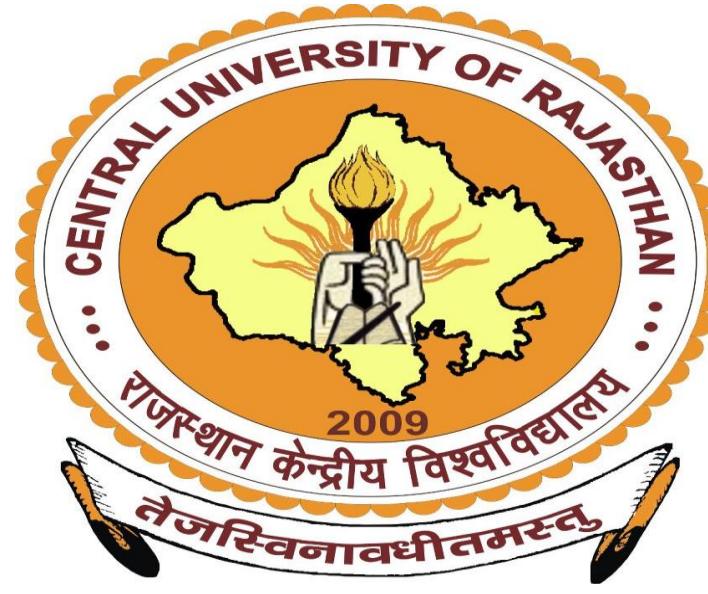


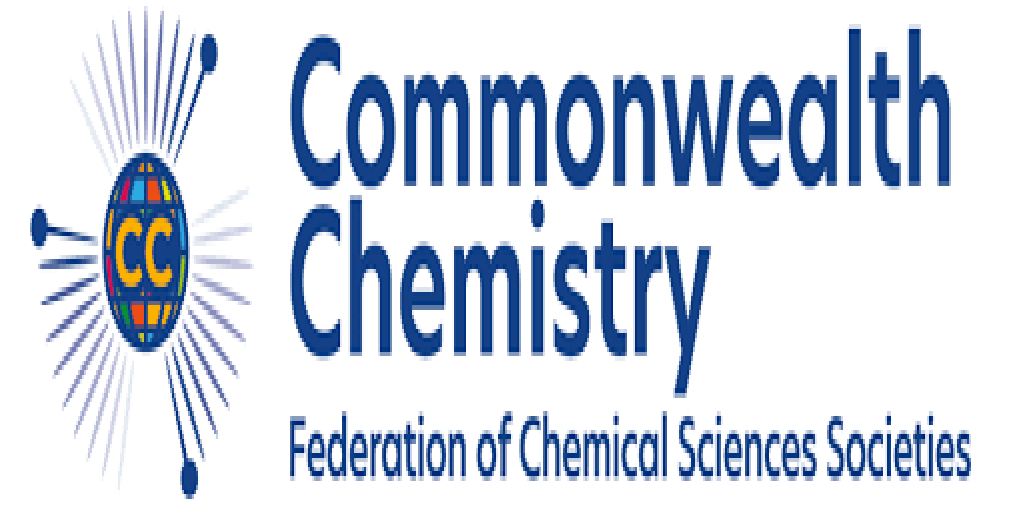
Developing a Innovative Slow-Release Fertilizer: Zinc Oxide/Gum Acacia Nanocomposite for Improved Zinc Uptake and Growth of *Spinacia oleracea* L



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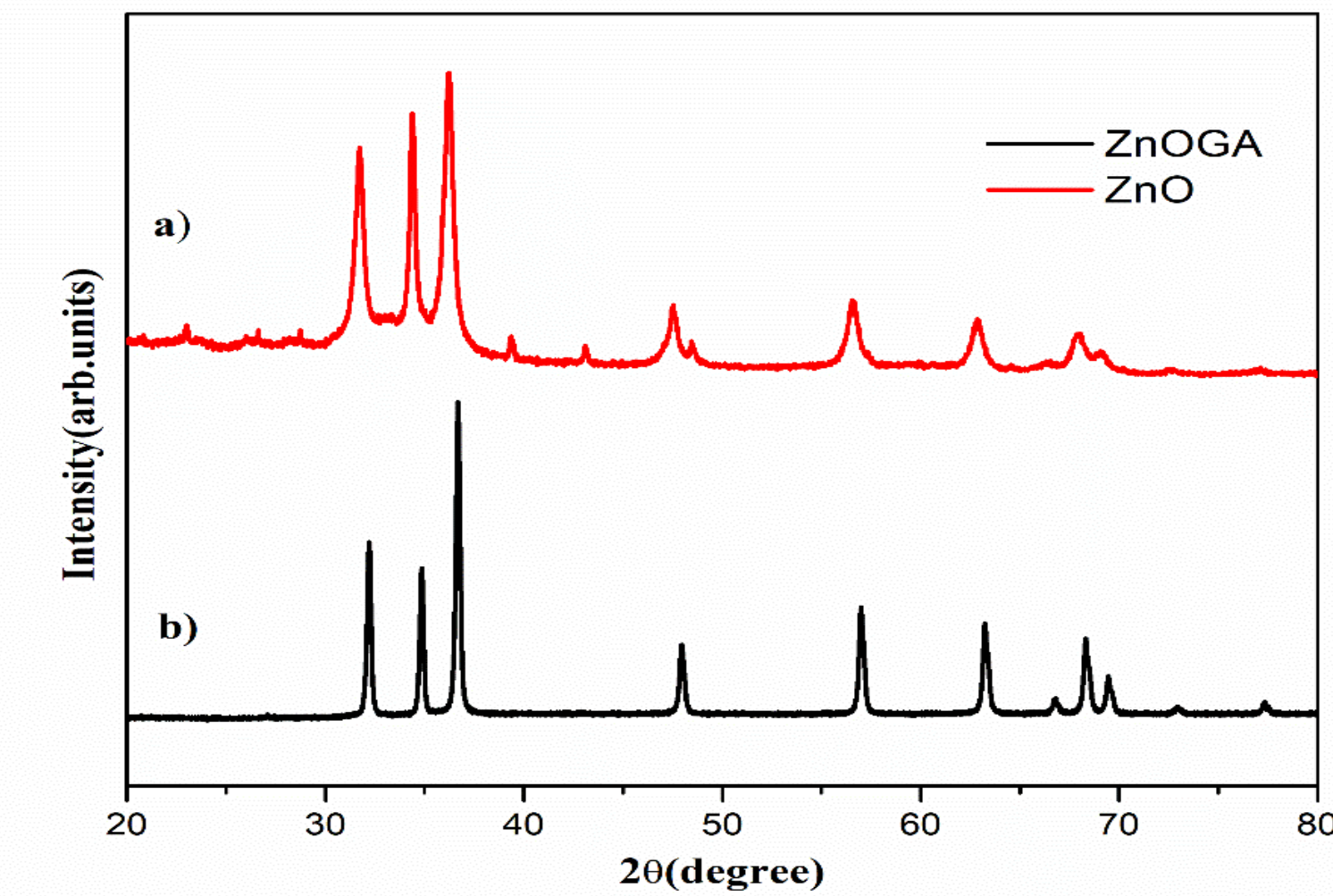


Background problem and Introduction

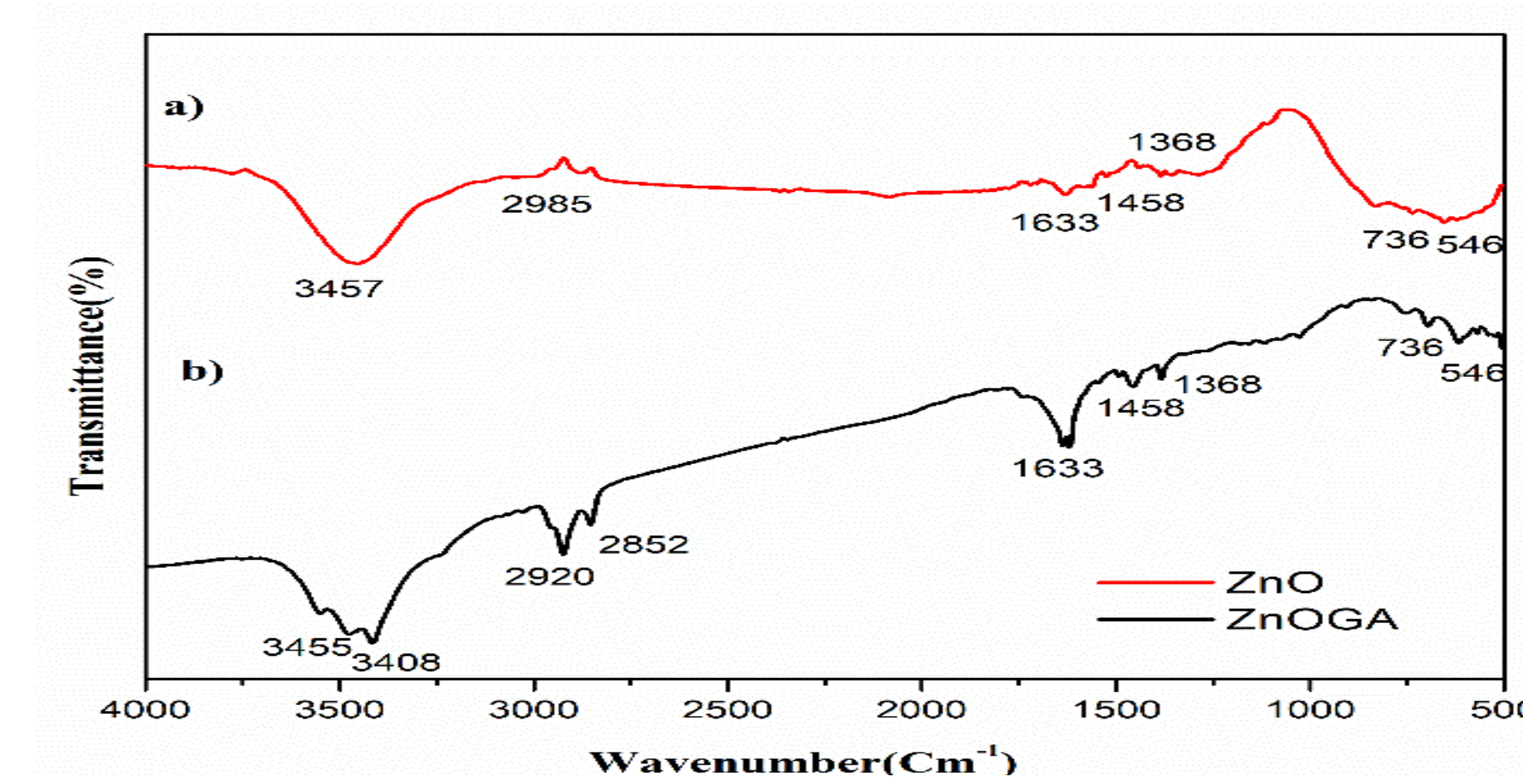
Characterization

Results

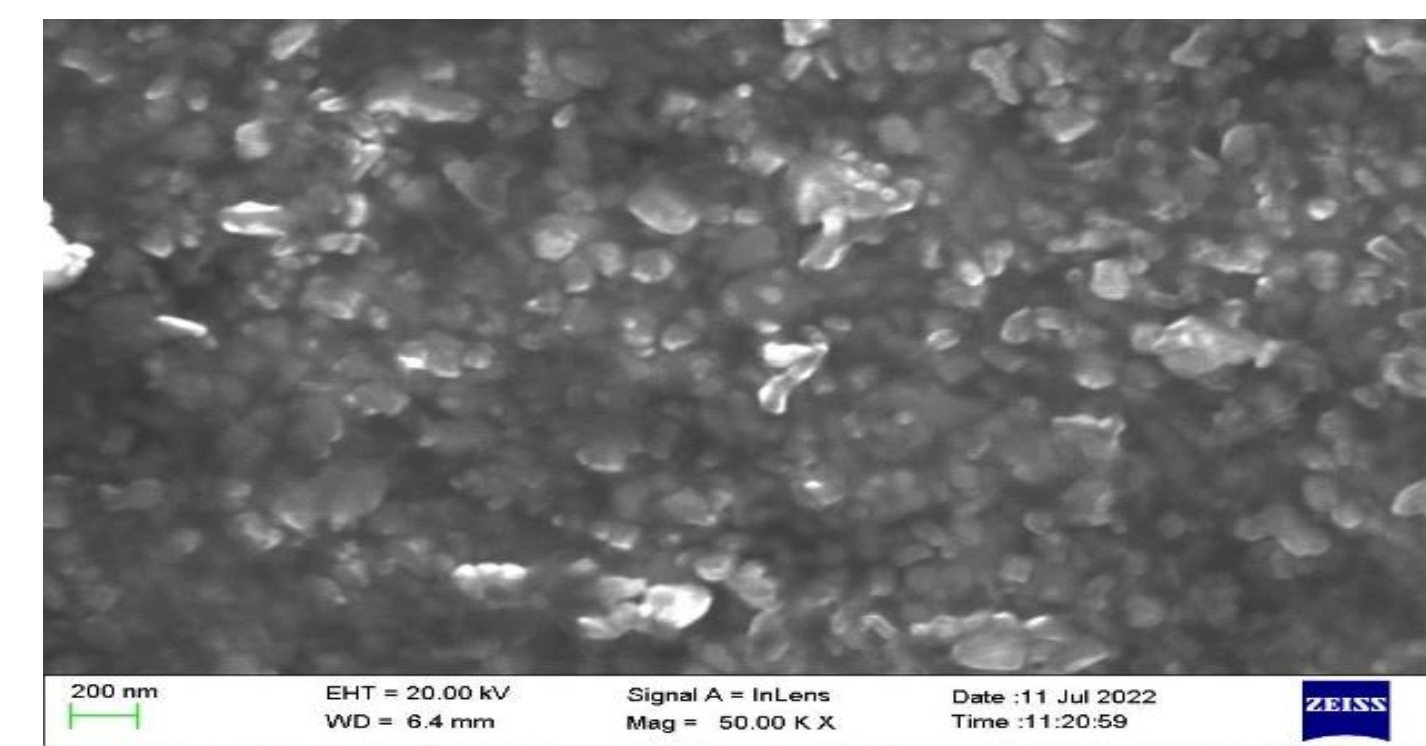
- ❖ Zinc deficiency has been recognized as a "hidden hunger" causing **nutritional disorders in 17%** of the world's population.
- ❖ Nearly half of the world's soil has reduced bioavailable Zn, and its deficiency is projected to increase **from 42% to 63% by 2025**.
- ❖ Approximately **2 billion people** around the world are estimated to suffer from Zn deficiency, which can lead to reduced learning abilities, impaired immune response, malfunction of the reproductive system, and slower growth rates.
- ❖ Zinc (Zn) is an **essential micronutrient** required for the optimal growth and metabolic functioning of plants.



XRD

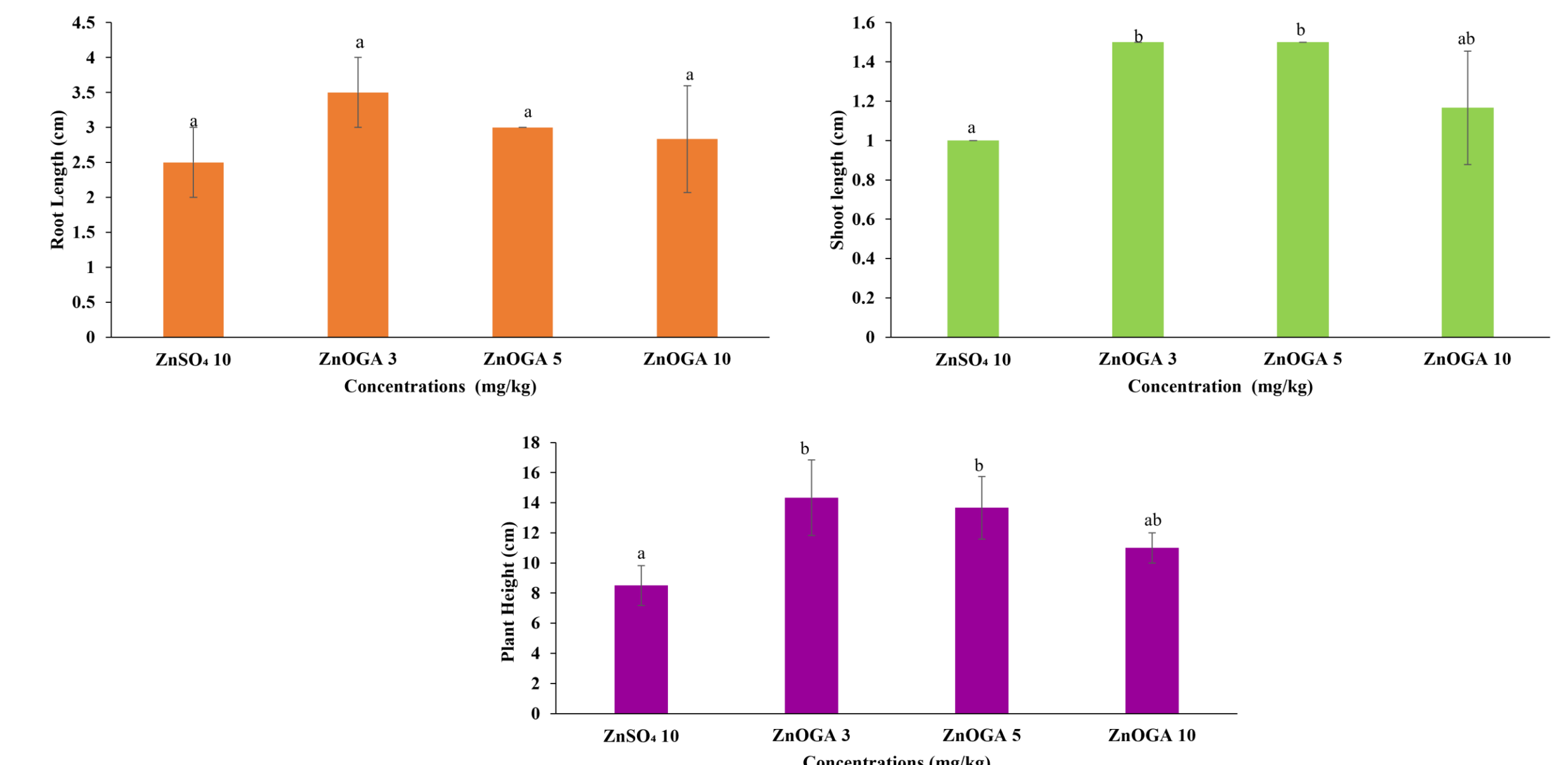


FTIR

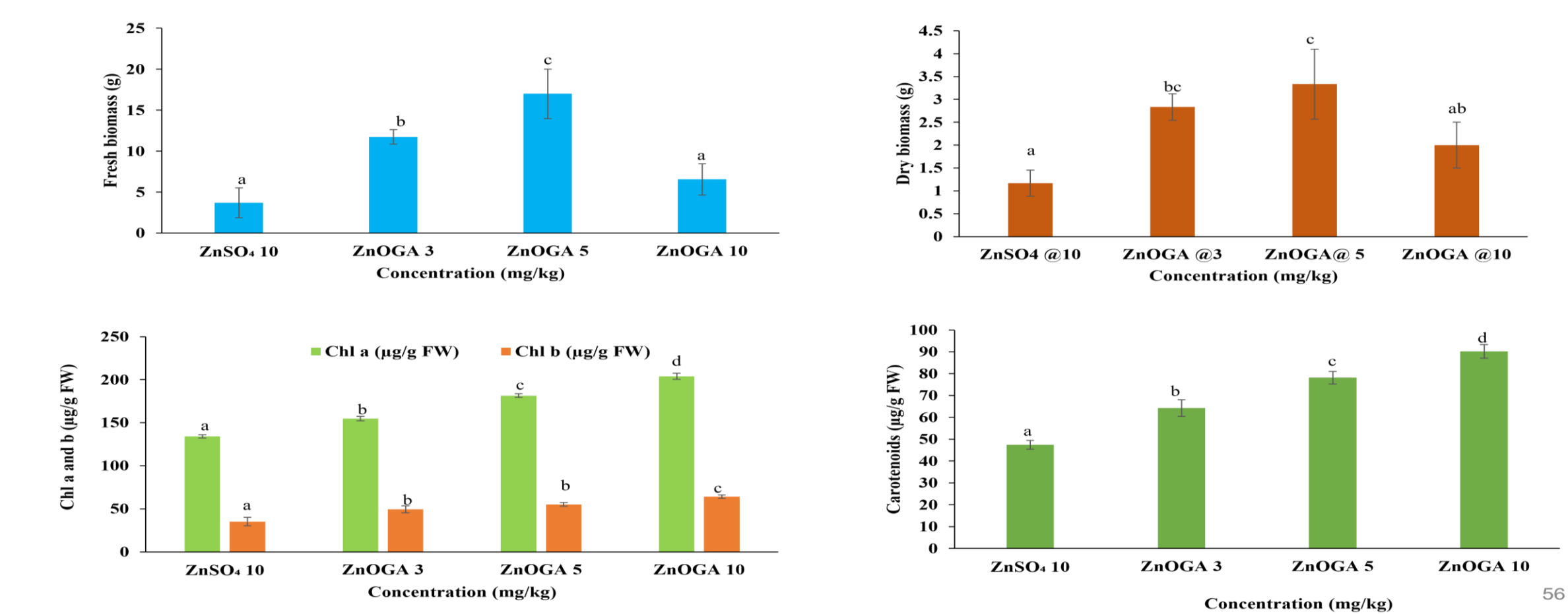


FESEM

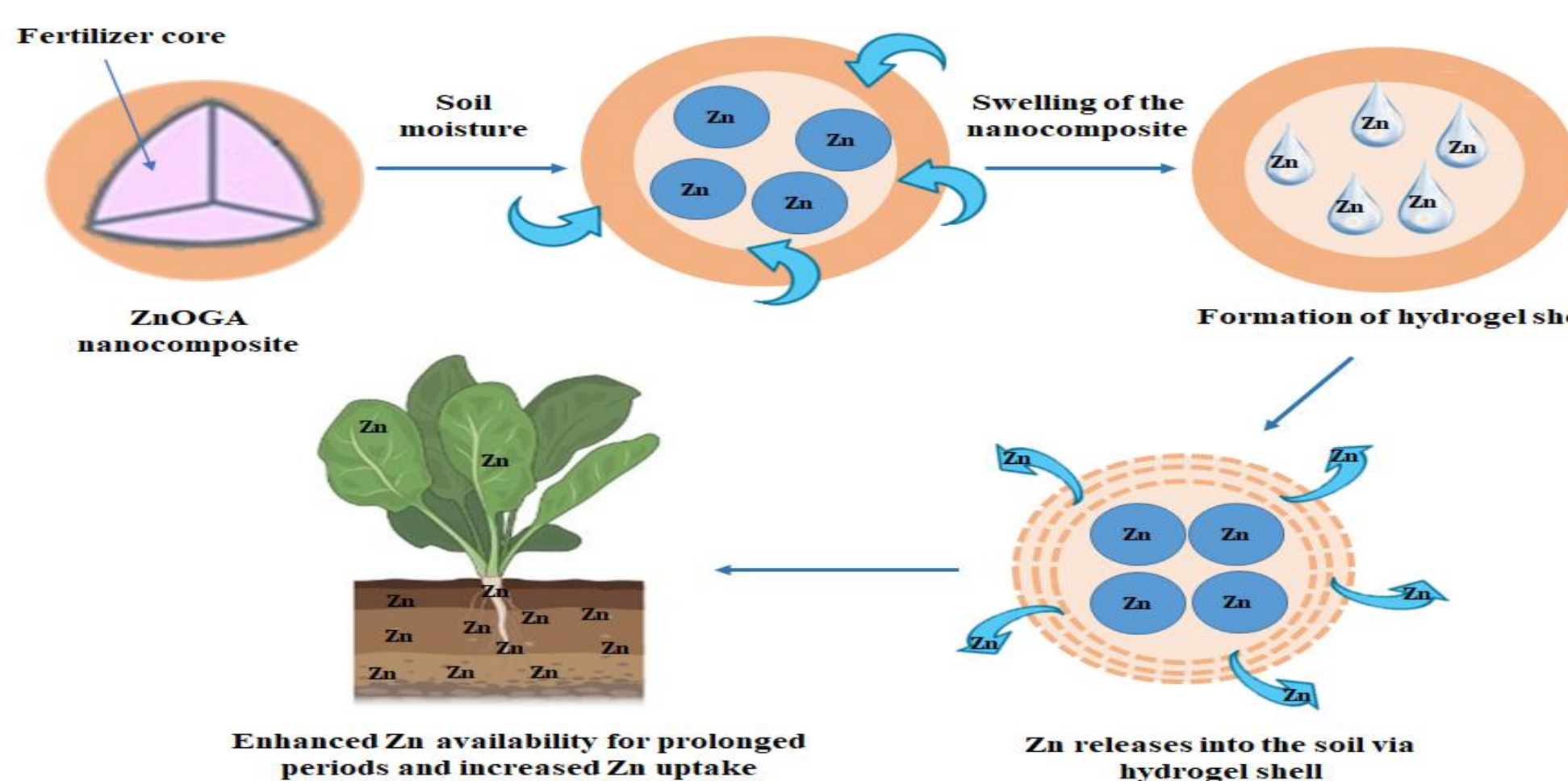
- The XRD pattern of ZnO-GA shows sharp crystalline peaks.
- The size was calculated to be 7.5 nm.
- The intense band observed at 3408 cm⁻¹ is attributed to the O-H group present in the GA.
- The absorption band at 758 and 546 cm⁻¹ corresponds to ZnO.
- The surface coating of ZnO is rough, disorganized. The Gum acacia coating serves as a physical barrier which could limit the rate of water diffusion as well as matrix dissolution along with zinc release.



Root-Shoot and Plant length

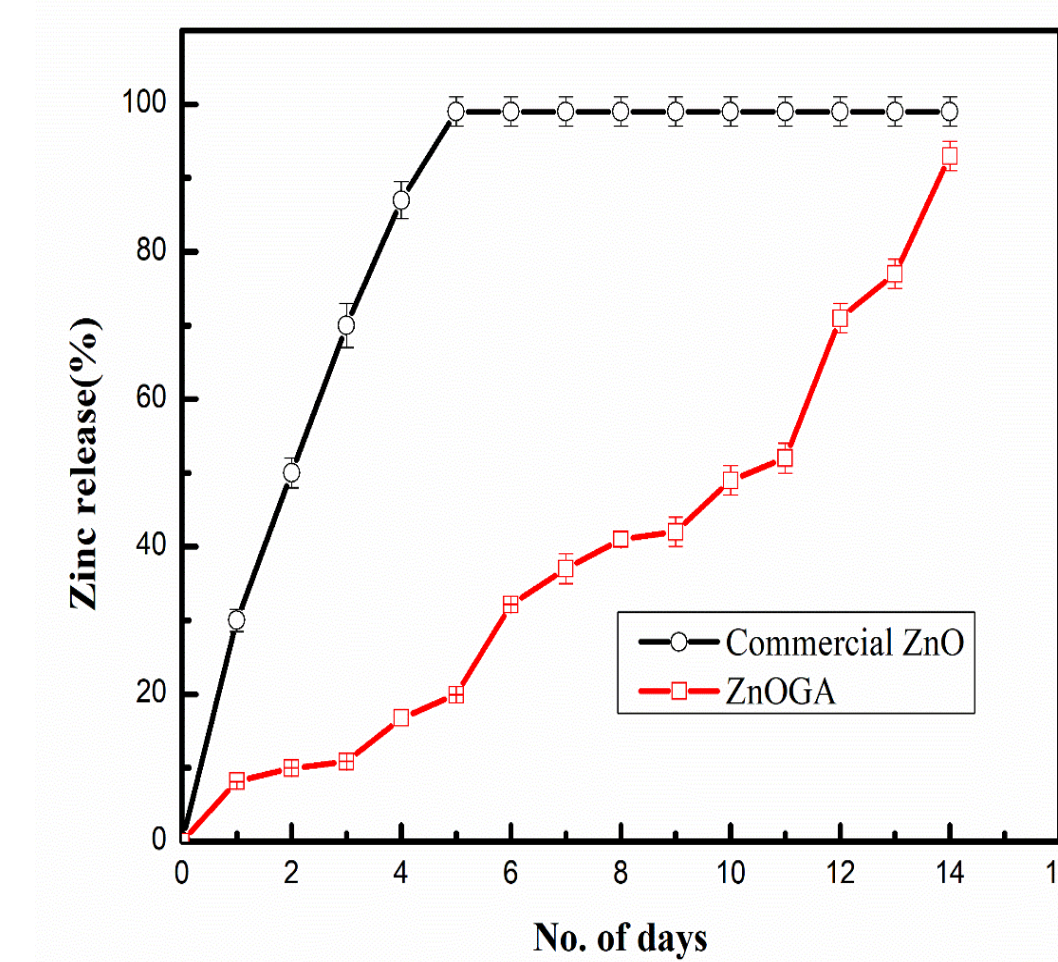


Biomass, Chlorophyll and Carotenoids content



Mechanism of ZnO release

Synthesis



Zinc release (%)

Biochemical analysis

S. No	Concentration (mg/Kg)	Total Phenolic Content (mg GAE/g)	Free Radical Scavenging activity (µg/g)	Protein (µg/g)	Total Soluble Sugars (mg/g)	Proline Content (mg/g)	Zinc fortification (mg/g)
1	Commercial ZnSO ₄ @ 10	54±2a	109±4.01a	300±2a	102±2.6a	50±4a	2.13±0.15a
2	ZnOGA @3	93±2d	170±3.1b	440±2d	123±3.5b	91±1.7b	4.07±0.08b
3	ZnOGA@ 5	90±5c	155±2.0b	400±3c	126±2b	92±2b	4.34±0.35
4	ZnOGA @10	88±6b	136±3.6b	352±4b	134±1.5c	97±4.3b	4.4±0.4b

Conclusion

- The slow rate of Zn release indicates that ZnOGA could effectively improve the soil conditions and its fertility.
- The efficacy of ZnOGA was compared with commercial Zinc fertilizer at different doses and 3 mg/Kg of ZnOGA showed the best results.
- The results revealed that ZnO as a nano-fertilizer enhanced the growth and yield of spinach and has the potential to be employed as a nano-fertilizer for crops cultivated in Zn-deficient soils to boost the quantitative and qualitative value of the crop.
- The findings of this study are more pertinent in the Indian context, where more than half of the agricultural soils are Zn deficient, and soil application of Zn fertilizers is recommended.