Research on Hydroponic Pump Systems, and Tubing

Abstract

This paper investigates suitable water pumps and system designs for the SmartHydro project, focusing on a tent-based hydroponic system growing chia, wheat, millet, strawberries, and lettuce. It evaluates different types of pumps submersible, inline, and peristaltic considering affordability, practicality, and efficiency. Recommendations for tubing sizes and system designs are also provided, ensuring optimal nutrient flow in a DIY plastic-shelving setup.

Introduction

SmartHydro is designed to use hydroponics to grow crops using a tent system equipped with automated controls. The right pump system is essential for moving nutrient-rich water efficiently while keeping costs low. This paper examines available pump types, their affordability, and tubing setups to identify the best combination for our crop selection and DIY shelving approach.

Pump Systems Research

Submersible Pumps

Submersible pumps are commonly used in hydroponic setups because they sit inside the nutrient reservoir, saving space and making installation simple. They are ideal for small to medium-sized systems like ours. These pumps generally cost between R400 and R1,000 and can handle a flow rate of 1,000–1,500 litres per hour (LPH), which suits the SmartHydro tent setup well (Hydrobuilder).

Inline Pumps

Inline pumps are external to the reservoir and provide higher flow rates and pressure, making them better suited for large or commercial systems. However, they are more expensive (R1,500+) and require additional plumbing. Since our system is DIY and relatively small, an inline pump may not be necessary.

Peristaltic Pumps

These pumps provide precise flow control by moving liquid through a flexible tube. They're mainly used in commercial hydroponics for dosing nutrients but can be quite pricey and complex for small DIY systems. Their flow rate is typically much lower (200–500 LPH), making them less suitable for our tent system (Wikipedia, 2025).

Tubing and System Design

For our crops chia, wheat, millet fodder, strawberries, and lettuce we'll need a system that supports both flood-and-drain for fodder and nutrient film technique (NFT) for strawberries and lettuce.

- **Tubing Recommendation**:
  Use food-safe PVC tubing, 13–25 millimetres in diameter (½ to 1 inch), to handle our expected flow rates. This tubing size offers a good balance between flow efficiency and flexibility in DIY setups (Smart Garden Guide, 2020).
- **System Design**:
  - **Fodder Crops (chia, wheat, millet)**: Use flood-and-drain trays on plastic shelving. Water should be pumped into the trays for 10–15 minutes every 2–3 hours to flood the roots and then drain back into the reservoir.
  - **Strawberries and Lettuce**: Use an NFT system with PVC pipes set at a gentle slope (around 2–4%) to let nutrient solution flow over the roots. A continuous or 30-minute-on, 1-hour-off pump cycle works well.

Pump Timings

Fodder Tent (Chia, Wheat, Millet)

Current Schedule: 5 minutes twice a day (morning and evening).

Assessment: This schedule aligns well with the needs of fodder crops in a flood-and-drain system. These crops have relatively shallow root systems and can thrive with intermittent watering.

Recommendation:

- **Maintain** the current schedule.
- **Monitor** the moisture levels to ensure the roots remain moist but not waterlogged.

- **Adjust** if necessary, especially during hotter periods when evaporation rates are higher.

Vegetable and Fruit Tent (Strawberries and Lettuce in PVC NFT System)

System Type: Nutrient Film Technique (NFT) using PVC pipes.

Optimal Watering Strategy:

- **Continuous Flow:** NFT systems typically require a constant flow of nutrient solution to ensure that plant roots receive adequate nutrients and oxygen.

Flow Rate:

- **Recommended:** 1–2 litres per minute per channel.
- **Reasoning:** This flow rate ensures a thin film of nutrient solution flows over the roots, providing necessary nutrients without causing waterlogging.

Pump Operation:

- **24/7 Operation:** Keeping the pump running continuously is ideal to maintain consistent nutrient delivery and oxygenation.
- **Alternative:** If continuous operation isn't feasible, implement short, frequent cycles (e.g., 15 minutes on every hour) to mimic continuous flow.

Additional Tips:

- **Aeration:** Ensure the nutrient reservoir is well-aerated to maintain high oxygen levels in the solution.
- **Monitoring:** Regularly check the pH (ideal range: 5.8–6.2) and electrical conductivity (EC) to ensure optimal nutrient availability.
- **Temperature Control:** Maintain the nutrient solution temperature between 18°C and 22°C to prevent root diseases and promote nutrient uptake.

Summary Table:

Crop Type	System Type	Watering Schedule	Flow Rate (L/min)	Notes
Chia, Wheat, Millet	Flood-and-Drain	5 min, twice daily	N/A	Maintain current schedule
Strawberries, Lettuce	NFT (PVC Pipes)	Continuous or frequent cycles	1–2 per channel	Ensure consistent nutrient flow and aeration

Conclusion

For SmartHydro's tent system, a submersible pump with a flow rate of around 1,200 litres per hour is recommended due to its affordability, simplicity, and adequate capacity for both flood-and-drain and NFT systems. Tubing should be food-safe PVC with a diameter of 13–25 mm to handle the flow rates and pressures in our setup. Combining a flood-and-drain system for fodder with an NFT design for strawberries and lettuce ensures efficient nutrient delivery and healthy crop growth.

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