

Microplastics as a Vector for Cadmium Pollution of Groundwater

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Abstract

Since the mid-1950's, plastics have been widely used in agriculture. They break down into microplastics (≤ 5 mm). They are a vector for heavy metal movement in soil. The microplastics end up in irrigation water. It is not known if the microplastics in irrigation water increase concentrations of heavy metals in groundwater. Therefore, the main objective of this experiment is to determine if drainage water from columns of soil with microplastics has more cadmium in the water than drainage water from columns without microplastics. Cadmium (Cd) is chosen, as it co-occurs geologically with phosphorus and is added to soil with phosphate fertilizer. Another objective is to determine if different types of microplastics affect the movement of cadmium through soil. Columns of soil will be irrigated with four types of microplastics: polyethylene glycol (hydrophilic); polystyrene (hydrophobic); polyethylene (neutral); polyvinyl chloride (neutral). Cadmium will be added to irrigation water. There will be ten irrigation treatments: control (tap water), with and without Cd; polyethylene glycol, with and without Cd; polystyrene, with and without Cd; polyethylene, with and without Cd; and polyvinyl chloride, with and without Cd. The concentration of Cd and microplastics in the drainage water will be analyzed by the Soil Testing Laboratory and by a laboratory in the College of Health and Human Services, respectively. The experiment will indicate if the presence of microplastics and their type in soil affect Cd and microplastic accumulation in groundwater, which is important to know to protect the aquifers in Kansas.

Objective

- Determine whether microplastics in irrigation water increase cadmium concentrations in leachate.
- Evaluate how different microplastic types influence cadmium and microplastic transport through soil.

Methodology



Anticipated Results

At the end of the experiment, each column will be divided into three parts to determine cadmium and microplastic distribution within the soil profile. Microplastics may leach into drainage water during the column experiment, which would indicate that microplastics are leaching into the groundwater in Kansas. The extent of leaching may vary by microplastic type (hydrophobic, hydrophilic, and neutral). The leaching of cadmium may be influenced by the presence and type of microplastic, which suggests that microplastic surface characteristics may act as vectors for cadmium transport into groundwater.

Table 1: The ten treatments that will be used in the experiment.

Microplastic	Cadmium	Conc. of microplastic (ppm)	Conc. of Cd (ppm)
Polyethylene	+	70	100
Polyethylene	-	70	0
Polyvinyl chloride	+	70	100
Polyvinyl chloride	-	70	0
Polystyrene	+	70	100
Polystyrene	-	70	0
PEG 8000	+	70	100
PEG 8000	-	70	0
Tap water	+	0	100
Tap water	-	0	0

Conclusion

A key goal of the Governor of Kansas is to protect the aquifers in Kansas, so they can be used by future generations. This experiment will show if the aquifers (groundwaters) are being polluted with microplastics and cadmium. It also will show if the type of microplastic (hydrophilic, hydrophobic, neutral) affects the transport of cadmium to groundwater. If the analyses show that microplastics are accumulating in the groundwater, steps must be taken to remove plastics from farm soils for proper water resource management in Kansas.