Comparison between organic and inorganic fertilizers

Abstract

This experiment was designed to investigate the effectiveness of chicken manure as organic fertilizer and urea as inorganic fertilizer on Lemna minor. Nowadays, Lemna minor have many uses such as food sources, sewage treatments and so on. Thus, Lemna farming is increasing around the world. Lemna minor was used as an indicator for the effectiveness of fertilizers in this experiment by observing the number of leaves after applying the fertilizers. Twenty beakers with each having 5 Lemna minor that have the same number of leaves were treated with urea and chicken manure. Then, all the beakers left under sufficient light condition for 8 days and the results were recorded and analysed. The statistical Mann-Whitney U test was chosen to test the experimental hypothesis with 0. 05% of significant level. The results appeared that urea was better than chicken manure in stimulating the growth of Lemna minor.

Additional words: Lemna minor, urea, chicken manure

Experimental Hypothesis:

There are significant differences in the final number of leaves between the inorganic fertilizer (urea) and organic fertilizer (chicken manure) on Lemna minor. Urea will be better than chicken manure on Lemna farming.

Null Hypothesis:

There is no difference in the final number of leaves between the inorganic fertilizer (urea) and organic fertilizer (chicken manure) on Lemna minor.

Research and Rationale:

The objective of this experiment is to compare the effectiveness of chicken manure and urea fertilizers on Lemna plants (Lemna minor). Fertilizer is a substance that contains essential plant nutrients which are added to the surrounding of plant. The fertilizers can add directly into the soil or water, or spray directly in the air or plants' leaves. The soil and water environment often do not contain sufficient nutrients for perfect growth in plants[1]. Therefore, fertilizers play a role to provide extra nutrients for plants to obtain maximum growth rate.

There are two types of fertilizers that are organic and inorganic. Organic fertilizers are derived from living materials such as animals' wastes, crop residues, compost and by-products of living organisms[2a]. In contrast, inorganic fertilizers are chemically synthesized from non-living sources which contain the same elements as organic fertilizers.

The organic fertilizers have the properties of slow release of nutrients; but, inorganic fertilizers do not. Problems will emerge if some plants' roots absorbed too much nutrients than necessary from the fertilizers. Thus, the roots will burn up and this is called fertilizer burn[3]. The slow releasing form of nutrients in organic fertilizers can partially prevent fertilizer burn[iii]. Furthermore, the organic fertilizers are even cheaper and safer compared to inorganic fertilizers[2c]. Apart from that, organic fertilizers are biodegradable which will not contaminate the water sources[2b].

On the other hand, the advantage of inorganic fertilizers is the immediate releasing of nutrients for the absorption to take place. It is also convenient to

use as well as affordable in term of pricing. The most preferable part is that all the necessary proportions of nutrients can be measured and altered to suit certain types of plants' growth.

Material

The most important nutrients for plant growth are macronutrients such as potassium, nitrogen and phosphate ions[3]. Nitrogen ion is essential for the production of amino acids, proteins and enzymes for photosynthesis. Besides, phosphate ion is important in the formation of cell membrane and adenosine triphosphate (ATP). Furthermore, potassium ion is crucial for the metabolisms of plant to take place[ii]. Without those macronutrients, the plant growth will get stunted. However, different plants might need different proportions of nutrients. This leads to different rate of plants' growth.

Recently, the researchers discovered that Lemna plants are very useful for the treatment of anaerobic effluents from digested pig waste under the temperate climatic conditions[11]. Furthermore, the Lemna minor are food sources for fish. Besides, Lemna minor can be used to assess the toxicity of chemicals and in the biopharmaceuticals field[4]. Moreover, Lemna minor were tested for the adjuvant properties to enhance the human immune system[12].

To conclude, both organic and inorganic fertilizers will have an effect on Lemna plants due to the released of extra nutrients.

Planning:

Several trials were carried out in the process of modifying the investigational procedure. To conduct the trials, small samples were used to give the idea of whole experiment.

Trial 1: The type of samples

A trial was done to choose the best sample for the experiment. Firstly, two petri dishes with 20 ml of distilled water were prepared. Three cabbage seedlings with each has 3 leaves were used in the first petri dish; whereas, three Lemna minor with each has 3 leaves were used in the second petri dish. Then, two grams of chicken manure was added into both petri dishes. After 4 days, the number of plants and leaves were observed and recorded in the table below.

Type of samples

Therefore, the Lemna minor obviously is the best sample to be used in the experiment because it showed dramatic effects when fertilizer is added.

Trial 2: The type of fertilizers

This trial was conducted to discover which materials of organic and inorganic fertilizers will give the most marked effects on Lemna plants. Five petri dishes with 20 ml of distilled water were prepared. Five Lemna plants of having same number of leaves were placed petri dishes. Then, ten grams of organics fertilizers (crop residues, chicken manure) and inorganic fertilizers (urea, anhydrous ammonium nitrate) were dissolved in the distilled water. Nevertheless, one control petri dish was designed with only distilled water

and Lemna plants. After 6 days, the number of Lemna plants were counted and recorded in the table below.

Type of fertilizers

Since organic fertilizer (chicken manure) and inorganic fertilizer (urea) showed the most significant result than other materials of fertilizers, thus both type of fertilizers are chosen as the manipulate variable in the experiment.

Trial 3: Suitable concentration of fertilizers

This trial experiment was designed to deduce the optimum concentration of fertilizers on Lemna plants. Six petri dishes with 20 ml of distilled water were prepared. Five Lemna plants with each having 3 leaves were placed in each petri dish. Then, different mass of fertilizers that are 5 g, 10 g and 15 g were weighed with electronic balance and dissolved in the petri dishes with glass rod. After 7 days, the number of plants and leaves were counted and recorded in the table below.

As is illustrated by the table, both fertilizers will give optimum effects within the range of 5 grams to 15 grams fertilizers on Lemna plants. Fifteen grams of fertilizers cause fertilizer burn to Lemna plants. Thus, some of the Lemna's leaves will turn brown and yellow in colour. Therefore, 10 g of both fertilizers are used in the main experiment.

This trial was conducted to determine the most suitable indicator for Lemna's growth. Two petri dishes with 20 ml of distilled water and 5 Lemna plants that each having 3 leaves were prepared. Ten grams of organic and

inorganic fertilizers were dissolved separately in petri dishes. After 7 days, the changes were observed and recorded in the table below.

Type of fertilizers

Growth is defined as the permanent increase in the number of cells, mass and size of organisms[iv]; in this experiment, it refers to the increase in number of leaves. This can indicate the effect of fertilizers on Lemna plants. In contrast, the number of Lemna plant was not consistent as Lemna plants reproduce vegetative by chance[i]. Some of the plants might have lots of leaves but low reproduction rate and vice versa. Thus, the number of leaves is the most appropriate indicator in measuring the growth of Lemna plants in this experiment.

Trial 5: The most suitable time to observe results

The trial was carried out to identify the best period of time to get the results. The experiment was set up with 20 ml of distilled water and 5 Lemna plants that each has 3 leaves with organic and inorganic fertilizers in 2 different petri dishes. Then, the changes in petri dishes were observed and recorded for 11 days in the table below.

Day 8 will be the most preferable day to get the results in this experiment. After day 8, some of the plants had decomposed or the nutrients might not sufficient to stimulate the Lemna’s growth. Thus, it is better to get the results below 10 days to prevent decomposition which might affect the accuracy of result. Besides, the petri dishes can be replaced by 100 ml of beaker to prevent water spill out.

Trial 6: The most suitable statistical test

Since the data from trial experiments were not normally distributed, non-parametric method is the most suitable method for statistical analysis. Non-parametric statistical methods are mathematical procedures for the hypothesis testing which is distribution-free on data[5]. There are a few methods such as Wald-Wolfowitz test, Mann-Whitney U test and the Kolmogorov-Smirnov for two sample test[6]. However, Mann-Whitney U test is chosen to verify the experimental hypothesis as it is more easily to work with small samples of 2 variables.

Main Experiment

Variables:

Manipulated variable

:

Inorganic fertilizer (urea) and organic fertilizer (chicken manure)

Responding variable

:

The final number of leaves on Lemna plants after 8 days

Fixed variable

:

The initial number of leaves on Lemna plants, the same mass of fertilizers' powder used, the same volume of distilled water

Apparatus:

Twenty 100 ml beakers, label stickers, measuring cylinder, electronic balance, forcep, glass rod, hand glove, spatula, mortar and pestle, cling film, open chamber, crucible

Materials:

Urea pellet, chicken manure pellet, distilled water, Lemna plants

Procedures:

Twenty 100 ml beakers that filled with 20 ml of distilled water were prepared by using a measuring cylinder.

Ten beakers were labelled with label stickers as “ Chicken Manure” whereas the remaining was labelled as “ Urea”.

The hand glove was worn as the fertilizers are irritant.

The mortar and pestle were used to crash the chicken manure pellets and urea pellets into powder form to ease dissolving process in distilled water.

Next, 10 g of urea and chicken manure fertilizers were weighed on crucible separately using an electronic balance.

Those powder fertilizers were added into respective beakers by using a spatula. The crucible was rinsed with some distilled water in the beaker.

1895 wordsThe glass rod was used for stirring to ensure the fertilizers were fully dissolved in the beakers.

Then, five Lemna plants of each having 2 leaves were chosen using a forcep and put into each beaker.

After that, all beakers were covered with the cling film to prevent other creatures which might disturb Lemna’s growth.

All the beakers were placed in an open chamber under sufficient light intensity to reduce the influences of abiotic factors on Lemna’s growth.

After 8 days, the final number of leaves on Lemna plants were observed and recorded in the table on the next page.

Risk assessment:

The fertilizers are irritant if prolong exposed with bare hands[13]. Thus, the hand glove must be worn to prevent itchiness on hands[7]. After the experiment, the beakers will release unpleasant smell which can cause vomiting. Hence, it is suggested to leave all beakers in a fume cupboard for few hours before cleaning process takes place. Nevertheless, all the fragile apparatus such as beakers and measuring cylinder must be handled carefully to prevent unwanted accidents. Thus, this is a low-risk experiment after applying risk assessment with some precautions.

Results:

For urea: Mode(24. 0) < Median(24. 5) < Mean(25. 4)

Thus, it can be concluded that the data were positively skewed.

For chicken manure: Mode(21. 0)> Median(19. 0) > Mean(18. 9)

Thus, it can be concluded that the data were negatively skewed.

Hypothesis Testing:

H0: There is no difference in the final number of leaves between the inorganic fertilizer (urea) and organic fertilizer (chicken manure) on Lemna minor.

H1: There are significant differences in the final number of leaves between the inorganic fertilizer (urea) and organic fertilizer (chicken manure) on Lemna minor. Urea will be the best fertilizers on Lemna farming rather than chicken manure.

Table 3: Ranking Number of Urea and Chicken Manure:

Refer to Mann-Whitney Table of Two-tailed Test in Appendix 2:

n1 = 10 and n2 = 10; Critical Value= 23

The smallest U-value is used to compare with the critical value (23). Since the urea had the smallest U-value (3. 5) which are below 23, it rejected the null hypothesis within the 5% of the significant value.

Decision:

There is sufficient evidence that there are significant differences in the final number of leaves between the effectiveness of chicken manure and urea.

Data Analysis:

From the Table 3 and Graph 3, the mean number of leaves for all the 10 similar experiments obviously showed that urea (25. 4) had an astounding effect than chicken manure (18. 9). There were differences about 6. 5 of both

fertilizers on Lemna plants. Thus, urea had greater effects than chicken manure on Lemna plants.

According to the Graph 1 and Graph 2, most of the data were within the range of 15 to 20 numbers of leaves after added chicken manure; In contrast, a big proportion of results were in the interval of 20 to 25 numbers of leaves after added urea. Besides that, urea experiment had the highest number of leaves (31) compared to chicken manure (21). Therefore, it can be generalised that Lemna plants grow better when supplied with urea.

Nevertheless, some Lemna plants had extraordinary numbers of leaves such as Experiment 3 with chicken manure and Experiment 1 and 9 with urea. Many factors such as genetic variation can cause the growing of abnormal number of leaves. Furthermore, an advantageous allele can survive and adapt better to the surrounding by reproduce rapidly. Hence, more growth taken place on Lemna plants.

In the Mann-Whitney U test, the significant value was set to be 5%. It is assumed that more than 0. 05 probabilities where the results will occurr by chance. In this experiment, the null hypothesis was rejected. Besides, the mean and statistical analysis were totally agreed with the experimental hypothesis that urea is better than chicken manure in stimulating the Lemna’s growth. As aforementioned in the rationale and research, urea (inorganic fertilizer) will release the mineral ions more readily and faster than chicken manure (organic fertilizer). Thus, Lemna plants with urea can absorb more mineral ions in a faster rate for growth and photosynthesis. More number of leaves was grown when more mineral ions are available. In

contrast, chicken manure (organic fertilizer) will release nutrients slowly for a long run; whereas, urea (inorganic fertilizers) might run out of nutrients.

2891 wordsNevertheless, the number of leaves after 8 days was decreasing for both experiments due to decomposition and thus, not recorded as a result in the Table 3. For urea, it might run out of nutrients and this lead to no growth in Lemna plants.

The outcomes of this experiment are very useful on Lemna farming. Hence, it is recommended to the farmers to use the inorganic fertilizer (urea) because the Lemna plants will grow more rapidly. Thus, the demand of society on Lemna plants can be fulfilled and the uses of Lemna plants can be maximised.

Evaluation:

The initial number of leaves and plants were remained the same in order to see the changes after adding urea and chicken manure. Random choosing of Lemna plants from the same population to ensure that there is no bias in this experiment. Besides that, the chosen size of leaves was approximately same for both experiments. Moreover, ten similar samples of both fertilizers were carried out at the same time to get the final mean number of leaves which can reduce the likelihood of inconsistent results.

To reduce the error, the crucible was rinsed with distilled water to ensure no any fertilizers that leave in crucible. This can partially prevent the imbalance distribution of fertilizers' content in the experiments. Furthermore, the abiotic factors such as light intensity, humidity and ambient temperature were kept under control in a chamber. This is to produce valid results that

were caused by the types of fertilizers. Besides, Lemna plants need at least 7 hours sunlight per day to reach the daily requirement[9]. Since this country is tropical, there is no problem of getting the sunlight for Lemna plants.

The experimental results can be considered accurate and reliable because the experiments were carried out with minimum errors, precautions and large repeated samples.

Limitation and Modification:

There were some limitations in the experiment. One of them was the abiotic factors which are impossible to be fully controlled with the college lab's equipment. It has been assumed that those abiotic factors were negligible and would not affect the experimental result. One of the modifications was controlling the abiotic factors with sensors under programming in more advanced labs.

Besides, the content of fertilizer in the pellets was less than what is written on the packaging due to several reasons such as long storage and process of manufacturing. There was a limitation to measure the content of the pellet with the equipment in college's lab. Hence, it was negligible and ignored in the experiment. Nevertheless, it can be further improved by manufacturing the specific content of fertilizer pellets for the experiment.

Furthermore, the genectic variation of Lemna plants was the limitation in this experiment. This is due to different genes in Lemna plants will determine its' survival rate and reproduction rate. It is not easy to identify genetically identical Lemna plants to carry out the experiment. But, it is possible to

reduce the limitation by choosing the same Lemna plants from the same population of same habitat.

In the future, more researches can be done on which mineral ions are more useful in stimulating Lemna's growth. It is commonly known that urea and chicken manure contain variety composition of mineral ions. The composition of the mineral ions in fertilizers plays a major role to give the best effects on plant's growth.

Conclusion:

Based on the collected data and statistical analysis, the experimental hypothesis was well-supported. Thus, it is concluded that both fertilizers will have an effect on Lemna plants and urea (inorganic fertilizer) will act better than chicken manure (organic fertilizer) on Lemna plants.

Evaluation of Sources:

A range of resources were chosen from internet for references and background study. One of the sources chosen is Source 7. This is a well-known website which belongs to United State National Library. It is a famous organization which works with federal agencies, public health institutions and international organizations to provide current scientific and health information for publics. Furthermore, the information in the website is always updated to provide quality information.

Besides that, the sources 11, 12 and 13 are online database journal from INTEC, UiTM. These sources are considered accurate and reliable because all the information are fully supported by evidences and links from other

websites. Moreover, all scientific database journals that signed up by INTEC, UiTM are internationally creditable.

Furthermore, sources 3, 4, 5 and 8 are from Wikipedia which is a popular reference sites for millions of people. The information is trustable because all the information are cited and linked to many other academic researches around the world.

A few book sources such as I, ii, iii and iv were used. Those are published book and thus the information should be reliable after reviewed by experts before publishing.