# MICROPLASTICS: POLYMER COATED FERTILIZERS IN URBAN LANDSCAPES

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## ABSTRACT

The introduction and use of polymer coated fertilizers in urban landscapes has proven beneficial in supplying nutrients with less loss to the environment. However, these have recently come under scrutiny due to concerns with microplastics in the environment. The objectives of this study were to determine the microplastics concentrations in runoff water in urban landscapes. The full factorial study design consisted of two fertilizer sources (Uncoated Dry and Coated Dry), compared to an unfertilized control, in all combinations of three landscape types (Sod, Mulched Beds, or Xeriscapes). Two runoff events were simulated during the season and microplastics concentrations determined. There were significant differences between each landscape type, with Mulched Beds and Xeriscape having 255% and 340%, respectively, more sediment loss than the Sod. As expected, there were no microplastics in the treatments receiving uncoated fertilizer and the control. For the coated fertilizer treatments, there were significant differences between each landscape type. The Sod prevented microplastics in the runoff, but 0.17% and 0.01% of the applied polymer coatings were found in the runoff water for the Mulched Beds and Xeriscape, respectively. It is apparent that there is potential for microplastics to enter the runoff water, but a sod cover can greatly reduce sediment and potentially eliminate microplastics movement compared to mulched beds and xeriscape systems.

## INTRODUCTION

Whether in large commercial agricultural settings or with smaller home gardens/yards, providing for plant nutrition and soil fertility is vital for a sustainable soil-plant system (Hopkins, 2020). In general, the law of the conservation of mass requires replenishment of nutrients that are removed. The development and use of fertilizers as part of the “Green Revolution” has greatly improved the availability of food, fuel, and fiber globally, but it has come with problems of nutrient pollution and natural resource depletion.

Agriculture is the leading cause of water quality problems in developed nations, with nitrogen and phosphorus enrichment resulting in eutrophication (Hopkins, 2020). Although agriculture covers vast tracts of land, increasing urban sprawl is also significant in its contribution. Although the urban footprint is relatively smaller, homeowners are less motivated to be conservative in their use of fertilizers and irrigation water (which can move these nutrients to surface waters) and these areas are frequently congregated in close proximity to surface water. These landscapes vary in their use and application, including sod covered surfaces, mulched beds, xeriscapes, etc. It is important to find ways to fertilize the urban landscape efficiently.

Significant efforts have been made to synergistically allow for efficient fertilization while minimizing negative impacts on water and other natural resources. One of the best discoveries in enhancing fertilizer efficiency is polymer coated fertilizers. This technology has resulted in decreased nutrient losses to the environment, while allowing reduced application rates without negatively impacting plant growth. However, recent concerns have cast scrutiny on this source due to potentially negative impacts of microplastics in aquatic environments, as well as possible concerns for these in terrestrial ecosystems (Alimi et al., 2018).

The objective of the study is to measure microplastics in the runoff water from three landscape systems with polymer coated fertilizers compared to traditional, uncoated fertilizers.

## MATERIALS AND METHODS

A field study was conducted in 2021 at Brigham Young University (BYU; 40°16’1.40”N 111°39’28.59”W) in Provo UT to measure microplastics loss in three urban landscape systems: (Sod, Mulched Bed, and Xeriscape). The study was conducted on a disturbed, calcareous sandy loam soil with various landscape plants. Best management practices were generally followed in growing the plants. Irrigation was supplied to keep adequate soil moisture while avoiding runoff.

The full factorial study design consisted of two fertilizer sources (uncoated or polymer coated) with the three landscape systems with four replications. Fertilized plots received 220-80-80-169(S)-3(Zn)-4(Fe)-3(Mn)-0.6(Cu)-1.4(B) in lb./ac. The macronutrients were applied as: 1) Uncoated = urea, monoammonium phosphate, and potassium sulfate or 2) Coated = Environmentally Smart Nitrogen (ESN) (Nutrien, Saskatoon, Saskatchewan, Canada) and Osmocote 14-14-14 (ICL, Dublin, Ohio, USA). The micronutrients were applied as an elemental sulfur impregnated dry material (Tiger Industries, Houston, Texas).

Plots were built to mimic urban landscapes with each plot 3.3 ft wide and 6.6 ft long. Plants placed in these plots consisted of Kentucky bluegrass (*Poa pratensis* L.) in the sod plots; Ornamental grasses (Bronze Veil Hair Grass (*Deschampsia cespitosa 'Bronzechleier'*), Strawberries and Cream (*Phalaris arundinacea*), Fountain Grass (*Pennisetum alopecuroides Hameln*), and Northern Sea Oats (*Chasmanthium latifoium*) and Ice Plant (*Delosperma*) and Creeping Jenny (*Lysimachia nummularia*) groundcover plants were used in the Xeriscape. In the mulched beds, Oregon Grape shrubs (*Creeping Mahonia, Mahonia repens*) were used with the ground covered with Scotts Brown mulch (The Scotts Company LLC.  Maryville, Ohio).

Plots were built to be gently sloping (~1%) towards one end where a 9 by 13 inch aluminum pan with a lid with holes drilled through the tops was buried at the soil surface to allow runoff water collection. Runoff water was collected on July 22 with a simulated large precipitation event until the pan had approximately ~16-32 ounces of water and sediment. The water and sediment were immediately transferred to 32 ounce glass jars and sealed and refrigerated (samples were stored in the dark to avoid microplastics degradation).

The sediment was filtered out (FisherBrand P5 paper, porosity medium, filter rate slow) and measured gravimetrically after drying. A drop of concentrated sodium hypochlorite was added to the remaining water and then a subsample stored for nutrient and non-visible microplastics analysis (data not complete).

Visible microplastics coatings were removed manually from the filtered sediment. The coatings were punctured and placed in a vial with deionized water in order to release any fertilizer left in the coatings. After 24 hours, the coatings were removed and rinsed and then dried at room temperature of at least 24 hours. Microplastics concentrations were determined gravimetrically.

Statistical analysis was performed by ANOVA with mean separation by the Tukey Kramer method using SAS software.

## RESULTS AND DISCUSSION

There were significant differences for sediment loss for landscape type, with Xeriscape (80 lb $ac^{-1}$) > Mulched Beds (60 lb $ac^{-1}$) > Sod (23 lb $ac^{-1}$) (Fig. 1). There were no differences between fertilizer sources.

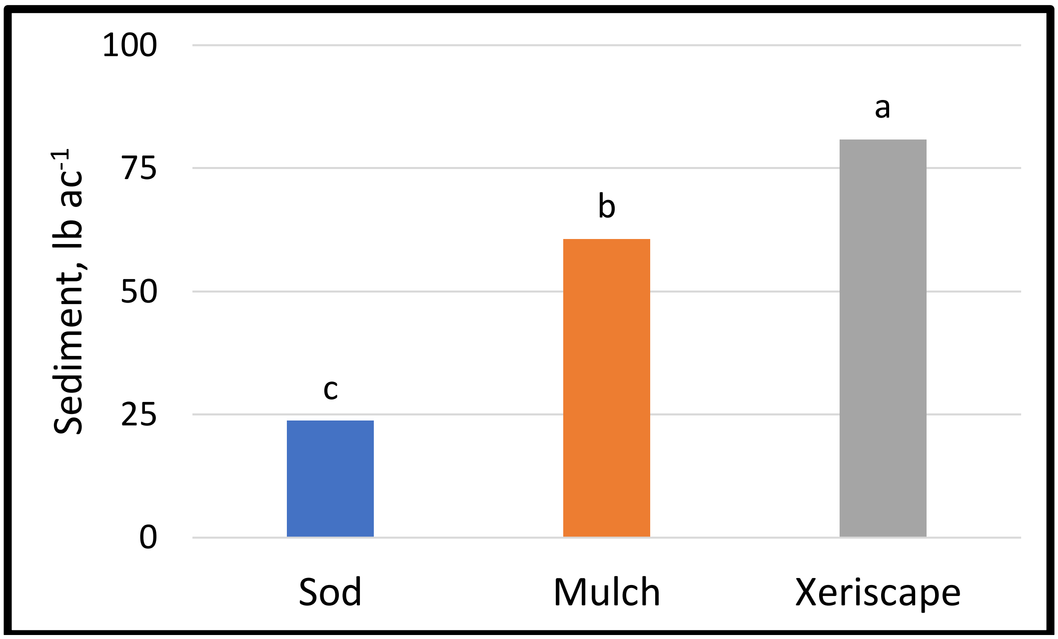


***Fig. 1. Orthogonal comparison for sediment loss for three urban landscape systems. All treatments were significantly different than each other (P = 0.05).***

As expected, there were no microplastics in the uncoated treatments (Fig. 2). Similarly, there were no microplastics found in the runoff water with sod, even when it was fertilized with coated materials (Fig. 2). However, there were microplastics found in the runoff water for Xeriscape and Mulched Beds, with Xeriscape having significantly greater (12 times) than Mulched Beds with 0.030 and 0.0025 lb $ac^{-1}$, respectively (Fig. 2).

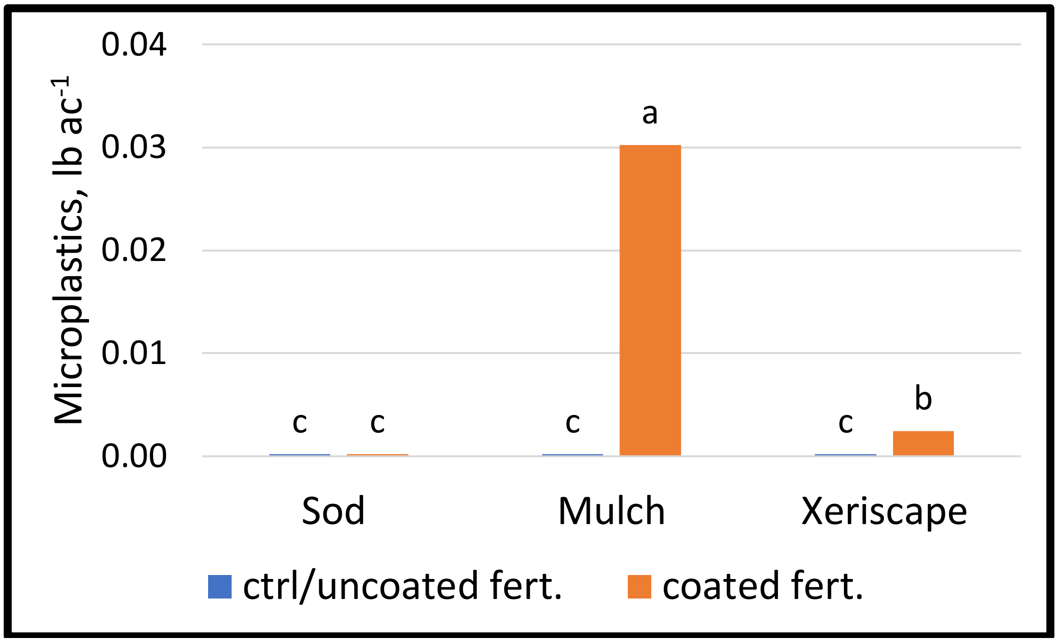


***Fig. 2. Microplastics in runoff water for three urban landscape systems with polymer coated urea (PCU) compared to uncoated control. Bars sharing the same letters on top are statistically identical to one another (P<0.001).***

The data provided by this study up to this point shows the presence of microplastics in the runoff water from two commonly used urban landscape types. The argument between which type the public should practice in their own landscape ventures is up for debate. There are pros and cons that are connected to each type. From an environmental standpoint and avoiding the contaminations microplastics pose, the Sod type of landscapes is the best choice as it experienced no microplastics in the runoff with very little sediment loss. The downside to using Sod is the extensive use of water, nutrients, and other inputs. However, sod helps sequester carbon from the atmosphere, provides a playable surface, and, as this study shows, greatly reduces soil erosion when the ground is covered in plants. In general, covering the ground in plants is a good management practice. We acknowledge that our results may change as the plants in the Mulched Beds and the Xeriscape become more established and spread to cover a larger portion of the landscape.

Concerning the mulched beds, it is a very moderate rate of care, having to maintain the mulch and care of the soil. However, mulched beds experienced the highest amount of microplastics contained in the runoff in this study. Which can negatively affect the environment, leading to eutrophication and the decrease of water quality.

Comparatively, the xeriscape experienced a significant amount of microplastic runoff as well as a very large amount of sediment. The sediment which was recorded as runoff shows the possible affect it may have if there is runoff and the fertilizer pieces are included in it.

The discussion derived from this study revolves around if the polymer coated fertilizers are present in the runoff water of common urban landscapes and to summarize the study to this point would be to say there are most definitely microplastics in the runoff water of urban landscapes. Further testing and analysis will be done, however, up to this point, there is enough evidence to suggest the presence of microplastics in the runoff and enough to assume the side effects will be present in the coming years. Possibly leading to eutrophication and microplastics contamination in surface waters.

## REFERENCES

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