The Development Of Kemiri Sunan Plants In Energy Garden in Gunung Kelir

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Abstract

Energy garden in Gunung Kelir is a pilot garden for bio-energy sources, one of which is based on Kemiri Sunan. Kemiri Sunan plant (*Reutealis trisperma* (Blanco) Airy Shaw) has advantages compared to other bio-energy sources, such as serving as a conservation plant to increase critical land productivity in Indonesia. In addition, this plant can also produce alternative energy, namely biodiesel. Kemiri Sunan has potentials to be further developed thus innovation is needed during its cultivation as an effort to improve the plant growth quality, aloowing the plants to produce optimally. Some of the innovation of Kemiri Sunan cultivation activities that have taken place on Gunung Kelir are provision of quality seedlings, application of chitosan, application of inorganic and organic fertilizers.

Keywords: *Kemiri Sunan, Energy Garden*

1. Introduction

In the last few years, Indonesia has continuously been stricken by disasters which, when observed, stem from environmental issues. Floods, tidal waves, landslides and droughts have become disaster traditions that have never ended, even they get worse every year. These disasters are a result of global warming, an issue that becomes the concern of all countries worldwide, that is caused by the excess of carbon dioxide (CO_2) in the air that is a by product of combustion. This is an impact of the loss of most of the world's forests whose trees should absorb carbon dioxide, so the temperature increase and the mountain of ice melts. Since the existence of trees and forests to overcome the dangers of global warming effects and to anticipate these is important, it is necessary to conduct environmental preservation by planting as many trees as possible. Apart from having disaster problems, Indonesia also faces problems related to petroleum reserves that are increasingly depleted yet there is an increasing need for domestic fuel to be imported. Unfortunately, the fuel consumption by the national population is still very dominant (63%). The community's high dependence on imported fuel has caused a budget problem that burdens the country.

Considering the two above-mentioned problems, there shall be an alternative of solution for them, i.e. overcoming critical land, conducting afforestation, and producing renewable energy. One solution is

to plant trees that could serve as a conservation plant that could generate alternative energies. As a tropical country, Indonesia has several types of plants that meet the criteria as a renewable energy source, one of which is Kemiri Sunan plant.

Kemiri Sunan plant (*Reutealis trisperma* (Blanco) Airy Shaw) has advantages compared to other bio- energy sources, such as serving as a conservation plant, having a high adaptability to the environment, being able to grow on dry land and wet climate, having strong and deep roots, being able to survive on sloping land thus being able to withstand erosion, having lush canopy as well as broad and heavy enough leaves to absorb CO_2, produce much O_2, and the leaves will shed in dry season so they can form thick humus as soil fertilizers, and having a long productivity.

Kemiri Sunan plant is one of the plants that have potentials as a biodiesel material. This plant is able to produce 4-6 tons of dry seeds per hectare per year, equivalent to 2-3 tons of crude oil per hectare per year. When extracted, Kemiri Sunan seeds will produce vegetable oil which is poisonous, not allowing it to be consumed. [1] stated that Kemiri Sunan oil contains 50% α-eleostearic acid, a poisonous compound in Kemiri Sunan oil. Kemiri Sunan oil can be used for various purposes such as a natural insecticide which is highly effective to kill pests, a raw material in paints, varnishes, inks, wood preservatives, cosmetics and pharmaceutical industries. In regard to the various uses of Kemiri Sunan, this plant has the potential to be developed.

Energy garden located in the Gunung Kelir Hamlet, Pleret Village, Pleret Subdistrict, Bantul Regency, Yogyakarta Province, Indonesia, is a garden which was developed based on the partnership between the Center for Research and Technological Development of Electricity, New Renewable Energy and Energy Conservation (P3TKEEBTKE) of the Ministry of Energy and Mineral Resources of the Republic of Indonesia with the University of National Development "Veteran"Yogyakarta. Energy garden is a pilot of bio-energy sources, one of which is Kemiri Sunan based. The objective of this garden is to diversify the sources of raw material for the development of Biofuels. Energy garden in Gunung Kelir is a hilly and dry land, categorized as a marginal land where the availability of water and nutrient is very limited, therefore the growth of Kemiri Sunan plant requires innovation in its cultivation activities. Currently the plants in Energy garden are approximately 4-5 years old. In addition, the development of Kemiri Sunan plants has taken place from the seedlings and the plant care is in its vegetative growth.

Gunung Kelir before Kemiri Sunan planting

Gunung Kelir after Kemiri Sunan planting

Innovation Of Cultivation Activities Of Kemiri SunanPlants On Gunungkelir

1. Provision of quality seedlings

The growth of Kemiri Sunan seedlings is an important thing in achieving optimum productivity. Therefore, the roles of fertilization and growing media used are very important. Fertilization is an effort to meet the nutrient needs of the plants, allowing an increase in soil productivity and plant growth. According to [2], the maximum results of fertilization will be obtained if done properly, including appropriate dose. Application of appropriate fertilizer dose at the beginning of vegetative growth can affect the growth of the plants. The application of N, P, and K fertilizers on Kemiri Sunan plants was carried out at a dose of Urea 10-25 g/seedling, SP36 15-30 g/seedling and KCl 10-25 g/seedling.

The use of various materials for growing media at the nursery level also plays an important role considering that, at this stage, the plants are at an initial stage of root formation. Soil is the main medium in nurseries. In addition to soil, organic materials such as manure in a system of soil-plant can improve soil structure, help the growth of microorganisms, increase the availability of P content both directly and indirectly, even increase saprophytic organisms, and suppress parasite organisms for plants. Chicken manure is a source of nutrients, i.e. a slow and continuous occurrence of organic matter decomposition by soil microorganisms. As for husk charcoal, although its ability to absorb water is low, it has high porosity so that the aeration and drainage of growing media become better.

[2]conducted a study entitled Response of Kemiri SunanSeedlings Growth to NPK Fertilizer Dosage on Various Planting Media Compositions, showing that there is an interaction between the treatment of planting media compositions and NPK fertilizer doses on the growth of plant height 3 weeks after planting and plant dry weight, the best combination of treatment is planting media composition of

soil: manure: husk charcoal of 1: 1: 1 and NPK fertilizer dose/seedling of 25 g Urea + 30 g SP36 + 25 g KCl.

An increase in seedling height will affect plant dry weight: when seedling height increases, plant dry weight also increases. Using manure can increase the availability of nutrients in the soil. Manure has a positive (good) effect on the physical and chemical properties of the soil, promoting the growth of microorganisms. In other words, manure has the ability to change various factors in the soil, thus serving as a factor that guarantees soil fertility. Similarly, the use of husk charcoal has a positive effect in improving the physical, chemical and biological properties of the soil, allowing optimum development of plant roots. The more the roots, the more optimum the uptake of manure. The research findings are presented in Table 1 below:

Table 1. Mean of increase in seedling height 3 weeks after planting and seedling dry weight at the end of observation of Kemiri Sunan plants

Growing media composition	Dose of Fertilizer N(Urea), P (SP36), K (KCl) g/seedling				Mean
	10 +15+10	15+20+15	20+25+20	25+30+25	
	Increase in height of Kemiri Sunanseedlings				
Soil	0.30 c P	0.43 b P	0.46 b p	0.41 b p	0.40
Soil : Manure 1:1	0.53 b P	0.55 b P	0.60 b p	0.62 b p	0.58
Soil : Husk Charcoal1:1	0.54 b p	0.55 b p	0.58 b p	0.60 p	0.57
Soiil : Manure: Husk Charcoal1:1:1	0.65 b q	0.60 b q	0.68 q	0.75 a p	0.67
Mean	0.51	0.53	0.58	0.59	(+)
	Dry weight Kemiri Sunanseedlings				
Soil	15.10 c r	17.13 b r	19.37 b q	26.10 ab p	19.43
Soil : Manure 1:1	14.37 c r	19.77 b q	19.60 b q	20.03 b q	18.44
Soiil : Husk Charcoal1:1	15.50 c r	22.83 b q	22.53 b q	20.80 b q	20.42
Soil : Manure: Husk Charcoal 1:1:1	16.23 c r	17.70 b r	26.43 ab p	27.73 a p	22.02
Mean	15.30	19.36	21.98	23.67	(+)

Description: Mean of treatment among columns and rows followed by the same letter shows there is no Significant difference in the DMRT test at the5% level.Sign (+) shows interaction

2. Application of chitosan to improve vegetative growth of plants

Chitosan is an organic fertilizer made from natural ingredients from shrimp shells which is processed with radiation technology to produce beneficial products in agriculture sector [3]. Chitosan is an organic compound derived from chitin, from chitin-based biomaterial which is currently widely used for various purposes such as plant growth booster, natural biopesticides to protect plants from bacteria and fungi, and a coating material for various plant seeds [4]. Application of chitosan in agriculture may

reduce environmental stress due to drought or nutrient deficiency, improve seed viability and vigor as well as crop production. In addition, application of chitosan is also able to increase the chlorophyll content, allowing an increased effectiveness of photosynthesis [5]. Chitosan has a wide range of uses and a high affinity; it is non toxic and easily degradable; it serves as natural raw materials. Chitosan regulates plants' immune system and causes the excretion of inhibitor enzyme. Besides, chitosan not only activates cells, but also improves the defense capabilities against diseases and insects. It has effects on agriculture, for examples, it serves as a carbon source for microbes in the soil, accelerates the transformation process of organic compounds into inorganic compounds, and helps the root system in plants to uptake more nutrients from the soil. Chitosan is absorbed by the roots after it is broken down by bacteria in the soil. In agriculture sector, the application of chitosan, even without chemical fertilizers, may increase the microbial population in large numbers, and ease the plant roots to absorb the nutrient transformation process from organic to inorganic [6].

Chitosan (Fitosan) contains growth-regulating substances such as giberelin: GA3, GA5, GA7, Auxin (Indole Acetic Acid) and Cytokinin (Kinetin and Zeatin). Some of its uses are to accelerate plant growth; treat diseases caused by fungi, bacteria and viruses; increase plant disease resistance; shorten harvest time; and improve the quality of fruit, flower and vegetable production [7]

According to the results of a research conducted by [5] on Chitosan Response to Vegetative Growth of Kemiri Sunan plants, out of several parameters being observed, it is evident that the vegetative growth of plants with chitosan applicationhas a better growth response than that of plants without chitosan application. An increase in the plant growth due to chitosan is because chitosan plays a role in improving plant metabolism. Chitosan is a form of polysaccharide that serves as a biological signal in cells and it is able to regulate defenses, symbiosis, and plant development processes. Chitosan contains Plant Growth Promoter in the forms of giberelin, IAA, and Zeatin. According to [7] , chitosan is known to increase the number of leaves, chlorophyll, and the availability of amino acids for plants.

Table 2 shows that the application of chitosan through the leaves is more effective than that through the roots or sprayed on to the plant stems. The application of chitosan through the leaves has a number of advantages, such as faster absorption of nutrients because it is done through the surfaces of the leaves or stomata. The mechanism of nutrient absorption through the leaves is related to the process of opening and closing of the stomata, the absorption of nutrients through the leaves occurs due to diffusion and osmosis through stomatal aperture so that it is easy for plants to absorb thus increasing the vegetative growth of the kemiri sunan plants. Chitosan that was applied to Kemiri Sunan plants aged ± 18 months with administration frequencies of 4 times (application at age 15, 30, 45 and 60 days) and 5 times

(application at age 20, 30, 40, 50 and 60 days) provided better effects than that of 3 times (applications at age 20, 40, and 60 days).

Plant dry weight is an indicator that is commonly used to determine whether the vegetative growth of plants is good because the plant dry weight can describe the efficiency of physiological processes in plants. An increase in plant height and the number of leaves may increase the plant dry weight. When there is an increase in the plant height and the number of leaves, the plant dry weight increases as well.

Table2. Mean of increase in plant height (cm), the number of leaves,root dry weight (g), plant dry weight (g) of Kemiri Sunanplants at the end of observation

Treatment	Plant Height (cm)	Number of Leaves	Root Dry Weight (g)	Plant Dry Weight (g)
Chitosan Application Procedure				
Through Root	9.09 b	21.93 b	106.67 a	500.00 b
Through Leaf	11.65 a	23.37 a	100.00 a	548.89 a
Through Stem	9.09 b	21.81 b	100.00 a	462.22 b
Chitosan Application Frequency				
3 times	8.52 q	22.44 q	91.11 q	491.11 p
4 times	11.31 p	20.41 q	91.11 q	508.89 p
5 times	10.00 q	22.37 p	124.44 p	511.11 p
Combined Treatment	9.94 (-) x	22.37 (-) x	102.22 (-) x	503.70 (-) x
No Chitosan	7.50 y	9.67 y	60.00 y	440.00 y

Description: Mean of treatment among columns and rows followed by the same letter shows there is no significant difference in the DMRT test at the 5% level. Sign (-) shows the absence of interaction

3. Application of inorganic and organic fertizilers on Kemiri Sunan plants have not given results

Farmers nowadays tend to always use inorganic fertilizers than organic ones. A relatively high and continuous application of inorganic fertilizers may bring negative impacts on soil environment and reduce the productivity of agricultural land, thus decreasing crop production. This way, it is necessary to reduce the use of inorganic fertilizers, by alternatively using only organic fertilizers or combining both organic and inorganic fertilizers. The application of fertilizers shall consider things that are the key to its effectiveness so that the maximum root absorption and fertilizer could provide benefits for plant growth, including the types and doses of fertilizer.

A research was conducted by [8] on Kemiri Sunan plants aged ± 36 months given treatments of fertilizer (P1 = Inorganic Fertilizer, P2 = Organic Fertilizer and P3 = Inorganic + Organic Fertilizers) and treatments of fertilizer doses (D1 = the recommended dose of inorganic fertilizer for Kemiri Sunan i.e. 150g Urea + 90g SP36 + 90g KCl; D2 = 75% of the recommended dose; D3 = 50% of the recommended

dose; and D4 = 25% of the recommended dose). The results showed that the application of the combined inorganic + organic fertilizers brings a better effect than those of other types of fertilizers in terms of increased plant height, increased number of leaves, increased stem diameter, and increased number of branches of Kemiri Sunan plants. The application of 100% fertilizer recommended dose brings a better effect than those of other fertilizer doses in terms of increased number of leaves, increased stem diameter, and increased number of branches of Kemiri Sunan plants. However, the 75% of the recommended dose brings a better effect than other doses of fertilizers on increased plant height. There is no interaction between the types and doses of fertilizers in influencing the growth of Kemiri Sunan plants (Table 3).

The application of combined inorganic + organic fertilizers can provide complete nutrients, both macro and micro elements. According to [9], elements N, P, and K are the most needed elements in photosynthesis process by creating compounds in plants that later will be transformed to form plant organs such as leaves, twigs and branches. Optimal availability of N, P, and K for plants may increase the quantity of chlorophyll, which then increases photosynthetic activities, resulting in more assimilation. Application of organic fertilizer can meet the plants' needs for micro nutrients. Organic fertilizers contain nutrients that are available and absorbable by plant roots. In addition, organic fertilizers can also improve the physical and biological properties of soil.

Table3. Mean of increase in plant height (cm), the number of leaves, stem diameter (cm) and the number of branches of Kemiri Sunan plants at the end of observation

Treatment	Plant Height (cm)	Number of Leaves	Stem Diameter (cm)	Number of Branch
Types of Fertilizer				
Inorganic	6.42 b	13.23 b	0.75 b	3.61 b
Organic	4.69 b	9.19 c	0.32 c	3.83 b
Inorganic + Organic	10.36 a	17.61 a	0.95 a	4.50 a
Dose of Fertilizer				
Recommendation	7.63 q	19.07 p	0.90 p	4.29 p
75% recommendation	10.92 p	16.44 q	0.69 q	3.92 q
50% recommendation	5.26 q	12.37 r	0.61 q	3.85 q
25% recommendation	4.81 q	8.89 s	0.49 q	3.85 q
	(-)	(-)	(-)	(-)

Description: Mean of treatment among columns and rows followed by the same letter shows there is no significant difference in the DMRT test at the 5% level. Sign (-) shows the absence of interaction

4. Summary

The development of Kemiri Sunan plants based on its potential as a source of non-food vegetable oil is expected to be a raw material for biofuels that can substitute or even replace fossil fuels. The development can be carried out in marginal lands. Kemiri Sunan plants can be used as a conservation plant because of its rapid growth and deep roots, giving it the ability to withstand landslides and erosion. This plant has a high adaptability to the environment, lush canopy, broad and heavy leaves so that it can absorb CO_2 and produce much O_2; the leaves will shed in dry season and form thick humus as a soil fertilizer.Therefore, it is highly possible to develop Kemiri Sunan plants on Gunung Kelir and this could serve as an alternative to perform afforestation and land reclamation. Other benefits to obtain are: it may increase the economic value of the land, it can be used as a plant with a high economic value that is able to provide the energy needs for the surrounding community as well as for broader areas in the future. This research on Kemiri Sunan plants in Energy garden is expected to increase the growth of Kemiri Sunan plants, thus eventually providing maximum crop productivity. For the development of Kemiri Sunan plants' potentials, more in-depth studies are still needed, particularly those aimed at increasing the crop productivity, biodiesel quality and economic value in order to promote the industry and the welfare of farmers.

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