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Original Article

Method for the economic recovery of Sugar-palm (Tao) (*Arenga westerhoutii* Griff.) community forests

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Abstract

This study purposes to find a practical method to increase the number of sugar-palm (Tao) trees and restore the community forest in northern Thailand. The experiments dealt with three aspects of sugar-palm seedlings. These were: 1) to find the most efficient method of propagation, 2) to search for the best way for separation and transplantation, and 3) to find the best growth promoter. This project was conducted from October 2005 to June 2007 at San Charoen Village, Pha Thong Community, Tha Wang Pha District, Nan Province. The results were as follows: Firstly, trimming both ends of 36-month-old sugar-palm seeds provided the shortest period of germination. As a side benefit, it was easier to peel the seeds out of the fruit. Secondly, the most efficient way of separating seedlings was transplanting them immediately with their one leaf cut two-thirds off. Spraying with water every two hours during the first week guaranteed 82 percent of survival of the seedlings. Lastly, 15-15-15, 13-13-21 and 46-0-0 fertilizer formulations promoted the growth of one- to three-year sugar-palm seedlings. These seedlings produced more new green emerging leaves than the unfertilized plant. However, when economics are considered, the non-fertilizer application gave a better net benefit than the three fertilizer formulations. Therefore, we recommend that the sugar-palm be planted in community forests in northern Thailand using plenty of water, with a proper tillage practice, and without costly fertilizer. We also imply that farmers will be more confident in restoring their sugar-palm forests using this technique because they have an active role in the research project.

Keywords: *Arenga westerhoutii*, propagation, recovery, restore, sugar-palm

1. Introduction

Sugar-palm or Tao (*Arenga westerhoutii* Griff.) (Jones, 1994; Whitmore, 1998; Pongsattayapipat and Barfod, 2005) is an economical fruit tree in the Palmaceae family of Nan Province in northern Thailand (Hoare *et al*., 1998; Jintana *et al*., 2001; Chantaraboon, 2005). In Indonesia, sugar-palm is used to make wine, sugar and starch (sago), but in Thailand sugar-palm's endosperm (Johnson, 1991, Dransfield *et al*., 2004; Pongsattayapipat and Barfod, 2005) is processed either as a dessert or syrup, called "loog tao" or "loog chid" ("loog" means fruit in Thai). Moreover, the young pith in its stem makes a delicious dish.

The sugar-palm seed takes about 4 to 20 months to germinate. Its germination rate is 65 percent (Chantaraboon, 1998). During its first to third year is grows very slowly, taking about 15 to 18 years from seedlings to fruiting stage. The fallen mature seeds can grow naturally into many seedlings under their mother trees, but not all grown seedlings survive because of their high density plot. A sugar-palm tree produces 5 to 6 clusters. When the last cluster is senescent, the tree will die. This is known as a hapaxanthic tree (Pongsattayapipat and Barford, 2005).

Tao is not grown commercially in Thailand. In addition, sugar-palm is valued as a non-timber forest product (Chantaraboon, 1998; Pampasit, 2002). Those products have

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been harvested in Pha Thong Sub-district, Tha Wang Pha District, Nan Province. The sugar-palm harvested from this area accounts for 80 percent of the province's forest (Chantaraboon, 2005). In terms of sugar-palm density distribution, people can earn 10,000 to 20,000 baht per year. They use a part of their income to buy fertilizer and chemicals for the next upland rice crop. Recently, the number of sugar-palm trees in the forests has decreased (The Botanical Garden Organization, 2004). In turn this meant a decrease in the supply of sugar-palm fruits to the two sugar-palm processing factories in Nan. Indeed, now 75 percent of sugar-palm fruits are imported from Laos, costing Thailand approximately of 15 million baht per year.

We propose to use an objectives-oriented approach (LogFrame) (Burikam, 2003) with participatory action research (PAR) to analyze this problem. We believe it probably consists of a lack of technology of sugar-palm propagation, taking into account the long period for germination, low survival rate after separation and transplantation, as well as the slow growth habit in the first three years. The main aim of this study was to increase the number of sugar-palm trees in Pha Thong community by 1) studying the most efficient sugar-palm seedlings culture, 2) finding the appropriate time for seedling separation and transplantation, and 3) investigation how sugar-palm seedling growth could be suitable promoted.

2. Materials and Methods

This study was conducted from October 2005 to June 2007 at San Charoen Village, Pha Thong Sub-district, Tha Wang Pha District, Nan Province. The three aspects of the experiments were as follows:

1) Comparison of the various ages of sugar-palm seeds and treatment methods affecting the growth of the seedlings.

2) Determination of the percentage of seedlings survival after their plantation by comparison of seedlings with three different numbers of leaves (1, 2 and 3).

3) Study of sugar-palm tree growth promotion using three fertilizer formulae (both organic and chemical).

2.1 Experiment 1: The study on the most efficient sugar-palm seedlings culture

The two-by-four factorial in completely randomized design (CRD) was utilized with four replications (rep.), 10 seeds per rep. Factor one was using two different ages of sugar-palm seeds, 30, 36 months respectively. Factor two involved four seed treatment methods: trimming one end, trimming both ends, soaking seeds in 80°C for three minutes, and not treated as a control. Data were collected from the number and percentage of germinated seedlings and were analyzed by a 5% Duncan's multiple range test (DMRT). Software R version 2.3.1 (Murrell, 2006) was used to analyze the average days and percentage of seedling germination.

2.2 Experiment 2: The search for the appropriate time of seedlings separation and transplantation

The different seedlings with one, two and three sugar-palm leaves were planted in 4x6 inch black plastic bags filled with a 1:1 ratio of soil and organic fertilizer. In order to analyze the survival seedling percentage during one, two and three months of age, a CRD was used for three treatments and four replications (50 trees per rep.). Five percent DMRT was used to compare tree survival means.

2.3 Experiment 3: The investigation of how sugar-palm seedlings growth could be promoted properly

One-to-three year-old sugar-palm trees were planted in 6x10 inch black plastic bags filled with a 1:1 ratio of soil and organic fertilizer. CRD planning was used to test three different fertilizer formulae: 46-0-0, 15-15-15, 13-13-21 and

Figure 1. A) Sugar-palm fruits 30 month of age. B) 36 month. C) Sugar-palm seeds. D) Trimming seeds. E, F) Planting in husk of coconut with 10x10 inch of black plastic bucket.

Figure 2. A, B) Pha Thong's villagers were planting sugar-palm seedlings in 4x6 inch of black bag. C, D) 1, 2, 3 leaves of sugar-palm seedlings.

non fertilizer as a control (four rep. with 25 trees each). The treatment of fertilization was done by putting in 5 gm. of specified fertilizer every month for one-year period. At the end of the experiment, several number of leaf and plant height were recorded. Software R version 2.3.1 was used to analyze the number of growing, remaining and dead leaves, and the height. DMRT was used to compare the average of each of the four classes of data mentioned above. The economic study was undertaken using CIMMYT (1998).

3. Results and Discussion

The results of the increasing number of sugar-palm trees in Pha Thong Sub-district, Tha Wang Pha District, Nan Province are shown in Tables 1, 2, 3 and 4.

3.1 The study on the most efficient sugar-palm seedlings culture

For both 30 and 36 month old seeds there was no difference in the percentage of seed germination and the average of germination days. We found that two-end trimming was better than one end cut and non-treated method of the seed. Soaking in 80°C for three minutes was ineffective because it produced a dead embryo.

Normally, the sugar-palm tree spends 4-20 months to develop from seed to seedling (Chantaraboon, 1998). We only collected data for germination during one year, and found that only 45% of seeds germinated. However, if we would have collected more data over 20 months, the percentage of germination could exceed 65% (Chantaraboon, 1998). Table 1 show that 36-month-old seeds together with two-end trimming had a higher percentage of the germination than 30 month-old-seeds.

From this result, it can be recommended that a 36-month-old sugar-palm seed with both ends cut has the highest efficiency of germination. This is because seeds were easier to squeeze out from the fruit at 36 months. In addition, the itchy latex of a 36-month-old fruit was lower than one 30-months-old.

3.2 The search for the appropriate time of seedling separation and transplantation

To search for the percentage of seedlings surviving and growing naturally under their mother trees, trees with one, two and three leaves were used. We found that one, two and three month after separation, the one leaf trees had higher survival percent than trees with two and three leaves, (Table 2). The percentages of survival of trees with one, two and three leaves were 83.3%, 62.3% and 49.2% respectively.

Using a one leaf tree together with two-thirds leaf cutting helped the sugar-palm tree decrease evaporation, and therefore decreased the percentage of dead seedlings. Furthermore, cutting off two-thirds of the leaf area, assisted in recovery and inducted the second leaf to be developed more quickly. This was because the cut leaf had a reduced evaporation area. When sugar-palm roots are not fully developed, the plant cannot absorb water efficiently, therefore watering seedlings every two hours during the first week was needed to increase the survival rate to 82%. This agrees with the research of Gardiol *et al*. (2003); Lund and Soegaard (2003).

3.3 The investigation of how to promote the growth of sugar-palm seedlings

Growth promotion in sugar-palm seedlings was studied using different formulae of fertilizers (both organic and chemical ones) and no fertilizer as a control. There were no significant differences in the height of trees, or the number of remaining and dead leaves of the seedlings.

Table 1. Percentage of sugar-palm germination and average of germination days

Treatments	Age of sugar-palm seeds	Method of treats	Percentage of germination	Average of germination days
1	30 months	one end trimming	20	283.3 a 3/
2	30 months	both ends trimming	45	286.6 a b
3	30 months	seeds soaking in 80°C, 3 min.	0	>365 c
4	30 months	non treated (control 1)	15	297.2 b
5	36 months	one end trimming	27.5	260.8 a
6	36 months	both ends trimming	30	279.2 a b
7	36 months	seeds soaking in 80°C, 3 min.	0	>365 c
8	36 months	non treated (control 2)	17.5	313 b
Pr>F	ns. 1/	** 2/		
CV (%)	8.65			

1/ Not significant; 2/ significant at probability level of 0.01; 3/ average of germinate days; means in each column followed by the same letters are not significantly different by DMRT.

Table 2. Percentage of sugar-palm surviving after planting 1, 2, 3 months

Number of leave	Percentage of sugar-palm survive after planting			Mean of survival in 3 months (%)
	1 month	2 months	3 months	
1	85 a 2/	82.5 a	82.5 a	83.3 a
2	64.5 b	61.5 b	61 b	62.3 b
3	52 c	48 c	47.5 c	49.2 c
F-test	** 1/	**	**	
CV(%)	11.13	12.30	12.32	

1/ Significant at probability level of 0.01; 2/ number of Sugar-palm survive after planting; means in each column followed by the same letters are not significantly different by DMRT.

Table 3. The means of number of rising leaves, height of tree, number of remaining leaves and number of dead leaves

Treatments	Means			
	No. rising leaves	Height of tree (cm)	No. remaining leaves	No. dead leaves
Organic soil + 15-15-15	3.18 a 3/	37.29	3.36	1.25
Organic soil + 13-13-21	3.01 a	38.00	3.23	1.25
Organic soil + 46-0-0	3.04 a	35.42	3.12	1.31
Organic soil (Control)	2.65 b	36.57	3.19	1.09
F-Test	* 2/	ns. 1/	ns.	ns.
CV(%)	6.20	6.87	7.13	17.87

1/ Not significant; 2/ significant at probability level of 0.05; 3/ number of leave increased; means in each column followed by the same letters are not significantly different by DMRT.

Table 4. Partial budget between fertilizers application and non-fertilizer application (control)

Items	Organic soil +			
	15-15-15	13-13-21	46-0-0	Control
- Yield (remaining leaves / tree)	3.36	3.23	3.12	3.19
- Adjust yield (10% reduced)	3.02	2.90	2.80	2.87
- Gross field benefit (US$ / hectare) (A)	275.73	220.58	220.58	220.58
- Partial budget (US$ / hectare)				
- Fertilizer (US$ / hectare)	13.00	13.67	13.88	0
- Labor (8.82 US$ / month / hectare)	105.84	105.84	105.84	0
- Total partial budget (US$ / hectare) (B)	118.84	119.51	119.72	0
- Net benefit (US$ / hectare) (A) – (B)	156.89	101.07	100.86	220.58

Remark: 1) Planting spacing 4x4 meter, 625 trees / hectare
2) The price of sugar-palm trees (December, 2006)
2.1) 1-2 leaves = 0.29 US$ 2.4) 4-5 leaves = 0.52 US$
2.2) 2-3 leaves = 0.35 US$ 2.5) 5-6 leaves = 0.58 US$
2.3) 3-4 leaves = 0.44 US$
3) The price of fertilizers (December, 2006)
3.1) 15-15-15 = 0.34 US$ / kg; 17.35 US$ / bag
3.2) 13-13-21 = 0.36 US$ / kg; 18.23 US$ / bag
3.3) 46-0-0 = 0.37 US$ / kg; 18.52 US$ / bag

There was a significant difference in the number of growing leaves in the data collected. We found that using three fertilizer formulae produced a higher number of growing leaves than the control, in agreement with Paudel *et al*. (2004) who studied the effect of organic manures on lettuce growth (Table 3).

Before we can make any recommendation of what fertilizer to use, we had to consider the cost-benefit analysis. Table 4 shows that the number of remaining leaves of sugar-palm tree was indeed related to fertilizer cost. We found that 15-15-15 fertilizer formula gave higher number of growing leaves than others. Furthermore, gross field benefit of 15-15-15 fertilizer was 275.73 US$ per hectare, higher than all other treatments. However, when net benefits are compared, the 15-15-15 fertilizer with its 156.89 US$ per hectare has a much lower benefit than the non fertilizer 220.58 US$ per hectare. This means that not fertilizing gains the farmers 63.69 US$ per hectare (220.58-156.89 = 63.69) in income. This consideration is important because farmers have to be concerned about the worth of their investment in raising the cash for the next cycle of agricultural products; therefore net benefit seemed more important than gross field benefit.

4. Conclusions

The study reveals that a 36-months-old sugar-palm seed with both ends cut had the highest efficiency of germination. Moreover, the most appropriate time of seedling separation and transplantation was when it had one leaf and it was cut by two-thirds. This method was helped the sugar-palm tree decrease evaporation and grow roots. Therefore until the roots function properly, watering seedlings every two hours during the first week was needed to guarantee 82% survival. Finally, all three methods of fertilizer treatment were better in activating leaf growth than non-fertilizer treatment of one-to-three-year-old sugar-palm tree. However, considering the remaining leaves and the results of the economical analysis, the study shows that non-fertilizer treatment had a better net benefit than the fertilizer formulae used in this study.

It also implies that farmers can be confident in their ability to restore the number of sugar-palm trees by using these techniques because they took an active part in the development of this research.

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