Can A New Hydroponics System Help Combat Drought?

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ABSTRACT

The severe droughts in rural New South Wales and Queensland pressurise the agricultural industry that ultimately negatively impact Australians. If a new sustainable way to utilise hydroponics and conserve water was made available, it would relieve dangerous risks of crop growth and sustain the already limited supply of water. In the case of the said hydroponic system being used with spinach plants, the amount of water used can be reduced by 25%; compared to the conventional watering system. Two types of small-scale irrigation setups will test this. The first setup will be a standard irrigation system and the second setup filters water into the container accessible to the spinach plants which then drips into a main water source; a hydroponic system. The water left in the source will be measured, thus the more sustainable setup will have saved more water - we anticipate more water to be conserved by the hydroponic setup. If successful, such systems can be standardised in agriculturally used areas to combat dying crops during a drought.

PURPOSE OF THE INVESTIGATION

The increasing risk of irreversible climate change and global warming, has already been experienced in Australia. As a result water, being such a vital necessity for agricultural practices, has been limited in the areas most affected by droughts and the recent bushfires. The tested hydroponic system aims to reduce water use than a conventionally farmed crop. Therefore it is hypothesised that the hydroponic farm, will have a smaller difference between initial height and final height than the difference in initial height to final height in the conventional farm.

Figure 1 – hydroponic system setup to compare with experimental setup

MATERIALS

- Large Plastic Container and lid
- 12 Baby spinach plants
- Plant fertiliser
- Electric pump and wire (around 2 metres is sufficient, 5 metres was used in this experiment)
- 6 rockwool cubes
- Cups for planting plants in the hydroponics setup
- 28.0 litres of filtered water (accessed at home)
- Conical flask (or anything that measures the volume of water accurately)
- Weight scales (to determine the mass of fertiliser)

METHOD

Experimental Group

- Obtain a plastic container. Cut six 5cm * 5cm squares from its lid. Cut a hole that allows tubing to come through.
- Measure the height of the initial baby spinach plants and record them.
- Measure out 14L of distilled water and pour in container
- Measure out 2g of plant fertiliser for each litre of water in the container. Gently shake the container and stir the solution so fertiliser is dissolved.
- Cut rockwool into cubes that fit in the cups. Soak rockwool in solution.
- Place baby spinach plants with roots intact into rockwool cubes, which are then placed into the cups.
- Attach the tubing to the pump and attach the pump on the bottom of the container. Pull the other side of the tubing out from the pre-existing hole in the lid of the container.
- Turn on the pump and start the hydroponics set up.
- Arrange the excess tubing in a way so that all plants have access to the water that is dripping into their cups. (See figure 1)
- Observe plant growth and condition.
- By the end of 14 days measure the height of the spinach plants and record the data. Measure the volume of water left in the container.

Control Group

The same methodology as the experimental group, except the medium where the plants grow. The plants are cultivated in 10.2 kg of soil mix of pine bark which contains living microorganisms, including bacteria, fungi and protozoa. It may also contain mineral and fertiliser additives. 28g of the same fertiliser was used prior to planting the plants (so same access to essential nutrients in both groups).

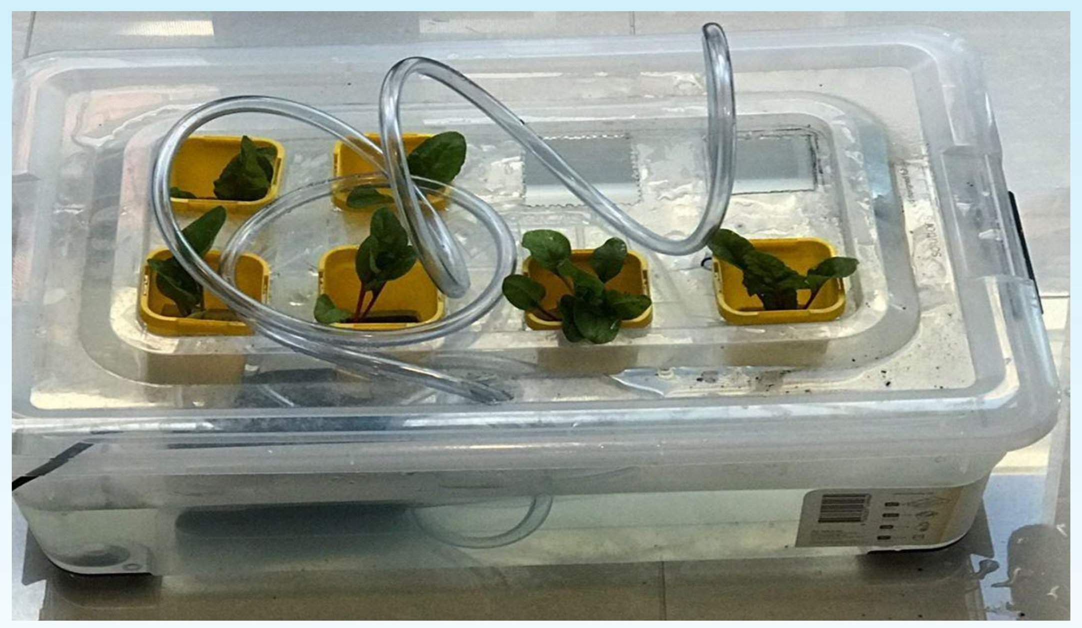

Figure 2 – experimental hydroponic system setup

RESULTS

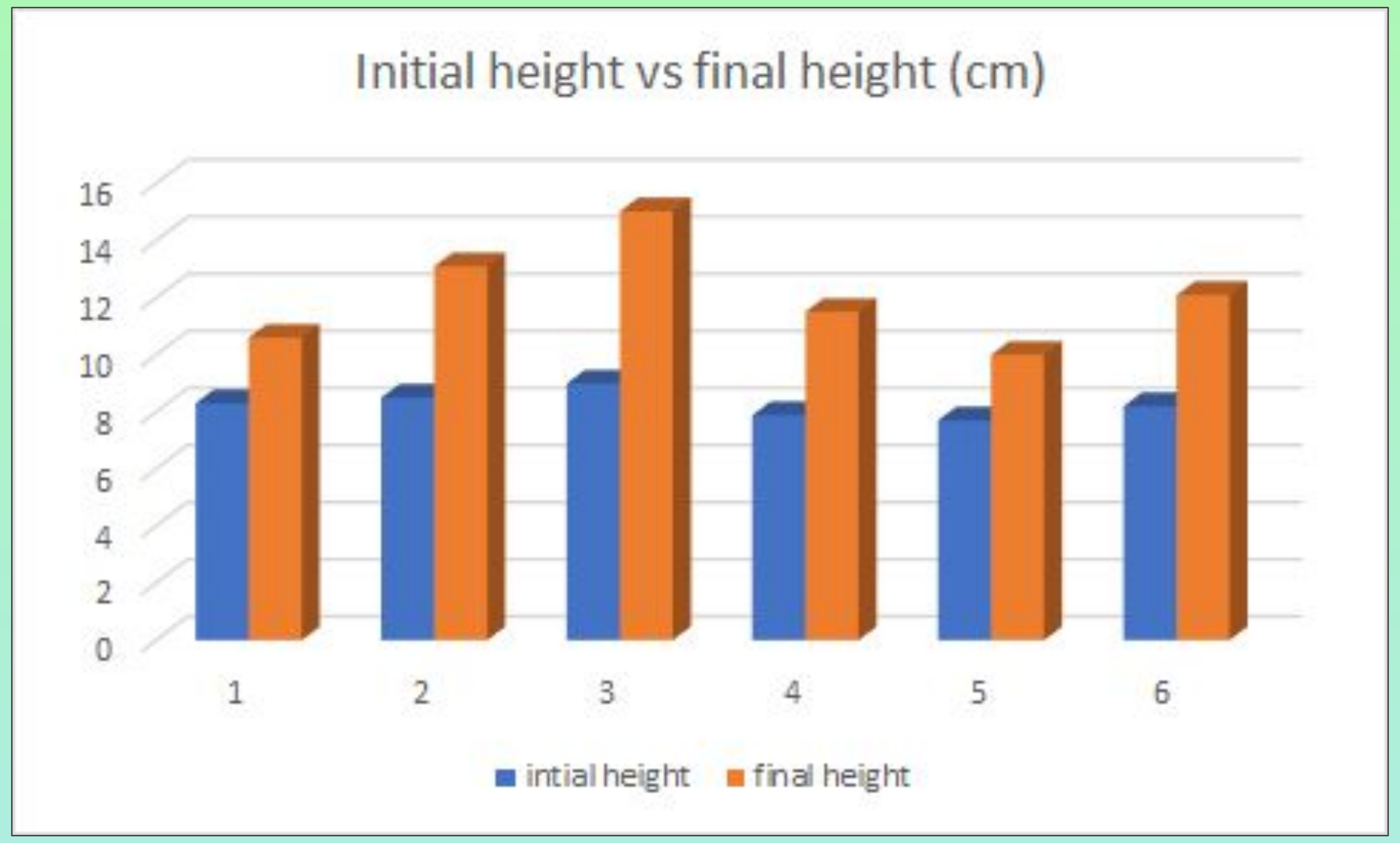

Figure 3 – Initial height v. final height of water in the Hydroponic system

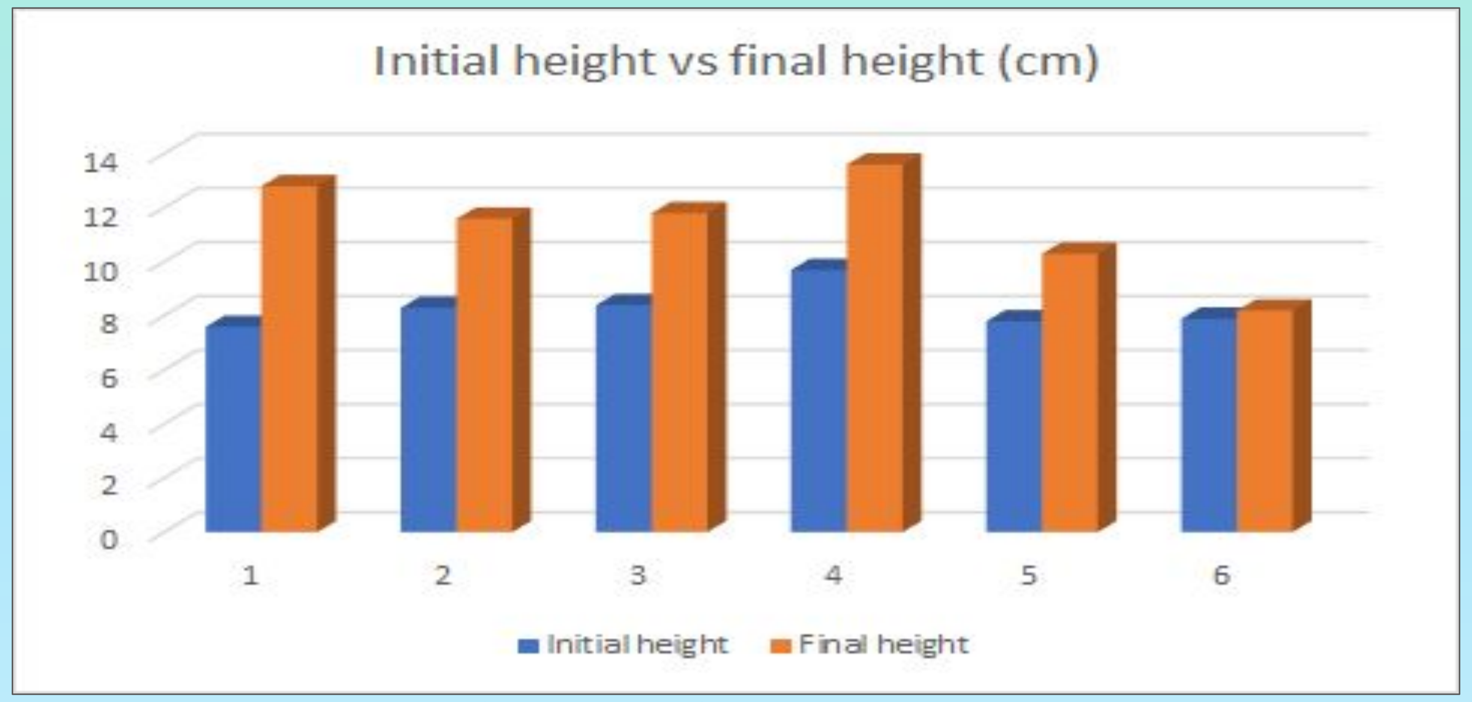

Figure 4 – Initial height v. final height of water in the control group system

COMPARISON OF METHODOLOGY

The original method involved cutting evenly sized cubes for all the plants in a plastic container filled with 14L of distilled water with 2g of fertilizer. A pump is then attached to the bottom of the container to help pump oxygen and circulate the water. Compared to figure 1, there is a fundamental difference, as Dr Cook's hydroponic setup has multiple air pumps underneath his plants to increase the amount of oxygen in the water. Furthermore, Doctor Cook's setup used foam instead of rockwool as a medium for the plants.

Urban Green Farms, a hydroponic store in Melbourne, have a vertical hydroponic setup. In this setup, water is pumped to the top of the pipe, which leads to the container with the plants' roots; as the pumped water flows the roots have direct access to the pumped water. The medium in this setup is also rockwool. The reason why vertical hydroponic setups are generally preferred, is due to its ability to occupy less space. If used at a commercial scale, the vertical hydroponic system can meet the large demand of plants.

DISCUSSION

The data collected from the results of the experiment show that the experimental hydroponic system has consumed 65.86% ((9.2L) less water than soil irrigation system. The soil irrigation system however, had plants 1 , 4 and 5 leaves turn yellow. This indicates a lack of secondary nutrients in the water such as zinc calcium and other minerals necessary for plant health. The average change in height of the hydroponic system was 3.78 cm which was 0.68cm more than the average change in height for the soil irrigation system. The larger increase in the average height change for the hydroponic system may be due to the roots for the spinach were in constant contact with water, roots could absorb the water and nutrients with more ease compared to a soil system where the roots are in search of nutrients alluding to more energy being prioritised for expanding root systems for more access to nutrients. In the soil system all the plants had traces of fungal growth. Fungal growth can be caused by various factors: such as poor air circulation or over watering causing a humid environment suitable for fungal growth and development.

The hydroponic system consumed 3.18 L (22.71%) compared to the soil system which consumed 12.4 L of water (88.57%) supporting the initial hypothesis. Hydroponic systems use a lot less water in comparison to the soil system is because the hydroponic system delivers water directly to the roots of the plants and any excess water is caught in a reservoir and reused. Therefore water loss in the hydroponic system is may be due to water being absorbed by the spinach and lost through evaporation whereas the soil system consumes more water due to the soil absorbing more water.

CONCLUSION

Supporting the initial hypothesis, the results of the experiment demonstrate the water efficiency of hydroponic systems in comparison to conventional irrigation systems being much more efficient. If the hydroponic system can be efficiently used commercially throughout NSW or at a national scale, over half of the water currently lost due to standard irrigation practices could be conserved in hydroponic systems; especially considering the arid climate common to Australia.

With the growing population and demand for food Hydroponic systems could be a solution to this as they require less space and less water to grow the same if not even more food than standard soil systems. The experiment supports the idea that less water is used in hydroponic systems. However there are a variety of hydroponic systems out there in the future it would be ideal to test different types of hydroponic systems to see which is the most viable.

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Acknowledging