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Response of foliar application of magnesium sulphate on growth and canopy development of groundnut (*Arachis hypogaea* L.)

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ABSTRACT

A field experiment was conducted during Kharif 2025 at the Main Agricultural Research Station (MARS), University of Agricultural Sciences, Raichur, Karnataka, to evaluate the response of foliar application of magnesium sulphate on growth and canopy development of groundnut (*Arachis hypogaea* L.) variety Dh-256. The experiment was laid out in a Randomized Complete Block Design with six treatments and four replications. The treatments comprised recommended dose of fertilizers (RDF) alone, foliar application of magnesium sulphate at 0.5, 1.0, 1.5 and 2.0 per cent at 30 and 45 days after sowing (DAS) and soil application of magnesium sulphate @ 10 kg ha⁻¹. Growth observations were recorded at 30, 60 and 90 DAS and at harvest.

At 30 DAS, differences among treatments were non-significant for all growth parameters. However, T₆, receiving MgSO₄ through soil application at sowing, recorded the higher numerical values for plant height, branches plant⁻¹, total dry matter plant⁻¹, leaf area and leaf area index. This early response may be attributed to the availability of Mg through soil application from the beginning of crop growth, whereas the foliar treatments received their first MgSO₄ spray only at 30 DAS. From 60 DAS onwards, the response to foliar Mg application became more evident. T₄, receiving 1.5 per cent MgSO₄, recorded the higher plant height (31.23 cm), branches plant⁻¹ (6.50), total dry matter (27.37 g plant⁻¹), leaf area (835.94 cm² plant⁻¹) and leaf area index (2.79) at 60 DAS. At 90 DAS, T₄ recorded 46.18 cm plant height, 9.75 branches plant⁻¹, 49.21 g total dry matter plant⁻¹, 1105.97 cm² leaf area plant⁻¹ and 3.69 leaf area index. At harvest, T₄ recorded 49.43 cm plant height, 9.85 branches plant⁻¹ and 58.56 g total dry matter plant⁻¹, while leaf area and leaf area index were 995.84 cm² plant⁻¹ and 3.32, respectively. At 60, 90 DAS and harvest, T₄ was statistically on par with T₅ and T₃ for growth parameters. The study indicated that foliar application of MgSO₄ at 1.5 per cent at 30 and 45 DAS was effective in improving growth and canopy development of groundnut under the conditions of the experiment.

Keywords: Groundnut, Magnesium sulphate, Foliar application, Plant height, Total dry matter, Leaf area, Leaf area index

Introduction

Groundnut (*Arachis hypogaea* L.) is an important oilseed crop cultivated widely in India under rainfed as well as irrigated conditions. The productivity of groundnut is influenced by the development of an effective crop canopy, production of photosynthetically active leaves and accumulation of dry matter during vegetative and reproductive growth. Balanced nutrition is therefore essential for maintaining vigorous crop growth. Magnesium (Mg) is an essential secondary nutrient involved in several physiological and biochemical processes in plants. It is a central constituent of the chlorophyll molecule and has an important role in photosynthesis, enzyme activation, energy transfer and carbohydrate metabolism. Magnesium is also involved in the transport and partitioning of photoassimilates within the plant. Terry *et al.* (1974) [1] reported that Mg deficiency substantially reduced photosynthetic activity in sugar beet leaves, particularly when leaf Mg concentration declined below the critical range. Fischer *et al.* (1993) [2] also observed reductions in leaf expansion and assimilation under Mg deficiency.

Magnesium nutrition is closely associated with photosynthetic carbon assimilation and plant biomass formation. Fischer *et al.* (1998) [3] reported that Mg deficiency altered carbohydrate accumulation in source and sink leaves of spinach. More recently, Mg deficiency has been shown to reduce leaf area, biomass and photosynthetic activity in different crop species. Meng *et al.* (2023) [4] observed reductions in biomass, leaf area and chlorophyll under Mg deficiency in rice and cucumber, with a greater decline in chlorophyll in cucumber.

Field studies have also demonstrated positive responses to Mg application. Wang *et al.* (2020) [5], in a large-scale meta-analysis of Mg fertilization experiments, reported an overall positive yield response to reasonable Mg application, particularly where Mg availability was limiting. However, the response to Mg application depends on crop, soil nutrient status, rate and method of application.

Groundnut has a relatively high requirement for several secondary nutrients during active growth and reproductive development. Earlier research has shown that Mg nutrition can influence groundnut growth and disease response. Bledsoe *et al.* (1945) [6] reported an association between Mg deficiency and leaf spot development in peanut. Rajitha *et al.* (2018) [7] reported beneficial responses of groundnut to secondary and micronutrient application. Vineela *et al.* (2023) [8] further demonstrated that Mg nutrition influenced late leaf spot development in groundnut.

Recent studies have provided additional evidence for the importance of Mg nutrition in peanut. Gao *et al.* (2024) [9] reported that Mg application improved photosynthetic activity and dry matter accumulation in peanut under reduced nitrogen supply. The response was associated with improved chlorophyll synthesis, Rubisco activity and assimilate transport. Hu *et al.* (2024) [10] also investigated different MgSO₄ rates in peanut and evaluated their effects on growth, nutrient absorption and photosynthetic characteristics. More recently, Ma *et al.* (2026) [11] reported that foliar Mg application improved peanut biomass and photosynthetic performance under phosphorus-limited conditions.

The method of Mg application may also influence the timing of crop response. Soil application makes the nutrient available through the root zone from the early stages of crop growth, whereas foliar application supplies the nutrient directly to the foliage only after spraying. Therefore, differences between soil and foliar application may become visible at different stages of crop development.

Despite the importance of Mg in plant growth, information on the response of groundnut to different concentrations of foliar-applied MgSO₄ under the agro-climatic conditions of northern Karnataka is limited. Therefore, the present investigation was undertaken to evaluate the effect of different concentrations of foliar magnesium sulphate on growth and canopy development of groundnut variety Dh-256.

Material and methods

A field experiment was conducted during Kharif 2025 at the Main Agricultural Research Station, University of Agricultural Sciences, Raichur, Karnataka, located in the North Eastern Dry Zone (Zone-II) at 16°12' N latitude, 77°20' E longitude and 389 m above mean sea level. The soil was red sandy loam (*Alfisol*). The crop season received 752.2 mm rainfall in 54 rainy days, with mean maximum and minimum temperatures of 32.9 and 20.6 °C, respectively. Groundnut variety Dh-256 was evaluated in a Randomized Complete Block Design with six treatments and four replications. The gross and net plot sizes were 4.5 × 3.0 m and 3.9 × 2.4 m, respectively, with a spacing of 30 × 10 cm. All treatments received RDF of 18:46:25 kg N:P₂O₅:K₂O

ha⁻¹ and FYM @ 7.5 t ha⁻¹. The treatments comprised RDF alone (T₁), RDF + MgSO₄ @ 0.5, 1.0, 1.5 and 2.0 per cent foliar spray at 30 and 45 DAS (T₂-T₅, respectively) and RDF + MgSO₄ @ 10 kg ha⁻¹ through soil application (T₆). The soil-applied MgSO₄ was incorporated at sowing, whereas foliar treatments were applied at 30 and 45 DAS.

The crop was sown on 25 July 2025 and harvested on 21 November 2025. Weeding was carried out at 20 and 35 DAS, and other crop management practices were followed uniformly across treatments. Growth observations, including plant height, number of branches plant⁻¹, total dry matter, leaf area and leaf area index, were recorded at 30, 60 and 90 DAS and at harvest. Leaf area index was calculated as the ratio of leaf area per plant to the land area occupied by one plant. The data were analysed statistically using the procedure appropriate for a Randomized Complete Block Design, and SEM ± and CD at 5 % were calculated for comparison of treatment means.

Results and discussion

1. Plant height

Plant height is an important indicator of vegetative vigour and canopy development. The treatment means are presented in Table 1.

At 30 DAS, plant height ranged from 14.12 to 15.28 cm and the differences among treatments were non-significant. However, T₆ recorded the higher numerical plant height (15.28 cm). This early numerical advantage of T₆ can be related to its mode of application. In T₆, MgSO₄ was applied directly to the soil at sowing, providing Mg through the root zone from the beginning of crop growth. In contrast, the foliar treatments received their first MgSO₄ application only at 30 DAS. Thus, the soil-applied treatment had an opportunity to influence early crop growth before the foliar treatments received Mg.

At 60 DAS, T₄ recorded the higher plant height (31.23 cm), followed by T₅ (30.92 cm) and T₃ (30.45 cm). T₄ was statistically on par with T₅ and T₃. T₁ recorded the lower plant height (28.57 cm).

At 90 DAS, T₄ recorded the higher plant height (46.18 cm), which was statistically on par with T₅ (45.65 cm) and T₃ (45.25 cm). At harvest, T₄ recorded the higher plant height (49.43 cm) and was statistically on par with T₅ (48.84 cm) and T₃ (48.61 cm).

The increase in plant height following Mg application may be associated with the role of Mg in chlorophyll formation, photosynthesis and carbohydrate metabolism. Fischer *et al.* (1993) [2] reported that Mg deficiency reduced leaf expansion and net assimilation, while adequate Mg supply supports continued photosynthetic activity and vegetative growth. Similar responses have been observed in peanut, where Mg application improved growth and dry matter accumulation under reduced nitrogen supply (Gao *et al.*, 2024) [9].

Table 1. Effect of magnesium sulphate application on plant height at different growth stages of groundnut

Treatments	Plant height (cm)			
	30 DAS	60 DAS	90 DAS	At harvest
T ₁ - RDF (Control)	14.34	28.57	42.83	45.16
T ₂ - RDF + Foliar spray of MgSO ₄ @ 0.5 % at 30 and 45 DAS	14.12	29.24	43.96	46.32
T ₃ - RDF + Foliar spray of MgSO ₄ @ 1.0 % at 30 and 45 DAS	14.56	30.45	45.25	48.61
T ₄ - RDF + Foliar spray of MgSO ₄ @ 1.5 % at 30 and 45 DAS	14.18	31.23	46.18	49.43
T ₅ - RDF + Foliar spray of MgSO ₄ @ 2.0 % at 30 and 45 DAS	14.26	30.92	45.65	48.84
T ₆ - RDF + Soil application of MgSO ₄ @ 10 kg ha ⁻¹	15.28	29.83	44.51	47.90
S. Em. ±	0.41	0.44	0.48	0.50
CD @ 5 %	NS	1.30	1.42	1.47

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2. Number of branches plant⁻¹

Number of branches plant⁻¹ is an important indicator of vegetative growth and the treatment means are presented in Table 2.

The number of branches plant⁻¹ increased progressively with crop age. At 30 DAS, the differences among treatments were non-significant. T₆ recorded the higher numerical number of branches (2.85 plant⁻¹). The early numerical advantage of T₆ may again be related to soil application of MgSO₄ at sowing, which made Mg available through the soil before the first foliar spray treatments were applied.

At 60 DAS, T₄ recorded the higher number of branches (6.50 plant⁻¹), followed by T₅ (6.30) and T₃ (6.15). T₄ was statistically on par

with T₅ and T₃.

At 90 DAS, T₄ recorded the higher number of branches (9.75 plant⁻¹), which was statistically on par with T₅ (9.45 plant⁻¹) and T₃ (9.10 plant⁻¹). At harvest, T₄ recorded the higher number of branches (9.85 plant⁻¹) and was statistically on par with T₅ (9.55 plant⁻¹) and T₃ (9.30 plant⁻¹).

Improved branching under Mg application may be related to greater photosynthetic activity and assimilate availability for vegetative growth. Adequate Mg supports chlorophyll formation and enzyme activity and thereby contributes to continued plant growth. Recent studies have also reported improved physiological performance following Mg application.

Table 2. Effect of magnesium sulphate application on number of branches per plant at different growth stages of groundnut

Treatments	Number of branches plant ⁻¹			
	30 DAS	60 DAS	90 DAS	At harvest
T ₁ - RDF (Control)	2.70	5.20	7.55	7.65
T ₂ - RDF + Foliar spray of MgSO ₄ @ 0.5 % at 30 and 45 DAS	2.55	5.45	8.20	8.45
T ₃ - RDF + Foliar spray of MgSO ₄ @ 1.0 % at 30 and 45 DAS	2.75	6.15	9.10	9.30
T ₄ - RDF + Foliar spray of MgSO ₄ @ 1.5 % at 30 and 45 DAS	2.60	6.50	9.75	9.85
T ₅ - RDF + Foliar spray of MgSO ₄ @ 2.0 % at 30 and 45 DAS	2.65	6.30	9.45	9.55
T ₆ - RDF + Soil application of MgSO ₄ @ 10 kg ha ⁻¹	2.85	5.95	8.75	8.80
S. Em. ±	0.08	0.16	0.24	0.25
CD @ 5 %	NS	0.47	0.71	0.74

3. Total dry matter production

Total dry matter production reflects overall crop growth and biomass accumulation and the treatment means are presented in Table 3.

Total dry matter production reflects the cumulative growth and photosynthetic activity of the crop. At 30 DAS, differences among treatments were non-significant. T₆ recorded the higher numerical dry matter production (9.64 g plant⁻¹). The higher early value under T₆ may be associated with soil application of MgSO₄ at sowing and the resulting early availability of Mg to the developing crop.

At 60 DAS, T₄ recorded the higher dry matter (27.37 g plant⁻¹), followed by T₅ (26.56 g) and T₃ (25.76 g). T₄ was statistically on par with T₅ and T₃.

At 90 DAS, T₄ recorded the higher dry matter (49.21 g plant⁻¹), which was statistically on par with T₅ (47.59 g plant⁻¹) and T₃ (45.44 g plant⁻¹). At harvest, T₄ recorded the higher dry matter (58.56 g plant⁻¹) and was statistically on par with T₅ (55.65 g plant⁻¹) and T₃ (54.09 g plant⁻¹).

Magnesium plays an important role in photosynthetic carbon assimilation and carbohydrate movement. Mg deficiency has been reported to reduce photosynthetic performance and alter carbohydrate distribution. In peanut, Gao *et al.* (2024) [9] reported increased dry matter accumulation following Mg application under reduced nitrogen conditions, which was associated with improved photosynthetic activity and assimilate transport.

Table 3. Effect of magnesium sulphate application on total dry matter production at different growth stages of groundnut

Treatments	Total dry matter production (g plant ⁻¹)			
	30 DAS	60 DAS	90 DAS	At harvest
T ₁ - RDF (Control)	9.26	20.93	35.78	43.20
T ₂ - RDF + Foliar spray of MgSO ₄ @ 0.5 % at 30 and 45 DAS	8.59	22.81	39.27	47.23
T ₃ - RDF + Foliar spray of MgSO ₄ @ 1.0 % at 30 and 45 DAS	9.37	25.76	45.44	54.09
T ₄ - RDF + Foliar spray of MgSO ₄ @ 1.5 % at 30 and 45 DAS	8.80	27.37	49.21	58.56
T ₅ - RDF + Foliar spray of MgSO ₄ @ 2.0 % at 30 and 45 DAS	9.12	26.56	47.59	55.65
T ₆ - RDF + Soil application of MgSO ₄ @ 10 kg ha ⁻¹	9.64	24.15	41.95	49.91
S. Em. ±	0.28	0.62	1.42	1.64
CD @ 5 %	NS	1.83	4.28	4.90

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4. Leaf area

Leaf area is an important component of canopy development and photosynthetic activity and the treatment means are presented in Table 4. Leaf area is an important component of canopy development and determines the photosynthetic surface available to the crop. At 30 DAS, differences among treatments were non-significant. T₆ recorded the higher numerical leaf area (475.13 cm² plant⁻¹).

At 60 DAS, T₄ recorded the higher leaf area (835.94 cm² plant⁻¹), followed by T₅ (812.47 cm²) and T₃ (789.66 cm²). T₄ was statistically on par with T₅ and T₃.

At 90 DAS, T₄ recorded the higher leaf area (1105.97 cm² plant⁻¹), which was statistically on par with T₅ (1078.34 cm² plant⁻¹) and T₃

(1042.74 cm² plant⁻¹). At harvest, T₄ maintained the higher leaf area (995.84 cm² plant⁻¹) and was statistically on par with T₅ (940.20 cm² plant⁻¹) and T₃ (935.69 cm² plant⁻¹).

The greater leaf area under adequate Mg nutrition may be associated with improved photosynthetic performance and leaf development. Mg deficiency has been shown to reduce leaf area and biomass in Mg-sensitive species. Meng *et al.* (2023) [4] reported lower leaf area and biomass under Mg deficiency in rice and cucumber, with stronger effects on chlorophyll in cucumber. Similarly, Ma *et al.* (2026) [11] reported that foliar Mg application improved plant growth and photosynthetic performance of peanut under phosphorus-limited conditions.

Table 4. Effect of magnesium sulphate application on leaf area at different growth stages of groundnut

Treatments	Leaf area (cm ² plant ⁻¹)			
	30 DAS	60 DAS	90 DAS	At harvest
T ₁ - RDF (Control)	448.62	711.65	940.87	810.72
T ₂ - RDF + Foliar spray of MgSO ₄ @ 0.5 % at 30 and 45 DAS	400.96	748.38	985.44	865.25
T ₃ - RDF + Foliar spray of MgSO ₄ @ 1.0 % at 30 and 45 DAS	458.87	789.66	1042.74	935.69
T ₄ - RDF + Foliar spray of MgSO ₄ @ 1.5 % at 30 and 45 DAS	418.24	835.94	1105.97	995.84
T ₅ - RDF + Foliar spray of MgSO ₄ @ 2.0 % at 30 and 45 DAS	435.45	812.47	1078.34	940.20
T ₆ - RDF + Soil application of MgSO ₄ @ 10 kg ha ⁻¹	475.13	765.80	1012.61	885.48
S. Em. ±	15.17	21.28	30.43	24.28
CD @ 5 %	NS	63.83	91.27	72.88

5. Leaf area index

Leaf area index indicates the extent of canopy development and photosynthetic surface and the treatment means are presented in Table 5. Leaf area index followed a trend similar to leaf area. At 30 DAS, differences among treatments were non-significant. T₆ recorded the higher numerical LAI (1.58). The higher early value under T₆ may again be related to the soil application of MgSO₄ at sowing.

At 60 DAS, T₄ recorded the higher LAI (2.79), followed by T₅ (2.71) and T₃ (2.63) and these treatments were statistically on par.

At 90 DAS, T₄ recorded the higher LAI (3.69), which was statistically on par with T₅ (3.59) and T₃ (3.48). At harvest, T₄ recorded the higher LAI (3.32) and was statistically on par with T₅ (3.13) and T₃ (3.12).

The higher LAI under T₄ indicates better canopy development during the active growth period. An adequately supplied crop can maintain a larger photosynthetically active surface, supporting greater dry matter accumulation. Studies on Mg deficiency have shown reductions in photosynthetic performance, leaf development and biomass, while Mg supplementation can improve these processes.

Table 5. Effect of magnesium sulphate application on leaf area index at different growth stages of groundnut

Treatments	Leaf area index (LAI)			
	30 DAS	60 DAS	90 DAS	At harvest
T ₁ - RDF (Control)	1.50	2.37	3.14	2.70
T ₂ - RDF + Foliar spray of MgSO ₄ @ 0.5 % at 30 and 45 DAS	1.34	2.49	3.28	2.88
T ₃ - RDF + Foliar spray of MgSO ₄ @ 1.0 % at 30 and 45 DAS	1.53	2.63	3.48	3.12
T ₄ - RDF + Foliar spray of MgSO ₄ @ 1.5 % at 30 and 45 DAS	1.39	2.79	3.69	3.32
T ₅ - RDF + Foliar spray of MgSO ₄ @ 2.0 % at 30 and 45 DAS	1.45	2.71	3.59	3.13
T ₆ - RDF + Soil application of MgSO ₄ @ 10 kg ha ⁻¹	1.58	2.55	3.38	2.95
S. Em. ±	0.05	0.07	0.09	0.09
CD @ 5 %	NS	0.22	0.28	0.28

Conclusion

Foliar application of magnesium sulphate influenced the growth and canopy development of groundnut variety Dh-256, particularly from 60 DAS onwards. At 30 DAS, treatment differences were non-signifi-

cant; however, T₆ receiving MgSO₄ through soil application at sowing recorded the higher numerical values for most early growth parameters. This early response may be attributed to the availability of Mg through soil application from the beginning of crop growth, whereas the foliar treatments received their first MgSO₄ spray at 30 DAS.

From 60 DAS onwards, T₄ receiving 1.5 per cent MgSO₄ foliar spray at 30 and 45 DAS consistently recorded the higher plant height, number of branches, total dry matter, leaf area and leaf area index. T₅ and T₃ were statistically on par with T₄.

Under the agro-climatic and soil conditions of the experiment, foliar application of MgSO₄ at 1.5% at 30 and 45 DAS was the most effective treatment for improving growth and canopy development of groundnut variety Dh-256.

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Abbreviations

DAS, days after sowing; RDF, recommended dose of fertilizers; SEM $\pm$, standard error of mean; CD, critical difference; NS, non-significant; LAI, leaf area index.

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