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Evaluating leachate nutrient flux losses from various compost treatments in urban agriculture

College of Arts and Sciences | University of St.Thomas

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I. Background

Urban agriculture is a rapidly expanding practice across the United States. It's known that composting can recycle nitrogen (N) and phosphorus (P) from the waste stream back into the food system; however, excess application of compost-derived nutrients can contribute to nutrient buildup in soil and losses through sub-surface leachate or runoff, contaminating groundwater and receiving waters downstream and creating hotspots of pollution (Small et. al 2017). This type of waste discharge within urban areas is capable of altering both local and regional hydrology as well as altering biogeochemical processes across urban landscapes that can in turn affect climate (Grimm et. al 2008). This research will aid in understanding what soil management practices to utilize to minimize nutrient losses from urban agriculture, which can thereby reduce environmental impacts on both climate and local watersheds.

II. Research Objectives

1. Evaluate the average mass flux of nitrogen and phosphorus lost as leachate for 5 different treatments
2. Analyze leachate volume vs nitrogen and phosphorous concentrations found in the leachate for 5 different treatments
3. Summarize the amount of rainfall and subsequent drainage from the garden plots in order to analyze impacts of possible nutrient runoff

III. Experimental Design

32 garden plots were set up with four subplots (A, B, C, D) in each plot. Each subplot corresponds to a specific vegetable grown in the plot (beans, collards, peppers, and carrots) and each plot uses one of 5 compost treatments with different N and P inputs (Manure (N), Manure (P), Municipal (N), Municipal (P), Synthetic). Each subplot had a lysimeter installed and leachate volumes were collected weekly and analyzed for PO_4^{3-}, NO_3^-, and NH_4^+. Rainfall data was also recorded using a data logger in one of the plots. Nutrient mass flux was then calculated by summing the products of leachate volume and concentration over the sampling duration. This data represents the initial findings of the second year of a five year experiment.

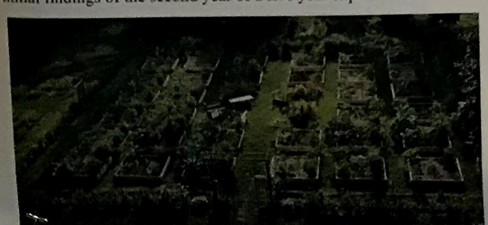
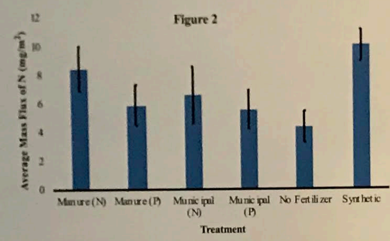


Figure 1. Aerial view of the garden plots located at the University of St. Thomas South Campus in St. Paul, Minnesota.

IV. Results & Discussion



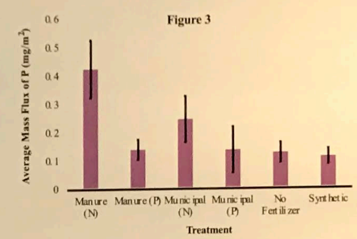


Figure 2. Average mass flux of nitrogen during the time period of 5/29/18 to 7/17/18. Synthetic and Manure (N) treatments are shown to have the highest average mass fluxes. Standard deviation error bars are used.

Figure 3. Average mass flux of phosphorus in mg during the time period of 5/29/18 to 7/17/18. Manure (N) and Municipal (N) treatments are shown to have the highest average mas fluxes. Standard deviation error bars are used.

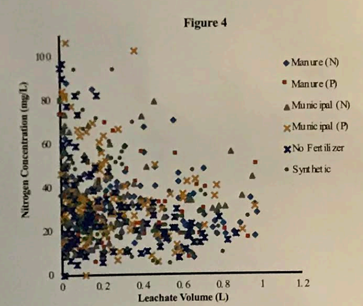


Figure 4. Inorganic nitrogen concentrations (NO_3-N + NH_4-N) in leachate varied across treatments with the highest concentrations coming from the Synthetic and Municipal (P) treatments.

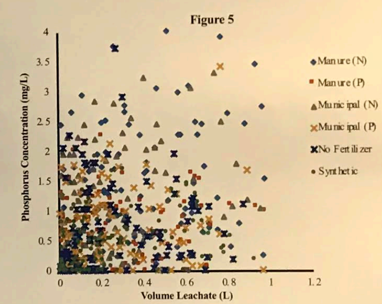


Figure 5. Phosphorus concentrations (PO_4-P) in leachate varied across treatments with Manure (N) and Municipal (N) having the highest concentrations while Manure (P) and Municipal (P) generally have lower concentrations.

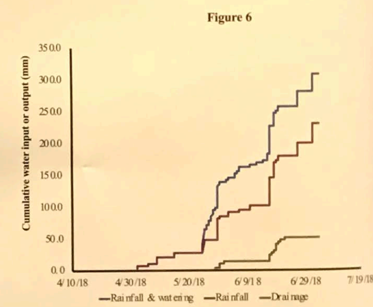


Figure 6. Rainfall and watering compared to just rainfall and compared to drainage, all measured in mm of water. Drainage is shown to be approximately 12% of rainfall and watering combined.

V. Conclusions

These data support the hypothesis that P leachate will increase over time in plots receiving excess P. During Year 1, there were no differences in P leachate across treatments, but these Year 2 data show that the two treatments receiving the highest P inputs (manure and municipal compost applied to meet crop N demand) are exporting P at the highest rates. These results indicate that careful P management in urban gardens may be important in preventing the loss of P to groundwater and surface waters, and maximizing the ecosystems services derived from urban agriculture. Data from this project will continue to be collected for the next three years and provide results that will give insight in to the future of sustainable soil management practices in urban agriculture that can be utilized by urban areas across the country.

References

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