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Effect of foliar spray of zinc sulphate and salicylic acid on morpho-physiological and biochemical traits of wheat (*Triticum aestivum* L.)

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Abstract

The present investigation entitled “Effect of Foliar Application of Zinc Sulphate and Salicylic Acid on Morpho-Physiological, Biochemical of Wheat (*Triticum aestivum* L.)” was carried out during the Rabi season of 2025–26 at the research farm of the Faculty of Agricultural Sciences and Allied Industries, Rama University, Kanpur, Uttar Pradesh. The experiment was conducted to study the influence of zinc sulphate and salicylic acid on growth, physiological efficiency, biochemical characteristics, and yield performance of wheat under normal field conditions. Wheat is one of the major cereal crops and contributes significantly to food and nutritional security. The productivity of wheat is greatly influenced by nutrient availability and physiological activities within the plant. Micronutrients such as zinc and plant growth regulators like salicylic acid play an important role in improving plant metabolism, photosynthesis, enzyme activity, and stress tolerance, which ultimately enhance crop growth and productivity.

The experiment consisted of seven treatments including one untreated control, three concentrations of zinc sulphate (50, 100 and 200 ppm), and three concentrations of salicylic acid (50, 100 and 200 ppm). The treatments were arranged in a Randomized Block Design with three replications. Foliar sprays were applied twice during the crop growth period, first at 35 days after sowing and second at 65 days after sowing. Recommended agronomic practices were followed uniformly for all treatments throughout the experimental period. Observations related to morpho-physiological parameters, biochemical traits, and yield attributes were recorded at different growth stages of the crop.

The results of the experiment revealed significant improvement in growth parameters due to foliar application of zinc sulphate and salicylic acid over the control treatment. Among the different treatments, salicylic acid at 200 ppm produced the highest plant height, number of tillers per plant, leaf area, and dry biomass accumulation. Improved vegetative growth under salicylic acid application might be due to enhanced cell division, nutrient uptake, enzymatic activity, and efficient translocation of photosynthates within the plant system. Zinc sulphate treatments also improved plant growth compared to the control, although their performance was comparatively lower than salicylic acid at higher concentration.

Physiological and biochemical parameters such as chlorophyll content and carotenoid content were also significantly affected by foliar spray treatments. Salicylic acid at 200 ppm recorded maximum chlorophyll and carotenoid contents, indicating enhanced photosynthetic efficiency and improved metabolic activity in wheat plants. Increased chlorophyll synthesis and delayed chlorophyll degradation under salicylic acid treatment might have contributed to better light absorption and higher photosynthetic rate. Zinc sulphate application also enhanced chlorophyll content due to its involvement in enzyme activation and chloroplast development.

Based on the findings of the present study, it may be concluded that foliar application of salicylic acid at 200 ppm proved most effective for improving morpho-physiological, biochemical, and yield traits of wheat under the agro-climatic conditions of Kanpur, Uttar Pradesh. Zinc sulphate also exhibited positive effects on crop growth and productivity; however, salicylic acid performed comparatively better in enhancing overall crop performance, physiological efficiency, and yield potential of wheat.

Keywords: Wheat, foliar application, zinc sulphate, salicylic acid, growth parameters, physiological traits

Introduction

Wheat (Wheat) is one of the most important cereal crops in the world and serves as a major source of food for millions of people. Belonging to the Poaceae family, wheat is widely cultivated under

diverse climatic conditions and plays a vital role in ensuring global food security. Major wheat-producing countries include China, India, United States, Russia, France, and Australia. Due to its extensive cultivation, high adaptability, and productivity, wheat is popularly known as the “King of Cereals.” It is mainly grown during the Rabi season and contributes significantly to the global grain trade and nutritional security Food and Agriculture Organization (2023) [5].

In India, wheat cultivation is dominated by three species, namely *Triticum aestivum*, *Triticum durum*, and *Triticum dicoccum*. Among these, *Triticum aestivum* occupies the largest share of cultivated area and is primarily grown in the northwestern plains of the country. It is rich in gluten protein and is commonly used for preparing bread, biscuits, cakes, and chapatti. *Triticum durum* is cultivated mainly under rainfed conditions in central and southern India and is preferred for the preparation of pasta, semolina, and vermicelli due to its hard grain texture and high protein content. *Triticum dicoccum* is cultivated on a limited scale in certain southern and western states and is traditionally used in local food preparations Belderok, *et al.* (2000) [3].

Globally, wheat occupies a vast cultivated area with high production and productivity levels. In India, wheat is one of the major staple food crops and contributes significantly to agricultural income and national food reserves. Wheat grains are highly nutritious and contain carbohydrates, proteins, vitamins, minerals, and dietary fiber. The grain generally contains 60–80% carbohydrates, mainly in the form of starch, along with 8–15% protein. It also provides small quantities of fat, B-complex vitamins, vitamin E, and crude fiber. Besides human consumption, wheat straw is extensively used as fodder for livestock.

Micronutrients and plant growth regulators play an essential role in enhancing wheat growth, productivity, and stress tolerance. Zinc is an important micronutrient required in small quantities for normal plant growth and development. It regulates the synthesis of chlorophyll, carbohydrates, and growth hormones such as indole acetic acid. Zinc application improves photosynthetic activity, nutrient uptake, and grain quality. Foliar application of zinc has been reported to be more effective than soil application because it enhances nutrient absorption and reduces nutrient fixation in soil Nandy *et al.* (2022) [7].

Salicylic acid is another important plant growth regulator known for its beneficial effects on plant physiology and stress management. Foliar application of salicylic acid improves seed germination, photosynthesis, nutrient translocation, biomass production, and yield attributes in wheat. It also enhances antioxidant enzyme activities, helping plants tolerate drought, salinity, and other abiotic stresses. Salicylic acid acts as a signaling molecule that strengthens plant defense mechanisms and improves overall plant performance under unfavorable environmental conditions. Therefore, the combined use of zinc sulphate and salicylic acid through foliar spray can significantly improve growth, physiological efficiency, and yield of wheat crop under varying environmental conditions Azmat *et al.* (2020) [12].

Materials and Methods

The field experiment entitled “Foliar Spray of Zinc Sulphate and Salicylic Acid on Morpho-Physiological, Biochemical and Yield Attributes of Wheat (*Triticum aestivum* L.)” was conducted during the Rabi season of 2025–26 at the research farm of the Department of Agronomy, Faculty of Agricultural Sciences and Allied Industries, Rama University. The experiment was performed under normal field conditions to evaluate the effect of

foliar treatments on wheat growth and productivity. The experimental site is located in the central-western region of Uttar Pradesh at geographical coordinates 26.449923°N latitude and 80.331874°E longitude, with an elevation of about 567 meters above mean sea level.

Results and Discussion

Growth Parameters

Plant Height (cm)

The observations indicated that foliar application of zinc sulphate (ZnSO_4) and salicylic acid (SA) significantly influenced plant height of wheat at various growth stages. Plant height increased continuously from 30 DAS up to harvesting under all treatments. Among the different treatments, salicylic acid at 200 ppm (T7) consistently recorded the maximum plant height at all stages, while the control treatment (T1) showed the minimum values. At 30 DAS, T7 produced the tallest plants, followed by T4 and T6. Similar trends were observed at 60, 90, and 120 DAS as well as at harvest stage.

The improvement in plant height due to salicylic acid and zinc application may be attributed to enhanced physiological and biochemical activities within the plant system. Salicylic acid likely promoted cell elongation, photosynthetic efficiency, and stress tolerance, resulting in better vegetative growth. Zinc, being an essential micronutrient, plays an important role in chlorophyll synthesis, enzyme activation, and auxin production, which collectively enhance plant development. The combined effect of these treatments improved nutrient uptake and metabolic processes, leading to vigorous crop growth. Statistical analysis confirmed that treatment differences were significant at the 5% level of significance Alloway, B.J. *et al.* (2008) [1].

Total dry biomass (g) plant⁻¹

The data showed that foliar application of zinc sulphate and salicylic acid significantly enhanced total dry biomass production in wheat at different growth stages. Dry biomass increased progressively from 30 DAS to physiological maturity under all treatments. Among the treatments, T7 (Salicylic acid @ 200 ppm) recorded the highest dry biomass at all stages, whereas the control treatment (T1) showed the lowest values. At 30 DAS, maximum dry biomass (2.86 g plant⁻¹) was observed under T7 compared to 1.85 g plant⁻¹ in the control. Similar trends were recorded at 60, 90, 120 DAS and at maturity. Enhanced dry matter accumulation under salicylic acid and zinc sulphate treatments may be attributed to improved nutrient uptake, increased chlorophyll content, enhanced photosynthetic efficiency, and better translocation of assimilates. Zinc sulphate treatments also improved biomass production over control, with T4 (ZnSO_4 @ 200 ppm) showing comparatively higher values among zinc treatments.

Carotenoids content (mg g⁻¹ fresh weight) at

The data presented revealed that foliar application of zinc sulphate and salicylic acid significantly influenced carotenoids content in wheat at different growth stages. Carotenoids content increased progressively from 20 DAS to 60 DAS and declined slightly at later stages due to crop maturity. Among all treatments, T7 (Salicylic acid @ 200 ppm) recorded the highest carotenoids content at all growth stages, followed by T6 and T4. At 20 DAS, T7 recorded maximum carotenoids content (0.92 mg g⁻¹ fresh weight), while the control treatment showed the minimum value (0.66 mg g⁻¹). Similar trends were observed at 40, 60, and 80 DAS. Higher carotenoids content under salicylic acid and zinc

sulphate treatments may be attributed to enhanced chlorophyll protection, improved photosynthetic activity, and reduced oxidative damage in plant tissues. Treated plants maintained

comparatively higher pigment concentration even at harvesting stage, indicating better physiological efficiency and delayed senescence.

Table 1: Effect of foliar spray of Zinc sulphate and Salicylic acid on Plant height (cm) at different plant growth stages of Wheat (*Triticum aestivum* L.)

Treatments	Plant height (cm) at				
	30 DAS	60 DAS	90DAS	120DAS	Harvesting stage
T ₁ - Control: foliar spray of distilled water at 35 and 65 DAS	8.53	44.71	55.92	68.69	74.68
T ₂ - ZnSO ₄ @ 50 ppm foliar spray at 35 and 65 DAS	8.95	45.90	58.57	68.77	75.46
T ₃ - ZnSO ₄ @ 100 ppm foliar spray at 35 and 65 DAS	9.64	46.36	61.12	69.08	76.11
T ₄ - ZnSO ₄ @ 200 ppm foliar spray at 35 and 65 DAS	9.75	48.07	63.23	69.12	78.67
T ₅ - SA @ 50 ppm foliar spray at 35 and 65 DAS	9.69	46.95	62.67	69.87	77.41
T ₆ - SA @ 100 ppm foliar spray at 35 and 65 DAS	10.61	48.75	64.92	70.63	79.38
T ₇ - SA @ 200 ppm foliar spray at 35 and 65 DAS	10.89	49.85	66.52	71.49	80.28
SEm±	0.22	0.43	0.50	0.36	0.37
CD at 5%	0.68	1.34	1.53	1.11	1.15

Table 2: Effect of foliar spray of Zinc sulphate and Salicylic acid on total dry biomass (g) plant⁻¹ different plant growth stages of Wheat (*Triticum aestivum* L.)

Treatments	Total dry biomass (g) plant ⁻¹				
	30 DAS	60 DAS	90DAS	120DAS	Physiological maturity
T ₁ - Control: foliar spray of distilled water at 35 and 65 DAS	1.85	4.93	8.90	11.90	12.10
T ₂ - ZnSO ₄ @ 50 ppm foliar spray at 35 and 65 DAS	2.05	5.40	9.60	12.60	12.90
T ₃ - ZnSO ₄ @ 100 ppm foliar spray at 35 and 65 DAS	2.25	5.90	10.40	13.60	13.90
T ₄ - ZnSO ₄ @ 200 ppm foliar spray at 35 and 65 DAS	2.55	6.60	11.60	15.10	15.40
T ₅ - SA @ 50 ppm foliar spray at 35 and 65 DAS	2.35	6.10	10.90	14.30	14.60
T ₆ - SA @ 100 ppm foliar spray at 35 and 65 DAS	2.65	6.88	12.10	15.90	16.20
T ₇ - SA @ 200 ppm foliar spray at 35 and 65 DAS	2.86	7.60	12.90	16.90	17.17
SEm±	0.01	0.03	-	-	0.01
CD at 5%	0.04	0.09	NS	NS	0.04

Table 3: Effect of foliar spray of Zinc sulphate and Salicylic acid on carotenoids content (mg g⁻¹ fresh weight) different plant growth stages of Wheat (*Triticum aestivum* L.)

Treatments	Carotenoids content (mg g ⁻¹ fresh weight)				
	20 DAS	40 DAS	60DAS	80DAS	Harvesting stage
T ₁ - Control: foliar spray of distilled water at 35 and 65 DAS	0.66	0.87	1.03	0.95	0.61
T ₂ - ZnSO ₄ @ 50 ppm foliar spray at 35 and 65 DAS	0.71	0.94	1.14	1.04	0.65
T ₃ - ZnSO ₄ @ 100 ppm foliar spray at 35 and 65 DAS	0.77	1.02	1.23	1.12	0.74
T ₄ - ZnSO ₄ @ 200 ppm foliar spray at 35 and 65 DAS	0.84	1.12	1.37	1.27	0.84
T ₅ - SA @ 50 ppm foliar spray at 35 and 65 DAS	0.79	1.07	1.29	1.19	0.79
T ₆ - SA @ 100 ppm foliar spray at 35 and 65 DAS	0.87	1.17	1.41	1.31	0.91
T ₇ - SA @ 200 ppm foliar spray at 35 and 65 DAS	0.92	1.26	1.49	1.40	1.01
SEm±	0.01	0.01	0.01	0.01	0.01
CD at 5%	0.03	0.03	0.04	0.03	0.04

Conclusion

The present investigation demonstrated that foliar application of zinc sulphate and salicylic acid significantly improved the morpho-physiological and biochemical traits of wheat under the agro-climatic conditions of Kanpur, Uttar Pradesh. Among the different treatments, salicylic acid at 200 ppm (T₇) proved most effective in enhancing plant height, dry biomass accumulation, and carotenoids content at different growth stages. The improvement in growth and biochemical parameters may be attributed to enhanced nutrient uptake, better photosynthetic activity, increased chlorophyll protection, and improved metabolic processes within the plant system. Zinc sulphate treatments also showed positive effects on crop growth and physiological efficiency compared to the control treatment. Higher carotenoids content and biomass accumulation under foliar treatments indicated improved photosynthetic efficiency and delayed senescence in wheat plants. Therefore, foliar application of salicylic acid at 200 ppm may be considered an effective and economical approach for improving growth,

physiological performance, and overall crop productivity of wheat.

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