Report on Algae Growth Control on Cooling Pads

1. Introduction

Polyhouse cultivation is an advanced farming technique that allows crops to be grown in a controlled environment, protected from harsh climatic conditions such as excessive heat, rainfall, or strong winds. To ensure healthy plant growth and higher yields, parameters such as **temperature, humidity, and light intensity** must be carefully maintained within the polyhouse.

One of the most common and effective climate control mechanisms used in polyhouses is the **evaporative cooling system**. This system typically consists of **cooling pads** through which water continuously circulates. As warm air passes through the wet pads, evaporation takes place, lowering the air temperature and increasing humidity—creating a favorable environment for crop growth.

However, the same conditions that benefit crops—**moisture, light, and nutrient presence in circulating water**—also provide an ideal environment for the growth of **algae**. Algae are photosynthetic microorganisms that multiply rapidly under such conditions. Their growth on cooling pads poses several problems:

- **Reduced Cooling Efficiency:** Algal biomass clogs the pores of cooling pads, reducing water absorption and airflow. This decreases the cooling capacity of the system.
- **Increased Energy Consumption:** Fans and pumps have to work harder when pads are clogged, leading to higher electricity cost.
- **Frequent Maintenance & Replacement:** Algal growth necessitates regular cleaning and shortens the life span of cooling pads, increasing operational costs.
- **Crop Health Risks:** Algae-contaminated water may harbor pathogens or cause changes in water chemistry, indirectly affecting plant health.

Therefore, **algae growth on cooling pads is a major challenge in sustainable polyhouse farming**. Effective control strategies are required to maintain system efficiency, reduce costs, and ensure optimal environmental conditions for crop production.

Why Algae is a Problem

The growth of algae on cooling pads is not just a surface-level issue; it directly affects the performance, efficiency, and economics of polyhouse operations. The key problems caused by algae include:

1. **Clogging of Cooling Pad Pores:** Algae form thick green biofilms on the surface and within the pores of cooling pads.This obstructs the free passage of air through the pad material, restricting airflow.Reduced airflow lowers the effectiveness of evaporative cooling, leading to higher inside temperatures.
2. **Decreased Cooling Efficiency :** When pad pores are blocked, water distribution becomes uneven.Dry spots develop on the cooling pad, reducing the area available for evaporation.As a result, the air entering the polyhouse is not cooled adequately, creating stress conditions for crops.

3. **Increased Energy Consumption and Operational Costs :** Fans and pumps must work harder to maintain desired cooling when algae restrict airflow.This increases electricity usage and running costs.Algae also increases the load on circulation pumps, reducing their service life.
4. **Frequent Cleaning and Pad Replacement :** Algae-covered pads require regular cleaning, which is labor-intensive and time-consuming. Repeated cleaning reduces the structural strength of pads, shortening their lifespan. Farmers often face higher costs due to frequent replacement of cooling pads.
5. **Risk of Secondary Issues :** Stagnant water with algal growth can harbor **mosquitoes, fungi, and bacteria**, creating hygiene concerns.Algae decomposition releases organic matter that may affect water chemistry, possibly impacting crop health.

Therefore, controlling algae growth is not optional—it is essential for ensuring the long-term efficiency, cost-effectiveness, and sustainability of polyhouse cooling systems.

2. Problem Statement

Polyhouse cooling pads play a vital role in maintaining optimal temperature and humidity for crop production. However, they are highly prone to algae growth due to continuous water circulation, exposure to sunlight, and favorable warm–humid conditions. The problem becomes particularly severe during the summer season, when algae proliferate rapidly.
Currently, farmers rely mostly on manual cleaning or replacement of pads, which are **labor-intensive, time-consuming, and provide only temporary relief**. There is a lack of clear, scientific guidelines for practical, long-term algae management in polyhouse cooling systems.
Therefore, there is an urgent need to identify **cost-effective, efficient, and easily applicable methods**, such as chemical treatments, to control algae growth and improve the sustainability of cooling pad operations in polyhouses.

3. Objectives

The study was undertaken to address the issue of algae growth on polyhouse cooling pads and to identify effective control measures. The specific objectives of the work are:

1. **To study the factors contributing to algae growth on cooling pads** Investigate how environmental factors such as sunlight, humidity, water quality, and continuous circulation create favorable conditions for algae. Understand how these factors affect the efficiency and longevity of cooling pads.
2. **To evaluate bleaching powder treatment as a chlorine-based method for algae control** Examine the effectiveness of bleaching powder in releasing free chlorine for direct oxidation of algal cells. Compare speed of action, residual effect, and overall efficiency against lime treatment.
3. **To design an experimental setup simulating actual cooling pad conditions :** Create a small-scale polyhouse cooling pad model with circulating water and pads exposed to natural light. Provide realistic testing conditions to ensure accurate and applicable results.

4. **To compare results and recommend the most effective treatment for farmers :** Analyze algae growth patterns under different treatments. Develop practical recommendations for farmers to adopt cost-effective, long-term algae control strategies in polyhouses

4. Methodology

1. Experimental Design

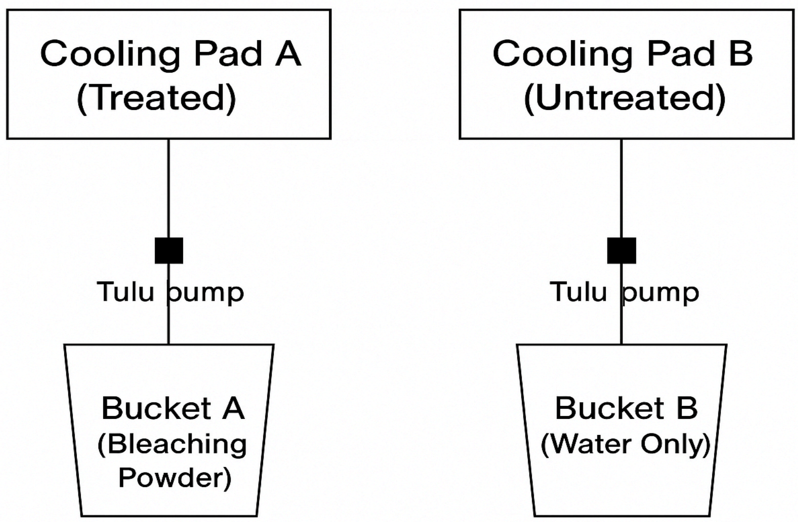
- The experiment was designed to simulate real polyhouse cooling pad conditions on a small scale, allowing controlled observation of algae growth and evaluation of algae control strategies. Two parallel setups were create:
- **Treated System (Bucket A):** Water treated with bleaching powder (chlorine-based treatment).
- **Untreated s System (Bucket B):** Untreated water to observe natural algae growth.

✧ **Materials Required**

- 2 plastic buckets (capacity: 15 liters each)
- Submersible water pumps (for continuous circulation)
- Polyhouse cooling pads (sample sections)
- Bleaching powder ($Ca(OCl)_2$) – chlorine content ~30%
- Weighing balance

✧ **Setup Design**

1. Two plastic buckets (15 L each) were prepared:
2. **Bucket A (Treated):** Water treated with Bleaching powder
3. **Bucket B (Control):** Untreated water.
4. Cooling pad samples were placed above each bucket.
5. Submersible water pumps circulated water continuously from the buckets to the top of the pads,simulating real polyhouse cooling systems.
6. Both setups were kept in natural light to encourage algae growth.



Preparation of Treated Water

- Target concentration: 100 ppm chlorine (~1 g/L).
- Calculation for 15 L bucket:

$$\text{Required chlorine} = 15\ \text{L} \times 1\ \text{g/L} = 15\ \text{g chlorine}$$

- Bleaching powder required:

$$\text{Bleaching powder} = 15 / 0.3 = 50\ \text{g}$$

- Dissolve 50 g of bleaching powder in 15 L of water in Bucket A.

Methods to Measure Algae Growth

1. **Visual Observation** (Inspect the cooling pad surface daily.)

Link of Visual Observation photos of Algae Growth :
https://drive.google.com/file/d/1cltXR7z6slo-eG-YEjuXrMfWj_a-6Zq6/view?usp=sharing

Algae Growth Observation Table :

Week No.	Date	Notes/Remarks (color, patch location, spread, etc.)	
		Treated Water	**Untreated Water**
Week 1	13/09/2025	No algae visible	The cooling pad is clean and dry; no visible algae growth. Cellulose structure fully visible.
Week 2	20/09/2025	No algae visible	Slight darkening observed at the lower edge of pad, no visible algae yet.
Week 3	27/09/2-25	No algae visible	Thin green film starts forming at the base and corners. Early algae colonization seen on continuously wet areas.
Week 4	4/10/2025	No algae visible	Green colouration is noticeable on the lower half of the pad. Algae spreading upward.
Week 5	11/10/2025	No algae visible	Moderate algae growth; patchy green and brown zones visible. Slight clogging observed .
Week 6	18/10/2025	No algae visible	Dense green growth on 60–70% of the surface. The top area is still cleaner.
Week 7	25/10/2025	No algae visible	Algae layer thickens and turns darker green to brownish-green. Airflow through pad slightly reduced; slime accumulation visible.
Week 8	1/11/2025	No algae visible	Full pad covered with thick green film. Flow resistance increased; detached algae seen floating in tray water.
Week 9	8/11/2025	No algae visible	Thick, mature algae layer across pad. Greenish-brown colouration, clogged structure notice.
Week 10	15/11/2025	No algae visible	Complete algae mat formation. Brownish-green thick layer blocks airflow. Strong odour of algae noticeable.

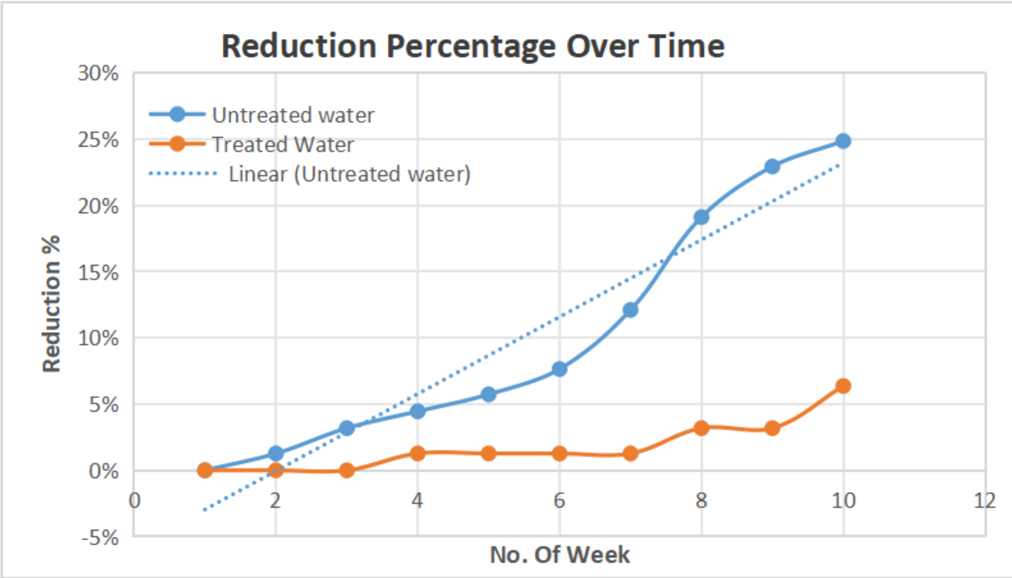
2. Measuring Airflow With Anemometer

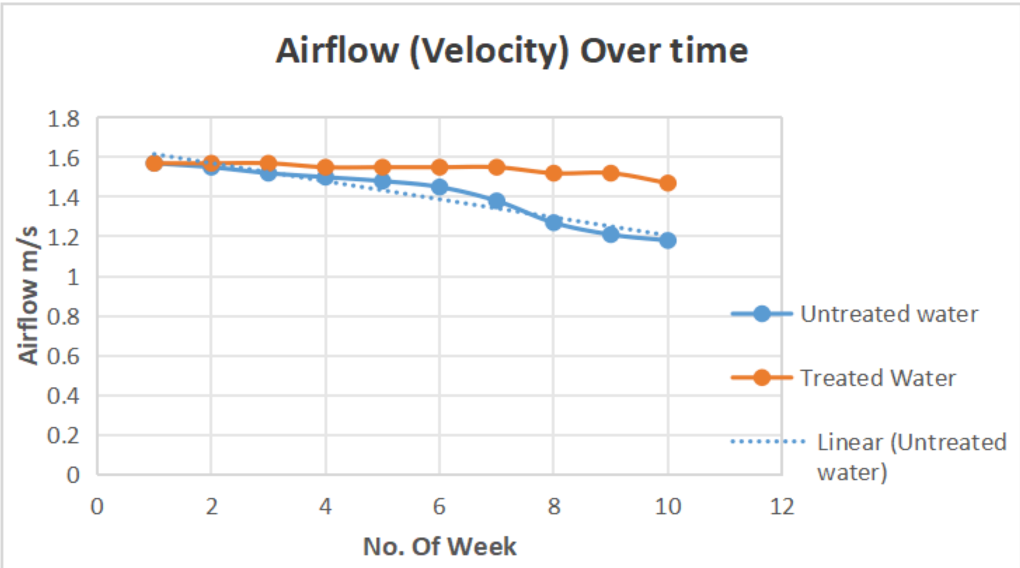
Why?

- Algae clog the pores of cooling pads.
- When pores are blocked, airflow through the pad decreases.
- An anemometer (which measures wind speed/air velocity) can directly quantify this effect.
- Gives direct evidence of how algae affects cooling pad efficiency.
- Strong, practical parameter for farmers (airflow relates to cooling performance).

Observation Table :

Week No.	Date	Treated Water		Untreated Water	
		Airflow (Velocity m/s)	Reduction %	Airflow (Velocity m/s)	Reduction %
week 1	13-09-2025	1.57	0%	1.57	0%
week 3	27-09-2025	1.57	0%	1.52	3.18%
week 4	04-10-2025	1.55	1.27%	1.5	4.45%
week 5	11-10-2025	1.55	1.27%	1.48	5.73 %
week 6	18-10-2025	1.55	1.27%	1.45	7.64 %
week 7	25-10-2025	1.55	1.27%	1.38	12.01%
week 8	01-11-2025	1.52	3.18%	1.27	19.10 %
week 9	08-11-2025	1.52	3.18%	1.21	22.92 %
week 10	15-11-2025	1.47	6.36%	1.18	24.84 %





Conclusion: Algae Growth on Cooling Pads (Based on Airflow Observation and Reduction Percentage)

The experiment aimed to study the effect of algae growth on the performance of cooling pads by measuring **airflow velocity** over a period of 10 weeks using an **anemometer**. The comparison was made between two systems — one using **treated water(Bleaching Powder)** and the other using **untreated water**.

1. Airflow (Velocity) Analysis

✔ In the **Untreated water** setup, the airflow velocity gradually decreased from **1.57 m/s in Week 1** to **1.18 m/s by Week 10**.
This represents a **24.84% reduction** in airflow.

✔ In contrast, the **treated water** system maintained a nearly steady airflow, decreasing only slightly from **1.57 m/s to 1.47 m/s**, which corresponds to a **6.36% reduction**.

✔ The trend clearly indicates that untreated water led to **faster clogging of pad pores**, reducing air movement efficiency over time.

2. Reduction Percentage Analysis

✔ The **reduction percentage graph** shows a continuous and steep increase for the untreated pad, while the treated pad shows only a slight rise toward the end of the observation period.

✔ After 6 weeks, the untreated pad had already shown around **7–8% reduction**, which continued to rise rapidly, reaching **nearly 25%** by the 10th week.

✔ The treated pad, however, maintained low reduction levels (below 5%) for most of the duration, demonstrating the effectiveness of the treatment.

- ☐ In the **treated system**, the use of anti-algae or biocidal treatment **inhibited algal formation**, thus maintaining the porosity of the pads and consistent airflow.
- ☐ **Untreated water systems** are highly susceptible to algae formation, leading to decreased airflow velocity and poor cooling performance over time.
- ☐ **Treated water systems** show a clear advantage, maintaining better airflow, cleaner pad surfaces, and improved long-term performance.
- ☐ Therefore, the use of **treated or anti-algae water** is highly recommended in evaporative cooling systems to **prevent biological clogging**, **enhance cooling efficiency**, and **extend pad lifespan**.