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Title: Performance of three cardoon cultivars in an industrial heavy metal-contaminated soil: effects on morphology, cytology and photosynthesis

Authors: M.C. Sorrentino, F. Capozzi, C. Amitrano, S. Giordano, C. Arena, V. Spagnuolo



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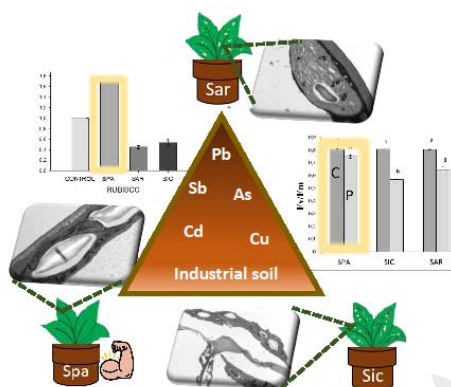
Performance of three cardoon cultivars in an industrial heavy metal-contaminated soil: effects on morphology, cytology and photosynthesis

Sorrentino M.C., Capozzi F., Amitrano C., Giordano S., Arena C.*, Spagnuolo V.

Dipartimento di Biologia, Università degli Studi di Napoli Federico II, via Cinthia 4, 80126 NAPOLI

Corresponding author: Carmen Arena: carmen.arena@unina.it

Graphical abstract



Highlights

- Morpho-physiological traits were studied in 3 cardoon cvs. grown on a polluted soil
- Metals induced severe ultrastructural damage in Sardo and Siciliano cvs.
- Pigments and photochemistry showed a significant decline in Sardo and Siciliano cvs.
- Rubisco protein significantly increases in Spagnolo cv.
- Spagnolo cv. faces metal stress by balancing morphology and physiology

Abstract

In the present work the cytomorphological and physiological effects on three cardoon cultivars – Sardo, Siciliano, Spagnolo - grown in a metal-polluted soil, were investigated, to assess the traits concurring to the high tolerance to metal stress observed in cv. Spagnolo compared to the other two cultivars. The plants were grown for one month on a real polluted soil collected at a dismantling battery plant, highly enriched by heavy metals, especially Cd and Pb, and their leaves were analyzed by a multidisciplinary approach. TEM observations highlighted severe ultrastructural damage in Sardo and Siciliano, and preserved cytological traits in Spagnolo. Both pigment content and photochemistry indicated a decline in photosynthesis in Sardo and Siciliano and a substantial stability of the same parameters in Spagnolo. Protein analysis indicated a decrease in D1 level in all cultivars; in Spagnolo the D1 decrease was more pronounced and associated to a significant increase in Rubisco, a pattern likely preserving photosynthetic efficiency and high biomass production. In

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