A CONCRETE SOLUTION TO WATER SCARCITY

EXAMINING OLLA MATERIALS FOR SUSTAINABLE FARMING

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BACKGROUND INFORMATION

Irrigation plays a critical role in agricultural productivity and water conservation. Ollas (O-yas), porous clay pots made for the use of irrigation, can be found in garden centers and online. The pots historically have been produced multiple times in early cultures starting in China and Africa and eventually spreading to North and South America.

By utilizing the porous nature of terracotta, this technology was an effective method of irrigation and was especially useful in hot and dry climates where water is scarce. Due to the permeability of the olla, water leaves the system and enters the surrounding soil at a greatly reduced rate compared to simply watering the plant. The pots are covered to reduce water loss via evaporation. (Man Mohan, 2021). Over time a plants root system will grow toward an olla eventually drawing water directly from the olla itself.

As the climate changes, weather patterns historically found close to the equator are now reaching further north, this can be seen throughout Canada in the form of ongoing droughts and wildfires. Canadian farmers used 23% more water in 2022 compared to 2020. This was due to drier conditions in Canada (Statistics Canada). While ollas are not able to address events such as a wildfire directly it is important to recognize that they will help indirectly via water conservation. Meaning there will be more water available to fight fires and less water being pumped out of precious reservoirs.

RESEARCH OBJECTIVES

Currently much of the research regarding irrigation is applied to systems that use high energy and require high costs to maintain. This study aims to investigating a zero-energy irrigation system. Specifically, I am examining the differences in irrigation efficiency and performance between ollas made from terracotta and those made from concrete. Concrete was selected because it is a more readily accessible material compared to terracotta. Additionally, a mix of concrete and bamboo fiber will be tested. Using bamboo as an aggregate was selected as it is inexpensive, has a low carbon footprint and added porosity to the Olla. The value in using non-traditional materials is that it increases olla accessibility as terracotta ollas can be quite costly both financially and energy wise to produce. Research objectives of this experiment include:

- **Evaluate the irrigation efficiency of ollas made from terracotta and concrete mixes.**
- **Investigate the impact of olla material on plant growth.**

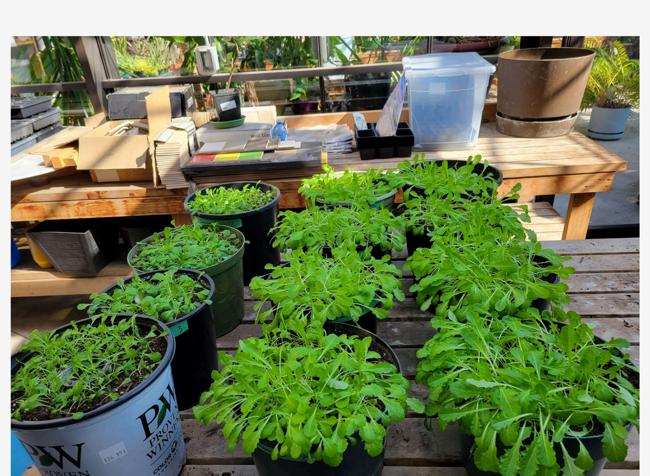
The major hypothesis for this experiment is that non-traditional materials used to make ollas will affect plant growth. I predict concrete will negatively affect plant growth while bamboo mixed ollas will be as good or better than terracotta ollas at growing baby leaf lettuce.

METHODS

The study followed a design involving the use of identically sized ollas and baby leaf lettuce (BLL). BLL was chosen because of its fast germination and growth time. Growth was measured across the three olla types and ollas were tested in the same agricultural setting. This was essential to remove other natural variables such as soil composition and lighting. Ollas were produced to identical dimensions using a 150ml soup can as a mold. Pots of identical size were used for each treatment. Each olla type had 4 treatments for a total of 12 treatments. Each pot was sown with 100 seeds and data was collected every 48 hours.

That data collected included soil moisture, water used and total biomass. Moisture readings were taken at random locations multiple times in each pot then averaged. Water use was measured throughout the experiment. All ollas were filled to 150ml during each watering period, if water remained in the olla the difference was added. These results were compared to suggest which material works best for agricultural purposes.

Plants were dried and weighed to assess total biomass in each treatment. The drying occurred in the Douglas College greenhouse over the course of seven days. Each treatment was individually weighed and an average biomass for each material was calculated.


Figures 1-3: Baby leaf lettuce at various stages of the experiment. From left to right, germination, maturation, drying process.

RESULTS

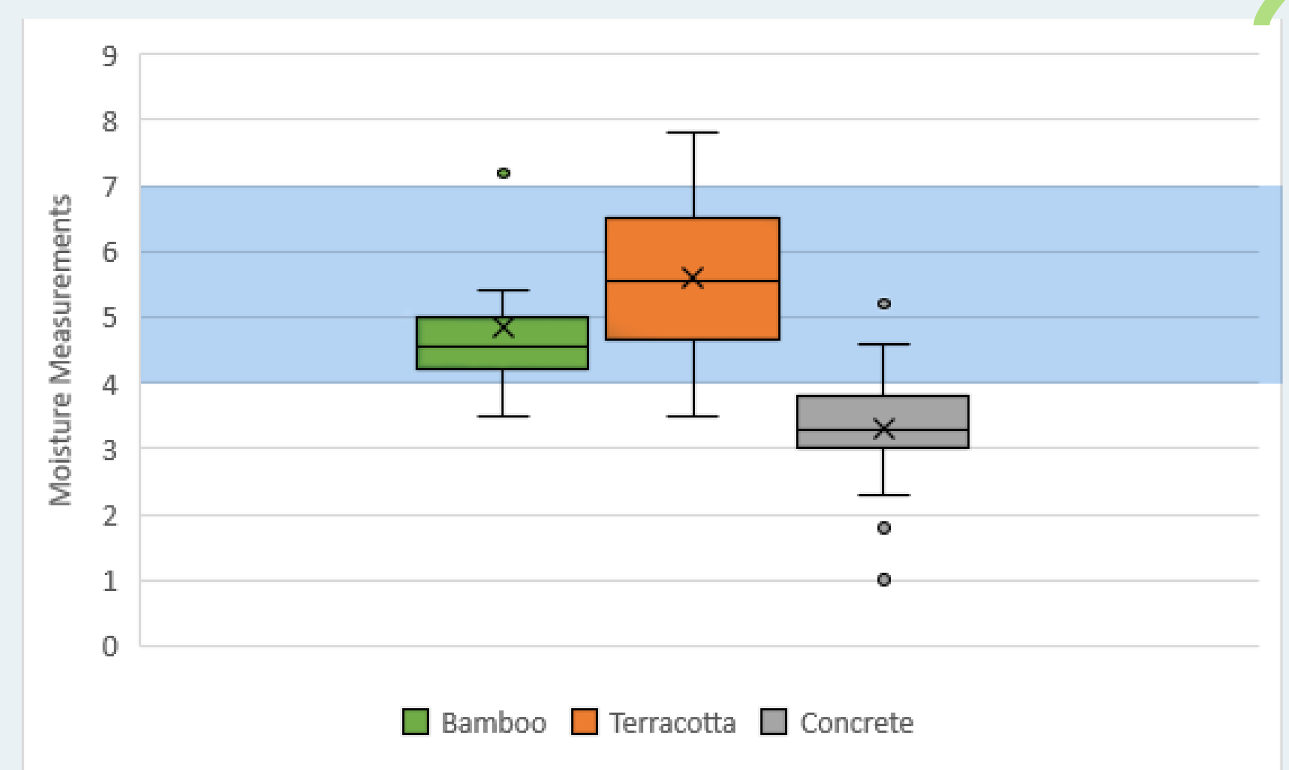


Figure 4: Moisture readings were taken every 48 hours over a 3-week period. Baby Leaf Lettuce requires maintaining "moist" (4-7) soil to maintain homeostasis. The blue bar represents optimal moisture zone. X represents mean, lien represents median.

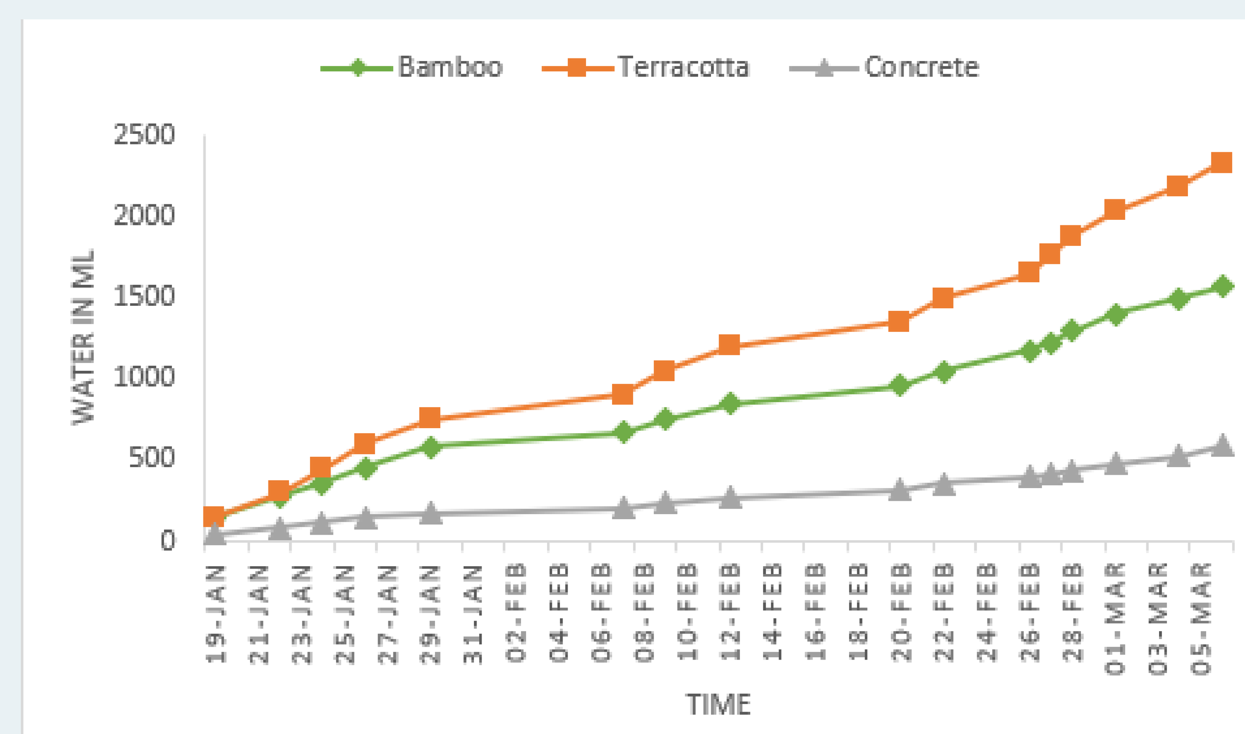


Figure 5:. Cumulative water used over the course of the experiment. Terracotta used the most water at 2333 ml, Concrete with Bamboo used 1567 ml, and concrete only used 588 ml.

Figure 6: The average biomass produced was highest in terracotta followed closely by bamboo and the lowest biomass was produced in concrete only. Plants dried for 7 days. Bamboo Total: 3.63g, Terracotta Total: 4.33g, Concrete Total: 2.17g

RESULTS

Concrete is a valid material for producing ollas if a bamboo aggregate is used. Both bamboo and terracotta mostly stayed in the optimal moisture zone (Fig 3). Furthermore, concrete with bamboo and terracotta maintain optimal soil moisture, while concrete only does not maintain adequate moisture (Fig 4). Additionally, bamboo has less variability compared to terracotta.

Terracotta ollas used the most water over the experiment at 2333 ml. Concrete with bamboo used 1567 ml and concrete only used 588 ml. It is important to note that the concrete bamboo mix only used 67% of the water that terracotta used. (Fig 5)

Bamboo produced on average 0.91 grams of plant biomass compared to 1.08 grams in terracotta. Concrete only produced 0.54 grams of biomass on average. (Fig 6) While there was significant difference between concrete and terracotta there was no significant difference between the bamboo mix and terracotta. ANOVA $F(2,9)=8.321, 0.432$.

DISCUSSION

Concrete alone does not support substantial plant growth. However, my data suggests that concrete produced with a bamboo aggregate preformed as well as traditional terracotta ollas. Additionally, they used less water and cost 20% as much to produce. These results support my hypothesis and prediction.

Water conservation will be paramount in the future. Bamboo Concrete ollas use less water than terracotta and much less water than traditional watering practices. While terracotta may be more effective, they are not as accessible.

This experiment is very scalable. It would be easy to reproduce on a large scale with the use of silicon molds. Additionally concrete based ollas can be made at room temperature and are not limited by the size of kiln available. They can be made any size quickly and cheaply.

The cost of producing the concrete bamboo ollas was less then a dollar but the cost of producing terracotta ollas was over 6 dollars. This cost difference justifies the use of bamboo concrete ollas. Especially after taking into consideration that alternative mixes can be tested, and a superior mix of concrete and bamboo is likely possible.

This study shows that ollas can be produced with easily accessible materials without sacrificing significant irrigation performance. Further testing could show that different compositions of concrete and bamboo may perform even better then terracotta. As the climate changes less water and energy will be available. Saving both water and energy through ollas is not only possible but it is widely accessible when using concrete.

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Ask me about my Ollas !