Concentration of elements in tissues of cobalt- or cadmium-stressed barley seedlings grown hydroponically

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Abstract

The physiological effect of toxicity of Co and Cd on the barley (*Hordeum vulgare* L. cv. Minorimugi) grown hydroponically in green house or phytotron was investigated. Growth of the plants was not affected under the Co concentration between 0 and 1 μM. In the 10 μM Co treatment, however, Fe chlorosis and necrosis was observed in shoots and growth of the plant was retarded clearly. Elongation of lateral roots was severely repressed and growth of the roots was totally repressed, resulting in significant reduction of dry weight. Concentration of Co in plant tissues was elevated in 10 μM Co treatment comparing with the other treatments (0 and 1 μM Co). Concentration of Co of shoots was fairly low as compared with that of roots. Cobalt was accumulated in roots.

In Fe-deficient barley, Fe concentration of the shoots (μmol g^{-1} DW) decreased significantly in 10 μM Co treatment. But Fe concentration of roots was increased significantly. The results suggested that accumulation in roots and translocation to the shoots of Fe was repressed by Co toxicity.

The data of Co or Fe concentration of the solution obtained Flame Atomic Absorption (Flame AA) or PIXE was compared. Sensitivity of PIXE was higher and about twice than that of Flame AA. Result of statistical analysis performed on the data of Flame AA and PIXE was consistent. Iron concentration in all solution applied was a little higher in PIXE measurement than Flame AA.

Iron, Mn, Zn, Cu concentrations in xylem sap of barley grown under +Fe condition were measured by Flameless Atomic Absorption(Flameless AA) or PIXE and the data were compared each other. Fe：Except for on sample. In all of the solution, the data of Flameless AA was 1.5-2 times higher than that of PIXE. Mn: Data of Flame AA was about twice of that of PIXE. Zn: Data of Flameless was 2-5 times larger than that of PIXE. Cu: There was no consistent tendency between the data of two methods. Ratio of the data between two methods seemed to fluctuate from 0.5 – 2. Generally, PIXE gave larger values. The reason needs to be considered in the future.

There were no visual symptoms induced by Cd toxicity up to 0.5 μM Cd of the concentration of the medium. It indicated that visual symptoms of Cd toxicity may not be observed under the solutions of usual Cd-contaminated soil in nature. In dry weight of the shoots and roots, there was no significant difference among the treatment with varied concentration of Cd. Cadmium concentration of shoots and roots increased clearly at Cd 0.5 μM treatment. Cadmium concentration of roots was 15 times higher than that of shoots. The result showed that elevation of Cd concentration in this extent does not induce symptoms in plants. It was suggested that recognition of Cd toxicity in foods, such as vegetables, is difficult and that Cd can be easily incorporated into food chain and human body.

The data of the concentration of Fe, Cu, Zn, and Mn in the solution of shoots or roots digested by nitrate was obtained using Flame AA and PIXE. The tendency of the data of Flame AA and PIXE were almost similar. In Fe, the data of Flame AA and PIXE were almost identical. In Zn, the data of Zn was a little larger than that of Flame AA. In the case of Cu in roots, the data of PIXE was 3-6 folds lower than that of Flame AA. Therefore, the data of Fe may be comparable between Flame AA and PIXE. It is suggested, however, that the values between two methods should not be compared in the data of Zn or Cu.