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Growth and Quisition N, P, K of Oil Palm Seedling on Plant Media Made from Solid Decanter and Oil Palm Empty Fruit Bunches

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ABSTRACT

The Indonesia oil palm industry is one of the most highly organized sectors in the nation's agriculture system. Plantation agriculture has largely determined many of the country's current economics, social and politics. This research is focused on the development of oil palm seedling by using oil palm empty fruit bunches and solid decanter as planting media. A pot experiment was conducted with oil palm seedling, to assess seedling growth and chlorophyll content. The result of the research showed that treatment combination of solid decanter and oil palm empty fruit bunches as growing media had a significant effect on the increase of seedling height at 12 and 14 after sowing time, in addition to stem diameter, number of chlorophyll a, chlorophyll band total chlorophyll. The highest root dry weight was obtained on treatment of sub-soil +solid decanter + OPEFB(10:50:40), and shoot dry weight was obtained in the subsoil, solid decanter, and oil palm empty fruit bunches (OPEFB) (10:20:70). Root volume obtained on the mixture of subsoil, solid decanter, and OPEFB (10:20:70).

INTRODUCTION

Palm oil plantation expansion in Indonesia showed increased production rate by 9.4% per year. In 2001-2004, the total area of oil palm production in each year grew at a rate of 3.97% and 7.25% per year, while exports increased by 13.05% per year. In 2010, crude palm oil production was expected to increase between 5-6%, while for the period of 2010-2020, growth in production is expected to range between 2-4% (Harahap, 2011).This industry is also considered a strategic element in the Indonesia economy, rather than its contribution to foreign exchange earnings, the cooking oil produced from palm oil plantation is one of the dominant factors in determining the inflation rate of the Indonesian economy.

Palm oil industry will produce waste, which is grouped into liquid, solid and gas waste. Solid waste includes Oil Palm Empty Fruit Bunches (OPEFB), palm shells, fibers and sludge. To avoid environmental pollution caused by palm oil industry waste, it is necessary leads to the concept of preventive environmental management, which integrated into all industrial activity. Protecting the environment has been the priority of many sectors in our endeavor to ensure sustainable development. The Roundtable on Sustainable Palm Oil (RSPO) was set up in 2004 to try to address such issues, and to help stakeholders develop best practices approaches to financing, growing, refining, distributing and using palm oil. The organization seeks to advance the production, procurement and use of sustainable oil palm products.

OPEFB compost can be used as a fertilizer and is rich in nutrients like nitrogen, phosphor, potassium, and magnesium. Fresh OPEFB can be processed into compost, thus giving it an additional economic benefit as a supplier of organic materials for plants. OPEFB compost has been widely used, and some researchers showed that it has a positive effect on oil palm seedlings growth (Widyastuti, Hand TriBannerman, 2007), soybean yield and quality (Hanum, Ch. 2013), as well as citrus and chili yield and quality (PPKS, 2008). The technology used to produce OPEFB compost is a waste treatment technology that can process waste into organic fertilizer, thus helping oil palm industries to apply the concept of zero waste (Westpal and Jansen, 1993).

Solid decanter is one of the solid wastes produced from processing crude palm oil. Industries generally did not use this waste because they needed a relatively large fund to manage it. Therefore, this waste generally filled landfills, thus polluting the environment. Based on these reasons, this research attempted to find a positive use for solid decanter to handle this waste.

Solid decanter waste has a potential to be used as a growing media. This organic material contains a number of nutrients, especially nitrogen. Based on samples analysis from several plantations in Sumatra, wet solid decanter contained nutrients N(0.472%), P(0.046%), K(0.304%) and Mg(0.070%). Nutrient content from solid decanter is similar to OPEFB, but potassium (K) content from solid decanter is lower than OPEFB (Pahan, 2008).

Productivity and sustainability of palm oil plantations industry depend on seedling. Choosing the best seedlings is one of the critical factors in palm oil plantation, and its growth depends on planting media used. Recently, palm oil plantation shaves begun to experience difficulties in finding and providing topsoil on a large scale as planting media for seedling nursery. Some problems related to the provision of top soils are: 1) top soil locations are far from nursery location; 2) the price of top soils are relatively expensive and 3) many soils are not free of ganoderma.

Crude palm oil industries produced around 4-6% of solid waste from total production. Each hectare of oil palm plantations will produce as much as 840 – 1260 Kg sludge waste (Sianipar, *et. al.* 2003). This solid organic material contains a number of nutrients, especially nitrogen (N). Nutrient content can vary, but 1 ton of wet decanter solid (DS) generally contains about 17 kg of Urea, 3 Kg of TSP, 8kg and 5kg MOP kiserit. Using solid decanter as a fertilizer in the field will help reduce the use of chemical fertilizer. Solid materials like mud contain about 75% water, 11.14% crude protein and 10.14% crude fat. Water content is higher because this material decays easily. If a solid decanter was left in the field for about 2days, it will be covered by a yellowish fungus. When it dried, it will become hard and brown in color.

To resolve these issues, one alternative is to utilize OPEFB and solid decanter with a certain composition ratio for planting media. Using this waste as planting media will make palm oil plantations a green industry by using the concept of 3R (Reduce, Recycle, and Reuse). Chavalvarit *et al.* (2006) indicated that crude palm oil industries must apply waste recycling methods that resemble food chains, food webs and natural nutrient cycles. Ecology-based palm oil industries can develop clean technology options while improving other economic activities.

The objective of this research was to study the response of oil (*Elaeis guineensis* Jacq.) seedlings growth and N, P and K acquisition in various planting media, which are solid decanter, OPEFB, and various combinations of both.

MATERIALS AND METHODS

Plant culture and treatments

A pot experiment was conducted with oil palm seedling, to assess seedling growth. One seedling per treatment replicate was planted in a randomized block design in small plastic pots filled with ten plant media modification based on solid decanter and OPEFB. 90 days after planting, seedling growth was assessed. Three plants per replicate were harvested for chemical analysis and fresh weight determination, and two plants per replicate were harvested for the determination of chlorophyll.

Chlorophyll determination

Two plants per replicate at each stage were used for chlorophyll determination. Fresh leaf samples taken from the youngest fully expanded leaf were extracted with 90% acetone and absorption values were obtained by using a UV/Vis Spectrophotometer (Bausch & Lomb, Belgium). Chlorophyll concentration was calculated using the formulae from Strain and Svec (1966).

RESULTS AND DISCUSSION

Shoot growth

Plant height, stem diameter, and shoot dry weight were used to assess seedling and vegetative growth at planting media treatment to test the effect of planting media on plant growth. Three parameters, plant height, stem diameter and shoot dry weight, showed significant effect in planting media treatment (Table 1).

Table 1. Shoot growth of oil palm seedling in various plant media treatment

Treatment	Parameter		
	Plant height	Stem Diameter	Shoot dry weight
S0 (Topsoil)	28.23bc	0.37b	1.54d
S1 (Solid decanter)	17.13f	0.15e	0.22g
S2 (TKKS)	32.93a	0.55a	2.81bc
S3 (Topsoil+solid decanter+OPEFB 10:80:10)	20.10e	0.18c	0.70f
S4 (Topsoil+solid decanter+ OPEFB10:70:20)	17.90f	0.17d	0.70f
S5 (Topsoil+solid decanter+OPEFB10:60:30)	21.87d	0.25b	1.95d
S6 (Topsoil+solid decanter+OPEFB10:50:40)	24.30cd	0.25b	0.39g
S7 (Topsoil+solid decanter+ OPEFB10:40:50)	25.90cd	0.30b	0.93f
S8 (Topsoil+solid decanter+ OPEFB10:30:60)	24.33cd	0.25b	1.05e
S9 (Topsoil+solid decanter+ OPEFB10:20:70)	35.60a	0.68a	5.02a
S10 (Topsoil+solid decanter+ OPEFB10:10:80)	26.60cd	0.30b	2.90b

Note: The figures followed by different letters in the row, column, andon the same variables showed significant effect according to Duncan's Multiple Range Test at α= 5%

Table 1 shows that planting media and OPEFB compost (70%) mixture with solid decanter (20%) gave the best plant height, stem diameter, and shoot dry weight. The result of this research indicated that the mixture of solid decanter and OPEFB have the potential to be used as growing media. Laboratory analysis of solid decanter (Table 2) and OPEFB (Table 3) showed the following criteria:nitrogen and potassium = high; phospor = medium criteria; and magnesium= very low. The high nitrogen content of the growing media allowed plants to get enough nutrient for growth and development.

Table 2. Nutrient content of solid decanter

			Method
Organic Carbon	11,23	%	Walkley & Black Titration
Organic Matter	63,90	%	Ashing
N	0,55	%	Kjeldahl
P	0,06	%	Spectrophotometry
K	0,24	%	Flamephotometry
Ca	0,17	%	AAS
Mg	0,10	%	AAS
B	80,29	ppm	Spectrophotometry
Fe	0,15	ppm	AAS
Cu	7,89	ppm	AAS
pH	6,07		Electrometry

Nitrogen is used in building proteins and is an essential nutrient for plant growth. Metabolic processes, based on protein, led to increase in vegetative and reproductive growth and yield, and fully depended on the adequate supply of nitrogen (Lawlor, 2002). Both field and laboratory investigations have demonstrated that increasing the supply of nitrogen fertilizer would increase plant growth (I. Cechin, T and de Fatima Fumis, 2004). The sensitivity of plant growth to nitrogen fertilization is of great importance in agriculture. For example, nitrogen deprivation will reduce leaf production, individual leaf area and total leaf area (Toth, *et al* 2002; J. Vos, H. Biemond, 1992), resulting in a reduced area for light interception for photosynthesis.

Table 3. Nutrient content of oil palmempty fruit bunches (OPEFB) compost

Parameters			Method
Organic Carbon	3,61	%	Walkley & Black Titration
BO	31,88	%	Ashing
N	0,28	%	Kjeldahl
P	0,09	%	Spectrophotometry
K	0,80	%	Flamephotometry
Ca	0,21	%	AAS
Mg	0,15	%	AAS
B	86,87	ppm	Spectrophotometry
Fe	4200,00	ppm	AAS
Cu	10,95	ppm	AAS
pH	8,63		Electrometry

Potassium (K) is vital in many plant processes including in basic biochemical and physiological systems of plants. While potassium does not become a part of the chemical structure of plants, it plays many important regulatory roles in development. Potassium activates at least 60 different enzymes involved in plant growth. It changes the physical shape of the enzyme molecule, exposing the appropriate chemically active sites for reaction. Potassium also neutralizes various organic anions and other compounds within the plant, helping to stabilize pH between 7 and 8, optimum for most enzyme reactions. Potassium is required for every major step of protein synthesis. The reading of the genetic code in plant cells to produce proteins and enzymes that regulate all growth processes would be impossible without adequate potassium.

When plants are deficient in potassium, proteins are not synthesized despite an abundance of available nitrogen (N). Instead, protein raw materials (precursors) such as amino acids, amides and nitrate would accumulate. In order for proteins to form, enzyme nitrate reductase is needed. This enzyme requires K for its activation and synthesis (Patil *et al*, 2011).

The composition of solid decanter on growing media may only constitute a maximum 20% of the media's total weight. Solid decanter has a unique characteristic because of its oil content and it became compact when it dried. When soil particles are forced together by compaction, both the number of voids contained in the soil mass and the size of the individual void spaces were reduced. This has an obvious effect on the movement of water through the soil. One effect was reduced permeability, reducing the seepage of water. Similarly, if compaction was accomplished with proper moisture control, the movement of capillary water could be minimized. This reduced the tendency for the soil to take up water and suffer later reductions in shearing resistance. Soil compaction will make it difficult for young roots to penetrate the soil, thus inhibiting its growth (Table 4).

Table 4. Root growth of oil palm seedling in various planting media treatment

Treatment	Root parameters		
	Root Volum	Root dry weight	Shoot/root ratio
S0 (Topsoil)	0.50c	0.40c	4.21cd
S1 (Solid decanter)	0.10b	0.08d	3.37cd
S2 (TKKS)	0.10b	0.13d	23.83a
S3 (Topsoil+solid decanter+ OPEFB(10:80:10)	0.10b	0.24c	3.07d
S4 (Topsoil+solid decanter+ OPEFB (10:70:20)	4.00a	0.65b	1.11d
S5 (Topsoil+solid decanter+ OPEFB (10:60:30)	0.50b	0.24c	8.57bc
S6 (Topsoil+solid decanter+ OPEFB(10:50:40)	0.20b	0.37c	1.06d
S7 (Topsoil+solid decanter+OPEFB(10:40:50)	0.50b	0.96a	1.06d
S8 (Topsoil+solid decanter+ OPEFB(10:30:60)	0.20b	0.36c	2.95d
S9 (Topsoil+solid decanter+ OPEFB(10:20:70)	5.00a	0.87a	5.84c
S10 (Topsoil+solid decanter+ OPEFB(10:10:80)	0.10b	0.24c	12.30b

Note: The figures followed by different letter sin the row, column, and on the same variables showed significant effect according to Duncan's Multiple Range Test atα=5%

Plant roots on planting medium that uses only OPEFB showed decreased growth (Table 4). Inhibited root growth on OPEFB was caused by this media becoming saturated in the process. The result of several studies of organic matter was known that organic matter its have more water holding capacity. Therefore, if the planting media use only OPEFB, they will become very humid.Soil biological activity requires air and moisture. Optimal microbial activity occurs at near field capacity which is equivalent to 60% water-filled pore space (Linn and Doran, 1984). On the other hand, periods of water saturation lead to poor aeration. Most soil microorganisms need oxygen and thus a reduction of oxygen in the soil led to a reduction of the mineralization rates as these organisms became inactive or even died. Some of the transformation processes became anaerobic, which can lead to damage to plant roots caused by waste products or the formation of favorable conditions for disease-causing organism.

The mixture of top soil, solid decanter and OPEFB with composition 10:20:70 can increase shoot growth (Table 1) and root growth (Table 4). However, for chlorophyll parameter (A, B, and total) highest on plant media OPEFB (Table 5). The average amount of chlorophyll was higher on seedling that planting on the OPEFB compost. This indicates the growing media capabilities to meet the needs of plants. The results in Table 1 showed the average seedling height and stem diameter were higher in the OPEFB compost planting medium.

The average amount of chlorophyll was higher in the planting medium OPEFB compost indicates the ability of root system to increase absorption water and nutrient. Table 1 also showed that the average seedling height and stem diameter were higher in the planting medium OPEFB compost.

Chlorophyll is a green photosynthetic pigment which helps plants to obtain energy from light. Plants use this energy to combine carbon dioxide and water into carbohydrate to sustain their life process.Chlorophyll content could depend on seasonal and environmental changes.

The low amount of chlorophyll in plant media solid decanter was allegedly caused by poor root growth (Table 4). The low root growth caused decrease of absorb water and nutrient 6y. Low ability roots in water supply, will lead to limited raw material for photosynthesis.

Table 5. Some of palm oil seedling chlorophyll on the planting media treatment

Treatment	Chlorophyll content		
	A	B	Total
	mm/g bb		
S0 (Topsoil)	0.37b	0.01b	0.50c
S1 (Solid decanter)	0.14d	0.00c	0.21e
S2 (TKKS)	0.53a	0.10a	0.77a
S3 (Topsoil+solid decanter+ OPEFB10:80:10)	0.36b	0.05b	0.49c
S4 (Topsoil+solid decanter+ OPEFB10:70:20)	0.47a	0.01c	0.63b
S5 (Topsoil+solid decanter+ OPEFB 10:60:30)	0.43a	0.00c	0.56e
S6 (Topsoil+solid decanter+ OPEFB10:50:40)	0.18d	0.01b	0.22e
S7 (Topsoil+solid decanter+ OPEFB10:40:50)	0.26c	0.01b	0.36d
S8 (Topsoil+solid decanter+ OPEFB10:30:60)	0.20d	0.00c	0.25e
S9 (Topsoil+solid decanter+ OPEFB10:20:70)	0.22d	0.10a	0.25e
S10 (Topsoil+solid decanter+ OPEFB10:10:80)	0.20d	0.10a	0.25e

Note: The figures followed by different letter sin the row, column, and on the same variables showed significant effect according to Duncan's Multiple Range Test atα = 5%

Chlorophyll is essential to plant existence. Monitoring chlorophyll levels is a direct way of tracking plant growth. Thus, chlorophyll measurement can be utilized as an indirect indicator of nutrient levels especially nitrogen and magnesium.

Table 6. Leaf N, P, K, and Mg level

Treatment	N	P	K	Mg
S0 (Topsoil)	2.24c	016	1.20	0.30
S1 (Solid decanter)	1.12f	0.15	1.40	0.33
S2 (OPEFB)	3.08a	0.22	1.30	0.39
S3 (Topsoil+solid decanter+ OPEFB10:80:10)	1.54e	0.19	1.35	0.34
S4 (Topsoil+solid decanter+ OPEFB10:70:20)	0.98f	0.20	1.37	0.40
S5 (Topsoil+solid decanter+ OPEFB10:60:30)	1.68e	0.21	1.35	0.34
S6 (Topsoil+solid decanter+ OPEFB10:50:40)	1.40f	0.21	1.35	0.33
S7 (Topsoil+solid decanter+ TKKS 10:40:50)	1.96d	0.21	1.37	0.40
S8 (Topsoil+solid decanter+ OPEFB10:30:60)	2.66b	0.20	1.34	0.43
S9 (Topsoil+solid decanter+ OPEFB10:20:70)	2.94a	0.20	1.33	0.35
S10 (Topsoil+solid decanter+ OPEFB10:10:80)	2.38c	0.20	1.30	0.23

Note: The figures followed by different letter sin the row, column, and on the same variables showed significant effect according to Duncan's Multiple Range Test atα = 5%

Plant media with nitrogen availability resulted in higher leaf nitrogen content. This resulted in strong positive correlation between photosynthesis and leaf nitrogen content for many C4 and C3 species. Up to 75% of leaf nitrogen was found in the chloroplasts, most of it invested in ribulose bisphosphate carboxylase alone.

Amino acids are not only central metabolites but are also one of the most abundant forms of nitrogen transported in plants. Distribution and cycling of amino acids through the xylem and phloem are critical in optimizing nitrogen allocation between organs. It is well known that auxin regulates many critical aspects of plant growth and development. Auxin was synthesized mainly in young tissues and transported into and out of cells by membrane-associated auxin transporters. Auxin transport in root gravitropism, shoot branching, leaf patterning, phototropism, as well as post-translational modification and flavonoid regulation in auxin transport (Peer *et al*., 2011).

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CONCLUSION

Treatment combination of solid decanter and oil palm empty fruit bunches (OPEFB) as growing media had a significant effect on the increase of seedling height at 12 and 14 weeks after sowing time, stem diameter, number of chlorophyll a, chlorophyll-band total chlorophyll. The highest root dry weight was obtained on treatment of solid sub-soil+ decanter+ OPEFB (10:50:40), and shoot dry weight was obtained in the subsoil, solid decanter, and OPEFB (10:20:70). Highest root volume was obtained on the mixture of subsoil, solid decanter, and OPEFB (10:20:70)

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