# ASSESSING THE CORRELATION OF THE WATER ENVIRONMENTAL QUALITY AND THE GROWING ABILITY OF THE WATER HYACINTH

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***Abstract***

*The results of the analysis and evaluation of the growth and development of water hyacinth in experimental locations by the ecological fixation method of vegetable development in Sai Gon river basin - Thu Dau Mot, Binh Duong showed that after 84 days of experiment, the water hyacinth in different locations had the growth of stem, roots, leaves and buds. However, this growth at other locations is different. Statistical results also showed that the water quality indexes of $BOD_5$, COD, total nitrogen, total phosphorus were highly correlated with the increase in the raw weight of the hyacinth. In which total nitrogen, total phosphorus is the largest correlation.*

***Keywords**: plant growth, surface water pollution, Water hyacinth, water quality indicators*

## INTRODUCTION

Water hyacinth is a very common aquatic plant in our country, which can adapt to many different types of water sections such as canals, ditches, ponds, lakes, rivers, etc... (Pham Hoang Ho, 2000). In some areas, water hyacinth is very useful because they are exploited as raw materials for the production of handicrafts, food of animals (Nguyen Dang Khoi & Nguyen Huu Chiem, 1985) , or for the treatment of wastewater (Nguyen Xuan Hoang & Le Hoàng Viet, 2004), biogas digesters, However, in other areas , hyacinth is considered as a dangerous exotic species, because they grow very quickly when they are in favorable condition, they rapidly spread over the surface of the water causing the traffic jam in the river and threatening the life of other aquatic species. Over the past years, the appearance of hyacinths on the canals of the Saigon river basin, which flows through Thu Dau Mot, Binh Duong, has become increasingly dense. One of the main reasons for the rapid development of water hyacinths is the fact that the water in Saigon River is seriously polluted by industrial, agricultural and domestic wastes. The paper studies on the correlation between water quality and the development of hyacinth helping to predict the outbreak of hyacinth through water quality indexes.

## METHOD OF STUDYING

### Method of ecological experiment layout

***Hyacinth used for experimentation*:** Hyacinths are harvested from different water places around the study site such as rivers, ponds, ditches, and then raised in the same watershed. Selecting

the hyacinths has similar weight, stem length, root length, and number of leaves for the experimentation.

***Experiment layout*:** Three frames are put on each survey site. They are three square metres each by using bamboo to fix the cells and using the net to surround around this the selected location. The experiment was arranged as follow:

***Figure 1.*** *Experiment layout to feed the water hyacinths*

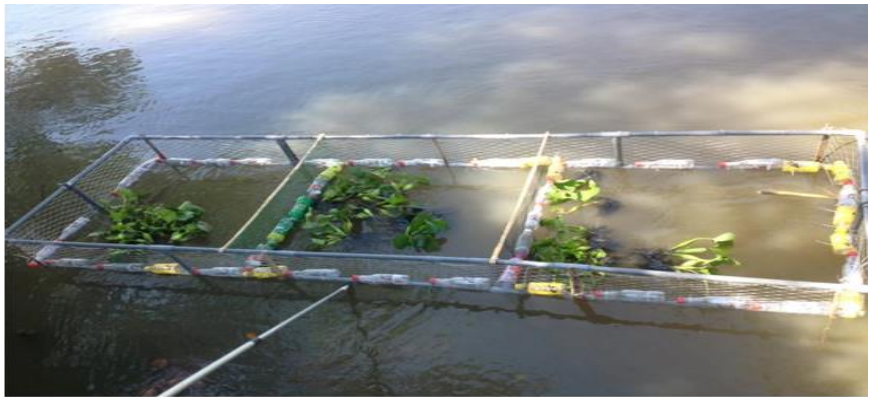


***Table 1.*** *Experimental locations and Coordinates*

| Location (LC) | LC1 | LC2 | LC3 |
|---|---|---|---|
| Coordinate | 11°1'4"N | 11°1'1"N | 11°2'19"N |
| | 106°37'3"E | 106°35'56"E | 1 06°36'15"E |

*LC1: There are no waste sources around; LC2: There are some fishing ponds; LC3: There are some pig farms with a wastewater ditch draining into the river*

Weighing the fresh weight of hyacinth (W1). Measuring the length of the stem and root. Counting the number of shoots, number of leaves, and then putting 10 trees in each plot. The selected hyacinths should be approximately the same length (27-28 cm), root length (18-19 cm) (Xie & Yu, 2003), weight (169-172 g), leaf number (4 leaves).

Measuring the growth parameters of the hyacinth (fresh weight, stem length, root length, number of shoots and leaf ) every one time per two weeks (Nguyen Thi Thu Thuy, 1988). The water hyacinths are measured within 84 days (Tran Si Nam, Nguyen Vo Chau Ngan, & Nguyen Phuong Chi, 2014), (Huynh Thanh Tuan, 2013).

**Sampling and analysis methods**

Samples were taken every one time per two weeks at three locations with coordinates as arranged experiment. At each cross section, taking water samples at depths of 50 cm and 100 cm underwater by using a horizontal sampling device (Wildco, USA). Sampling and preservation methods comply with the current Vietnamese Standards TCVN 6663-6: 2008 (Sampling) and TCVN 6663-3: 2008 (preservation of samples) (Holst, Rees & Wilson, 2005), (Haller, Sutton &William, 1972).

***Table 2.*** *Methods of analysis of water quality Indexes at Thu Dau Mot University Laboratory.*

| Number | Index / Unit | Method |
|---|---|---|
| 1 | DO/ mg/l | Electrochemistry |
| 2 | COD/ mg/l | Closed Return - Photometry |
| 3 | $BOD_5$/ mg/l | Keep at $20^0$C, Measuring $DO_0$ and $DO_5$ |

| Number | Index / Unit | Method |
|---|---|---|
| 4 | Total phosphorus/ mg/l | Decomposing the sample by persulfate method and then determining the ortho-phosphate by ascorbic acid method. |
| 5 | Total nitrogen/ mg/l | Decomposing the sample by persulfate method and then transforming all nitrogen compound in the sample to nitrate then determining by the OPP method. |

**Method of Calculating and Data Processing**

Data of the analysis indexes were processed by descriptive statistics and checked correlation with fresh weight of hybrids by regression statistic model.

## RESULTS AND DISCUSSION

**Development of water quality indexes**

**pH:** At each experimental location, the pH value was measured twice per month. Taking three values for one time. Calculating the average value (6 samples) in each month at three test locations with the following results:

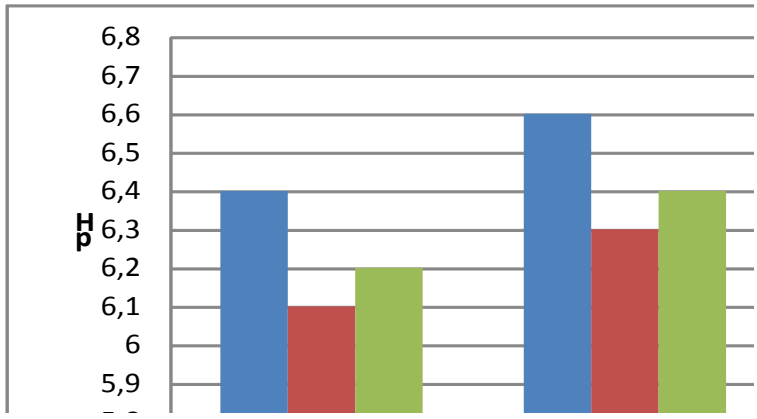



***Figure 2**. Development of pH value (monthly average) at three experimental locations*

The results showed that the pH value range from 6.1 to 6.7 at all three text locations, which were suitable for the development of the water hyacinth. The appropriate value range for the development of hyacinth is 6-8 (Wilson et al., 2005).

**COD:** The sampling frequency for COD, BOD, total phosphorus and total nitrogen analyzes at three test locations was done similar to the pH sampling.

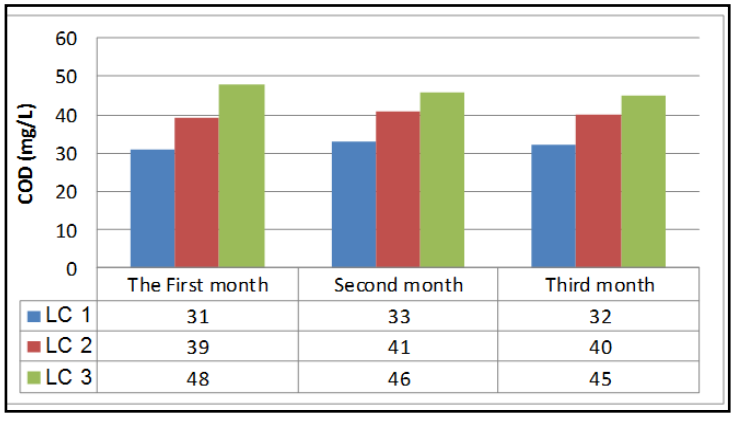



***Figure 3**. Development of COD value ( monthly average ) at three experimental locations*

Analysis Results showed that the highest COD value at the third location was 48 mg / L. The COD value at the other two positons range from 50 mg / L to 40 mg / L. The COD concentration is quite high compared to QCVN 08: 2008 / BTNMT (between B1 and B2 columns)

**BOD**

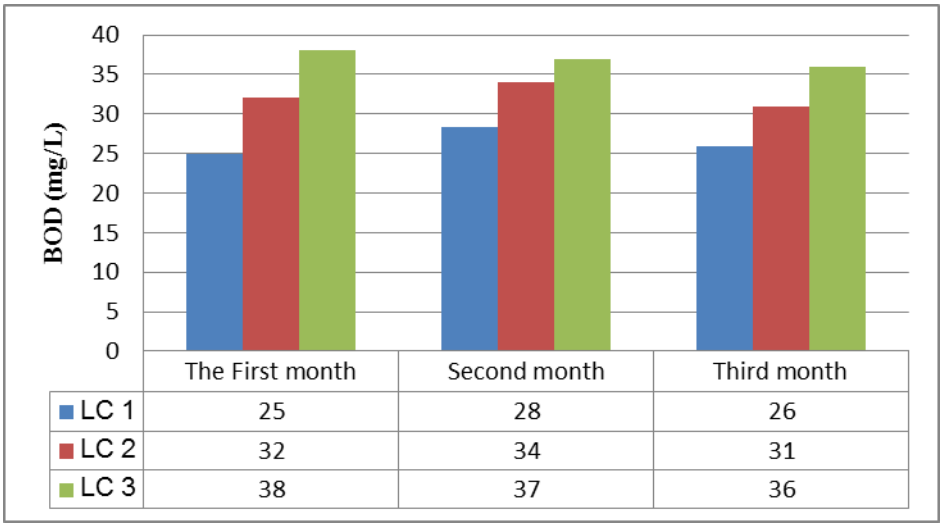



***Figure 4**. Development of BOD value ( monthly average ) at three experimental locations*

The Results of the analysis showed that the BOD value at three study locations were stable. There was no significant difference between months. The highest BOD level is at the third location was 38 mg /L. For the other two locations, the BOD value range from 25 mg /L to 34 mg /L.

**Total phosphorus**

The results showed that the highest concentration of phosphorus at the third position was 0.6 mg / L due to this place was passed through to the fish ponds for changing water or supplying water in it. The other locations have a total phosphorus concentration range from 0.3 mg / L to 0.5 mg / L. In general, the phosphorus level stayed on the limit of column B2 (0.5 mg / L). However, some values at the third location are higher than 0.1 mg / L.

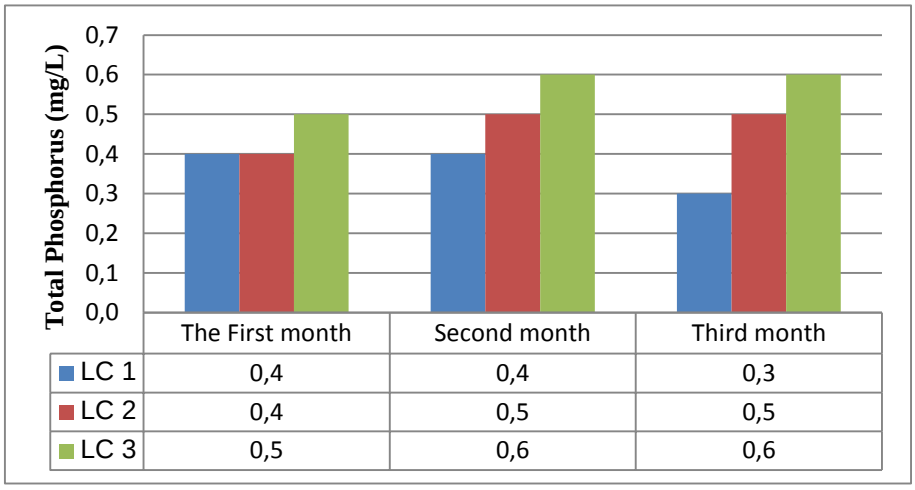
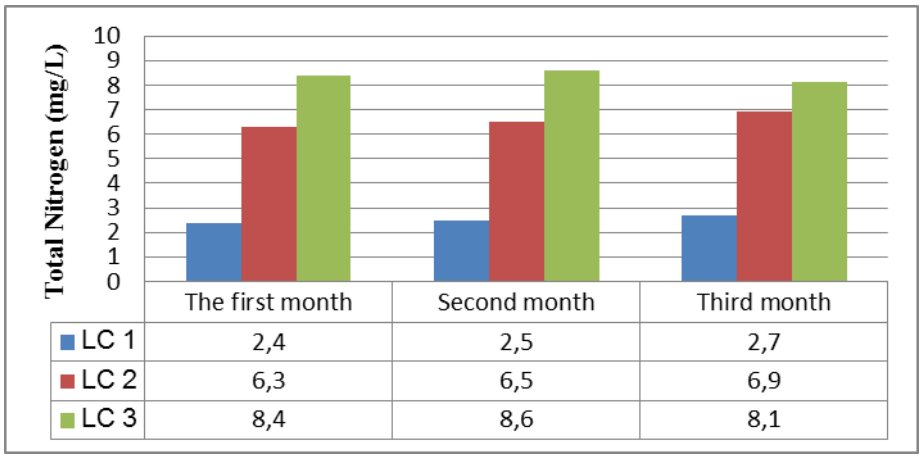



***Figure 5**. Development of* Total phosphorus *value ( monthly average ) at three experimental positions*

**Total nitrogen**




| | The first month | Second month | Third month |
|---|---|---|---|
| LC 1 | 2,4 | 2,5 | 2,7 |
| LC 2 | 6,3 | 6,5 | 6,9 |
| LC 3 | 8,4 | 8,6 | 8,1 |

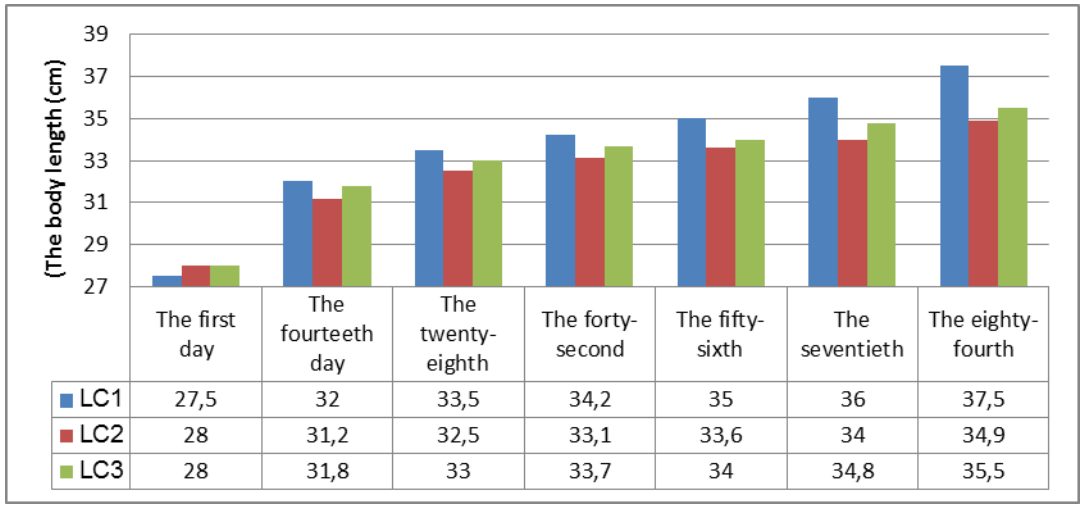
***Figure 6**. Development of* Total Nitrogen *value ( monthly average ) at three experimental locations*.

The results showed that the total nitrogen concentration in each study location was quite stable. However, there is a big difference in the research positions. The values ranged from 2.4 to 8.1 mg / L. The lowest total nitrogen concentration was at the first location (2.4 mg / L) and highest at the third location (8.6 mg / L). This is interpreted that the water environment in the first location is often disturbed by traffic vehicles on the river and there is also no secondary discharge source. At the third location have a high nitrogen value due to there is a waste from the pig farm. However, this value is still in the limits of QCVN 08: 2008 / BTNMT (column B1).

**The growth of hyacinth in the experimental locations**

***Growth of the body length***

At the beginning of the experiment, the length of the hyacinth was about 27.5-28cm. At the end of the tests, the length of the hyacinth was increased. In particular, hyacinth in the first location has the largest body length (37.5cm), the smallest was in the second location (34.9cm), and the third position was 35.5cm.

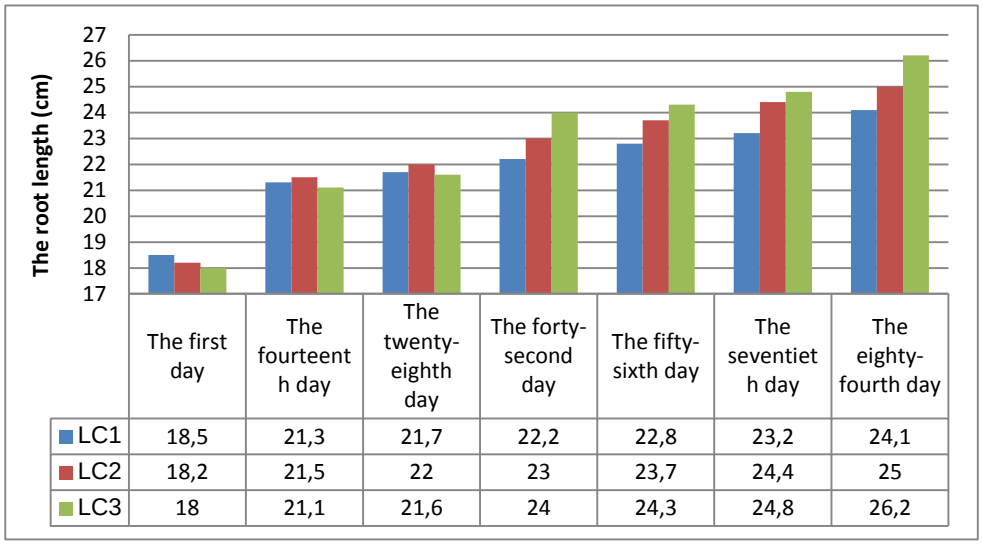



| | The first day | The fourteeth day | The twenty-eighth | The forty-second | The fifty-sixth | The seventieth | The eighty-fourth |
|---|---|---|---|---|---|---|---|
| LC1 | 27,5 | 32 | 33,5 | 34,2 | 35 | 36 | 37,5 |
| LC2 | 28 | 31,2 | 32,5 | 33,1 | 33,6 | 34 | 34,9 |
| LC3 | 28 | 31,8 | 33 | 33,7 | 34 | 34,8 | 35,5 |

***Figure 7**. Development of the body length* over time *at three experimental locations***.**

The picture shows that the hyacinth in the first position grew fast on the length of the stem because of its high intensity of light, so the tree tends to grow in length. The fastest body length of the hyacinth grows in the first 14 days, the average increase from 1.8-2cm, the highest increase in the first position and the least increase in the second location. After this period the body length grow slowly and stably.

***Growth of root length***



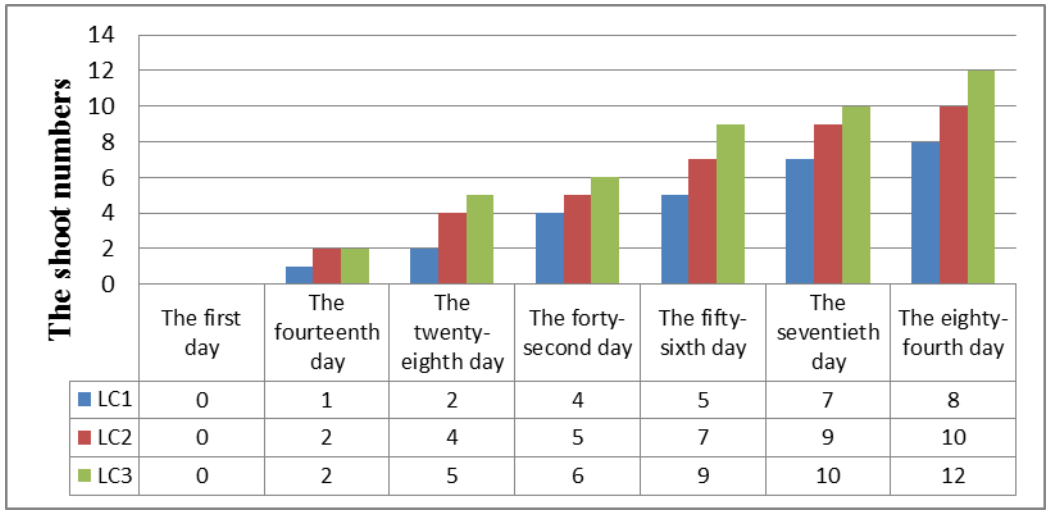

| | The first day | The fourteenth day | The twenty-eighth day | The forty-second day | The fifty-sixth day | The seventieth day | The eighty-fourth day |
|---|---|---|---|---|---|---|---|
| LC1 | 18,5 | 21,3 | 21,7 | 22,2 | 22,8 | 23,2 | 24,1 |
| LC2 | 18,2 | 21,5 | 22 | 23 | 23,7 | 24,4 | 25 |
| LC3 | 18 | 21,1 | 21,6 | 24 | 24,3 | 24,8 | 26,2 |

***Figure 8****. Development of the root length* over time *at three experimental locations***.**

The root length of the hyacinths at the beginning of the experiment was relatively uniform around 18 and 18.1 cm. After 84 study days, the root length of the hyacinth was the highest at the third location (26.2 cm), the lowest at the first location was 24.1 cm. Results of the study also showed that in the first 14 days of experiment the root length increased steadily, from the next day the root length at the third location increased significantly, the other two locations grew slowly. Because in the first location has a disturbance frequently, so when the tide changes, the roots in the bottom will be hurt causing the damage. On the other hand, there is no secondary source of waste at this location so that affects the growth of the hyacinth . According to Nguyen Dang Khoi (1985), roots contribute 20 ÷ 50% of total weight depending on the nutritive environment. So the growth of the root greatly influences the weight of the hyacinth.

***Growth of the shoot hyacinth numbers.***

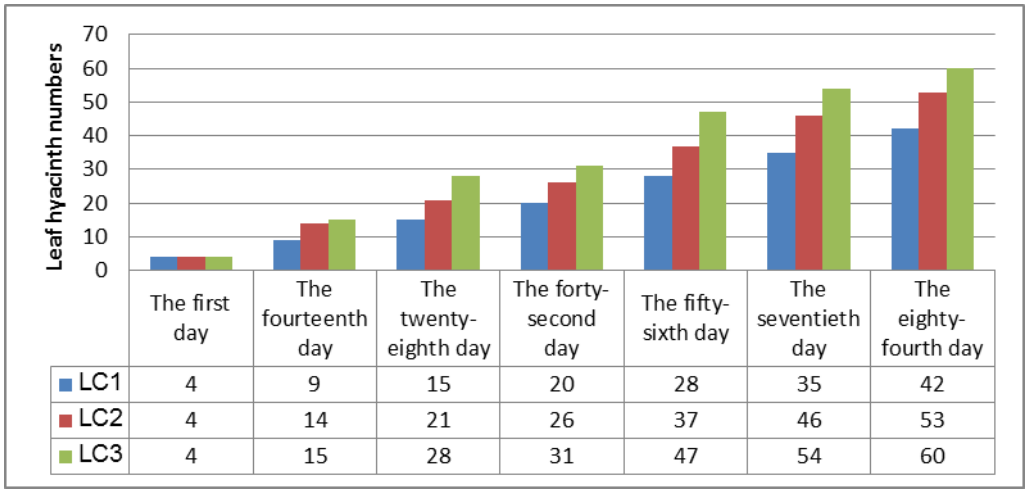
The results showed that after 84 days, the shoot hyacinth at the third location was one of the highest numbers (12 shoots), 4 shoots compared to the first location (8 buds) and 2 shoots compared to the second location (10 buds). During the first 14 study days the number of the shoot hyacinth only increased from 1 to 2 shoots. That is explained due to in the first days, hyacinths need time to adapt and grow. After adapting to the environment, the water hyacinth grows and the number of shoots increases more quickly. In addition, the open area and nutrition of the habitat is related to the increasing of the shoot numbers.




| | The first day | The fourteenth day | The twenty-eighth day | The forty-second day | The fifty-sixth day | The seventieth day | The eighty-fourth day |
|---|---|---|---|---|---|---|---|
| LC1 | 0 | 1 | 2 | 4 | 5 | 7 | 8 |
| LC2 | 0 | 2 | 4 | 5 | 7 | 9 | 10 |
| LC3 | 0 | 2 | 5 | 6 | 9 | 10 | 12 |

***Figure 9**. Development of the shoot numbers* over time *at three experimental locations*

***Growth of the leaf hyacinth.***




| | The first day | The fourteenth day | The twenty-eighth day | The forty-second day | The fifty-sixth day | The seventieth day | The eighty-fourth day |
|---|---|---|---|---|---|---|---|
| LC1 | 4 | 9 | 15 | 20 | 28 | 35 | 42 |
| LC2 | 4 | 14 | 21 | 26 | 37 | 46 | 53 |
| LC3 | 4 | 15 | 28 | 31 | 47 | 54 | 60 |

***Figure 10**. Development of the leaf numbers* over time *at three experimental locations*

Initially, the number of the leaf hyacinth was chosen equally (4 leaves). After 84 days, the number of leaf hyacinth was increased many times compared to the beginning of the experiment. The average numbers of leaf hyacinth at the third location was 60 (highest), 42 leaves at the first location, and 53 leaves at the second location. The results showed that the number of leaf hyacinth in the first 14 days increased slowly, but after that period the its number increased rapidly, especially at the second location 2 and the third location. It can be said that the increase of leaves depends entirely on the increase of shoots and it depend on the nutrient of the habitats.

***Growth of the raw hyacinth weight.***

At the beginning, the fresh weight of the hyacinth at positions 1, 2, and 3 were 115g, 116g, 116g in turn. During the first 14 days of the experimentation, hyacinths started adapting and growing well. The fresh weight of hyacinths on the fourteenth day at locations 1, 2,and 3 were 150g, 157g and 160g in turn. The results showed that the fresh weight of the hyacinth in all locations tended to increase in the next periods. At the end of the experiment, the fresh weight of

water hyacinth in the third location was 765g, The growth increases 1.39 times over the first location and 1.1 times over the second location. They grow fast and the raw weigh at the third location is the highest because of the pig farm near there while at the first position the hyacinths grows slowly due to there is low nutrient such as nitrogen and phosphorus.

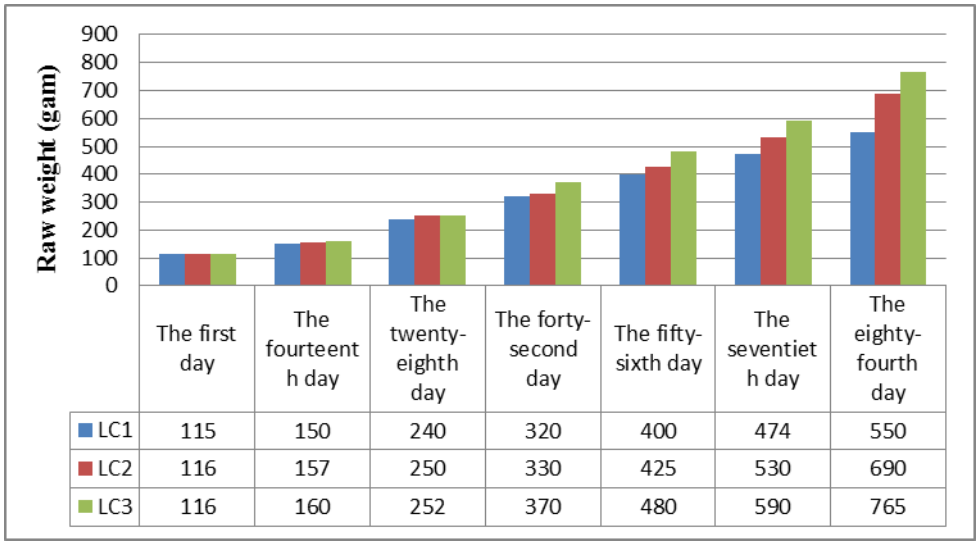



***Figure 10**. Development of the raw weight hyacinth* over time *at three experimental locations*

**The correlation between the increase of the hyacinth weight and the environmental factors.**

***Table 3.** The correlation between the hyacinth weight and the environmental factors.*

| | **LC1** | **LC2** | **LC3** |
|---|---|---|---|
| Increasing weight (g) | 435.0 | 574.0 | 649.0 |
| $COD_a$ | 32.0 | 40.0 | 46.3 |
| $BOD_{5a}$ | 26.4 | 32.3 | 37.0 |
| Total phosphorus ($P_a$) | 0.4 | 0.5 | 0.6 |
| Total nitrogen ($N_a$) | 2.5 | 6.6 | 8.4 |

*Note: Average is abbreviated "a"*

***Table 4**. Regression model of the correlation between the hyacinth weight and the environmental factors at three test locations.*

| **Factors** | ***Regression model*** |
|---|---|
| $COD_a$ | RW = 15.071* COD – 41.648 (2) |
| $BOD_{5a}$ | RW = 20.33* $BOD_5$ – 95.85 (3) |
| Total phosphorus ($P_a$) | RW = 1070* $P_{tb}$ + 17.667 (4) |
| Total nitrogen ($N_a$) | RW = 35.864* $N_{tb}$ + 343.46 (5) |

*Note: Row weight is abbreviated "RW"*

The growth of water hyacinth depends on environmental factors such as pH, BOD5, COD, total nitrogen, total phosphorus. Each factor affects the growth of the hyacinth in different directions. Statistical results showed that COD, $BOD_5$, total nitrogen, and total phosphorus (BOD5), total phosphorus were strongly correlated with the increasing of raw hyacinth weight (0.9 <R Square <1).

## CONCLUSION

After three months of experiment, all parts of the hyacinth body such as roots, shoots and leaves have grown. The raw weight growth of hyacinths was linear with the environmental factors are COD, BOD, Total Nitrogen, Total Phosphorus.

The growth of hyacinth was the best at the third location and was the worst at the first location due to there is a waste water from the pig farm nearby and also less boat crossings at the third location so that do not disperse nutrients or affect the roots.

Statistical results showed that the COD, BOD, total nitrogen and total phosphorus values were highly correlated with the growth of the raw hyacinth weight.

The growth of the shoot numbers at the third location was 1.5 times compared to the first location and 1.4 times compared to the second location.

At present, that the hyacinths grow fast is a problem of traffic jam on the Saigon River. It also threatens to the lives of other aquatic species that lead to an ecological imbalance. So we need to control of secondary sources. We are also particular about nutrient-rich sources such as nitrogen, phosphorus, and BOD that cause eutrophication. On the other hand, it is necessary to clean the surface of water in the river to reduce the rapid growth of the hyacinth.

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