



Phytoremediation Capacity of *Tagetes patula* L. Under Constant Exposure to Zinc, Nickel and Chromium in Irrigation Water

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Received: 10 July 2025 / Revised: 10 October 2025 / Accepted: 2 November 2025 / Published online: 17 November 2025
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Abstract

The pot experiment was conducted to study the phytoremediation capacity and to evaluate the response of *Tagetes patula* L. under the conditions of constant input of high concentrations of Zn, Cr and Ni into the soil with irrigation water. *Tagetes patula* could thrive well at high levels of Zn (232–1356 mg/kg), Cr (241±35.2 mg/kg) and Ni (118±1.46 mg/kg) in the soil during 28 days, with Ni (19.9±7.79 mg/kg dry weight), Zn (114–661 mg/kg dry weight) and Cr (77.1±23.8 mg/kg dry weight) accumulated mainly in plant roots. By the end of the experiment, Cr content in the roots and shoots, as well as Ni in all parts of the contaminated *Tagetes patula* samples, was approximately 200 and 100 times, respectively, higher than in the control samples. The average values of bioconcentration factor (BCF) were < 1, with the maximum accumulation capacity observed for Zn (BCF ~ 0.65) and the minimum one for Cr (BCF ~ 0.06). High concentrations of Ni had a stimulating effect on chlorophyll synthesis in leaves and phenolic compounds in flowers of *Tagetes patula*. On the contrary, the decrease in chlorophyll and phenolic compounds in *Tagetes patula* leaves was a response to exposure to high Zn and Cr content. The antioxidant response of *Tagetes patula*, in particular the increased 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging capacity of leaves and tissue-specific responses in the 2,2'-Azino-di-(3-ethylbenzthiazoline sulfonic acid) (ABTS) assay at high Zn and Ni content in soil, may serve as a functional indicator of physiological involvement in remediation processes.

Highlights

- *Tagetes patula* withstand increased loads with a constant input of Zn, Cr, and Ni to the soil without visible signs of phytotoxicity.
- *Tagetes patula* is not a hyperaccumulator of Zn, Ni and Cr at their high content in the soil.
- High concentrations of Ni had a stimulating effect on chlorophyll synthesis in *Tagetes patula* leaves.
- The decrease in chlorophyll and phenolic compounds in *Tagetes patula* leaves was a response to exposure to high Cr concentrations.
- High content of Ni and Zn in the soil led to a significant modulation of antioxidant activity in *Tagetes patula*.

Keywords Chromium · Nickel · Ornamental plant · Phytoremediation · *Tagetes patula* · Zinc

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