Effects of Cr(VI)-contaminated irrigation water on growth and development of selected crop species

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Chromium (Cr) is a metal well-known to cause environmental pollution due to its association with a number of industrial processes involving leather, steel, electroplating, chemicals, dyes and paints. It is toxic to plants and microorganisms, and its study is attracting a lot of attention due to its increasing occurrence in groundwater under current changing climate scenaria. Of the several valence states of Cr, the trivalent [Cr(III)] and the hexavalent [Cr(VI)] species are the stable forms. Cr(VI) is considered as more toxic than the relatively innocuous and less mobile Cr(III), and is easily taken up by cells where it is subsequently reduced to Cr(III) and other intermediate oxidation states [Cr(V), (IV)] generating reactive oxygen species (ROS) in the process. A greenhouse experiment has been initiated at the Agricultural Research Institute aiming at evaluating the effects of various Cr(VI) concentrations in irrigation water on growth, development and yield of major cultivated crops, such as alfalfa, tomato, wheat and lettuce. Plants were irrigated with tap water spiked with Cr(VI) at concentrations of 0 (Control), 0.05, 0.5, 1, 5 and 10 mg L^{-1}. Physiological processes and cellular damage levels were monitored in leaves by means of spectrophotometric determination of lipid peroxidation, chlorophyll loss and H_2O_2 content, further supported by stomatal conductance measurements, fresh/dry weight and SPAD units in leaves. Tomato, wheat and lettuce were not affected by Cr(VI) contaminated irrigation water, whereas phenotypic observations revealed that high Cr(VI) concentrations dramatically impacted growth and development of alfalfa plants. Alfalfa plants displayed increased damage levels and ROS content as concentrations of Cr(VI) in the contaminated irrigation water increase, while leaves showed lower stomatal conductance, fresh/dry weight, leaf area and SPAD units. ICP-OES method was performed for the quantification of Cr(VI) concentration, which yielded increasing rates for concentrations of 5 and 10 mg L^{-1} compared with control plants. Biochemical, enzymatic and molecular analysis is currently underway for alfalfa plants in order to elucidate the effect of Cr(VI) contamination in alfalfa plants.

Keywords: alfalfa, Cr(VI), reactive oxygen species, cellular damage levels

References

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