



UNIVERSITY OF LIFE SCIENCES "KING MIHAI I" FROM
TIMISOARA

"YOUNG PEOPLE AND MULTIDISCIPLINARY RESEARCH
IN APPLIED LIFE SCIENCES"

section

"HOTICULTURE, FORESTRY AND BIOTECHNOLOGY"

21-22 November 2024



"Young people and multidisciplinary
research in applied life sciences"

Morphological Development of *Ocimum basilicum* Plants Under the Influence of Zinc

Emilian ONIȘAN ¹, Irina PETRESCU ¹, Ioan SĂRAC ¹, Lucian CALUGAR ¹, Ardelean DANIELA ¹

¹Universitatea de Științele Vieții „Regele Mihai I” Timișoara, Romania

Abstract

This study examines the effects of varying zinc (Zn) concentrations on the growth and development of sweet basil (*Ocimum basilicum*), focusing on germination, biomass, nutrient content, and aromatic quality of the leaves. Zinc improved plant growth, increased germination rates, and boosted biomass and root development. It also enhanced nutrient uptake and the aromatic quality of the leaves, increasing essential oil yield. Zinc helped mitigate abiotic stresses, such as water deficiency and salinity, improving plant resilience. Optimizing zinc concentrations can maximize basil growth and quality without causing toxicity.

This study investigates the impact of zinc (Zn) application on the growth and development of sweet basil (*Ocimum basilicum*), focusing on key parameters such as germination rate, biomass accumulation, root morphology, and leaf quality. Zinc is an essential micronutrient that plays a pivotal role in enzymatic activity, protein synthesis, and stress mitigation in plants. Four zinc treatment levels were tested: Control (0 mM Zn²⁺), low (0.25 mM Zn²⁺), moderate (0.50 mM Zn²⁺), and high (1.0 mM Zn²⁺).

The findings reveal a bell-shaped response to zinc concentrations, with optimal growth observed at low zinc levels (0.25 mM Zn²⁺), characterized by enhanced root development, increased plant height, and improved leaf size and number. Moderate zinc levels (0.50 mM Zn²⁺) sustained similar trends but showed signs of plateauing growth, while high zinc concentrations (1.0 mM Zn²⁺) led to significant reductions in growth parameters, indicative of zinc toxicity. Notably, zinc application improved nutrient uptake efficiency and increased the aromatic quality of basil leaves, with higher essential oil yields observed at optimal concentrations.

These results underscore the importance of precise zinc management in enhancing basil productivity and quality. Balancing zinc application is essential to maximize plant growth while mitigating potential toxic effects. This study contributes to understanding the role of zinc in optimizing agronomic practices for aromatic and medicinal plants like basil.

Introduction

Basil belongs to the mint family (Lamiaceae) and is characterized by square stems, opposite leaves, flower spikes, and oil glands, which are typical features of many members of this plant family. Sweet basil (*Ocimum basilicum*) is a sun-loving annual with highly aromatic leaves, possessing a pleasant, spicy aroma and a taste reminiscent of anise or cloves. Both the leaves and their essential oils are used as flavoring agents. There are many varieties of sweet basil, including large and dwarf forms with green, purple, or variegated leaves. Many of these widely cultivated plants are not only edible but also ornamental. The plant is highly sensitive to frost and thrives in warm climates. Like many herbs, basil is reputed to have numerous medicinal properties, such as the ability to draw out poison from insect bites, act as a sedative, treat digestive disorders, soothe pain, promote perspiration, and enhance breast milk production in nursing mothers. Zinc (Zn), a vital micronutrient, plays an essential role in key biophysicochemical processes within plants, including protein synthesis and gene regulation. Furthermore, zinc acts as a cofactor for antioxidant enzymes, aiding in the mitigation of oxidative damage in plant cells during abiotic stress conditions. Additionally, zinc is particularly significant in protecting plants against water deficiency stress. Salinity is one of the most critical abiotic stress factors, adversely affecting the growth, nutrient uptake, and yield of crop plants. The application of various micronutrients, particularly zinc (Zn), has shown potential to alleviate the detrimental effects of salinity stress.

In this study, we analyze the impact of different concentrations of zinc (Zn) on the growth and development of sweet basil (*Ocimum basilicum*). Specifically, we examine its effects on germination rate, biomass, nutrient content, and the aromatic quality of the leaves.

Material and method

The biological material used for the study was *Ocimum basilicum* (common basil), an aromatic and medicinal annual plant, widely recognized for its adaptability and ease of cultivation in gardens or pots. This study evaluated the effects of different concentrations of Zinc on the growth and development of basil plants.

Control (0 mM Zn²⁺): No zinc application.
V1 (0.25 mM Zn²⁺): Low zinc concentration
V2 (0.50 mM Zn²⁺): Moderate zinc concentration.
V3 (1.0 mM Zn²⁺): High zinc concentration.

The plants were grown in controlled environmental conditions, and observations were recorded over two growth periods to assess the effect of zinc application on plant development.

Measured Parameters

1. Root Development: Number and length of roots formed under different zinc concentrations.
2. Plant Height: Measurement of vertical growth.
3. Leaf Morphology: Number, length, width, and total leaf area per plant were analyzed.
4. Growth Performance: Overall biomass accumulation and visual health indicators.

Results and discussions

The application of varying concentrations of zinc (Zn²⁺) had a significant impact on the growth and physiological traits of *Ocimum basilicum*. The results revealed distinct trends across the four treatment groups (Control, V1, V2, and V3), highlighting both beneficial and inhibitory effects of zinc.

Root Development

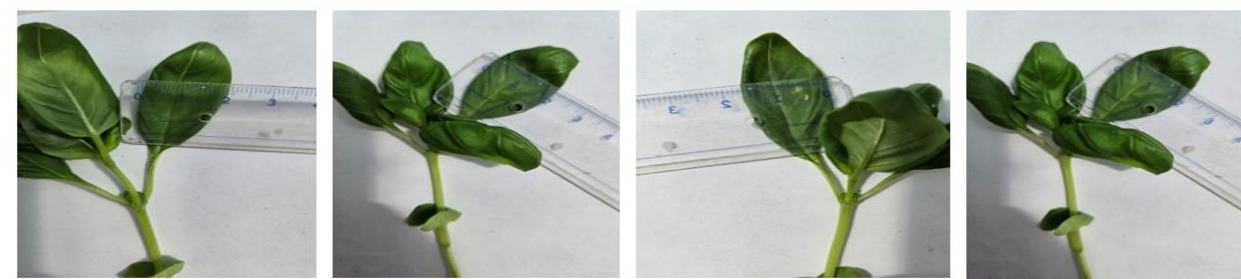
In the control group (0 mM Zn²⁺), the roots exhibited moderate growth with an average length of 7.5 cm and a count of 8 roots per plant, indicating no nutrient stress. At V1 (0.25 mM Zn²⁺), root length and count increased significantly (9.3 cm and 10 roots), suggesting that low zinc concentrations positively influence root development by enhancing enzymatic activity and nutrient uptake. At V2 (0.50 mM Zn²⁺), root development plateaued, with a slight decrease in length (8.5 cm) but maintained root count. This indicates that moderate zinc concentrations may reach an optimal level for growth without adverse effects. At V3 (1.0 mM Zn²⁺), root length and count decreased markedly (5.2 cm and 6 roots), demonstrating zinc toxicity, which disrupts cell division and elongation processes.

Plant Height

Zinc application showed a bell-shaped response in plant height. The control plants grew to an average height of 20 cm. Maximum growth was observed in the V1 (0.25 mM Zn²⁺) group, with an average height of 23.5 cm, indicating that low zinc concentrations stimulate auxin synthesis and internode elongation. At V2 (0.50 mM Zn²⁺), plant height slightly decreased to 21.8 cm, reflecting a near-optimal concentration for growth. At V3 (1.0 mM Zn²⁺), plant height significantly reduced to 16.5 cm, consistent with the onset of zinc toxicity, which impairs photosynthesis and cellular function.

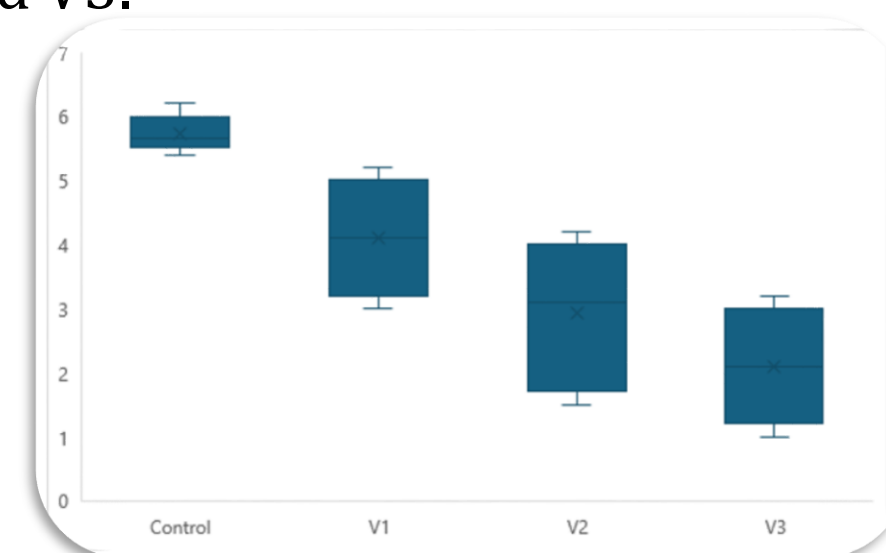
Leaf Morphology

Leaf Number: Zinc positively influenced leaf production in the V1 group (12 leaves/plant compared to 10 in the control). However, at V2 and V3, leaf production declined (9 and 7 leaves/plant, respectively), reflecting the toxic effects of higher zinc levels. Leaf Size: Leaf length and width were maximized at V1 (0.25 mM Zn²⁺), with an average length of 5.5 cm and width of 3.2 cm. These dimensions declined progressively with increasing zinc concentration, reaching 3.2 cm and 1.9 cm at V3 (1.0 mM Zn²⁺), demonstrating reduced photosynthetic efficiency and nutrient imbalance.



Overall Growth Performance

Total leaf area followed the same trend as individual leaf size, peaking at V1 (0.25 mM Zn²⁺) and declining sharply at V3 (1.0 mM Zn²⁺). The control group exhibited intermediate values, indicating that zinc deficiency also limits optimal leaf expansion. Biomass accumulation mirrored the trends in plant height and leaf area, with maximum biomass observed at V1, followed by progressive reductions at V2 and V3.



Conclusions

Zinc plays a crucial role in the growth and development of *Ocimum basilicum*. Low to moderate zinc concentrations (0.25–0.50 mM Zn²⁺) significantly enhance root development, plant height, and leaf quality, while higher concentrations (1.0 mM Zn²⁺) result in toxicity and reduced growth. Proper management of zinc levels is essential to optimize basil growth, improve nutrient uptake, and boost the aromatic quality of the plant without causing adverse effects.