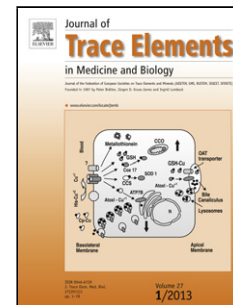


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Manganese modulates the physiological and biochemical responses of *Mentha aquatica* L. to ultraviolet radiation

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Highlights

1. UV radiation had negative effects on the growth parameters of *M. aquatica*.
2. Manganese supply had positive effects on the plant growth parameters.
3. Manganese and UV treatments affected the physiological and biochemical processes.
4. Manganese supply increased significantly the plant resistance to UV radiation.

Abstract

Ultraviolet (UV) radiation as an environmental factor alters the physiological and metabolic processes in plants. Manganese (Mn) is an essential element that is required for plant growth and development. This experiment was conducted in order to determine the effects of Mn supply and UV radiation on the physiological and metabolic responses in *Mentha aquatica*. With this aim, three levels of Mn and UV treatments were used as follows: basic Hoagland's nutrient solution without UV radiation (control), Mn supply (100 μ M), UV radiation (2 hours daily), and UV + 100 μ M Mn. After three weeks of treatments, the root and shoot dry weights and the contents of photosynthetic pigments were decreased under UV radiation condition. However, the contents of flavonoids, soluble carbohydrate, anthocyanins, malonaldehyde (MDA), hydrogen peroxide (H_2O_2), and the activity of antioxidant enzymes (superoxide dismutase, catalase, and peroxidase) were increased. Interestingly, Mn at 100 μ M concentration decreased the harmful effects of UV radiation on *M. aquatica*. In addition, the clear differences were observed in the terpene constituents of *M. aquatica* after the Mn and UV treatments. In this study, 1, 8-cineole, menthofuran and β -caryophyllene were the most abundant constituents of essential oils in both the control and treated plants. The correlation

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