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# Effect of Foliar Nutrition on Growth and Yield of Sesame in Cauvery Delta Zone of Tamil Nadu

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## ABSTRACT

In 2024, a field experiment was conducted at the Experimental Farm, Department of Agronomy, Faculty of Agriculture, Annamalai University, Annamalai Nagar, Tamil Nadu, to study the effects of foliar nutrition on the growth and yield of sesame in a garden land ecosystem. The experiment was laid out in a randomized block design with eleven treatments, each replicated three times. The sesame variety TMV 4 was chosen for the study. The treatments involved foliar applications of macronutrients like DAP, KCl, and NPK (19:19:19), along with micronutrients such as $ZnSO_4$ and $MnSO_4$, applied both individually and in combinations at 30 and 45 days after sowing (DAS). The growth and yield of sesame viz., plant height (38.74, 96.68, 115.36 cm), number of branches per plant (6.36), dry matter production (671, 1478, 2190 kg $ha^{-1}$), seed yield (877 kg $ha^{-1}$) and stalk yield (1885 kg $ha^{-1}$) were notably increased with the foliar application of 2% DAP, 0.5% KCl, 0.5% $ZnSO_4$, and 0.5% $MnSO_4$ at 30 and 45 days after sowing (DAS) ($T_8$).

**Keywords** DAP, DMP, Foliar nutrition, KCl, $MnSO_4$, Number of branches, Plant height, Sesame, Biological yield, $ZnSO_4$.

## INTRODUCTION

Sesame (*Sesamum indicum* L.) is an essential oilseed crop with a rich history. Sesame is often referred to as the "Queen of Oilseeds". It is rich in high-quality polyunsaturated fatty acids, including palmitic acid (16%), stearic acid (18%), oleic acid (18.1%) and linoleic acid (18.2%), which naturally resist rancidity (Taware *et al.* 2006). Sesame is cultivated worldwide on 12.84 million hectares, yielding 6.74 million tonnes, with an average productivity of 525 kg per hectare. In India, sesame is grown on 1.627 million hectares, producing 7,89,000 tonnes, with an average yield of 485 kg per hectare (FAOSTAT 2023). Despite being an important oilseed crop, sesame's average productivity remains low compared to leading sesame-producing countries like China (1,393 kg per hectare), Egypt (1,315 kg per hectare), and Nigeria (1,063 kg per hectare). This lower yield is mainly due to poor management practices and cultivation on less fertile, marginal, and sub-marginal lands. Additionally, sesame cultivation faces several challenges, such as significant flower shedding, nutrient deficiencies, hormonal imbalances, slow dry matter accumulation,

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inefficient transfer of assimilates from source to sink, and issues with endogenous growth regulators (Saha and Bhargava 2001). Yield in sesame is the outcome of various physiological processes in plants, which are often influenced by management practices and environmental factors. Among these, nutrient management, particularly through foliar nutrition, plays a crucial role in determining sesame yields. Applying essential nutrients via foliar feeding, alongside soil application, is vital for sesame production as it enhances root development, energy transformation, metabolic processes, and nutrient translocation, and improves capsule setting, all of which contribute to increased yields (Dutta and Bera 2021). Applying NPK and micronutrients directly to the leaves is more effective than soil application, as the leaves absorb and transport nutrients more rapidly and efficiently to essential parts of the plant. The foliar application of DAP at critical stages of the crop has been shown to improve photosynthetic activity as as reported by Dhayanethi *et al.* (2024a). Zinc and manganese are particularly important for various enzymatic activities that are essential for the growth and development of sesame plants (Elayaraja and Singaravel 2017). Therefore, the current study aims to "investigate the effects of foliar applications of macronutrients, such as NPK fertilizers and micronutrients like zinc and manganese on the growth and yield of sesame under irrigated conditions.

## MATERIALS AND METHODS

A field experiment was carried out from January to April 2024 at the Experimental Farm of the Department of Agronomy, Faculty of Agriculture, Annamalai University, Annamalai Nagar, Tamil Nadu. The experimental farm is located at 11° 38' N latitude and 79° 72' E longitude, with an elevation of +5.79 m above mean sea level (MSL). The soil at the experimental site was classified as clay loam, with a pH of 7.4 and an electrical conductivity (EC) of 0.46 dS $m^{-1}$. It had low levels of available nitrogen (215.6 kg $ha^{-1}$), a medium level of available phosphorus (18.84 kg $ha^{-1}$), and high levels of available potassium (316.4 kg $ha^{-1}$). The experiment was laid out in a RBD with eleven treatments, each replicated three times. The treatments were: $T_1$ - Control (water spray), $T_2$ - Foliar spray of 2% DAP + 0.5% KCl (30 and 45 DAS), $T_3$ - Foliar spray of 2% NPK (19:19:19) (30 and 45 DAS), $T_4$ - Foliar spray of 0.5% $MnSO_4$ (30 and 45 DAS), $T_5$ - Foliar spray of 0.5% $ZnSO_4$ (30 and 45 DAS), $T_6$ - Foliar spray of 2% DAP + 0.5% KCl + 0.5% $ZnSO_4$ (30 and 45 DAS), $T_7$ - Foliar spray of 2% DAP + 0.5% KCl + 0.5% $MnSO_4$ (30 and 45 DAS), $T_8$ - Foliar spray of 2% DAP + 0.5% KCl + 0.5% $ZnSO_4$ + 0.5% $MnSO_4$ (30 and 45 DAS), $T_9$ - Foliar spray of 2% NPK (19:19:19) + 0.5% $ZnSO_4$ (30 and 45 DAS), $T_{10}$ - Foliar spray of 2% NPK (19:19:19) + 0.5% $MnSO_4$ (30 and 45 DAS) and $T_{11}$ - Foliar spray of 2% NPK (19:19:19) + 0.5% $ZnSO_4$ + 0.5% $MnSO_4$ (30 and 45 DAS). The sesame variety TMV 4 was utilized for the study. The experiment adhered to a recommended seed rate of 5 kg $ha^{-1}$ and a spacing of 30 × 30 cm. Fertilization followed the recommended schedule of 35:23:23 kg N, $P_2O_5$, and $K_2O$ $ha^{-1}$, with entire dose of nitrogen, phosphorus, and potassium applied as a basal dose. Urea, single super phosphate, and muriate of potash were used for nitrogen, phosphorus, and potassium, respectively. According to the treatment plan, DAP (2%), KCl (0.5%), NPK (19:19:19) (2%), $MnSO_4$ (0.5%), and $ZnSO_4$ (0.5%) were sprayed at 30 and 45 days after sowing (DAS) using a hand-operated knapsack sprayer with a spray volume of 500 liters per hectare, during the morning hours. In each treatment, five samples per net plot were randomly tagged. Various biometric observations were subsequently recorded at different stages of crop growth. The crop was harvested from each plot when it reached physiological maturity. The seeds from each plot were sun-dried until they reached a constant weight. Finally, the seeds and stalks were weighed and recorded in kg $ha^{-1}$. The data collected on various traits during the field study were statistically analyzed according to the method described by Panse and Sukhatme (1978). Significant results were assessed by calculating the critical differences at a five percent probability level for statistical inference. Differences between treatments that were not statistically significant were denoted as "NS".

### Results and discussion

### Plant height

The foliar spray treatment of 2% DAP + 0.5% KCl + 0.5% $ZnSO_4$ + 0.5% $MnSO_4$ applied at 30 and 45

DAS ($T_8$) produced the tallest plants, measuring 96.68 cm at 60 DAS and 115.36 cm at harvest (Table 1). The increase in plant height can be attributed to the combined effects of macro and micronutrients. Foliar application of NPK and micronutrients plays a direct role in synthesizing tryptophan, a precursor to Indole Acetic Acid and in the formation of enzymes essential for cell growth and elongation, resulting in maximum plant height (Patil *et al.* 2020). Furthermore, the same treatment also delivered zinc and manganese through foliar application, which boosted plant height. This could be due to zinc, sulfur, and manganese enhancing the photosynthetic process by increasing the plant's size, thereby providing more photosynthates to the developing buds and resulting in greater crop height (Haritha *et al.* 2022). The next higher plant height was observed with the foliar spray of 2% NPK (19:19:19) + 0.5% $ZnSO_4$ + 0.5% $MnSO_4$ applied at 30 and 45 DAS ($T_{11}$), resulting in plant heights of 91.67 cm at 60 DAS and 109.95 cm at harvest. The shortest plant height was recorded in the control ($T_1$), with plant heights of 54.05 cm at 60 DAS and 67.56 cm at harvest.

**Number of branches plant$^{-1}$**

The number of branches per plant ranged from 3.35 to 6.36 at the flowering stage. The plots treated with 2% DAP + 0.5% KCl + 0.5% $ZnSO_4$ + 0.5% $MnSO_4$ (at 30 and 45 DAS) ($T_8$) showed the higher number of branches per plant, with a recorded value of 6.36 which was 89.85% over control at the flowering stage (Table 1). This effect may be attributed to the foliar application of macronutrients such as NPK and micronutrients like manganese and zinc, which were essential for various enzymes, proteins, and chlorophyll, and contributes to increased cell division and elongation. Further macro and micronutrients enhance the net assimilation rate, leaf area production, leaf area duration, and photosynthesis. This boosts the photosynthetic rate and improves the movement of photosynthates from the source to the shoot, leading

**Table 1.** Effect of foliar nutrition on plant height (cm), number of branches plant$^{-1}$ and dry matter production (kg ha$^{-1}$) in sesame.

| Treatments | Plant height (cm) | | | Number of branches plant$^{-1}$ | DMP (kg ha$^{-1}$) | | |
|---|---|---|---|---|---|---|---|
| | 30 DAS | 60 DAS | At harvest | | 30 DAS | 60 DAS | At harvest |
| $T_1$ - Control (Water spray) | 38.21 | 54.05 | 67.56 | 3.35 | 660 | 1116 | 1565 |
| $T_2$ - Foliar spray of 2% DAP + 0.5% KCl (30 & 45 DAS) | 38.28 | 71.69 | 87.25 | 4.57 | 664 | 1267 | 1830 |
| $T_3$ - Foliar spray of 2% NPK (19:19:19) (30 & 45 DAS) | 38.23 | 66.66 | 81.73 | 4.13 | 663 | 1223 | 1749 |
| $T_4$ - Foliar spray of 0.5% $MnSO_4$ (30 & 45 DAS) | 38.19 | 59.35 | 73.16 | 3.68 | 661 | 1159 | 1643 |
| $T_5$ - Foliar spray of 0.5% $ZnSO_4$ (30 & 45 DAS) | 38.21 | 61.55 | 76.19 | 3.72 | 662 | 1177 | 1668 |
| $T_6$ - Foliar spray of 2% DAP + 0.5% KCl + 0.5% $ZnSO_4$ (30 & 45 DAS) | 38.47 | 86.61 | 104.48 | 5.59 | 668 | 1389 | 2025 |
| $T_7$ - Foliar spray of 2% DAP + 0.5% KCl + 0.5% $MnSO_4$ (30 & 45 DAS) | 38.39 | 84.28 | 101.32 | 5.57 | 667 | 1374 | 2008 |
| $T_8$ - Foliar spray of 2% DAP + 0.5% KCl + 0.5% $ZnSO_4$ + 0.5% $MnSO_4$ (30 & 45 DAS) | 38.74 | 96.68 | 115.36 | 6.36 | 671 | 1478 | 2190 |
| $T_9$ - Foliar spray of 2% NPK (19:19:19) + 0.5% $ZnSO_4$ (30 & 45 DAS) | 38.34 | 79.16 | 95.77 | 5.14 | 666 | 1328 | 1934 |
| $T_{10}$ - Foliar spray of 2% NPK (19:19:19) + 0.5% $MnSO_4$ (30 & 45 DAS) | 38.31 | 76.89 | 92.78 | 5.07 | 665 | 1315 | 1912 |
| $T_{11}$ - Foliar spray of 2% NPK (19:19:19) + 0.5% $ZnSO_4$ + 0.5% $MnSO_4$ (30 & 45 DAS) | 38.68 | 91.67 | 109.95 | 5.91 | 669 | 1433 | 2100 |
| SEd | **0.70** | **1.42** | **1.72** | **0.09** | **12.08** | **18.40** | **21.70** |
| CD (p=0.05) | **NS** | **2.99** | **3.61** | **0.19** | **NS** | **38.66** | **45.59** |

**Table 2.** Effect of foliar nutrition on seed yield, stalk yield and biological yield in sesame.

| Treatments | Seed yield (kg ha$^{-1}$) | Stalk yield (kg ha$^{-1}$) | Biological yield (kg ha$^{-1}$) |
|---|---|---|---|
| $T_1$ - Control (Water spray) | 522 | 1230 | 1752 |
| $T_2$ - Foliar spray of 2% DAP + 0.5% KCl (30 & 45 DAS) | 645 | 1480 | 2125 |
| $T_3$ - Foliar spray of 2% 19:19:19 (NPK) (30 & 45 DAS) | 608 | 1405 | 2013 |
| $T_4$ - Foliar spray of 0.5% $MnSO_4$ (30 & 45 DAS) | 560 | 1309 | 1869 |
| $T_5$ - Foliar spray of 0.5% $ZnSO_4$ (30 & 45 DAS) | 569 | 1329 | 1898 |
| $T_6$ - Foliar spray of 2% DAP + 0.5% KCl + 0.5% $ZnSO_4$ (30 & 45 DAS) | 780 | 1734 | 2514 |
| $T_7$ - Foliar spray of 2% DAP + 0.5% KCl + 0.5% $MnSO_4$ (30 & 45 DAS) | 756 | 1681 | 2437 |
| $T_8$ - Foliar spray of 2% DAP + 0.5% KCl + 0.5% $ZnSO_4$ + 0.5% $MnSO_4$ (30 & 45 DAS) | 877 | 1885 | 2762 |
| $T_9$ - Foliar spray of 2% 19:19:19 (NPK) + 0.5% $ZnSO_4$ (30 & 45 DAS) | 719 | 1606 | 2325 |
| $T_{10}$ - Foliar spray of 2% 19:19:19 (NPK) + 0.5% $MnSO_4$ (30 & 45 DAS) | 696 | 1556 | 2252 |
| $T_{11}$ - Foliar spray of 2% 19:19:19 (NPK) + 0.5% $ZnSO_4$ + 0.5% $MnSO_4$ (30 & 45 DAS) | 841 | 1812 | 2653 |
| SEd | **12.12** | **28.74** | **41.62** |
| CD (p=0.05) | **25.46** | **60.37** | **87.42** |

to an increased number of branches plant$^{-1}$, as reported by Priya *et al.* (2022). This treatment was followed by the application of 2% NPK (19:19:19) combined with 0.5% $ZnSO_4$ + 0.5% $MnSO_4$ at 30 and 45 DAS ($T_{11}$), resulting in an average of 5.91 branches per plant at the flowering stage. The control treatment ($T_1$) had the lower number of branches.

**Dry matter production**

Among the treatments, the foliar application of 2% DAP + 0.5% KCl + 0.5% $ZnSO_4$ + 0.5% $MnSO_4$ at 30 and 45 DAS ($T_8$) resulted in the higher DMP, with 1478 kg ha$^{-1}$ at 60 DAS and 2190 kg ha$^{-1}$ at harvest which was 32.43% and 39.93% at 60 DAS and harvest stage, respectively over control (Table 1). Foliar feeding of NPK likely increased total dry matter production due to the improved source and sink capacity, which enhanced dry matter accumulation in the assimilatory surface area. This also boosted photosynthetic efficiency, leading to greater production of photosynthates and ultimately better growth and yields, resulting in higher dry matter accumulation. These findings are consistent with those of Bochalya *et al.* (2021). Additionally, the foliar application of micronutrients like zinc and manganese significantly enhanced nutrient uptake. Improved nutrient uptake bolstered physiological processes such as photosynthesis, chlorophyll formation, protein synthesis, nitrate metabolism, and carbohydrate synthesis, which collectively contributed to increased dry matter production (DMP). These results align with the findings of Yadav *et al.* (2021). It was statistically followed by the foliar application of 2% NPK (19:19:19) combined with 0.5% $ZnSO_4$ + 0.5% $MnSO_4$ at 30 and 45 DAS ($T_{11}$), which resulted in a dry matter production (DMP) of 1433 kg ha$^{-1}$ at 60 DAS and 2100 kg ha$^{-1}$ at harvest. The control ($T_1$) recorded the lower dry matter production.

**Yields**

Among the treatments, the foliar application of 2% DAP + 0.5% KCl + 0.5% $ZnSO_4$ + 0.5% $MnSO_4$, applied at 30 and 45 days after sowing ($T_8$), resulted in a significantly higher seed yield of 877 kg ha$^{-1}$ and stalk yield of 1885 kg ha$^{-1}$ (Table 2). The notable rise in yield was mainly due to combined effects of macronutrients (NPK) and micronutrients (zinc and manganese) resulting in enhanced dry matter accumulation, more branches per plant and a higher number of capsules per plant (Mahajan *et al.* 2016). Improved nutrient uptake, supported by effective nutrient translocation to the reproductive parts, appears to be a key factor in achieving these higher yields, as noted by Dhayanethi *et al.* (2024b). Furthermore,

the foliar application of zinc and manganese likely activated various enzymes, increased metabolic rates, supported nucleic acid and hormone synthesis, which led to more efficient conversion of photosynthates from source to sink resulting in higher seed yield. These observations are consistent with the studies by Elayaraja *et al.* (2019). Following this, the foliar application of 2% NPK (19:19:19) combined with 0.5% $ZnSO_4$ + 0.5% $MnSO_4$, applied at 30 and 45 days after sowing ($T_{11}$), resulted in a seed yield of 841 kg $ha^{-1}$ and stalk yield of 1812 kg $ha^{-1}$. The lower seed and stalk yield were recorded in the control treatment ($T_1$), with 522 kg $ha^{-1}$ and 1230 kg $ha^{-1}$, respectively.

## CONCLUSION

Based on the above results it can be concluded that foliar application of 2% DAP + 0.5% KCl + 0.5% $ZnSO_4$ + 0.5% $MnSO_4$ at 30 and 45 days after sowing (DAS) recorded the higher growth attributes such as plant height, number of branches $plant^{-1}$, dry matter production and higher biological yield over other treatments under irrigated sesame in the Cauvery Delta zone of Tamil Nadu.

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