Effect of Age and Mesocarp Removal on Germination Success of *Chrysalidocarpus lutescens* (Arecaceae)

LINTON L. ARNEAUD, FRADIAN MURRAY, AND DONALD R. HODEL

Abstract

The areca palm (*Chrysalidocarpus lutescens* H. Wendl.) is widely cultivated in tropical landscapes, yet we observed that volunteer seedlings are rarely seen beneath mature trees in Barbados, West Indies, despite apparently favorable environmental conditions. Thus, we conducted a study investigating the effect of age or freshness (zero, one, and over three months old) and presence or absence of mesocarp on germination of seeds of *C. lutescens*. Our findings support those in the literature that fresh seeds from fully mature, soft-ripe fruits planted immediately provided the best germination. The literature also reported that the benefits of mesocarp removal for seed germination of *C. lutescens* are mixed, and we found in our study that this practice did not significantly affect germination. While our results tend to suggest why old, fallen seeds below the mature palms rarely if ever germinate (old age and desiccation), it does not explain why even our best germination percentage was low, about 10 percent, when our extensive past experience shows it should be from 75 to 90 percent. Numerous factors could cause this discrepancy in germination percentage and rates between our present study and our past experiences, including unknown pathogens, seed medium moisture levels, light levels, temperature, and/or the possibility that an underlying issue unrelated to cultivation and environmental factors presented or discussed in this paper might be present. For example, a genetic aberration leading to poor embryo development and/or poor germination success, which proper seed handling, planting, and favorable germination environment would only be able to partially overcome, might be present.

Introduction

Palms are among the most important woody monocots used in tropical and subtropical landscapes, valued for their evergreen nature and longevity. Their striking foliage and often relatively low water demands make them attractive features in landscape plantings. Unlike most woody ornamentals, though, most palms are difficult or impossible to propagate vegetatively and must be seed propagated. However, germination of palms seeds can be slow and erratic (Koebernik 1971, Maciel and Mogollon 1995, Rauch 1995). Indeed, Tomlinson (1990) estimated that 25 percent of palm species have seeds that required more than 100 days to germinate and that final germination percentages were less than 25 percent. These figures likely apply to seeds in a natural habitat where they are exposed to predators, insect damage, diseases, microsites, and season. Corley and Tinker (2016) reported that under forested areas only about 5 percent of palm seeds germinated and that 80 percent of ungerminated seeds were damaged or eaten by rodents. Germination only happened after a brief, seasonal period of heavy rainfall. The low germination percentages that Tomlinson (1990) reported do not appear representative of our experiences in a nursery setting or even as volunteers in a cultivated landscape.

The lack of seedlings beneath mature, fruiting trees of *Chrysalidocarpus lutescens* in cultivated landscapes in Trinidad and Tobago, Guyana, and Barbados, West Indies piqued co-author Arneaud's interest, particularly during recent field studies in Barbados (Arneaud and Murray 2025). After *Cocos nucifera* (coconut palm), *Chrysalidocarpus lutescens* is perhaps the most common or at least the most readily recognized palm species in tropical cultivated landscapes worldwide, where it can be found growing under a wide range of conditions, some of them harsh environments. The lack of or poor germination of *C. lutescens* under mature, fruiting, cultivated, landscape trees in a tropical moist climate was curious because our abundant experience in germinating hundreds of thousands of seeds of this species in a nursery setting suggested that the lack of germination that Arneaud observed was an anomaly if not unusually intriguing. These observations and our experiences provided the impetus for the present study, warrranting a closer look into the germination of *C. lutescens*.

Chrysalidocarpus lutescens (formerly *Dypsis lutescens*) (Arecaceae: Arecoideae: Areceae: Dypsidinae) (Dransfield et al. 2008) is a moderate, clustered, attractive palm having ringed stems supporting arching, regularly pinnate leaves held on typically showy, colourful, golden orange to yellow petioles and rachises with ascending pinnae and waxy-white leaf bases forming a conspicuous crownshaft. Endemic to eastern Madagascar, it is restricted to littoral forest or heath vegetation on white sands, or sometimes on rocks and in secondary or disturbed situations, and at low elevations close to the seacoast (Dransfield and Beentje 1995). This specialized habitat is a rather harsh and challenging environment for most plants, let alone palms, and further highlights the apparently anomalous, poor seed germination of this species in what one could consider a suitable environment for germination found in a cultivated, tropical moist landscape in the West Indies.

Here we illustrate and report on a germination study we performed on *Chrysalidocarpus lutescens* where we investigated the effects of age (freshness) and removal of the mesocarp on seed germination.

Previous Germination Work Applicable to *Chrysalidocarpus lutescens*

To examine the paradox of poor field germination of *Chrysalidocarpus lutescens*, it is necessary to consider the known germination requirements of palms because little work has been done on the species itself. Broschat et al. (2014), Hodel (1998), and Robinson (2009), who have done extensive reviews of seed propagation of palms, have reported that optimal germination of palm seeds is attained by using fully mature, fresh, and cleaned (mesocarp removed seeds. Seeds should be planted in a disease-free, moist but well aerated medium; using clean containers, benches, and other equipment; maintaining temperatures of 25 to 35 °C and relative humidity of 90 to 100 percent (Hodel 1998). Considering the importance of these factors for successful germination, nearly all these factors are of interest for testing in the present study, especially age or freshness and mesocarp removal of seeds.

Age or Freshness of Seeds

Generally, only fresh, cleaned seeds from fully mature, soft-ripe fruits of most palm species are preferable for planting (Hodel 1998, Meerow and Broschat 2012, Pivetta et al. 2005, Rauch 1995, Silva et al. 1999). Such fruits are typically black, red, yellow, orange, purple, blue, brown, or white (Hodel 1998, Rausch 1995, Meerow and Broschat 2012) and typically have fully mature and ready-to-germinate seeds. In *Chrysalidocarpus lutescens*, fully mature, soft-ripe fruits are typically dark yellow to orange or golden amber with a brownish tinge.

Because seed viability of most palm species declines rapidly, it is best to plant seeds immediately after collection and mesocarp removal (which will be discussed later) (Meerow and Broschat 2012, Hodel 1998, Rauch 1995). Desiccation of palm seeds leading to embryo and endosperm shrinkage is the primary cause of decreased seed viability (Carpenter and Gilman 1988; Carpenter and Ostmark 1989, 1994; Martins et al. 2003).

Seed dormancy, where embryos are recalcitrant and fail to germinate even though seeds originated from mature, soft-ripe fruits, might be independent of seed age or freshness. In such instances, seeds of some palm species fail to germinate because embryo maturation lags behind fruit maturation and embryos need additional time to mature before germination occurs, a phenomenon called morphological seed dormancy (Baskin and Baskin 2004, Bautista et al. 2016, Jaganathan 2021). In contrast, seeds of other palm species might have a mostly temperature-dependent physiological dormancy where cold or warm stratification (the latter is likely more common in palms because of their mostly tropical origins) is necessary to break dormancy and germinate. Seeds of some palm species might have both morphological and physiological dormancies (Baskin and Baskin 2004, Pérez et al. 2008), requiring time and treatment to facilitate germination.

While typically preferable to plant mature, fresh palm seeds immediately after collection and cleaning of mesocarp, palm seeds can be stored for up to a year although viability will be reduced and success varies widely among species and storage methods (Broschat et al. 2014). Generally, seeds from palms from subtropical areas and/or areas with distinct wet-dry and/or hot-cool seasons can remain viable for two to three months when stored properly (DeLeon 1958) while those from moist to wet, ever-warm tropical areas remain viable for only up to a month if stored properly. Desiccation is the primary obstacle for storing palm seeds (Broschat et al. 2014).

Broschat and Donselman (1986b) found that germination of seeds of *Chrysalidocarpus lutescens* stored in paper bags was reduced by half at three months while those stored in polyethylene bags was not reduced by half until 15 months, which likely confirms that desiccation is a primary factor of loss of viability of stored seeds.

For best results in storing fresh, cleaned palm seeds, air dry them at 80 to 90 percent relative humidity for 24 hours and store them in air-tight, plastic bags or other containers at temperatures of 20 to 23 °C (Broschat and Donselman 1988, Carpenter and Gilman 1988, Carpenter and Ostmark 1989). Germination of seeds of *Chrysalidocarpus lutescens* at a temperature of 23 °C was reduced by half after 450 days but at a temperature of 15° C was reduced by half after only 70 days (Broschat and Donselman 1986b, Sento 1972). Under optimal conditions, seeds of *Chrysalidocarpus lutescens* have been stored for up to 12 months with little loss in viability (Hodel 1998).

Because desiccation is a primary reason for palm seeds to lose viability, several seeds of a batch can be sampled to check for desiccation by cutting the seed in the middle longitudinally and examining the embryo and endosperm. Healthy, viable embryos are typically moist, firm, white to yellow, and full, and not shrunken away from the endosperm, while the endosperm itself is moist, firm, white, and not shrunken (Hodel 1998).

Removal of Mesocarp from Seeds

Seeds of most palm species are enveloped within a fleshy or soft-fibrous pulp that is typically best removed for optimal germination: increased germination percent and decreased germination time (Broschat et al. 2014; Broschat and Donselman 1986b, 1987b; Ehara et al. 2001, Hodel 1998, Maciel 2001, Martins et al. 1996; Rauch 1995; Yoshii and Rauch 1989b). In many cases the mesocarp can contain germination inhibitors, which need to be removed to allow germination (Broschat and Donselman 1987b, Rauch 1995, Rauch and Crivellone 1989). Using lettuce seed bioassays, Khan (2006) for *Washingtonia filifera* (California fan palm) and Rauch and Crivellone (1989) for *Chrysalidocarpus lutescens* confirmed that mesocarps of these species contain germination inhibitors.

However, Broschat and Donselman (1986b) found that mesocarp removal from mature but green, not-soft-ripe fruits of *Chrysalidocarpus lutescens* actually decreased germination percentage, suggesting that the mesocarp might be necessary for the developing embryo. Furthermore, Broschat and Donselman (1988) found that seeds from mature, soft-ripe fruits of *C. lutescens* are not obligate to have the mesocarp removed if planted immediately after collection. In contrast, seeds from mature but green fruits of *Syagrus romanzoffiana* (queen palm) had higher final germination percentage when the mesocarp was removed (Broschat and Donselman 1987b). Hodel (1998) found that fresh, cleaned seeds of *C. lutescens* typically germinate within one to six months of planting.

Other Considerations (pre-plant treatments, potting media, light/temperature, pests and diseases)

Following cleaning or storage, seeds can be soaked for two to seven days in fresh water (with daily water changes) to counteract desiccation and promote germination (Broschat and Donselman 1988; Carpenter et al. 1993a, b; Schmidt and Rauch 1982; Yoshii and Rauch 1989a; Yoshii et al. 1989). Seeds of *Chrysalidocarpus lutescens* germinated faster after such a pre-plant water soak (Rausch et al. 1982, Schmidt and Rauch 1982, Morales-Payan and Santos 1997).

A pre-plant solution of 1,000 ppm of gibberellic acid (GA_3) induced seeds of *Chrysalidocarpus lutescens* to germinate faster (Broschat and Donselman 1986b, Schmidt and Rauch 1982) but can produce weak, elongated, and distorted growth (Broschat and Donselman 1986b, 1987b).

Any clean, moisture-retentive yet extremely well aerated medium can be used for planting palm seeds (Broschat et al. 2014, Hodel 1998). Typically, such a medium has an organic compound of 25 to 50 percent by volume for retaining moisture, like peat moss, thoroughly composted leaves, or coir, and an inorganic component of 50 to 75 percent by volume for aeration, such as perlite, sand, or volcanic cinders (Hodel 1998).

Seeds can be positioned on a pre-moistened medium with their long axis horizontal and then immersed half-way into the medium. In this technique, with half the seeds visible above the medium and the other half in the medium, the container with the medium and planted seeds can then be enveloped in an air-tight plastic bag or container to prevent drying out of the medium and seeds (Hodel 1998). Seeds planted in this manner will likely not have to be irrigated until germinating seeds are removed and potted into their own container. However, light levels must be monitored because too high light can heat up the medium and seeds in enclosed in plastic containers to unacceptable levels and damage or kill seeds. An alternative is to cover the planted seeds with 5 to 10 mm of medium and not enclose them within a plastic container but then they will have to be regularly checked for moisture and carefully irrigated, if necessary. Broschat and Donselman (1986b) found that seeds of *Chrysalidocarpus lutescens* germinated better if planted deeper in full sun but shallower if in shade.

Temperatures from 25 to 35 °C typically provide for optimal germination (Broschat and Donselman 1986a, b, 1988; Carpenter 1988; Hodel 1998; Sento 1972; Yoshii et al. 1989; Yoshii and Rauch 1989a). Yoshii and Rauch (1989b) found that for *Chrysalidocarpus lutescens* a water pre-soak treatment for 72 hours and 35 °C seed bed bottom heat produced the fastest germination. Light levels typically provided by 40 to 60 percent shade are best for palm seed germination.

Damping-off disease organisms, like *Pythium*, *Phytophthora*, and *Rhizoctonia*, and insects, such as weevils, can cause severe damage and death of seeds, germinated seeds, seedlings, and young plants; thus, fruits collected from the palm rather than the ground are preferable because the chances of contamination from these disease organisms and insects, like seed weevils, are higher on ground-collected fruits (Broschat et al. 2014, Hodel 1998, Meerow and Broschat 2012, Pivetta et al. 2005, Rauch 1995, Silva et al. 1999).

Summary of Seed Germination Requirements

Optimal germination of seeds of *Chrysalidocarpus lutescens* can be attained following these factors:

1. Seeds obtained from fully mature, soft-ripe fruits collected from the palm.
2. Seeds cleaned of fleshy pulp or mesocarp.
3. Cleaned seeds soaked in water for 72 hours prior to planting to mitigate desiccation; changing water every 24 hours.
4. Cleaned, water-soaked seeds planted immediately in a clean, well aerated, moist medium in clean containers and covered with five mm of medium; germination environment maintained at temperatures from 25 to 35° C and relative humidity of 90 to 100 percent.

Materials and Methods

Seed Collection and Treatment Groups

Mature, soft-ripe fruits attached to the palm and mature, soft-ripe fruits that had fallen from the palm and had variously dried mesocarps were collected from *Chrysalidocarpus lutescens* trees in the St. James parish, Barbados (**Fig. 1**). The fruits that were collected formed three seed ages:

- **Age 1:** seeds harvested from palm at zero months.
- **Age 2:** fallen seeds which were in the field for one month.
- **Age 3:** fallen seeds which were in the field for ≥ three months.

For each of the seed ages, there were two mesocarp treatments:

- **Mesocarp intact:** The fibrous outer fruit layer was left intact.
- **Mesocarp removed:** The mesocarp was manually cleaned from the seeds.

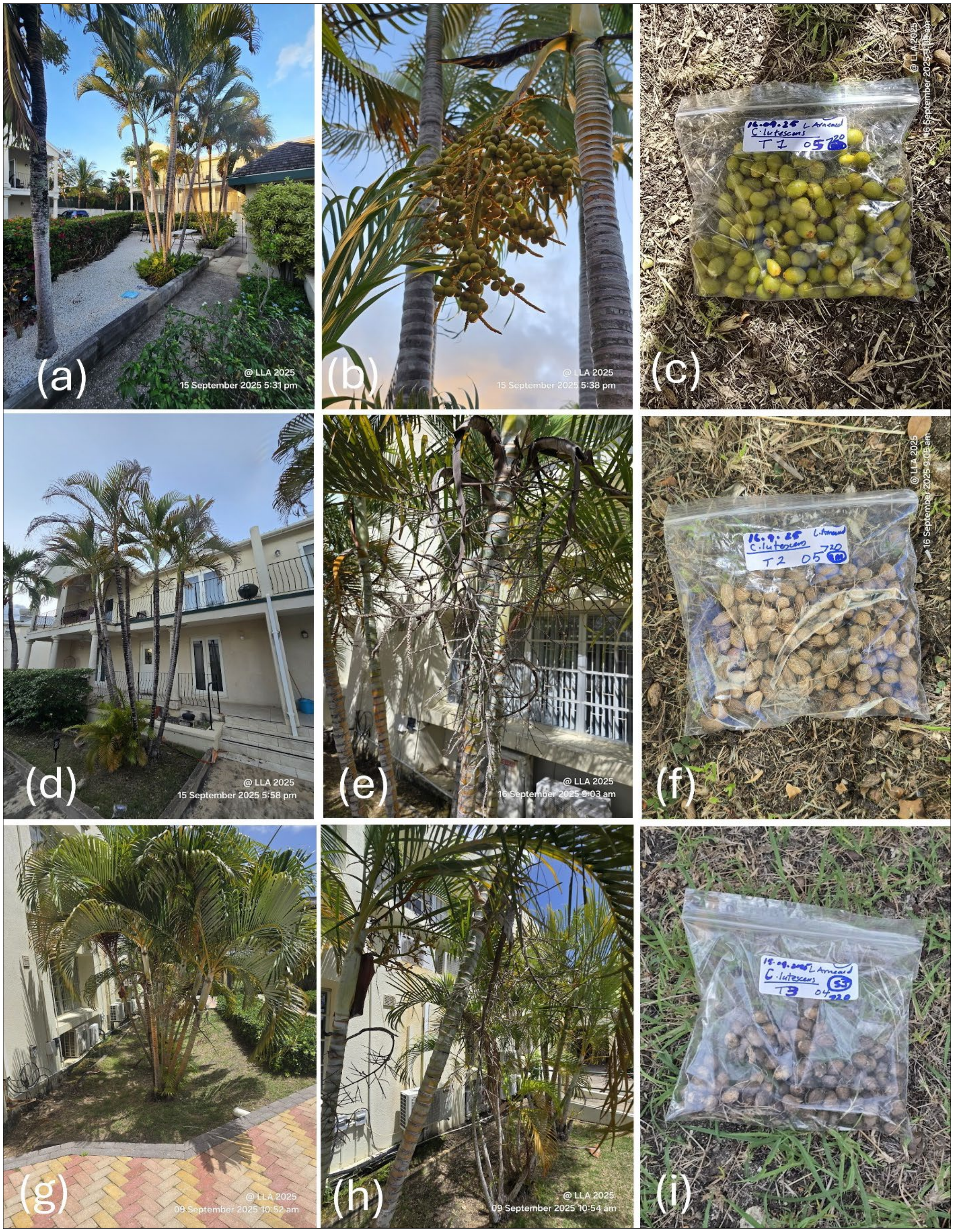

Figure 1. Representation of overall habit and fruit/seed stage of studied *Chrysalidocarpus lutescens* palms: [**a–c**] T1 (0 months); [**d–f**] T2 (1 month); and [**g–i**] T3 (>3 months). © 2026 by L. L. Arneaud.

These treatments resulted in a 3 × 2 factorial design (3 ages and 2 mesocarp treatments) to yield six treatment combinations (see **Fig. 1**).

Experimental Design

To ensure reliability, each treatment group included seeds from five separate trees (from two locations), with each tree serving as a replicate. For each replicate, three sets of 10 seeds were prepared, resulting in a total of 30 seeds per tree. Also, within each replicate, half (15) the quantity of the seeds had their mesocarp removed and half (15) were left intact. Altogether, a total of 150 seeds were used per treatment.

Seed Preparation

- **Pulp (Mesocarp) Removal:** Fruit were placed in a bucket of water and mashed by hand. Fruit were then agitated in the water to separate and decant the pulp from seeds.
- **Cleaning:** The mashing and decanting process were repeated until all seeds were clean and the pulp had been removed.
- **Drying:** After cleaning, the seeds were spread in a shaded, well-ventilated area for 24 hours to dry.
- **Endosperm and Embryo Assessment:** Seven to eight randomly selected seeds in each of the seed categories were cut longitudinally and the colour of the endosperm and presence or absence of the embryo were noted. (**Fig. 2**).

Figure 2. Randomly selected seeds of each of the three seed age categories were cut longitudinally and the colour of the endosperm and presence or absence of the embryo were noted; [**Left]** Seeds harvested from palm at zero months; [**Center]** Fallen seeds, which were in the field for one month; and [**Right]** Fallen seeds which were in the field for ≥ three months. © 2026 by F. Murray.

Planting

- **Germination Medium:** Seeds were planted in clean containers filled with a porous germination medium composed of 30 percent organic material in the form of compost and 70 percent inorganic material of sand.
- **Planting Depth:** Seeds were lightly covered with two to four mm of medium.
- **Moisture:** After planting, trays containing medium and seeds were thoroughly watered and allowed to air dry overnight before covering with clear, plastic garbage bags to maintain moisture and prevent desiccation.
- **Labelling:** Each container with its corresponding treatment number, replicate tree number, and planting date were clearly labeled.

Environmental Conditions

Planted, watered, and plastic-covered containers were placed in a shade house at The University of the West Indies Cave Hill Campus, within the Biological and Chemical Sciences Department. The specific area in the shade house receives morning sunlight (until approximately 10:00 a.m.) and remains in the shade for the rest of the day. Consistent moisture by watering the medium as needed were maintained over the duration of the experiment. Day and night maximum temperatures during the study were 30.1 to 30.7°C and 22.0 to 25.4°C, respectively (Barbados Meteorological Services 2025).

Observations and Data Collection

Regular checks for germination were made every week, and the quantities of seeds that germinated and sprouted above the medium surface were recorded. The experiment run for a total of 12 weeks and two days. The general layout of shade house, representation of experimental sowing design, and examples of germination success of studied *Chrysalidocarpus lutescens* palms are illustrated in **Figure 3**.

Data Analysis

A Generalized Linear Models (GLiM) were utilized to detect significant germination differences among seed age (0-month, 1-month, and >3 months) and fruit type (with and without mesocarp). The GLiM model used a binomial probability distribution and logit functions. Normal residual error distributions were checked by visual inspection of histograms and Q–Q plots. Model fit checks were done using the Scaled Pearson Chi-Square test and the Goodness of fit statistics. Whenever significant differences were seen, Fisher's Least Significant Difference (LSD) tests were used to indicate which factor/s was responsible for statistical differences. Data analysis was conducted in IBM SPSS Statistics v 30.0.0, using the generalized Linear Model [GENLIN] command

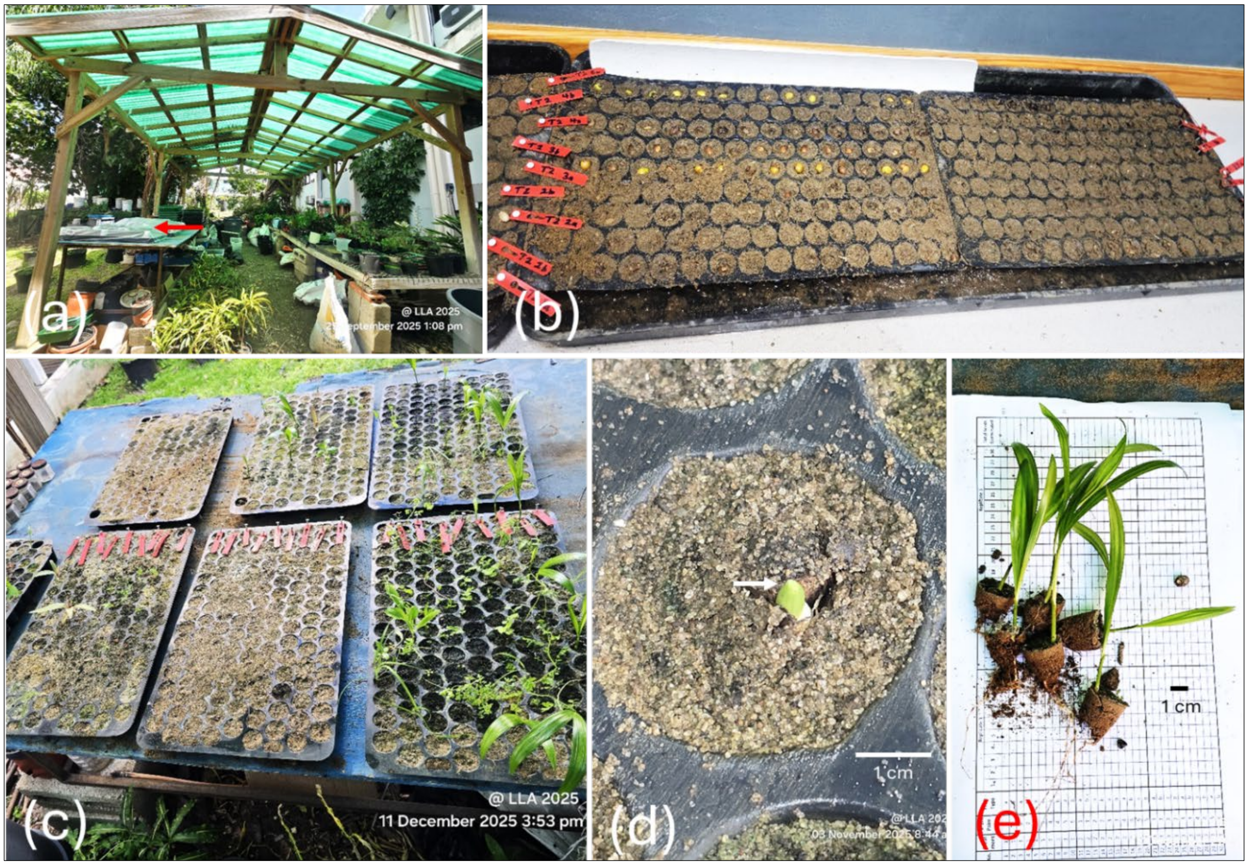

Figure 3. General layout of shade house, representation of experimental sowing design, and germination success of studied *Chrysalidocarpus lutescens* palms: [**a**] Overview of the shade house environment showing the spatial arrangement of germination trays (indicated by red arrow) used to maintain standardized environmental conditions; [**b**] Detailed view of seed orientation and sowing density within the trays (one seed per hole); note the semi-exposed state of seeds prior to final substrate coverage; [**c**] Germination success of seeds within three treatments (see figure 1 for treatment types); [**d**] Emergence of first shoot (white arrow); and [**e]** Development of root and shoot systems of seedlings; note the shoot to root ratio (1:1). © 2026 by L. L. Arneaud.

(IBM Corp. 2026). The reliability level (confidence interval) during these statistical tests was 95 percent.

Results

Figure 2 illustrates the state of the embryo and endosperm among the three seed age categories. Although a viability test was not done, seeds from Age 1 (0 months) were noted to have whiter endosperms and noticeable embryos. Six out of the eight seeds had viable and noticeable embryos (a). Age 2 seeds (1 month old) had more discolouration of the endosperm and 1 out of 7 viable embryos. Age 3 seeds (3-month-old) had even greater discolouration, no viable embryos shown because the three observed were shrunken and considered non-viable by this condition; one of the seeds even had pest damage.

Seed age produced significant differences in germination success (GLiM, x^2 = 40.71, df = 2, P<0.001) (**Table 1**). The Fisher's Least Significant tests show that fresh seeds (Age 1) had a significantly higher germination success rate than 1-month-old seeds (Age 2), and >3 month-old seeds (Age 3), with mean differences of -0.07 and -0.09 respectively (P < 0.001 for both). In contrast, the presence or absence of a mesocarp did not significantly influence germination outcomes (P = 0.269), and no significant interaction effect was found between age treatment and presence or absence of the mesocarp (P = 0.929) (**Table 1**).

Table 1: Effect of seed age and presence or absence of mesocarp on the germination success (%) of *Chrysalidocarpus lutescens*.

Treatments (n=150)	Germination Success (%)	Standard Error
0 months (with mesocarp	7.33	± 0.55
1 month (with mesocarp)	1.33	± 0.13
>3 months (with mesocarp)	0.00	0.00
0 months (without mesocarp	10.00	± 0.66
1 month (without mesocarp)	2.67	± 0.22
>3 months (without mesocarp)	0.00	0.00

Germination success, which was measured as a percentage was highest in fresh seeds (9% ± 1.20 SE), followed by a significant decrease (2% ± 0.36 SE) in 1-month-old seeds Also, no seeds germinated (0% ± 0.0 SE in the >3 month-old seed treatment The highest germination rate was recorded in the 0-month treatment with mesocarp removed, which had a peak mean germination of 10% ± 0.66 SE (**Table 1**).

Discussion

The findings of this study corroborate established literature regarding the germination requirements of *Chrysalidocarpus lutescens*; specifically, that peak germination and success are achieved when seeds are harvested from fully mature fruits and sown immediately to preserve viability.

Because older, poorly germinating seeds in our study were lying on the ground and exposed to sun and wind for up to three or more months, seed desiccation might have occurred and be largely responsible for the poor germination (Broschat et al. 2014; Carpenter and Gilman 1988; Carpenter and Ostmark 1989, 1994; Martins et al. 2003). In our case, perhaps a pre-plant, 72-

hour water soak to mitigate desiccation and improve germination in these older seeds, which was shown to enhance germination of seeds of *Chrysalidocarpus lutescens* (Rausch et al. 1982, Schmidt and Rauch 1982, Morales-Payan and Santos 1997), might have been a revealing treatment option.

Also, diseases and insect pests might have contributed to the decreased germination in older seeds because these older seeds were gathered from the ground where diseases and pests are more common than on seeds gathered from the palm (Broschat et al. 2014, Hodel 1998, Meerow and Broschat 2012, Pivetta et al. 2005, Rauch 1995, Silva et al. 1999). One of the eight seeds being affected by pest damage (Coleoptera) from the oldest seed age suggests that other seeds in the age group might have also been affected. From the older, ground-gathered seeds, perhaps a viability test, such as the use of tetrazolium (TTZ), could have been done and mitigation measures implemented as treatment options in our study.

While the literature generally supports mesocarp removal to enhance palm seed germination, this practice is more nuanced for *Chrysalidocarpus lutescens*. Though Rauch and Crivellone (1989) confirmed the presence of seed inhibitors in the mesocarp of *C. lutescens*, Broschat and Donselman (1986b) found that mesocarp removal from mature but green, not-soft-ripe fruits actually decreased germination percentage, suggesting that the mesocarp might be necessary for the developing embryo. However, Broschat and Donselman (1988) also found that seeds from mature, soft-ripe fruits of *C. lutescens* are not required to have the mesocarp removed if planted immediately after collection, suggesting that if an embryo developmental process was present in the seeds of this species, sufficient embryo development for germination had occurred by the time fruits had matured, coloured up, and were soft ripe. In our study, mesocarp removal of seeds of *Chrysalidocarpus lutescens* did not significantly affect germination in any of the age treatments, suggesting intermediate results between those of Broschat and Donselman (1986b) and (1988). Mesocarp removal would be an interesting topic for a further, detailed study.

The fact that even the best germination percentage was low (ca. 10 percent) in our present study is curious because we have had extensive experience germinating hundreds of thousands of freshly harvested, cleaned seeds of *Chrysalidocarpus lutescens* and they typically germinated readily within 60 days at rates of 75 to 90 percent. It is especially interesting because the representative sample of the age group showed that 75 percent of the seeds had viable embryos. A myriad of factors could cause this discrepancy in germination percentage and rates between our present study and our past experiences, including unknown pathogens, seed medium moisture levels, and/or light levels and temperature, and is another topic for further study.

In some ways, our results seem to reflect the poor or lack of germination of fallen seeds under the mother palms in Barbados, and by extension, Trinidad and Tobago and Guyana. These results raise the possibility that an underlying issue unrelated to cultivation and environmental factors presented or discussed in this paper might be present, for example, a genetic aberration leading to poor embryo development and/or poor germination potential, which proper seed handling, planting, and germination environment were only partially able to overcome. Perhaps a more detailed examination of a greater representative sample of embryos from palms used in our study would be revealing.

Conclusions

In conclusion, achieving optimal germination of *Chrysalidocarpus lutescens* requires the utilization of fully mature, soft-ripe drupes harvested directly from the parent palm. Immediate sowing of fresh seed is critical to maintaining maximum viability and accelerating emergence rates. While removal of the mesocarp seems to be unnecessary, following the tenets of good, general palm seed germination will likely enhance germination, including a pre-plant, 72-hour water soak; using a clean, well aerated, moist germination medium in clean containers and covered with five mm of medium; and maintaining an evenly moist germination medium, temperatures from 25 to 35 °C, and relative humidity from 90 to 100 percent.

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Linton Arneaud is a Lecturer in ecology within the Department of Biological and Chemical Sciences (BCS) at The University of the West Indies (UWI), Cave Hill Campus, Barbados. *linton.arneaud@uwi.edu* / *lintonarneaud1@gmail.com*

Fradian Murray is a Lecturer in plant biology within the Department of Biological and Chemical Sciences (BCS) at The University of the West Indies (UWI), Cave Hill Campus, Barbados. *fradian.murray@uwi.edu*

Donald R. Hodel is the emeritus landscape horticulture advisor for the University of California Cooperative Extension in Los Angeles and specializes in the selection and management of palms and trees. *drhodel@ucanr.edu*

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