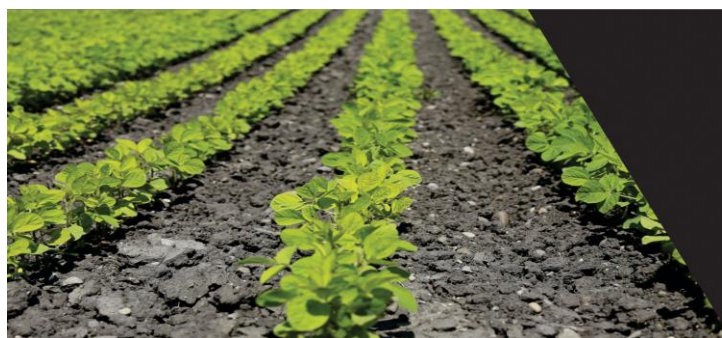




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## Effect of foliar application of macro and micronutrients on growth and yield of wheat (*Triticum aestivum* L.)

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### Abstract

A field experiment was conducted during Rabi 2025–26 at the Agricultural Research Farm, Gangrar Chittorgarh, Rajasthan, to evaluate the effect of foliar application of macro and micronutrients on the growth and yield of wheat (*Triticum aestivum* L.). The experiment was laid out in a Randomized Block Design (RBD) with nine treatments and three replications. The treatments comprised T<sub>1</sub>: Control (no fertilizer and no foliar spray), T<sub>2</sub>: 75% RDF, T<sub>3</sub>: 100% RDF, T<sub>4</sub>: 125% RDF, T<sub>5</sub>: 75% RDF + foliar spray of N (2% urea), T<sub>6</sub>: 100% RDF + foliar spray of N (2% urea), T<sub>7</sub>: 100% RDF + foliar spray of N (2% urea) + ZnSO<sub>4</sub> (0.5%), T<sub>8</sub>: 100% RDF + foliar spray of N (2% urea) + FeSO<sub>4</sub> (0.5%) and T<sub>9</sub>: 100% RDF + foliar spray of N (2% urea) + ZnSO<sub>4</sub> (0.5%) + FeSO<sub>4</sub> (0.5%). The results revealed that foliar application of macro and micronutrients significantly improved the growth and yield of wheat. The treatment T<sub>9</sub> recorded the maximum plant height (80.84 cm), dry matter accumulation (34.46 g plant<sup>-1</sup>), number of tillers (8.86 plant<sup>-1</sup>), grain yield (5558 kg ha<sup>-1</sup>), straw yield (6928 kg ha<sup>-1</sup>) and biological yield (12486 kg ha<sup>-1</sup>), and remained statistically at par with T<sub>7</sub> and T<sub>8</sub> for most of the growth and yield parameters. Harvest index was not significantly influenced by the treatments. The superior performance of T<sub>9</sub> was attributed to the combined effect of balanced fertilization and foliar application of nitrogen, zinc and iron, which enhanced crop growth and biomass production. Based on the results of the present investigation, application of 100% RDF supplemented with foliar spray of 2% urea + 0.5% ZnSO<sub>4</sub> + 0.5% FeSO<sub>4</sub> may be recommended as an efficient nutrient management practice for improving the growth and productivity of wheat under the agro-climatic conditions of Rajasthan.

**Keywords:** Wheat, foliar nutrition, nitrogen, zinc, iron, growth, yield, RDF

### Introduction

Wheat (*Triticum aestivum* L.) is one of the most important cereal crops in the world and serves as a staple food for more than one-third of the global population. It contributes substantially to global food and nutritional security by providing carbohydrates, proteins, vitamins and minerals. In India, wheat is the second most important food crop after rice and occupies a pivotal position in the agricultural economy. The crop is extensively cultivated under diverse agro-climatic conditions and plays a vital role in ensuring food security, livelihood generation and income enhancement of farming communities. Despite continuous improvements in varietal development and crop man practices, the productivity of wheat in many regions remains below its attainable potential due to imbalanced nutrient management and declining soil fertility (FAOSTAT, 2024; Ministry of Agriculture and Farmers Welfare, 2024) [3, 6].

Balanced nutrition is one of the most critical factors governing growth, yield formation and productivity of wheat. The recommended dose of fertilizers (RDF) supplies essential macronutrients required for optimum crop development; however, continuous cultivation and intensive fertilizer use have resulted in widespread deficiencies of several micronutrients, particularly zinc (Zn) and iron (Fe). Such deficiencies adversely affect physiological and biochemical processes including chlorophyll synthesis, enzyme activation, photosynthesis, carbohydrate metabolism and protein synthesis, ultimately reducing crop growth and grain yield (Alloway, 2013) [1]. Therefore, integrated nutrient management involving both macro-and micronutrients has become increasingly important for sustaining wheat productivity under intensive production systems.

Foliar application has emerged as an efficient nutrient management strategy for correcting nutrient deficiencies during critical growth stages because nutrients applied directly to foliage are absorbed rapidly and utilized efficiently by plants. Foliar feeding of nitrogen through urea improves nitrogen availability during periods of peak demand, while zinc enhances auxin synthesis, membrane integrity and enzyme activity. Iron plays an indispensable role in chlorophyll formation, electron transport and energy metabolism. Combined foliar application of nitrogen, zinc and iron along with the recommended fertilizer dose has been reported to improve vegetative growth, tillering, biomass accumulation, photosynthetic efficiency and assimilate translocation, thereby resulting in higher grain yield and improved crop performance (Shivay *et al.*, 2010; Meena *et al.*, 2018; Verma *et al.*, 2019; Choudhary *et al.*, 2021) [9, 4, 11, 2]. Considering the increasing need for balanced nutrient management and efficient fertilizer use in wheat cultivation, the present investigation was undertaken to evaluate the effect of different fertility levels in combination with foliar application of nitrogen, zinc and iron on the growth and yield of wheat. The findings are expected to provide an effective nutrient management strategy for improving wheat productivity under arid and semi-arid regions.

### Materials and Methods

The field experiments were carried out during *summer* season (2025) to study the “Effect of Foliar Application of Macro and Micronutrients on Growth and Yield of Wheat (*Triticum aestivum* L.)” in randomized block design (RBD) with consisted nine treatments viz., T<sub>1</sub>: Control (no fertilizer, no foliar spray), T<sub>2</sub>: 75% Recommended Dose of Fertilizers (RDF), T<sub>3</sub>: 100% RDF, T<sub>4</sub>: 125% RDF, T<sub>5</sub>: 75% RDF + foliar spray of nitrogen (2% urea), T<sub>6</sub>: 100% RDF + foliar spray of nitrogen (2% urea), T<sub>7</sub>: 100% RDF + foliar spray of nitrogen (2% urea) + ZnSO<sub>4</sub> (0.5%), T<sub>8</sub>: 100% RDF + foliar spray of nitrogen (2% urea) + FeSO<sub>4</sub> (0.5%) and T<sub>9</sub>: 100% RDF + foliar spray of nitrogen (2% urea) + ZnSO<sub>4</sub> (0.5%) + FeSO<sub>4</sub> (0.5%). at Research Farm, Mewar University, Chittorgarh (Rajasthan). The experimental farm is geographically located at 075°88'99" E longitude and 26°81'17" N latitude and this region falls under agro-climatic zone IV A of Rajasthan. The experimental fields were clay loam and the soil fertility status contained available nitrogen (137.8 kg ha<sup>-1</sup>) by Subia and Asija 1996, available phosphorus (16.3 kg ha<sup>-1</sup>) by Olsen *et al.* 1954 and available potassium (250.12 kg ha<sup>-1</sup>). The organic carbon content was from 0.34-0.38 per cent. The weekly mean maximum and minimum temperatures were of temperature during both summers (40.6°C) and winters (2.7°C). The mean relative humidity fluctuated from 63.50 to 91 per cent during the crop season. The average rainfall is 557 mm per annum, which is mostly received during july to september. The sporadic showers during winters are also common, which are probably observed during this period. The observation was recorded at harvest was analysed by statistical methods.

### Result and Discussion

The data presented in Table 1 revealed that foliar application of macro and micronutrients significantly influenced plant height,

dry matter accumulation and number of tillers plant<sup>-1</sup> of wheat. The maximum plant height (80.84 cm), dry matter accumulation (34.46 g plant<sup>-1</sup>) and number of tillers plant<sup>-1</sup> (8.86) were recorded under T<sub>9</sub> (100% RDF + foliar spray of N 2% + Zn 0.5% + Fe 0.5%). The treatment T<sub>9</sub> remained statistically at par with T<sub>7</sub> (100% RDF + foliar spray of N 2% + Zn 0.5%) and T<sub>8</sub> (100% RDF + foliar spray of N 2% + Fe 0.5%) for plant height and dry matter accumulation, whereas for tillers plant<sup>-1</sup> it was at par with T<sub>7</sub> and significantly superior to the remaining treatments. The lowest values were recorded under the control treatment T<sub>1</sub>, which produced plant height of 66.52 cm, dry matter accumulation of 21.46 g plant<sup>-1</sup> and 5.12 tillers plant<sup>-1</sup>.

The increase in growth parameters under integrated application of RDF along with foliar nitrogen, zinc and iron may be attributed to improved nutrient availability, enhanced chlorophyll synthesis, greater photosynthetic activity and better metabolic efficiency of plants. Nitrogen supplied through foliar urea likely met the crop demand during active growth stages, while zinc enhanced enzyme activation and auxin synthesis, and iron improved chlorophyll formation and energy metabolism. The combined effect of these nutrients resulted in greater biomass accumulation and tillering, ultimately improving overall crop growth. Similar improvements in wheat growth due to combined application of nitrogen and micronutrients have been reported by Shivay *et al.* (2010) [9], Singh *et al.* (2016) [10], Meena *et al.* (2018) [4] and Verma *et al.* (2019) [11].

The results presented in Table 2 showed that grain yield, straw yield and biological yield were significantly affected by the different nutrient management treatments, whereas harvest index remained non-significant. The highest grain yield (5558 kg ha<sup>-1</sup>), straw yield (6928 kg ha<sup>-1</sup>) and biological yield (12486 kg ha<sup>-1</sup>) were obtained under T<sub>9</sub> (100% RDF + foliar spray of N 2% + Zn 0.5% + Fe 0.5%). This treatment was statistically at par with T<sub>7</sub> for grain yield and biological yield, while it remained significantly superior to all other treatments. The lowest grain yield (3385 kg ha<sup>-1</sup>), straw yield (4532 kg ha<sup>-1</sup>) and biological yield (7917 kg ha<sup>-1</sup>) were recorded under the control treatment T<sub>1</sub>. Harvest index varied from 42.76 to 44.51 per cent, but the differences among treatments were not statistically significant.

The higher grain and biomass yield under T<sub>9</sub> may be attributed to the cumulative improvement in growth attributes, nutrient uptake and assimilate production resulting from balanced nutrition. Adequate supply of N, Zn and Fe through foliar application along with 100% RDF likely enhanced photosynthetic efficiency, translocation of photosynthates and grain filling, leading to superior yield performance. Zinc is known to improve reproductive development and grain formation, while iron supports chloroplast functioning and energy transfer, thereby contributing to better sink development and higher productivity. The non-significant effect on harvest index indicates that the treatments increased grain and straw yield proportionately, resulting in relatively stable partitioning of biomass between economic and total yield. Similar findings were reported by Sharma *et al.* (2019) [8], Yadav *et al.* (2020) [12], Meena *et al.* (2022) [5] and Rath *et al.* (2025) [7], who observed significant enhancement in wheat yield following integrated application of RDF with foliar nitrogen and micronutrients.

**Table 1:** Effect of foliar application of macro and micronutrients on growth parameters of Wheat

| Treatment                                                                              | Growth parameters |                                 |               |
|----------------------------------------------------------------------------------------|-------------------|---------------------------------|---------------|
|                                                                                        | Plant height (cm) | Dry matter accumulation g/plant | Tillers/plant |
| T <sub>1</sub> : Control (No fertilizer, no spray)                                     | 66.52             | 21.46                           | 5.12          |
| T <sub>2</sub> : 75% RDF                                                               | 68.87             | 22.78                           | 5.78          |
| T <sub>3</sub> : 100% RDF                                                              | 70.95             | 23.96                           | 6.54          |
| T <sub>4</sub> : 125% RDF                                                              | 72.89             | 25.28                           | 6.82          |
| T <sub>5</sub> : 75% RDF + Foliar spray of N (2% Urea)                                 | 72.78             | 25.16                           | 6.68          |
| T <sub>6</sub> : 100% RDF + Foliar spray of N (2% Urea)                                | 74.16             | 31.72                           | 7.54          |
| T <sub>7</sub> : 100% RDF + Foliar spray of N (2% Urea) + Zn (0.5% ZnSO <sub>4</sub> ) | 78.06             | 33.06                           | 8.22          |
| T <sub>8</sub> : 100% RDF + Foliar spray of N (2% Urea) + Fe (0.5% FeSO <sub>4</sub> ) | 77.96             | 34.38                           | 8.08          |
| T <sub>9</sub> : 100% RDF + Foliar spray of N (2%) + Zn (0.5%) + Fe (0.5%)             | 80.84             | 34.46                           | 8.86          |
| SE(m) ±                                                                                | 0.26              | 0.39                            | 0.10          |
| CD (P=0.05)                                                                            | 0.80              | 1.17                            | 0.31          |
| CV (%)                                                                                 | 7.67              | 8.48                            | 6.87          |

**Table 2:** Effect of foliar application of macro and micronutrients on grain yield, straw yield, biological yield and harvest index of Wheat

| Treatment                                                                              | Yield (kg/ha) |             |                  | Harvest index (%) |
|----------------------------------------------------------------------------------------|---------------|-------------|------------------|-------------------|
|                                                                                        | Grain yield   | Straw yield | Biological yield |                   |
| T <sub>1</sub> : Control (No fertilizer, no spray)                                     | 3385          | 4532        | 7917             | 42.76             |
| T <sub>2</sub> : 75% RDF                                                               | 3728          | 4906        | 8634             | 43.18             |
| T <sub>3</sub> : 100% RDF                                                              | 4026          | 5348        | 9374             | 42.95             |
| T <sub>4</sub> : 125% RDF                                                              | 4512          | 5828        | 10340            | 43.64             |
| T <sub>5</sub> : 75% RDF + Foliar spray of N (2% Urea)                                 | 4418          | 5736        | 10154            | 43.51             |
| T <sub>6</sub> : 100% RDF + Foliar spray of N (2% Urea)                                | 4826          | 6138        | 10964            | 44.02             |
| T <sub>7</sub> : 100% RDF + Foliar spray of N (2% Urea) + Zn (0.5% ZnSO <sub>4</sub> ) | 5218          | 6576        | 11794            | 44.24             |
| T <sub>8</sub> : 100% RDF + Foliar spray of N (2% Urea) + Fe (0.5% FeSO <sub>4</sub> ) | 5136          | 6508        | 11644            | 44.11             |
| T <sub>9</sub> : 100% RDF + Foliar spray of N (2%) + Zn (0.5%) + Fe (0.5%)             | 5558          | 6928        | 12486            | 44.51             |
| SE(m) ±                                                                                | 99.14         | 127.84      | 178.07           | 1.72              |
| CD (P=0.05)                                                                            | 297.42        | 383.54      | 534.23           | NS                |
| CV (%)                                                                                 | 7.48          | 6.90        | 6.88             | 6.48              |

## Conclusion

Based on the results of one year experimentation, it may be concluded that the Application of 100% RDF combined with foliar application of N 2% + Zn 0.5% + Fe 0.5% (T<sub>9</sub>) found suitable to produce good yield of mustard.

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