

# VESICULAR-ARBUSCULAR MYCORRHIZAL STATUS OF PLANT SPECIES IN THE PEAT SWAMP FOREST OF SETIA ALAM JAYA, SEBANGAU, CENTRAL KALIMANTAN

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## ABSTRACT

In order to describe the vesicular-arbuscular mycorrhizal (VAM) status of plants growing on peat soil, a study was carried out in the peat swamp forest of Setia Alam Jaya in Sebangau, Central Kalimantan. Out of 146 plant root samples belonging to 48 plant species from 25 families examined, all plants colonized by VAM fungi namely 14 (29.2%) high level, 32 (66.7%) medium level, and 2 (4.1%) low level respectively.

**Key words:** colonization; peat; VAM fungi

## INTRODUCTION

Mycorrhizal associations between the roots of plants and fungi are common and they are the usual absorbing organs for soil-derived nutrients of a great many plants. Non-mycorrhizal roots are probably less common in natural ecosystems. It has been estimated that over 90% of all higher plants are mycorrhizal with 300.000 species forming vesicular-arbuscular mycorrhizae (VAM) (Kendrick & Berch, 1985). Some plant families are composed of species that are not or scarcely mycorrhizal under natural conditions, and these include the Caryophyllaceae, Chenopodiaceae, Cruciferae, Cyperaceae, Juncaceae, and Urticaceae (Harley & Smith, 1983). In other cases, reports differ as to the mycorrhizal status of particular species. For instance, *Equisetum arvense* L. was reported to be usually nonmycorrhizal by Berch and Kendrick (1982) and VA mycorrhizal by Laferrere and Koske (1981) and Koske *et al.* (1985).

The widespread occurrence and importance to plant nutrition of mycorrhizae are well established (Harley & Smith, 1983) and there are many reports of mycorrhizal plants from natural ecosystems (Ekamawanti 1999; Harley & Harley 1987; Suciatmih & Antonius in press). However, mycorrhizal plants have not yet been reported in peat swamp forest in Sebangau, Central Kalimantan. In nature, this fungi are absolutely needed, because they have an important role for effectively cycling of some elements (Jaffries & Barea, 1994). Besides that, the fungi have also role to increase natural succession in extremely disturbed habitats (Janos, 1980) and via hyphal structure, the fungi can maintain stability of plant diversity by transferring nutrient between plants (Allen & Allen, 1992).

## MATERIALS AND METHODS

### Study Site

To know the occurrence of VA mycorrhizal plants, 10% of plot (50 m × 50 m) taken as study site. There were 10 sub-plots (5 m × 5 m) as study site located in one transect. Root samples were taken from plant (diameter 1-5 cm) of every sub-plot. This study was carried out in the peat swamps forest of Setia Alam Jaya in Sebangau, Central Kalimantan. Setia Alam Jaya lies the upper catment of the Sebangau River. The site is ca. 2.5 km from the river at an altitude of ca. 12 m asl. The most common species in the forest is *Palaquium leicocarpum*, *Syzygium densinervium*, *Hydnocarpus* sp., *Xanthophyllum palembanicum*, and *Shorea guiso* (Simbolon & Mirmanto, 1999).

### Measurement of VAM Fungi Colonization

Root samples were taken from healthy plant, washed to remove any adhering soil or organic debris and, then cleared and stained to reveal mycorrhizal fungus structures, using the method of Koske and Gemma (1989) with modification. Roots were washed in water and Tween-20. They were cleared and bleached with NaOCl and 35% H<sub>2</sub>O<sub>2</sub> for 24 to 48 hours. The root segments were washed with distilled water and acidified by immersing in 2% HCl for 24 hours. They were stained with 0.05% trypan blue in lactoglycerol. Stained root segments were destained with lactoglycerol. The root segments were mounted in PVLG (polyvinyl lactoglycerol) and observed for mycorrhizal colonization under microscope. Percent of mycorrhizal colonization was determined using the gridline intersect method as described in Giovannetti and Mosse (1980).

According to Bethlenfalvai and Yoder (1981), there are 4 levels of colonization: 1. High level if fungal colonization in roots > 50%; 2. Medium level if fungal colonization in roots 25-50%; 3. Low level if fungal colonization < 25%; and no colonization if fungal colonization in roots 0%.

## RESULTS

VAM status of plants growing in peat swamp forest of Setia Alam Jaya could be seen in Table 1. Out of 146 root samples belonging to 48 plant species from 25 families studied indicated that all samples colonized by fungi. Coarse hyphae, vesicles, and arbuscules were all present in mycorrhizal roots. Virtually all roots observed were colonized by other fungi than VAM, including regularly septate, dark hyphae and conidia. Out of soil examined indicated that *Glomus* spp. and *Gigaspora* spp. were found in that site. Besides those two genera, *Acaulospora*, *Entrophospora* and *Scutellospora* were also reported on peat ecosystems in West Kalimantan (Ekamawanti, 1999).

Colonization level of plants ranged between low to high. Colonization level of *Calophyllum biflorum* (Guttiferae), *Cratoxylum glaucum* (Clusiaceae), *Dysoxylum* sp. (Meliaceae), *Elaeocarpus longipetiolatus* (Elaeocarpaceae), *Garcinia eugeniifolia*, *G. tetandra* (Guttiferae), *Gonystylus macrophyllus* (Thymelaeaceae), *Litsea rufo-fusca* (Lauraceae), *Michelia montana* (Magnoliaceae), *Shorea teysmanniana* (Dipterocarpaceae), *Syzygium castaneum*, *S. densinervium* (Myrtaceae), and *Malilis* (Sapotaceae) were high. Colonization level of medium was in 32 plant species. Of the 32 species, four species each from Fagaceae, Guttiferae, and Myristicaceae, three species from Rubiaceae, two species each from Ebenaceae, Elaeocarpaceae, and Euphorbiaceae and one species each from Anacardiaceae, Aquifoliaceae, Burseraceae, Dipterocarpaceae, Fabaceae, Leguminosae, Myrtaceae, Oleaceae, Polygalaceae, Rutaceae, and Tetrameristicaceae. Colonization level was low in *Camptosperma squamosa* (Anacardiaceae) and *Diospyros* sp. B (Ebenaceae).

The rate of VAM colonization substantially differed from species to species of plant as well as between different specimens of the same species.

**Table 1.** Vesicular-arbuscular mycorrhizal status of plant species in the peat swamp forest of setia Alam jJaya, sebangau, central Kalimantan

No	Family/species	Depth of peat soil (cm)	VAM status (%)	Colonization level
1.	<b>Anacardiaceae</b>			
	1. <i>Camptosperma coriaceum</i>	150-200 200	40.0 ± 8.7 18.0	medium low
	2. <i>C. squamosa</i>			
2.	<b>Aquifoliaceae</b>	150	46.0	medium
	3. <i>Ilex</i> sp.			
3.	<b>Burseraceae</b>	200-250	45.0 ± 24.0	medium
	4. <i>Santiria griffithii</i>	200	67.0 ± 18.4	high
5.	<b>Clusiaceae</b>	115-250	44.0 ± 15.9	medium
	5. <i>Cratoxylum glaucum</i>	200	62.0	high
6.	<b>Dipterocarpaceae</b>	140-250	26.0 ± 6.0	medium
	6. <i>Shorea guiso</i>	190	28.0	medium
	7. <i>S. teysmanniana</i>	200	24.0	low
7.	<b>Ebenaceae</b>	200	46.0	medium
	8. <i>Diospyros dajakensis</i>	200	52.0	high
	9. <i>D. hermaphroditica</i>	200	28.0 ± 17.0	medium
	10. <i>Diospyros</i> sp.B			
8.	<b>Elaeocarpaceae</b>	250	34.0	medium
	11. <i>Elaeocarpus longipetiolatus</i>	200-250	34.0 ± 10.6	medium
	12. <i>E. mastersii</i>			
	13. <i>E. ovalis</i>			
9.	<b>Euphorbiaceae</b>	150-200	45.0 ± 12.8	medium
	14. <i>Glochidion</i> sp.			
	15. <i>Neoscortechinia philippinensis</i>			
10.	<b>Fagaceae</b>	200-250	43.0 ± 12.7	medium
	17. <i>Castanopsis foxworthii</i>	250 150	38.0 44.0	medium medium
	18. <i>Lithocarpus elegans</i>	200-210	44.7 ± 10.6	medium
	19. <i>L. rassa</i>			
	20. <i>L. resinosa</i>			
	11. <b>Guttiferae</b>	150-250	53.6 ± 14.1	high
21.	<i>Calophyllum biflorum</i>	200-250	38.0 ± 9.2	medium
	22. <i>C. teysmanii</i>	200	53.5 ± 6.0	high
	23. <i>Garcinia eugeniifolia</i>	200-250	45.5 ± 10.5	medium
	24. <i>G. lateriflora</i>	140	42.0	medium
	25. <i>G. parvifolia</i>	150-200	46.0 ± 8.5	medium
	26. <i>G. rostrata</i>	200	75.0 ± 1.4	high
	27. <i>G. tetandra</i>			
12.	<b>Icacinaceae</b>	200	52.0 ± 26.0	high
	28. <i>Stemonurus scorpioides</i>			
13.	<b>Lauraceae</b>	200-250	58.0 ± 2.8	high
	29. <i>Litsea rufo-fusca</i>			
14.	<b>Leguminosae</b>	200	26.0	medium
	30. <i>Koombassia malaccensis</i>			

Lanjutan Tabel 1

No	Family/species	Depth of peat soil (cm)	VAM status (%)	Colonization level
15.	<b>Magnoliaceae</b> 31. <i>Michelia montana</i>	200	51.0 ± 1.4	high
16.	<b>Meliaceae</b> 32. <i>Dysoxylum</i> sp.	270	52.0	high
17.	<b>Myristicaceae</b> 33. <i>Gymnacranthera eugeniifolia</i> 34. <i>Horsfieldia crassifolia</i> 35. <i>Knema cinerea</i> 36. <i>K. intermedia</i>	150-200 190-200 150-250 200	39.3 ± 15.2 48.0 ± 11.3 47.3 ± 18.7 38.0	medium medium medium medium
18.	<b>Myrtaceae</b> 37. <i>Syzygium castaneum</i> 38. <i>S. densinervium</i> 39. <i>Tristania bakhuzeni</i>	180 250 240	58.0 55.0 ± 12.7 38.0	high high medium
19.	<b>Oleaceae</b> 40. <i>Chionanthus</i> sp.	150-300	47.6 ± 13.3	medium
20.	<b>Polygalaceae</b> 41. <i>Xanthophillum palembanicum</i>	140-250	43.8 ± 15.1	medium
21.	<b>Rubiaceae</b> 42. <i>Psychotria</i> sp. 43. <i>Scyphiphora hydrophyllacea</i> 44. <i>Timonius flavescens</i>	150-250 170-200 200-250	37.3 ± 13.3 47.0 ± 26.8 42.7 ± 5.0	medium medium medium
22.	<b>Rutaceae</b> 45. <i>Acronychia porteri</i>	200	34.0	medium
23.	<b>Sapotaceae</b> 46. <i>Malilis</i>	200	56.7 ± 9.2	high
24.	<b>Tetrameristicaceae</b> 47. <i>Tetramerista glabra</i>	190-240	31.7 ± 22.3	medium
25.	<b>Thymelaeaceae</b> 48. <i>Gonystylus macrophyllus</i>	200	52.0	high

## DISCUSSION

Abundant VA mycorrhizal colonization in peat forest plant is in accordance with results reported by Suciatmih and Antonius (in press) in Mensemat, West Kalimantan. Depth of peat and pH were about 200 cm (Table 1) and 3.7-4.1 (Haraguchi *et al.*, 1999) respectively might be promote plant to form mycorrhizal symbiosis.

Some of plant species examined in present study were also found to be VA mycorrhizal in another study. These include species of *Garcinia rostrata*, *Koompassia malaccensis*, *Knema cinerea*, *Stemonurus scorpioides*, and *Tristania bakhuzeni* have also been reported by Suciatmih and Antonius (in press). However, colonization level of fungi of those plants in this study was different with in Mensemat, West Kalimantan. It may be due to environmental factor of two places was different, so it affected colonization level of fungi.

The rate of VAM colonization substantially differed from species to species of plant as well as between different specimens of the same species. As did Smith and Newton (1986), Berch *et al.* (1988), and Suciatmih and Antonius (in press), we observed large variation in percent colonization of some plants (Table 1). Fungal colonization of plant such as *Garcinia tetandra* was 75.0% (high), whereas *Camposperma squamosa* was 18.0% (low). According to Malloch and Malloch (1982), two factors such as genetica and environment affected fungal colonization level of root. Even in the same species, there were variation in percent colonization such as *Knema cinerea* (12.0-74.0%), *Shorea guiso* (14.0-70.0%), and *Tetramerista glabra* (14-68%). The same result also reported by Berch *et al.* (1988) on *Lactuca muralis* (14-67%) and *Geranium molle* (15-72%). This variation might be explained in a number of ways. It may be result from local variation in edaphic factors such as soil type (Antibus & Lesica 1985 cit Berch *et al.*, 1988) and soil nutrients (Sparling & Tinker, 1975 cit Berch *et al.*, 1988) or differences in tree genotype, stage of development, or proximity to other plant species (Hayman *et al.*, 1975 cit Berch *et al.*, 1988).

VAM colonization was observed in the roots of *Shorea guiso* and *S. teysmanniana* (Dipterocarpaceae) with their colonization level were medium and high respectively. So far, reported family Dipterocarpaceae forming ectomycorrhiza. However, Ali *et al.* (1995); and Suciatmih and Antonius (in press) found that Dipterocarpaceae family also forming VA mycorrhiza. In present study was also found *Castanopsis foxworthii* (Fagaceae) colonized by VAM fungi with its colonization level was medium. In contrast, Brundrett *et al.* (1996) reported that VA mycorrhizal association was absent in this genus. According to Tester *et al.* (1987), plants may be uncolonized for one of several reasons. They may be susceptible to colonization but not have come into contact with any inoculum; they may be susceptible but growing in a habitat which precludes or markedly discourages colonization (e.g., waterlogged conditions); they may appear nonmycorrhizal because they were examined at the wrong time of year or stage of development; or they may be genuinely not susceptible or weakly susceptible to colonization. Any of these factors can lead to complete absence or very low levels of colonization. One attractive hypothesis made by Iqbal and Qureshi (1976) was that the failure of mycorrhizal infection in some plants was due to their toxic exudates in the rhizosphere region.

A number of plants reported here may be for the first time were VA mycorrhizal. These include *Acronychia porteri*, *Callophylum biflorum*, *C. teysmanii*, *Camposperma coriaceum*, *C. squamosa*, *Castanopsis*

*foxworthii*, *Chionanthus* sp., *Cratogeomys glaucum*, *Diospyros dajakensis*, *D. hermaphroditica*, *Dysoxylum* sp., *Elaeocarpus longipetiolatus*, *E. mastersii*, *E. ovalis*, *Garcinia eugeniifolia*, *G. lateriflora*, *G. parvifolia*, *G. tetandra*, *Gonystylus macrophyllus*, *Gymnacranthera eugeniifolia*, *Horsfieldia crassifolia*, *Knema intermedia*, *Lithocarpus elegans*, *L. rassa*, *L. resinosa*, *Litsea rufo-fusca*, *Michelia montana*, *Neoscortechinia philippinensis*, *Psychotria* sp., *Santiria griffithii*, *Shorea guiso*, *S. teysmanniana*, *Scyphophora hydrophylacea*, *Syzygium castaneum*, *S. densinervium*, *Tetramerista glabra*, *Timonius flavescens*, and *Xanthophyllum palembanicum*.

Out of 146 plant root samples belonging to 48 plant species from 25 families colonized by VAM fungi namely 14 (29.2%) high level, 32 (66.7%) medium level, and 2 (4.1%) low level respectively.

The rate of VAM colonization substantially differed from species to species of plant as well as between different specimens of the same species.

VAM colonization was observed in the roots of *Shorea guiso* and *S. teysmanniana* (Dipterocarpaceae) and *Castanopsis foxworthii* (Fagaceae) with their colonization level were medium, high, and medium respectively.

Isolated VAM fungi from peat ecosystems were identified into two genera, namely *Glomus* and *Gigaspora*.

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