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Application of Fe_3O_4 NPs and IAA in Synthetic Seed Technology: Effects on Chrysanthemum Generative Growth, Metabolism, and Genetic Stability

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INTRODUCTION & AIM

The increasing role of nanoparticles (NPs) in horticulture is transforming agricultural practices by enhancing plant growth, improving nutrient absorption, and enabling precise delivery of agrochemicals. However, little is yet known about the use of NPs in the production of synthetic seeds; a propagation technique particularly valuable for seedless species. This research studied the impact of pure iron oxide nanoparticles (Fe3O4 NPs), citrate-stabilized iron oxide nanoparticles (Fe3O4CA NPs) and indole-3-acetic acid (IAA) on the genetic stability and metabolic activity of Chrysanthemum × morifolium (Ramat.) Hemsl. plants obtained from synthetic seeds.

METHOD

axillary buds of chrysanthemum ‘Richmond’ were embedded in 3% calcium alginate supplemented with NPs and IAA, either singularly or in combination. Next, the synthetic seeds were either stored at 4oC in the dark (for eight weeks) or directly cultured in vitro on an agar-water medium at room temperature for 30 or 60 days. Next, the germinated seeds were transplanted to the greenhouse until full flowering of the plants. The content of total polyphenols was determined in the leaves and inflorescences of the plants. Moreover, the content of anthocyanins was measured in the inflorescences. RAPD markers were used to assess the genetic stability of plants.

RESULTS

It was found that NPs and IAA significantly affected the content of total polyphenols (TCP) in the leaves of chrysanthemum. Most treatments stimulated the accumulation of these compounds but in a time-dependent manner. No decline in the value of this parameter was reported compared with the untreated control. Conversely, Fe_3O_4NPs and IAA + Fe_3O_4CA NPs stimulated the biosynthesis of polyphenols and anthocyanins in the inflorescences after 30 days of treatment, however, a decline in the content of these compounds was reported after 60 days in most experimental objects, except for Fe_3O_4CA NPs and IAA + Fe_3O_4CA NPs. The inflorescences of plants treated with nanoparticles usually exhibited a larger diameter than the control, but only after a shorter exposure to the analyzed factors. In contrast, prolonged treatment resulted in the opposite effect. The genetic uniformity of the plants was confirmed with 2160 RAPD markers.

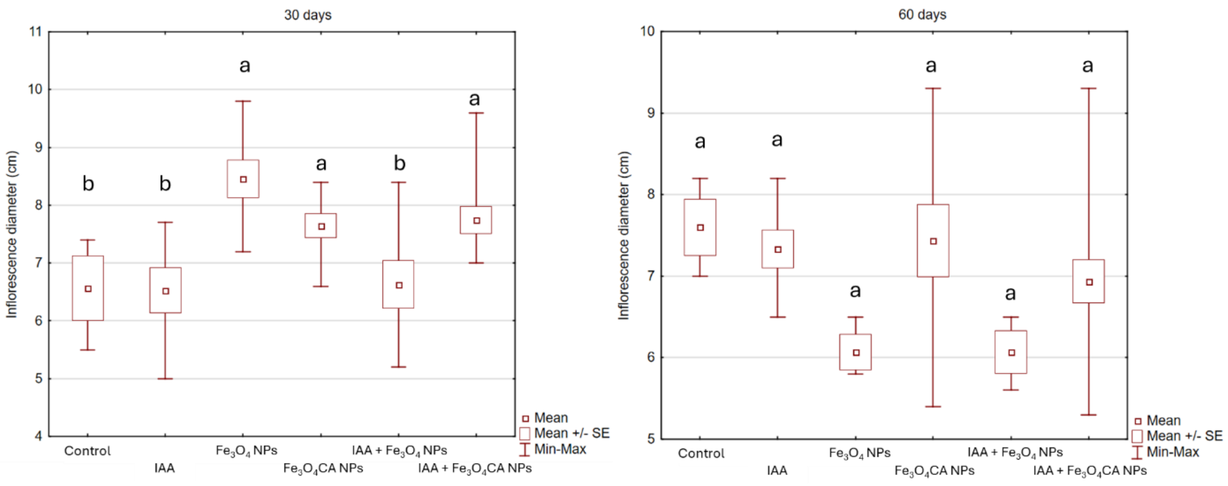

Fig. 1. Effect of indole-3-acetic acid (IAA) and iron nanoparticles in pure (Fe_3O_4 NPs) or stabilized form (Fe_3O_4CA NPs), applied singularly or in combination, on the inflorescence diameter of *Chrysanthemum* × *morifolium* ‘Richmond’ after 30 and 60 days of treatment.

RESULTS

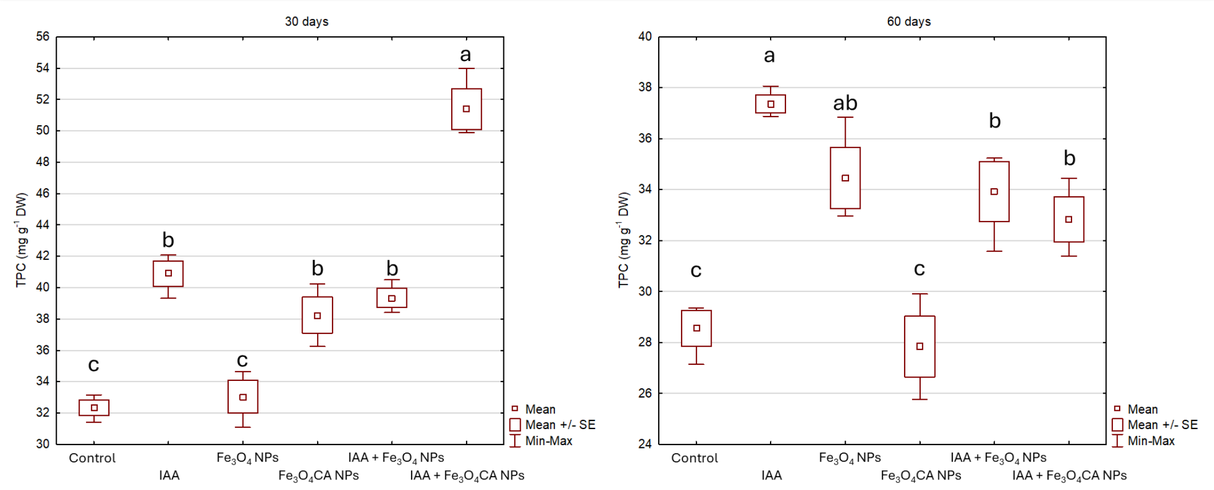

Fig. 2. Effect of indole-3-acetic acid (IAA) and iron nanoparticles in pure (Fe_3O_4 NPs) or stabilized form (Fe_3O_4CA NPs), applied singularly or in combination, on the content of polyphenols in the leaves of *Chrysanthemum* × *morifolium* ‘Richmond’ after 30 and 60 days of treatment.

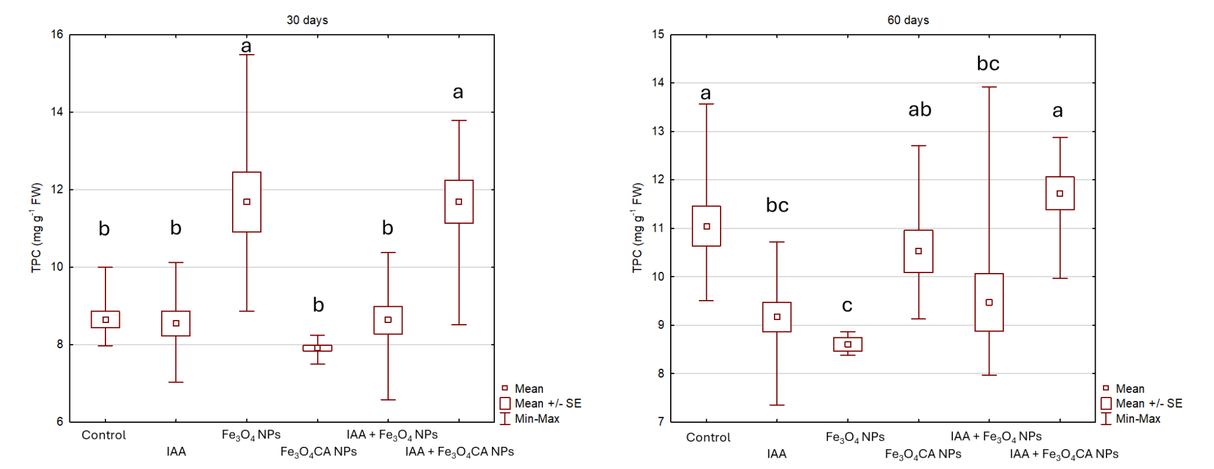

Fig. 3. Effect of indole-3-acetic acid (IAA) and iron nanoparticles in pure (Fe_3O_4 NPs) or stabilized form (Fe_3O_4CA NPs), applied singularly or in combination, on the content of polyphenols in the inflorescences of *Chrysanthemum* × *morifolium* ‘Richmond’ after 30 and 60 days of treatment.

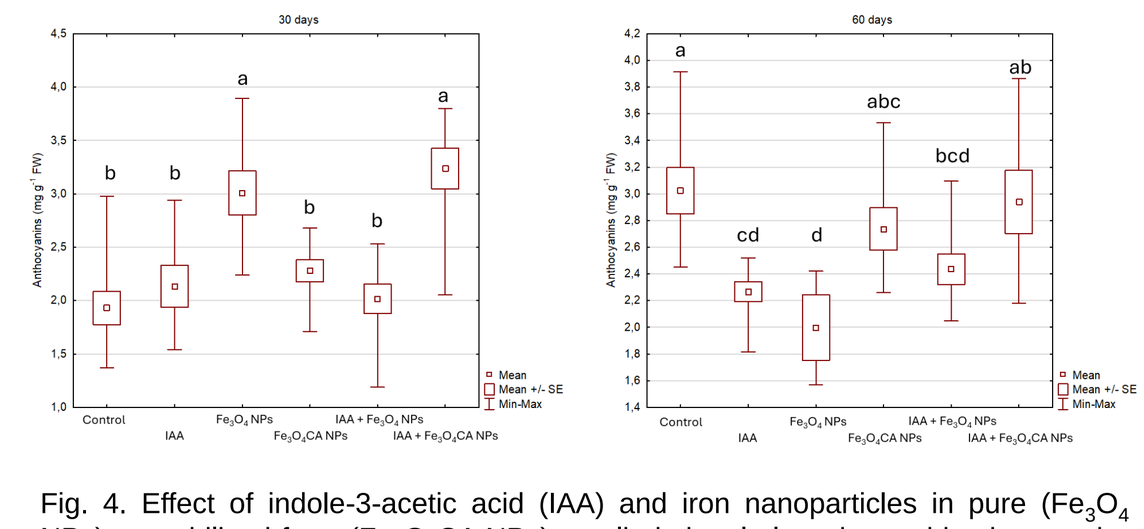

Fig. 4. Effect of indole-3-acetic acid (IAA) and iron nanoparticles in pure (Fe_3O_4 NPs) or stabilized form (Fe_3O_4CA NPs), applied singularly or in combination, on the content of anthocyanins in the inflorescences of *Chrysanthemum* × *morifolium* ‘Richmond’ after 30 and 60 days of treatment.

CONCLUSION

This study demonstrates that iron oxide nanoparticles and IAA can affect the metabolic activity and flower quality of *Chrysanthemum* × *morifolium* plants derived from synthetic seeds. The size of inflorescences was higher following shorter exposure to nanoparticles but decreased with prolonged treatment. Likewise, NPs and IAA generally increased the content of polyphenols and anthocyanins, especially after shorter exposure times. Longer treatment durations often reduced these beneficial effects. Importantly, no genetic variation was detected.