Growth and physical quality of *Paraserianthes falcataria* (L) Nielsen seedling on ten types of transplanting media

Slamet Santosa

Department of Biology, Faculty of Mathematics and Natural Sciences, Hasanuddin University, Indonesia

Abstract

Growth and physical quality of *Paraserianthes falcataria* (L) Nielsen seedling is determined by the quality and quantity of transplanting media. The aim of this research is to determine the best transplanting media for growing *P. falcataria* seedling. Research started with sowing *P. falcataria* seed in plastic container until the seedling grow. After 2 weeks of age, seedling was placed in ten types of transplanting media. Transplanting media consist of Sidoarjo's mud soil, rice husk, compost and cow manure. Each types of transplanting media were made from different concentration of mud, rice husk, compost and cow manure. Result showed that the highest growth of *P. falcataria* seedling was found in M4 with 31.0 cm. However, this result was not significantly different with M1 which the high is 30.,6 cm. Other *P. falcataria* seedlings showed varied growth with the value ranging from 27.6 to 29.9 cm. M4 also showed highest stem diameter, root length and leaves number with value 0.50 cm; 20.6 cm; 50.1 respectively. Root dry weight and stem+leaf dry weight were also highest on M4 with value 1.4g and 4.9g. RRSL and Seed Quality Index were also highest on M4 with value 3.50 and 0.09. It was concluded that M4 is the best transplanting media for *P. falcataria* seedling.

Introduction

Paraserianthes falcataria (L) Nielsen is the potential plant for industrial wood forest because it has high economical and ecological values. Wood from *P. falcataria* are mainly used for paper pulp industries. *P. falcataria* was also known for its ability to improve soil fertility, increase water management quality and create microclimate.[1] Determination of seedling qualities were generally based on the assessment of three criteria: physical, physiological and genetics.[2]

Generally, seedling production of *P. falcataria* using transplating media consists of topsoil and organic compound. The use of topsoil as main mixture in transplanting media could rise negative impact to surrounding environment. If 50% topsoil were used as mixture in 1 billion transplanting media, it will be eroded approximately 5 million m^3 of soil.[3] Thus, the use of topsoil as material should be restricted and it is advisable to look for other alternative materials. There are some requirements that must be considered in making transplanting media.[4] It should be porous for root aeration and drainage, has nutrient content, able to hold water, compact in texture and ability to support seedlings.[5]

An alternative material to substitute topsoil is mud soil from Sidoarjo. This material is abundant and is formed from oil drilling mudflow Lapindo Brantas Limited Company, Inc. Chemical analysis shows this mud soil consist of 62% clay and Cation Exchange Capacity (CEC) 42.48 me/100 g.[6] Clay component >55% and it has potential ability to hold water in transplanting media.[7] While CEC is important for soil fertility.

Materials and Methods

Seedling of *P. falcataria* (L) Nielsen

Research began with sowing *P. falcataria* seed in plastic container until the seedlings grow. Seedling was watered twice a day. After 2 weeks of ago, seedling was placed in 10 types of transplanting media consisting of: Sidoarjo's mud soil (S), Rice husk (R), Compost (C) and Cow Manure (M). Each type of transplanting media were made from different concentration of mud, rice husk, compost and cow manure. The ratio of mixture on each transplanting media were: M1 (20% S: 40% R: 20% C: 20% M); M2 (50% S: 20% R: 10% C: 20% M); M3 (50% S: 20% R: 20% C: 10% M); M4 (50% S: 40% R: 10% C); M5 (50% S: 40% R: 10% M); M6 (80% S: 10% C: 10% M); M7 (80% S: 20% R); M8 (80% S: 20% C); M9 (80% S: 20% M) and M10 (100% S). After 3 months, the growth and physical quality of *P. falcataria* was analyzed.

Analysis of growth and transplanting media fertility

Some growth parameters from *P. falcataria* seedlings that will be measured were the height of the plants (cm), stem diameter (cm), root length (cm), leaves number, root dry weight (g), and stem+leaf dry weight (g). The dry weight obtained by drying samples on oven with temperature 105°C. Chemical content in transplanting media: total N (%), phosporus ($mgkg^{-1}$), potassium (me/100g) and physical properties: water holding capacity (%) were analyzed. Chemical content analysis was conducted before transplanting media was used for growing *P. falcataria* seedling.

Correspondence: Slamet Santosa, Department of Biology, Faculty of Mathematics and Natural Sciences, Hasanuddin University, Tamalanrea Makassar, 90245, South Sulawesi, Indonesia.
Tel.: +62 85242113320.
E-mail: slamet_santosa@science.unhas.ac.id

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Assessment of the physical quality

There are two parameters to assess physical quality of *P. falcataria* seedling: i) the Ratio of Root dry weight with Stem+Leaf dry weight (RRSL), and ii) Seed Quality Indexs (SQI). The formula used to analyzed are as follows:[8]

$$RRSL = \frac{Rdw\ (g)}{Sldw\ (g)}$$

$$SQI = \frac{Rdw+Sldw}{RRSL+\frac{H}{D}}$$

where: RRSL, ratio of root dry weight with stem+leaf dry weight; SQI, Seed Quality Index; Rdw, root dry weight (g); Sldw, Stem+leaf dry weight (g); H, height plant (cm); D, stem diameter (cm).

Data analysis

The data were analyzed using F test with confidence interval 95%. Furthermore, if the treatment significantly affected the measurement of parameters, the analysis would be continued with Duncan's test. The analysis of the feasibility of seedling ready for planting were

compared with the National Standard of Indonesia (SNI), which determined the average of high plant (seedling) values ≥30.0 cm and stem diameter ≥0.50 cm.[9]

Results and Discussion

Growth and transplanting media fertility

The highest growth of *P. falcataria* seedling was found in M4. However, the growth was not significantly different with the high growth of M1 growth. Growths of other transplanting media (M2, M3, M5, M6, M7, M8, M9 and M10) were varied, ranging from 27.6 to 29.9 cm (Table 1). These results were not different with some results from other researchers.[1] Seedling on transplanting media with topsoil and compost resulted in high growth 32.3 cm.[10] While transplanting media with manure supplement was only resulted 27.4 cm.[11] Transplanting media with manure and compost showed various high growths ranging from 14.52 to 30.04 cm.[9] According to SNI, the high growth of *P. falcataria* seedling ≥30.0 cm was eligible to be planted in the field.

The highest root growth of *P. falcataria* seedling was also found in M4 with length 20.6 cm. However, this length was not significantly different with root growth of M2. The use of 40% rice husk as mixture in M4 transplanting media provided large space for root of seedling to grow.[6] Rice husk also increased the porocity of media, not easy to decompose and produced less solid media.[12] The plants grew better when having adequate growing space. Growing space affected root development. Limited growing space will disturb root growth.

Roots are important parts of plant, which affect growth and development. Roots are used by the plant to absorb nutrients and water for the growth of leaves and stems. Better root growth in M4 transplanting media influenced the number of leaves and stem diameter of *P. falcataria* seedling. Leaves are primary location for photosynthesis.[13] The number of leaves is a major determinant for growth rate. More leaves number will increase high growth.[14] Meanwhile, stem diameter is influenced by photosynthetic rate, which depend on leaf growth.[8] Lower photosynthetic rate will inhibit stem diameter growth.[15] On the other hand, growth of plant is the final manifestation of photo synthetic processes.

The growth of *P. falcataria* seedling varies in 10 types of transplanting media. This happens because each transplanting media has different quality and quantity.[16] Good quality media contains nutrient elements N, P, K and water. Meanwhile media has optimum quantity if they provide growing space for root to grow. From chemical content analysis, result showed that nutrient element varied among transplanting media. Total N ranged from 0.12 to 0.46%, P Bray availability ranges from 4.8 to 98.12 mgkg^{-1} and K availability ranged from 0,09 to 2,54 me/100g. Analysis of water holding capacity ranged from 55.0-68. 57% (Figures 1 and 2).[17] Total N ranged from 0.21 to 0.50% which is categorized as middle fertility. P Bray availability value was >35.0 mgkg^{-1}and K available value 1.0 me/100g. Both values were categorized as very high fertility.

Based on these criteria, the transplanting media (M1, M2, M3, M4, M5, M6 and M7) have total N ranged from 0.23 to 0.46%, and categorized as middle class fertility. While transplanting media (M1, M2, M3, M4, M6, M7, M8 and M9) have P Bray ranged from 35.72 to 98.12 mgkg^{-1} and K availability ranged from 1.02 to 2.54 me/100g. Both ranged of value categorized as high-class fertility. Only M10 categorized as infertile because it has total N 0.12%, P Bray availability 4.8 mgkg^{-1} and K availability 0.09 me/100 g. M10 consist of 100% mud soil without rice husks, compost and cow manure.[6] This sample made from Sidoarjo's mud soil from

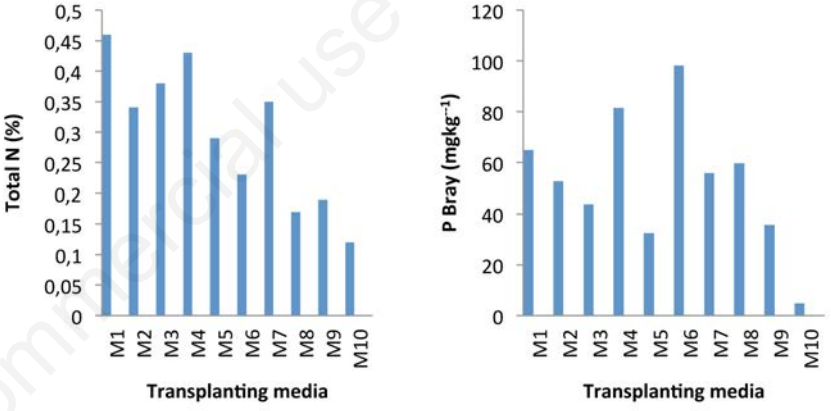

Figure 1. Contents of total N and P Bray on ten types of transplanting media.

Table 1. Duncan's test of growth and physical quality of *P. falcataria* (L) Nielsen seedling.

Code of transplanting media	Height plants, cm	Stem diameter, cm	Length root, cm	Leaves number	Root dry weight, g	Stem + leaf dry weight, g	RRSL	SQI
M1	30.6	0.50^{c}	19.8^{bc}	48.2^{b}	1.3^{c}	4.7^{cd}	3.62^{a}	0.09^{a}
M2	28.9^{ab}	0.48^{b}	20.4^{c}	50.0^{bc}	1.3^{c}	4.7^{cd}	3.62^{a}	0.09^{a}
M3.	29.9^{b}	0.50^{c}	19.6^{bc}	49.2^{b}	1.3^{c}	4.8^{d}e	3.69^{a}	0.09^{a}
M4	31.0^{c}	0.50^{c}	20.6^{c}	50.1^{c}	1.4^{cd}	4.9e	3.50^{a}	0.09^{a}
M5	28.3^{a}	0.48^{b}	19.8^{bc}	48.0^{b}	1.3^{c}	4.3^{bc}	3.31^{a}	0.09^{a}
M6	28.1^{a}	0.41^{a}	10.0^{a}	44.4^{ab}	0.4^{a}	4.0^{ab}	10.00^{b}	0.06^{b}
M7	28.4^{a}	0.48^{b}	19.0^{a}	48.4^{b}	1.1^{b}	4.4^{bcd}	4.00^{a}	0.09^{a}
M8	28.3^{a}	0.42^{a}	9.0^{a}	44.4^{ab}	0.4^{a}	4.0^{ab}	10.00^{b}	0.06^{b}
M9	27.6^{a}	0.42^{a}	8.4^{a}	42.0^{ab}	0.4^{a}	4.0^{ab}	10.00^{b}	0.06^{b}
M10	27.8^{a}	0.41^{a}	8.0^{a}	33.2^{a}	0.4^{a}	3.8^{a}	9.50^{b}	0.06^{b}

^{a,b,c,d}Values in columns followed by the same letter are not significantly different level of 95%CI. RSSL, ratio of root dry weight with stem+leaf dry weight; SQI, Seed Quality Index.

mud out of the depths over of 100 m,[18] where organic material was limited.

The ten types of transplanting media had a water holding capacity by varying amounts (Figure 2). Results of this analysis showed the water holding capacity of all transplanting media to provide water 50% to support the growth of *P. falcataria* seedling.[19] The water holding capacity >50% could keep moisture in order to avoid the risk of drought media.[20] The water in the plant served as the main compound forming protoplasm, solvent and means of transport of mineral nutrients from the soil to plants and raw materials photosynthesis.[21] Plant growth depended on the amount of water available in the soil. Growth would be limited by the very low water content and the very high one. However, plants had many ways to set themselves towards the conditions of limited water available. Water holding capacity was influenced by the existing pores. The quality and quantity of transplanting media were influenced materials.[7] The clay component was over of 55%, very potential to hold water in transplanting media.[22] Rice husks had a role in the improvement of soil physical properties, include: i) improving soil structure or soil loosening, and ii) add water absorption.[23] The addition of compost or cow manure at doses of 40 tonha^{-1} is able to increase the total N from 0.092 to 0.134%.

Physical quality

Physical quality of seeds is an expression or a picture of a seed which is expected to have high vitality and adaptable after planting. Quality of seeds can be judged from physical parameters such as the ratio of RRSL and seed quality index.[16] The ten types of transplanting media produced different of physical quality performances (Figure 3). The result of RRSL calculation showed that the transplanting media (M1, M2, M3, M4, M5 and M7) have a values ranged from 3.31 to 4.00. The RRSL on transplanting media (M6, M8, M9 and M10) have a values ranged from 9.50 to 10.00.[24] The RRSL is an important factor in plant growth which illustrates the comparison between the ability of water and mineral absorption by the process of transpiration and photosynthesis of the plant area.[25] The RRSL is identified with the state of the canopy and seedling, where the canopy growth influenced environmental conditions and activities of root growth. While the shoot meristem is affected by the media and the results of photosynthesis.[26] The RRSL values ranged from 2 to 5 when planted in the field will be easier to live.[27] The value of the RRSL can be used as the basis of quality seeds. The RRSL lower value indicates seedlings have the power of life and higher adaptability.

The result of SQI calculation showed that the transplanting media (M1, M2, M3, M4, M5 and M7) have an equal value of 0.09; while the SQI on transplanting media (M6, M8, M9 and M10) have an equal value of 0.06.[24] The SQI represents the value of quality seeds that can describe the ability of a particular seed may or may not adapt to the new environment. The SQI higher value indicates that the seedlings have the higher quality and when planted in the field will decrease the death rate.[27] The SQI values ≥0.09, adaptable and high vitality after planting.[28] The SQI shows the existence of a balance translocation of photosynthetic plant organs into a canopy (stems and leaves) as well as to the roots. There is a balance translocation of photosynthetic organs of plants to cause the seed to have a balance of growth between the canopy and the roots.

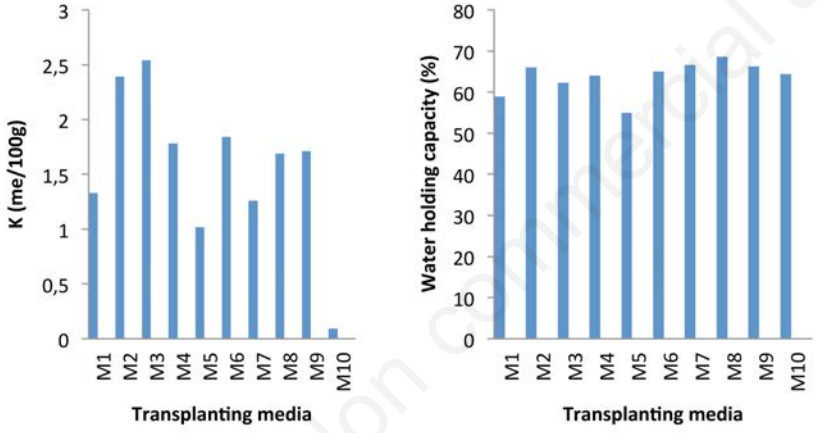

Figure 2. Contents of K and water holding capacity on ten types of transplanting media.

Figure 3. Physical quality performances of *P. falcataria* (L) Nielsen seedling on ten types of transplanting media.

Conclusions

It was concluded that M4 with mixture consisting of 50% Sidoarjo mud soil, 40% Rice husk and 10% Compost is the best transplanting media for *P. falcataria* seedling.

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