

# Growth and N and P Absorption Capability of *Pistia Stratiotes* Cultured in the Inorganic Fertilizer Enriched Media

Kamaruddin Eddiwan<sup>1\*</sup>, Efawani<sup>1</sup> and Rizky Janatul Magwa<sup>1</sup>

<sup>1</sup>Laboratory of Aquatic Biology, Faculty of Fisheries and Marine, University of the Riau, Campus BinawidyaJln HR Soebrantas, KM 12.5 Kecamatan Tampan, Pekanbaru City, Riau Province, 28293, Indonesia

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**\*Corresponding author:** Kamaruddin Eddiwan, Laboratory of Aquatic Biology, Faculty of Fisheries and Marine, University of the Riau, Campus BinawidyaJln HR Soebrantas, KM 12.5 Kecamatan Tampan, Pekanbaru City, Riau Province, 28293, Indonesia, Tel: +6285265408159; E-mail: kamaruddineddiwan@gmail.com

## Abstract

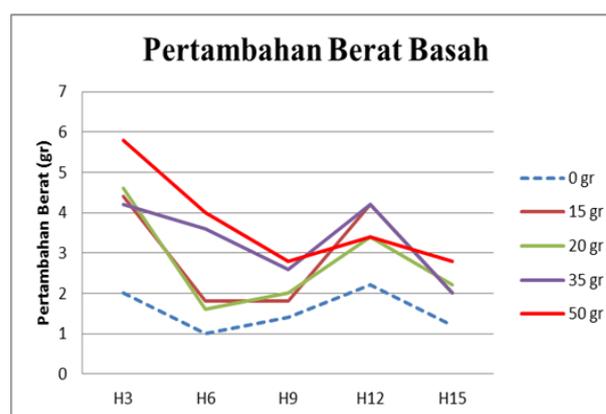
*Pistia stratiotes* are able to grow rapidly in culture medium given inorganic compounds. *P. stratiotes* cultured in a culture medium that has been given nitrates, phosphates and potassium (NPK) fertilizer. *P. stratiotes* cultured in a culture medium that has been given NPK fertilizer. A CRD with 5 concentrations of inorganic fertilizers tested, i.e. 0 (Co); 15 (T1); 20 (T2); 35 (T3); and 50 g / 10 L (T4). Observation of growth and decrease of the inorganic compound in culture medium was done 5 times, every 3 days. The results show that the best growth was identified in plants grown in T4. At the end of the experiment, 18.8 g BW with a daily growth rate was 17.9% of the baseline value of BW. On the 7th day of the experiment, the decrease was 0.187 mg / L (N) and 0.237 mg / L (P). So *P. stratiotes* were able to absorb relatively high N and P from water and use it for its growth.

**Keywords:** *P. stratiotes*; Growth; inorganic materials absorption;

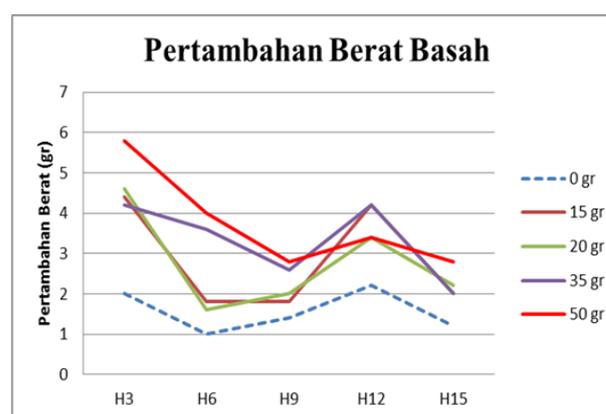
## Introduction

*P. stratiotes* is a species of water plants most commonly found in the public waters in Pekanbaru City, province of Riau, Indonesia. These aquatic plants usually grow in waters that have been polluted, especially those that contain a lot of organic waste, due to the large amount of disposal of food, household, market, and so on. The waste has resulted in an increase in the content of inorganic compounds in general waters. As a result, the content of inorganic compounds in general waters around the city of Pekanbaru to be high and this, in turn, will affect the balance of the ecosystem of public waters [11].

Based on reports from previous researchers, public waters in Riau province at this time have many that experienced pollution, mainly due to the inorganic and organic material into the water in excess. [19] States that the high content of inorganic compounds in the waters can affect the abundance of organisms, but for some organisms, such waters condition is still tolerable, although later there will be species dominance in the ecosystem



**Figure 1:** Test results on the change of wet weight due to the treatment of different organic materials during the study



**Figure 2:** Test results on the growth of the number of petiole to the treatment of different organic materials during the experiment

[21]. In an effort to control the imbalance of the ecosystem, and reduce the concentration of pollutants (organic and inorganic) in the common waters it can be done by utilizing the biological function of water plants, one of which can use *P. stratiotes* as phytoremediation [4].

The ability of *P. stratiotes* to decrease the content of organic and inorganic materials present in waters is very large and is environmentally friendly (Figure 2). The biological function of the *P. stratiotes* allows it to absorb the organic and inorganic compounds in the waters, and this capability varies greatly depending on the size of the plant [13]. One characteristic of hyper accumulator plants such as *P. stratiotes* is resistant to nutrients in high concentrations. Its root ability to absorb ground-based elements is quite high when compared to other aquatic plants, and it also has the capability of transplanting and accumulating organic and inorganic materials from root to tree canopy [14], *P. stratiotes* has the ability to directly absorb elements C, O, H from air, N, P, K, S, Ca, and Mg from pollutant and soil through their root organs [20], *P. stratiotes* ability to absorb organic and inorganic compounds are due to the process of ion movement between the cells and penetrate the cell membrane [15].

[19] Reported that the effect of feeding on fish pellets on the growth of *P. stratiotes* was able to reduce high ammonia levels in the waters. However, the study still does not explain the ability of *P. stratiotes* to absorb nutrients N and P is. In this connection, this experiment wanted to know clearly about the ability of *P. stratiotes* to absorb the nutrients (N and P).

## Materials and Methods

This research was conducted in February - March 2018, and the experiment was conducted in Aquatic Biology Laboratory Faculty of Fisheries and Marine University of Riau. Testing of *P. stratiotes* on N and P was done by using a completely random design with 1 factor and 5 levels. Then the pH, DO and temperature conditions during the experiment were observed.

## Experimental design

In this experiment was used Completely Randomized Design. Treatment is an inorganic compound with 5 levels (dose 0, 15, 20, 35, 50 gram), and repeated 5 times. Observations are made every 3 days for 15 days. (Figure 3) The observed responses were changes in root length (cm), leaf (mm), number of leaves (sheets/plants), new shoots (fruit), biomass (wet weight) and *P. stratiotes* ability to absorb nitrate and phosphate compounds in experimental media [15]. The experimental container uses a circular plastic jar. While the *P. stratiotes* test sample used was 7 grams' weight, which was cultured in water as much as 10 L per container, and on the bottom of the container was given 200 gram of soil substrate from the reservoir in public waters.

## Data analysis

Data of measurement result of NO<sub>3</sub>, PO<sub>4</sub>, pH, temperature were analyzed descriptively. Daily growth rate calculator (LPH) *P.*

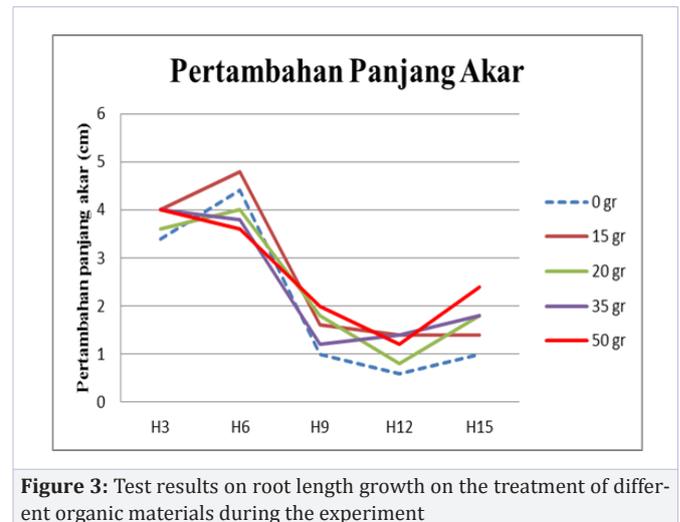


Figure 3: Test results on root length growth on the treatment of different organic materials during the experiment

*stratiotes* used the formula:

$$\alpha = \frac{Wt - Wo}{t}$$

Information:

$\alpha$  = Daily growth rate (gr / day)

Wt = final weight of *P. stratiotes* (gr)

WO = initial weight of *P. stratiotes* (gr)

t = length of maintenance (days)

The ability of *P. stratiotes* in absorbing organic compounds is calculated using the formula

$$Rate P = \frac{Nutrient\ early - Nutrient\ end}{T\ end - T\ early}$$

(Table 1) Meanwhile, to see the difference to the wet weight (biomass) it is used statistical analysis with the level of accuracy (significance)  $\alpha = 1\%$ .

## Results and Discussion

### Water Plant Growth *P. stratiotes*

#### Biomass Increase

From the experimental results, it is known that the highest growth of wet weight of *P. stratiotes* occurred at 50 g treatment with the average of 18.8-gram wet weight increase. (Table 2) At the 0-gram treatment is known to be very slow growth with an average of 7.8 cm. (Figure 1) The height of this wet weight growth is due to absorption of N and P elements from the culture medium so that it affects growth and is very good for the growth of *P. stratiotes*. Idris (2014), the increase of biomass in aquatic plants can occur due to the presence of luxury consumption which is marked by the decrease of nutrients in the waters. Excessive Luxury consumption is a common response to water plants in accumulating N and P elements higher than normal and used for

**Table 1:** A description of the difference in wet weight due to the effect of different treatments of organic matter on the day of the experiment

Test length (days)	The treatment of organic matter (g)				
	P <sub>0</sub>	P <sub>15</sub>	P <sub>20</sub>	P <sub>35</sub>	P <sub>50</sub>
1	7	7	7	7	7
3	9	11.4	11.6	11.2	12.8
6	10	13.2	13.2	14.8	16.8
9	11.4	15	15.2	17.4	19.6
12	13.6	19.2	18.6	21.6	23
15	14.8	21.2	20.8	23.6	25.8
Total	7.8	14.2	13.8	16.6	18.8
Percentages (%)	111	203	197	237	269

**Table 2a:** The test results on the average length of the total number of petiole due to the treatment of different organic materials during the experiment

The treatment of organic matter	Day of the test					
	1	3	6	9	12	15
P <sub>0</sub>	0	0.8	1.4	2.2	3	3
P <sub>15</sub>	0	1.6	3	4.2	4.8	6.8
P <sub>20</sub>	0	1.4	3	4.2	5.8	7.6
P <sub>35</sub>	0	1.4	3.6	5.2	6.2	7.6
P <sub>50</sub>	0	1.4	3	4	5.6	7.8

**Table 2b:** Experimental results of giving different organic materials to the range of stalk growth on *P. Striotes*

The treatment of organic matter	Day of the test					
	1	3	6	9	12	15
P <sub>0</sub>	0	1-2	2-4	2-4	2-4	2-4
P <sub>15</sub>	0	1-2	3-5	2-7	3-9	5-12
P <sub>20</sub>	0	1-2	2-5	3-8	3-10	3-10
P <sub>35</sub>	0	1-2	2-5	3-7	3-9	3-12
P <sub>50</sub>	0	1-2	2-4	3-6	3-8	4-11

growth, as a form of food reserves to support its growth activity [18].

### Added New Shoots

The result of the measurement of the new shoot increase is known to increase the most shots occur on the 15th day (5-12 shoots) and at least occur on day 3 (1-2 shoots). Many of its new buds are caused by growth activity as a result of the absorption of organic compounds present in the culture medium. (Table 3) While the small shoots are caused at the time of the 3rd day the plant is still adaptable and the energy obtained from organic compounds is still used for the growth of leaves and other organs, and yet for shoot formation. Where the increase of inorganic compounds on the test medium tends to increase the new shoots in the *P. stratiotes* [13]

The highest number of shoots was found in the 50 g treatment with a shoot-increase range of 4-11 fruit/plants. The treatment

of inorganic compound 0 g is the least shoot growth (0-4 fruits/plant), and this new shoot comes from stolen. A stolen is more formed on test media containing nutrients. Bey (2007), more stolen is formed on the test water which contains many nutrients (inorganic material) in high concentration so that the number of tillers produced more and more. The formation of saplings in plants *P. stratiotes* derived from stolen.

Rijal (2014), *P. stratiotes* is a plant that can breed not only generatively through pollination on flowers, but also vegetative. Breeding can be done because it is able to form stolen. (Table 4) The stolen can be cut off at the end and will break off and grow into a new individual. Rao, PN, and Reddy, USA (1984) stated that this water plant can develop rapidly, because it can be done with generative and also vegetative by using stolen so that with the ability, the plant can grow and can expand and form big colony that can cover the entire surface of the waters available to them [6].

**Table 3:** Test results on root length growth on the treatment of different organic materials during the experiment

Test length (days)	The treatment of organic matter (g)				
	P <sub>0</sub>	P <sub>15</sub>	P <sub>20</sub>	P <sub>35</sub>	P <sub>50</sub>
0	18.2	18.4	18.4	18.2	18.4
3	21.6	22.4	22	22.2	22.4
6	26	27.2	26	26	26
9	27	28.8	27.8	27.2	28
12	27.6	30.2	28.6	28.6	29.2
15	28.6	31.6	30.4	30.4	31.6
Total	10.4	13.2	12	12.2	13.2
Percentage (%)	57	72	65	67	72

**Table 4:** The results of the test on the increase of leaf number on the treatment of different organic materials during the experiment

The treatment of organic matter		Test length (days)					
		0	3	6	9	12	15
P <sub>0</sub>	Average	5.4	7	9	10.4	11.6	12.4
	Range	5-6	6-8	9-12	9-12	11-12	11-13
P <sub>15</sub>	Average	5.4	7.2	9.2	11.2	12	13
	Range	5-6	7-8	8-10	10-12	11-13	12-14
P <sub>20</sub>	Average	5.4	6.4	8.2	10.2	11.6	13
	Range	5-6	6-7	7-10	9-12	10-12	12-14
P <sub>35</sub>	Average	5.2	6	7.6	9.4	10.4	12
	Range	5-6	5-7	6-9	8-10	9-12	10-14
P <sub>50</sub>	Average	5.2	6.8	8.4	10	10.8	12.2
	Range	5-6	6-7	7-9	9-12	9-13	10-14

### The growth of Root Length

The measurements on the longest root growth length of roots are 31.6 mm and the mean of 22 mm. This longest root addition is due to the ability of *P. stratiotes* to absorb the organic compounds optimally. While the shortest root growth occurs because in concentrations 20 and 35 the *P. stratiotes* cannot absorb organic compounds optimally. Sridhar, (1986), the tendency that increased doses of inorganic compounds on test media will prolong the growth in the root of water plants *P. stratiotes*. N nutrient elements will be absorbed through the roots first by water plants *P. stratiotes* for the sake of growth [19].

At the 50 g treatment known to occur the largest growth of root length, with a total average growth of 13.2 cm while the longest root length growth is on the treatment of 0 g inorganic compounds with a total growth rate of 10.4 cm. (Figure 8) This can happen because the elements of nitrate and phosphate in the test medium affect root growth in plants. Sitrabio (2012), the function of phosphorus (P) elements for plants is for root growth, flowering, ripening fruit/ seed/grain. (Table 5) The P element

also serves for the preparation of cell nuclei, fats, and proteins. In addition, P element also serves to stimulate the defense of plant cells and enlarge cell tissues [15].

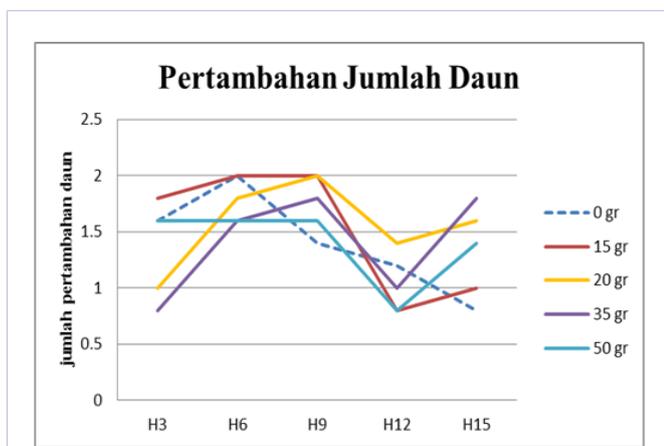
The treatment of inorganic compounds with a dose of 50 g has the longest root growth. This is caused by aquatic plants of *P. stratiotes* using N nutrients in test medium for root length growth. Walstad (2007) explains that many N compounds in the waters will be able to accelerate the growth of roots but also can damage the plant because it can be toxic to the roots. Water plants *P. stratiotes* utilize the excess of N elements in the test medium for root growth [20].

### Increase in Number of Leaves

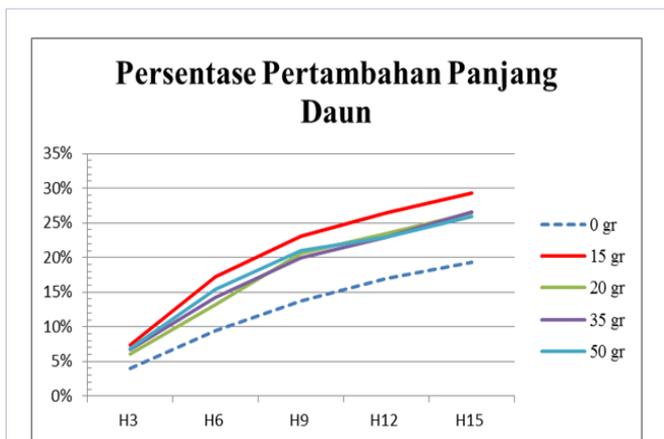
The highest number of leaves was found in the treatment of inorganic compound 35 g with a leaf range of 10-14 sheets/plant. While the least leaf growth is found in the treatment of 0 g with a leaf range of 11-13 sheets/plant. In the treatment of inorganic compound, 35 g is the highest leaf addition. This occurs because of the presence of excess nitrogen elements in the treatment of

**Table 5:** Experimental results on the treatment of different organic matter to the leaf length (mm) during the study

Test length (days)	The treatment of organic matter (g)				
	P <sub>0</sub>	P <sub>15</sub>	P <sub>20</sub>	P <sub>35</sub>	P <sub>50</sub>
0	31.2	29.7	30.3	29.1	32.6
3	32.5	32.1	32.3	31.1	34.1
6	34.5	35.9	34.9	33.9	37.6
9	36.2	38.7	38.2	36.3	40.2
12	37.6	40.5	39.6	37.7	41.2
15	38.7	42.1	41.2	39.8	42.9
Total	7.4	12.3	10.9	10.5	10.3
Percentage (%)	24	41	36	36	35



**Figure 4:** The results of the test on the increase of leaf number on the treatment of different organic materials during the experiment



**Figure 5:** Experimental results on the treatment of different organic matter to the leaf length (mm) during the study

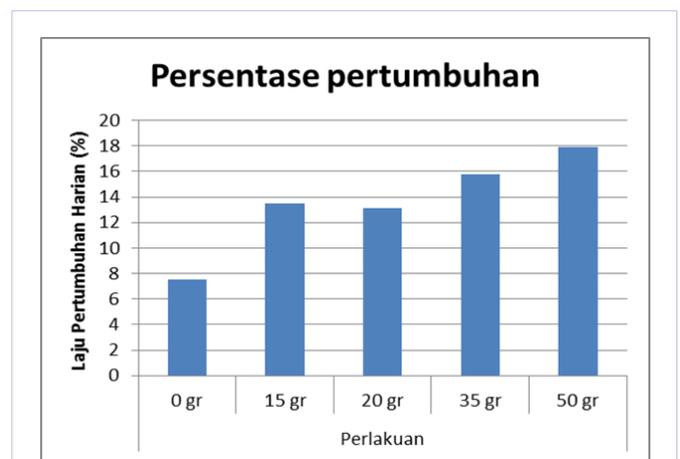
inorganic compounds 35 gr. Sitrabio (2012), nitrogen function for plants is for vegetative growth (to enlarge, enhance, and green the leaves), and nitrogen also serves to arrange chlorophyll and leaves. Lack of nitrogen elements will cause the plant will experience slow growth/dwarf. The leaves will be yellowish-

green, the size of the leaves narrow or small, and the leaves will quickly fall. (Figure 4) Leaf number growth is one of the vegetative growth parameters for *P. stratiotes* [14].

(Figure 5) Leaf growth is more likely to grow in high concentrations of inorganic compounds so that the number of leaves produced is also more numerous, but the number of leaves decreases with increasing dose of inorganic compounds on the test media, there has been a change of inorganic compounds into glutamine (Warsono and Sigit, 2001), In the test medium, the ammonium changes into glutamine that takes place rapidly in the leaves will accelerate the formation of new leaves. The impact will be the number of leaves that many in a relatively short time.

#### Daily Growth Rate

(Figure 6) The percentage of daily growth of *P. stratiotes* on the treatment of several doses of inorganic compounds showed that the fastest daily growth occurred at 50 g treatment, with the growth of 18% per day. While at 0 g showed very slow growth (7.5% per day) Very slowly this growth is due to differences in the level of inorganic compounds given to the *P. stratiotes* Besides environmental factors such as turbidity, temperature, and availability of nutrients in the water, can have an effect on water plants [24-38].



**Figure 6:** Percentage of Growth

### Influence of Inorganic Compound Growth on Growth

Based on the result of variance analysis test with SPSS application ver.17, at 35 g and 50 g of the inorganic compound showed the very real difference (Ho rejected, F arithmetic <F

table). (Table 6) The accepted hypothesis is that alleged inorganic compounds dissolved in the culture medium affect the growth of *P. stratiotes*. The administration of inorganic compounds in *P. stratiotes* showed the very different effect on the treatment of 35 g and 50 gr.

**Table 6:** The average daily growth measurements on the treatment of different organic materials during the study

Measurement	Treatment				
	P <sub>0</sub>	P <sub>15</sub>	P <sub>20</sub>	P <sub>35</sub>	P <sub>50</sub>
Daily growth (gr/Hari)	0,52	0,95	0,92	1,1	1,25
Percentage (%)	7,5	13,5	13,1	15,8	17,9

### Absorption of *P. stratiotes* Water Plant on Nutrients (N and P)

Absorption of water plants *P. stratiotes* most drastically decreased i.e. until the day of 7 (middle), with the absorption of N (0.122 mg / L) and P (0.054 mg / L). After the 7th day until the 15th shows the elements of N and P increase again, because on observation day 9 and 12 shows the leaves of dead water plants and roots that fall into the bottom of the water. The leaves that fall to the bottom of these waters will become the envelope of nutrients in the culture medium. In addition, *P. stratiotes* also decreased in growth, ranging from growth of weight and root length because *P. stratiotes* have reached maximum absorption on the 7th day. Increased morphological size of *P. stratiotes* is due to its ability to absorb nutrients in the water medium used for its growth. Nutrients that are needed in sufficient quantities for plants are N and P. Other very important elements are K,

Ca, Mg, and S. This is possible because each plant has different capabilities to absorb and translocate nutrients [5]. In addition, each test plant has a maximum limit of nutrient absorption of different elements, so that when the nutrient absorption of plants to nutrients has reached the maximum limit, how much nutrients that exist in the planting medium, the plant will not absorb again [3].

(Table 7) Plants derive the ingredients necessary for growth through the roots by absorbing water from the surrounding environment by isotonic means. Roots also absorb minerals along with water absorption [7]. The transport of water and mineral salts is carried out by absorption by root cell cells, after passing through the root cells, which dissolves into the wood vessels (xylem) and then there will be vertical transport from root to stem to leaf, then taken to all parts of the plant by plant tissues ie phloem [10].

**Table 7:** Decrease of Nutrient Elements (N and P) during the experiment

Nutrient	Time	The treatment of organic matter (g)					Mean
		P <sub>0</sub>	P <sub>15</sub>	P <sub>20</sub>	P <sub>35</sub>	P <sub>50</sub>	
Nitrate	Early	0,0958	0,1479	0,1792	0,2313	0,1688	
	Central	0,0125	0,0646	0,0542	0,0438	0,0333	
	End	0,1276	0,1792	0,2729	0,5021	0,3979	
	Decrease	0,0833	0,0833	0,1250	0,1875	0,1355	0,1229 (75%)
	Rate of decline	0,0119	0,0119	0,0178	0,0267	0,0193	0,0176
Phosphate	Early	0,3319	0,3540	0,4425	10,841	11,261	
	Central	0,2367	0,4403	0,5465	0,8473	0,9934	
	End	0,6546	0,7965	0,8031	19,496	22,898	
	Decrease	0,0952	0,0863	0,1040	0,2368	0,1327	0,0548 (20%)
	Rate of decline	0,0136	0,0123	0,0148	0,0338	0,0189	0,0078

(Figure 9) shows that the more roots absorb the nutrients the darker the root color of the *P. stratiotes*. [3] On root morphological observation, it is known that *P. stratiotes* roots begin to change color at the observation interval where the roots of plants are reddish or brown so that the petals are finally released from the stem. This happens because the root of *P. stratiotes* is part

of the plant that first interacts directly with the water media, so that the root organ will be quickly damaged compared to other organ parts of the plant in response to toxins from outside the plant body especially for aquatic plants [3]. In addition, the longer phytoremediation time also showed a change in the color of leaves that began to look yellowish green and in some plants appeared

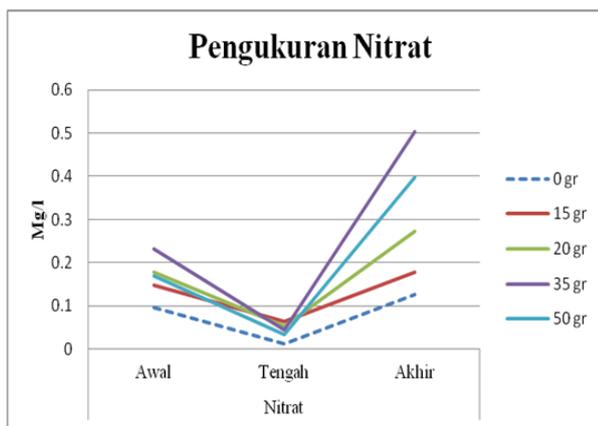


Figure 7: The result of measurement of nitrate compound content in culture medium during the study

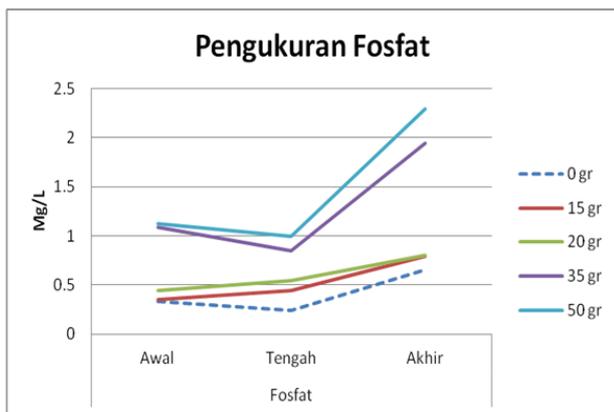


Figure 8: The result of measurement of phosphate compound content in culture medium during the study

new shoots. Furthermore, Haslam in Hermawati (2005) states that leaf color changes to yellowish in some species can be caused by contamination of organic matter. The growth of new roots and buds may be the way plants survive [2].



Figure 9: Test samples and differences in root length of *P. stratiotes* due to the effect of different treatments of organic matter during the study

### Water Quality in Culture Media

Measurements of supporting parameters such as temperature and pH are performed to determine environmental conditions that can support the growth of water plants *P. stratiotes*. Research results on water quality parameters can be seen in (Table 8). Based on (Table 8) it can be seen that the increase in pH value at the end of observation is caused by photosynthesis of water plants *P. stratiotes*. Mara in Priyono (2007), that in the process of photosynthesis intensive (daytime), free CO<sub>2</sub> in water will be used up under these conditions, bicarbonate (HCO<sub>3</sub>) converts to CO<sub>2</sub> and ions of OH<sup>-</sup> [22] the dominance by these hydroxyl ions results in increased pH in the waters [16].

Table 8: Water Quality in Culture Media

Waters Parameter	Time	The treatment of organic matter (g)				
		P <sub>0</sub>	P <sub>15</sub>	P <sub>20</sub>	P <sub>35</sub>	P <sub>50</sub>
Temperature	Early	29	29	29	29	29
	Central	28	28	28	28	28
	End	28	28	28	28	28
pH	Early	6	6	6	6	6
	Central	6	6	6	6	7
	End	6	6	7	7	7
Nitrate	Early	0,0958	0,1479	0,1792	0,2313	0,1688
	Central	0,0125	0,0646	0,0542	0,0438	0,0333
	End	0,1276	0,1792	0,2729	0,5021	0,3979
Phosphate	Early	0,3319	0,3540	0,4425	1,0841	1,1261
	Central	0,2367	0,4403	0,5465	0,8473	0,9934
	End	0,6546	0,7965	0,8031	1,9496	2,2898

The value of N and P analysis on the test media showed that on the 7th day experienced a drastic decrease due to rapid absorption by water plants *P. stratiotes*. Absorption of N and P is used of aquatic plants for the growth of these aquatic plants [19]. After the 7th day of N and P again rises due to the introduction of new organic matter from loose leaves According to Idris (2014), the presence of fluctuating nitrate in test media is a combination of dispersion by aquatic plants and the process of nitrification of ammonia and nitrite (Figure 7). This is thought to occur because of the absorption of ammonia by low water plants and the ammonia undergoes a nitrification process that produces nitrate [12].

## Conclusion

The growth of *P. stratiotes* in culture medium given inorganic compounds shows the growth of water plants biologically. The longest leaf growth and the fastest number of leaves occur in the treatment of inorganic compounds 15 gr / 10 L of water. In the treatment of inorganic compounds, 50 gr / 10 L can affect the weight gain of wet, root length, and new shoots. The fastest daily growth is in the 50 gr treatment, with the growth of 18% per day. The result of statistical analysis showed that the effect was very different from the inorganic compound treatment of 35 g and 50 g / 10 L water.

*P. stratiotes* were able to decrease N-nutrient N by 75% from initial nitrate and decrease of nutrient P by 20% up to day 7 (centre). After the 7th day the water plants of *P. stratiotes* must be removed from the waters, otherwise, the nutrients in the water will again increase due to the ingress of nutrients from the *P. stratiotes* plant. Based on the results of the research, *P. stratiotes* showed nutrient uptake which is the result of decomposition of organic matter characterized by increasing biomass. Therefore, water plants *P. stratiotes* can be utilized as a nutrient absorbent nutrient (N and P) phytoremediator in the waters.

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