Geophysical Research Abstracts
Vol. 13, EGU2011-11539, 2011
EGU General Assembly 2011

Accumulation of selenate and selenite uptake in Zea mays in hydroponic system

Melanie longchamp (1), Nicolas Angeli (2), Philippe Biron (1), Patricia Richard (1), Thierry Bariac (1), and Maryse Castrec-Rouelle (1)

(1) BioemCo, Université Pierre et Marie CURIE, Paris, France (melanie.longchamp@upmc.fr/ +33144274164)), (2) INRA-UHP, Champenoux, France

Keywords: Essential elements, selenium, uptake, Zea mays.

Selenium (Se) is an essential nutrient for animals and humans at very low dose. The recommended dietary allowance of selenium is between 40 and 70 μg/person/day (World Health Organization, 1996). Especially several countries (UK, Brazil, France, and part of China, for example) suffer from deficiency in selenium intake. Plants hold important role in introduction of Se in food chain, but selenium is not a micronutrient for higher plants (Terry et al, 2000). Currently, the deficiency of selenium intake can notably be rectified by agronomic biofortification of crops with Se fertilizers. However, plants are able to absorb and metabolize selenium and are classified according to their accumulation rate in natural media: "non-accumulators", "indicators" or "accumulators" (Brown and Shrift, 1982; White et al, 2004). The metabolic pathway of selenium depends not only on the plant species but also on the selenium form supplied. The plants absorb selenium by root system; it is then stocked in tissues or/and metabolized in selenoamino-acids and/or volatilized as methyl organic compounds. With selenate-supplied, selenium is principally accumulated in shoots but is poorly metabolized. With selenite-supplied, it is less absorbed, principally stocked in roots and strongly volatilized. Despite Zea mays is the cereal the most widely cultivated in the world for consumption, few research were realized about their behavior as regard as selenium. The aim of this study is to evaluate the influence of selenite and selenate forms on accumulation and eventually toxicity of selenium in Zea mays and the latter's transfer in water-soil- plant system.

During the experiment, the Zea mays plants grew in Plexiglas chamber "Rubic I" (Bariac et al, 1991), and was irrigated with modified Hoagland solution supplemented or not with selenium (1mg/L of Se). Four treatments were realized: control-treatment (C-T), selenate-treatment (SeVI-T), selenite-treatment (SeIV-T) and selenite+selenate-treatment (SeIV+VI-T). At the end of the experiment, leaves, stems and roots of each plant were separated, freeze-dried, weighed (DW) and ground; an aliquot was digested. Se concentration is determined by inductively coupled plasma mass spectroscopy (ICP-MS, Thermo X Series II).

The study of biomass production shows that only the dry weight of SeIV-T plants was 46 % lower than that of C-T plants. The Se concentration in plants was 297a (280; 307) μg/g DW in SeVI-T and 161b (140; 190) μg/g DW in SeIV-T. According to these results, selenite is more toxic than selenate. The ratio selenate/selenite in this study is 1.8; this ratio and the accumulation rate in maize plant show that maize is "Se-indicator" plant, considering our experimental conditions. The distribution of Se in plants is influenced by inorganic Se forms. In the roots, the accumulation rate is higher in SeIV-T compared to SeVI-T. In the leaves, the accumulation rate is significantly higher in SeVI-T compared to SeIV-T. This difference can be explained by mobility and assimilation of inorganic Se-form. Selenate is more bioavailable than selenite; this form is better absorbed and translocated to the leaves.

The Se concentration in plants was 106b (96; 122) μg/g DW in SeIV+VI-T. In this treatment, Se-accumulation rate in roots correspond to a mean between SeVI-T and SeIV-T values. However, this rate in leaves is low and similar to the rate in SeIV-T. The selenite seems to inhibit the selenium translocation to leaves.

In order to reach recommended selenium intake, the use of Se-enriched maize plant can be considered. The biofortification of Zea mays by selenate-supplement is more effective because selenium is principally stocked in the shoots that are consumed by livestock. Furthermore, maize plant can contribute to phytoextraction of selenium in contaminated soils that may contain up to 1 mg/L (Plant et al, 2003).

References

Bariac, T., Deleens, E., Gerbaud, A., Andre, A., and Mariotti, A. 1991. La composition isotopique (18O,2H) de la vapeur d'eau transpirée: étude en conditions asservies. Geochimica et Cosmochimica acta 55, 3391-3402.

Brown, T. A., and Shrift, A. 1982. Selenium : toxicity and tolerance in higher plants. Biological Reviews 57,

59-84.
Plant, J. A., Kinniburgh, D. G., Smedley, P. L., Fordyce, F. M., Klinck, B. A., Heinrich, D., et al. 2003. Arsenic and Selenium. Treatise on Geochemistry 9, 17-66.
Terry, N., Zayed, A. M., De Souza, M. P., and Tarun, A. S. 2000. Selenium in higher plants. Annual Review of Plant Physiology and Plant Molecular Biology 51, 401-432.
White, P. J., Bowen, H. C., Parmaguru, P., Fritz, M., Spracklen, W. P., Spiby, R. E., et al. 2004. Interactions between selenium and sulfur nutrition in Arabidopsis thaliana. Journal of Experimental Botany 55, 1927-1937.
World Health Organization, 1996. Selenium. In: (Ed) Trace elements in human nutrition and health. WHO, Geneva, pp.105-122.