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PRESENCE AND DISTRIBUTION OF WASTEWATER-DERIVED PHARMACEUTICALS IN SOIL IRRIGATED WITH RECLAIMED WATER

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Three sites in the Front Range of Colorado, USA, were monitored from May through September 2003 to assess the presence and distribution of pharmaceuticals in soil irrigated with reclaimed water derived from urban wastewater. Soil cores were collected monthly, and 19 pharmaceuticals, all of which were detected during the present study, were measured in 5-cm increments of the 30-cm cores. Samples of reclaimed water were analyzed three times during the study to assess the input of pharmaceuticals. Samples collected before the onset of irrigation in 2003 contained numerous pharmaceuticals, likely resulting from the previous year's irrigation. Several of the selected pharmaceuticals increased in total soil concentration at one or more of the sites. The four most commonly detected pharmaceuticals were erythromycin, carbamazepine, fluoxetine, and diphenhydramine. Typical concentrations of the individual pharmaceuticals observed were low (0.02–15 µg/kg dry soil). The existence of subsurface maximum concentrations and detectable concentrations at the lowest sampled soil depth might indicate interactions of soil components with pharmaceuticals during leaching through the vadose zone. Nevertheless, the present study demonstrates that reclaimed-water irrigation results in soil pharmaceutical concentrations that vary through the irrigation season and that some compounds persist for months after irrigation.

Keywords: Pharmaceuticals, Wastewater, Reclaimed water, Soil, Leaching tendencies

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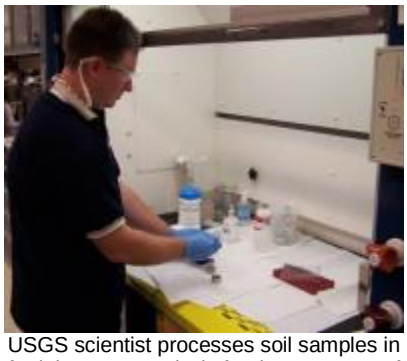
Pharmaceuticals Found in Soil Irrigated with Reclaimed Water



USGS scientist processes soil samples in for laboratory analysis for the presence of pharmaceuticals
(Click on image for larger version)

Many areas of the Nation are faced with water shortages due to significant demand for water. As a result, supplies are being augmented with treated wastewater for uses such as irrigation. In a study recently published in the journal "Environmental Toxicology and Chemistry," a team of U.S. Geological Survey (USGS) scientists reported that pharmaceuticals in wastewater used for irrigation persist in soil for several months after the irrigation stopped for the season.

Previous studies have documented that wastewater from sewage treatment plants contains a variety of pharmaceuticals and other organic-wastewater contaminants. As a result, increased attention is being given to the use of reclaimed water as a potential source for such contaminants in the environment. To help understand this issue, USGS scientists monitored three sites in Colorado from May through September 2003 to assess the presence and distribution of pharmaceuticals in soil irrigated with reclaimed water from an urban sewage treatment plant. Soil cores were collected before, during, and after the irrigation season on a monthly basis. Scientists then tested the soil cores for the presence of 19 pharmaceuticals. In addition, samples of reclaimed wastewater used for irrigation were analyzed three times during the study to assess the input of pharmaceuticals from the wastewater. Soil samples collected before the irrigation season in 2003 contained pharmaceuticals, including erythromycin (an antibiotic), carbamazepine (a drug used to prevent and control seizures), fluoxetine (an antidepressant), and diphenhydramine (a common non-prescription antihistamine), which were most likely left over from the previous year's irrigation. Several of the pharmaceuticals detected in the soil cores increased in concentration during the study, which suggests that the soil retained or absorbed the pharmaceuticals. Several other pharmaceuticals appeared to be transported through the soil zone to greater depths. Throughout the study measured concentrations of pharmaceuticals were low (0.02 to 15 milligrams/kilogram dry soil).

The results of this study demonstrate that use of reclaimed water can result in the presence and accumulation of pharmaceuticals in soil. This information can be used as a basis to design further studies to more fully understand the significance of pharmaceuticals in soil irrigated with reclaimed water, particularly the potential for effects on ground water and streams.

Reference

- Kinney, C.A., Furlong, E.T., Werner, S.L., and Cahill, J.D., 2006, Presence and distribution of wastewater-derived pharmaceuticals in soil irrigated with reclaimed water: Environmental Toxicology and Chemistry, v. 25, no. 2, p. 317-326, doi: 10.1897/05-187R.1.

More Information

- List of the 19 Pharmaceuticals in the Study of Pharmaceuticals in Soil Irrigated with Reclaimed Water
- Emerging Contaminants in the Environment