Proceeding International Conference on Green Agro-Industry
Volume 4, 2020 | Pages : 314-321

The Development Of Kemiri Sunand Plants For Supporting Energy Security

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Abstract.

High community dependence on fossil fuels can spur energy scarcity or energy crisis. Kemiri Sunan or Sunan candlenut is one of the types of vegetable oil producing plants that has great potential as a raw material for biodiesel. The development of biofuel on marginal land in the context of supporting national energy security. In the development of kemiri sunan plants in marginal land, it is necessary to do innovation in its cultivation, namely the use of chitosan, an organic fertilizer made from natural materials derived from shrimp shells that are processed with radiation technology to produce useful products in agriculture. Based on the results of the study showed that plants were treated with chitosan showed a better growth response compared to plants that were not treated with chitosan.

Keywords: kemiri sunan, energy security

1. Introduction

Energy becomes an important part of the drive of human life. Energy demand will continue to increase in line with population growth and economic growth. High community dependence on energy sourced from fossils can spur energy scarcity or crisis. When fossil energy is on the verge of a crisis and human needs for energy are increasing, the agricultural sector provides the right answers and solutions to meet people's energy needs. The government's effort to overcome the energy crisis is conducted among others by finding alternative energy that can be renewed (new renewable energy) that is environmentally friendly. In tropical countries, Indonesia has several types of plants that meet these renewable energy source criteria. Among them, which is prospective is kemiri sunan or sunan candlenut plant.

Kemiri sunan or sunan candlenut (*Reutealis trisperma* (Blanco) Airy Shaw) is one type of vegetable oil producing plant that has great potential as a source of raw material for biodiesel. The level of productivity that can reach 8-9 tons of crude oil or equivalent to 6-8 tons of biodiesel/ha/year has a strategic value related to government programs in finding alternative renewable energy sources. Kemiri sunan plants have many advantages. Among them are (1) can grow in critical land so it is suitable as a plant for reforestation and as a conservation plant because of its rapid growth and

deep roots so that it can resist landslides and erosion, (2) kemiri sunan oil contains acids - oleostearate which is poisonous so that it can be used as a mixture of vegetable pesticides, (3) including long-lived plants (> 30 years) so that it has a long production life and economic value, (4) plants have wide leaf canopies with dense leaf structures so can reduce air pollution because it absorbs CO_2 and produces a lot of O_2, (5) has a high adaptability to the environment, and (6) can increase soil fertility because the leaves will fall out in the dry season so that it can form thick humus as a soil fertilizer (Tresniawati *et al*., 2014).

During its growth and development, plants will form various organs. In general, plant organs consist of vegetative organs and generative organs. Roots, stems, and leaves are classified as vegetative organs, while flowers, fruits, and seeds are classified as generative organs. Vegetative growth is characterized by various plant growth and development activities related to leaf formation and enlargement, formation of apical or lateral meristems and growth into branches, and expansion of plant root systems.

The vegetative growth of kemiri sunan plants is an important thing to know where later it is expected to support better generative plant growth so that plants can provide optimum productivity. Therefore, it is necessary to do innovations in the cultivation of sunan candlenut on vegetative growth, one of which is the use of chitosan.

Chitosan is an organic nutrient obtained from processing waste skin or shrimp shells, crabs, molds and others which solution contains macro and micro nutrients, plant hormones and is able to increase plant antibodies. Chitosan has an environmentally friendly nature and is easily degraded (Anonymous, 2016). Application of chitosan in agriculture can reduce environmental stress due to drought or nutrient deficiency, increase seed viability, vigor and production. Chitosan application is also able to increase chlorophyll content thereby increasing the effectiveness of photosynthesis (Subiksa, 2013). In addition, chitosan acts as a fertilizer to strengthen growth (Anisa, 2014).

Based on the test quality, chitosan contains 6.74% organic C; 0.05% N; 0.01% P2O5; and 0.01% K2O. Levels of micro elements such as Fe, Cu, Zn, and B are 8 ppm each; 0.8 ppm; 7 ppm; and 1 ppm. Levels of micro elements of Mn, Zn, and Mo were not detected. Heavy metal content of Cd was detected 0.02 ppm and other heavy metals such as Pb, Co, As and Hg were not detected. The content of growth hormones such as auxin (IAA) 319.11 ppm; cytokinin (zeatin) 18.46 ppm and gibberellins (GA_3) 252.48 ppm per chitosan solution (Anonymous, 2013).

One of the factors that influence plant growth is growth hormone, including the hormone gibberellins (GA_3). In an effort to increase the influence of chitosan on the growth of kemiri sunan plants, it is necessary to add gibberellins (GA_3). Gibberellins will affect the extension of plant segments by increasing the number and size of cells in these segments (Wattimena, 1988 in, Tetuko *et al*., 2015). With the help of fertilizing, it is expected that the sunan candlenut plants can grow well.

The balance of the use of inorganic and organic fertilizers is the key to proper fertilization. That is because organic fertilizers and inorganic fertilizers have their respective advantages. Nitrogen (N), Phosphorus (P), and Potassium (K) are macro nutrients that plants need in large quantities. Nutrient N in plants functions as forming of green substances (chlorophyll) and protein forming elements. Nutrient P serves as a storage and transfer of energy, an important component in nucleic acids, coenzymes,

nucleotides, phosphoproteins, phospholipids, and phosphate sugars. Nutrient K functions in the formation of starch, activates enzymes and photosynthesis storage catalysts.

Based on the description above, the researchers tried to apply chitosan to young sunan candlenut plants, conducted in several stages of research. The purpose of this study is to determine the effect of chitosan on various agronomic characteristics of vegetative growth parameters of Kemiri sunan or Sunan candlenut plants.

2. Materials and research methods

Kemiri sunan plants which are the object of research are planted on marginal land where the availability of water and nutrients is very limited in the energy garden located in Gunung Kelir sub-Village, Pleret Village, Pleret District, Bantul Regency, Yogyakarta Special Province. It is a garden developed in collaboration with The Center for Research and Development of Electricity Technology, New Energy, Renewable and Energy Conservation (P3TKEEBTKE) Ministry of Energy and Mineral Resources of the Republic of Indonesia with Universitas Pembangunan Nasional "Veteran" Yogyakarta, is a pilot plant of vegetable energy sources. The research took place from 2016 to 2019, conducted in 3 stages using superior varieties of KS2 planted with a spacing of 8 m x 8 m.

The first study with plants aged ± 18 months, using a Randomized Completely Block Design consisting of 2 factors. The first factor is how to give chitosan (C) consists of 3 levels, which are: C1 (poured into the planting hole near the root), C2 (sprayed on the leaves), and C3 (sprayed on the stem). The second factor is the frequency of administration of chitosan (F), consisting of 3 levels, which are: F1 (3 times giving at 20, 40, and 60 days from the application of NPK fertilizer), F2 (4 times giving at 15, 30, 45, and 60 days from the application of NPK fertilizer), and F3 (5 times giving, which are at the time of 20, 30, 40, 50 and 60 days after the application of NPK fertilizer). Of the two factors, nine treatment combinations were obtained, repeated three times, each treatment combination consisting of 3 plants. As a control is without chitosan treatment, so that the total = 84 kemiri sunan plants.

The second study with plants aged ± 36 months, using a Randomized Completely Block Design consisting of 2 factors. The first factor is the concentration of chitosan (C) consisting of 4 levels, which are: C1 (10 ml/l), C2 (20 ml/l), C3 (30 ml/l), and C4 (40 ml/l). The second factor is the frequency of administration of chitosan (F), consisting of 3 levels, that is: F1: 3 times giving, which are at the time of 20, 40, and 60 days from the beginning of the observation, F2: 4 times giving that are at the time of 15, 30, 45, and 60 days since the beginning of the observation, and F3: 5 times the giving is at the time of 20, 30, 40, 50 and 60 days since the beginning of the observation. From these two factors, 12 treatment combinations were obtained, repeated three times, each treatment combination consisting of 3 plants. The control was without chitosan treatment, so that the total number = 111 kemiri sunan plants. The way chitosan is administered through leaves is the result of the first research.

The third study with plants aged ± 48 months. The experiment used a two-factor Randomized Completely Block Design. As the first factor is the dose of Urea + SP36 + KCl fertilizer, consisting of 3 levels, which are: D1 = 150 g + 90 g + 90 g; D2 = 200 g + 120 g + 120 g; D2 = 200 g + 120 g + 120 g (Herman *et al*., 2013); D3 = 250 g + 150 g + 150 g. The second factor is the provision of chitosan, consisting of 3 levels,

comprising of: K1 = chitosan concentration of 30 ml/l (the best concentration of the second study, Sasmita *et al*., 2018); K2: chitosan 30 ml/l + GA_3 (100 ppm) per plant; K3: without chitosan. In order to obtain 9 treatment combinations, each treatment combination was repeated 3 times, each treatment combination consisted of 3 plants, so the total = 81 plants.

3. Result and Discussion

Based on the results of Sasmita and Haryanto's (2016) research on the Response of Chitosan to Vegetative Growth of Kemirin Sunan Plants showed that from several parameters observed, it was seen that vegetative growth of plants that were given chitosan showed a better growth response compared to plants that were not given chitosan. (Table 1).

Table 1. Average increase in plant height (cm), increase in number of leaves (strands), root dry weight (g) and plant dry weight (g) of sunan candlenut plants

Treatment	Plant Height (cm)	Number of Leaves (sheet)	Root Dry Weight (g)	Plant Dry Weight (g)
How to Give Chitosan				
Through the root	43,76 b	65,07 b	106,67 a	500,00 b
Through theleaves	49,10 a	68,19 a	100,00 a	548,89 a
Through the stem	44,81 b	63,04 b	100,00 a	462,22 b
Frequency of Chitosan administration				
3 times	38,57 q	56,90 q	91,11 q	491,11 p
4 times	47,45 p	58,55 q	91,11 q	508,89 p
5 times	51,65 p	77,85 p	124,44 p	511,11 p
Treatment combination	45,89 (-) x	64,43 (-) x	102,22 (-) x	503,70 (-) x
Without Chitosan	34,99 y	38,31 y	60,00 y	440,00 y

Note: Average treatment between columns and rows followed by the same letter shows no significant difference in the DMRT test at 5% level. The (-) sign indicates that there is no interaction

Increased plant growth due to chitosan is caused by the role of chitosan in improving plant metabolism. Chitosan is a form of polysaccharide that functions as a biological signal in cells and is able to regulate symbiotic defenses and plant development processes. Chitosan contains Plant Growth Promoter in the form of gibberellins, IAA, and Zeatin. According to Anonim (2016), chitosan is known to increase the number of leaves, chlorophyll, and the availability of amino acids for plants.

In table 1, it can be seen that the application of chitosan through leaves is more effective than the application of chitosan through the roots and sprayed on the stem of the plant. Chitosan application through leaves has several advantages including the absorption of nutrients more quickly because through the mouth of the leaf or stomata. The mechanism of nutrient entry through leaves is related to the process of opening and closing the stomata, nutrient absorption through the leaves can occur due to diffusion and osmosis through the stomata hole so that it is easy for the plants to absorb and has an effect on increasing the vegetative growth of sunan candlenut plants. In general, chitosan which is applied with the frequency of giving chitosan 5 times (applications aged 20, 30, 40, 50 and 60 days) gives a better effect than frequency 3 times (applications aged 20, 40, and 60 days) and 4 times

(applications age 15, 30, 45 and 60 days).

Plant dry weight is an indicator commonly used to determine whether or not the vegetative growth of plants, because plant dry weight can describe the efficiency of physiological processes in plants. Increasing plant height and increasing the number of leaves affects the dry weight of plants. If the increase in plant height and number of leaves has increased, the dry weight of the plant will increase.

Based on the results of research by Sasmita *et al*., (2018) on the Effects of Concentration and Frequency of Chitosan Giving on Vegetative Growth of Kemiri sunan or sunan candlenut plants shows that the use of chitosan can be an alternative nutrient that can be given in an effort to increase the vegetative growth of sunan candlenut plants. The results showed vegetative growth of sunan candlenut plants which were given chitosan showed a better growth response than those not given kemiri sunan (Table 2). The increasing diameter of the stem is caused by a reasonably good plant growth. Good growth is indicated by the ability of plants to photosynthesize higher and more photosynthesis results. More carbohydrates are transplanted through phloem and can be used to stimulate secondary growth, that is the expansion of stem cells, indicated by a larger stem diameter than others.

Nutrition must be applied properly, both the concentration and the frequency. Appropriate concentration is when fertilizing the given concentration must be in accordance with the needs of the plant. Giving improper concentration will cause inefficiency to plants, even damage plants. Exact frequency, that is when applying fertilizer should be adjusted when the need for nutrient intake and at the right time. The concentration of 30 ml/L is the right concentration, meaning that it is in accordance with the needs of the plant so that it is efficient for its growth. The frequency of giving 4 times is the right frequency and is sufficient to support the vegetative growth of Sunan candlenut plants.

Table 2. The mean increase in plant height, number of leaves, stem diameter, number of secondary branches, and width of the canopy of Sunan candlenut leaves

Treatment	Plant height (cm)		Number of leaves (sheet)		Stem diameter (cm)		Number of secondary branch		Leaf canopy width (cm)	
Chitosan consentration										
10 ml/L	38,55	c	61,30	c	4,85	b	13,29	b	50,41	b
20 ml/L	43,01	b	65,40	bc	4,97	b	16,32	b	55,92	b
30 ml/L	61,43	a	80,82	a	6,15	a	20,88	a	64,75	a
40 ml/L	48,64	b	71,07	b	5,12	b	19,74	a	61,00	a
Frequency of Chitosan Administration										
3 times	39,48	q	67,44	q	5,13	p	14,49	b	59,67	q
4 times	50,83	p	74,13	pq	5,45	p	19,15	a	66,55	p
5 times	43,52	q	74,97	p	5,24	p	16,47	b	65,83	p
Treatment Combination	32,24	(-) x	72,21	(-) x	5,29	(-) x	16,72	(-) x	60,02	(-) x
Without Chitosan	14,77	y	45,25	y	5,15	x	15,33	x	50,67	y

Note: Average treatment between columns and rows followed by the same letter shows no significant difference in the DMRT test at 5% level. The (-) sign indicates that there is no interaction

Based on the results of the study of Sasmita *et al*., (2019) about the Effect of NPK Fertilizer Dose and the Application of Chitosan to the Growth of Kemiri Sunan Plants in Marginal Land, showed that there was no interaction between NPK fertilizer

dosage treatment and chitosan administration on all vegetative growth parameters observed. The NPK fertilizer dose gives 200 g Urea + 120 g SP_{36} + 120 g KCL per plant gives a better effect on the parameters of plant height and number of leaves but has the same effect on the parameters of stem diameter and width of the leaf canopy. Chitosan plus (chitosan 30 ml/L + GA_3) gives a better effect on all vegetative parameters observed. Chitosan treated plants had a better effect on the vegetative parameters observed (Table 3).

Table 3. The mean increase in plant height, number of leaves, stem diameter, number of secondary branches, and width of the canopy of Sunan candlenut leaves

Treatment	Plant Height (cm)		Number of leaves (sheet)		Stem diameter (cm)		Number of secondary branch		Leaf canopy width (cm)	
Dose of Urea+SP36+KCl (g/tan)										
150 + 90 + 90	41,93	b	60,22	b	3,42	a	15,20	b	60,62	a
200 +120 + 120	63,81	a	71,59	a	3,23	a	17,22	b	56,44	a
250 + 150 + 150	40,15	b	62,73	b	3,29	a	19,44	a	66,32	a
Chitosan admninistration										
30 ml/L	46,16	q	61,56	q	3,45	q	17,11	q	57,59	q
30 ml/L + GA3	57,34	p	76,62	p	3,70	p	20,93	p	73,59	p
Without chitosan	41,74	r	56,25	r	2,80	r	13,82	r	50,30	r
Interaction	(-)		(-)		(-)		(-)		(-)	

Note: Average treatment between columns and rows followed by the same letter shows no significant difference in the DMRT test at 5% level. The (-) sign indicates that there is no interaction

Fertilization of 200 g Urea + 120 g SP_{36} + 120 g KCl per plant is the right dose, the plant is able to utilize the available nutrients optimally. The existence of NPK fertilizer as an inorganic fertilizer is very quickly absorbed by plants, especially the nitrogen element compared to elements P and K. According to Lingga and Marsono (2007), the role of nitrogen for plants is to stimulate overall growth and encourage the formation of chlorophyll so that the leaves turn green which is useful for the process photosynthesis.

Chitosan 30 ml/L + GA_3 treatment gives a better effect. According to Abidin (1990), GA_3 can stimulate stem growth, increase plant cell enlargement and propagation, so that plants can reach a maximum height. GA_3 affects the extension of plant segments by increasing the number and size of cells in these segments (Wattimena, 1998 *in*., Tetuko *et al*., 2015. The addition of gibberellins causes elongation of the stem by spurring cell division and cell elongation so that plant height is more significant than the plant height. Without the addition of gibberellins, one of the effects of gibberellins is to encourage leaf lengthening (Ratna, 2008), expand leaves and influence the growth of leaf counts (Tetuko *et al*., 2015). The more the number of leaves, the more secondary branches are produced, the number of leaves affected by genotype and environment. The addition of gibberellins is effective in influencing the number of productive branches, this is in accordance with Willkins (1989) opinion that the hormone gibberellins work on genes so that it requires the right concentration Concentration of the 100 ppm gibberelline hormone can effectively increase the number of productive branches. Leaves have something to do with the number of secondary branches. The more the number of secondary branches will cause an increase in the leaf growing segment, the number of leaves tends to be more and the leaf canopy wider. In addition, gibberellins have a synergistic effect on cambium activity and differentiation of the transport network which causes the trunk diameter to be greater.

4. Conclusion

1. Cultivation innovation through the use of chitosan which is applied to the kemiri sunan or sunan candlenut plants gives a better effect than plants that are not given chitosan.
2. Application of chitosan through leaves is more effective than application of chitosan through roots and sprayed on the stem of the plant.
3. The concentration of chitosan 30 ml/L and the frequency of giving chitosan 4 times is the right treatment according to the needs of plants and efficient to support the vegetative growth of kemiri sunan or sunan candlenut plants.
4. The treatment of chitosan 30 ml/L + GA_3 gives a better effect than the treatment of chitosan without the addition of gibberellins.

Acknowledgement

This paper is one of the outputs of the pre-eminent tertiary research of higher education on Kemiri Sunan or Sunan Candlenut. Thank you to the Directorate of Research and Community Service, Directorate General of Strengthening Research and Development of the Ministry of Research, Technology and Higher Education of the Republic of Indonesia, for financial assistance so that this research can be conducted.

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