Improvement of Sexual Propagation in Sugar Palm (Tao) 
(*Arenga westerhoutii* Griff.) Seeds

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Abstract

Three seedling establishment methods were investigated during October 2005 -June 2007 in Pha Thong community forest, Nan province, Thailand contributed to an increment in the number of the sugar palm or Tao (*Arenga westerhoutii* Griff.). Treatments tested were: seed scarification, seedling transplanting age, and seedling fertilization. Trimming both ends of 36-month seeds not only gave high percentage of germination and short germination period, but also provided easier seed remove out of the fruit. Transplanting of seedlings with one leaf offered the highest survival percentage. Moreover, cutting the leaf by two-thirds and frequent watering further increased the transplantation success rate. Applying three formulas of fertilizers on 1-3 years old seedlings gave a minor growth rate than no fertilization. Economical considerations of A. westerhoutii seedling establishment are discussed from the viewpoint of villagers.

**Keywords:** *Arenga westerhoutii*, sexual propagation, sugar palm, Tao

Introduction

The sugar palm or Tao (*Arenga westerhoutii* Griff.) of the family Palmae (Arecalesae) is an economical fruit tree in Nan province of northern Thailand (Chantaraboon, 2004). In Indonesia and formerly in southern Thailand, sugar, wine, and alcoholic drinks are made from the plant sap of a related species *Arenga pinnata* (Wurmb) Merr. A starch called sago is made from the pith (Dransfield and Mogea, 1984; Johnson, 1991; Pongsattayapipat and Barford, 2005). The leaves produce a moisture–resistant fiber. In Thailand, the use of *A. westerhoutii* is somewhat different, the main product is the endosperm or young seed eaten as a dessert called “loog chit” (Chantaraboon, 2004).

Germination of *A. westerhoutii* takes 4-20 months. The germination rate is rather low with an average of 65% (Chantaraboon, 1998). The plant grows very slowly in the early age (1-3 years old). It takes about 15 to 18 years from the seedling to the fruiting stage. Full grown plants have 5-6 inflorescence clusters. The plant dies when the last inflorescence cluster is mature, classified as a hapaxanthic tree (Pongsattayapipat and Barford, 2005).

*A. westerhoutii* is harvested as a non timber forest product from Pha Thong community forest, Nan province, Thailand (Chantaraboon, 1998; Pampasit, 2002). The palm harvested from this area accounts for 80% of the total collection from Nan forests (Chantaraboon, 2005). Recently, the number of *A. westerhoutii* trees in the forest showed a decreasing trend (The Botanical Garden Organization, 2004); particularly the reduction in numbers of trees in the fruiting stage in Pha Thong.
between 1998-2001 and 2002-2005 accounted for almost 50 percent decrease (Chantaraboon, 2005). Supplies of fruits were only maintained by the importation of 75% *A. westerhoutii* fruits to the two processing factories in Nan from various sources in Laos at the cost of 15 million Baht annually.

The main problems of *A. westerhoutii* in Nan results from the limited knowledge on *A. westerhoutii* propagation such as the long germination period, low survival rate after seedling uproot and transplantation as well as the slow growth habit during the first 1-3 years. The main aim of this study was to increase the number of *A. westerhoutii* trees in Pha Thong community by enhancing the growth during the early stage. Specifically, the objectives of this research were: 1) selection of the most efficient seed treatment techniques; 2) identification of suitable stages of seedling uproots and transplantation; and 3) establishment of seedling fertilization practice.

**Materials and Methods**

The study was done during October 2005 to June 2007 in Pha Thong community forest, Tha Wang Pha district, Nan province. Three seedling establishment methods were investigated, which were seed treatment techniques, seedling transplanting periods, and seedling fertilization treatments.

**Seed Treatment**

*A. westerhoutii* fruits of 30 or 36 months old seeds were squeezed from the fruit before planting. There were four seed treatment techniques: trimming seed at one end; trimming seed at both ends; soaking seed in hot water (80°C) for 3 minutes; and do nothing or control treatment. All four seed treatment procedures were tested with *A. westerhoutii* seed of two different ages (30 and 36 months old). The 4×2 = 8 treatment combinations were completely randomized and 4 replications, 10 seeds per replication. The percentage of seedling germination and germination periods were recorded. The germination periods were compared using a statistical package (Software R Version 2.3.1) (Merrell, 2006).

**Seedling Transplantation**

*A. westerhoutii* seedlings collected from Pha Thong, Nan province, Thailand with numbers of leaves ranging from 1-3 were transplanted into 10×15 cm. black plastic bag filled with a 1:1 mixture of soil and organic fertilizer. Transplantation of 50 *A. westerhoutii* seedlings with 1, 2 and 3 leaves respectively were replicated four times at different periods of experiment. Seedling survival was observed for three months.

**Seedling Fertilization**

*A. westerhoutii* trees aged from 1-3 years old were planted in 15×25 cm. black plastic bags filled with a 1:1 mixture of soil and organic fertilizer. A bag with *A. westerhoutii* planted was randomly applied with one of four treatments i.e. three different formulae of inorganic fertilizer (N-P-K): 46-0-0; 15-15-15; 13-13-21 and no inorganic fertilization as a control treatment. There were 4 replications with 25 trees each and with the total of 200 trees for each treatment. The treatment of fertilization was done by putting in 5 g of specified fertilizer every month for one-year period. At the end of the experiment, both number of leaf and plant height were recorded.

**Results and Discussion**

**Seed Treatment**

There were no significant differences between seed ages 30 and 36 months old on the percentage of seedling germination and the germination period (Table 1). *A. westerhoutii* seeds with both ends trimmed gave better germination percentage than seeds with one end trimmed and non treated seeds. Seed soaking in water 80°C for three minutes killed the embryo.

Table 1 shows that *A. westerhoutii* seeds aged 30 months old with both ends trimmed had higher percentages of germination than the other treatments. The germination percentage in this experiment did not reach 50% because of the data were based 12 months observation. If we could have extended the observation period up to 12 months, the percentage of germination could have exceeded 65% (Chantaraboon, 1998).
Although, the germination of *A. Westerhoutii* between 30 and 36 months old were no significant differences (Table 1). However, it was easier to remove the seeds out of 36 months old fruits compared with fruits aged 30 months old by squeezing, because the peel was softened by aging. In addition, 36 months old fruits had less itchy latex than 30 month fruits. This itchy substance causes severe skin allergy, normally the villagers get rid of the latex by boiling the fruit in hot water before squeezing the seeds out (Chantaraboon, 1998).

**Seedling Transplantation**

The transplanting of seedlings of *A. westerhoutii* with 1, 2, and 3 leaves indicated that young *A. westerhoutii* with 1 leaf had higher survival percentage than plants with 2 and 3 leaves. Most of the seedlings that did not survive died in the first month after transplanting (Table 2). Average percentages over the three-month periods of *A. westerhoutii* seedlings with 1, 2, and 3 leaves were 83.3, 62.3, and 49.2%, respectively.

Cutting off 2/3 of the leaf area did not only help reducing *A. westerhoutii*’s evaporation, but also caused the plant to rapidly produce the subsequent leaf. However, the application of intensive watering system every two-hour period during the first week after transplanting could increase survival percentage up to 82% regardless the number of leaves of the *A. westerhoutii* seedlings. This has been indicated in several publications (Gardiol et al., 2003; Lund and Soegaard, 2003).

**Seedling Fertilization**

There were no significant differences on using three inorganic fertilizers compared with no treatment during the early stage of *A. westerhoutii* development in terms of number of leaves and plant height after one year of monthly application (Table 3). It may not be worthwhile to add fertilizer costs into the *A. westerhoutii* cropping system (Chantaraboon et al., 2007). This insensitivity of the *A. westerhoutii* to inorganic fertilizers may be caused by several reasons, e.g. the organic fertilizer employed in soil preparation of the experiment trapped major components of the inorganic fertilizers; and the organic fertilizer in the soil had already provided enough substances needed for the early stage of *A. westerhoutii* development. It had also been reported that result did not show the effect of fertilizer treatment in any of the parameter measured. It may be possible that it would take a longer time than the experimentation period before the effect of fertilizer will be pronounced (Mak et al., 2008).

### Table 1 Germination of *A. westerhoutii* seeds from different seed treatment techniques

<table>
<thead>
<tr>
<th>Seed age (month)</th>
<th>Seed treatment</th>
<th>Germination (%)</th>
<th>Germination period (day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>Trimming: one end</td>
<td>20</td>
<td>283.3a</td>
</tr>
<tr>
<td></td>
<td>Trimming: both ends</td>
<td>45</td>
<td>286.6ab</td>
</tr>
<tr>
<td></td>
<td>Hot water 80°C; soaking 3 min</td>
<td>0</td>
<td>&gt;365c</td>
</tr>
<tr>
<td></td>
<td>None</td>
<td>15</td>
<td>297.2b</td>
</tr>
<tr>
<td>36</td>
<td>Trimming: one end</td>
<td>27.5</td>
<td>260.8a</td>
</tr>
<tr>
<td></td>
<td>Trimming: both ends</td>
<td>30</td>
<td>279.2ab</td>
</tr>
<tr>
<td></td>
<td>Hot water 80 °C; soaking 3 min</td>
<td>0</td>
<td>&gt;365c</td>
</tr>
<tr>
<td></td>
<td>None</td>
<td>17.5</td>
<td>313b</td>
</tr>
</tbody>
</table>

1 Means followed by the same letters are not significant difference at P ≥ 0.05 by DMRT.
2 Non significance.

### Table 2 Survival of *A. westerhoutii* seedlings after transplanting.

<table>
<thead>
<tr>
<th>Leaf (number)</th>
<th>Survival after transplanting (%)</th>
<th>1 month</th>
<th>2 months</th>
<th>3 months</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>85a</td>
<td>82.5a</td>
<td>82.5a</td>
<td>83.3a</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>64.5b</td>
<td>61.5b</td>
<td>61b</td>
<td>62.3b</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>52c</td>
<td>48c</td>
<td>47.5c</td>
<td>49.2c</td>
<td></td>
</tr>
</tbody>
</table>

CV (%) 11.13 12.30 12.32

1 Means followed by the same letters are not significant difference at P ≥ 0.05 by DMRT.
Table 3  Number of remaining leaves and plant height of A. westerhoutii seedlings after one year of application.

<table>
<thead>
<tr>
<th>Fertilizer type</th>
<th>Remaining leaf (number)</th>
<th>Plant height (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-15-15</td>
<td>3.36a</td>
<td>37.29a</td>
</tr>
<tr>
<td>13-13-21</td>
<td>3.23a</td>
<td>38.00a</td>
</tr>
<tr>
<td>46-0-0</td>
<td>3.12a</td>
<td>35.42a</td>
</tr>
<tr>
<td>None</td>
<td>3.19a</td>
<td>36.57a</td>
</tr>
<tr>
<td>F-test1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CV (%)</td>
<td>7.13</td>
<td>6.87</td>
</tr>
</tbody>
</table>

1 Means followed by the same letters are not significant difference at P ≥ 0.05 by DMRT.

Conclusions

The study reveals that 36 months old A. westerhoutii seed with both ends cut has the highest efficiency of A. westerhoutii germination. Moreover, the most appropriate time of seedlings uproot and transplantation was one leaf tree together with two-thirds leave cutting. This method could help A. westerhoutii tree to decrease evaporation. In addition, watering seedlings in every two hours during the first week was needed to increase 82% of survivals. Finally, all three methods of fertilizer treatment could not better activate the plant height than non-fertilizer treatment of 1 to 3 year-old A. westerhoutii tree. This study implies that Pha Thong villagers are more confident that they are able to increase number of A. westerhoutii trees for restoration by the techniques they actively experienced within this research project.

Acknowledgments

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Remark: Reference highlighted with yellow color need correction (in complete page number).

References


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