Research Article

Growth and Development of *Tristaniopsis merguensis* Seedling Inoculated by Natural Ectomycorrhiza

Triadiati Triadiati*, Anastasia Raditya Hidayanti, Nampiah Sukarno

Department of Biology, Faculty of Mathematics and Natural Sciences, IPB University, 16680 Bogor, Indonesia

**ABSTRACT**

*Tristaniopsis merguensis* (pelawan tree, Indonesia) is a potential plant as a firewood, host for edible fungi, and nectar from the flower produce bitter honey. The existence of *T. merguensis* in the forest is important because the fungi grow under the tree, particularly in the above of the roots. However, it has not cultivated and conserved optimally due to slow growth and lack of information about the cultivation. Information about how to grow the *T. merguensis* seeds is very limited; therefore, research in growth and development of *T. merguensis* seedling was important. The aims of this study were to determine the appropriate planting medium for *T. merguensis* seed germination and to stimulate growth and development of *T. merguensis* seedling by using its fungi. Status of *T. merguensis* fungi was studied by analyzing root morphology. Fungi isolation was carried out from colonized root and fungi fruit body. The stimulated growth of *T. merguensis* seedling was carried out by using fungi isolated from colonization root in laboratory scale, as well as treated at a different phosphate concentration. The result showed that *T. merguensis* was associated with ectomycorrhizal fungi. Planting medium consists of sawdust and *T. merguensis* fine root resulted the highest percentage of germination. Seedlings were treated with ectomycorrhizal fungi grew better than without ectomycorrhizal fungi. The treatment of ectomycorrhizal fungi and phosphate 25% showed the highest growth rate.

**Keywords:** Ectomycorrhizal fungi, Sawdust, Heimiporus fungi, Tristaniopsis

**Introduction**

In Indonesia, *Tristaniopsis merguensis* (Myrtaceae), known as the Pelawan trees is a valuable tree have a strong and dy wood for firewood, furniture, build houses, and timber stands. Local people using the *T. merguensis* leaves for tea. The leaves have alkaloids, phenols, tannins, and flavonoids as antioxidants [1]. In addition, these trees produce bitter honey from flowers and edible fungi (*Heimiporus* sp) where growing under the tree canopy and above its roots. These fungi grow only at the beginning of the rainy season, once a year. The color of fungi is red when fresh and expensive in local market and for export.

*T. merguensis* grows in evergreen forests at low altitudes and on ridges up to 1,000 m altitude. It is a tree up to 30 m tall, with its smooth, light-brown, trunk bark flaking off in large, spiral, scroll-like pieces. The distribution of these plant is in Andaman Islands, Mergui Archipelago, Cambodia, Vietnam, Peninsular Malaysia, Singapore, Nepal, and Indonesia, especially found in Kalimantan [2, 3, 4]. *T. merguensis* tree in Indonesia also grows in the Province of Kepulauan Bangka Belitung. This species has been recognized as one of the key species for biodiversity sustainability in Kepulauan Bangka Belitung, since the *T. merguensis* tree can guarantee the growth of the fungi and as a feed trees by honey-bee [5]. Naturally, *T. merguensis* tree grows in the forest. Thus, *T. merguensis* is a tree with high economic value; however, it is not cultivated and conserved optimally due to slow growth and lack of information about cultivation. Currently, *T. merguensis* trees are rarely found in the Province of Kepulauan Bangka Belitung due to excessive exploitation. It is impor-
t need to develop
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
The design of this research was completely randomized design with five replicates. All treatments were placed under the plastic lid for 2 months until the seedlings have 4 leaves. The humidity of planting medium was maintained about 70-80% by watering every day with sprayer. The parameters measured were percentage of germination, plant height, and number of leaves during 8 WAP.

Data analysis

All data were analyzed using general linear models (GLMs). All post hoc tests were carried out using DMRT. The standard level of significance was p < 0.05. All analyses were done using SPSS 20.0 software.

Results and Discussion

Germination of T. merguensis seeds

The T. merguensis seeds were spread in tray number 1 - 4 germinated a week after spreading, whereas no germination in tray number 5 – 7 (Table 1). Tray number 1 to 4 contained T. merguensis fine roots, on the other side, tray 5 to 7 did not contain fine roots. The tray no. 4 had the highest percentage of germination.

To analyze the T. merguensis seedlings growth rate we used treatments of natural ectomycorrhiza mycelium (isolated from T. merguensis roots in the forest) and different phosphate concentrations (Johnson solution) in the laboratory. Figure 1 shows that all treatments have a quite similar growth rate pattern during 19 WAP, but treatment of phosphate 25% with inoculation (P25-i) has the best growth indicated by plant height. On the other side, leaves number of controls was significantly different (p < 0.05) with the inoculation and phosphate concentrations treatments during 19 WAP (Figure 2). The number of leaves and plant height of T. merguensis seedlings were influenced (p < 0.05) by interaction between ectomycorrhizal mycelium and different phosphate concentrations treatments. The leaves number and plant height of T. merguensis seedlings treated by phosphate 75% with inoculation (P75-i) have the highest than others at 19 WAP (Table 2).

Symbiotic bioassay of T. merguensis seeds

Symbiotic bioassay of T. merguensis seeds was conducted to prove that symbiotic fungi affected T. merguensis seedlings growth. The plant height of T. merguensis seedlings treated by phosphate and without inoculation was not significantly different from control. The plant height of T. merguensis seedlings was not influenced by treatments of phosphate without inoculation (Figure 1 and 3). On the other side, the plant height of P25-i was higher than that of P50-i and P75-i (Figures 1 and 4). The number of leaves from T. merguensis seedling of all phosphate and with or without inoculation treatments were not significantly different, but significantly different from control (Figure 2).

The leave color of T. merguensis seedlings was treated by ectomycorrhizal fungi with phosphate greener than that of control. The treatment of P25% with ectomycorrhizal fungi inoculation P25-i) exhibited dark green (scale of 5-6) than all the phosphate treatments (Table 3).
The root of seedlings was treated without inoculation (k) did not form a symbiosis with ectomycorrhizal mycelium. On the other side, the seedlings were treated with inoculation and 25% phosphate (P25-i) formed colonization. Treatment of inoculation with 50% phosphate (P50-i) and 75% phosphate (P75-i) did not have root colonization (Table 4).

The root of *T. merguensis* treated with ectomycorrhizal fungi has shown in initial colonization from mycelium structures surrounding the outer surface of the root (Figure 5).

The symbiotic between the *T. merguensis* and the fungus was analyzed using *T. merguensis* growth parameters. In this study, the plant height of the treatment 25% phosphate with inoculation (P25-i) was higher than that of the treatment 25% phosphate without inoculation (P25-k) (Table 2). The increased plant height of the 25% phosphate treatment with inoculation (P25%-i) may have been influenced by successful of symbiosis between ectomycorrhiza and seedling roots of *T. merguensis*. This data supported by observations on the roots of *T. merguensis* inoculated by ectomycorrhizal fungi. The other study reported that the plant height of *Populus hopeiensis* (myco-rhizal plants) was significantly stimulated with ectomycorrhiza (*Boletus edulis*) inoculation [9]. The root of *T. merguensis* which was colonized with ectomycorrhiza have hyphal growth on the outer surface of the root. This result is consistent with research conducted by Taylor and Alexander; Perrier *et al.* that colonization of plant roots by ectomycorrhiza was characterized by existing hypha in surface of root until penetrating the root epidermis [10, 11]. Therefore, the height of *T. merguensis* seedlings was inoculated with a soil-mycelium system was higher than that of seedlings without inoculated. The mutuality symbiosis between ectomycorrhizal fungi with plant’s roots can increase the height of the host plant [12]. Mycorrhizal fungi regulate nutrient flow between the soil and plants [10], it helps in the absorption of the relatively immobile ions in soils such as phosphate, copper, and zinc [13]. This mutualistic symbiosis provides the fungi with relatively constant and direct access to carbohydrates, such as glucose and sucrose [14, 15]. The carbohydrates are translocated from leaves to root tissue and on to the plant’s host. In return, the plant gains the bene-

### Table 2. Number of leaves and plant height of *T. merguensis* seedlings treated by ectomycorrhizal mycelium and different phosphate concentrations (Johnson solution) in the laboratory (19 WAP)

| Treatment of phosphate | Treatment of inoculation | Number of leaves | Plant height (cm) |
|------------------------|--------------------------|-----------------|------------------|
| Control                | without inoculation (k)  | 3\(^c\)          | 2.7\(^a\)        |
| P25%                   | without inoculation (k)  | 10\(^b\)         | 3.3\(^c\)        |
|                        | with inoculation (i)     | 10\(^b\)         | 6.1\(^a\)        |
| P50%                   | without inoculation (k)  | 10\(^b\)         | 3.2\(^c\)        |
|                        | with inoculation (i)     | 11\(^b\)         | 4.0\(^c\)        |
| P75%                   | without inoculation (k)  | 10\(^b\)         | 4.9\(^b\)        |
|                        | with inoculation (i)     | 13\(^b\)         | 5.8\(^c\)        |

The data was followed by the same letter in the same column indicate not significantly different (Duncan-test; \(\alpha = 5\%\)).

### Table 3. Leaves color based on color chart\(^*\) of *T. merguensis* (20 WAP)

| Treatment of phosphate | Treatment of inoculation | Leaves color scale based on color chart \(^*\) | Note |
|------------------------|--------------------------|-----------------------------------------------|------|
| Control                | -                        | 2 to 3                                        | Yellow to green yellowish |
| P25%                   | without inoculation (k)  | 4 to 5                                        | Green to dark green      |
|                        | with inoculation (i)     | 5 to 6                                        | Dark green to very dark green |
| P50%                   | without inoculation (k)  | 4                                              | Green                        |
|                        | with inoculation (i)     | 3 to 4                                        | Green yellowish to light green |
| P75%                   | without inoculation (k)  | 3 to 4                                        | Green yellowish to light green |
|                        | with inoculation (i)     | 3                                              | Green yellowish            |

\(^*\)Leaf Color Chart from IRRI (scale 1-6)
fits of the mycelium’s higher absorptive capacity for water and mineral nutrients due to the comparatively large surface area of mycelium/root ratio, thus improving the plant’s mineral absorption capabilities [16]. Most plants consist of two P-uptake pathways, namely the direct root P-uptake pathway and the mycorrhizal fungi P uptake pathway [17]. Most P fertilizers are immobilized in soils because P is strongly adsorbed to iron and aluminium cations at low soil pH and to calcium at high soil pH [18, 19]. Thus, root architectural features and the growth of mycorrhizal hyphae are important for maximizing the acquisition of P because the root and mycorrhizal systems with a relatively high surface area are able to effectively use a given volume of soil [20]. The mycelium of the ectomycorrhizal fungi can access these phosphorus sources and make them available for the host plants. Phosphate ions are required by the host plants to stimulate early growth and development and root formation [21].

In this study, the *T. merguensis* fine roots in planting media stimulated the germination of *T. merguensis* seeds. When compared with the treatments without *T. merguensis* fine roots in planting medium, it was assumed that fine roots of *T. merguensis* affected the germination of *T. merguensis* seeds. The *T. merguensis* fine roots is thought to be symbiotic with fungi forming ectomycorrhiza. Symbiotic association between plant roots and certain fungi is referred to as mycorrhiza [22].

Planting medium consisting of sawdust gave the best result because it can retain planting medium moisture which is suitable for *T. merguensis* seed germination. Moisture planting media are needed in the early stages of germination for seedling growth [23]. Moreover, sawdust is organic matter consists of carbon organic from cellulose, nitrogen, potassium, and phosphate. These nutrients in sawdust are important for the seedling of *T. merguensis* growth.

Roots of seedling were treated without inoculation did not form a symbiosis with ectomycorrhizal fungi. On the other side, seedlings were treated with inoculation and P25% (P25-i) formed colonization. The treatment of inoculation and P50% (P50-i) and P75% (P75-i) did not produce root colonization. There was no colonization in the treatment of P50% (P50-i) and P75% (P75-i) due to seedling were harvested too early (20 WAP). Therefore, there was no penetration of hyphae into the root epidermis, which subsequently could form the structure of colonization. Initial penetration of hyphae ectomycorrhizal *Tricholoma* sp. to the root epidermis of *Pinus densi*flora in greenhouse was found about 6 months after inoculated. At this stage, no formation of colonizing roots structures since hypha only penetrated upper layer of epidermis roots [24].

Seedling height treated with inoculation and P25% (P25-i) differed significantly from treatment without inoculation and P25% (P25-k). It is suspected that inoculation and P25% treatment (P25%-i) caused symbiotic formation between ectomycorrhiza with *T. merguensis*. Mycorrhizal fungi are able to form symbiotic relationship with the host plants when it’s grown in soil that contains low nutrients, thus, the host plant can grow well, even it planted in poor soil. The host plant will develop resistance to the fungal penetration when the concentration of phosphate in soil is too high, due to high soil phosphate levels have been found to be detrimental for the symbiotic association of mycorrhizal fungi with plants. The lower content of soil phosphate can increase the activity of fungi in the establishment of mycorrhizal symbiosis which can provide increased growth and development of the host plant [25].

---

**Table 4. Colonization evaluation of *T. merguensis* seedling treated by phosphate (Johnson solution) and ectomycorrhiza inoculation for 5 months.**

| Treatment of phosphate | Treatment of inoculation | Colonization | Response |
|------------------------|--------------------------|--------------|----------|
| Control                | with inoculation (i)     | no colonization | - (neg.) |
| P25%                   | without inoculation (k)  | no colonization | - (neg.) |
| P50%                   | with inoculation (i)     | colonization  | + (pos.) |
| P75%                   | without inoculation (k)  | no colonization | - (neg.) |
|                        | with inoculation (i)     | no colonization | - (neg.) |

---
Figure 3. Plant height of *T. merguensis* seedlings. (a) Seedling of control plant and without inoculation (b) with phosphate 25% (P25-i), (c) phosphate 50% (P50-i), (d) phosphate P75% (P75-i). Scale bar = 5 cm

Figure 4. Plant height of *T. merguensis* seedlings. Seedling of *T. merguensis* treated with ectomycorrhiza fungi inoculation and Johnson solution contained (a) phosphate 50% (P50-i), (b) phosphate 75% (P75-i), and (c) phosphate P25% (P25-i) in 5 MAP. Scale bar = 5 cm.

The leaves number in all treatment was not significantly different until 20 WAP. However, although the leaves' number did not differ, they have different leaves color. Leaves of seedlings treated with inoculation and P25% (P25-i) has greener than the other treatments. On this treatment, the phosphate nutrient that play a role in the chlorophyll biosynthesis which affects photosynthesis. This result is consistent with Curtis and Clark which stated that the phosphate has an effect on plant growth and development through photosynthesis [26].

Figure 5 shows that roots of *T. merguensis* which inoculated by ectomycorrhizal mycelium form colonization with mycorrhizas fungi. This data proves that the root of *T. merguensis* need ectomycorrhizal fungi since the beginning of growth. This study is supported by the previous studied that *T. guillainii*, *T. calobuxus*, and *T. whiteana* have mycorrhizal symbioses with arbuscular mycorrhizas fungi [11, 27]. It can be assumed that *T. merguensis* tree has a similar symbiotic association between ectomycorrhiza with others Tristaniopsis.

**Conclusion**

From present study it is concluded that *T. merguensis* is able to form a symbiosis with ectomycorrhizal fungi. Inoculation treatment with P25% (P25-i) improves plant growth and promote the ectomycorrhizal colonization. It was observed that formation of mycorrhizal colonization beginning at 20 WAP. Fine roots (soil-mycelium system) mixed with planting medium especially sawdust was important for the purpose of stimulating seed germination and seedling growth of *T. merguensis*. 
Acknowledgment

We thank PEMDA Central Bangka for permission to sample of natural fungi in the Pelawan forest.

References

1. Sito E, Istiqomah F, Daniati K et al. (2018) Ekstraksi daun Pelawan (Tristaniopsis merguensis) sebagai antioksidan menggunakan Microwave Assisted Extraction (MAE). Indonesian Journal Pure Application Chemical 1(2): 50-55.
2. Govaerts R, Sobral N, Ashton P et al. (2008) World Checklist of Myrtaceae: 1-455. Kew Publishing, Royal Botanic Gardens, Kew.
3. Souladeth P, Meesawat A (2012) Myrtaceae in Phou Khao Khousay National Protected Area, Lao PDR. Proceeding: Ist ASEAN Plus Three Graduate Research Congress. 927-931.
4. Rahajoe JS, Alhamd L, Atikah TD et al. (2016) Floristic Diversity in the Peatland Ecosystems of Central Kalimantan. In: Osaki M., Tsuji N. (eds) Tropical Peatland Ecosystems. Springer, Tokyo.
5. Akharini D, Iskandar J, Partasasmita R (2017) Collaborative planning for development of the Pelawan Biodiversity Park in Bangka, Indonesia. Biodiversitas 18 (4): 1602-1610.
6. Smith SE, Read DJ (1997) Mycorrhizal symbiosis 2nd. London: Academic Press.
7. Alexander H, Hogberg P (1986) Ectomycorrhize of tropical angiospermous trees. New Phytologist 102:541-549.
8. Johnson CM, Stout PR, Broyer TC, Carlton AB (1957) Comparative chlorine requirement of different plant species. Plant and Soil 8 (4): 337-353.
9. Liang J, Sun Z, Qu Z et al. (2010) Long-term effect of an ectomycorrhizal inoculum and other treatments on survival and growth of Populus hopeiensis. Forest Ecology and Management 259:2223-2232.
10. Taylor AFS, Alexander I (2005) The ectomycorrhizal symbiosis: life in the real world. Mycologist 19:102-112.
11. Perrier N, Amir H, Colin F (2006) Occurrence of mycorrhizal symbioses in the metal-rich lateritic soils of the Komianmo Massif, New Caledonia. Mycorrhiza 16 (7):449-58.
12. Wenkart S, Roth B, Kagan Z (2001) Mycorrhizal associations between Tuber melanosporum and roots of Cistus incanus. Plant Cell Reports 20: 369-373.
13. Munyantziza E, Kehri HK, Bagyaraj DJ (1997) Agricultural intensification, soil biodiversity and agroecosystem function in the tropics: the role of mycorrhiza in crop and trees. Applied Soil Ecology 6:77-85.
14. Harrison MJ (2005) Signaling in the arbuscular mycorrhizal symbiosis. Annual Review Microbiology 59: 19-42.
15. Li H, Smith SE, Holloway RE et al. (2006) Arbuscular mycorrhizal fungi contribute to phosphorus uptake by wheat grown in a phosphorus-fixing soil even in the absence of positive growth responses. New Phytologist. 172 (3): 536-543.
16. Selosse MA, Richard F, He X, Simard SW (2006) Mycorrhizal networks: des liaisons dangereuses?. Trends Ecology Evolution 21 (11): 621–628.
17. Smith SE, Smith FA, Jokobsen I (2003) Mycorrhizal fungi can dominate phosphate supply to plants irrespective of growth responses. Plant Physiology 133:16–20.
18. Yang LT, Jiang HX, Tang N, Chen LS (2011) Mechanisms of aluminum-tolerance in two species of citrus: secretion of organic acid anions and immobilization of aluminum by phosphorus in roots. Plant Science180:521–30
19. Schachtman DP, Reid RJ, Ayling SM (1998) Phosphorus uptake by plants: from soil to cell. Plant Physiology 116:447–53.
20. Lynch JP, Ho MD (2005) Rhizoeconomics: carbon costs of phosphorus acquisition. Plant Soil. 269:45–56.
21. Sousa NR, Franco AR, Oliveira RS, Castro PML (2012) Ectomycorrhizal fungi as an alternative to the use of chemical fertilizers in nursery production of Pinus pinaster. Journal of Environmental Management 95: S269-S274.
22. Pešková V, Lorenc F, Modlinger R, Pokorná (2015) Impact of drought and stand edge on mycorrhizal density on the fine roots of Norway spruce. Annals of Forest Research. 58(2): 245-257.
23. Schutz W, Milberg P, Lamont BB (2002) Germination requirements and seedling responses to water availability and soil type in four eucalypt species. Acta Oecologia 23:23-30.
24. Yamada A, Ogura T, Ohnma M (2001) Cultivation of mushroom rooms of edible ectomycorrhizal fungi associated with Pinus densiflora by in vitro mycorrhizal synthesis. I. Primordium and basidiocarp formation in open-pot culture. Mycorrhiza 1: 59-66.
25. Ushio M, Wagai R, Balser TC, Kitayama K (2008) Variations in the soil microbial community composition of a tropical montane forest ecosystem: Does tree species matter? Soil Biology and Biochemical 40: 2699-2702.
26. Curtis OF, Clark DG (1995) An Introduction to Plant Physiology. New York: Mac Grow Inc.
27. Tawaraya K, Takaya Y, Turjaman M et al. (2003) Arbuscular mycorrhizal colonization of tree species grown in peat swamp forests of Central Kalimantan, Indonesia. Forest Ecology and Management 182: 381-386.
This page is intentionally left blank.