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Plant Growing in Isolated Conditions

Mohammad Reza Daneshfar*

Kimia Gostar ghomes co.(ltd), Unit 5, No 2, Fathi blind alley, Felestin Squ, Tehran, Iran.

Corresponding Author: Mohammad Reza Daneshfar, Kimia Gostar ghomes co.(ltd), Unit 5, No 2, Fathi blind alley, Felestin Squ, Tehran, Iran.

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Abstract

This study presents a novel method for cultivating wheat in isolated environments designed to dramatically reduce water consumption in agriculture. As wheat is a critical staple crop for addressing global food shortages and hunger, developing efficient cultivation techniques is essential for sustainable agricultural advancement. The research evaluates multiple disinfection and sterilization strategies to ensure successful germination and growth under minimal-water, isolated conditions. Among the tested approaches, Method 5 utilizing Whitex as a disinfectant proved to be the most effective, promoting healthy seed germination and growth while preventing mold formation. In contrast, alcohol-based methods, though successful in inhibiting mold, impeded germination, underscoring the importance of balancing sterility with seed viability. The findings demonstrate the feasibility of isolated growth systems as a means of substantially reducing water use, offering a promising pathway for agricultural production in arid and resource-limited regions.

Keywords: Isolated Plant Growth, Water Conservation, Seed Disinfection, Controlled Agricultural Environments, Mold Prevention

1. Introduction

Freshwater on Earth is becoming more crucial for humanity every day [1, 2]. With limited freshwater resources, particularly in hot and dry regions, and the looming water crisis facing humanity, significantly reducing water consumption in agriculture is paramount[3]. This inefficient water use not only leads to environmental problems like depletion of groundwater, but also limits agricultural productivity and threatens food security [4].Traditional and uncontrolled methods of cultivating plants and grains result in high water consumption compared to the product's weight [5]. For example, wheat requires approximately 1500 kg of water to produce 1 kg of grain, while tomatoes, cucumbers, and other similar crops need around 120 kg of water per 1 kg of produce (Table1).

Food Produced	Water needs for food production kg of water per kg of food
Rice	1900-4000
Wheat	900-2000
Potato	500-1500
Tomato	8-150

Table1: Water Consumption Mmount in Grains Production Using Traditional Methods

The bar chart below (Figure 1) shows the water consumption for different food types based on the provided data in TABLE 1. The chart compares the minimum and maximum water requirements (in kilograms) needed to produce 1 kilogram of each food type [6]. Therefore, efforts must be made to reduce these ratios by a factor of 10 to 5.

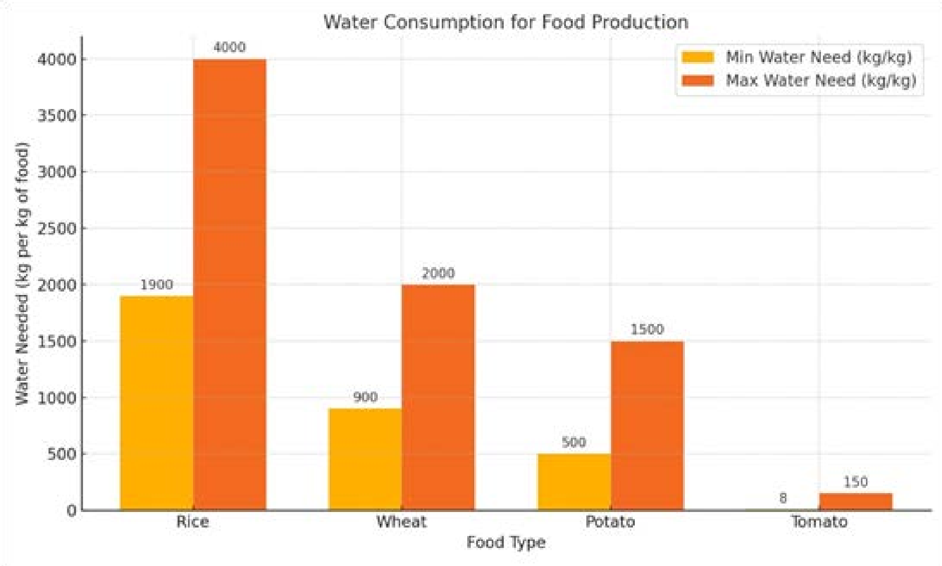

Figure 1: Water Consumption Chart

Furthermore, from a mass and energy balance perspective, consuming 200 or 1500 kg of water to produce a mere 1 kg of product is highly inefficient, unreasonable, and unaccepted Table [7]. To address this imbalance in input and output mass, measures must be taken to bring the balance closer to more reasonable proportions. There are many kinds of water losses in plant growing, and they can be categorized in different ways, illustrated in Figure 2. Here are some common types.

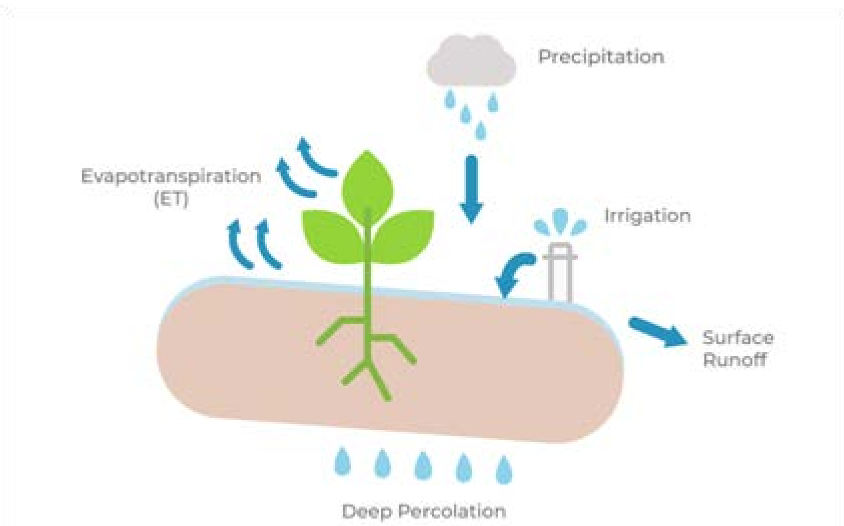

Figure 2: Types of Water Losses in Plant Growing

1.1. By Process

- **Evapotranspiration:** This is the most common type of water loss and is the combined loss from both evaporation from the soil surface and transpiration from plant leaves. It's the major factor determining water needs for crops [8].
- **Runoff:** This is water that flows over the soil surface, usually due to heavy rainfall or poor soil structure. It's a loss of water that doesn't benefit the plants [9].
- **Deep Percolation:** This is water that moves down through the soil profile beyond the root zone. While some deep percolation is natural, excessive loss can deplete soil moisture and nutrients [10].
- **Leaching:** This is the movement of dissolved nutrients (like nitrogen) through the soil profile. It can be a loss of nutrients for the plants[11].

1.2. By Stage of Growth

- **Seedling Stage:** Seedlings are very vulnerable to water loss, as their root systems are small and their leaves have a high surface area[12, 13].
- **Vegetative Stage:** Plants in the vegetative stage are actively growing, requiring more water[14].
- **Reproductive Stage:** Flowering and fruit development require significant water[15].
- **Senescence:** As plants age, their water requirements decrease[16].

1.3. By Plant Type

- **C3 Plants:** These plants, like wheat and rice, have higher water requirements than C4 plants.
- **C4 Plants:** These plants, like corn and sorghum, are more efficient in using water[17].

• **Xerophytes:** Plants adapted to dry environments are particularly water-efficient[18].

1.4. By Environmental Factors

• **Temperature:** Higher temperatures increase evaporation rates.
• **Humidity:** Lower humidity increases transpiration rates.
• **Wind:** Wind increases evaporation and transpiration rates[19].

Therefore, it is very important to find new ways to produce agricultural products with less water consumption. Modern agricultural techniques like drip irrigation, precision farming, and drought-resistant crop varieties can reduce water consumption[20]. Adopting these practices can help conserve water resources, improve agricultural yields and contribute to sustainable agriculture[21]. New agricultural methods have succeeded to a small extent in reducing water consumption for crop production. The technique proposed in this article has significantly reduced this amount of water and is not comparable to previous methods. In this way, plant growth and grains is done in isolated conditions which means the system is sealed and does not exchange mass with the outside environment but can exchange energy. The seeds are provided with a specific amount of water and CO_2 (or other plant growth needs) at the beginning and then the system is isolated.

The important point in this technique is disinfection of the seeds before isolation. If this isn't done correctly, mold or fungus can grow, killing the plant. This research uses alcohol in different forms and Whitex (sodium hypochlorite) for disinfection, which will be discussed in more detail later. Wheat, being the most widely consumed grain and having a high-water requirement, was chosen as the sample plant in this experiment.

2. Experimental

2.1. Materials

All materials used in this work were purchased from Merck or Aldrich and used as received.

2.2. Methods

About one gram of wheat was used in each of the four samples (Figure 3) as follows.

Samples: 1 2 3 4 5

Figure 3: Condition of Five Samples After a Few Days

Sample 1 (Control):
One gram of wheat, without disinfection, was placed in a small container with water-soaked Kleenex for 5 minutes. After removing excess water, the wheat was spread on the surface of the Kleenex with a spatula and the container was tightly sealed (FIGURE 4).

Figure 4: Starting Conditions of all Samples Included Wetted Wheat and Kleenex

• Kleenex weight: 1.20 grams.
• Wheat weight: 1.0 grams.
• Number of wheat seeds: 25.
• Container, Kleenex, wheat, and water weight: 355.07 grams.
• Nylon weight under the lid: 0.27 grams.
• Total initial weight (container, lid, Kleenex, nylon, wheat, water): 369.43 grams.
• Net weight of water: 8.31 grams.
• Ratio of wheat to water: 1.0/8.31.
• Ambient temperature (day/night): 25-30 degrees Celsius.

Sample 2 (Alcohol Disinfection)

The container was sterilized with 70% alcohol. One gram of wheat was added, soaked in a small amount of 70% alcohol for a few minutes, and then rinsed with water once or twice. After that, a small amount of water was added; not covering the surface of the wheat, and the container was sealed.

Sample 3

Wheat was soaked in 70% alcohol in a beaker for a few minutes, and then the alcohol was decanted. The wheat was then transferred to a folded Kleenex, which was soaked in water for about a minute. Excess water was squeezed out. After that, the Kleenex was submerged again in a container of water and transferred to the final container. Finally, the container was tightly sealed. This method aimed to minimize contact between the wheat and alcohol after disinfection.

Sample 4

Wheat was soaked in water in a Kleenex, following the procedure outlined in previous samples, and then transferred to a container. Next, 70% alcohol was sprayed twice on the wheat for disinfection. Finally, the lid of the container was closed.

Sample 5

First, 2 cc of homemade 5% Whitex was mixed with 8 cc of tap water in the container. Then, wheat was added and mixed, while the container and lid were also disinfected with the Whitex solution by turning the container. After that, the container remained sealed for 10 minutes, and then the Whitex solution was decanted. Next, the wheat was washed twice with tap water, then transferred to a Kleenex and soaked in water for 5 minutes. Finally, the wheat was placed in another container and sealed.

3. Results and Discussion

Sample 1

Changes observed in sample 1 over 15 days are summarized in Table 2. The information in Table 2 is crucial for understanding the experiment's progression and comparing the growth and development of sample 1 with other samples that underwent different disinfection treatments.

Day	Total weight (g)	Weight loss %	Wheat germ length (cm) The tallest	the shortest	Mold presence	Description
3	369.35	negligible	1.5	1	-	The mold is too much and the greens are gone.
5	369.38		4.5	2	+	
6	369.35		6	2	+	
7	369.34		6	2	+	
.					.	
.					.	
15					+	

Table 2: Results of Sample 1 During 15 Days

Sample 2 (Alcohol Disinfection)

After several days, the total weight remained unchanged, but the wheat seeds did not germinate at all. The color of the wheat seeds turned brown or chocolate. This method proved ineffective, with no germination and a change in wheat color suggesting potential damage.

Sample 3 (Minimized Alcohol Contact)

After several days, only a few roots appeared, and a small amount of wheat (a few millimeters) sprouted. Some limited germination occurred, but it was significantly less than expected.

Sample 4 (Alcohol Spray)

After several days, only a few wheat seeds sprouted and rooted individually. There was limited individual germination, indicating that this method also had a negative impact.

Sample 5 (Whitex Disinfection)

After several days, the following results were observed, as detailed in Table 3. This Table provides further details about the germination success, growth, and no mold was observed for this sample. Figure 5 illustrates this success very well.

Figure 5: Condition of Sample 5 After 9 Days

Day	Total weight (g)	Wheat germ length (cm) The tallest	the shortest	Mold presence	Average Wheat germ length (cm)
2	According to previous researches, this type of system is completely isolated and there will be no weight loss.	2	0.2	-	-
3		4	2.5	-	-
4		6	2.5	-	5-6
5		8.5	3	-	6-8.5
6		10	-	-	-
7		13	-	-	-
9		13.5	4	-	12.5

Table3: Result of sample 5 During 9 Days

Here is the line chart (Figure 6) illustrating the growth of the tallest wheat germ length over the days. The diagram shows a clear upward trend, indicating consistent growth throughout the experiment. This visualization highlights the effectiveness of the disinfection and isolation process for Sample 5, with no mold and steady germination. Based on the results of this experiment, alcohol is not an effective method for disinfecting wheat seeds or grains for growth in an isolated environment. While alcohol prevented mold growth, it also inhibited germination entirely.

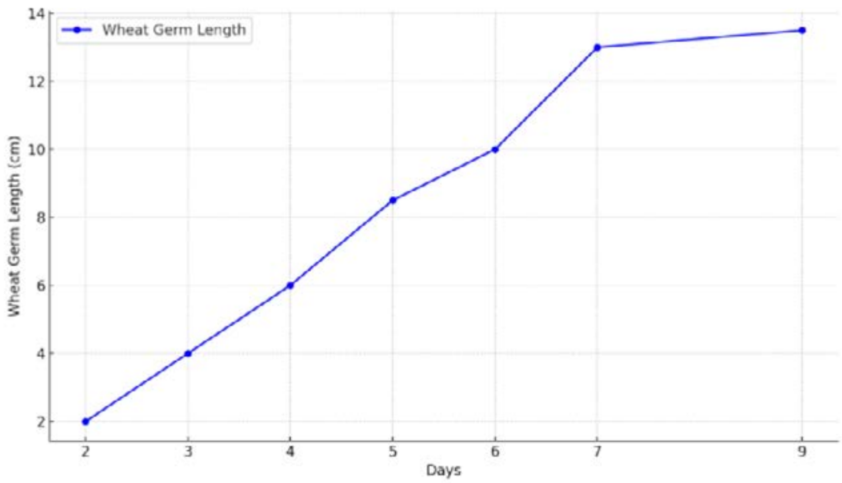

Figure 6: Growth of the Tallest Wheat Germ Length Over the Days (Sample 5)

4. Conclusion

Method 5, which involved the use of Whitex for disinfection, was identified as the most effective technique for cultivating wheat under isolated conditions. This method successfully promoted seed germination and growth while preventing mold development, highlighting its potential for applications in water-scarce agricultural practices. In contrast, alcohol-based disinfection methods effectively inhibited mold but also impeded germination, emphasizing the need for balanced approaches that preserve both sterility and seed viability. The study demonstrates the feasibility of isolated growth systems in significantly reducing water consumption, a critical step towards sustainable agriculture in arid and resource-limited regions. Future research should focus on understanding the dynamics of key factors such as CO_2, O_2, and water vapor within the isolated environment. Additionally, conducting a mass and energy balance analysis could enhance the overall efficiency and scalability of this method. This novel approach has the potential to revolutionize traditional agricultural practices, conserve freshwater resources, and contribute meaningfully to global food security amidst climate change and increasing water scarcity.

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Author contributions

The author confirms sole responsibility for the following: study conception and design, data collection, analysis and interpretation of results, and manuscript preparation.

Reference

1. Baggio, G., Qadir, M., & Smakhtin, V. (2021). Freshwater availability status across countries for human and ecosystem needs. Science of the Total Environment, 792, 148230.
2. Darwall, W., Bremerich, V., De Wever, A., Dell, A. I., Freyhof, J., Gessner, M. O., ... & Weyl, O. (2018). The Alliance for Freshwater Life: A global call to unite efforts for freshwater biodiversity science and conservation. Aquatic Conservation: Marine and Freshwater Ecosystems, 28(4), 1015-1022.
3. Taft, H. L. (2015). Water scarcity: Global challenges for agriculture. In Food, energy, and water (pp. 395-429). Elsevier.
4. Chartres, C. J., & Noble, A. (2015). Sustainable intensification: overcoming land and water constraints on food production. Food security, 7(2), 235-245.
5. Srivastava, A., Parida, V. K., Majumder, A., Gupta, B., & Gupta, A. K. (2021). Treatment of saline wastewater using physicochemical, biological, and hybrid processes: Insights into inhibition mechanisms, treatment efficiencies and performance enhancement. Journal of environmental chemical engineering, 9(4), 105775.
6. Ahmadi, M., Etedali, H. R., Salem, A., Al-Mukhtar, M., & Elbeltagi, A. (2024). Simulation of wheat water footprint using AquaCrop model under the climate change, case study in Qazvin plain. Applied Water Science, 14(12), 264.
7. Yasmeen, K., Yasmin, K., & Adnan, M. (2024). Traits impacting water crisis management. Discover Water, 4(1), 12.
8. Lin, B. B. (2010). The role of agroforestry in reducing water loss through soil evaporation and crop transpiration in coffee agroecosystems. Agricultural and forest meteorology, 150(4), 510-518.
9. Mohanty, S., Wasim, M., Pandey, P. C., & Srivastava, P. K. (2024). Exploring aquatic environments through geographical information science: A comprehensive review and applications. Geographical Information Science, 231-251.
10. Hunt, A., Faybishenko, B., Ghanbarian, B., Egli, M., & Yu, F. (2020). Predicting water cycle characteristics from percolation theory and observational data. International journal of environmental research and public health, 17(3), 734.
11. Rashmi, I., Shirale, A., Kartikha, K. S., Shinogi, K. C., Meena, B. P., & Kala, S. (2017). Leaching of plant nutrients from agricultural lands. In Essential plant nutrients: uptake, use efficiency, and management (pp. 465-489). Cham: Springer International Publishing.
12. Harrison, S., & LaForgia, M. (2019). Seedling traits predict drought-induced mortality linked to diversity loss. Proceedings of the National Academy of Sciences, 116(12), 5576-5581.
13. Markesteijn, L., & Poorter, L. (2009). Seedling root morphology and biomass allocation of 62 tropical tree species in relation to drought-and shade-tolerance. Journal of Ecology, 97(2), 311-325.
14. Chawla, R., & Kumar Sharma, S. (2025). Nitrogen fertilization of stone fruits: a comprehensive review. Journal of Plant Nutrition, 48(3), 445-485.
15. Li, X., Qiang, X., Yu, Z., Li, S., Sun, Z., He, J., ... & He, L. (2024). Effects of different water stresses under subsurface infiltration irrigation on eggplant growth and water productivity. Scientia Horticulturae, 337, 113548.
16. Thomas, H. (2013). Senescence, ageing and death of the whole plant. New Phytologist, 197(3), 696-711.
17. Nayyar, H., & Gupta, D. (2006). Differential sensitivity of C3 and C4 plants to water deficit stress: association with oxidative stress and antioxidants. Environmental and Experimental Botany, 58(1-3), 106-113.
18. Chen, X., Zhao, C., Yun, P., Yu, M., Zhou, M., Chen, Z. H., & Shabala, S. (2024). Climate-resilient crops: lessons from xerophytes. The Plant Journal, 117(6), 1815-1835.
19. Raju, C., Pazhanivelan, S., Perianadar, I. V., Kaliaperumal, R., Sathyamoorthy, N. K., & Sendhilvel, V. (2024). Climate Change as an Existential Threat to Tropical Fruit Crop Production—A Review. Agriculture; Basel, 14(11).
20. Jing, L., Farooq, M., Yang, L., Rafiq, A., Anwar, A., Shah, I., & Ameen, M. (2024). Optimal water-saving techniques for agricultural production under climate Change in China: A comprehensive review. Eur. Chem. Bull, 13, 52-76.
21. Rastogi, M., Kolur, S. M., Burud, A., Sadineni, T., Sekhar, M., Kumar, R., & Rajput, A. (2024). Advancing water conservation techniques in agriculture for sustainable resource management: A review. Journal of Geography, Environment and Earth Science International, 28(3), 41-53.