Studies on the Relationship Between Soil Heavy-metal Contents and Uptake of Heavy Metals by Rice

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Abstract

1. Rice fields irrigated with contaminated water had lower yield than those irrigated with uncontaminated water. Grain yield was reduced 16.5% for second crop and 7.9% for first crop in slightly polluted fields, 32.6% for second crop and 17.3% for first crop in moderately polluted fields, and 40.6% for second crop and 38.0% for first crop in highly polluted fields at Chiaotou village. Similar reduction was found in Fengshan city, 7.4% for second and 0.5% for first crop in slightly polluted fields, 13.9% for second and 10.5% for first crop in moderately polluted fields, and 37.3% for second and 30.6% for first crop in highly polluted fields. The yield reduction was mainly caused by abnormal vegetative growth, low grain formation, and serious plant diseases due to high concentration of ammonium nitrogen in irrigation water.

2. The heavy metals Cd, Cr, Cu, Zn, and Pb were found mainly in the 0~to 5~cm and 5~to 15~cm soil layers but slightly in 25~to 35~cm layers. However, maximum accumulation of As was found in the 15~to 25~cm and 25~to 35~cm layers, while 0~to 5~cm layers hab the minimum.

3. The order of heavy-metal (Cd, Cr, Cu, Zn, Pb, and As) contents in rice tissues was root > straw > grain, with an exception of Zn at Chiaotou village, which order was straw > root.

4. Grain yield of second crop in 1989 had significant negative correlation with Cr content at Chiaotou village and with Cr, Cu, Zn contents in Fengshan city. Same correlations were found between heavy-metal contents (Cr at Chiaotou, Cd, Cr, Zn, Cu in Fengshan and the yield of first crop in 1990.

5. Significant correlations between heavy-metal contents in soils and those in plant tissues were observed for sevond crop in 1989, including Cr in soils and in roots, Cu, Zn, As in soils and in straw, Cr, Cu, Pb in soils and in grains at Chiaotou village, Cr in soils and in roots and straw in Fengshan city. The first crop in 1990 also hab the same correlation, including Cu in soils and in roots (or in grains), Cu and As in soils and in straw at Chiaotou village, Cd, Cu, Zn, Pb in soils and in roots, Zn in soils and in straw in Fengshan city.
6. Based on the standard concentrations for heavy-metal classification established by Enviromnental Protection Association, heavy-metal contents in Chiaotou surface soils (0～15cm) would be classified as medium for Cd, Cr, Cu, Zn, Pb, and as low for As; moreover, those in Fengshan surface soils were classified partly as medium and partly as high for Cd, as medium for Cr, Cu, Zn, Pb, and as low for As.
7. The electric conductivities, ammonium nitrogen concentration, and COD of irrigation water sampled at medium stage of rice growth cycle were 3820～4320, umho/cm. 37.10～44.10 ppm, and 906 ppm, respectively. They were all higher than the standards for uncontaminated irrigation water. However, heavy-metal contents in the water did not exceed the standards.

Keywords: Heavy metal, rice

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