GNG1103

Design Project User and Product Manual

Building a Deep Water Culture Hydroponics System

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April 11, 2023

University of Ottawa

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1.0 Introduction

In this manual, we will cover the basics of our DWC hydroponics system, including the equipment needed to get started, how to set up your system, safety measures to consider, how to prevent failures, and best practices for maintaining and optimizing plant growth. Whether you're an experienced hydroponics user or new to the world of indoor gardening, this manual will provide you with the information you need to create an efficient hydroponics system.

2.0 Overview

The purpose of building a hydroponic system is to ensure automatic watering and nourishing of plants when users aren't around to manually take care of the plants. The system should be user-friendly, easy to maintain, and allow the nourishment of a variety of plants. This hydroponic system can be easily assembled/disassembled and can be used with a variety of growth mediums.

Figure 1 View of the projected design

This hydroponic system functions by turning on an air pump which pumps air to ensure the circulation of nutrients and water to the plants.

2.1 Conventions

Any text, part of a numbered list, is part of the procedure in setting up the hydroponic system.

2.2 Cautions & Warnings

When cutting and filing the holes on the bin lids, make sure to rest your hand when holding the cutting tool in order to prevent cutting yourself. The bins will get heavy when filled with water so it is recommended to use a trolley to transport the bins in order to prevent breaking your back.

3.0 Getting started

Before the system can even be set up, first start by drilling seven holes on four bin lids each. 6 holes will be the size of a little larger than the diameter of the planters so that the planters can fit in perfectly well. The 7th hole will be much smaller (the size of a glue hole) so that a pipe can pass through.

3.1 Set-up Considerations

Consider setting up the system in a way to ensure maximum walkway path for users i.e. as less pipes as possible in the way so that they don't trip on the pipes.

3.2 User Access Considerations

Before turning on the system, fill the plant pots with plants of the same category in the same bin so that they can grow with the same growth medium.

3.3 Accessing the System

The system can start running once the growth medium is placed with water inside the bins, the plant pots are filled with plants in the lids, the lids are placed on the bins, there's a pipe in each bin that connects the air stones in the bins to the air pump, and the air pump is turned on.

3.4 System Organization & Navigation

Once the system is set up, it is possible to monitor and change the airflow through each of the pipes. In order to do this, rotate the switches on the multiplug for each pipe until you get the airflow you desire.

3.5 Exiting the System

Once the air pump is turned on and it is verified that bubbles are being generated inside all the bins, this means that the system is working. Monitor the system once every week.

4.0 Using the System

Before using the system, it is important to note that the system consists of multiple parts that are to be assembled together. The function of each part is stated below.

4.1 Functions of Each Component of the System

Air Pump: Pumps air to flow throughout the system.

Airstone: (Connected to one end of the airline tubing) Generates bubbles in the water.

Multiplug: The multiplug is the bridge between the air pump and the airstone.

Valves: (Connected to the multiplug on each airline tubing) Prevents air from flowing backward.

Airline Tubing: Allows the passage of air to the air stones placed in the water solution in the bins.

5.0 Troubleshooting & Support

5.1 Error Messages or Behaviors

Low water level: This message may indicate that the water level in the system has dropped below the minimum level required for proper plant growth. Users should check the water level and refill the system with fresh water as needed.

High water temperature: This message may indicate that the temperature of the water in the system has exceeded the optimal range for plant growth. Users should check the temperature of the water and adjust the temperature control as needed.

Low Nutrient Levels: This message may indicate that the nutrient levels in the system are too low to support healthy plant growth. Users should check the nutrient solution and add more nutrients as needed.

Clogged Pump: This message may indicate that the pump in the system is clogged or not functioning properly. Users should check the pump and clean or replace it if necessary.

pH Imbalance: This message may indicate that the pH level of the nutrient solution is outside the optimal range for plant growth. Users should check the pH level and adjust it as needed using a pH testing kit and appropriate pH adjusters.

Plant Wilting: This behavior may indicate that the plants are not receiving enough water or nutrients. Users should check the water level and nutrient solution and adjust as needed.

5.2 Special Considerations

1. Safety precautions: Begin the manual with a section on safety precautions that should be taken when setting up and using the hydroponic system. This could include information on electrical safety, how to handle chemicals, and how to avoid drowning in the deep water.
2. Assembly instructions: Provide detailed instructions for assembling the hydroponic system, including diagrams or pictures to help users understand how the various components fit together. Be sure to specify any tools or additional materials that will be needed for assembly.
3. Water quality: Explain how to maintain proper water quality in the deep water hydroponic system. This could include information on pH levels, nutrient concentrations, and how to avoid algae growth.

5.3 Maintenance

- Water level requires regular checking and refilling every 1-2 weeks.
- Mix the recommended amount of liquid plant solution into water as suggested on the bottle.
- Air stones require replacement every 6 months.
- Soak/rinse the clay growing medium before use.

5.4 Support

- Online Resources: https://makerepo.com/Nia/1597.gng1103bulbasaurd1group2hydroponic
- Replacement Parts: If one part of the system is broken, get that part again from the bill of materials. Replacement won't affect the whole system.

6.0 Product Documentation

6.1 Bill of Materials (BOM)

Item Name	Unit of measurement	Quantity	Unit Cost ($)	Extended cost ($)	Link
Wood planks	2*4 in.	4	0.00	0.00	N/A
Bins for planter (6-pack)	22.0*16.5*13.1 (in.), plastic, 53 qt.	1	127.99	127.99	https://www.amazon.ca
Planters (50-pack)	3 in. diameter, 2.5 in. height	1	24.89	24.89	https://www.amazon.ca
Growing medium (25 L)	N/A	1	57.52	57.52	https://www.amazon.ca
Air pump and stone kit (4 valves)	254 GPH, 7W	2	71.99	143.98	https://www.amazon.ca
Airline tubing (8 ft)	3/16 in. diameter, vinyl	4	2.97	11.88	https://www.amazon.ca
Extension cord	25 ft., 13 amps	1	25.99	25.99	https://www.amazon.ca
Nutrient solution (1 qt)	N/A	1	39.99	39.99	https://www.amazon.ca
Product Subtotal				432.24	
+ **Tax**				56.19	
Total Product Cost				488.43	

6.2 Subsystem 1: Plant Fittings and Structure

6.2.1 Equipment list

- Wood planks (4)
- Storage bins (6)
- Net planters (36)
- Drill press
- Hole saw
- X-ACTO knife
- File
- Table saw
- Nail gun

6.2.2 Instructions

Plant fittings

1. Plan out the placement of the planters on the lids of the storage bins.
2. Trace the circumference of the planters at the preferred spots on the lids.
3. Set the drill press speed to D-2, and use a hole saw that is of equivalent size to the size of the planter holes.
4. Secure the lid under the drill press and drill. Repeat for all planter holes on all lids.
5. If needed. cut/file any excess plastic until planters fit in the hole without resistance.
6. Create a small hole on the very end of the lids using a 1.5 inch hole saw.
7. Create a small hole on the right side of the lid, about 4 inches from the end, using a ⅛-inch drill bit. Repeat for 2 of the lids
8. Repeat step 7 for the remaining 3 lids, drilling the holes on the left side instead of the right side.

Structure

1. Using a table saw, cut four 62-inch long, twelve 1-foot long, and two 22-inch long planks of 2x4 wood.
2. Connect two pieces of 1-foot long planks on the 4-inch side with two nails. Repeat for 6 pairs in total.
3. Use a nail gun to connect two 1-foot long planks together on the 4-inch side, making 6 table legs.
4. Place two 62-inch long planks parallel to each other, 22 inches away, laying flat on the 4-inch side.
5. Place one 22-inch long plank perpendicularly on each end of the two planks, laying flat on the 2-inch side.
6. Connect the 4 planks using a nail gun.
7. Place one 62-inch long plank on the inside of the structure so that the 40-inch side is against the already connected 62-inch plank. Repeat on the other side.

8. Secure the planks in place using a nail gun.
9. Place one table leg on each end of the 62-inch plank and one leg in the middle of the plank, for both planks.
10. Connect the legs by using a nail gun diagonally.
11. Flip the table upside down so that it is being supported by the legs, then use the nail gun to secure the legs from the top with at least 2 nails per leg.

6.3 Subsystem 2 : Pumps

6.3.1 Equipment list

- Storage bins (6)
- Net planters (36)
- Growing medium
- 4-valve air pump (2)
- Air stone (6)
- 8ft airline tubing (4)
- Nutrient solution
- Extension cord

6.3.2 Instructions

Pumps

1. Cut a 3-4 inch long piece of airline tubing, and connect the outlet divider to the air pump.
2. Measure out airline tubing to desired length and connect to one of the outlets.
3. Feed the other end of the tube through the ⅛-inch hole on the lid.
4. Connect the tube to an air stone, and place the air stone in the water.
5. Cut the tubing and add a valve to connect the cut tube if the pump is sitting lower than the water surface.
6. Repeat steps 1-5 with the second air pump kit.

6.4 Testing & Validation

Structural and technical tests were made to assure the safety, stability and of the plant fittings, tables and bins.

Test Item	Description of Test	Recorded results
Table	Applied weight (3 bins full of water) on table and swayed the table. Test for stability and safety	Table showed no issues and can be deemed reliable and safe
Plant fittings/pots	Fitted into slots and test for stability when lids are swayed and shaked	Plant pots demonstrated a good fit and only rarely fell out of position when the lid was overturned, which is unlikely.
Air pump/air stone	Test for performance and distributing air bubbles through water. Tested alone and multiple valves open.	Air pump worked well with no major issues. Any lack in air flow is mitigated by second air pump if used.

Overall, the system was tested and validated to work in all aspects designed. The system showed no major flaws to be reported and this should be reflected if reproduced.

7.0 Conclusions and Recommendations for Future Work

To conclude, our hydroponic system utilized a simple DWC framework using a cost effective design and materials. This is reflected by the ease of construction and use once built. Due to the low number of subsystems and the overall simplicity of the design, there are low chances of issues arising in the reproduction and continuous use of the design. If the design was to be reproduced, a few aspects could be improved upon to increase the overall satisfaction and effectiveness of the design. Firstly, if required, a solar panel-battery system could be easily implemented if electricity would ever be a concern. Along with this, the design of the table and plant fittings could be made into more rigid designs, connecting the table to the greenhouse walls and permanent plant pots as required.

8.0 Bibliography

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Client's Evaluation

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Grant, A. (2022, December 16). *DIY hydroponic deep water culture - learn about deep water culture nutrients*. Gardening Know How. Retrieved February 12, 2023, from https://www.gardeningknowhow.com/special/containers/deep-water-culture-for-plants.htm

Lab 5 Instructions on Brightspace: https://uottawa.brightspace.com/d2l/le/dropbox/350472/242190/DownloadAttachment?fid=134

APPENDICES

APPENDIX I: Design Files

Document Name	Document Location and/or URL	Issuance Date
Project Deliverable F: Prototype I and Customer Feedback	https://uottawa.brightspace.com/d2l/le/dropbox/350472/242188/DownloadSubmissionFile?fid=13844770&sid=4798378	March 5, 2023
Project Deliverable G: Prototype II and Customer Feedback	https://uottawa.brightspace.com/d2l/le/dropbox/350472/242191/DownloadSubmissionFile?fid=13914649&sid=4830592	March 12, 2023
Deliverable H: Prototype III and Customer Feedback	https://uottawa.brightspace.com/d2l/le/dropbox/350472/242193/DownloadSubmissionFile?fid=14041651&sid=4907777	March 26, 2023
GNG1103 Group 2 Hydroponics Final Presentation	https://uottawa.brightspace.com/d2l/le/dropbox/350472/242197/DownloadSubmissionFile?fid=14091419&sid=4932836	March 31, 2023