The effect of fertilizer on *bambang lanang* (*Michelia champaca* L) seedling growth in mesocarp fiber from oil palm media

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Abstract. Palm oil mill in Indonesia disposed of 4 million tons of fibers’ waste from oil palm fruits mesocarp in 2016. The waste has excellent potential as a growing medium for seedlings. The study aimed to analyze its fertilizer effect on *bambang lanang* seedling growth. The study was conducted from May to August 2018, at the nursery of Agriculture Faculty, Bengkulu University. A complete randomized design was applied with seven treatments and six replications. The treatments were controlled, NPK (2 g; P1), NPK and Osmocote® (1 and 1.5 g; P2), NPK and (1.5 and 2 g; P3), Osmocote® (1.5 g; P4), Osmocote® (2 g, P5), and Osmocote® (3 g, P6). The fibers’ waste from oil palm fruits mesocarp was chosen as the media. The addition of fertilizer yielded significantly different results in height, diameter, leaf number, and dry weight of seedlings. The treatments of P1, P2, and P3 gave better result on height (30.14 - 33.95 cm), diameter (5.65 - 5.97 mm), leaf numbers (11.04 - 11.17 leaf), leaf width (64.22 - 65.86 cm²), and dry weight (1.60 - 2.27 g seedling⁻¹) than other treatments (P4, P5, and P6). The seedling sturdiness ratio for those treatments was 5.36 - 5.70 and could be classified as good seedlings. The P2 treatment could be applied as fertilizer to improve seedlings growth in nursery.

1. Introduction

The oil palm industry produces many fruit fibers as unwanted waste. The oil palm industry could generate fruit fibers, approximately 11.5% in the weight of its fresh fruit bunch [1]. Fruit fibers that have generated by the oil palm industries in Indonesia were about 4,023,361 and 4,319,820 tons year⁻¹ in 2015 and 2016 [2]. In Malaysia, palm oil mill produced about 11.4 million tons of fruit fiber [3]. This waste has caused environmental problems [4]. Fruit fiber has mainly been used to recycle energy and agricultural input [3]. However, this waste has the potential to be a resource for growth media to substitute polybags. It is capable of keeping the root system in good condition due to its light and compact characteristics [5]. Mesocarp fiber from oil palm fruit is one of the types of solid waste that is produced in the oil palm industry, which has the potential to be a growth media material [2].

Growth media is an essential factor in producing good seedlings. The media should be able to provide nutrition, protect the root system from damage and dryness, and guarantee better seedling growth during preparation in the nursery, in the storage, and during transportation. Good growth media should also be easy to handle, efficient, compatible with the plantation technique and tool, and assure better survivability and growth of the seedling after planting in the field [6].
Mesocarp fiber from oil palm fruit can be used as a cultivation media for chili [7], banana [3], *Casuarina equisetifolia* [8], *Terminalia catappa* and *Calophyllum inophyllum* [5], oil palm [9]; however, mesocarp fiber from oil palm fruit is low in nutrients content. The nutrient content of mesocarp fiber from oil palm fruit is N (0.32 %), P (0.08 %), K (0.47 Mg (0.02 %), and Ca (11 %) [10]. The mesocarp fiber from oil palm fruit has sufficient nutrient supplies of P and Mg but requires additional N and K nutrients for growth media [3].

Nutrient availability in media during seedling production should be fulfilled to produce good quality seedlings. The seedling quality, which is used in planting, can affect the survival and grow ability after planting in a field environment [11, 4]. Dealing with the application of fertilizer is an essential part of providing nutrients for seedling production. Highly soluble fertilizer has been widely used in seedling production, allowing an enormous supply of nutrients to the plant. However, high nutrient loss of the fertilizer also occurs due to the leaching process. The need for nutritional replacement in a short time may cause an increase in the cost of production [12]. Dealing with the condition, fertilizer with controlled release of nutrients, such as Osmocote®, has provided greater efficiency in fulfilling nutrients for seedling production. It increases availability time for plant nutrients, reduces nutrient loss by leaching, reduces environmental impact, and is economically viable for forest businesses [13-16].

Therefore, this study aimed to analyze the effects of different fertilizers such as slow-release fertilizer (Osmocote®), soluble fertilizer (NPK), and combinations of soluble and slow-release fertilizer on the development of *bambang lanang* seedlings.

2. Methodology
The study was conducted from July to November 2018, in the nursery of Faculty Agriculture, University of Bengkulu, Bengkulu. Materials used in this study were mesocarp fiber from oil palm fruit waste, *bambang lanang* (*M. campaka*) seedlings, pipe, glue, caliper, measure glass, analytical balance, digital camera, rules and oven. A completely random design was applied in the experiment with fertilizer as a treatment, which was replicated six times. The fertilizer treatments were controlled, NPK (2.00 g; P1), NPK and Osmocote® (1.00 g and 1.50 g; P2), NPK and Osmocote® (1.00 g and 2.00 g; P3), Osmocote® (1.50 g; P4), Osmocote® (2.00 g; P5), and Osmocote® (3.00 g; P6). Height and diameter were measured at 14, 28, 42, 56, 70, and 84 days after transplanting. Seedling leaf area, number of leaves, biomass, and seedling sturdiness ratio were measured at the end of the experiment. Data were analyzed using analyses of variance at α= 5% and Duncan Multi Range Test (DMRT).

3. Results And Discussion
3.1 Height
The seedling height growth of *bambang lanang* has increased after fertilizer application in 42 days age, and tend to have a slightly slower rate after 82 days (Figure 1). Seedlings which received the NPK fertilizer tended growth better than other applications. The untreated seedling showed slower growth during the experiment.
Figure 1. The effect of fertilizer on *bambang lanang* seedling height growth planted on mesocarp fiber from oil palm media at 84 days age.

Variance analysis showed that fertilizer application has a significant effect on the seedling height from 14 until 84 days (Figure 2). The highest seedling height was found in the combination of NPK and Osmocote® (1.00 gr and 2.00 g; P2) fertilizer, which was 33.95 ± 1.70 cm. It was followed by the combination of NPK and Osmocote® (1.00 g and 1.50 g, P3) fertilizer with a height of 33.03 ± 1.98 cm. The treatments did not have a significant effect on height growth. However, they were significant differences with other treatments. It was due to the presence of the macro and micronutrients in media, which were able to fulfill seedling requirements. Macronutrient mesocarp fiber from oil palm media was provided through NPK fertilizer, a high soluble fertilizer addition. Osmocote®, as a slow-release fertilizer, also contributed macro and micronutrients into the media. This finding was also following [18], which stated that slow-release fertilizer has a positive effect on the growth of *Inga heterophylla* seedlings [18] and *Cordia trichotoma* seedlings according to [19]. The vegetative growth of plants needs a suitable amount of macronutrients such as N, P and K, and micronutrients [20]. N nutrients were responsible for plant height growth [21]. Seedlings height with only NPK fertilizer treatment was lower than the combination NPK with slow-release fertilizer, Osmocote®, with a height of about 30.14 ± 1.08 cm. However, it was higher than seedlings that were only receiving slow-release fertilizer, Osmocote® (1.50 g and 2.00 g seedling⁻¹). The application of NPK fertilizer also resulted in a positive effect on seedlings growth in nursery and field [17, 22, 23]. NPK fertilizer also significantly stimulated the height growth of *Shorea ovalis* and *Aquilaria malaccensis* seedlings [17, 22].

The application of slow-release fertilizer (Osmocote®) with doses of 3 g seedling⁻¹ (27.65 ± 1.52 cm) did not have any significant difference in seedling height compared to the application of NPK fertilizer. The application of Osmocote doses 1.50 g and 2.00 g seedling resulted in lower *bambang lanang* seedling height.
Figure 2. The effect of fertilizer on the *bambang lanang* seedling height on the mesocarp fiber from oil palm media at the age of 84 days.

3.2. Diameter

The seedlings' diameter with fertilizer treatment increased drastically after 84 days of treatment. The application of NPK fertilizer alone or combined with Osmocote® resulted in better growth on seedlings' diameter compared to the other treatments. The application of slow-release fertilizer resulted in moderate growth of seedling diameter. Untreated seedlings produce the lowest growth of seedling diameter (Figure 3).

Based on variance analysis, fertilizers application have a significant effect on seedling diameter growth. The highest seedling diameter at the age of 84 days was achieved by the combination of NPK fertilizer and Osmocote® (1.00 g and 2.00 g), about 5.97 ± 0.05 cm) and the combination fertilizer application of NPK and Osmocote® (1.00 g and 1.50 g), about 5.90 ± 0.09 cm. It was due to the seedling need for nutrients being fulfilled by the NPK and slow-release fertilizer. The availabilities of macro- and micro-nutrients were essential for vegetative growth of plants [20]. Those treatments were significantly different from other treatments. The application of NPK alone resulted in the second-highest in seedling diameter about 5.65 ± 0.11 cm and was significantly different from other treatments. The application of NPK fertilizer increased seedling diameter growth [23].

![Figure 3](image-url)
Moreover, the growth of plant stem was affected by the N nutrient [22]. The slow-release fertilizer (Osmocote®) with doses of 1.50 g, 2.00 g and 3.00 g seedling⁻¹ resulted in lower growth of seedling diameter compared to the other treatments. The effects of those treatments were not significantly different from each other in the diameter growth of seedlings. The untreated seedling resulted in the lowest diameter growth of seedlings. It was due to the insufficient supply of nutrients that can result in metabolic alterations in the plant [24].

![Graph showing the effect of fertilizer on seedling diameter](image.png)

**Figure 4.** The effect of fertilizer on the *bambang lanang* seedling diameter on the mesocarp fiber from oil palm at the age of 84 days.

3.3. Leaf

The application of NPK and (Osmocote®) (1.00 g and 1.50 g) and NPK and Osmocote® (1.00 g and 2.00 g) produced higher leaf numbers of seedling and leaf area (Table 1). The variance analysis showed that these treatments were not significantly different from each other's, but these treatments were significantly different from other research results. The plants need N nutrient to produce protein, chlorophyll, and other essential materials in cell development [25]. As a consequence, treated seedlings with the combination fertilizer NPK with slow-release fertilizer and NPK fertilizer alone had better photosynthesis process than others due to higher leaf numbers and areas of seedlings. The vegetative growth of the height and diameter of the seedling were faster than seedlings with other treatments. Seedlings with higher leaf numbers and areas can receive sunlight better, which resulted in a better photosynthesis process.

**Table 1.** The effect of fertilizer on the number of the leaf (leaf) and leaf area (cm²) of *bambang lanang* seedling growing in the mesocarp fiber of oil palm at the age of 84 days.

| Treatment                             | Leaf number (leaf) | Leaf area (cm²) |
|---------------------------------------|--------------------|-----------------|
| Control                               | 7.79±0.16 c        | 24.18±2.92 d    |
| NPK (2 g seedling-1)                  | 11.17±0.43 b       | 64.81±7.89 a    |
| NPK (1 g) + Osmocote® (1.50 g)        | 11.63±0.35 a       | 64.22±7.76 a    |
| NPK (1 g) + Osmocote® (2.00 g)        | 12.04±0.42 a       | 65.86±7.97 a    |
| Osmocote® (1.50 g)                    | 9.88±0.30 b        | 42.01±5.08 c    |
| Osmocote® (2.00 g)                    | 10.79±0.44 b       | 46.24±5.58 c    |
| Osmocote® (3.00 g)                    | 11.08±0.26 b       | 53.14±6.43 b    |
3.4. Biomass

Biomass or seedling dry weight represents the net of photosynthesis [19]. The effects of fertilizer application on dry seedling matter produce significantly different dry weights. The highest seedling dry weight (2.27±0.27 g) was produced by a combination of NPK and Osmocote® (1.00 g and 2.00 g; P3) (Table 2), followed by the combination fertilizer application of NPK and Osmocote® (1.00 g and 1.50 g) with a dry weight of about 2.00±0.24 g. It seemed that treated seedling with combination NPK with slow-release fertilizer and NPK alone produced higher dry weight than slow-release fertilizer alone. This was due to seedling demand for nutrients being fulfilled by the fertilizer application of NPK with slow-release fertilizer and NPK alone. Based on the nutrient analysis, it showed that the content of N was (0.43 - 0.51%), P (15.39 - 16.17 ppm), K (0.62 - 0.66 me/100, and C (2.98 - 3.83%) in the fiber media from oil palm mesocarp. After treated with the combination fertilizer of NPK with Osmocote® and NPK alone, biomass value showed higher value comparing other treatments.

The dry seedling weight is responsible for performing photosynthesis and allocate carbon for a different part of seedling [27]. Dealing with this finding, seedling with a higher value of dry seedling weight will be able to adapt and survive to the conditions of planting due to presenting more significant reserves of photo-assimilation, which are essential to the supply of the vital necessities to the seedling [27]. Root dry matter of *bambang lanang* seedling that were treated with the combination fertilizer of NPK - slow-release fertilizer and NPK alone reached more than 40 % of dry seedling matter. Seedling with higher root dry matter tends to survive and better growth than seedling with a lower value of root dry matter [28]. Seedlings with higher dry matter refer to a good root system. Seedlings with a well-developed root system could grow and survive better in the field [23]. It was due to the broader area of water and nutrients absorption that leads to the higher capacity of sustainability of seedling in the field [29, 6].

![Image](https://via.placeholder.com/150)

The application of slow-release fertilizer on seedling grown in the mesocarp fiber of oil palm fruit gave root dry matter about 33.5 - 40.9 %. It indicates that the dry seedling had a good root system so that it had a better capacity to survive and develop in the field after planting. The application of slow-release fertilizer could support seedling survival and growth in the field because of nutrients release during nursery propagation with a more extended timeframe for nutrient release continuing to provide elevated levels of nutrients to seedlings following outplanting [30].

**Table 2.** The effect of fertilizer on the *bambang lanang* seedling biomass on the mesocarp fiber from oil palm at the age of 84 days.

| Treatments | Seedling (g) | Root | Leaf | Stem |
|------------|--------------|------|------|------|
|            | g            | %    | G    | %    |
| P0         | 0.38±0.05 g  | 0.16±0.02d | 42.6 | 0.07±0.01c | 18.5 | 0.15±0.02e | 39.0 |
| P1         | 1.60±0.19c   | 0.55±0.07c | 34.2 | 0.15±0.02b | 9.3  | 0.90±0.11a | 56.6 |
| P2         | 2.00±0.24 b  | 0.82±0.10b | 40.8 | 0.17±0.02a | 8.8  | 1.01±0.12a | 50.4 |
| P3         | 2.27±0.27 a  | 0.96±0.12a | 41.6 | 0.18±0.02a | 8.4  | 1.13±0.14a | 50.0 |
| P4         | 0.88±0.11 f  | 0.36±0.04c | 40.9 | 0.11±0.01b | 12.4 | 0.41±0.05d | 46.8 |
| P5         | 1.11±0.13 e  | 0.40±0.05c | 35.6 | 0.12±0.0b | 10.8 | 0.59±0.07c | 53.6 |
| P6         | 1.36±0.16    | 0.47±0.06c | 33.5 | 0.14±0.02b | 10.3 | 0.76±0.09 b | 56.2 |

3.5. Seedling sturdiness ratio

Based on statistical analysis, the seedling sturdiness ratio of treated *bambang lanang* seedling was significantly different. The application of slow-release fertilizer (Osmocote® 3.00 g) resulted in the highest seedling sturdiness ratio of about 6.75. Other treatments resulted in a seedling sturdiness ratio of 4.92 – 5.70 [31]. The value of the seedling sturdiness ratio on an excellent seedling performance is about 5.10 - 12.00. Therefore, the seedlings treated with NPK (F1), the combination fertilizer NPK
with slow-release fertilizer (Osmocote®), F2 and F3, Osmocote® 3.00 g (F5), Osmocote® 3.00 g (F6) could be classified as excellent seedling performance. A good quality seedling will have better performance in the field after planting [27].

Table 3. The effect of fertilizer on the *bambang lanang* seedling sturdiness ratio on the mesocarp fiber from oil palm media at the age of 84 days.

| Treatments                          | Seedling sturdiness |
|-------------------------------------|---------------------|
| P0; Control                         | 3.38±0.14c          |
| P1; NPK (2.00 g)                    | 5.36±0.38b          |
| P2; NPK (1.00 g) + Osmocote® (1.50 g) | 5.62±0.16b          |
| P3; NPK (1.00 g) + Osmocote® (2.00 g) | 5.70±0.28b          |
| P4; Osmocote® (1.50 g)              | 4.92±0.36b          |
| P5; Osmocote® (2.00 g)              | 5.61±0.30b          |
| P6; Osmocote® (3.00 g)              | 6.75±0.49a          |

Based on statistical analysis, it was identified that the seedling sturdiness ratio of treated *bambang lanang* was significantly different. The application of slow-release fertilizer (Osmocote® 3.00 g) on the seedling resulted in the highest seedling sturdiness ratio of about 6.75. Other treatments resulted in a seedling sturdiness ratio of 4.92 – 5.70 [31]. Therefore, the application of NPK (F1), the combination fertilizer NPK with slow-release fertilizer (Osmocote®), F2 and F3, Osmocote® 3.00 g (F5), Osmocote® 3.00 g (F6) could be classified as excellent seedling performance. A good quality seedling will have better performance in the field after planting [27].

4. Conclusion
The utilization of the mesocarp fiber of oil palm as growth media for forest tree seedling would need fertilizer in order to produce a good quality of seedling. The application of combination fertilizer NPK with slow-release fertilizer (1.00 and 1.50 g seedling-1) resulted in better *bambang lanang* seedling performance while growing in the mesocarp fiber from oil palm fruit media in the nursery.

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References
[1] Yunindanova M B, Agusta H and Asmono D 2013 Pengaruh tingkat kematangan kompos tandan kosong sawit dan mulsa limbah padat kelapa sawit terhadap produksi tanaman tomat (*Lycopersicon esculentum* Mill.) pada tanah ultisol (the effect of maturity level of empty fruit bunch compost and mulch from palm oil waste to tomato productivity in ultisol soil) *Jurnal Ilmu Tanah dan Agroklimatologi* 10 (2) 91-100
[2] Dorman L I 1975 *Variations of Galactic Cosmic Rays* (Moscow: Moscow State University Press) p 103
[3] Hoe T K 2014 Utilization of oil palm fruits mesocarp fibres waste as growing media for banana tissue culture seedling in Malaysia *JOAAT* 1 (1) 52-5
[4] Sreekala M S, Kumaran M G and Thomas S 1997 Oil palm fibres: morphology, chemical composition, surface modification, and mechanical properties *Appl. Pol. Sci.* 66 (5) 821-835
[5] Apriyanto E, Sudjatmiko S, Susatya A, Putranto B A N and Aulia E 2018 The potency of oil palm fruit fiber as growth media for ketapang (*Terminalia catappa*) seedling *IJAFP* 7 73-78
[6] Nyland R D 2016 Silviculture concepts and applications. 3rd ed. Mc Graw-Hill
[7] Lyana N 2015 Potential Of Oil Palm Empty Fruit Bunch And Mesocarp Fibre As Possible Coco Peat Substitute In Fertigation System http://eprints.ums.edu.my/17086/1/Potential_of_oil_palm_empty_fruit_bunch_and_mesocarp_fiber.pdf

[8] Apriyanto E, Nugroho P B A and Saputra L 2016. The growth of Casuarina equisetiofolia seedling On various growth media densities of oil palm fruit fiber. at The 2nd Int. Multidisciplinary Conf. (2nd IMC) 2016 in University of Muhamadiyah, Jakarta, Indonesia 24

[9] Ekator F, Ogundipe O A and Ikuenobe C E 2018 Response of oil palm nursery seedlings to soil amended with oil palm mesocarp fibre. International Journal of Agronomy and Agricultural Research (IJAAR) ISSN: 2223-7054 (Print) 2225- 3610

[10] Direktorat Pengolahan Hasil Pertanian. 2006 Pedoman Pengelolaan Limbah Industri Kelapa Sawit. Departement pertanian. Indonesien

[11] Garcia E A, and Souza J P (2015). Avaliação da qualidade de mudas de Schizolobium parahyba em função dediferentes aplicações de adubo fosfatado Tekhne e Logos 6 (1) 51-59

[12] Dutra T R, Massad M D and Sarmento M F Q 2016 Fertilizante de liberação lenta no crescimento equidade de mudas de Canafístula (Peltophorum dubium) Floresta 46 (4) 491-498 https://doi.org/10.5380/RF.Vol 46i3.44570

[13] Andiru G A, Pasian C C, Frantz J M and Jones M 2011 How much water and nitrogen is wasted when a hose is used? OFA Bul. 6 (3) 17-18

[14] Cabrera R I 1997 Comparative evaluation of nitrogen release patterns from controlled release fertilizers by nitrogen leaching analysis Hort. Sci. 32 669-673

[15] Merhaut D J, Blythe E K, Newman P J and Albano J P 2006 Nutrient release from controlled-release fertilizers in acid substrate in a greenhouse environment. I. Leachate electrical conductivity, pH, and nitrogen, phosphorus, and potassium concentrations Hort Sci. 41 780-787 https://doi.org/10.21273/HORTSCI 41 3 780

[16] Mendonça V, Arruda N A A, Souza H A, Teixeira G A, Hafle O M and Ramos J D 2008 Diferentes ambientes e Osmocote® na produção de mudas de tamarindeiro (Tamarindus indica) Ciência e Agrotecnologia, 32 (2) 391-397 https://doi.org/10.1590/S1413-70542008000200007

[17] Herdiana N, Lukman, A H and Mulyadi K 2008 Pengaruh dosis dan frekuensi aplikasi pupuk NPK terhadap pertumbuhan Shorea ovalis Korth. (Blume) J. PHKA 5 (3) 289-296

[18] Elson J S da Silva, Jéssy A V S, Ádson E da Silva, Marcos A P G, Selma T O, Giuliana M P de Souza, Gracialda C F, Norberto C N, Gilson S B de Matos and Dêmora G de Araujo 2019 Growth and quality of Inga heterophylla Wild seedlings according to the slow release fertilizer J. Agr. Sci. 11 (5) 479- 484

[19] Bergheetti A L P, Araujo M M, Thaïse da Silva T, Aimí S C, Navroski M C, Turchetto F and Zavistanovich Th Cl 2016 Growth of Cordia trichotoma seedlings in different sizes of recipients and doses of fertilizer African Journal of Agricultural Research 11 (28) 2450-2455

[20] Sutedjo M M 2008 Pupuk dan Cara Pemupukan. Rineka Cipta. Jakarta

[21] Lingga P and Marsono 2003 Petunjuk Penggunaan Pupuk. Penebar Swadaya. Jakarta

[22] Sumarno Y 2008 Pengaruh media dan pupuk NPK terhadap pertumbuhan bibit pohon penghasil gaharu karas (Aquilaria malaccensis Lamk.) Jurnal Tanaman Pangan 5 (2) 1993-1999

[23] Fiolita V A, Muin, Fahrizal 2017 Penggunaan Pupuk Npk Mutiara Untuk Peningkatan Pertumbuhan Tanaman Gaharu Aquilaria spp Pada Lahan Terbuka Di Tanah Ultisol Jurnal Hutan Lestari 5 (3) 850 – 857

[24] Taiz L. and Zeiger E (2013) Fisiologia vegetal. 5. ed. Porto Alegre: Artmed 954 p

[25] Hardjowigeno S 2007 Ilmu Tanah. Akademika Pressindo. Jakarta
[26] Navroski MC 2013 *Hidrogel como condicionador de substrato para produção de mudas de Eucalyptus dunnii* Maiden. 2013. 207f. Tese (Doutorado em Engenharia Florestal) – Universidade Federal de Santa Maria, Santa Maria, RS

[27] Bellote A F J and Silva H D 2000 *Técnicas de amostragem e avaliações nutricionais em plantios de Eucalyptus spp.* In: Gonçalves J LdeM, Benedetti V. Nutrição e Fertilização Florestal, Piracicaba: IPEF pp. 106-129

[28] Haase D 2008 *Understanding forest seedling quality: measurements and interpretation.* Tree Planter’s Notes. United States: Department of Agriculture/Forest Service 52 (2) 24-30

[29] Almeida L S de, Maia N, Ortega A R, Ângelo A C 2005 Crescimento de mudas de *acaranda puberula* Cham. em viveiro submetidas a diferentes níveis de luminosidade. Ciênc. Florest 15 (3) 323-329

[30] Jacobs D F 2005 *Variation in Nutrient Release of Polymer-Coated Fertilizers.* In: Dumroese R K, Riley L E, Landis T D, tech coords 2005. Nat. proc.: Forest and Conservation Nursery Associations—2004; 2004 July 12–15; Charleston N C; and 2004 July 26–29; Medford, OR. Proc. RMRS-P-35. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station

[31] Badan Standarisasi Nasional 1999 *Mutu Bibit (akasia, ampupu, gmelina, sengon, tusam, meranti dan tengkawang).* Standar Nasional Indonesia (SNI 01-5006.1-1999) p 1-15