Resesrch Title : Study on the relationship between environmental factors and the population density of *Azolla microphylla*

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Abstract

Currently, Azolla (*Azolla microphylla*) is popular in the field of trade, and it can be used as animal feed or consumed in households because of its low cultivation cost. However, the cultivation method is not difficult and can propagate quickly and yields high yields, but the cultivation of Azolla has some limitations, such as the uncertain increase in the amount of Azolla and pests. Acidity-base (pH), dissolved oxygen content (DO), amount of light, etc. Therefore, studying the factors that affect the increase in the number of Azolla is important for farmers who cultivate Azolla. Recognizing this importance, the organizers studied the relationship between environmental factors and the density of the Azolla population in 8 ponds. The average pH was 6.09, the average temperature was 27.65 °C**,** the average TDS was 54.83 ppm, the EC was 87.83 μs/cm, the salinity was 48 ppm, the DO was 3.9 mg/L, and the water translucency was 23.14 cm. The average pH was 5.71, the average temperature was 27.67 °C, the average TDS was 57.49 ppm, the EC was 149.8 μs/cm**,** the salinity was 57 ppm , the DO was 5.1 mg/L, and the water translucency was 35.18 cm. It was found that the average EC, average DO, average Salt and average water translucency in ponds with dense Azolla populations were lower than in ponds with light Azolla populations, while the average pH, average temperature and TDS values in ponds with dense Azolla populations and ponds with light Azolla populations were similar. Based on the estimation of the population density of Azolla by the plot-based sampling method. The Quadrat Sampling Method showed that ponds 1-4 were ponds with dense Azolla populations with estimated population densities of 7,300, 6,900, 7,800 and 9,800 plants/square meter, respectively, and ponds 5-8 were ponds with light

Azolla populations with 2,575, 1,206, 331 and 672 plants/square meter, respectively. The results of the study showed that the physical properties were EC , DO, Salt and water translucency. It affects the density of the Azolla population.

Introduction

Azolla (*Azolla microphylla Kaulf.*) is a type of water fern. The leaves of the Azolla consist of green upper leaves and translucent lower leaves. The upper part of the leaf has a space in the middle of the leaf where cyanobacteria live. These cyanobacteria are called *Anabaena azollae*, which can fix nitrogen from the air. Azolla does not need nitrogen fertilizer from other sources, which contains 1.96 - 6.50 percent nitrogen. Phosphorus 0.16 - 1.59 percent Potassium 0.31 - 5.97 percent and protein 19 - 30 percent. In addition, Azolla also helps to absorb heavy metals such as mercury and chromium (Nam and Yoon, 2008; Montri Pantu et al., 2016; FAO, 2009).

Currently, Azolla is popular with farmers and the general public, such as using Azolla as animal feed. Raising Azolla for trade or even for household consumption (Home and Garden, 2024) Because it uses low cultivation costs, the cultivation method is not difficult. Azolla can propagate and grow to fill the pond within 1-2 weeks, and then it can be used and get high yields. However, the cultivation of Azolla is still limited. The main thing is that the amount of Azolla is uncertain and pests are increasing. The problem depends on many environmental factors such as climate , acidity-base (pH), water turbidity, dissolved oxygen (DO), light content, Azolla content, and water temperature, etc.

Therefore, studying the factors that affect the increase in the number of Azolla is important for farmers who cultivate Azolla. Therefore, the organizers are interested in doing a project entitled Study on the relationship between environmental factors and the population density of Azolla To use the knowledge gained to develop effective Azolla cultivation techniques. Increase yield and meet the needs of general farmers.

Objective

- To study the relationship between environmental factors and the population density of *Azolla microphlla*

Research question

1. Does the water quality affect the azolla? How?
2. Does the density of the azolla population affect the quality of water?

Hypothesis

- The high density of azolla results in poor water quality.

Methodology

This project, titled "Study of the Relationship Between Environmental Factors and the Density of Azolla Populations," was conducted using the following methods

Measuring device

1. Multiparameter Water Quality Tester (EC/pH/TDS/SALT/TEMP): 1 unit
2. Dissolved Oxygen Meter (DO Meter): 1 unit
3. Secchi Disk: 1 piece
4. Quadeate Wood Frame 1 piece

Experimental metod

1. Set survey points by searching for red algae in the area of Mueang Kalasin District, Kalasin Province, at various water sources, totaling 20 points as shown in Figure 1. Red algae were found at 8 points as shown in Figure 2, with the following coordinates
   - Point 1 coordinates 16.43056° N, 103.51339° E
   - Point 2 coordinates 16.43055° N, 103.51341° E
   - Point 3 coordinates 16.43053° N, 103.51341° E
   - Point 4 coordinates 16.48525° N, 103.45833° E
   - Point 5 coordinates 16.48501° N, 103.45841° E

- Point 6 coordinates 16.48507° N, 103.45840° E
- Point 7 coordinates 16.48515° N, 103.45833° E
- Point 8 coordinates 16.37012° N, 103.54997° E

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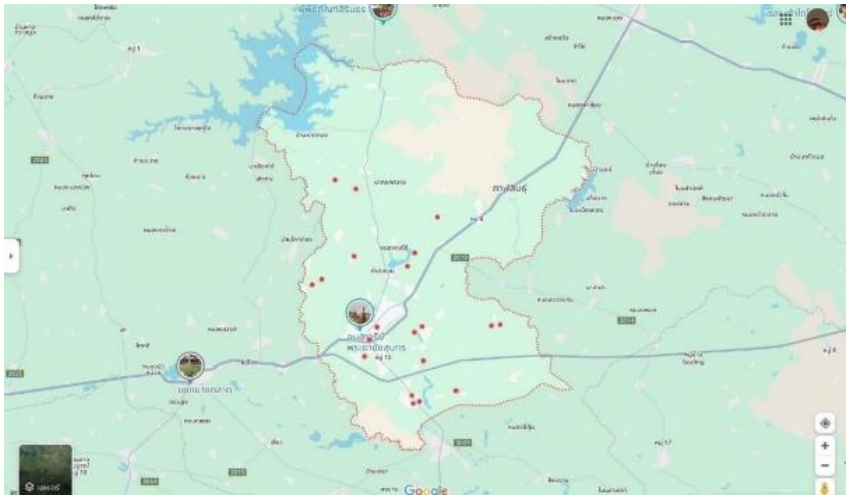


Image 1 shows the monitoring points of red algae along the water sources.

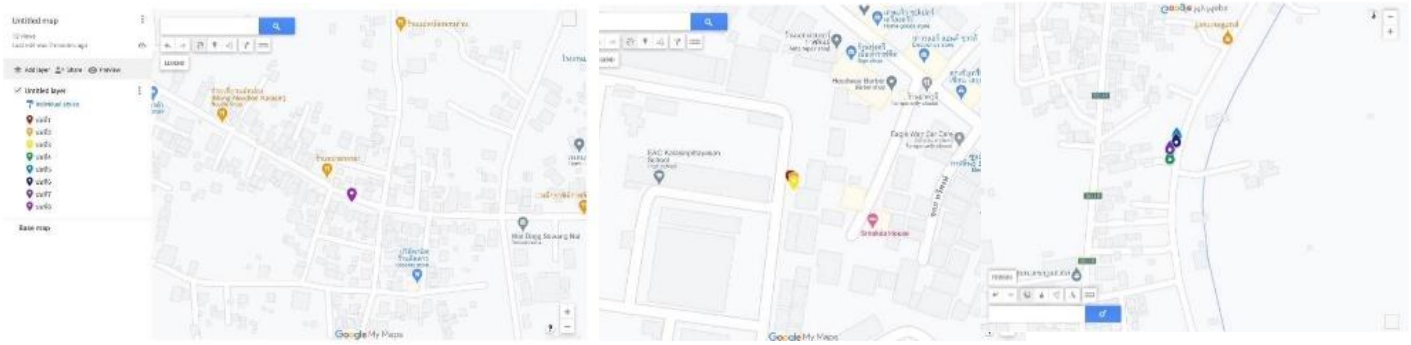


Image 2 shows the location where the red algae was found.

1. Conduct water quality measurements by measuring pH, TDS, EC, DO, temperature, salinity, and transparency in areas where azolla are found, according to GLOBE data entry, by repeating the measurements three times at each point. Then, measure the population density of red algae using a systematic sampling method.

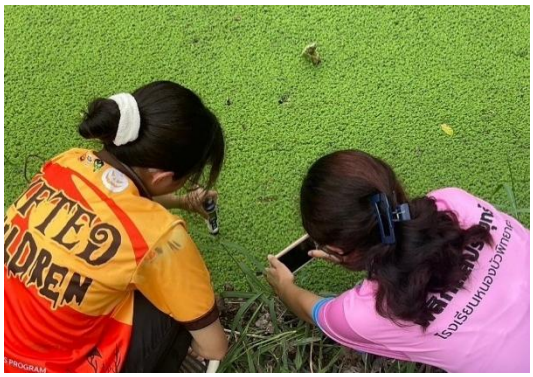


Image 3 Water Quality Measurement

Image 4 Water quality measurement values

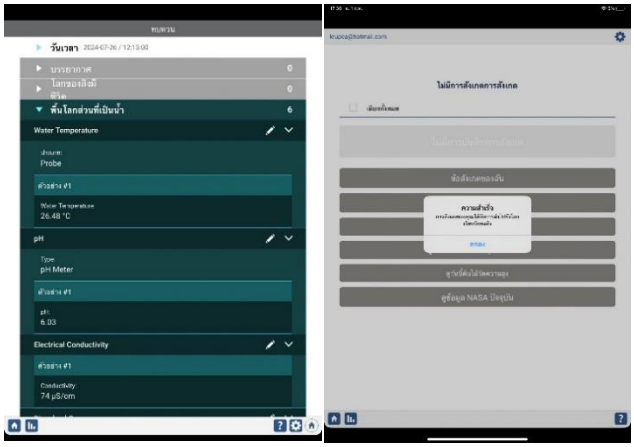


Image 5 GLOBE data entry

2. Repeat 2. three times and record the survey results.

3. Estimate the population of Azolla by the Quadrat Sampling Method using a wooden frame and plastic tubes.

   D = N/A

   D is the population density of Azolla (trees/square meter).

   N is the total number of people who can be counted (early).

   A is the total area (square meters).

Image 6 Placing a wooden frame to count the population at a pond with a light population of Azolla.

Image 7 Placing a frame of a population counting tree at a pond with a dense population of Azolla.

4. Compare the results of all Azolla surveys and make tables and graphs showing the relationship between environmental factors and Azolla population density.

Results

The study of the relationship between environmental factors and the population density of red algae has yielded the following results.

Table presenting the density and water quality parameters observed in 8 ponds with Azolla.

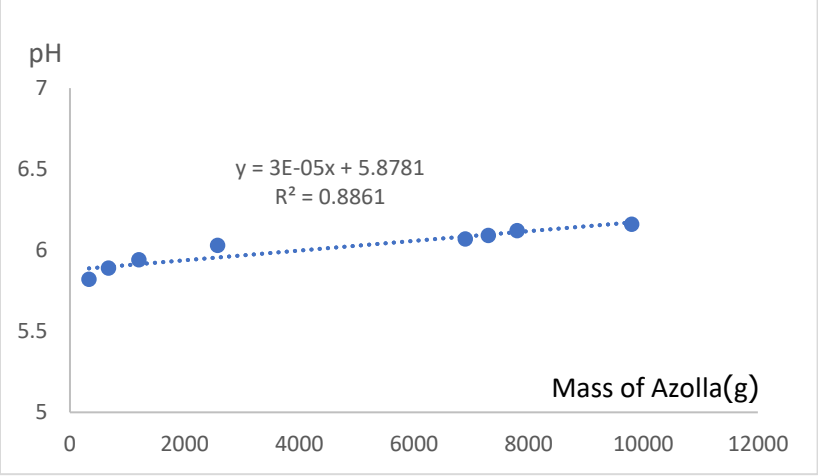
Azolla population	ponds	pH	temperature (°C)	TDS (ppm)	EC (µs/cm)	Salinity (ppm)	DO (mg/L)	Translucency (cm)	density (Tree/Sq.m.)
dense	1	6.19	27.11	34.33	73	38	3.06	18.2	7300
	2	6.03	26.48	65.33	129	64.6	2.76	13.33	6900
	3	6.16	27.1	25.33	38.66	16	3.16	27.7	7800
	4	5.98	29.94	59.33	105	59	3.86	33.33	9800
Lightweight	5	6.01	28.63	53.67	71.3	57	5.53	43.67	2575
	6	6.1	28.52	58.33	119.3	59.6	5.33	27.1	1206
	7	5.89	29.67	56	119.6	58	4.87	25.56	331
	8	5.77	27.09	56.33	289.33	56.33	5.43	44.4	672

From the table, the pH values of all 8 ponds are similar. The water temperature of the 8 wells was quite uniform at 26.89-30.89 °C, the TDS of the 1st well was 34.33, the 2nd well was 65.33 ppm, the 3rd well was 26.66 ppm, the 4th-7th well was in the range of 56-59.33 ppm, and the 8th well was 116.33 ppm, the EC value of the 1st-8th well was 78 µs/cm, 129 µs/cm, 38.66 µs/cm, 105 µs/cm, 71.3 µs/cm, 119.3 µs/ cm, 119.6 µs/cm, and 289.33 µs/cm, respectively. The salinity of pond 1 was 38 ppm, pond 2 was 64.6 ppm , pond 3 was 16 ppm, and pond 4-8 was in the range of 57-59 ppm, the DO value in ponds 1-4 was in the

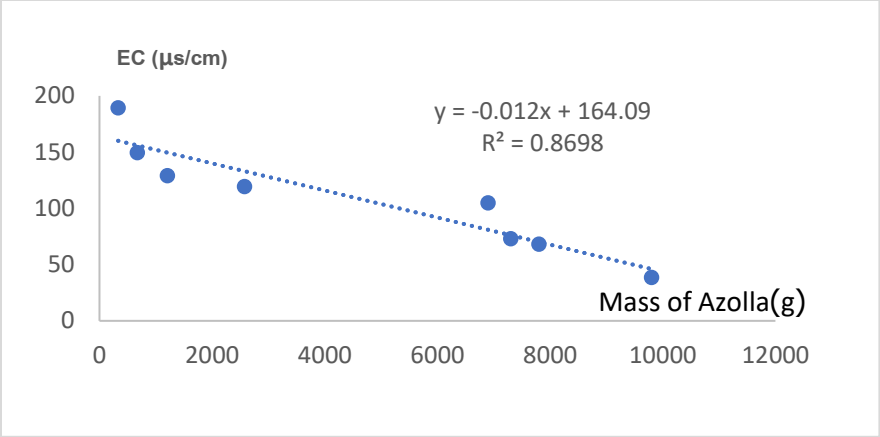
range of 2.76-3.86 mg/L, ponds 5-8 were in the range of 4.87-5.53 mg/L, the translucency in pond 1 was 18.2 cm, pond 2 was 13.33 cm, pond 3-4,6-7 was in the range of 25.56-33.33 cm, and pond 5,8 was in the range of 43.67 cm and 44.4 cm, respectively. Ponds 5-8 have a population density of 1206, 331 and 672 plants/square meter, respectively.

That the environmental factors that directly impact the density of azolla include electrical conductivity (EC), dissolved oxygen (DO), and water transparency. It was observed that azolla tend to thrive in water with low electrical conductivity, low oxygen levels, and low transparency. Meanwhile, the pH and water temperature do not show a clear correlation. When analyzing the relationship between environmental factors and the increase in the number of water hyacinths, the data is presented as follows.

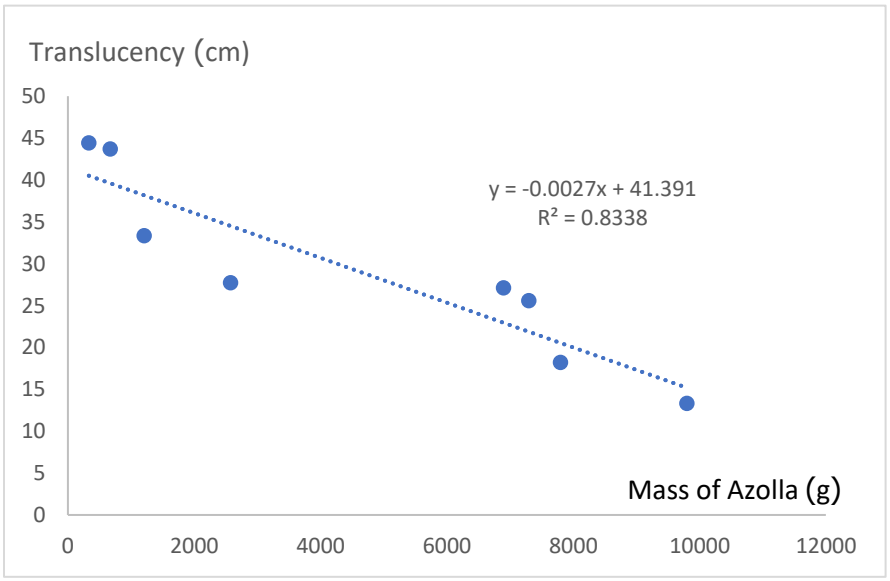
The graph shows a negative correlation between the mass of azolla (g) and dissolved oxygen (DO), indicating that as the mass of azolla increases, the DO value tends to decrease significantly (R2=0.8837).



The graph shows a positive correlation between the mass of azolla (g) and the pH value of water. It was found that as the mass of azolla increases, the pH value tends to rise according to the trend equation (R2=0.8861). However, the relationship is still not very clear as the values do not differ significantly.



The graph shows a negative correlation between the mass of azolla (g) and the electrical conductivity (EC) of water. It was found that as the mass of azolla increases, the EC tends to decrease according to the trend equation (R2=0.8698), indicating that duckweed may play a role in absorbing ions or solutes in the water, resulting in a decrease in electrical conductivity.



The graph shows the relationship between azolla mass (g) and transparency value (cm) with a negative linear trend (y = -0.0027x + 41.391), indicating that an increase in azolla mass results in a decrease in transparency value. This relationship has a correlation coefficient of R2=0.8338, indicating a strong correlation between the two variables.

Summary and Discussion

This study found that *Azolla* thrives in environments with low electrical conductivity, low dissolved oxygen levels, and low water transparency, while pH and water temperature showed no clear correlation with its growth. Additionally, *Azolla* biomass exhibited a negative correlation with electrical conductivity, dissolved oxygen, and water transparency, but a positive correlation with pH. These findings suggest that *Azolla* may play a significant role in altering the chemical balance of aquatic ecosystems.

Discuss the results of the experiment

Finding the relationship between environmental factors and the population density of Azolla. Areas studied from natural water sources Wastewater source and Azolla pond in Kalasin Province It was found that the acidity-base and temperature values In ponds with dense and light populations of Azolla, the values are similar. It was found that the TDS value, EC value, DO value, salinity value, and translucency value were It is related to the population density of Azolla.

In ponds with a dense population of Azolla, there is a correlation in the opposite direction to the TDS , EC, DO, salinity and translucency in ponds with light Azolla populations were correlated in the same direction with TDS , EC, DO, salinity and translucency. In conclusion, Azolla is a plant that often lives in wastewater. In line with Pantip Klomjek (2015), it was found that Azolla can be well formed in the wastewater where the Azolla is in the treatment system . It has values between 25.3-32 ℃, 0.26-5.52 mg/L, 6.02-8.88 and 489.0-670.0 **µs/cm**, respectively.

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