# 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.

**KEYWORDS**
Drought; Australia; New South Wales; hydroponics; irrigation

## PURPOSE OF THE RESEARCH

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.

## METHODOLOGY

### Experimental Group

- Obtain a plastic container. Cut six 5cm * 5cm squares from its lid. Cut a hole that allows the tubing to come through.
- Measure and record the height of the initial baby spinach plants.
- Measure 14L of distilled water and pour in a container.
- Measure 2g of all-purpose plant fertiliser for each litre of water in the container. Gently shake the container to dissolve all fertiliser molecules.
- Cut rock wool into cubes that fit in the cups. Soak rock wool into solution.
- Place baby spinach plants with roots intact into rock wool cubes, then placed into the cups.
- Attach the tubing onto the pump and attach the pump on the bottom of the container. Pull out the other side of the tubing from the pre-existing hole in the lid of the container.
- Turn on the electricity to 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 attached image).
- Observe plant growth and condition.
- By the end of the experimental period, which is 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 for the median where the plants grew. The plants were cultivated in 10.2 kg of soil mix of pine bark and contained living microorganisms, including bacteria, fungi and protozoa. 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).

**COLLECTING DATA**

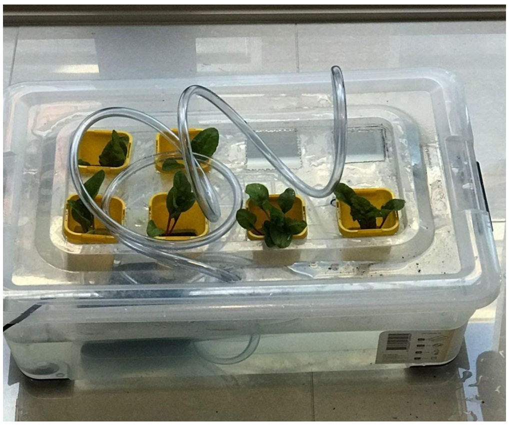

**Figure 1.1 -** Chen's hydroponic set up

**Figure 1.2 -** Dr Cook's hydroponic set up

**RESULTS**

| | Plant 1 (cm) | Plant 2 (cm) | Plant 3 (cm) | Plant 4 (cm) | Plant 5 (cm) | Plant 6 (cm) |
|---|---|---|---|---|---|---|
| **Initial height** | 8.30 | 8.50 | 9.00 | 7.90 | 7.70 | 8.20 |
| **Final height** | 10.6 | 13.1 | 15.0 | 11.5 | 10.0 | 12.1 |
| **Change in height** | 2.30 | 4.60 | 6.00 | 3.60 | 2.30 | 3.90 |
| **observation** | 2 leaves inside the cup became yellow by day 3 | n/a | Yellowing of leaves + black dots on leaves | n/a | 1 leaf inside the cup became yellow by day 3. Another leaf was dotted with black dots by day 5. Root didn't form a strong structure in rockwool. | n/a |

| | |
|---|---|
| **Initial volume of water** | 14.0L |
| **Final volume of water** | 10.8L |

**Figure 2.1** - Results of hydroponic set up table

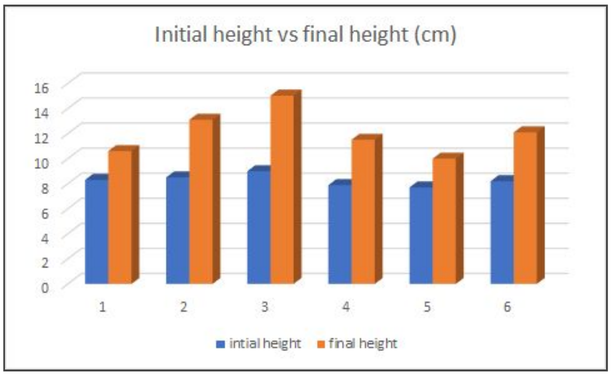


**Figure 2.2** - Initial height v. final height of water in the Hydroponic system

| | Plant 1 (cm) | Plant 2 (cm) | Plant 3 (cm) | Plant 4 (cm) | Plant 5 (cm) | Plant 6 (cm) |
|---|---|---|---|---|---|---|
| **Initial height** | 7.60 | 8.30 | 8.40 | 9.70 | 7.80 | 7.90 |
| **Final height** | 12.8 | 11.6 | 11.8 | 13.6 | 10.3 | 8.20 |
| **Change in height** | 5.20 | 3.30 | 3.40 | 3.90 | 2.50 | 0.30 |
| **Observation** | 2 leaves inside the cup became yellow by day 3 | n/a | Yellowing of leaves + black dots on leaves | n/a | 1 leaf inside the cup became yellow by day 3. Another leaf was dotted with black dots by day 5. Root didn't form a strong structure in rockwool . | n/a |

| | |
|---|---|
| **Initial volume of water** | 14.0L |
| **Final volume of water** | 1.60 L |

**Figure 3.1 -** Result table of the controlled experiment

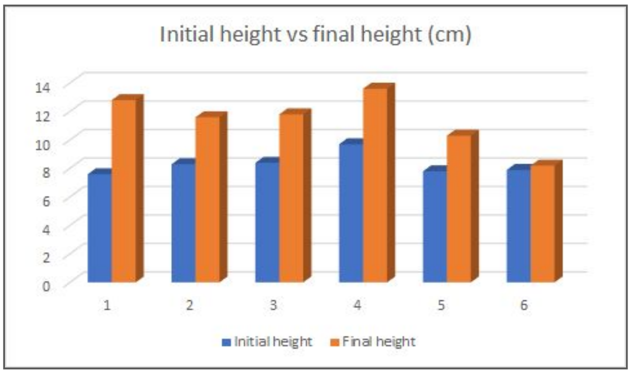


**Figure 3.2 -** Initial height v. final height of water in the control group system

**ANALYSIS OF DATA**

The data collected from the results of the experiment show that the 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 turning yellow. This could be an indication that there was a lack of secondary nutrients in the water such as zinc calcium and other minerals found within the soil. 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 reason for the larger increase in the average height change for the hydroponic system could be due to the fact that because the roots for the spinach were in constant contact with water, they could absorb the water and nutrients with more ease compared to a soil system where the roots are in search of nutrients meaning they require are larger root system and expending more energy in search for nutrients. In the soil system, all the plants had traces of fungal growth, Fungal growth could be caused by a wide range of factors. Such as poor air circulation or overwatering causing a humid environment suitable for fungal organisms to thrive in. The hydroponic system consumed 3.18 L (22.71%) compared to the soil system which consumed 12.4 L of water (88.57%). The reason why the hydroponic system used a lot less water than then the soil system is because the hydroponic system delivers water straight to the roots of the plants and any excess water is caught in a reservoir and reused. Therefore the water loss in the hydroponic system is due to water being absorbed by the plant and some evaporation whereas the soil system consumes a lot more water because the excess water is trapped in the soil.

## CASE STUDIES

The original method involved cutting evenly sized squares 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 another hydroponic setup (Dr cooks) there is a fundamental difference as Dr cooks hydroponic setup has multiple air pumps underneath his plants to increase the amount of oxygen in the water furthermore doctor cooks setup used foam instead of rock wool.

Urban green farms a hydroponic store in Melbourne have vertical hydroponic setup. In this setup water is pumped to the top of the pipe which all the plants' roots have access too and then as water flows down due to gravity the roots of the plant access the water. The medium in this setup is also rock wool. The reason why some people prefer vertical hydroponic setups is that because it consumes less space so if done on a commercial scale a lot more plants could be grown using a vertical hydroponic system.


**Figure 3** - urban green farms hydroponic system

## CONCLUSION

Through this experiment, it is evident that hydroponic system seems to be much more viable and water efficient system compared to standard irrigation systems, due to the way it conserves water which is important in Australia where droughts can happen often due to Australia being such a dry continent and lack of rainfall. If the hydroponic system can be efficiently used on a commercial scale throughout NSW or even Australia, over half of the water currently lost due to standard irrigation practices could be conserved.

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.

## ACKNOWLEDGMENTS

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