promoting lateral growth and branching. Organic manures likely improved soil structure and microbial activity, while biofertilizer inoculation enhanced nitrogen availability and zinc application supported enzymatic and hormonal activities responsible for branch initiation. In contrast, the minimum number of branches under control treatment may be attributed to nutrient deficiency and poor soil biological activity, highlighting the importance of integrated nutrient management in improving growth attributes of mungbean.

Kumar *et al.*, (2021) [8], Balo *et al.*, (2026) [2] and Gupta *et al.*, (2024) [6] revealed that integrated nutrient management significantly increased the number of branches per plant in mungbean due to improved nutrient availability and balanced nutrition. The results of the present study are in close conformity with these findings, clearly indicating that integrated nutrient management has a positive and significant impact on branches per plant in mungbean.

3.3 Effect on Number of Nodules per Plant

On pooled basis, number of nodules plant⁻¹ ranged from 14.41 to 27.41 among all the treatments. The highest number of nodules plant⁻¹ (27.41) was recorded under T₁₁ (75% RDF + 2.5 t vermicompost + *Rhizobium* + foliar spray of ZnSO₄), which was significantly superior to all other treatments. The next best treatment was 75% RDF + 3 t FYM + *Rhizobium* + FS of ZnSO₄ (T₇), followed by 125% RDF (T₃). The lowest number of nodules plant⁻¹ was observed under control (T₁) during both the years as well as in pooled analysis (Table 2).

RDF combined with organic manures, *Rhizobium* inoculation and foliar application of zinc sulphate indicate that integrated nutrient management created a conducive soil environment for effective root–*Rhizobium* symbiosis. Organic sources likely improved soil physical conditions and microbial activity, while *Rhizobium* inoculation directly enhanced biological nitrogen fixation, leading to increased nodule formation. In contrast, poor nutrient availability and limited microbial activity under control treatment resulted in significantly lower nodulation, emphasizing the importance of integrated nutrient management in improving nodulation and nitrogen economy of mungbean.

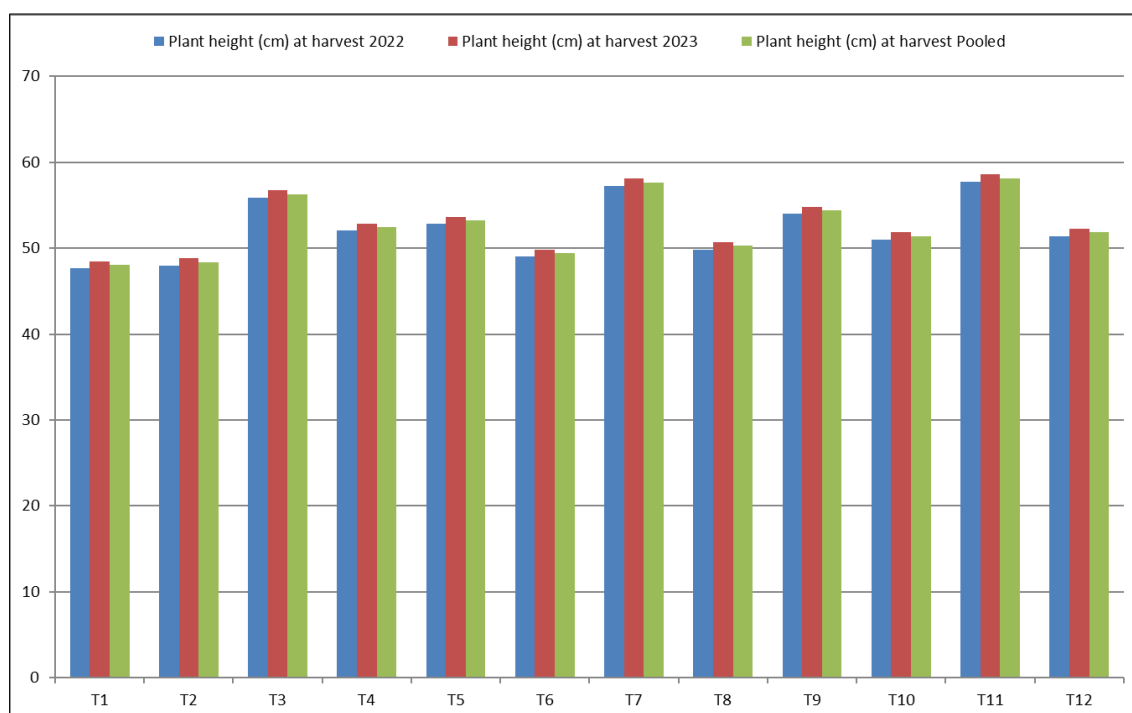
The findings of Kumar (2021) [8] and Wang *et al.*, (2025) [14] reported a significant increase in number of nodules per plant with the application of integrated nutrient management practices. The results of the present investigation are in close conformity with these findings, clearly indicating that integrated nutrient management has a positive and significant impact on nodulation in mungbean.

Table 1: Effect of integrated nutrient management on plant height at harvest and branches plant⁻¹ of mungbean

Treatment	Plant height (cm) at harvest			Branches plant ⁻¹		
	2022	2023	Pooled	2022	2023	Pooled
T ₁ : Control	47.71	48.46	48.09	6.00	6.37	6.19
T ₂ : 100% RDF	47.97	48.82	48.39	6.00	6.37	6.19
T ₃ : 125% RDF	55.87	56.73	56.30	8.00	8.38	8.19
T ₄ : 100% Rdf + FS of ZnSO ₄	52.02	52.88	52.45	7.67	8.04	7.85
T ₅ : 75% RDF + 3 t FYM+ Rhizobium	52.80	53.66	53.23	8.00	8.38	8.19
T ₆ : 50% RDF + 6 t FYM+ Rhizobium	49.01	49.86	49.44	6.33	6.71	6.52
T ₇ : 75% RDF + 3 t FYM+ Rhizobium + FS of ZnSO ₄	57.21	58.07	57.64	8.67	9.04	8.86
T ₈ : 50% RDF + 6 t FYM+ Rhizobium + FS of ZnSO ₄	49.85	50.70	50.27	7.00	7.37	7.19
T ₉ : 75% RDF + 2.5 t Vermicompost + Rhizobium	53.98	54.83	54.40	8.00	8.38	8.19
T ₁₀ : 50% RDF + 5 t Vermicompost + Rhizobium	50.97	51.82	51.40	7.00	7.37	7.19
T ₁₁ : 75% RDF + 2.5 t Vermicompost + Rhizobium + FS of ZnSO ₄	57.70	58.56	58.13	9.00	9.39	9.20
T ₁₂ : 50% RDF + 5 t Vermicompost + Rhizobium + FS of ZnSO ₄	51.40	52.25	51.83	7.00	7.37	7.19
SEM±	1.69	1.71	1.20	0.19	0.19	0.13
CD at 5%	4.95	5.03	3.43	0.54	0.57	0.38

Table 2: Effect of integrated nutrient management on nodules plant⁻¹ of mungbean

Treatment	Nodules plant ⁻¹		
	2022	2023	Pooled
T ₁ : Control	14.00	14.82	14.41
T ₂ : 100% RDF	16.00	16.82	16.41
T ₃ : 125% RDF	23.67	24.49	24.08
T ₄ : 100% Rdf + FS of ZnSO ₄	21.00	21.82	21.41
T ₅ : 75% RDF + 3 t FYM+ Rhizobium	21.33	22.15	21.74
T ₆ : 50% RDF + 6 t FYM+ Rhizobium	17.33	18.15	17.74
T ₇ : 75% RDF + 3 t FYM+ Rhizobium + FS of ZnSO ₄	24.67	25.49	25.08
T ₈ : 50% RDF + 6 t FYM+ Rhizobium + FS of ZnSO ₄	19.00	19.82	19.41
T ₉ : 75% RDF + 2.5 t Vermicompost + Rhizobium	22.33	23.16	22.74
T ₁₀ : 50% RDF + 5 t Vermicompost + Rhizobium	19.33	20.15	19.74
T ₁₁ : 75% RDF + 2.5 t Vermicompost + Rhizobium + FS of ZnSO ₄	27.00	27.83	27.41
T ₁₂ : 50% RDF + 5 t Vermicompost + Rhizobium + FS of ZnSO ₄	20.33	21.15	20.74
SEM±	0.54	0.56	0.39
CD at 5%	1.59	1.64	1.11

**Fig 1:** Effect of integrated nutrient management on plant height of mungbean.

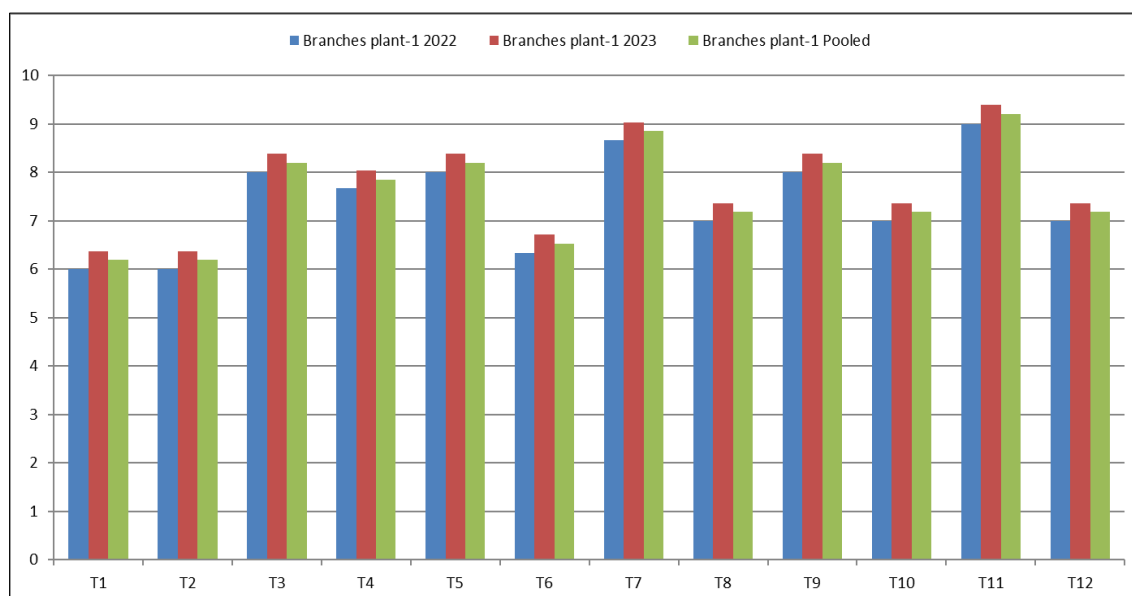


Fig 2: Effect of integrated nutrient management on branches plant⁻¹ of mungbean.

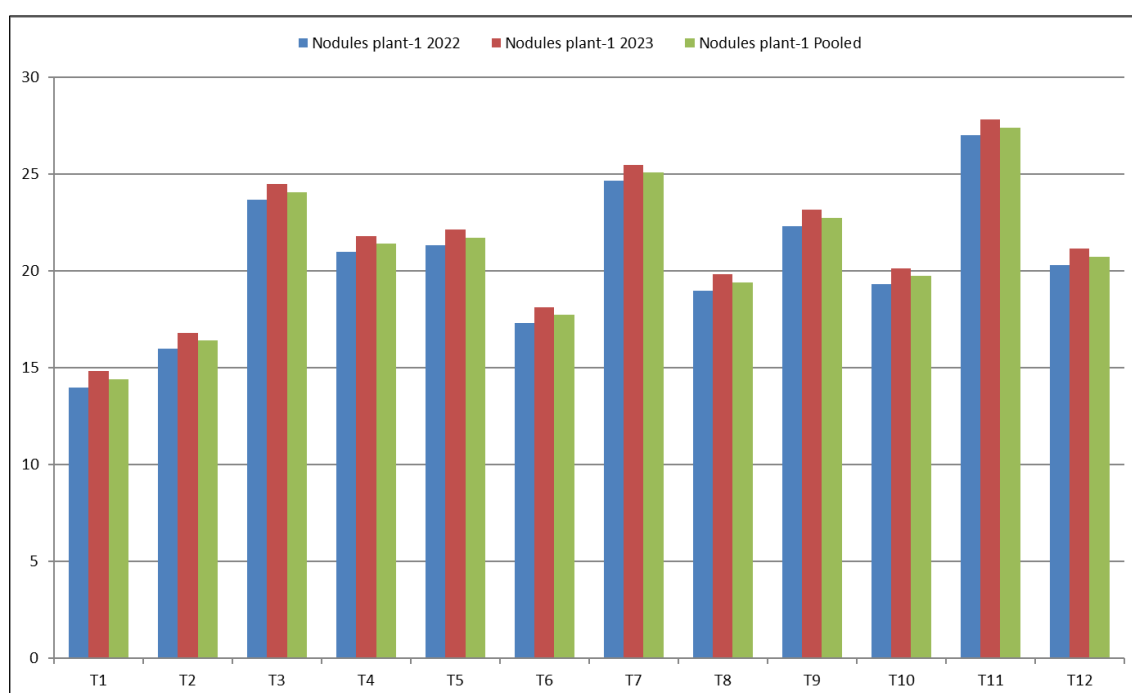


Fig 3: Effect of integrated nutrient management on nodules plant⁻¹ of mungbean.

4. Conclusion

Integrated nutrient management significantly improved the growth parameters of mungbean, including plant height, number of branches, and nodules per plant, over the control. The application of 75% RDF + 2.5 t vermicompost + Rhizobium + foliar spray of ZnSO₄ (T₁₁) proved to be the most effective treatment, producing the highest values for all growth attributes and remaining statistically at par with 75% RDF + 3 t FYM + Rhizobium + foliar spray of ZnSO₄ (T₇) and 125% RDF (T₃) for most parameters. The superior performance of integrated nutrient management may be attributed to balanced nutrient supply, improved soil physical and biological properties, enhanced biological nitrogen fixation, and increased nutrient-use efficiency. These findings suggest that integrated nutrient management can sustain optimum mungbean growth while reducing the dependence on chemical fertilizers under the agro-climatic conditions of southern Rajasthan.

References

1. Asante KOH, Aduhene-Chinbuah J, Peprah CO, Agyeman K, Frimpong F, Danquah EO, Bam R. Sustainable intensification: Agroecosystem and plant nutrient management in a changing climate. In: Organic Fertilizers-Their Role in Sustainable Agriculture. London: IntechOpen; 2025. Article 1007336.
2. Balo S, Mukhopadhyay D, Patra PS, Debnath MK. Integrated management of nutrients on growth and yield of mungbean. International Journal of Bio-resource and Stress Management. 2026;17(1):1-8.
3. Choudhary H, Devi ND, Rinwa V, Singh A, Roy A, Rana N, Verma R. Impact of integrated nutrient management on soil health and yield of mungbean: A review. Indian Journal of Agricultural Research. 2025;59(4):517-522.
4. Dixit GP, Satheesh Naik SJ. Global research status of grain legumes. In: Fundamentals of Legume Breeding: A Text for

- Students and Practitioners. Singapore: Springer Nature Singapore; 2025. p. 1-18.
5. Gomez KA, Gomez AA. Statistical Procedures for Agricultural Research. New York: John Wiley & Sons; 1984.
 6. Gupta A, Dwivedi A, Shukla A, Agnihotri G. Integrated nutrient management for sustainable mungbean production: A review of the opportunities and challenges. *International Journal*. 2024;8(12):1156-1162.
 7. Kishor K, Kumar V, Upadhaya B, Borpatragohain B. Effect of integrated nutrient management on growth, yield and economics of summer mungbean (*Vigna radiata*). *The Pharma Innovation Journal*. 2021;10(8):978-983.
 8. Kumar S. Effect of integrated nutrient management in summer mungbean [doctoral dissertation]. Hisar: Haryana Agricultural University; 2021.
 9. Mehendi S, Quatadah SM, Mishra SP, Singh IP, Praveen N, Dwivedi N. Mungbean (*Vigna radiata* L. Wilczek): Retrospect and prospects. In: *Legume Crops - Characterization and Breeding for Improved Food Security*. London: IntechOpen; 2019.
 10. Mohit, Kumar V. Integrated nutrient management in green gram (*Vigna radiata* L.). *Journal of Eco-Friendly Agriculture*. 2022;17(1):52-55.
 11. Nanda A, Dwivedy D, Reddy MB, Pedapatruni R. Integrated nutrient management: Balancing productivity and environmental health. *Practices and Innovations*. 2025:26-42.
 12. Srivastava RP, Ali M. Nutritional Quality of Common Pulses. Kanpur: Indian Institute of Pulses Research; 2004. p. 1-65.
 13. Tsou CS, Hsu MS, Tan ST, Park HG. The protein quality of mungbean and its improvement. In: *Symposium on Quality of Vegetable*. 1979;9:279-288.
 14. Wang X, Guo T, Zhang Y, Lyu X, Yan S, Yan C, *et al*. Systemic effects of nitrate on nitrogen fixation and sucrose catabolism in soybean (*Glycine max* (L.) Merr.) nodules. *Agronomy*. 2025;15(5):1032.