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Studies on Seed Dormancy, Viability, and Germination in Ornamental Palms*

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ABSTRACT

Initial seed viability and presence or absence of dormancy were found to affect germinability of different species of palms newly introduced into Nigeria. Requirements differed among species and the paper discusses optimum conditions of germination for many palms of ornamental and economic importance.

Seed dormancy may be defined as the cessation of growth under environmental conditions that normally favor later growth of a species. It is often considered as an evolutionary adaptation to the environment, preventing germination that would otherwise cause death of young sprouts by unfavorable environment, and delaying further development until favorable conditions for growth prevail. However, dormancy is regarded as a nuisance in many instances in agriculture and horticulture when conditions that support growth of young seedlings could be provided artificially in nurseries.

Palms are a unique group of plants by their widespread importance in agriculture, horticulture, and floriculture. As a rule true seed dormancy (i.e. embryo dormancy) is absent among the Palmae. In many instances development of the intact embryo after fruit ripeness is continuous (Kozlowski and Gunn 1972) and vivipary is not uncommon. There should therefore be no great difficulty in germinating most palm seeds. Nevertheless, many members of the family exhibit various degrees of seed dormancy. In those palms of economic value or of other interest to growers it is desirable to devise simple techniques of ensuring satisfactory germination especially when seed is not available in large quantities. In addition, it is essential that methods of fruit processing and seed storage are appropriate in order to preserve maximum seed viability.

With the exception of a few commercial palms like the oil palm (*Elaeis guineensis*) and coconut palm (*Cocos nucifera*) most of the information on germination of palm seeds has been acquired from purely empirical trials, and reports of systematic investigations, such as in *Jubaeopsis caffra* (Robertson and Small 1977), are very few. It is now known that failure experienced by growers in seed germination is often due to initial nonviability of samples, or to use of inappropriate procedures for germination.

Dormancy is overcome and germination hastened in many plant species by scarification, exposure to light (sometimes of specific wavelength) or to ionizing radiations, cold or warm stratification, treatment with various growth substances and chemicals, or simple leaching with ordinary water. In order to devise the simplest and most appropriate procedures for large-scale production of different palms, mostly exotic to Nigeria, seeds were given different treatments to overcome their dormancy, or to hasten their germination.

* Work carried out while author was Chief Research Officer at the Nigerian Institute for Oil Palm Research.

Table 1. Optimum treatments for germinating seeds of different palms.

Species	Optimum Treatment
Aiphanes erosa	4 (100.0), 3 (97.0), 5 (96.6), 2 (93.5), 1 (93.3)
Archontophoenix alexandrae	2 (98.0), 3 (97.5), 1 (94.7)
Areca lynn	4 (100.0), 4 (100.0), 2 (90.0)
Arenga microcarpa	4 (85.7), 3 (80.0), 2 (74.3)
Butia capitata	3 + 5 (87.5)
Caryota mitis	4 (93.4), 1 (89.5)
Chrysalidocarpus lutescens	2 (100.0), 4 (100.0), 1 (86.6)
Dictyosperma aureum	1 (100.0), 4 (100.0), 2 (90.0)
Gaussia attenuata	4 (100.0), 1 (90.0), 3 (80.0)
Hyphaene schatan	3 (75.0), 4 (75.0), 5 (75.0)
Livistona rotundifolia	3 (96.3)
**Livistona* spp.	2 (100.0), 3 (100.0), 4 (100.0), 1 (90.0), 5 (90.0)
Phoenix acaulis	3 (91.5), 2 (86.3), 1 (85.3)
Phoenix dactylifera	2 (100.0), 3 (100.0), 1 (90.5)
Phoenix reclinata	3 (88.1)
Ptychandra glauca	4 (100.0), 3 (98.0), 1 (93.8)
Ptychosperma macarthuri	4 (96.0), 2 (88.0), 1 (83.2)
Ptychosperma sanderianus	3 (96.7), 2 (96.4), 1 (93.0), 4 (89.6)
Roystonea oleracea	3 (88.5), 1 (83.3)
Sabal palmetto	4 (100.0), 1 (89.5), 3 (86.9)
Syagrus romanzoffianum	4 (83.0)
Syagrus schizophylla	1 (100.0), 3 (100.0)
Thrinax parviflora	2 (85.0), 4 (83.0)
Veitchia merrillii	3 (100.0), 5 (100.0)
Verschaffeltia splendida	1 (100.0), 3 (92.0), 2 (83.3), 4 (83.3)

Numbers outside of brackets represent treatment numbers.
Figures in brackets represent mean germination percentages.
* Unidentified species.

Among the hormonal treatments only gibberellic acid gave consistent results with the exception of thiourea on *Thrinax parviflora*. In responding species gibberellic acid was not effective below 10 ppm. In *Aiphanes erosa*, and *Sabal palmetto*, gibberellic acid enhanced germination at 10 ppm and 25 ppm, but not at 50 ppm. In *Arecastrum romanzoffianum* on the other hand, the minimum effective concentration of gibberellic acid was 25 ppm.

Materials and Methods

Fruits were harvested at different stages from bearing palms. Mesocarp was removed by retting, scrubbing, and washing in tap water. In difficult cases where this process was unsatisfactory because of a fibrous, hard or relatively impermeable mesocarp (e.g. *Syagrus romanzoffianum* and *Latania* spp.), the latter was removed by scraping with a sharp knife. Indication of initial seed viability was obtained by bisecting nuts and placing (cut surface downwards) in a 0.5% solution of triphenyl tetrazolium chloride (TTC) in a dark cupboard for 24 hours. Palm nuts were given different regimes of the following treatments:

(1) Control: placement in 500 gauge translucent polyethylene bags at ambient temperature.
(2) Soaking in standing or running tap water for 1, 3, 5, 7, or 14 days.
(3) Warm stratification for 2, 4, or 6 weeks at ambient temperature (circa 27° C), 35° C, or 40° C in 500 gauge translucent polyethylene bags.
(4) Soaking overnight in different concentrations of dilute solutions of growth substances and chemicals including gibberellic acid (5, 10, 25, or 50 ppm

Table 2. Comparison of mean germination rates (m.g.r.) of some palm seeds under different treatments.*

Palm Species	Treatments and m.g.r. (in Parentheses)				L.S.D. between m.g.r.
Aiphanes erosa	10 ppm GA (16.3)	40° C for two weeks (19.4)	scarification (14.8)	Control (24.1)	3.6
Arenga microcarpa	10 ppm GA (28.4)	40° C for four weeks (31.0)	soaking in running water five days (39.3)	Control (44.7)	5.1
Hyphaene schatan	10 ppm GA (32.5)	38° C for four weeks (36.3)	scarification (18.9)	Control (50.6)	5.6
Phoenix acaulis	10 ppm GA (33.8)	40° C for two weeks (28.5)	soaking in running water five days (24.3)	Control (35.2)	4.8
Sabal palmetto	25 ppm GA (40.9)	40° C for four weeks (61.6)	scarification (36.7)	Control (60.5)	7.2
Phoenicophorium borsiqianum	10 ppm GA (25.7)	38° C for two weeks (42.8)	scarification (23.1)	Control (47.0)	3.5
Veitchia merrillii	10 ppm GA (43.4)	40° C for four weeks (29.5)	scarification (22.0)	Control (41.2)	8.6

* Mean germ rate = Mean no. of days to attain 50% of total germination.

Table 3. Comparative germination behavior of species in some palm genera.

Genus	Species	Treatment	Mean Lag†	Mean Germination %	Mean Germination Speed††	Mean Total Germination Period (Days)
Phoenix	*acaulis*	Soaking in water 5 days	16.5	85.8	24.3	81.8
	dactylifera		7.2	100.0	19.6	50.3
	reclinata		15.7	63.4	27.5	91.7
		L.S.D.	3.8	15.7	5.0	18.2
Phoenix	*acaulis*	40° C for 2 weeks	11.0	91.5	28.5	97.5
	dactylifera		8.3	100.0	20.2	52.1
	reclinata		11.0	88.1	21.0	34.0
		L.S.D.	2.2	10.7	3.1	14.5
Ptychosperma	*elegans*	Soaking in water 3 days	26.0	76.7	29.5	98.0
	macarthuri		24.7	90.4	30.0	86.7
	sanderianus		19.6	94.7	31.0	71.0
		L.S.D.	4.3	5.2	3.5	12.8
Sabal	*palmetto*	25 ppm. GA.	23.0*	92.6*	40.9**	75.1***
	texana		20.0	72.5	70.0	133.0

Key:
† Lag means time elapsed between completion of treatment and first visual observation of germination.
†† Speed represents time to attain 50% of total germination.
* Represents significant difference at the 5% level.
** Represents significant difference at the 1% level.
*** Represents significant difference at the 0.1% level.

of GA_3), ethrel (2 chloroethyl phosphonic acid at 5, 10, 25, or 50 ppm), potassium nitrate (0.5%, 1%, or 2%), thiourea (1%, 2%, 5%, or 10%), and ethylene chlorhydrin (5, 10, 25, or 50 ppm).

(5) Various degrees of scarification (removal of seed-covering structures such as endocarp) followed by surface sterilization with 0.05% $HgCl_2$/Teepol solution for 2 minutes.

(6) Exposure in 500 gauge polyethylene bags to continuous light from fluorescent tubes or to continuous darkness in a dark room.

Each treatment was replicated five times but the number of seeds per replicate depended on seed set and availability. One hundred seeds per replicate were used wherever sufficient quantities of seeds were available. In other cases fewer seeds were used, such as 50 seeds/replicate in *Dictyosperma aureum*, *Sabal palmetto*, and *S. texana*; and 20 seeds/replicate in *Butia capitata*. After appropriate treatment seeds were placed in 500 gauge translucent polyethylene bags at ambient temperature.

Records were taken of earliness to germinate, speed of germination, and total germination obtained.

Results

Highest viability was observed with TTC when fruits were harvested just ripe. This stage was observed by the coloration of the pericarp and by the falling of fruits when the healthy bearing palm was gently shaken.

There was no consistent relationship between palms and type of dormancy at the sub-familial level. However, at the generic level some palms appeared to have common dormancy or germination characteristics. Furthermore, in many species dormancy could be overcome by more than one method, but the best or simplest methods are summarized below (Table 1).

A comparison of Tables 1, 2, and 3 with results obtained by earlier investigators (Table 4) shows improved results for many species such as *Aiphanes erosa*, *Arikuryroba schizophylla*, *Livistona rotundifolia*, *Phoenix reclinata*, *P. acaulis*, *Ptychosperma macarthuri* etc. The methods outlined in Table 1 have been successfully applied to large-scale germination of the different palms at the Nigerian Institute for Oil Palm Research.

Discussion

Braun (1968) remarked that no plant family showed so many germination peculiarities as the palms. From these studies no single treatment was found that was equally satisfactory for all the different species of palms. On the contrary a wide variety of germination triggers is required to obtain satisfactory performance among the Palmae.

Seed dormancy and germination requirements have been considered as evolutionary adaptations to environment (Thompson 1972, Nikolaeva 1969). Exhibition of these characters underscores the success of the palms in different environments. This success has been well stressed by Corner (1966). Within the family there are species in which germination is accomplished by a wide variety of treatments, such as *Aiphanes erosa* in which excellent or satisfactory germination is provided by soaking in water, heat treatment, hormonal application, scarification, or simple placement in a polyethylene bag. On the other hand there were palms in which only one, or at most two different treatments resulted in removing dormancy or hastening germination. An example of these is *Butia capitata* in which the best result was obtained by a combination of heat treatment and scarification. Another interesting observation was that in some cases seed dormancy and the germination requirement appeared to be a generic property, whereas in others

Table 4. Comparison of germination data on palms by different investigators.

Palm Species	Germ %	Lag (Days)	Speed (Days)	Reference
Areca catechu	—	79	—	Loomis, H. F., 1958 *Principes* 2: 98–102
Areca sp.	29	22	—	Rees, A. R., 1963 *Principes* 7: 27–30
Arenga pinnata	4	27	—	Rees, A. R., 1963 *Principes* 7: 27–30
Arenga wightii	8	3	—	Rees, A. R., 1963 *Principes* 7: 27–30
Aiphanes erosa	—	115	—	Carroll, 1969 *Principes* 13: 109
Aiphanes erosa	67	4	—	Rees, A. R., 1963 *Principes* 7: 27–30
Bentinckia nicobarica	—	75	—	Loomis, H. F., 1958 *Principes* 2: 98–102
Butia capitata	—	142	—	Loomis, H. F., 1958 *Principes* 2: 98–102
Borassus flabillifer	65	—	35	Rees, A. R., 1963 *Principes* 7: 27–30
Chrysalidocarpus lutescens	—	31	—	Loomis, H. F., 1958 *Principes* 2: 98–102
Chrysalidocarpus lutescens	86	150	—	School, G. B., 1962 *Principes* 6: 118
Chrysalidocarpus lutescens	9	—	—	Rees, A. R., 1963 *Principes* 7: 27–30
Cocos nucifera	—	119	—	Loomis, H. F., 1958 *Principes* 2: 98–102
Caryota mitis	46	—	28	Rees, A. R., 1963 *Principes* 7: 27–30
Caryota mitis	—	135	—	Murrow, R. B., 1973 *Principes* 17: 64–66
Coccothrinax argentea	—	120	—	Murrow, R. B., 1973 *Principes* 17: 64–66
Dictyosperma aureum	—	75	—	Loomis, H. R., 1958 *Principes* 2: 98–102
Dictyosperma aureum	—	102	—	Kobernick, J., 1966 *Principes* 10: 4
Gaussia attenuata	—	43	—	Loomis, H. R., 1958 *Principes* 2: 98–102
Gaussia attenuata	—	25	—	Kobernick, J., 1966 *Principes* 10: 4
Livistona rotundifolia	—	67	—	Kobernick, J., 1966 *Principes* 10: 4
Phoenix reclinata	—	42	—	Loomis, H. F., 1958 *Principes* 2: 98–102
Phoenix reclinata	—	12	—	Kobernick J., 1966 *Principes* 10: 4
Phoenix acaulis	37	—	59	Rees, A. R., 1963 *Principes* 7: 27–30
Pinanga sp.	—	49	—	Carroll, 1969 *Principes* 13: 109
Pinanga sp.	—	140	—	Murrow, R. B., 1973 *Principes* 17: 16–64
Pinanga kullii	81	—	13	Rees, A. R., 1963 *Principes* 7: 27–30
Pritchardia sp.	—	46	—	Kobernick, J., 1966

Table 4. Continued.

Palm Species	Germ %	Lag (Days)	Speed (Days)	Reference
				Principes 10: 4
Ptychosperma macarthuri	57.1	90	—	School, G. B., 1962 *Principes 6: 118*
Sabal mauritiaeformis	—	55	—	*Braun, A., 1968* *Principes* 12: 5
Syagrus schizophylla	—	51	—	Kobernick, J., 1966 *Principes* 10: 4
Verschaffeltia splendida	—	38	—	Kobernick, J., 1966 *Principes* 10: 4
Veitchia merrillii	—	38	—	Kobernick, J., 1966 *Principes* 10: 4
Veitchia spp.	—	49	—	Carroll, 1969 *Principes* 15: 136
Thrinax argentea	63	—	30	Rees, A. R., 1963 *Principes* 7: 27–30

"Lag" represents period of time between treatment and first observation of germination.
"Speed" represents days to 50% of final germination.

only certain species of a genus had dormant seeds. There are also some genera such as *Ptychosperma* in which a single treatment accomplished germination of many species. In this genus soaking in water was satisfactory for *P. macarthuri* and *P. sanderianus* and to a lesser extent, *P. elegans*. Still, there are cases in which germination of seeds of different species of the same genus is promoted by different treatments. Kitzke (1958) gave the example of *Copernicia* in which prolonged soaking in water yielded excellent germination in fifteen species. However, in *C. alba*, soaking was ineffective, but germination was enhanced by scarification or use of sulphuric acid.

Many palm species have nondormant seeds and germinate readily without special requirements. When propagators find such seeds difficult, the problem is due to other factors. As De Leon (1958) pointed out many failures of germination attributed to poor practices were really due to low initial viability. This could be a consequence of harvesting unripe seeds, faulty storage or of collecting aged, desiccated, or unhealthy, immature, fallen fruits from palm bases. Little is known of precise storage requirements of many palm seeds, but the present studies confirmed that palm seeds are best harvested at the "just ripe" stage of the fruit. Indication of ripeness may be obtained by closely watching for changes in pericarp color or by the fall of fruits when palm is gently shaken. Test of initial seed viability of a sample with triphenyl tetrazoliun chloride solution may be helpful.

A comparison of results of the present work with those of earlier investigators (Table 4) shows tremendous improvement over earlier work. In some cases such as *Ptychosperma*, the more important improvement was in the shortening of the lag and total germination period. In others, total germination has been greatly increased through improved treatments. This is exemplified by results presented for *Areca*, *Chrysalidocarpus lutescens*, *Arenga*, etc. It should be noted however, that not all satisfactory treatments may be useful under all circumstances. For instance, scarification gives excellent results in *Aiphanes erosa*, *Hyphaene schatan*, *Livistona*, *Stevensonia grandifolia*, and *Veitchia merrillii*. However in large-scale or commercial production of

these species, the less tedious but slower methods of heat or hormone treatment may be preferable for economic reasons. The reasons for varied success of different germination treatments in different palm species were not investigated. Nevertheless, it seems likely that species which germinate well after prolonged soaking in water may have seed-covering structures that have low permeability to water. Those seeds that responded to prolonged soaking in running water (such as *Thrinax parviflora*) may contain water-soluble inhibitors. Species whose seeds germinate after scarification may have seed coats that act as mechanical barriers to embryo elongation, as the situation in the oil palm, *Elaeis guineensis* (Odetola and Kozlowski 1979). Further research is required, therefore, to elucidate the physiological basis for the responses of different palms to different germination treatments.

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