

The Research Paper Awarded Sago Palm Research Prize Sago Palm (*Metroxylon sagu*) Cultivation: Factors Affecting the Subsequent Survival Rate of Suckers in the Nursery

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Abstract Suckers are the most popularly used planting materials in establishing sago palms in small-holder gardens and plantations in Sarawak. This is because suckers are true-to-type and are faster in their subsequent establishment as compared to seedlings raised from open pollinated seeds.

In the world's first sago palm plantation in Mukah, Sarawak, large numbers of suckers were nursed for three to five months in nurseries before field planting. The nurseries were usually sited in open fields and frequently, a substantial proportion of the suckers failed to survive. The mortality rate was extremely high especially in the dry season and most of the death occurred during the first month of planting in the nursery, causing substantial financial losses in the nursery.

In the current study, factors suspected to affect the subsequent survival rate of sago palm suckers were investigated. It was found that survival was significantly enhanced if suckers were planted promptly, notably within three days after removal from the parental palm. Suckers stored for more than two weeks before planting generally showed a marked decrease in their subsequent survival in the nursery. When the cut-ends as well as part or whole rhizome were completely buried in the soil, an increased rate of survival was also obtained. Rhizomes planted 8 cm below or just placed on top of the soil surface were shown to have lower survival rate. Trimming of roots to as short as 1 cm did not affect the subsequent survival of the suckers but excessive trimming of the rhizomes was deleterious. Shading of suckers during the dry season appeared to contribute positively to their successful establishment.

When planting of suckers was delayed, treatment with a wide spectrum fungicide together with keeping the suckers in cool and moist places were shown to reduce their mortality rate.

Based on the above findings and experience gained in the field, a recommendation on some of the important aspects in sago palm nursery practices is made.

Key words: Sago palm, Sucker, Nursery bed, Survival rate

サゴヤシ (*Metroxylon sagu*) の栽培：苗床における苗の生存率に影響する要因

要約 サゴヤシは通常サッカー移植される。その際、3-5 ヶ月間戸外の苗床で育成した苗が移植されるが、最初の苗床1 ヶ月間にかんりの割合のサッカーが途中で枯死する。とくに乾期に枯死率が高い。本研究に於て苗床での枯死率に影響する要因について検討した結果、高い生存率は親株から分離後3日以内のサッカーを用いる、根茎を表土直下に埋める、根長を1 cm以上残す、乾期にはシェイドする、移植が遅れた場合はベンレート処理などが有効であることが明らかになった。

キーワード サゴヤシ, サッカー, 苗床, 生存率

Introduction

Sago palms (*Metroxylon sagu*) can be propagated vegetatively from suckers or generatively from seeds. In Sarawak, suckers are conventionally used for planting in gardens owned by small-holder farmers as well as in the plantation mainly because they are true to type and faster in their subsequent establishment. As compared to suckers, seedlings derived from the same parent are variable in growth vigour, degree of thorniness and suckering capability (Jong 1991). Besides, sago fruits are scarce owing to the regular harvest of mature palms and also the majority of sago palms in Sarawak produce seedless fruits.

Suckers are normally nursed for a period of three to five months before field planting. However, direct planting is also practised during the wet season. With the establishment of the world's first sago plantation at Mukah by Land Custody and Development Authority (LCDA), some problems that have not been realised before are now experienced in the plantation. One of them is the high mortality rate of sago palm suckers in the nursery.

Owing to the great demand for planting materials in the plantation, suckers have to be purchased from other sago growing areas in Sarawak, some of them several hundred kilometers away. Apart from this, contractors supplying sago palm suckers have to purchase them from different farmers and gather sufficient quantity before they are sent to the plantation. By the time the suckers arrive at the nursery site, some of them have been extracted for a few weeks and such delay in planting is believed to contribute towards the high mortality rate.

In view of the above, investigations are made in the current study with the objective of identifying the factors affecting the subsequent survival of sago palm suckers in order to reduce losses during nursery establishment.

Materials and Methods

(1) Sucker preparation

Unless otherwise stated, the following procedure was used in the preparation of sago palm suckers.

Suckers of about 2 kg in weight (8–10 cm in base diameter) were chosen. Each sucker is extracted by making a cut at the narrow and woody section (neck) of the rhizome with a wedge shaped implement to separate the sucker from the parental palm. Soil around the sucker was removed and roots of the sucker were cut to facilitate the extraction. After removal, the roots on the ventral side of the rhizome were further trimmed to about 5–10 cm and fronds including the folded leaves (spears) were trimmed to about 30 cm from the base (Figure 1).

(2) Nursery method

Unless otherwise stated, the following procedure was practised. Suckers collected as described above were planted in the nursery within two days of preparation. The nursery was sited on peat soil where the water table was close to the soil surface and planting was done in December 1991 when the rainfall was about 300 mm per month.

Stumps and logs were removed before the soil was levelled. Small trenches of 30 cm width by 10 cm depth were dug and suckers were arranged to sit on the bottom of the trench. The cut end of the rhizome was loosely covered and spaces in between the rhizomes filled with soil in order to anchor the suckers firmly.

(3) Replication and size of treatments

Unless otherwise stated, each treatment was replicated three times and 10 suckers were used in each replicate.

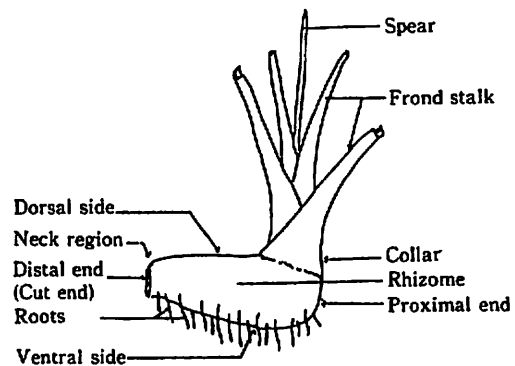


Fig. 1 A sucker used for the vegetative propagation of sago palm.

(4) Assessment of survival rate

After four months of nursing in the nursery, the number of suckers that survived in each treatment was recorded. The results were analysed by a PC-STAT programme using a one way analysis of variance. Observations were also made during and at the termination of the experiment.

(5) Experimental procedure

In this study, the effects of the following treatments on the subsequent survival rate of sago palm suckers were investigated:

(a) Duration of sucker keeping under shaded and open conditions.

Three hundred and sixty sago palm suckers prepared as described were divided into two equal lots. One lot was kept in the open field exposed to the sun and the other lot shaded with leaves.

Suckers kept under the above two conditions were taken out at the following treatment periods for planting in the nursery in order to find out how the duration and condition of sucker keeping affect their subsequent survival in the nursery.

- (i) Treatment 1- Suckers were kept for 0 day
- (ii) Treatment 2- Suckers were kept for 3 days
- (iii) Treatment 3- Suckers were kept for 7 days
- (iv) Treatment 4- Suckers were kept for 14 days
- (v) Treatment 5- Suckers were kept for 21 days
- (vi) Treatment 6- Suckers were kept for 28 days

(b) Rhizome trimming and corresponding duration of sucker keeping

Suckers were prepared as described in (1) except that the rhizomes were trimmed to the following treatment lengths:

- Treatment 1: 10 cm
- Treatment 2: 15 cm
- Treatment 3: 20 cm
- Treatment 4: 25 cm
- Treatment 5: 30 cm

They were then subdivided into two groups, each including the above 5 treatments. However, one group was planted in the nursery (as described) on the same day and the left exposed in the open field for two weeks before planting.

(c) Root trimming

Suckers were prepared as described in (1) except that the roots on the ventral side of the rhizomes were trimmed to the following treatment lengths.

- (i) Treatment 1: 1 cm
- (ii) Treatment 2: 5 cm
- (iii) Treatment 3: 10 cm

These suckers were then nursed in the manner described in (2).

(d) Depth of planting

Suckers as prepared in (1) were planted at the following depths:

- Treatment 1: With the rhizome just sitting on soil surface
- Treatment 2: With half the rhizome (ventral side) buried
- Treatment 3: With the whole rhizome just completely buried
- Treatment 4: With the whole rhizome buried 8 cm below soil surface

(e) Shading of suckers in the nursery during wet and dry season

Suckers were established in the nursery with and without shade during August and December, representing the dry and wet seasons respectively. The August and December rainfall was 87.1 and 391 mm respectively (appendix A). Shades were made of sago palm fronds and were provided overhead as well as on the east and west sides. The amount of shading was not measured but was estimated to be about 50%. Twenty suckers were used in each replicate.

(f) Treatments of the cut-ends of suckers

The cut-ends of sago palm suckers as prepared in (1) were treated as follows:

- (i) Dipped in wood ash
- (ii) Dipped in 1% benlate powder diluted with talcum powder
- (iii) Dipped in 1% carbofuran granules
- (iv) Dipped in a mixture of 1% benlate and 1% carbofuran
- (v) Control (no treatment)

Suckers treated as described above were divided into two lots, one lot planted on the same day and the other left for two weeks in an open field before planting in the nursery in the manner described.

(g) Methods of sucker handling

Suckers were extracted in the manner described in (1) except that fronds were trimmed in the following manner:

- (i) All fronds were trimmed to about 30 cm in length except for the spear which was left for handling (carrying).
- (ii) Fronds including the spear were trimmed to 30 cm except for an older frond which was trimmed to a slightly longer length for handling. Suckers trimmed and handled by the above methods were planted in the nursery as described in (2).
- (iii) 20 suckers were used in each replicate.

Results

(1) Duration of sucker keeping under shaded and open conditions

Both the duration as well as the condition of keeping suckers affected their subsequent survival rate (Table 1).

When suckers were stored under shaded condition for a period not exceeding 14 days, at least 80% of the suckers were able to establish successfully in the nursery. However, the survival rate of suckers dropped sharply if they had been exposed to the sun in an open field for more than three days.

(2) Rhizome trimming and corresponding duration of sucker storage

The length of rhizomes left attached to the suckers affected their survival in the nursery significantly (Table 2). Viability of suckers that had been stored for 2 weeks prior to planting appeared to be more severely affected by increased trimming of the rhizomes.

(3) Root trimming

No significant difference was detected in the survival of suckers when roots trimmed to different lengths (Table 3).

(4) Depth of planting

The depth of planting significantly affected the subsequent survival rate of sago palm suckers.

Table 1 Effects of duration and condition of sucker keeping on their subsequent survival rate

Duration of keeping (days)	Survival rate (%)	
	Shaped condition	Open condition
0	86.0 b	93.0 d
3	93.3 b	90.0 d
7	93.3 b	56.3 bc
14	80.0 b	60.3 cd
21	56.7 a	26.7 ab
28	60.0 a	13.3 a
S.E (Difference)	0.69	1.41
C.V. (%)	10.8	30.0

Footnote : In all the tables presented, means that are not significantly different are followed by the same letter (sig. level = 0.05)

Table 2 Effect of rhizome trimming and corresponding duration of storage on their subsequent survival

Length of rhizome left attached to sucker (cm)	Survival rate (%)	
	Sucker kept for 1 day	Suckers kept for 14 days
10	80.0 ab	13.3 a
15	63.3 a	36.7 ab
20	76.6 ab	56.7 bc
25	93.3 b	83.3 d
30	93.3 b	76.7 cd
SE (Difference)	0.76	1.07
C.V. (%)	11.4	24.7

Table 3 Effect of root trimming on the survival of sago palm suckers

Root lengths after trimming (cm)	Survival rate (%)
1	90.0 a
5	93.3 a
10	90.0 a
SE (Difference)	0.38
C.V. (%)	5.1

When the rhizomes were half or just completely buried in soil, 90% of them established successfully. However, when they were just sitting on the soil or buried to a depth of 8 cm below soil surface, their survival rates were markedly reduced (Table 4).

(5) Shading of suckers in the nursery during wet and dry season

During the dry season, shading of suckers in the nursery appeared to enhance their survival rate although the result was not conclusive. However, their rate of survival was reduced during the wet season when suckers were shaded. The highest survival rate was obtained when suckers were planted without shade during the wet season (Table 5).

(6) Treatments of cut-ends of suckers

When newly collected suckers were used in the nursery, ash and chemical treatments did not enhance or depress their survival to any significant extent. However, the effects of Benlate and a mixture of Benlate and Carbofuran were significant in enhancing the survival of suckers that have been kept for two weeks prior to planting (Table 6). Carbofuran or ash treatment alone did not increase the survival of stored suckers.

(7) Methods of sucker handling

No significant difference in the survival rate of suckers was detected when they were handled differently although there appeared to be a decreased rate of survival when they were handled by the spears (Table 7).

Discussion

(1) Duration of sucker keeping under shaded and open conditions

The results in Table 1 confirmed the speculation that the survival rate of sago palm suckers in the nursery could be enhanced by the use of freshly prepared suckers. This is in agreement with the recommendations of Flach (1983). To achieve higher percentage of sucker establishment, they should be planted in the nursery within three days of extraction. If suckers have to be obtained from a distance,

Table 4 Effect of planting depth on the survival of sago palm suckers

Depth of planting	Survival rate (%)
Rhizome sitting on soil surface	76.7 ab
Rhizome half buried on ventral side	90.0 a
Rhizome just completely buried	90.0 a
Rhizome buried 8 cm below soil surface	70.0 b
SE (Difference)	0.74
C.V. (%)	11.4

Table 5 Effect of shading on the survival of suckers in nursery during dry and wet season

Treatment	Survival rate (%)	
	Dry season	Wet season
Shading	83.3 a	66.7 b
No shading	66.7 a	90.0 a
SE (Difference)	2.90	0.67
C.V. (%)	23.6	5.2

Table 6 Effect of ash and chemical treatments on the survival of sago palm suckers

Treatments	Sucker survival rate (%)	
	Newly prepared	Kept for two weeks
Ash	76.7 a	63.3 b
Carbofuran 1%	93.3 a	66.7 ab
Benlate 1%	83.3 a	83.3 a
Carbofuran + Benlate	86.6 a	80.0 a
Control	70.0 a	66.7 ab
SE (Difference)	1.48	0.89
C.V. (%)	22.0	15.4

Table 7 Effect of sucker handling on the survival of sago palm suckers

Methods of handling	Survival rate (%)
By spear	78.3 a
By frond stalk	93.3 a
SE (Difference)	1.37
C.V. (%)	9.8

shading while awaiting and during transportation would reduce the mortality rate considerably. It was observed that when extracted suckers were exposed to the hot sun in an open field, dehydration of the rhizome and frond stalk occurred gradually. Once a sucker was dehydrated, its viability was correspondingly reduced.

It was observed that jelly-like exudates appeared on the cut ends of the suckers. Such exudates were believed to have some protective function against microbial infection. If suckers were kept moist continuously such as by shading, watering or prompt planting in the soil, such jelly-like exudates remain on the cut-end for several days. However, the exudates dried up rapidly when the suckers were exposed to the sun in the open field.

When dead suckers were split open along the rhizome, it was frequently observed that browning of the tissue in the rhizome occurred and this initiated from the cut-end of the rhizome. Such browning (decaying) of tissue was more pronounced in dehydrated suckers that had been exposed to sun in an open field.

When suckers were shaded, the loss of viability was reduced probably due to the reduction in dehydration and concurrent lowering of the surrounding temperature, making it less susceptible to microbial attacks.

(2) Rhizome trimming and corresponding duration of sucker storage

In normal practice in the cultivation of sago palms in Sarawak, suckers were extracted with a fair portion of the rhizome attached. The sucker was usually separated at the 'neck' of the rhizome where it was woody and constricted. Local sago farmers believed that such a method of sucker extraction would enhance its subsequent survival and this was supported by our findings as shown in Table 2. Suckers with longer rhizome survived better, especially when delay in planting was encountered. Such enhanced viability could be due to the greater food reserve as well as protection of the growing point from dehydration and disease attack which usually initiated from the cut end of the rhizome.

Although it was shown that suckers with longer rhizomes survived better, it is not easy or practical to obtain suckers with very long rhizomes. Besides, suckers with excessively long rhizome are more bulky and heavy to be transported, especially when they have to be hand-carried to the field from the nursery. In general, suckers be separated from the parent at the 'neck' of the rhizome and in some cases where such 'neck' region is absent, suckers should be extracted with a rhizome length which is about twice its diameter.

(3) Root trimming

In conventional practice, roots on the ventral side of the rhizome were trimmed to about 5–10 cm. This experiment reflected that trimming of roots to as short as one cm did not have any negative effects on the subsequent survival of the suckers that were planted promptly after extraction. Examination of the surviving suckers indicated that new generated equally well and in similar numbers in all the three trimming treatments. The practical implication of this experiment is that the bulk of suckers could be reduced by trimming roots to a shorter length, facilitating transportation and handling.

(4) Depth of planting

In Sarawak, making of proper planting holes for the cultivation of sago palm suckers as described by Flach (1983) is not commonly practised. On muddy or peat soils, planting is simplified by placing the rhizome on the soil and pressing it down slightly so that the cut-end as part of the rhizome are buried in the soil. Sometimes, suckers are just sat on shallow impressions made on the soil by trampling.

The result (Table 4) indicated that the highest survival rate was obtained from suckers with rhizomes half or fully buried in the soil. This finding is in agreement with the methods practised by local farmers.

When suckers just sat on the soil surface, some of the suckers were observed to be dehydrated under dry condition. The cut-ends of some rhizomes were also observed to be mouldy and attacked by sago worms. When rhizomes were buried 8 cm below the

soil surface, rotting of the meristem and young shoots was occasionally observed, probably due to suffocation as the growing points were frequently submerged in water during rainy days.

(5) Shading of suckers in the nursery during wet and dry season

In the context of sago palm cultivation by small holders in Sarawak, suckers were nursed in drains or floating rafts (on river) in small numbers. Artificial shade was not provided but some shading by the natural vegetation in the surrounding area was very common. In contrast, nurseries in the LCDA plantation were sited in the open where shading was not available.

As indicated in Table 5, shading appeared to promote the survival of palm suckers in the drier months. However, this result was statistically inconclusive (high c.v.) and the experiments will be repeated with larger replications.

As reflected from field observation, most of the death was encountered during the first month of planting, mainly due to dehydration under the hot sun in the open field. Shading appeared to reduce such dehydration.

The requirement for shade was not necessary during the wet season as 90% of the suckers survived without shading. In fact, shading of suckers during the wet season was observed to cause the decay of fronds as well as the growing points at the base of the spear.

(6) Treatments of cut-ends of suckers

When heaps of sago palm suckers arrived at the nursery site of a plantation, it was observed that the cut ends of some suckers were covered with moulds, predominantly *Penicillium*, *Mucor* and *Aspergillus* species (T. K. Kueh, pers. comm.). However, no work has been done yet to ascertain whether these moulds are harmful to the sago palm suckers.

In this experiment, it was shown that treatment with a wide-spectrum fungicide such as Benlate greatly enhanced the survival rate of suckers especially those that were stored for 2 weeks before planting. This is most likely due to the reduction in

the growth of fungi and their harmful activities. Treatments with 1% Carbofuran or ash alone did not increase the survival rate of sago palm suckers as pest attacks was not observed during the experiment. When fresh suckers were used in the nursery, the effects of the various treatments were inconclusive in enhancing survival. Also, the survival rate of suckers in the control was lower than those usually observed in this series of studies.

In general, no treatment was made to the extracted suckers by most sago palm farmers in Sarawak. Suckers were usually nursed in a drain or floating raft within a day or two after extraction and the mortality rate was low. This indicated that chemical treatments of suckers might not be essential if they were planted promptly, unless in areas where the incidence of pest and disease attacks were high.

When suckers have to be kept while awaiting transportation, treatment with a wide-spectrum fungicide would be essential to minimize death caused by fungal attacks. Treatment with insecticide would be venefitinal as a preventive measure against sago worm infestation.

(7) Methods of sucker handling

In Sarawak, most farmers carry the sago palm sucker by the frond stalk because it is believed that handling the suckers by the spears will increase the chance of damaging the growing point which is located at the base of the spear. In the current study, a slightly lower survival rate of the suckers was recorded for those handled by the spear, indicating that normal-sized suckers can be handled quite safely by the spear. Rough handling of large suckers by the spear may damage the growing point.

Although it was observed that those suckers with spears produced leaves earlier, it would be rather difficult to find large number of suckers in such a similar stage of growth at the same time. Thus, as far as sago cultivation is concerned, suckers with different stages of frond development could be used and they can be either handled by the frond stalk or the spear. In thorny palms where sharp thorns are present on the frond stalks, handling by the spear

will be more convenient.

Conclusions

To increase the subsequent survival rate of sago palm suckers either in the nursery or in the field, the following measures are recommended:

- (1) Suckers should be planted promptly in the nursery or in the field, preferably within three days of extraction.
- (2) Suckers should be separated from the parental palm at the 'neck' region of the rhizome. If the 'neck' region is not found, a length of rhizome approximately twice its diameter should be left attached to the sucker.
- (3) For a normal sized (2 kg) sucker, roots should be trimmed to about 1–2 cm.
- (4) If delay in planting is unavoidable, the extracted suckers should be kept in a cool and moist

Appendix A: Daily Rainfall from Aug. 1991–April 1992

Day of month	Daily rainfall (mm)									
	Aug. 1991	Sept. 1991	Oct. 1991	Nov. 1991	Dec. 1991	Jan. 1992	Feb. 1992	Mar. 1992	Apr. 1992	
1	0.7	0.9	17.3	0.0	7.0	0.0	4.1	0.0	39.8	
2	1.7	0.0	0.0	0.8	4.0	0.0	1.8	0.0	0.0	
3	21.9	0.0	1.9	6.8	17.8	54.6	0.0	0.0	0.0	
4	0.0	1.3	0.0	1.3	5.7	0.0	0.2	0.1	5.4	
5	1.7	0.0	0.0	0.8	25.7	0.0	18.7	0.0	0.0	
6	0.0	8.2	20.5	0.0	0.3	1.2	16.0	0.0	0.0	
7	0.0	0.0	0.0	0.0	48.4	5.0	57.9	10.2	0.0	
8	36.5	0.0	0.0	0.0	0.0	0.0	0.0	1.8	18.7	
9	0.0	0.3	1.5	5.4	21.0	0.0	1.1	0.9	5.0	
10	0.0	22.6	0.0	0.0	0.0	0.0	0.0	15.3	7.4	
11	0.0	0.1	21.3	0.2	22.2	0.0	0.7	106.6	2.1	
12	0.0	25.8	7.9	5.0	29.3	0.0	15.7	19.0	32.4	
13	1.2	0.0	13.0	13.9	15.6	0.0	0.3	0.0	0.0	
14	0.0	0.2	2.8	5.5	57.6	0.0	0.0	16.3	0.0	
15	9.7	0.0	86.6	0.0	1.0	19.8	0.0	75.5	1.4	
16	4.0	0.0	0.0	51.9	0.0	4.2	0.0	9.0	4.7	
17	0.0	0.0	72.2	0.2	3.4	2.0	20.9	1.0	5.9	
18	0.0	0.0	4.0	54.4	1.4	1.9	0.0	56.2	4.0	
19	0.0	0.0	1.6	1.4	0.7	3.4	0.0	1.3	1.3	
20	0.0	6.8	8.0	22.0	9.2	12.3	0.0	1.0	0.0	
21	0.0	0.0	1.8	0.0	43.2	0.0	0.0	1.7	28.3	
22	0.8	0.0	0.0	1.0	62.0	0.0	1.0	60.8	10.5	
23	0.0	67.9	0.5	1.3	0.0	0.0	0.0	17.2	31.5	
24	0.0	13.1	6.6	0.0	4.4	0.0	0.0	2.3	0.0	
25	0.0	0.0	2.3	0.0	2.2	0.2	0.0	0.9	1.2	
26	0.0	8.4	0.0	92.5	0.0	13.8	0.0	0.0	0.0	
27	0.4	0.0	15.2	13.3	4.0	0.6	0.0	0.0	11.9	
28	0.0	0.0	0.3	6.8	0.0	12.0	28.5	42.5	0.0	
29	0.0	0.0	0.0	15.0	0.4	1.0	22.2	0.0	1.7	
30	0.0	1.6	0.0	3.8	4.4	2.5	–	24.5	13.7	
31	8.3	–	0.2	–	0.4	0.0	–	3.0	–	
Total	86.9	157.2	285.5	303.3	391.3	134.5	189.1	467.1	226.9	

place such as under a shade. A wide spectrum fungicide should be used to treat the sucker, especially the cut-end of the rhizome. Storage of suckers for more than two weeks should be avoided.

- (5) Suckers should be planted by partially or just completely burying the rhizome in the soil. The cut-end of the rhizome should be covered to avoid dehydration and pest attack.
- (6) In the dry season, a nursery should be sited in a place where there is ample moisture in the soil so as to keep the rhizome moist at all times. A nursery surrounded by natural shade would be beneficial in the dry season. Shading of suckers in the wet season is undesirable.
- (7) Direct planting in the field can be practised in the rainy season when the water table in the soil is high. However, freshly extracted suckers should be used.

With the practices as mentioned above, the survival rate of suckers in the nursery can be

increased to as high as 90%, thereby reducing the loss in the cost of establishment.

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