CORD Vol. VIII No. 1 1992

COCONUT GENETIC RESOURCES

by

Dr. M K NAIR*

I. Origin of Coconut

It is presumed that the generic name, Cocos as well as the popular name coconut are derived from the spanish word 'coco' meaning 'monkey face' probably a reference to the three scars on the base of the shell resembling a monkey's face (Rosengarten, 1984). The origin of coconut was placed by Martius (1850) on the West Coast of Central America near the Isthmus of Panama. On the basis of evidences for the cultivation of coconut in Sri Lanka by about 300 BC, as well as the discovery of a fossil (Pliocene) Cocos in Newzealand (Hill, 1929) and in the deserts of Rajasthan (Kaul, 1951) the theory of Central American origin has been contested. Early spanish explorers discovered the cultivation of coconut on the Pacific Coast of Panama in pre-Columbian times. The first report of appearance of coconut in Western Mexico came around 1540 AD and it is believed to have spread to Mexico in the last decade of the 16th century (Bruman, 1945). It is presumed that coconut might have been carried to Mexico by ocean currents from Polynesia before the discovery of the New World (Purseglove, 1972). The available evidences point to the domestication of coconut in the Indo-Pacific area (de Candolle, 1886; Beccari, 1917; Vavilov, 1951; Corner, 1966; Child, 1974). According to the most widely accepted theory, the origin of coconut is in the Old World, somewhere in Southeast Asia or the Pacific Islands from where it might have been transported to other regions either by man or by sea currents. Evidences are available in literature regarding the germination capacity of coconut even after floating in the sea for a period of 110 days and within this period it is capable of travelling up to 4900 kilometers (Edmondson, 1941). It indicates the possibility of natural dissemination between the islands in the Pacific and Indian Oceans (Harries, 1978).

II. Genetic Variability and Varieties

Tall and dwarf are the two distinct varieties of coconut. The tall palms, sometimes referred as var. *typica* Nar., are the most commonly cultivated in all the coconut growing areas the world. Tall palms generally grow to a height of 25-30 m and have a comparatively long pre-bearing age of 6-10 years. They are normally cross-pollinated as there is usually no overlapping of male and female phases. Fruit is generally medium to large in size and the nuts mature within a period of 12 months. West Coast Tall, Lakshadweep Ordinary, East Coast Tall and Andaman Ordinary are some of the distinct tall types present in India.

---

* Director, Central Plantation Crops Research Institute Kasaragod - 671 124, Kerala.

Dwarf palms, sometimes referred to as var. *nana* (Griff.) Nar., are characterised by their short stature. They are quicker to come to bearing (3-4 years), are easier to harvest and are short-lived. They have thin trunks without a swollen base or 'bole' and the fully developed fronds rarely exceed 4 m. Though the dwarf palms yield heavily, they have a tendency to irregular bearing. Dwarfs are identified mainly by the colour of their nuts. They are presumed to have originated from tall palms either through mutation (Menon and Pandalai, 1958) or by inbreeding in talls (Swaminathan and Nambiar, 1961). In India, two important dwarf types found are Chowghat Green Dwarf and Chowghat Orange Dwarf mainly described by the colour of their nuts and petiole. In the case of talls, the copra content is usually over 150 g/nut, while in dwarfs it ranges from 90 g to 120 g/nut. The oil percentage varies from 66-70 in talls and is about 65 in dwarfs.

In India, in addition to these two groups, there are few other distinct type such as Lakshadweep Micro, Kappadam, Andaman Giant, Calangute, Nadora and Benaulim which are talls, and Gangabondam a dwarf from Andhra Pradesh. Ramachandran et al. (1977) reported Ayiramkachi an intermediate type between tall and dwarf in Tamil Nadu. Different tall and dwarf cultivars have also been identified from Orissa (Panda, 1982).

III. Collection and Conservation

Systematic research on crop improvement programme in coconut was perhaps started first in India in 1916. The earliest exotic introductions into India were in 1924 from the Philippines, Malaysia, Fiji, Indonesia, Sri Lanka and Vietnam which formed the nucleus population for many of the research programmes. The germplasm exchange programme was further intensified in 1952 and in 1958 surveys for collection of indigenous germplasm was started.

At present, the Central Plantation Crops Research Institute, Kasaragod is maintaining the World's largest assemblege of germplasm of 40 indigenous and 86 exotic cultivars. The exotic collections from 22 countries of South and South East Asia, Caribbean Islands, Indian Ocean Islands, Pacific Ocean Islands and African countries comprise of 72 talls, 12 dwarfs, one semi tall and one hybrid (Table 1A). These include the collection made by a team of two scientists from CPCRI based on a survey in seven Pacific Ocean Territories during 1981. The purpose of the survey was to collect and conserve coconut germplasm with a view to screening for their reaction to root (wilt) disease prevalent in 8 southern districts of Kerala. The collections were made using the descriptor approved by the IBPGR (1978) and all the tall cultivars were sampled randomly and the dwarf cultivars sampled on

Table 1A COCONUT GERMPLASM ACCESSIONS AT CPCRI (Kasaragod and Sipighat)

A. Exotic accessions.

Source of collection	No. of access-ions	Sl. No.	Name of cultivar	No. of palms	
				Talls	Drawfs
1	2	3	4	5	6
SOUTH EAST ASIA					
I. Borneo	3	1	Borneo	20	-
		2	Kongthienyong	8	-
		3	Standard Kudat	13	-
II. Indonesia	1	4	Java	24	-
III. Malaysia	8	5	Malayan Orange Dwarf	-	26
		6	Malayan Yellow Dwarf	-	40
		7	Malayan Green Dwarf*	-	37
		8	Malayan Tall	2	-
		9	F.M.S.	22	-
		10	Klapawangi	9	-
		11	S.S. Green	30	-
		12	S.S. Apricot	14	-
IV. Philippines	7	13	Phil. Ordinary	28	-
		14	Phil. Laguna	6	-
		15	Phil. Kalambahim	2	-
		16	Phil. Lono	13	-
		17	Phil. Palawan	3	-
		18	Phil. Dalig	8	-
		19	San Ramon	56	-
V. Vietnam	1	20	Cochin China	26	-

*Semi Tall

1	2	3	4	5	6
PACIFIC OCEAN					
VI. Papua New guinea	9	21	New Guinea	41	-
		22	Markham Tall	12	-
		23	Karkar	14	-
		24	Dwarf spikeless	-	3
		25	New Guinea I (Kiriwana)	37	-
		26	New Guinea II (Tall Muwa)	47	-
		27	New Guinea III (Nikkore)	-	31
		28	New Guinea IV (Kavieng)	28	-
		29	New Guinea V (Natava Tall)	55	-
VII. New Caledonia	6	30	Nufella	5	-
		31	Nugili	7	-
		32	Nuwallis	2	-
		33	Nu Que Wen	4	-
		34	Nuwe Hung	5	-
		35	Nuhimi Kupin	2	-
VIII. New Hebrides	1	36	New Hebrides Tall	1	-
IX. Tonga Islands	3	37	Niu Ui	43	-
		38	Niu Taukave	9	-
		39	Niu Hako	83	-
X. Fiji Islands	9	40	Fiji Ringed Nut	1	-
		41	Fiji Longtongwan	7	-
		42	Fiji Rotuma	30	-
		43	Fiji Tall	44	-
		44	Niu Leka	-	13
		45	Waini Gata	58	-
		46	Niu Drau	22	-
		47	Fiji III (Niu Leka-II)	-	71
		48	Niu Bulavu	53	-

1	2	3	4	5	6
XI. American Samoa	3	49	Tutiala	58	-
		50	Niu Oma	-	10
		51	Samoan Tall	27	-
XII. French Polynesia	7	52	Mataica	30	-
		53	Pao Pao	45	-
		54	Haepiti	34	-
		55	Bora Bora	10	-
		56	Hari Papua	-	24
		57	Rangiroa Tall (Avatoru)	19	-
		58	Tiputa	10	-
Guam	3	59	Guam I	8	-
		60	Guam II	8	-
		61	Guam III	3	-
Lifou	1	62	Lifou Tall	10	-
Solomon Islands	3	63	B.S.I.	13	-
		64	Solomon Tall	3	-
		65	Rennel Tall	2	
CENTRAL AMERICA, SOUTH AMERICA AND ATLANTIC REGION					
Surinam	2	66	Surinam Tall	7	-
		67	Surinam Dwarf	-	5
Jamaica	2	68	Jamaica Tall	8	-
		69	Jamaica Sanblas	28	-
Trinidad	2	70	St. Vincent	16	-
		71	Blanchissuse	11	-
Panama	1	72	Panama Tall	5	-

Thus, From-Lab-to-Farm is a useful work-a-day motto which underlines the needed cooperation as a basis for effective collaboration of efforts between Research and Extension. As such, it should serve as a practical guide in ensuring that the relevant research findings, ideas and knowledge reach, and are used by, the farmers.

Lab and farm should meet.

NOTES AND REFERENCES

1. For detailed discussion on this see P.A. Muma, the Therapy of Distance : The Human Face of Economics, Paper delivered at the Development Studies Association Conference, University of Oxford, Queen Elizabeth House, Oxford, Vol. 14, England, September 1981; See also Patrick A. Muma, Economics and Development : A Third World View, in Journal of Pacific Studies U.S.P. 1988; and Dudley Seers, The Limitations of the Special Case, Bulletin of Oxford University Institute of Statistics, 1968.

2. Michael Lipton Theory of the Optimising Peasant, Occasional Paper Series, Institute of Development Studies, University of Sussex, 1968.

3. Maria Paulo : Coconut based Farming Systems in Fiji, Sumith de Silva (ed.), Coconut based Farming Systems : Proceedings of the XXVII Coco-tech Meeting, 1990.

4. Maria Paulo, op.cit. p. 137.

5. K.V.A Bavappa, Management of Coconut based Farming Systems, in Sumith de Silva (ed.) op. ct p. 493

6. Prafulla K. Das, Economics of Coconut based Farming Systems, in Sumith de Silva (ed.) op.cit, p. 539.

7. P.K. Das, op. cit.

Table 1B. Indigenous accessions.

1	2	3	4	5	6
Kerala	6	1	Chowghat Orange Dwarf	-	84
		2	Chowghat Green Dwarf	-	36
		3	Kaithathali	1	-
		4	Kappadam	14	-
		5	Spicata	19	-
		6	West Coast Tall	77	
Tamil Nadu	8	7	Adirampatnam	1	-
		8	Ayiramkachi	18	-
		9	Kulasekharam Green Dwarf	-	55
		10	Kulasekharam Orange Dwarf	-	30
		11	Kulasekharam Yellow Dwarf	-	50
		12	Pattukottai Green Dwarf	-	4
		13	Pattukottai Red Dwarf	-	1
		14	East Coast Tall	35	-
Karnataka	2	15	Kenthali	-	4
		16	Tiptur Tall I	4	-
Andhra Pradesh	5	17	Gangabondam	-	44
		18	Gangabhavani	2	-
		19	Gangapani	5	-
		20	Rangoon Kobbari	9	-
		21	Verrikobbari	4	-
Goa	3	22	Benaulim	13	-
		23	Calangute	10	-
		24	Nadora	11	-
Gujarat	1	25	Gujarat Zanzibar	9	-
Orissa	1	26	Sakhi Gopal	7	-

1	2	3	4	5	6
Andamans	11	27	Andaman Ordinary	34	-
		28	Andaman Giant	25	-
		29	Andaman Ranguchan	19	-
		30	Andaman Dwarf	-	5
		31	Carnicobar	58	-
		32	Auck Chung	36	-
		33	Tamaloo	36	-
		34	Kimos	36	-
		35	Kimmai	36	-
		36	Katchal	35	-
		37	Campbell Bay	34	-
Lakshadweep	3	38	Laccadive Ordinary	76	-
		39	Laccadive Micro.	37	-
		40	Laccadive Orange Dwarf	-	2
			Talls	29	-
			Dwarfs	-	11
			Total	40	

Germplasm collections are also being maintained at twelve centres under the All India Co-ordinated Research Projects on Palms (Table 2).

Table 2 Coconut germplasm available in the Co-ordinating Centres

S.No.	Centres	Exotic	Indigenous	Total
1.	Aliyarnagar	13	6	19
2.	Ambajipet	6	5	11
3.	Arsikere	11	2	13
4.	Andamans	-	8	8
5.	Coimbatore	2	5	7
6.	Jagadalpur	11	5	16
7.	Jalalgarh	11	5	16
8.	Konark	11	2	13
9.	Mondouri	11	1	12
10.	Pilicode	28	34	62
11.	Ratnagiri	11	6	17
12.	Veppankulam	15	15	30

As most of the exotic types available at CPCRI have been assembled through germplasm exchange, data on the site of collection and source characters are not available. The recording is confined to appropriate entry in the Introduction Register giving details about the source, country of origin and local names. The local names are mostly derived based on fruit colour (green, yellow, orange etc.) bearing capacity (e.g. Ayiramkachi-1000 nuts), size of nut (e.g. Kappadam-big nut), leaf characteristics etc. In some cases the name indicates the secondary source of introduction (Gujarat - Zanzibar, Kulasekharam - Malayan Dwarf etc.) (Rao and Nayar, 1980).

IV. Documentation of Coconut Germplasm

The IBPGR Consultation on Coconut Resources held in January, 1978 at FAO Headquarters identified a minimum list of descriptors to be used in collecting the field data (IBPGR, 1978). The IBPGR descriptor list is mainly based on the descriptor made available by CPCRI and includes information on collection, evaluation, maintenance and occurrence of diseases.

V. Evaluation

1. Nursery evaluation

Descriptors used for evaluation at the nursery stage fall into two categories i.e. identifier and actual measurements. The local name and accession number fall into first category. The number of days for germination, leaf length, leaf width, girth at collar and leaf showing first splitting fall into the second category.

2. Juvenile stage evaluation

From the time the seedlings are transplanted into the field, the palm number has an important role as the identification is based on this number. As there is a time lag of 15-20 years between the initial introduction and final yield evaluation, it is absolutely necessary to maintain the individual identity within the accession for any numerical evaluation. The data on leaf production, leaf length, increment in girth and other growth parameters are recorded in the juvenile stage (before flowering - 5-6 years old).

3. Agronomic evaluation:

Three registers are used for recording the data collected from the time the palm starts bearing. The Flowering Notes Register includes description on duration of male phase, duration of female phase, female flower distribution, length of peduncle, number of inflorescences produced and abortion of bunches. The Harvest Register (Yield Register) includes the mean number of female flowers per bunch, number of nuts harvested, and setting percentage. The Nut Characters Register includes data collected from nut analysis, fruit shape and nut shape (qualitative descriptors) and weight of fruits, nut and nut without water, meat (kernel) and copra (at 6% moisture content) (IBPGR, 1978).

Evaluation of coconut germplasm is a long drawn process due to its long juvenile phase and also time taken for stabilisation of yield. For evaluating at the nursery stage, seedling characters such as the sprouting period of seed nuts, number of leaves, girth at collar and seedling height are generally used (Satyabalan and Mathew, 1976). Most of these characters have correlation with the adult palm bearing. An index was developed by Rao and Mathew (1981) using mean and CV of these characters for evaluation and characterisation of coconut germplasm at the nursery stage. Usually the performance of cultivar is evaluated against the local material only after stabilisation of yield which may take 15-20 years after planting. However, Rao, Satyabalan and Mathew (1978) found that it is possible to evaluate the germplasm accession at an early stage as the cumulative yield of first eight years had high correlation ($R^2 = 0.95$) with the stabilised yield.

Among the exotic cultivars Fiji Tall, Fiji Longtongwan from Fiji Island, Philippines Ordinary Philippines Laguna from Philippines and Strait Settlement Green (SS Green) from Malaysia are superior to the local cultivar West Coast Tall, yielding over 30 per cent more nuts and 80-114 per cent more copra. Among the indigenous cultivars Kappadam, Andaman Ordinary and Lakshadweep Ordinary have higher yield potential than the local West Coast Tall. The performance of promising cultivars of exotic and indigenous origin in given in Table 3.

Table 3 PERFORMANCE OF PROMISING COCONUT CULTIVARS AT CPCRI, KASARAGOD

Cultivar	Mean Yield of nuts/palm/year (17-20 years)		Copra yield		
	No.	% over WCT	*Nut (gm)	Palm/year (kg)	% over WCT
Exotic					
1. FIJI TALL	106	55.9	179	19.0	86.3
2. FIJI LONGTONWAN	104	52.9	210	21.8	113.7
3. PHILIPPINES ORDINARY	108	58.8	198	21.4	109.8
4. PHILIPPINES LAGUNA	88	29.4	209	18.4	80.4
5. S.S. GREEN	108	58.8	189	20.4	100.0
INDIGENOUS					
1. KAPPADAM	90	32.4	299	26.9	163.7
2. ANDAMAN ORDINARY	94	38.2	169	15.9	55.9
3. LACCADIVE ORDINARY	98	44.1	169	16.6	62.7
4. WEST COAST TALL	68	-	150	10.2	

* Source : PLACROSYM - V, 1982 pp. 112-124

Based on the overall performance in the four co-ordinating centres in Andhra Pradesh, Tamil Nadu, Karnataka, Maharashtra and at CPCRI Kasaragod, Lakshadweep Ordinary has been recommended for release under the name 'Chandra Kalpa'. This cultivar gave 33% more yield in terms of nuts and 30% more copra yield at stabilised bearing period (Anonymous, 1985). Recently, Banawali Green Round with a mean number of 151 nuts and copra out turn of 22.8 kg has also been released.

The classification system based on fruit component analysis (Harries, 1978) and time taken for germination were adopted by Rao and Pillai (1982) to identify the degree of introgression in 40 accessions.

Rajagopal, Kasturibai and Voleti (1990) screened ten talls and six dwarf cultivars for the tolerance to drought using the sensitive parameters namely stomatal resistance (rs), leaf water potential (Ψ) and epicuticular wax content (ECW). They observed that the coconut genotypes have varying response to the prevailing soil and atmospheric droughts during the summer months. In June, tall genotypes had relatively high rs,(Ψ) and ECW as compared to the dwarfs. They concluded that it is possible to identify desirable drought tolerant characters in coconut genotypes under field conditions.

Studies on identifying coconut genotypes resistant/tolerant to root (wilt) disease were initiated by Varghese in 1934. Starting from 1961 CPCRI Regional Station Kayangulam has made considerable efforts to screen the available cultivars for their tolerance to root (wilt) disease (Menon, Thommen and Sukumaran, 1981). Large scale field experiments were undertaken during 1972 in CPCRI Regional Station, Kayangulam and also in cultivators' garden in 63 villages of Alleppey, Quilon and Kottayam districts. Further screening trial involving 27 cultivars were laid out in cultivators' garden during 1982. Twenty-four exotic accessions collected from South Pacific Ocean Islands during 1981 are under evaluation at the CPCRI World Coconut Germplasm Centre, Sipighat in Andamans. Inter-se and selfed seed nuts are being produced from these accessions and the first batch of seedlings from these source were planted in the 'hot spot' areas for screening for resistance/tolerance to root (wilt) disease. Thirty five West Coast Tall high yielding palms were identified based on intensive survey covering heavily diseased tracts ('hot spots') of Alleppey, Kottayam, Quilon and Pathanamthitta districts. These palms were confirmed to be disease free based on serological and physiological tests and these palms are being utilized in breeding programme to evolve the resistant/tolerant varieties in root (wilt) disease (Jacob and Rawther, 1991).

Future Strategy

Screening work undertaken so far has indicated that tolerance to root (wilt) disease is not available among the germplasm accessions evaluated so far. The fact that coconut belongs to a monotypic genus also limits the possibility of tapping gene pools from related species. As indicated earlier most of the exotic collections were assembled through exchange programmes and limited sample size collected from very few individual palms. In view of this, broadening the genetic base through collections from Melanasia, Micronesia and Indian Ocean Islands, which are known to have wide variability should receive top priority. Among the indigenous collections representative samples are not available from Orissa, West Bengal and North Eastern regions.

It is necessary to have a sizeable population (minimum 10 palms per accession) of the collections maintained preferably at more than one location. Maintenance of a duplicate set would help in meaningful evaluation and also as a standby in case of a disease outbreak. The size of seednut imposes serious limitations in sample size and transportation involving exotic germplasm collection.

Embryo culture technique has been standardised in coconut and this can be effectively used for the future germplasm collection. However, further studies in embryo collection procedure, response in relation to age and storage periods, medium for maintaining the embryo during transit, and procedure involved in field planting are needed.

REFERENCES

ANONYMOUS, 1985. gn Proc. of the Seventh Workshop on All India Co-ordinated Coconut and Arecanut Improvement Project, Nov., 6-9, 1985, Trivandrum. pp-160.

BECCARI, O. 1919. The Palms of the Philippines Islands. Philp. J. Sci. 14 : 295-362.

BRUMAN, H.J. 1945. Early coconut culture in Western Mexico, Hispanic American Historical Review, 25 : 212-23.

CHILD, R. 1974. Coconuts (2nd Edition). Longman Group Ltd. London, 335 pp.

CORNER, E.J.H. 1966. The Natural History of Palms. Weidenfeld and Nicolson, London, 393 pp.

de CANDOLLE, A. 1886. Origin of Cultivated Plants. Hafner Publishing Co., New York, 428 pp.

EDMONDSON, C.H. 1941. Viability of coconut seed after floating in sea. Occasional papers of Bernice. P. Bishop Museum. Honolulu, Hawaii, 16 : 293-304

HARRIES, H.C. 1978. The evolution, dissemination and classification of Cocos nucifera L. Bot. Rev. 44 : 265-319

HILL, A.W. 1929. The original home and mode of dispersal of the coconut, Nature, 124 : 133-134, 151-153.

IBPGR, 1978. Coconut genetic resources. IBPGR report, AGPE/ IBPGR/784. 24 pp. Secretariat, Rome.

JACOB, P.M. and RAWTHER, T.S.S. 1991. Varietal resistance, pp. 67-71. In : Coconut root (wilt) disease (Ed. Nair, M.K. et al.,) Central Plantation Crops Research Institute, Kasaragod. 92 pp.

KAUL, K.N. 1951. A palm fruit from Kapurdi (Jodhpur, Rajasthan desert) Cocos sahnii sp., Curr. Sci., 20 : 138.

MARTIUS, C.F.P. 1850 (1823-50). Historia Naturalis Palmarum 3. Munich.

MENON, K.P.V. and PANDALAI, K.M. 1958. The Coconut Palm - a monograph. Indian Central Coconut Committee Ernakulam. pp. 384.

MENON, K.S., THOMMEN, K.J. and SUKUMARAN, A.S. 1981. Varietal resistance studies. In Review of Research on Coconut root (wilt) disease. Central Plantation Crops Research Institute, Kayangulam. pp. 78-82 (Mimeographed).

PANDA, K.C. 1982. Coconut types of Orissa. Indian Coconut J. 13 : 10-18.

PURSEGLOVE, J.W. 1972. Tropical Crops - Monocotyledons - Longmans Group Ltd., London, 607 pp.

RAJAGOPAL, V., KASTURIBAI, K.V. and VOLETI, S.R. 1990. Screening of coconut genotypes for drought tolerance. Oleagineux, 45 (5) : 215-223.

RAMACHANDRAN, M., MURALIDHARAN, V.N. and BALASUBRAMANIAN, K. 1977. A note on the new coconut variety Ayiramkachi, Indian Coconut J., 8 : 4-6.

RAO, E.V.V.B. and KOSHY, P.K., 1982. Coconut Germplasm Collection in Pacific Ocean Islands. Deputation Report. (Mimeographed), pp. 47. Central Plantation Crops Research Institute, Kasaragod.

RAO, E.V.V.B. and MATHEW JACOB, 1981. An index for evaluation of coconut germplasm in the nursery. PLACROSYM IV : pp 200-205.

RAO, E.V.V.B. and NAYAR, N.M. 1980. Documentation of coconut germplasm. Workshop on Documentation of Genetic Resources, New Delhi. pp. 5 (Mimeographed).

RAO, E.V.V.B. and PILLAI, R.V. 1982. Characterization of coconut germplasm based on fruit component analysis. PLACROSYM V pp. 112-124.

RAO, E.V.V.B., SATYABALAN, K. and MATHEW JACOB. 1978. Evaluation of ten cultivars of coconut germplasm. Abstracts of papers presented at the All India High Level Symposium Researches in Plant Cytogenetic at Andhra University, Waltair, India, 9-12 Feb. 1978. pp. 9.

ROSENGARTEN, F. (Jr.) 1984. The Book of Edible Nuts. Walker and Company, New York, 384 pp.

SATYABALAN, K. and MATHEW JACOB. 1976. Identification of prepotent palms in West Coast Tall coconuts based on the early stages of growth of the progeny in the nursery. In Coconut Research and Development pp. 15-22. Wiley Eastern Limited New Delhi.

SWAMINATHAN, M.S. and NAMBIAR, M.C. 1961. Cytology and origin of the dwarf coconut palm. Nature 192 : 85-86.

VARGHESE, M.K. 1934. Diseases of coconut palm. Supdt. Govt. Press, Trivandrum. pp. 105.

VAVILOV, N.I. 1851. The origin, variation, immunity and breeding of cultivated plants. Chronica Botanica, 13 : 1-366.