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Accumulation of antibiotics due to root water uptake enhances the abundance of antibiotics resistant genes in rhizosphere

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A good way to treat livestock wastewater is to irrigate crops. However, the livestock wastewater contains antibiotics and applying them to soil could result in an increase in abundance of antibiotics resistant genes (ARGs). As ARGs can spread through horizontal genes transfer by mobile genetic elements, their potential threat to human health is potential. As such, United Nation has recently warned that antibiotic resistance is a crisis we cannot ignore and call for responsible use of antibiotics at its World Antibiotic Awareness Week held in 2017. Investigating the movement of antibiotics and its associated impact on antibiotics resistant genes under livestock wastewater irrigation is thus crucial to protect environment.

In this work, we experimentally studied the change in antibiotic resistant genes in soil and plant irrigated with livestock wastewater by taking pepper as the model crop. Four treatments were examined: full irrigation by keeping soil moisture at field capacity level at 70% (WCK), alternate-furrow irrigation by using half of the water in WCK (W50), alternate-furrow irrigation by using 65% of the water in WCK, and alternate-furrow irrigation by using 80% of the water in WCK; for each treatment, there was a control irrigating using groundwater. The experiment was conducted on fluvo-aquic soil in a greenhouse at the Agriculture Water and Soil Environmental Field Science Research Station, Chinese Academy of Agricultural Sciences at Xinxiang City, Henan Province (35°15′44″N, 113°55′6″E). The abundance of ARGs in soil, as well as in roots and shoots (stems, leaves and fruits) of the pepper was measured. The results showed that there was no significant difference in pepper yield among all treatments, and irrigation with the wastewater decreased soil pH and increased soil electrical conductivity and available Cd concentration, compared to the control. The abundance of ARGs (tetA, tetG, tetO, tetW, tetX, sulI and sulII) in soil increased under all treatments compared to their associated controls, and the abundance of ARGs in W80 and WCK were much higher than that in W50 and W65. The results also revealed that, with few exceptions, under most controls the abundance of ARGs in the rhizosphere was lower than that in bulk soil, while under the treatments the abundance of ARGs in the rhizosphere was higher than that in the bulk soil. The measured antibiotics concentration in rhizosphere was found to be higher than that in bulk soil in all treatments, indicating that the antibiotics were brought to the rhizosphere by root water uptake first and then accumulated here. The accumulated antibiotics promoted the growth of the microorganisms capable of degrading the antibiotics, hence the increase of ARGs.