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Investigation of site conditions for early establishment of *Heritiera fomes* seedlings

Background

The Ayeyarwady mangrove forest in Myanmar was once dominated by *Heritiera fomes* and one of three major mangrove areas in the world. Its extent of 253,000 ha in 1924 was reduced to 112,000 ha in 2001 (FAO, 2003). Reforestation with pioneer species such as *Avicennia officinalis* was generally successful. However, previous reforestation efforts of *H. fomes* in open sites failed. For successful establishment of this climax species, it is necessary to understand its ecological characteristics. In this study, preliminary results on the early establishment of *H. fomes* seedlings in an *A. officinalis* plantation under different inundation classes and light conditions are presented.

Methodology

The seeding experiment of *H. fomes*, carried out in August 2007, involved six sites of a uniform stand of *A. officinalis* plantation. The sites were categorized into inundation classes 2 and 4 which are flooded 16-21 days per month by medium high tide and 3-4 days per month by spring high tides during the dry season, respectively (Myint Aung, 2004). Light conditions were low, moderate or high, depending on canopy height and density. Two open sites were established as control. In each of the six sites, five random plots were established with fencing. In each plot, 27 seeds were sown in nine clusters of three (Fig. 1). Each of the two control sites was fenced and 54 seeds were sown in 18 clusters of three. A total of 918 seeds were sown. Using a digital quantum meter, the photosynthesis photon flux density (PPFD) was measured twice at nine points for every plot. The PPFD outside the plot was also measured. The average relative photosynthesis photon flux density (RPPFD) was then determined for each plot and site. In December 2007, the survival of *H. fomes* seedlings was enumerated and their heights individually measured. The relationship between average RPPFD and height of *H. fomes* seedlings at each of the two inundation classes was correlated. The factors affecting height growth of seedling were examined by multiple linear regression analysis.

Results and discussion

The average canopy of *A. officinalis* ranged from 2.7–7.7 m in height. The average RPPFD at the forest floor varied between 10% and 55% (Table 1). Values between sites were significantly different ($P < 0.05$, z-test). There was an inverse correlation between canopy height and average RPPFD.

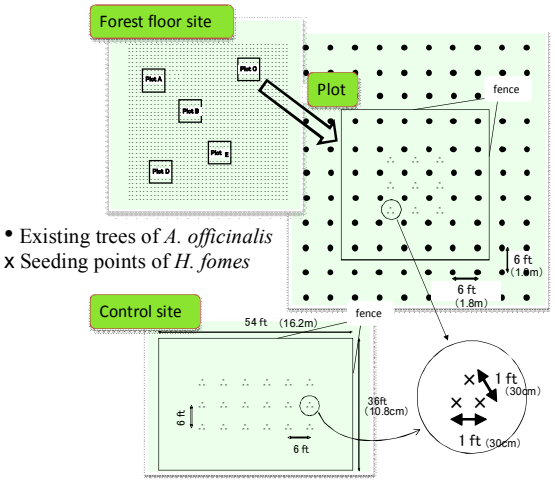

Fig. 1. Lay-out of seeding experiment

Enumeration showed that all 918 seeds of *H. fomes* germinated and survived both in the plantation and control sites, four months after seeding (Fig. 2). This indicates that in the early stage, *H. fomes* seedlings can grow under plantation canopy and in the open. As past experience has shown failure in open planting of *H. fomes*, it is crucial to monitor the growth performance of these seedlings and site conditions as subsequent mortality may occur.

Table 1. Site conditions

Inundation class 2	PS 4	PS 5	PS 6
Average canopy (m)	7.7 ± 0.8	6.1 ± 0.8	2.7 ± 0.5
Average RPPFD (%)	12 ± 6.9	23 ± 8.4	55 ± 13
Inundation class 4	PS 1	PS 2	PS 3
Average canopy (m)	7.0 ± 0.6	4.8 ±1.5	3.0 ± 0.6
Average RPPFD (%)	10 ± 3.5	12 ± 6.5	46 ± 9.5

Fig. 2. *Heritiera fomes* seedlings in *Avicennia officinalis* plantation

Analysis of the relationship between average RPPFD and height of *H. fomes* seedlings showed that seedlings in inundation class 4 tend to grow taller than those in inundation class 2 (Fig. 3). RPPFD did not appear to have any clear influence on the height of seedlings. Examining t-values of the two factors using multiple linear regression analysis, higher ground level as in inundation class 4 has significantly effect on height growth of seedlings but not RPPFD (Table 2).

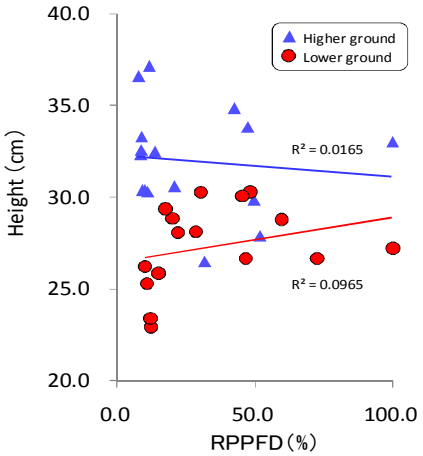

Fig. 3. Relationship between light condition (RPPFD %) and height growth (cm) of *Heritiera fomes* seedlings

Table 2. Multiple linear regression analysis (correlation coefficient R = 0.6809)

	Coefficient	S.E.	t-value
Intercept	27.148	0.923	29.408
Ground level	4.703	0.942	4.993
RPPFD	0.007	0.019	0.358

The habitat of *H. fomes* populations is between inundation classes 2 and 4 in a natural mangrove forest (JICA, 2005). Therefore if we expect faster height growth of *H. fomes*, the higher ground should be chosen for reforestation by sowing seeds or planting seedlings. Regarding the effect of light conditions, the survival and growth of seedlings of *Avicennia marina*, *Ceriops tagal* and *Rhizophora stylosa* have been reported to be poor in shaded stands with 15–20% RPPFD (Smith, 1987). Results of this study showed that *H. fomes* seedlings can grow under varying light conditions from dark under-canopy to open sites. Our study suggested that instead of light condition, we should pay more attention to the ground level based on inundation class as it is the determinant factor for the early establishment of *H. fomes* seedlings.

Conclusion

Seedlings of *H. fomes* grow faster on higher ground (inundation class 4) than on lower ground (inundation class 2). Light conditions in terms of RPPFD had no clear influence on the survival and growth in the early stage. So far, *A. officinalis* has been planted in denuded areas of the Ayeyarwady Delta. Information on early establishment of *H. fomes* seedlings from this study will contribute to future efforts of planting *H. fomes* in *A. officinalis* plantations.

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