Effects of Flooding and Adventitious Roots Formation on Height Growth of *Melaleuca cajuputi*

อิทธิพลของรากพิเศษและการท่วมขังของน้ำ ต่อการเจริญเติบโตทางด้านความสูงของไม้เสม็ดขาว (*Melaleuca cajuputi*)

ทาคาชิ ยามาโนชิตา[1] **Takashi Yamanoshita**
ธนิต หนูยิ้ม[2] **Tanit Nuyim**
ทาเคชิ ทังเก[1] **Takeshi Tange**
คัทซูมิ โคชิมา[1] **Katsumi Kojima**
ฮิซาโยชิ ยากิ[1] **Hisayoshi Yagi**
ซาโทฮิโก้ ซาซากิ[3] **Satohiko Sasaki**

บทคัดย่อ

ได้ทำการวัดการเจริญเติบโตของไม้เสม็ดขาว (*Melaleuca cajuputi* Powell.) ในป่าพรุบาเจาะ จังหวัดนราธิวาส โดยได้เลือกวางแปลงศึกษาจากป่าธรรมชาติที่มีน้ำท่วมขังในระดับความลึกและตื้นแตกต่างกัน พร้อมได้ทำการศึกษาถึงผลของรากพิเศษที่แตกออกมาจากส่วนโคนของลำต้น ซึ่งเชื่อกันว่าเป็นรากที่คอยเกื้อกูลให้ไม้เสม็ดขาวสามารถรอดตายและเจริญเติบโตได้ดี รวมทั้งได้ศึกษาถึงความสามารถในการดึงน้ำเข้าสู่ลำต้นของไม้เสม็ดขาวด้วย ผลการศึกษาพบว่ากล้าไม้เสม็ดขาวในพื้นที่ที่มีน้ำท่วมขังในระดับสูง มีอัตราการเจริญเติบโตทางความสูงได้ดีกว่าในพื้นที่ที่มีน้ำท่วมขังในระดับต่ำกว่า และพบว่าในช่วงเวลาที่มีน้ำท่วมขังมีแนวโน้มว่าไม้เสม็ดขาวมีอัตราการเจริญเติบโตเพิ่มขึ้น ส่วนการตัดรากพิเศษของไม้เสม็ดขาวออกนั้น พบว่าทั้งจำนวนใบ และ Xylem water potential ของกล้าไม้ ไม่ได้รับผลกระทบจากการตัดรากพิเศษนี้ออกแต่อย่างใด จึงสามารถกล่าวได้ว่าไม้เสม็ดขาวเป็นพันธุ์ไม้ชนิดหนึ่งที่สามารถเจริญ

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[1] The University of Tokyo, Japan

[2] นักวิชาการป่าไม้ 7ว สถานีทดลองปลูกพรรณไม้พิกุลทอง จังหวัดนราธิวาส

[3] Nihon University, Japan

เติบโตได้ดีในสภาพที่มีน้ำท่วมขัง โดยส่วนของรากพิเศษนี้ไม่ได้มีส่วนช่วยส่งเสริมให้เพิ่มการเจริญเติบโตทางด้านความสูงได้ดีขึ้นแต่อย่างใด

ABSTRACT

Height growths of *Melaleuca cajuputi* Powell on different water level sites in Bacho swamp was investigated. In addition, effects of adventitious roots, which are considered to support plant survival and growth in flooded condition, on water relations of *M. cajuputi* were also studied. Seedlings in the site with higher water level had greater relative growth rate of height than in the site with lower water level. Greatest relative growth rate of *M. cajuputi* tended to be achieved in flooded season. Both leaf number and xylem water potential of seedlings were not affected by removal of adventitious roots. It is considered that *M. cajuputi* in the peat swamp grow well in flooded season and that adventitious roots are not indispensable for *M. cajuputi* to grow in a flooded condition.

INTRODUCTION

Peat swamps are located extensively in Narathiwat Province, Thailand (Vijarnsorn and Matsumoto, 1987). Soil acidity, poor nutrient and periodical flooding, individually or complexly, impede an agricultural land use and prevent other trees except *Melaleuca cajuputi* Powell. from establishing in the swamps. Additionally, human impacts such as fire burning result in deterioration of vegetation and make rehabilitation difficult. The intensity and duration of flooding are important factors controlling plant growth in the swamp because flooded conditions commonly reduce plant growth.

Generally, flooding leads plant roots to decay caused mainly by oxygen deficiency and reduced toxic ions in rhizosphere. Tolerant plants to flooding have physiological and/or morphological adaptation mechanisms. For example, enhancement of fermentation process for obtaining energy is one of the most common physiological adaptation mechanisms. For morphological example, development of adventitious roots and aerenchyma formation are one of the most common adaptation mechanisms. *M. cajuputi*, which is common dominant species of secondary forest on the peat swamps (Suzuki and Niyomdham, 1992), has adventitious roots in the flooded swamps frequently. Adventitious roots seem to supplement absorption of water and mineral nutrition in flooded conditions (Sena Gomes and Kozlowski, 1980).

It is essential to reforestation by *M. cajuputi* in the swamp to understand its response to flooding. This study reports height growth of *M. cajuputi* in different water level sites and effect of adventitious roots on water relations of *M. cajuputi* in a flooded period.

SITE OF STUDY

The study area is located in Bacho peat swamp, Narathiwat province, Thailand. The peat in the swamp is poor in nutrient and acidic (Vijarnsorn and Matsumoto, 1987). The swamp is flooded in rainy season. Fire occurs frequently in dry season in the swamp, resulting in establishment of secondary forest dominated by *M. cajuputi.*

METHODS

Growth in the flooded swamp

Three quadrates (quadrate A, quadrate B and quadrate C) were made at different sites in the Bacho peat swamp. All the quadrates were considered to be burnt same time. Each quadrate size is 2m x 2m *M. cajuputi* seedlings generated densely after fire burning in the study sites in which the quadrates were made. Height of *M. cajuputi* in the quadrates was measured in December 1995, May 1996, September 1996 and December 1996. To except the effect of depressed seedlings, 20 highest seedlings in each quadrate were taken for growth analysis. Water levels near each quadrate were measured once a month from December 1995 to December 1996.

Water relations associated with adventitious roots

Ten *M. cajuputi* trees with adventitious roots were selected near quadrate A. For five trees of the ten trees, adventitious roots were removed on 23 December 1996. The other five trees were left for control. Three branches were selected form each tree. Fully expanded leaves attached to branches were counted on 23 December 1996 and 18 January 1997.

Other ten *M. cajuputi* trees with adventitious roots (Figure 1) were selected near quadrate A. For five trees of the ten trees, adventitious roots were removed. The other five trees were left for control. Xylem water potential were taken with pressure chamber in the daytime (10:00-14:00) under strong sunlight. The measurement procedure of xylem water potential described by Ritchie and Hinkley (1975) were taken. The measurements were carried out 3 times, before removal of

the adventitious roots, 1 day and 3 days after removal. Water level was more than 50 cm above ground during measurement period.

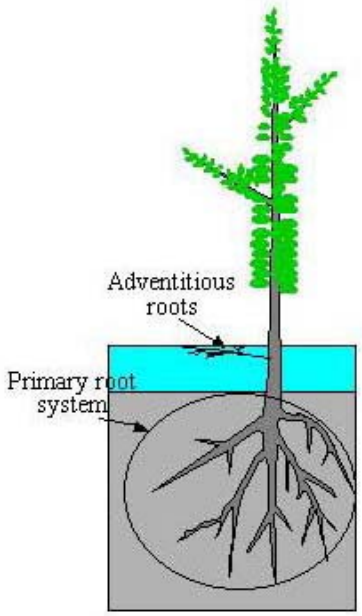

Figure 1. Root system of *Melaleuca cajuputi* Powell.

Statistical method

For the growth analysis, differences determined by Mann-Whitney test for all combinations of 2 categories with Bonferroni's inequality. For leaf number and xylem water potential in January, t-test was operated for each measurement time.

RESULTS AND COMMENTS

Water level

Water levels were decreasing in the period from December 1995 to May 1996 (Figure 2). Water levels were elevating in the period from May 1996 to September 1996 (Figure 2). Water levels elevated slightly and went over ground level in the period from September 1996 to December 1996 (Figure 2).

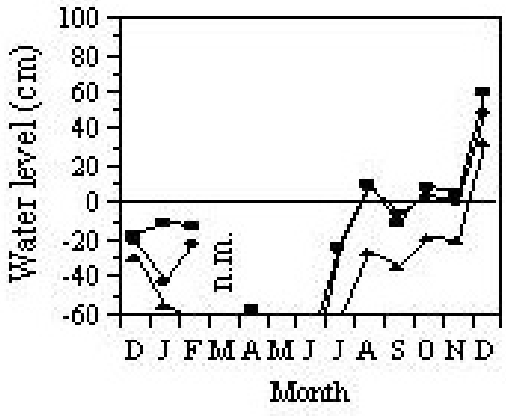

Figure 2. Seasonal fluctuations in water levels at 3 quadrates in Bacho peat swamp in Narathiwat, Thailand. Water levels were measured every month from December 1995 to December 1996 except March 1996. n.m. means "not measured ■ Quadrate A, ●Quadrate B, ▲Quadrate C.

Growth in the flooded swamp

Relative growth rate (RGR) of height differed among sites. Seedlings in the site with higher water level had greater RGR of height than in the site with lower water level (Figure 3). In sites with periodic flooding, better growth of *M. cajuputi* may be achieved in sites with higher water level.

In even flood tolerant tree species, for example *Nyssa sylvatica* var. *biflora* and *N. aquatica* (Harms, 1973), flooding with stagnant water reduced their growth. Maximum RGR of *M. cajuputi*, however, achieved in flooded season except in quadrate C (Figure 4). The previous study, in which relative growth rate of height of flooded *M. cajuputi* was nearly 150% of drained control (van der Moezel *et al.,* 1991), supports the result of this study. It is considered that *M. cajuputi* in the peat swamp grown well in flooded season.

In quadrate A and quadrate C, RGR was higher in the period when the water levels decreased down under soil surface rather in the period that the water levels increased nearly up to the soil surface (Figure 4). Therefore post-anoxic injury caused by re-exposure to air did not seem to be severe in *M. cajuputi.* Many rhizomatous species from wetland habitats have defense mechanisms against post-anoxic injury (Armstrong *et al*., 1994). *M. cajuputi* may also have the defense mechanisms.

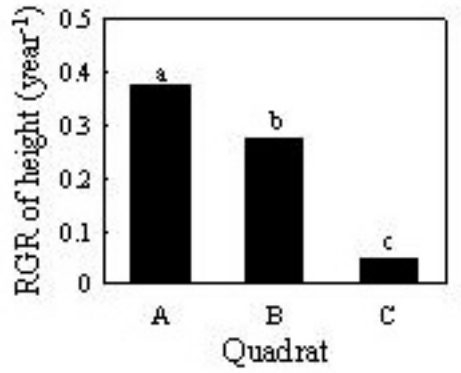

Figure 3. Relative growth rate (RGR) of *Melaleuca cajuputi* in the 3 quadrates. Bars show mean RGR of the highest 20 seedlings in each quadrate. The bars with different letters are significantly different at P<0.05 by the multiple test with Mann-Whitney test and Bonferroni's inequality.

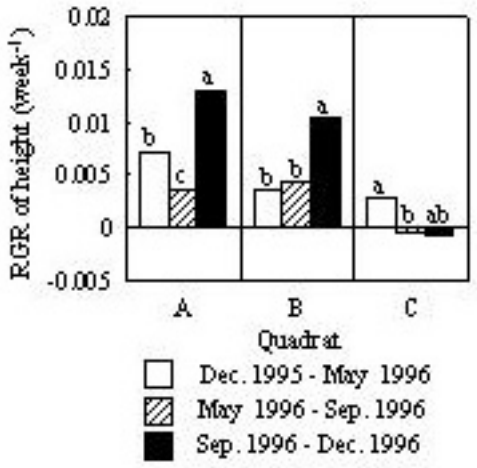

Figure 4. Relative growth rate of *Melaleuca cajuputi* in the 3 quadrates. Bars show mean RGR of the highest 20 seedlings in each quadrate. The bars with different letters are significantly different at P>0.05 by the multiple test with Mann-Whitney test and Bonferroni's inequality

Water relations associated with adventitious roots

There was no difference in increment of leaf number for one month between the control seedlings and the seedlings removed adventitious roots (Figure 5). Xylem water potential did not decrease either 1 day or 3 days after removal of adventitious roots (Figure 6). Flood tolerance often is considered as capacity for producing adventitious roots (Kozlowski, 1986). Adventitious roots seem to play roles of supplementing absorption of water and mineral nutrition (Sena Gomes and Kozlowski, 1980). In the present study, however, removal of adventitious roots did not affect increment of leaf number and midday xylem water potential. It is considered that adventitious roots are not essential for survival and growth of *M. cajuputi* in flooded period. These results are supported by the conclusion of a previous study on other species (Tripepi and Mitchel, 1984). Flooded *N. aquatica,* extremely flood tolerant tree species did not develop adventitious roots, but new secondary roots under a flooded condition (Hook and Brown, 1973). Capacity of rooting from original roots system in flooded period seems to be more important for tree growth in a swamp rather than development of adventitious roots.

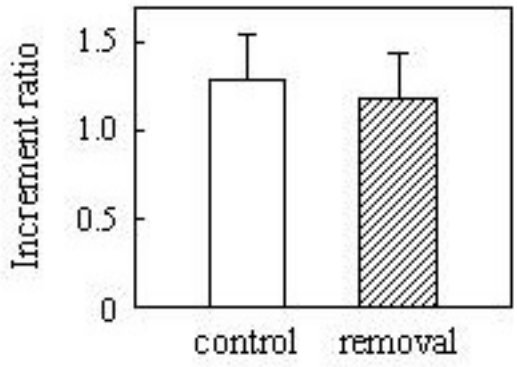

Figure 5. Increment ratio of leaf number for one month after removal of adventitious roots in flooded season. Bars show mean ratio of leaf number of 5 *M. cajuputi* trees. Vertical lines show standard deviation. The ratio means leaf number after treatment divided by leaf number before treatment.

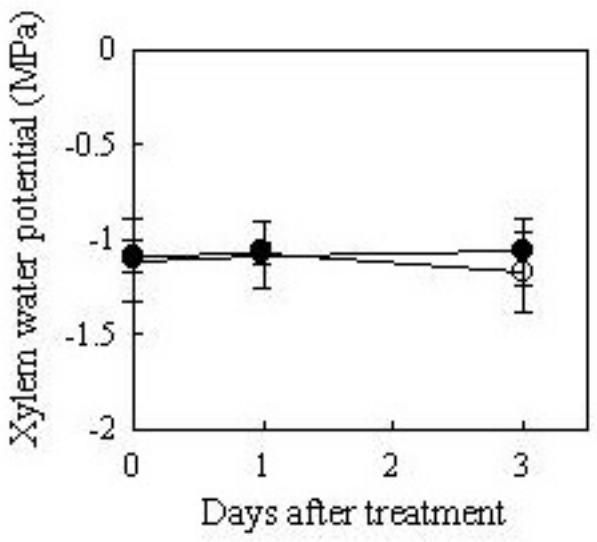

Figure 6. Midday xylem water potential of *M. cajuputi* after removal of adventitious roots in flooded season. Each symbol shows mean xylem water potential of 5 *M. cajuputi* trees. Vertical lines show standard deviation.
O control, ● removal of adventitious roots.

CONCLUSION

M. cajuputi may grow well in a flooded condition rather in a well-drained condition. In the flooded swamp, adventitious roots may not be indispensable for *M. cajuputi* to grow.

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