Slow & Steady: Engineering Sustainable Fertilizers with PBSA, Biochar, and Urea.

Mia Glaser, Zoya Zarafshani, and Ian Bartels
Project/Research Group: MNEXT
Contact information: il.bartels1@student.avans.nl
Date: 4 June 2025

Introduction and Goal

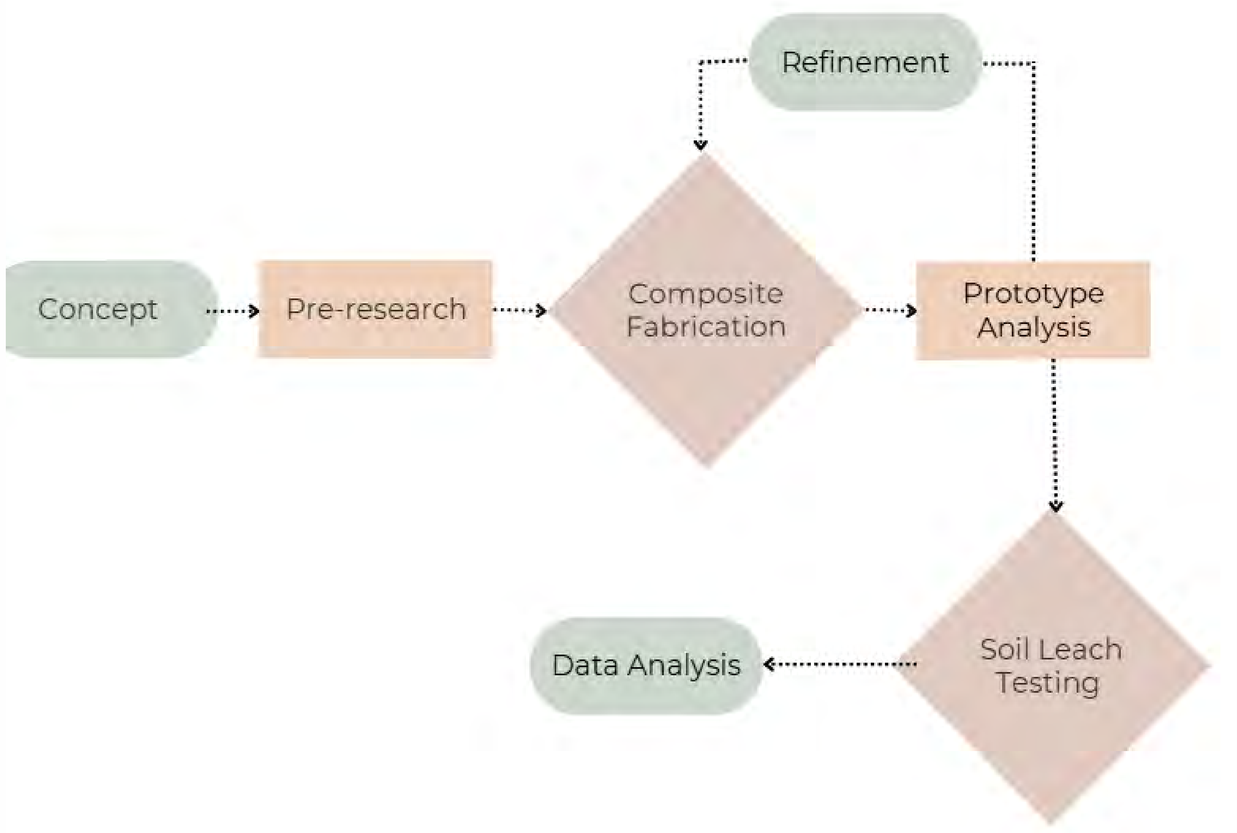
Introduction:

- Microplastic accumulation due to the addition of slow and controlled released fertilizers into agricultural soils has negatively impacted microbial life which has caused the degradation of soils.
- New developments in the bioplastic industry have opened opportunities to replace conventional plastics with biodegradable counterparts.

GOAL:

- Fabricate bioplastic composites comprised of PBSA, urea, and biochar and test its ability to be used as a slow-release fertilizer.

Project Methods



Composite Fabrication:

1.) PBSA, urea, and biochar were combined via extrusion at different ratios

2.) TGA analyses were run on the prototypes to determine effectiveness of fabrication method

Soil Leaching:

1.) Filled soil columns with material (Urea, Urea/Biochar, and Composite)

2.) Demi-water was poured every 3-4 days to simulate rainfall

3.) Leachate was collected and total N was determined using ISE probes

Results

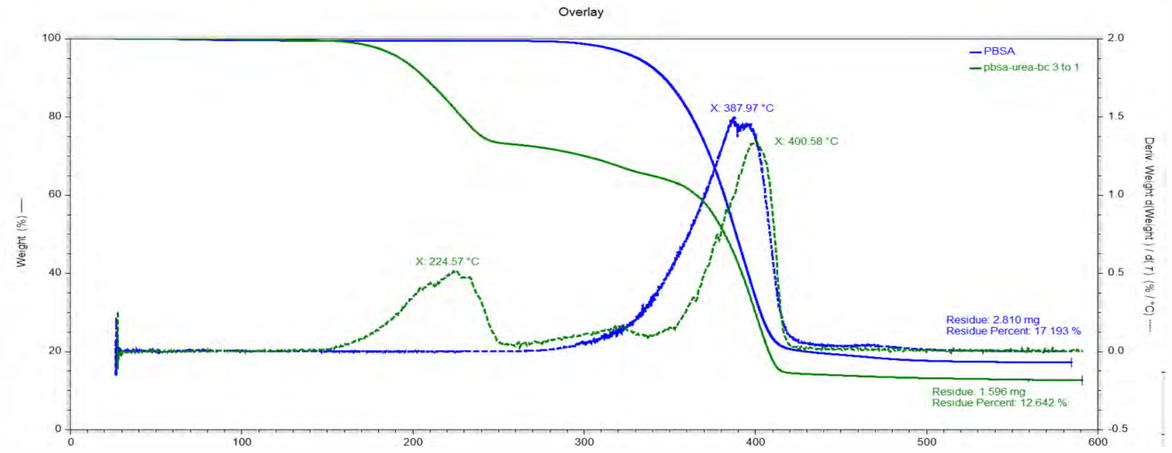


Figure 1: TGA analysis performed on PBSA, Biochar, Urea composite used in the soil leaching experiment.

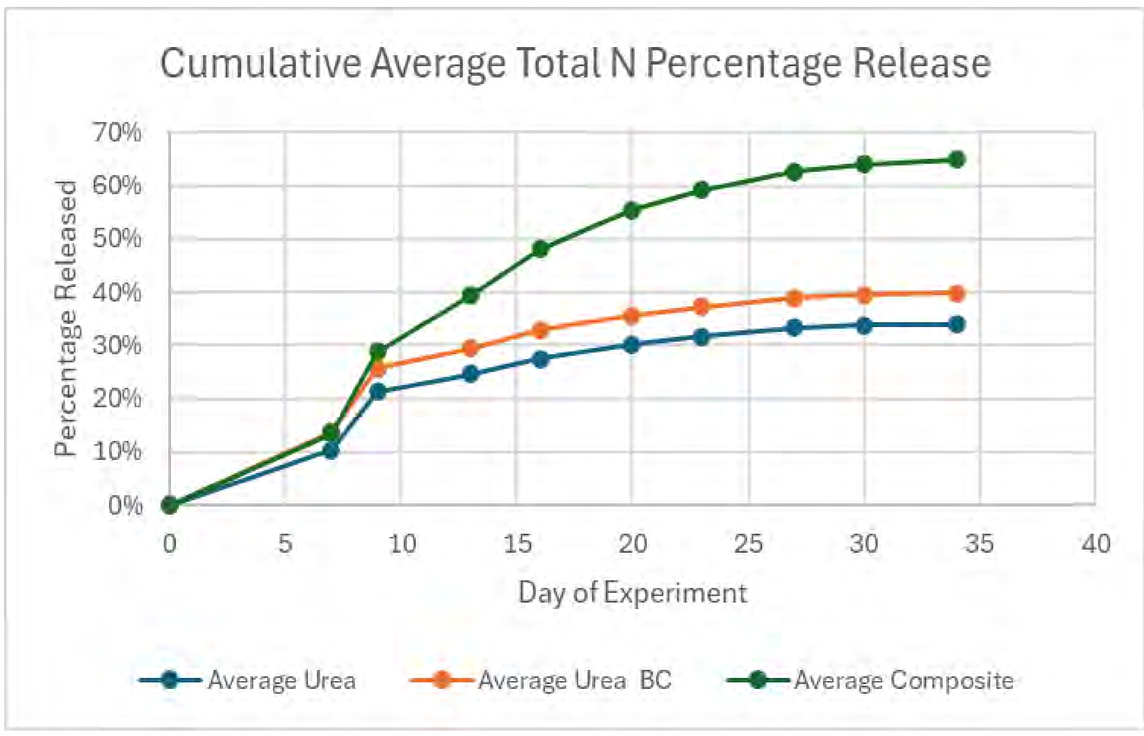


Figure 2: Cumulative average percentage of total N for all sample types. Urea (blue had the lowest percentage release, Urea BC (orange) had released slightly more than Urea, and the Composite (green) released the highest percentage of total N.

Conclusions and Reccomendations

Conclusions:

1.)Currently, extrusion is an ineffective method of combining PBSA and urea

2.) Biochar has a statistically significant effect on nitrogen release rates

3.) Hypothesis was proved incorrect; the composites released more nitrogen in the same time span.

Recommendations:

1.) Fabricate composites using a mixing method rather than extrusion/compounding

2.) Measure Total N in soil columns

3.) Measure microbial biomass N

4.) Equilibrium Tests

5.) Regulate pH to minimize volatization of $NH_4 \rightarrow NH_3$