Development of Phyto-technology for Decreasing Heavy Metal in Food Cadmium Accumulation and Root Morphology in Seedlings of Japanese Wheat Cultivars Differing in Grain Cadmium Concentration

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Notwithstanding the toxicity of cadmium (Cd) to humans, animals and plants, it is easily taken up from the soil by plant roots and translocated to above-ground tissues, where it then becomes available for human and animal consumption. Genetic selection directed to reducing grain Cd concentration in wheat might be a promising way to decrease human exposure to Cd through the food chain. A previous study revealed the varietal differences in grain Cd concentration among 237 common wheat varieties, including Japanese landraces, Japanese cultivars and introduced foreign cultivars used for breeding. The factors influencing the differences in grain Cd concentration in Japanese wheat cultivars remain unclear however, although such information is necessary for effective genetic improvement to reduce Cd concentration in the grain. In this study, we hypothesized that the concentration and quantity of Cd in grain is affected by Cd absorption from the soil through the roots during the early growth stage, and that Cd absorption from soil is affected by root morphology. These hypotheses were verified by investigating the concentration and quantity of Cd in root, shoot and leaf, and the root morphology of young seedlings of Japanese wheat cultivars with high or low Cd concentrations in grain. Field, pot and root box experiments were conducted using wheat cultivars ‘Nishikazekomugi’ (grain Cd concentration: high), ‘Kitakamikomugi’ (high), ‘Kitahonami’ (low), ‘Nanbukomugi’ (low) and ‘Kinunonami’ (moderately low). In the field and pot experiments, seedlings of ‘Kitahonami’ and ‘Nanbukomugi’ showed lower Cd concentration and quantity in shoot and root parts than ‘Nishikazekomugi’, ‘Kitakamikomugi’ and ‘Kinunonami’. In the root box experiment, seedlings of ‘Kitahonami’ and ‘Nanbukomugi’ showed less root branching than ‘Nishikazekomugi’ and ‘Kitakamikomugi’. These results indicate that low Cd absorption and translocation from root to shoot at the seedling stage in ‘Kitahonami’ and ‘Nanbukomugi’ are related to low grain Cd concentration. Low Cd absorption at the seedling stage is also related to slow and/or poor growth of branching roots. Relatively high
absorption and translocation from root to shoot of Cd at the seedling stage in ‘Kinunonami’, which exhibited relatively low Cd concentration in grain, may indicate that other factor(s) limiting Cd accumulation in grain may occur at a later stage following stem elongation in wheat. These results can contribute to efforts to reduce grain Cd concentration in wheat by genetic improvement.