PROJECT WASP

Autonomous Self Watering Planter using Atmospheric Water

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All graphics and pictures were created by **Rishi Bhargava** unless otherwise cited

Project WASP planter autonomously growing Basil

RESEARCH QUESTION

Can we design a fully autonomous, self-contained, customizable agricultural system that sustains plant life long-term using atmospheric water sources and self regulating moisture and UV Light?

OBJECTIVES

To design a system that:

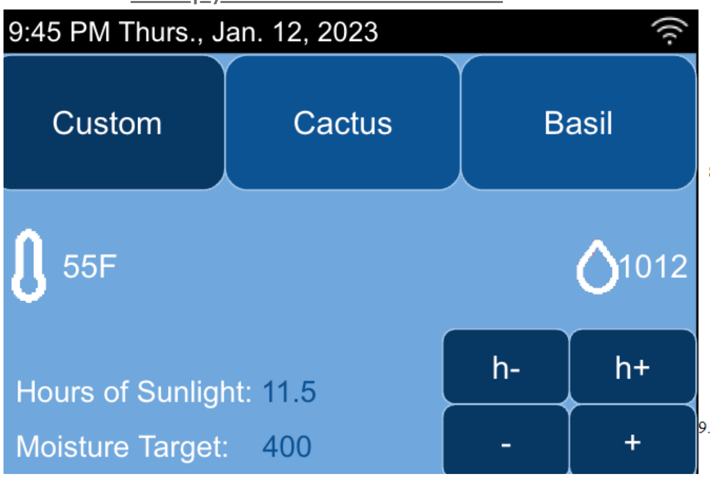
1. Is fully customizable for different plants and applications
2. Self-optimizes light and soil moisture
3. Sustainably harvests atmospheric water and solar power
4. Is proven to sustain plant growth in long-term trials
5. Can be scaled to automate large-scale agricultural applications

METHODS

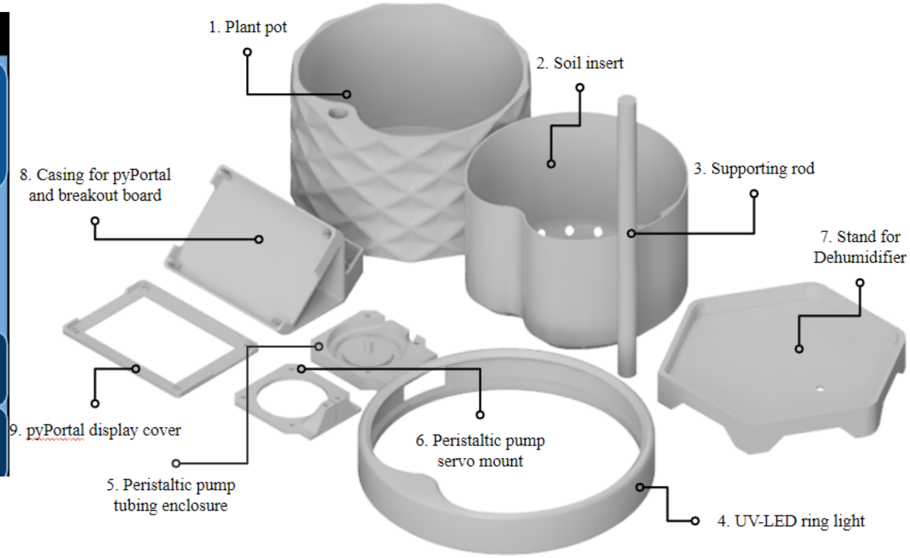
Hardware

Technology using cooling plates (dehumidifier) was selected to harvest AW. Custom components were designed in Fusion 360 and 3D printed using plant-based PLA. The WASP system is composed of UV-LED lights, a peristaltic pump, an Adafruit pyPortal Titano IoT device, a soil moisture sensor, and a Savinder dehumidifier for harvesting atmospheric water.

The pyPortal GUI interface



The 3D printed components of project WASP



Software

A microcomputer called the pyPortal Titano was programmed in Circuit Python to regulate soil moisture and light exposure by controlling the parastaltic pump and UV LED lights. It provides users with a GUI that enables them to select predefined values for moisture and light levels, as well as the ability to customize their own settings.

Power

Project WASP was powered by solar energy, which was generated by two solar panels. These panels were connected to a lead acid battery charger, which in turn supplied power to a lead acid battery. All the electrical components of Project WASP, including the pyPortal Titano, UV lights and the dehumidifier, were then powered by this battery.

EXPERIMENTAL DESIGN

Three trails were conducted

Trial 1:

Plant A (cactus)**:** connected to WASP water and light systems

Plant B (rosemary)**:** connected to WASP water and light systems

Plant C (basil)**:** connected to WASP water and light systems

Trial 2 [negative control]:

Plant D (cactus)**:** connected to WASP light system, no water.

Plant E (rosemary)**:** connected to WASP water system, no light system.

Plant F (basil)**:** not connected to WASP water or light systems

Trial 3 [positive control]:

Plant G (cactus)**:** manually watered and placed in natural light.

Plant H (rosemary)**:** manually watered and placed in natural light.

Plant I (basil)**:** manually watered and placed in natural light.

9 plants- 3 cactus, 3 rosemary and 3 basil tested in 3 trials as below

	Experiemental Plants (Trial 1)			**Negative Control (Trial 2)**			**Positive Control (Trial 3)**		
Plant Type	Plant	AW	UV-Light	Plant	AW	UV-Light	Plant	Manual Water	Sun light
Cactus	A	yes	yes	D	no	yes	G	yes	yes
Rosemary	B	yes	yes	E	yes	no	H	yes	yes
Basil	C	yes	yes	F	no	no	I	yes	yes

ANALYSIS

Plant height was measured at the start of the experiment and after 2 months. The difference in plant heights was used to estimate plant growth. The average difference in plant height was calculated for each trial, and the mean height differences between trials 1 & 2 and trials 1 & 3 were compared using a 2-tailed Student's t-test, assuming unequal variances. Significance was defined as $p < 0.05$.

RESULTS

Figure 1: Baseline plant type and height

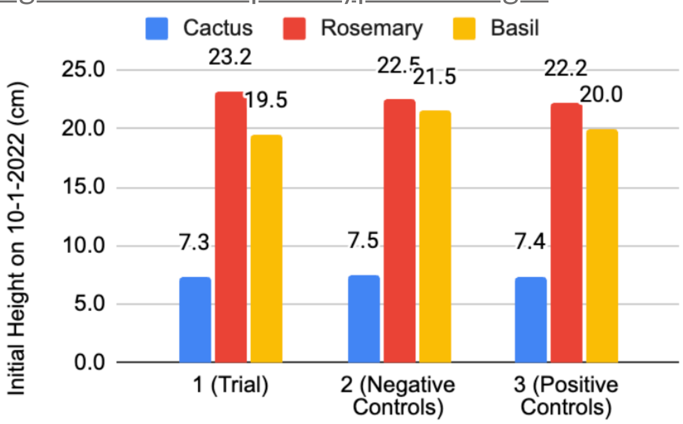


Figure 2: Mean height difference in all trials (+/-SD)

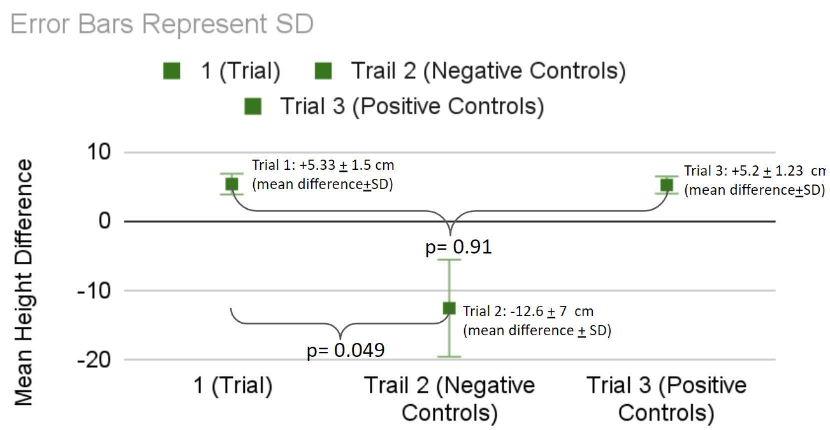


Figure 3: Soil Moisture Levels for Plants Connected to Project Wasp Irrigation Systems

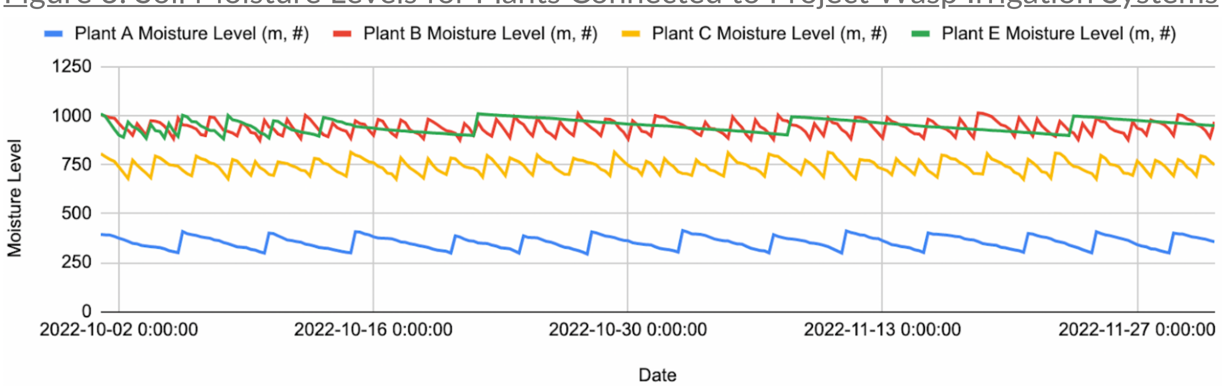
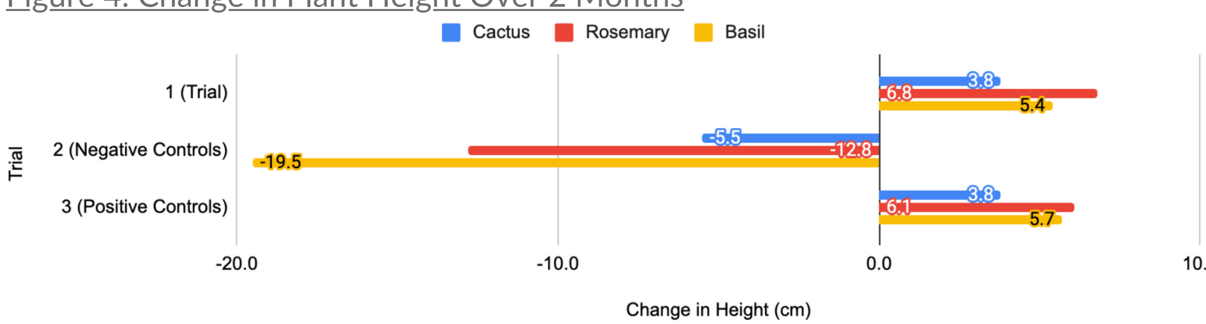


Figure 4: Change in Plant Height Over 2 Months



INTERPRETATIONS

Figure 2: A student's t-test compared mean plant growth between trial 1 & 2 and between trial 1 & 3. Mean plant growth was significantly greater in trial 1 (experimental plants) than trial 2 (NC) ($p=0.049$). Mean plant growth was similar between trial 1 (no human caretaking) and trial 3 (PC- with human caretaking) ($p=0.91$).

Figure 3: Target soil moisture levels were 400 for cacti, 800 for basil, and 1000 for rosemary. All soil moisture levels were maintained within 100 points of the target.

Figures 1&4: Trial 1 & trial 3 plants gained plant height over 2 months. Trial 2 plants showed plant death (plants D and F). Plant E showed a decrease in height by -12.8 cm.

CONCLUSIONS

Project WASP successfully designed and tested a self-sustaining technique to grow plants by utilizing atmospheric water, precisely specifying and controlling the environmental light and moisture levels. The system sustained plant growth in experimental plants without any external interference, and the growth was higher than in plants with disabled parts of the system (negative controls). Moreover, the system supported plant growth in experimental plants without any human caretaking, and the growth was comparable to that of plants in the positive control trial that required human caretaking.

FUTURE APPLICATIONS

Project WASP has the potential to revolutionize sustainable agriculture by using AW to provide freshwater for irrigation, precisely controlling soil moisture and light exposure levels, and powering the agricultural system with renewable solar energy. This technology has applications in farming in space, creating autonomous plant growth chambers, and constructing autonomous greenhouses. An industrial version of the project has been designed with a rectangular shape to optimize space efficiency, with the ability to hold multiple plant inserts. Each insert receives independent control over soil moisture and UV light levels. The design is easily scalable with two parameters, allowing for easy adjustment of planter pot size and number of plant inserts.

LIMITATIONS

Atmospheric water generation is less efficient in dry climates due to low humidity or temperature. The integration of additional AW harvesting technologies, such as desiccants, could improve atmospheric water capture. Cold plate-collected AW may require purification due to atmospheric pollutants in certain regions.

An automated farm concept utilizing the industrial version of Project WASP, rendered by the Project WASP team.