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FERTILIZING BARE LAND AND EX- MINES AS A WAY TO EDUCATE STUDENTS TO LOVE THE EARTH

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Abstract
Ecological destruction is very real today. It is increasing day by day along with many causes. Deforestation and mining are two of them, which truly threaten not only humans but also the environment and biodiversity. To gain awareness and knowledge about ecological destruction and to achieve ecological conversion, action and research study is needed. Related to this concern everyone, including students, must be involved. The aim of this article is to offer a methodical study which is based on research study. Its study is also integrated toward Arbuscular Mycorrhiza Fungi (AMF) which is associated toward pioneer plant like Koro Hijau (*Macrotyloma uniflorm*) as a unique technology to fertilize bare land and ex-mining. This study can be applied toward senior high school students specifically grade X related to microbiology subject or grade XII related to the growth and development of plants subject. The approach of this study is best applied in practicum class after students have received basic understanding on its subject in theoretical class. AMF application toward pioneer plants to solve bare land and ex-lime mine problems is one of the research studies which is applicable toward education method in school level. Following its method, students are not only able to gain their theoretical and practical knowledge but also able to empower their passion and preference to love and care about environment and earth.

Keywords: research, koro hijau, AMF, fertility, education, environment, growth, development

Introduction
Deforestation and mining are two of many causes of environmental destruction nowadays. Deforestation in Indonesia as a developing country does not only contribute to emission of greenhouse gases and loss of biodiversity of tropical forest but also left a wide range of bare lands (Margono, 2014). Unlike deforestation, mining is more dangerous. While the deforestation can be restored by planting vegetables or plants which are needed, mining has different treatment on renewing environment destruction. It is related to soil condition which is very important for vegetation.

The destructions cause by mining have a significant level of difficulty, specifically on its land restoration. Materials of ex-mining which are taken are not renewable and it applies on many types of mining. Lime stone mining is one of mining which is operating in Indonesia. It is commonly done in karst region. Karst region in Indonesia spreads throughout every major island like, Sumatra, Java, Bali, East Nusa, Kalimantan, Sulawesi, Maluku Island and Papua(Anonymous, 2013). In Java Island itself there are many areas which have becomekarst mining, for example in Gunungkidul, Yogyakarta. There are more than 20 areas of lime mining in Gunungkidul (Pribad, 2013).

Destructions caused by deforestation and mining do not only destroy environment but also soil quality. In Indonesia some efforts for reforestation and reclamation are still very low. In fact, bare land and ex-lime mine could be restored to be more productive and economic land that useful to revive the biodiversity that may have existed. In contrary, abandoning bare land and ex-lime mine potentially cause greater levels of environmental damages. For instance, a bad threat to the quality and quantity of water can occur in both bare land and ex- lime mine territories. On the ex-lime mining, the threat potentially leads to the existence of underground water pollution, the enclosure of limestone pores as water absorption which reduces the quantity of water sources, erosion between karst and non karst territory, loss of top soil in the karst region that threatens the biodiversity of the surrounding environment, and still many other effects (William, 2001).

Decision must be made to restore and maintain the destruction of our environment. It is not only responsibility for those who have role on destroying our environment but everyone may also have a same kind of responsibility since every person is living in the same environment as their home. Some efforts can be made in different fields and levels. In the level of education, it is possible to promote education methods which directly become solution for encountering the environment destruction cause by deforestation and mining. One of possible method is by applying research and application of Arbuscular Mycorrhiza Fungi (AMF) for pioneer plant.

In order to rehabilitate bare land and ex-mining the presence of AMF association with pioneer plant is needed. The application of AMF association toward pioneer plant can be done by applying some treatment for example different time of giving AMF or different amount of AMF toward pioneer plant. This research can be integrated in the process of studying in schools like in senior high school, manly while they are learning about microbiology or the growth and development of plant in grade X or XII. Further step of this methodological study can be continued by applying experimental research in practicum class. By applying this experimental research, students are not only expected understand about scientific method, the result and the benefit of their experiment, but also eager to love and care more about their environment.

Theory Application

Effect of time's giving of AMF for Koro Hijau (*Macrotyloma uniflorm*) growth as pioneer plants for soil fertility of ex-lime mine reclamation was one of

the researches which had done. The research was conducted to identify the influence of time's giving of AMF for the growth of Koro Hijau and examine its symbiosis mutualism, as well as examine the effect of giving AMF for Koro Hijau's growth compared to control plants (without AMF). This research was an experimental research. The research was conducted to 24 plant samples which consisted of 3 treatments and 1 control which were designed using one factor Anova as its statistical analysis became one factor research that was examining the effectiveness of giving AMF fertilizer in different time. AMF was given in three different time sequences with one-week interval as three different application treatments by spreading around near its roots plant. The data was collected in every 5 days for 50 days by measuring the length of the stem, number of leaves and stem diameter. Root length and its AMF infection rate were measured at the end of the experiment. The results showed that the time giving of AMF was significantly affected the growth of Koro Hijau and the first week (M1) had proven most effective in mutualistic symbiosis with the host plant and the effect of growth was greater compared to control plants (K).

Based on data from the average growth of Koro hijau shows that treatment of M1 has the best growth rate compared to the growth rate of M2 and M3. Treatments M1, M2 and M3 have rates below and the same (especially in mean diameter stem) compared to K as a negative control (Table 1). Based on the observations of AMF on root infection, M1 and M2 treatments have 52.4% and 59.8% which are categorized high rate of infection and M3 treatment has 30.6% infection which is categorized has a moderate infection rates.



Figure 1 (Root morphology M1, M2, M3 and K)

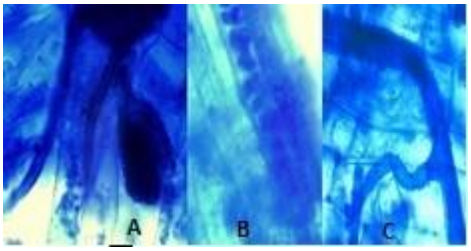


Figure 2 (AMF Morphology: A. Arsbuskular, B: Vesicle, C. Hyphae)

Table 1. Mean's Growth of Stem Length, Leaf Number, Stem Diameter and AMF Infection of Koro Hijau Root

No	Treatment and Control	Stem length (cm)	Leaf number	Stem diameter (cm)	AMF Infection %
1	M1	61.70	22	0.29	52,4
2	M2	44.30	19.75	0.21	59,8
3	M3	47.20	16	0.23	30,6
4	K	74.30	32	0.29	-

Note: M1: First week, M2: Second week, M3: Third week, K: Negative Control (without AMF).

Based on the results of mean growth, M1 treatment has higher mean compared to the mean of M2 and M3 treatments. It is related to AMF which has important roles in accelerating the definitive physiological phase and increasing the durability of the plant at the beginning of planting. Hanafiah 2014 also reported that the growth of Koro hijau as legume is dependent with the associationof AMF.

The influence of time giving of AMF for Koro hijau could also be seen by observing the root morphology and its length compared to the level of AMF infection. The thickness of the roots shows the level of mutuality between theroots of host plants with AMF. AMF will form a blanket outside and inside the roots, in the interstellar between cells of the epidermis and cortex (Salisbury, 1992). Furthermore, the AMF also intensively will produce external hyphae on the roots of host plants (figure 2). It is directly will optimize the process of photosynthesis; adsorb water and nutrients from the soil. From the results, M1 treatment has the thickness roots level compared with M2 and M3 treatments as well as negative control (figure 1). The level of thickness and length of the roots cannot be separated from the rate of AMF infection. Based on the development of roots, treatment of M3 has the greatest root length. However, it does not show the characteristic form of mutualism between the AMF and host plant. Good root growth enables plant roots to absorb nutrients around the roots. AMF works by covering the exterior root near the top root and the hyphae work like a coat. It is even able to spread up to 8 m (Soenartiningsih, 2013). Another hypha will penetrate between the host plant root cell membrane to form a network of nutrient absorption. Based on the characteristics of the development of AMF root infections, the early development of AMF symbiosis with the host plant showed a negative relation to geotropism (Khasa, 2009).

Application of AMF for the growth of plants is a simple technology which can be practiced not only for the students but also for farmers who live around damage environmental. For the students itself AMF technology can be applied while they are learning about the growth and development of plants. Technology is better to be practiced during practicum class. However, before the students learn about this technology, basic understanding about every factor of the growth and development of plants must be studied in theoretical class.

Based on actual research above, students are able to make research and development about AMF association in a more simple way. This research will be better practiced in a group so that the observation and data collection would be easier. Better understanding of the students about growth and development of plant can be obtained by following all the research process. Below are the worksheet and guidelines which can possibly use for AMF research and study bya group of students.

Student Worksheet

EXTERNAL FACTORS OF PLANT'S GROWTH AND DEVELOPMENT

Name :
Group :
Class :

1. Objectives Learning
   a. Following observation students understand about external factors for Koro Hijau's growth and its development.
   b. Through data collections students understand every external factor which influences the growth and development of Koro Hijau.
   c. After finish making written report, students understand external factors which influence the growth and development of Koro Hijau.
   d. After oral presentation, students understand dominant external factors which influence the growth and development of plants.
2. Tools and Materials

   Tools
   a. Ruler
   b. Pen
   c. Pencil
   d. *Log book*
   e. Polybag diameter 5 cm
   f. Camera
   g. Hygrometer
   h. pH meter



Figure 3: Koro Hijau (*Macrotyloma*

   Materials
   a. Water
   b. Soil
   c. AMF fertilizer
   d. *Macrotyloma uniflorm* seed

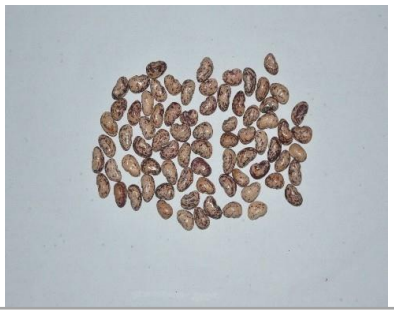


Figure 4: *Macrotyloma uniflorm* seed

3. Method
   a. Prepare 12 polybags which contain soil media.
   b. Soak Koro Hijau seeds in water and sort the seeds which float on water.
   c. Choose 12 Koro Hijau seeds to be grown in polybags.
   d. Prepare AMF fertilizer as much as 10 grams for each polybag.
   e. Place Koro Hijau's seeds at the center of the polybag and pour soft soil for cover.
   f. For treatment 1, place Koro Hijau seeds at the center of the polybag and sprinkle the AMF fertilizer around the seeds on the first day of planting.

For treatment 2, sprinkle AMF fertilizer on the 3rd day after planting. For treatment 3, sprinkle AMF fertilizer on the fifth day after planting.

g. The negative control is not given AMF fertilizer.
h. Observe each treatment and record every change, growth and development processes that occur on the log book.
i. Write down the length of the stem and the number of leaves in the table that is provided for data collection in every two days.
j. Record pH measurement on each treatment in a table which is provided.
k. Record temperature and humidity in a table which is provided.
l. Write a group report on your research result.

Table 1. Research Table of Stem's Length and Leaf's Numbers Observation

Growth Indicator	**Treatment and Control**											
	Treatment 1			Treatment 2			Treatment 3			Negative Control		
	P1	P2	P3	P1	P2	P3	P1	P2	P3	K1	K2	K3
Stem's length												
Leaf's numbers												

Note: P1-P3: Repetition and K1-K3: Control

Table 2. Results of pH, Temperature and Humidity Observation

External Factors	**Treatment 1**	**Treatment 2**	**Treatment 3**	**Negative Control**
pH				
Temperature				
Humidity				

4. Discussion Questions
   a. Based on the observation results, which treatments have the best growth rate?
   b. Compared to control, the treatments which are given AMF fertilizer is better?
   c. Which one is the external factor that the most influential toward the growth of Koro Hijau?
   d. Is group hypothesis proven on this research?

5. Conclusion (Karnedi, 2017).

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There is a wide range of possibilities of treatment and research design which can be applied toward AMF application. Research application which is presented here is one of them. Data analyzing can be chosen whether using complex or simple one. *Anova* one factor test can be used as complex or detail data analysis or descriptive data analysis for simple one. For senior high school students,descriptive data analysis is recommended. By using this data analysis students would be able to find and distinguish every external factor which influences the growth and development of plants and its relation to environment.

To deepen the learning process of this research study, students can be asked to do discussion, write a group report and do an oral presentation. In addition, this process of learning is also a good way to motivate student learning center. At the end of practicum process, point of reflections can be asked to every group of students. At this point, question reflection about their option to love earth and care about damage environmental can be asked. Eventually, some conclusions can be made from this research application.

Based on the learning process above, it is hoped that students also learn about another objectives learning. Inspired by the possibility of young students who want to invent new world based on a fair relationship with creation, education institution must be involved to promote experimental learningatmosphere where students are involved into real situation of environmental problems and issues. It is also hope that they will able to find applicable solution for environmental problems and issues based on experience (Alvarez, 2012).

AMF application and its association with pioneer plant are not only the good way for reforestation and reclamation efforts but also for technological farming advance. It will economically help farmers increase the production of their cultivated plants. At the same time, planting plant as much they can will also increase the soil quality. Soil quality improvement will directly improve the ability of environment to sustain life and biodiversity on earth.

Conclusions

Loving mother earth can be done in many ways. It can also be done by everyone, especially by students. Caring environment by paying serious attention toward environmental damages through education level is an essential way. AMF application toward pioneer plants to solve bare land and ex-lime mine problems is one of research studies which is applicable toward education method in school level. Following its method, students are not only able to gain their theoretical and practical knowledge, but also able to empower their passion and preference to love and care about the environment and the earth.

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