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Cocopeat as Soil Substitute Media for Rubber (*Hevea brasiliensis* Müll. Arg.) Planting Material

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Abstract

To establish rubber plantations smallholders in South Sumatra, Indonesia, plant materials are planted in polybags filled with top soil media from the local area. Good quality media is very important to ensure optimal growth of the rubber planting materials. The availability of top soil has become increasingly limited. In order to fulfill the need of planting media, cocopeat, which is available in abundance in the area, can potentially be an alternative to top soil. Cocopeat can potentially be used alone, or in combination with other type of media. In this study, cocopeat was mixed with soil at several mixture ratios to determine the best formula of cocopeat based planting media for rubber planting material. The study was conducted from August 2016 to January 2017 in the Nursery of Sembawa Research Centre Experimental Field, Palembang, South Sumatra, Indonesia. A completely randomized design was employed with six combinations of cocopeat and soil, replicated three times. This study showed that the best mixture ratio is 80% cocopeat and 20% soil, whereas 100% soil or 100% cocopeat is not recommended. The use of cocopeat as planting media should be followed by balanced fertilization in order to provide nutrients that are not available in cocopeat.

Keywords: cocopeat, soil, rubber planting material, planting media

Introduction

Indonesia is the second largest rubber producing country in the world. Most of the rubber producers in Indonesia are smallholders with production area of around 3.1 million hectares (Directorate General of Estate Crops, 2016). To establish their rubber plantation, they usually use plant materials that were prepared in the polybags with top soil as the growing media. Planting material is crucial in plantation establishment as it determines the production of rubber trees for the next 25 years. In addition, high quality planting material will ensure good plant growth and earlier and high yields.

Planting media is very important to produce quality rubber planting materials. Unfortunately, in Indonesia, especially in South Sumatra, the availability of quality top soil has increasingly became limited, so most of the rubber planting material producers use sub soil even though the quality is not optimal. The type of soil available in the study area is ultisol. The subsoil of ultisol is characterized by high compactness; making it hard for the roots of young trees to grow. The growth and development of root systems became limited, hence the growth of the whole plant was inhibited. To cope with this problem, cocopeat, a renewable planting media that can potentially accommodate the growth and development of root system, was tested. Cocopeat is a secondary product from the coconut processing industry (Arenas and Vavrina, 2002). Cocopeat is an ideal planting media for nurseries due to their good physical properties including high total pores, low shrinkage, low bulk density, and slow degradation (Treder, 2008). The low bulk density of cocopeat makes it light, thus it is easier and more efficient to handle in transportation and distribution to the field. Recently, cocopeat has been used widely as soilless planting media (Evans and Stamps, 1996; Handreck, 1992; Mak and Yeh, 2001, Meerow, 1994; Noguera et al., 1997; Offord et al., 1998; Stamps and Evans, 1999; Kumarasinghe et al., 2015). Cocopeat has an elastic, cellular, and cork like spongy non-fibrous tissue (Bhowmic and Depnath, 1985; Jayaseeli and Raj, 2010). The good physical properties of cocopeat includes high total pores, low shrinkage, low bulk density, and slowly degraded (Treder, 2008). Nazari et al. (2011) showed that cocopeat has total pore of 87%, bulk density 0.13 g/cm^3, and water holding capacity as high as 715% (weight:weight), hence cocopeat is suitable to be used as planting media. Cocopeat can potentially be used to grow a number of plant species in the tropics (Yahya et al., 1997; Yahya et al., 1999, and Yahya et al., 2009).

Although cocopeat seems to be an ideal planting media, cocopeat has to be soaked before being used as planting media to remove potentially toxic substances like thanine, chitine, and phenol that can inhibit root growth (Konduru et al., 1999; Soman and Jacob, 2013). Soaking cocopeat in fresh water is also aimed to reduce electrical conductivity (EC) of the cocopeat. EC values indicate inorganic ion concentration in the media. Low EC value indicates that the planting media has a low salinity level. Optimum EC value of cocopeat for plant growth is about 0.4 to 1.5 mS/cm (Awang et al., 2009).

Banyuasin has abundant supply and availability of cocopeat. The area of coconut plantation in Banyuasin is about 47,285 hectare (Detak Palembang, 2016). The coconut plantation per hectare produces about 5,000 coconuts, and each coconut fruit produces about 0.4 to 0.6 kg of coconut husk. Therefore coconut plantation per hectare can potentially produces for about 2,000 to 3,000 kg of coconut husk every month (Nara, 2018), or equivalent to 94,500 to 141,855 ton per month in Banyuasin district alone. The coconut husk can be processed into mattress, rope, or planting media (cocopeat) to increase coconut husk value. Cocopeat can be used alone or in combination with other materials (Wira et al., 2011). Therefore in this study, cocopeat was mixed with soil at several mixture ratios to determine the best formula of cocopeat based planting media for rubber planting material grown in polybags.

Materials and Methods

This research was conducted from August 2016 to January 2017 in the Nursery of Sembawa Research Centre Experimental Field, Palembang, South Sumatra, Indonesia. The experimental layout was completely randomized with six ratios of soil (ultisols) and cocopeat treatments: control (100% soil), 20% cocopeat and 80% soil; 40% cocopeat and 60% soil; 60% cocopeat and 40% soil; 80% cocopeat and 20% soil; and 100% cocopeat. Each treatment was replicated three times.

The cocopeat and soil were amended with 100 g of chicken manure per polybag prior to filling into 15 x 35 cm polybags with a volume of 2,750 cm^3 (2.7 L) each.The type of planting materials used in this experiment was rubber budded stump with weight of each stump between 160 to 190 g. Rubber budded stump was planted in the centre of polybags filled with a mixture of planting media and chicken manure. The budded stump was planted until the root neck was covered by the media. The measurement of growth parameters was started after a new shoot emerged from the stump.

Measurement was conducted on stem diameter, plant height, root volume, and plant biomass at harvest and dry weight for the whole plant. The plant dry weight was measured after drying in the 60^{o}C oven for four days until the weight was constant. Measurement on stem diameter and plant height was conducted once every two weeks started from August 2016 for 20 weeks. Root volume and plant biomass were measured destructively when the rubber plants were five-month-old. Maintenance of planting materials includes daily irrigation and application of fungicide to prevent disease when the symptoms were detected. Chemical fertilizer (NPK compound, 5 gram per polybag) was applied monthly. The methods used for N, P, and K analysis are presented in Table 1.

Data were analyzed using ANOVA using SAS 9 software (SAS Institute Inc., 2002). Significant differences between means were further analyzed with Duncan Multiple Range Test (DMRT) at 5 % level of significance.

Results and Discussion

The weight of different ratios of cocopeat and soil are described in Table 2. The media is lighter with the increasing ratio of cocopeat (Table 2).

Table 2 shows that planting media consists of 100% soil was almost three times heavier than 100% cocopeat because the bulk volume (BV) of cocopeat was lower than soil. These properties could increase cost efficiency due to the higher capacity of transportation and distribution from nursery to the field.

Cocopeat was more porous than soil, therefore the possibility of cocopeat core to crack in the polybag was higher than soil. However, the media for nurseries should contain sufficient amount of clay to form a

Table 1. Plants nutrient analysis methods

Parameter	Method of Analysis	References
N	Modified Kjeldahl	Chapman, 1965
P	Dry ashing, colorimetry	Chapman, 1965
K	Dry ashing, flame photometer	Chapman, 1965

Table 2. Weight (gram) of cocopeat and soil mixtures at different ratio

Media mixture	Weight (g)
Soil 100 %	3.13 a
Cocopeat 20%; soil 80%	2.65 b
Cocopeat 40%; soil 60%	2.30 c
Cocopeat 60%; soil 40%	1.90 d
Cocopeat 80%; soil 20%	1.80 d
Cocopeat 100%	1.32 e

Note: Values followed by the different letters are significantly different according to DMRT at 5%

cohesive core which will not break up during extraction (Webster, 1989). The cracked planting media core in the polybags of rubber planting material could reduce survival rate of rubber planting material in the field. In order to prevent cracking of the planting media core, the root system should be allowed to grown and filling the media core. In this experiment, the crack of cocopeat core in the polybag could be prevented by the fast growth of root sytem that quickly filled the cocopeat cores (Figure 1).

Figure 1 shows that all of the planting media was solid, no cracking occured. The core of ultisol (100% soil) was rather hard due to clay soil physical characteristic. Media containing cocopeat did not crack, likely due to the root system that has fully grown and filled the media. The good root growth of rubber on cocopeat can be seen from the gradual increment of root fresh weight and volume with increasing proportion of cocopeat (Table 3).
Table 3 shows that cocopeat used in this experiment was suitable as media of rubber planting materials. The good root system and plant growth on cocopeat was also reported by Treder (2008).

At the higher ratio of cocopeat to soil, fresh weight and root volume of the rubber planting materials tended to be higher. The higher N, P and K content in the cocopeat (Table 4) had possibly contributed to the better growth of the rubber trees grown on media containing cocopeat.

Table 4 showed that organic C, N, and P were higher than soil, but K content was not detected. The higher content of N in the cocopeat compared to soil could be because coir pith has ion exchange and and gas adsorptive properties that can be used to adsorb N and prevent losses to the environment (Evans et al., 1996; Handreck, 1993; Scagel, 2003). Application of cocopeat to agricultural soils could improve moisture retention capacity and increase available nutrient content of soil (Savithri and Khan, 1993; Abad et al., 1995; Vavrina, 1996) making it more favourable for plant growth. Good rubber growth in media containing

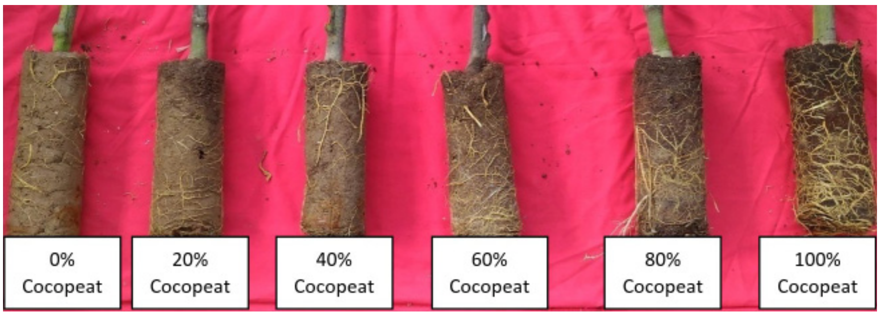

Figure 1. Rubber root systems in media containing cocopeat and soil of different ratios

Table 3 Effect of cocopeat and soil mixture ratio on root fresh weight (g) and volume (cc)

Media mixture	Root fresh weight (g)	Root volume (cc)
Soil 100%	14.33	13.33
Cocopeat 20%; soil 80%	20.00	20.83
Cocopeat 40%; soil 60%	18.00	16.67
Cocopeat 60%; soil 40%	29.33	26.83
Cocopeat 80%; soil 20%	26.00	26.67
Cocopeat 100%	36.66	33.67

Table 4 Electrical conductivity, C-organic, N, P and K content of soil and cocopeat

Planting media	EC (mS/cm)	C-Org (%)	N (%)	P (ppm)	K (cmol$^{(+)}$/kg)
Soil	-	1.8	0.1	1.0	0.03
Cocopeat	0.118	59.35	0.45	300	-

Note: - = not detected according to dry ashing, flame photometer method (Chapman, 1965)

Table 5. Plant height (cm), stem diameter (cm), plant fresh weight and dry weight (g) of five-month-old rubber plant materials

Media mixture	Plant height (cm)	Stem diameter (cm)	Plant fresh weight (g)	Plant dry weight (g)
Soil 100%	37.33d	0.64b	40.66b	11.68d
Cocopeat 20%; soil 80%	37.33d	0.66b	56.00b	16.97bcd
Cocopeat 40%; soil 60%	38.66cd	0.75ab	51.00b	14.34cd
Cocopeat 60%; soil 40%	53.66ab	0.86a	91.66a	24.94ab
Cocopeat 80%; soil 20%	64.33a	0.89a	93.33a	27.22a
Cocopeat 100%	49.66bc	0.90a	88.66a	23.29abc

Note: Values followed by the different letters within one column are significantly different according to DMRT at 5%

higher percentage of cocopeat (60 or 80%) can be seen in Table 5.

Table 5 shows that utilization of cocopeat as planting media with ratio of cocopeat to soil of >60% could significantly increase plant height, stem diameter, plant fresh weight, and plant dry weight. A similar result was reported by Scagel (2003) where leaf and stem dry weight and total stem length of Ericaceous plants increased with increasing proportion of coirdust. Nambiar et al. (1983) reported that the addition of cocopeat to media and fertilizer application improved growth of seedlings as compared to the application of fertilizers alone. Furthermore, adding the cocopeat to the media mixture could improve fertilizer use efficiency (Joshi et al., 1985), therefore the applied fertilizer could optimally been used by the plants and resulted in more optimal plant growth.

Table 5 also shows that the best plant growth, indicated by taller plants, high plant fresh and dry weight were obtained from rubber grown on cocopeat 80% : soil 20%, but plant growth was inhibited on 100% cocopeat. Reduction of the growth could be caused by poor aeration due to the high water holding capacity of cocopeat (Yahya et al., 2009). Reduction of growth using 100% cocopeat was also reported by Yahya et al. (1997). Results of this study demonstrated that 80% cocopeat: 20% soil is the best for the growth of rubber planting materials.

Conclusion

Cocopeat can be used as a substitute for top soil as planting media for rubber. The best ratio of cocopeat to soil for rubber planting material is 80:20. Media consists of only cocopeat is not recommended to grow young rubber trees. Utilization of cocopeat as planting media should be followed by balanced fertilization in order to provide nutrients that are not available in cocopeat.

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