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Viability of kithul (*Caryota urens* L.) seeds with storage time

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Abstract

There is a myth among the farmers that Kithul seeds, only dropped by birds and small mammals with their excretion, germinate. The main reason for this myth is the inherent difficulty of germination in Kithul seeds with storage time. Many experiments proved a high percentage of seed germination when the seeds are sowed soon after separating from fresh fruits. In this study, an attempt is made to model the viability of the seeds with the storage time of the seeds. Two types of Kithul seeds were collected and stored for different periods and tested for germination. The findings revealed that there is no dormant period for Kithul seeds and viability continuously decreases with time according to a model fitted for the probit of the germination probability. This fitted model contains the constants: $K_i = 3.145$ the probit of the initial probability of germination and K_E, a specific constant for Kithul found as 2.90. Although this equation provided a better fit, the terms for the environmental temperature and seed moisture content are to be introduced for further improvement.

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Introduction

Kithul, *Caryota urens* L. is a monocotyledon multipurpose single-stemmed palm that belongs to the family Arecaceae. This palm grows 13-20m in height and up to 0.5m diameters. The stem is cylindrical. Large bipinnate leaves (6-7 m long & 3-5m broad), contain 10 -20 leaflets. Flowering occurs from top to bottom, inflorescence initiates from axils of leaves when the tree reaches full growth at the age of fifteen years or more (Gunaratne *et al.,* 1996). The world distribution of this species is mainly found in the Indian Subcontinent and Southeast Asia where they grow in fields and rainforest clearings (Loftus, 2000). This tree was first observed in Cambodia (Germplasm Resources Information Network, 2000). This palm naturally grows in home gardens, forest plantations, and natural forests in the wet and intermediate zones in abundance and little extent in the dry zones of Sri Lanka. In the year 2009, a total of 2,977, 261 trees are found in Sri Lanka. This population consists of 1,496,116 young trees, 906,886 middle-age trees, and 574,259 mature trees. Only 15.64% of the mature trees are being tapped for commercial purposes (Department of Census and Statistics, 2009).

The phloem sap is collected by tapping the inflorescence of kithul used to make jaggery (crystal sugar), vinegar, treacle, and a popular drink at the village level called toddy. The wood of Kithul is used as timber for construction works and fuel wood. The leaves are often used as fodder, especially, for elephants. Fiber obtains from the leaf base is used for making ropes and brushes (Karunanayke, 1994). The pith flour of mature kithul palms is dried and pounded for making sweets. Young palms are also used as ornamental trees and leaves are used in interior decoration. The roots are used for tooth ailments. The bark and seed on boils and tender flowers which contain medicinal properties are used for promoting the growth of hair. This tree has traditional medicinal values in treating urinary disorders, gastric ulcers, migraine headaches, snake bite poisoning, and rheumatic swellings (Gunaratne *et al.,* 1996). A survey conducted by the Forest Department of Sri Lanka (by the author) in the Kandy and Ratnapura districts of Sri Lanka revealed that sap yield of treated single inflorescence may vary from 0.4 liters to 48 liters per day and generally, Sri Lankan Rupees of 240,000.00 to 360,000.00 income can be obtained from a good yielding single tree per year. Therefore, this palm is considered as an important source to increase the income of the rural people. The attractive attributes of this palm and high-income potential make trees a suitable candidate for agroforestry systems and rural development programs, especially, in the wet and intermediate zones of Sri Lanka.

Kithul propagates by seeds and propagation of Kithul palm is not easy as other palms. The seed coat is very hard consisting of endosperm and this is covered with endocarp (inner hard layer). The seed coat of Kithul contains some substances which inhibit germination (Taiz and Zeiger, 2010). These issues with this seed create low germination rates, uneven germination, long-duration taken for germination due to hard seed are major problems in large scale commercial propagation of species (Hitinayake *et al.*, 2018).

All facts created a belief among rural farmers that Kithul seeds should pass through the digestive system of either polecat or palm civet, the two major distributing agents of Kithul seed.

This belief was proved to be wrong by an experiment conducted by the author at the Forest Research Centre, Sri Lanka in 2004. Kithul seedlings were produced easily from fresh seeds where germination begins without any treatment in a maximum of three weeks when suitable conditions are provided.

This finding is supported by the finding of Marcus and Banks (1999) that fresh seed, good sanitation, proper medium, proper hydration, and adequate heat are the most important conditions for the successful germination of palm seeds. Hertmann *et al.*, (2010) reported that the viability of the palm seeds gets reduced quickly within a very short time after harvesting. This finding leads to the question of the viability of the Kithul seeds with time. The information is vital for the establishment of commercially high-yielding Kithul plantations. Therefore, this research was carried out for evaluating the pattern of change of Kithul seed viability, over time.

Material and methodology

Study Site

This laboratory experiment was carried out in the Forest Research Centre of the Forest Department, Kumbalpola, Kurunegala, Sri Lanka located in the low country intermediate (IL1) agro-ecological region of Sri Lanka (Wijesinghe, 1979).

The daytime temperature varies between 22.8 – 31.7 °C and relative humidity vary between 48% - 99% in this region.

Collection of Seeds

Kithul fruits were collected from fully matured kithul inflorescence. Collected fruits were stored in poly bags for 5 days for ripening. After ripening, pericarps were removed by pressing the fruits, and seeds were taken out. These seeds were dried inside the plant house.

Selection of Seeds

There were two major types of seeds (Types A and B) in this collection based on external shape: Type A is the elongated globular shape and Type B is half globular and half flat. A sample of 2,500 healthy seeds was selected from each type.

Storage of seeds

Each type of seed was kept in trays at room temperature openly without giving any special storage conditions.

Treatments

One hundred seeds from each type of seeds were selected randomly in the time interval of 0, 8, 14, 21, 28, 35, 42, 50, 56, 64, 70,77, 84, 91, 98, 105, 113,119, 127 and 133 days after storage and tested for germination. Germination test was done by soaking the seeds for 24 hours in 1% Atonik solution. After 24 hours Atonik solution was filtered and tap water was added till the seeds submerge partially (1/3) as shown in Fig. 1. The water level was maintained by adding the required volume whenever necessary.

Fig. 1. Kithul Seeds prepared for germination.

Recording of observations

Germination percentages were recorded for each type of seed after the selected period of storage time.

Statistical Analysis

The germination rates for different storage periods were expressed in the probit of the germination. Many models were tried to model the probit of the germination against the storage time.

The adequacy of the fitted models was tested using residual plots and adjusted R^2 values. The paired t-test was employed to compare the germination between the type of seeds across the number of days of storage.

These results clearly indicate that there is no dormant period for kithul seed germination and the germination rate is maximum just after removing from the fruit. The viability of the seeds continuously decreasing according to the model

$$V = 3.145 - \frac{1}{e^{2.90}} D.$$

The probability of germination after D days (P_D) can be estimated using the equation

$$P_D = \frac{e^{\left(3.145 - \frac{1}{e^{2.90}} D\right)}}{1 + e^{\left(3.145 - \frac{1}{e^{2.90}} D\right)}}.$$

For example, the estimated probability of germination after 26 days of storage can be obtained as:

$$P_D = \frac{e^{\left(3.145 - \frac{1}{e^{2.90}} \times 26\right)}}{1 + e^{\left(3.145 - \frac{1}{e^{2.90}} \times 26\right)}} = \frac{e^{1.71}}{1 + e^{1.71}} = \frac{5.553}{6.553} = 0.847.$$

After 57 days of storage, the germination becomes 50%. Therefore, storing Kithul seed for a long time is not possible and some techniques are to be explored for keeping the viability of the seed for a long period. The forecasted model for finding the germination is not perfect here without introducing the variables of Temperature and seed moisture content. This research further extended for different environmental temperatures and seed moisture content. Then the term K_E can be further extended to

$$K_E = K_A - C_W \ln(SFG) - C_H T - C_Q T^2$$

Where,

$T = Temperature\ in\ ^{o}C$

$SFG = Seed\ moisture\ content\ in\%$

$C_W, \quad CH, C_Q = Specific\ constants\ for\ Kithul$

As given by Kraak and Vos (1987) for modelling the viability of the Lettuce but the values for constants are to be Estimated.

Results and discussion

Table 1 below shows the germination of seed for both types of seed and the average germination percentages. A paired t-test to compare the germination between the type of seeds across the number of days of storage revealed that there is no significant difference in germination percentage between the seed type across the storage period (T-Value = 0.59, P = 0.567). Therefore, the germination for seed types A and B can be combined to explore the viability of the seeds over the storage time. Fig. 2 shows the germination rate over the storage period in days.

Table 1. Germination of seeds with storage time.

Storage Time in days	Number of Germinated seeds in Type A (out of 100)	Number of Germinated seeds in Type B (out of 100)	Average Germination%
0	98	97	97.5
8	82	86	84.0
14	94	91	92.5
21	86	88	87.5
28	71	71	71.0
35	86	80	83.0
42	69	70	69.5
50	75	71	73.0
56	65	60	62.5
64	21	20	20.5
70	32	30	31.0
77	48	52	50.0
84	27	29	28.0
91	29	29	29.0
98	2	4	3.0
105	3	3	3.0
113	0	0	0.0
119	0	0	0.0
127	0	0	0.0
133	0	0	0.0

From Fig. 2, it can be realized that the probability of germination after D days of storage (P_D) is decreasing with increasing storage time (D). A best-fitting model was found to express the pattern of decrease in the P_D with D as:

$$V_D = ln\left(\frac{P_D}{1-P_D}\right) = K_i - \frac{1}{e^{k_E}} D$$

Where,

$V_D = The\ probit\ of\ the\ germination\ at\ storage\ time\ D$

$K_i = Initial\ germination\ in\ probit$

$K_E = Specific\ germination\ constant\ for\ Kithul$

$D = Storage\ period\ in\ Days$

The values found for the constant are

$K_i = 3.145$

$K_E = 2.90.$

The residual plot was examined for any serious deviation between the fitted model and the real observation and no such deviations were found. This model has an adjusted R^2 of 86.2% and that implies the 82% of the variations in the probit of the germination can be explained by this model. From this model, it is obvious that the germination percentage of Kithul seeds decreases unusually not like the seeds of rice or mango. Fig. 3 compares the fitted model and the real observations.

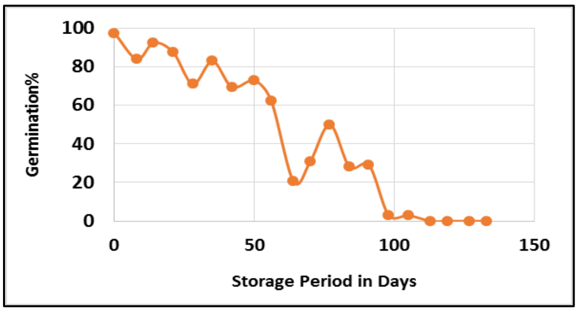

Fig. 2. Germination rate over the storage period.

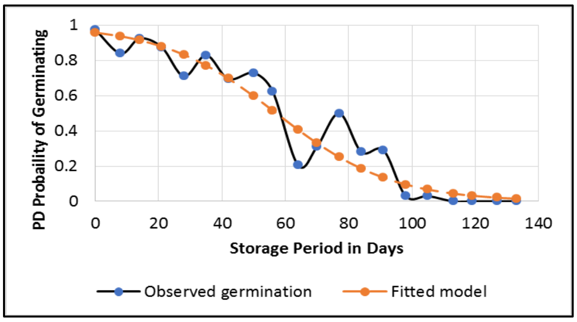

Fig. 3. Probability of germination with storage time.

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