A ROOT (WILT) DISEASE RESISTANT COCONUT HYBRID AND STRATEGY FOR RESISTANCE BREEDING

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The coconut root (wilt) disease reported over a century ago from Erattupetta in Kottayam district, Kerala has slowly spread to eight southern districts of Kerala to an extent of 0.41 million hectares and causes an estimated yield loss of 968 million nuts annually (Anon, 1985). It is also seen sporadically in the northern districts of Malappuram, Kozhikode and Cannanore districts of Kerala State suggesting the spreading nature of the disease. Systematic investigations over a period of five decades have ruled out the role of any physiological/nutritional disorders as the primary cause of the disease. The role of biotic agents like fungi, bacteria, nematodes and virus like particle has been ruled out after thorough investigations. Solomon *et al.* (1983) established Mycoplasma-like organisms (phytoplasmas) MLOs etiology in the disease based on the following evidences.

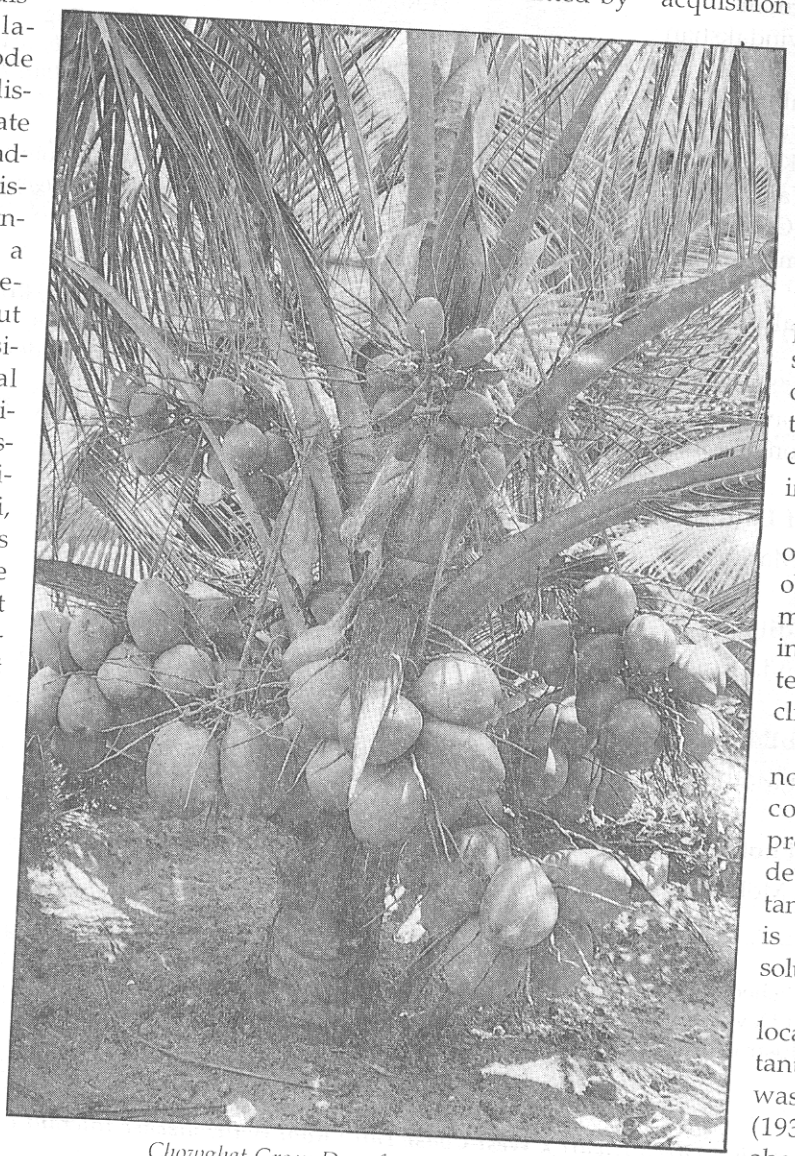
(i) The electron microscopic studies revealed the presence of MLOs in sieve tubes of roots, tender stems, petioles and developing leaf bases of diseased palms and MLO's were conspicuously absent in the tissues of healthy palms from disease-free areas.

(ii) Transmission studies in controlled condition established that the disease is transmitted by an insect lace bag, *Stephanitis typica*. The disease was transmitted to healthy coconut seedlings kept under insect proof conditions by inoculating with insect vectors that were allowed to feed on disease affected palms and released on healthy palms after a period of acquisition and incubation. MLO's were detected in the salivary glands of vectors as well as tissues of infected seedlings. The characteristic symptom expression in inoculated palms and their absence in uninoculated healthy palms kept under insect proof cages conclusively proved transmission of the disease through the insect vector.

(iii) Further proof of MLO etiology was obtained through remission of symptoms in diseased palms after injecting tetracycline hydrochloride.

As the disease cannot be controlled by conventional plant protection measures, development of resistant/tolerant varieties is the only practical solution to this disease.

The first attempt to locate root(wilt) resistant varieties in India was that of Varghese (1934) who surveyed about 4 sq. miles of highly diseased area in and around



Chowghat Green Dwarf x West Coast Tall - Root (wilt) disease tolerant coconut hybrid

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Kayangulam. Among 60545 palms observed by him 59.4 per cent were disease affected. Though he attempted to relate tolerance with nut colour he could not come to any positive conclusion. Menon, Thommen and Sukumaran (1981) based on a series of trials conducted from 1951-1968 observed that open pollinated progenies of healthy palms selected from disease endemic areas had higher yield and lesser disease incidence than progenies of disease affected palms. Healthy and high yielding palms among thousands of severely affected palms were observed by Davis (1953) and he suggested the need for selecting such palms for breeding for resistance to root (wilt) disease.

Screening of available coconut germplasm by planting the seedlings in the disease affected farm at CPCRI Regional Station, Kayangulam was initiated in 1961. However all of them developed characteristic symptoms of the disease at various intervals after planting (Menon, Thommen and Sukumaran, 1981). Davis (1979) suggested the need of large scale planting of Malayan Yellow Dwarf (MYD) in root (wilt) affected areas, since the cultivar was reported to be tolerant to Lethal Yellowing disease in Jamaica (Harries, 1973).

Large scale field experiments for screening, was laid out at CPCRI Regional Station, Kayangulam and also in and around Kayangulam in cultivators' field starting from 1968 to test 36 cultivars and 53 hybrid combinations in different soil types for their reaction to root (wilt) disease. However, in subsequent years all of them contracted varying intensities of the disease. Iyer *et al.* (1979) conducted a survey of natural population in root (wilt) disease affected areas during the period 1977-1981 to identify elite super palms exhibiting high yielding potential. Open pollinated seednuts from these palms were raised and planted in root (wilt) disease affected areas. But all of them took up the disease in subsequent years.

It was with this background a group meeting was called at CPCRI, Kasaragod in April 1987 to evolve a programme for breeding for tolerance/resistance to root (wilt) disease. The project finalised at the meeting and initiated during the same year had the following technical programme.

1. Survey and identification of elite disease-free West Coast Tall and Chowghat Green Dwarf (CGD) in hot spot areas.

2. Screening the selected palms serologically and histochemically to establish absolute freedom from MLO's and thereby from root (wilt) disease.

3. Production of *inter se* WCT seeds by utilising selected palms.

4. Production of CGD x WCT hybrids utilising the selected mother palms.

The survey was initiated during the year 1988 covering Kottayam and Changanasserry taluks of Kottayam district, Thiruvalla taluk of Pathanamthitta, Chengannur, Mavelikkara and Karthikapally taluks of Alleppey district and Karunagappally taluk of Quilon district. The following criteria were used for the selection of WCT and CGD.

West Coast Tall (WCT)

1. Mother palms should yield 80 nuts or more per year.

2. They should be regular bearers and their bunches should rest on the petioles.

3. They should be free from all diseases and pests.

4. They should be negative in reaction to the serodiagnostic test carried out systematically every six months for root (wilt) disease.

5. They should be more than 35 years old and at least 80 per cent of the surrounding palms should be affected by root (wilt) disease.

6. Tall mother palms should have all the typical WCT characters. A progeny test is done to cull out hybrid mother palms.

125 mother palms were finally selected in the disease endemic area (Table 1).

Table 1. Yearwise details of mother palms used for artificial pollination

Year	No. of motherpalms used		
	WCT	CGD	Total
1988-89	25	-	25
1989-90	30	6	36
1990-91	32	-	32
1991-92	40	8	48
1992-93	67	10	77
1993-94	104	5	109
1994-95	95	30	125

Chowghat Green Dwarf (CGD)

1. They should yield 100 nuts or more annually.

2. They should be at least 20 years of age and serologically negative (to root (wilt) disease) in the test.

3. The mother palms should show all the typical characters of CGD with regard to stem, crown, leaf, nut and inflorescence.

4. They should also be free from all disease and pests and at least 80 per cent of the surrounding palms should be affected by root (wilt) disease.

The number of mother palms under artificial pollination since the beginning of the crossing programme (1988-89) is given in Table 1. Selection of mother palms is done every year. The details of mother palms currently under artificial pollination are given in

Table 2. Particulars of artificial pollination carried out in farmers' plots from 1988-95 are given in Table 3. Hybridization was carried out in the following cross-combinations involving disease free WCT and CGD palms to generate progenies for the study on reaction to the root (wilt) disease.

1. WCT *inter se*
2. WCT self
3. WCT x CGD
4. CGD x WCT
5. CGD self

The details of seedlings from the above crossing programme planted within the experimental farm are given in Table 4. So far 1858 seedlings were planted in the experimental farm at CPCRI (RS), Kayangulam (highly disease endemic area) and among them only 12 seedlings have been affected by the root (wilt) disease. However, it was found that all the 12 seedlings have originated from seven mother palms which subsequently succumbed to the root (wilt) disease.

Importance of selection of motherpalms from disease enedemic areas was clearly established by another set of experiments. High yielding WCT and CGD mother palms were selected at Kasaragod, a root (wilt) disease free area, and 50 CGD x WCT hybrid progenies raised from these palms were planted at the disease endemic farm at CPCRI, Kayangulam in 1990. The data collected so far showed that 60 per cent (30/50) of the palms took up the disease by fifth year (1995) whereas none of the 50 CGD x WCT progenies produced by crossing selected healthy palms of disease enedemic areas showed disease symptoms.

Table 2. Details of palms under artificial pollination during 1994-95

District	Village	WCT	CGD	Total
Alleppey	Kayangulam	14	1	15
	Mannar	8	4	12
Pathanamthitta	Thiruvalla	25	12	37
	Chengannur	11	2	13
Kottayam	Changanacherry	6	ó	6
	Chingavanam	4	ó	4
	Kumarakom	10	3	13
	Kottayam	6	3	9
Kollam	Karunagappally	5	5	10
	Vavvakkavu	6	ó	6
	Total	95	30	125

CGD x WCT Hybrids

The first batch of 31 CGD x WCT hybrids from crosses involving disease free high yielding palms from hot spot areas were planted at CPCRI Regional Station Farm Kayangulam, where more than 80 per cent of the existing palms are root (wilt) disease affected. Observations till date shows that none of these hybrids have taken up the disease (Plate II). These hybrids are not only disease tolerant but also precocious and heavy bearing. The hybrids flowered between 30th and 40th month of planting.

The preliminary yield data shows that the hybrids are capable of yielding 100 nuts/palm even at the second year of bearing (1995). The copra content was as high as 215 g/nut. Thus the CGD x WCT hybrids developed by crossing disease-free high yielding CGD and WCT palms selected from disease endemic areas are not only disease tolerant but also have high yield potential.

Table 3. Details of artificial pollination carried out in farmer's plots

	WCTxWCT				WCT selfing		WCTx CGD		Total (WCT)		CGDx WCT		CGD Selfing		Total (CGD)		Grand Total	
	B.P.		M.P.															
Year	I	B	I	B	I	B	I	B	I	B	I	B	I	B	I	B	I	B
1988-89	18	504	--	--	12	232	--	--	30	736	58	1745	--	--	58	1745	88	2481
1989-90	134	2648	--	--	35	845	--	--	171	3439	51	1132	--	--	51	1132	222	4625
1990-91	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1991-92	43	808	141	2182	16	172	--	--	200	3112	15	269	7	240	22	509	222	3621
1992-93	159	3121	161	2740	21	477	4	63	345	6401	20	574	8	127	28	701	373	7102
1993-94	258	4875	71	1323	102	2220	9	226	440	8644	8	190	2	96	10	286	450	8930
1994-95	204	4166	68	1501	69	1756	100	2360	441	9783	88	1900	10	350	98	2250	539	12033

BP = Biparental (cross between two palms)
MP = Mixed pollen (Cross where mother palm is pollinated by mixing pollen of two or more elite palms)
I = Inflorescence
B = No. of female flowers

Table. 4: List of seedlings planted within the experimental farm

Year	Block	BP	MP	Self	TxD	DxT	DxD (s) selfing	Open pollination	Total Nos.
		WCT x WCT				CGD Crosses			
1991	4	74	--	--	--	31	--	--	105
1992	1, 4	286	172	79	--	14	20	20	591
1993	4, 6, 7	86	206	46	--	--	24	124	486
1994	3, 5, 6, 11	105	390	53	--	88	24	47	707
									1889

BP = Bi Parental (Crosses between two palms)
MP = Mixed pollen (Crosses using mixed pollen of two or more elite palms)

WCT x WCT hybrids

The *inter se* progenies raised from disease from high yielding WCT mother palms selected from disease endemic areas are also under evaluation in `hot spot' areas. These palms are yet to flower. However the indication with regard to disease tolerance is very positive.

The resistance breeding programme for root (wilt) disease initiated in 1987 has started showing positive results and this line of approach indicated the possibility of evolving disease tolerant/resistant high yielding CGD x WCT and WCT x WCT hybrids and thereby solving the root (wilt) disease problem.

Future thrust

The Indian Council of Agricultural Research, having considered the progress of disease-resistant breeding programme, has now sanctioned an *ad hoc* scheme for the Central Plantation Crops Research Institute for breeding high-yielding root (wilt) disease resistant/tolerant coconut hybrids. The project costing Rs.33 lakhs for a period of five years has started operation in December 1995 with Dr.M.K. Nair, Director, CPCRI as the Principal Investigator and Dr.P.K. Koshy, Head, CPCRI Regional Station, Kayangulam, as the Co-Principal Investigator. Dr.R.V. Nair, Senior Scientist and Shri.P.M. Jacob, Scientist (Selection Grade) are associated in the project as Investigators. Four Field Stations at Vaikom, Kaduthuruthy, Kaviyoor and Haripad have been established for the work. The objectives of the scheme are:

(i) To locate high yielding (80 nuts/palm/year) root (wilt) disease-free West Coast Tall and Chowghat Green Dwarf in the four disease endemic districts of Alleppey, Quilon, Kottayam and Pathanamthitta. These disease-free palms are tested serologically to make sure that the palms are free from root (wilt) disease.

(ii) Make large number of West Coast Tall x West Coast Tall and Dwarf x Dwarf crosses involving these disease-free palms for production of high yielding disease resistant *inter-se* West Coast Tall and Chowghat Green Dwarf planting materials.

(iii) Establish seed gardens utilising these *inter se* materials (WCT and CGD) in the farms of Coconut Development Board, Kerala Agricultural University, and District Agricultural Farms of the Department of Agriculture, Kerala.

(iv) Produce large number of CGD x WCT hybrids from these seed garden for distribution to the farmers.

At the end of the five years, the project is expected to produce 5,000 *inter se* disease-free West Coast Tall (WCT) and 15,000 Chowghat Green Dwarf (CGD) seedlings. The seed gardens to be established with the 20,000 seedlings are expected to produce eight lakhs of hybrid seedlings every year from 10th year onwards. These disease-free CGD x WCT seedlings will be enough to meet the annual planting material requirement of the eight disease endemic districts of Kerala.

REFERENCES

Anonymous (1985) *Coconut root (wilt) disease. Intensity, production loss and future strategy* CPCRI Kasaragod pp 45.

Davis TA (1953) Breeding in coconut for disease resistance. *Indian Cocon. J.* 6(3): 95-100.

Davis, T.A. (1979) The Malayan Dwarf: Probable answer to the root (wilt) in Kerala. *Cocon. Bull* 1(3) 3-7.

Harries, H.C. (1973) Selection and breeding of Coconuts for resistance to diseases such as lethal yellowing. *Oleagineux* 28 (8-9). 395-398.

Iyer, R.D. Rao, E.V.V.B. and Govindankutty, M.P. (1979) Super yielders in coconut. *Indian Fmg* 28 (10):3-5.

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 (Mimeo)

Solomon, J.J., Govindankutty, M.P. and Nienhaus, F.(1983) Association of mycoplasma like organisms with the coconut root (wilt) disease in India. *Z.Pflkrankh pflschutz* 90: 295-297.

Varghese, M.K. (1934) *Disease of the coconut palm.* Government press, Trivandrum pp 105.