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Cultivated Palm Seed Germination

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Abstract:

The propagation of palms for agricultural and ornamental purposes is accomplished typically by seeds. The few exceptions are certain cultivars of *Phoenix dactylifera* and some ornamental palms such as *Rhapis spp.*, which propagate by vegetative (division) and tissue culture. Because of slow, irregular germination in most species, seed propagation may be a challenge. New palm species are being introduced into cultivations, many of which show potential for enhancing the urban environment. A better understanding of the germination of palm seeds is needed to obtain a high germination percentage and improve germination rates. Some basic principles that would facilitate better production of palms can benefit the nursery industry as well as protect those palms that are losing habitat in their native areas and that show potential for ornamental use.

Introduction:

"We will begin with palms, the loftiest and noblest of all vegetable forms, that to which the prize of beauty has been assigned by concurrent voices of nations in all ages: for the earliest civilization of mankind belonged to the countries bordering on the region of palms and to parts of Asia where they abound" (Alexander von Humboldt 1849). Palms are extensively important to most of the world's population as providers of food and fiber, second only to the grasses that provide the grains (Ellison and Ellison 2001). In developed areas of the western world, palms not only provide aesthetic beauty, but play an important role in the urban environmental diversity of plant materials. They are an important part of the landscape nursery in warmer areas of the United States and an important part of the interiorscaping industry throughout the country. For many years, only a few palm species that were easily propagated were grown for both landscape and interior use. Today there are still nurseries in the United States and Europe that specialize in only a few species. Some may have 5 to 6 million plants of the same species in production at one

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time. In recent years, there has been a growing interest in palms, commercially and by private collector, throughout the world. This has helped to stimulate interest in adding greater diversity in the palm species that are available for cultivation. Today, thousands of people belong to palm societies dedicated to the growing of palms in cultivation, the introduction of new species, and the protection and propagation of endangered palms. These societies are found all over the world, from Australia to Seattle, Washington, and from Florida to France. Southern Nevada is a good example of how a few palm species that lend themselves to easy propagation are over-used. There are over 2,500 species of palms with more than 800 species in cultivation (Ellison and Ellison 2001). More than 50 species have potential for cultivation in a desert climate such as Southern Nevada, yet only 8 to 10 species are commonly used here.

Palm Seeds:

Most palms take 100 days or more to germinate, with an average germination rate of less than 20%. There is great diversity in palm seed size. They range in size from 5 mm in length to the largest seed of the *Lodoicea maldivica* weighing more than 20 kg (Jones 1995). Most of the seed tissue is endosperm, which provides food for the germinating embryo (Fig. 1). There are two types of palm seed germination, remote and adjacent. Remote germination takes place when a cotyledonary petiole grows out and away from the seed. A root or radicle and seedling shoot develops (Fig. 2 A-C). The actual cotyledon leaf remains inside the seed to transfer nutrients from the endosperm to the seedling. Three palms grown in Southern Nevada that germinate this way are *Chamaerops humilis, Livistona chinensis* and *Phoenix dactylifera*. Adjacent germination occurs when a small portion of the cotyledon emerges, forming a button from which the first radicle and shoot emerge (Fig. 2 D-F). The best example of a palm that germinates in this manner is the Cocos nucifera, which does not grow in Southern Nevada. *Butia capitata* and *Syagrus romanzoffiana* are palms grown in Southern Nevada that propagate through adjacent germination.

When propagating palms, environmental adaptations should be taken into consideration. Many have deep sinker roots that help establish the plant before the first plumule or seedling shoot emerges. Palms such as *Bismarckia* and *Hyphaene* are both desert palms that send a sinker root to establish a water source first. Deep pots are needed to adjust to this environmental adaptation.

Many palm seeds are extremely hard resulting in slow germination. Germination will vary from year to year and from region to region or even from plant to plant (Meerow 1990). Most palm seeds germinate best when harvested fully ripe, but they may not all ripen at the same time in the same bunch, giving mixed germination results. Most palms are from the warmer parts of the world, and chilling (especially below 0°C) will cause damage and death to the seed embryo.

Problems in palm seed germination:

Research reveals there are some basic external conditions that affect the germination percentage of palm seeds. As stated earlier, fewer than 20% of palm seeds normally germinate in nature. Even with this small germination rate, palms survive due to their prolific seed production.

In most cases, mature palm seeds facilitate higher percentages of germination. There are a few exceptions, such as *Dypsis lutescens*, in which the maturity of the seed does not matter (Broschat and Donselman 1986). Where mature seeds are collected is important. Seeds collected on the ground are more likely to have insect infestations (Rauch 1998). Maturity of seeds is important, but so is freshness. Seeds have a short life and can dehydrate quickly. Good sanitation practices are important, as they reduce the possibility of contamination by insects and disease organisms. However, it must be noted that treatment of palm seeds with full strength fungicides can delay germination or reduce total percentage of germination (Meerow 1994). Finally, soil may also be a factor in low germination. Soils that are too compact, that drain poorly, that are too cool, and that dry out too quickly can slow or stop germination.

The greatest cause of poor germination is dead seeds. There are several ways to test seeds for freshness. One of the oldest methods is the float test. For most seeds, this test works well. Place the seeds in a large container filled with water. If the seeds float, they are dead. The problem with this test is that many seeds have evolved to be dispersed by water, so they float naturally. It has been observed that if the floating seeds of non water dispersed seeds are planted, many will still germinate.

Other palm seeds simply need to be hydrated. After a few days of soaking they become hydrated, sink, and ready for planting. This too may indicate water dispersal of the seed in nature, or the need of large amounts of water to stimulate germination. With the potential for poor seed germination, it is recommended to plant 50 to 100% more seeds than are needed.

There are two more reliable methods of seed testing recommended by researchers (Broschat and Donselman 1986). Both methods require a random sampling and sacrificing of selected seeds. The first is to cut open the selected seeds and observe the endosperm and embryo. The endosperm should be firm and not discolored. The embryo should be fully developed and fill the area in which it rests. If the endosperm is soft and spongy, the embryo deformed, not fully developed or missing, the seed is not viable (Fig. 3). In some cases, the endosperm may be moldy and totally desiccated.

The other test is to coat the embryo with tetrazolium chloride. A mixture of 1% (10gm/l) is applied to sample seeds that have been cut in half. The test seeds are then placed in the dark for 2 to 24 hours. If the embryo is partially stained or completely red or pink, it is probably viable. No staining of the embryo indicates that the embryo is inviable.

Germination & Climate:

A random survey (20% of 830 cultivated palms) was conducted to determine the difference between the length of germination in varying climates. Overall, it was found that 80% required two to five months to germinate. The palms were then divided into three climatic groups, tropical (21%), tropical-subtropical (53%), and warm temperate (26%). A significant find was that warm temperate palms had the largest percent of species (17%) that required more than six months to germinate. This was twice that of the tropical-subtropical group, and three times that of the tropical group. The longer germination rate may be a survival technique similarly used by other temperate plants.

Storage:

Palms are from tropical, subtropical and warm temperate areas of the world. Conditions in these climatic areas do not lend themselves to long-term storage. Under natural conditions, most palm seeds remain viable for only a few weeks. Only under special storage conditions as developed and described by Broschat and Donselman (1986 and 1987) can seeds be successfully stored for a year or longer. With few exceptions, a rest or storage period is not beneficial. The key seems to be that the more seasonal the native habitat, the greater the low temperature storage tolerance. Butia capitata actually germinates following a period of dry storage in temperatures as low as 5.5°C for 150 days. This is not a recommended procedure for any species of palm, including Butia capitata. However, most tropical palms stored below 15°C will lose viability (Boschat & Donselman 1986). While it is generally recommended that palm seeds be planted immediately, Broschat and Donselman (1986 and 1987) showed how seeds of 4 species of palms could be successfully stored for long periods of time by removing the fruit pulp, air drving for 2 days, dusting with a fungicide, sealing in a plastic bag, and storing at room temperature. There is some indication that if storage is needed to produce different crop sizes, it would be best to germinate the seeds and store the seedlings at a lower growing temperature that will slow growth but not damage the plants. Stored seeds need to be kept at temperatures above 15°C, moist, and free from disease and insects

Preparation of Seeds:

After selection, the next fundamental consideration in palm seed germination is preplanting treatments. There are many treatments that are routinely used to enhance germination percentages. A list of common treatments follows: Soaking in water for certain periods of time Scarification – cutting, filing, or soaking in acid

Stratification - cool and warm, which duplicates a natural seed-bank situation

Removal of seed from the fruit to eliminate natural germination inhibitors

Chemical enhancers such as Gibberellic acid (GA)

In most palms with a fleshy fruit covering, there are natural germination inhibitors. Some of these are quite irritating to human skin. Broschat and Latham (1994) provides a listing of the amounts of oxalate within the fruits of 60 species of palms. It is important for people working with fruits of *Chamaedorea, Caryota, Roystonea, Arenga,* etc. to wear rubber gloves to prevent skin contact with these fruits. There are two recommended pretreatments for these seeds, the removal of the fleshy coat and the scarification of the hard, water-impermeable seed coat. A simple test was conducted at the University of Hawaii to determine if inhibitors were contained in the fleshy pericarp. The fleshy pericarp was removed and the pulp was placed in a blender with water. This solution was then strained through cheesecloth and filter paper, and the liquid was used to water lettuce seeds. The test results showed that by the 7th day, 91% of the control seeds had germinated, while none of the pericarp solution seeds had, indicating that the pericarp did in fact contain chemicals that inhibited the germination of seeds.

Other tests reveal that seeds washed and cleaned of the pericarp germinate faster, but that total germination rate is similar for both cleaned and uncleaned seeds. This is probably due to the

natural decomposition of the flesh and loss of the inhibitors. This means that germination takes longer with the fleshy pericarp still attached, but it is still accomplished. For the commercial producer, this can represent monetary loss.

All of these tests were conducted with fresh seeds, which have a considerable influence on the germination percentage. If seeds are to be stored, they must be cleaned of the fleshy pericarp and dusted with a fungicide. As previously indicated, this fungicide may also inhibit germination. (Meerow 1990) and others have suggested that those seeds with fibrous and fleshy pericarp require a water soak to soften for removal. This may take several days to weeks (Banks and Marcus 1999). The softening is accomplished by fermentation of the flesh, and the water must be changed daily (Fig. 4). Once this is accomplished, the softened pericarp is removed by hand (wearing protective gloves) (Fig. 5) or for large production in a small cement mixer. Seeds with very thin pericarp need only to be washed and planted.

Chemical Enhancers:

Research has been conducted by the University of Florida and the University of Hawaii on some of the more common palms in the commercial industry to show the effectiveness of chemical treatments in enhancing germination. The most beneficial method proved was soaking cleaned seeds in water. There was some increase of germination shown with the use of a GA soak, but the rate increase was not significant. After 60 days, the final germination percentage was not influenced by various chemical treatments (Murakami and Rauch 1989). Broschat and Donselman (1987), demonstrated that a GA treatment will cause elongated seedlings that do not support themselves (Fig. 6).

Sulfuric acid has had some success breaking up the hard seed coat of some palms. However, this treatment can harm the seed embryo as well as the person using it. When using chemical enhancers, proper protective clothing must be worn, and the seeds must not be over exposed to the acid solution.

Temperature Effects:

Of all factors, temperature has the greatest effect on the germination of viable seeds. Many research projects have been conducted that demonstrate the relationship between temperature and germination rates. It should be of no surprise that because most palms come from either hot humid tropical/subtropical or hot desert areas, that temperatures of 32°C are recommended to facilitate best germination of tropical seeds. For subtropical palms, 27°C appears to be ideal (Ellison and Ellison 2001). Some desert palms can be germinated best at 34 C to 37°C. Research conducted by the University of Hawaii showed that temperature is the major factor in improved germination. In one test, *Dypsis lutescens* and *Chamaedorea seifrizii* seeds were pretreated both with a water soak and a GA soak. The end result was that water soak with a bottom heat of 30°C to 35°C gave the best germination rate. Both of these palms are from the tropics and do best in tropical/subtropical landscapes and in warm interiorscapes. Warm soil is an important factor in germination, as it would be in the native habitat of these palms. Palm root activity is most active when soil temperature is above 20°C. Banks and Marcus (1999) concur

on this concept, that hydration and heat are the keys to the success of high levels of palm seed germination.

Mechanical treatments:

Many palm seeds have a hard seed coat under the fleshy/fibrous pericarp. It is often recommended to penetrate this coat mechanically to facilitate hydration. It has been shown that scarification increases the rate of germination of palm seeds with water-impermeable hard endocarp (Nagao et. al., 1980). This method is recommended only for those seeds that are very hard to germinate, as damage to the embryo during the process can be high (Meerow 1990). For *Hyphaene* palms, it is recommended that only the leathery husk be removed with sharp pruning shears to facilitate germination. *Jubaea*, another temperate palm from dry areas of South America, germinates best when the outer endocarp is shattered with a hammer. However, this can cause death of the embryo and destruction of the whole seed, if executed improperly. With the endosperm exposed, a treatment of fungicide is recommended to prevent rotting.

Conclusion:

As one reviews the limited research that has been conducted on palms seeds and their germination, there are some simple conclusions for better propagation that manifest themselves. Most practices that will improve the percentage of germination are simple, with little, if any, high tech involved.

- 1. The average percentage of palm seed germination in nature is 20%. This increases considerably under ideal horticultural conditions, from 50 to 90%.
- 2. With few exceptions, palm seeds should be fresh, with the fleshy pericarp soft and moist and planted immediately.
- 3. With the exception of such palms as *Syagrus romanzoffiana*, all seeds should be ripe to ensure complete embryo development. It is best to harvest from the tree, not from the ground.
- 4. The fleshy and fibrous pericarp should be removed by a water soak for several days to several weeks, changing the water daily. Once the pericarp is soft due to fermentation, it should be removed. This will eliminate any need for chemical germination inhibitors.
- 5. The soaking process should also facilitate hydration, which is an important part of stimulating germination. Soaking palm seeds in a gibberillic acid solution is not recommended.
- 6. Tropical and subtropical palms should be germinated with soil temperatures of 27°C to 32°C, desert palms at 34°C to 37°C. Research on more temperate palms such as *Sabal*, *Serenoa*, and *Washingtonia* showed that these species germinate better at higher temperatures.
- Sanitation is a key to high germination. Seeds should be clean of disease organisms and insects. As a precaution, a soak in a pesticide (either an insecticide or fungicide) may be beneficial. A 10% chlorine bleach dip may also be used.
- 8. A light soilless medium that drains well but retains adequate moisture is essential for palm seed germination and survival.

The literature researched reveals that these simple steps will produce the best germination results.



Fig. 1 Longitudinal and cross section through a coconut fruit (Meerow).



Fig. 2 Main classes of palm seed germination. A-C. Remote germination, date palm (*Phoenix dactylifera*). A. Early germination with cotyledonary petiole emerged and seedling root (*radicle*) beginning growth. B. Seedling stem (*plumule*) emerging from cotyledonary sheath. C. First leaf (*eophyll*) emerged, radicle continuing to elongate, and haustrorim inside seed absorbing nutrients from endosperm. D-F. Adjacent germination, Piccabean palm (*Archontophoenix cunninghamiana*). D. Early germination with button emerged. E. Seedling root (*radicle*) and stem (*plumule*) emerging from button. F. First leaves (*eophylls*) emerging, first adventitious root formed and supplanting radicle, and haustorium inside seed absorbing nutrients from endosperm from (Meerow 1990).



Fig. 3 Cross section through viable (right) and inviable (left) seed of Areca palm (Dypsis lutescens). Note shrunken endosperm and embryo in seed on left. (Broschat and Donselman).



Fig. 4 *Chamaerops humilis* seeds soaking. These seeds have been soaking for 4 days. When they were first placed in the water 90% floated, after 3 days only 10% were still floating. After the seeds were cleaned 0% floated.



Fig. 5 *Chamaerops humilis* seeds. A. Soaked seeds partially fermented. B. Outer fleshy pericarp removed. C. Seeds totally cleaned of fleshy and fibrous coverings.



Fig. 6 Excessive elongation of Areca palm (Dypsis lutescens) seeds on left was caused by pretreating seed with a presoak of gibberelic acid (GA3). (Broschat and Donselman).

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