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The Impact of Alternate-Furrow Irrigation with Livestock Wastewater on Antibiotic Resistance Gene Abundance in Soil

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ABSTRACT

One effective approach to treating large amounts of wastewater produced during livestock production is to use it to irrigate crops. ARGs are spread readily among microbial populations by mobile genetic elements, and may pose threats to human health here, swine wastewater was used to irrigate cultivated peppers, and compared to relatively ARG-free groundwater. AFI was compared to CFI (100%) at three AFI irrigation rates (80%, 65% and 50% of CFI). The results showed that wastewater irrigation resulted in greater accumulation of antibiotics and ARGs in soil than groundwater irrigation. The effect of wastewater was much more pronounced in rhizosphere than in the bulk soils. Compared with CFI, AFI using wastewater reduced the relative abundance of ARGs in rhizosphere, but the concentration of antibiotics was largely unaffected; though antibiotic concentrations in roots were significantly. The soil bacterial communities did not change significantly between the different irrigation rates, but different behaviours were observed between ARGs and antibiotics at different irrigation rates. Antibiotic availability plays an important role in the diffusion of ARGs. In conclusion, AFI with livestock wastewater can reduce the relative abundance of ARGs in rhizosphere, but reducing irrigation amount should be employed carefully for the safe agricultural production.

Keywords: Livestock, Wastewater, Alternate Furrow Irrigation, Antibiotics resistance, Water quality.

BACKGROUND STUDIES:

Water used in agricultural production accounts for 50–80% of freshwater consumed globally. The combined pressures from agricultural production, increasing demand for water from population growth and global climate change have necessitated the use of recycled wastewater for agricultural irrigation to relieve water scarcity. Concurrently, livestock production is shifting towards large and more specialized farms, producing greater and more centralized quantities of wastes. For example, in China, $>3 \times 109$ tons of manures are produced each year. There are potential benefits of using wastewater from livestock production for irrigation due to its richness of nutrients and it is also an effective way to reduce pollution resulting from arbitrary discharge of such wastes to the environment.

However, livestock wastewaters are reservoirs of both antibiotics and microbial antibiotic resistance genes (ARGs). Over the past few decades, development of large-scale, concentrated animal feeding operations has increased the extensive use of veterinary antibiotics for infection treatment, disease prevention and growth promotion. Daily global consumption of antibiotics had increased from 2000 to 2015. In China alone, it is estimated that 53,800 tons of antibiotics entered the environment in 2013 even after waste treatment. Residual antibiotics could exert selection pressure on environmental microorganisms, contributing to the spread of ARGs and antibiotic resistant microorganisms. This pressure-driven spread of antibiotic resistance compromises the efficacy of antibiotics in animal and human medicine and is a global public health threat.

CONCLUSION:

We studied the differences in ARGs distribution in soil and plant tissues between conventional furrow irrigation (CFI) and alternate-furrow irrigation (AFI) with groundwater and wastewater at different irrigation rates. ARGs abundance in the rhizosphere was more sensitive to wastewater-irrigation than in the non-rhizosphere. Compared with CFI, AFI reduced ARGs abundance in the rhizosphere, but could risk the occurrence of ARGs in plant tissues. Water quality had a manifest effect on the spread of ARGs: the genes were more responsive to wastewater irrigation than to groundwater irrigation. Under AFI with wastewater, decreasing the irrigation amount could reduce the ARGs abundance in the rhizosphere, but not the ARGs accumulation in plant tissues. Antibiotic bioavailability was of great significance in dispersion of ARGs. Further research is hence required to achieve water savings without a risk to public health arising from dissemination of antibiotic resistance in microorganisms when using livestock wastewater for irrigation.