Research Article

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Performance of CGD x WCT hybrid in the coconut root (wilt) disease prevalent tract

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Abstract

Root (wilt) is a debilitating disease of coconut in Kerala. With a view to developing a root (wilt) resistant / tolerant variety, performance of thirty one CGD x WCT hybrid palms, planted during 1991 was studied. The hybrid palms gave an average yield of 82.5 nuts/palm/year, copra yield of 14 kg/ palm/year and oil yield of 1.65 t/ha. Sixty eight percent of hybrid palms contracted the root (wilt) disease, fourteen years after planting. The disease-free hybrid gave an average yield of 96.3 nuts/palm/year. The diseased hybrid gave 72 nuts/palm/year. With regard to resistance to root (wilt) disease, hybrid palms were intermediate between the parental varieties viz. CGD and WCT. Though the parental varieties viz. CGD and WCT were deficient in either one or the other characteristics such as nut characteristics, palm size, precocity and disease resistance, the hybrid was superior in overall performance. Integrated management practices centered around this hybrid variety offered a better alternative to the farmers for the management of root (wilt) disease of Kerala.

Key words: Coconut, hybrid, field resistance/tolerance, heterosis, CGD x WCT, root(wilt) disease

Introduction

The coconut root (wilt) disease, reported over a century ago in Kerala, is a debilitating disease in the eight southern districts from Thiruvananthapuram to Thrissur, and in isolated tracts in the remaining six districts (Solomon *et al.*, 2001). Sparse occurrence of this disease has also been reported from parts of Tamil Nadu adjoining Kerala (Srinivasan *et al.*, 2000). The disease causes an annual loss of 969 million nuts (Anon., 1985). A survey conducted during 1996 revealed that 24.1 % of the 102 million palms in the disease endemic region as diseased (Anon., 1996). In the contiguously diseased area, vast majority of palms have succumbed to the disease.

Flaccidity, yellowing and necrosis of leaflets, are the major distinguishing symptoms of the disease. Studies on the etiology of the disease suggested the association of phytoplasma (Solomon *et al.*, 1983 a), transmitted through *Stephanitis typica* (lace wing bug) (Mathen *et al.*, 1987) and the plant hopper *Proutista moesta* (Anon., 1991).

Nearly 84 cultivars and 63 hybrid combinations from the Coconut Germplasm maintained at CPCRI Kasaragod were evaluated under field conditions for resistance to root (wilt) disease at CPCRI Regional Station, Kayangulam. None of them were found to have the desired level of resistance to the disease (Jacob *et al.*, 1998).

West Coast Tall (WCT) variety, which is the only extensively cultivated variety in the root (wilt) prevalent tract, is highly susceptible to root (wilt) disease. Even though 12 hybrids have been released for general cultivation in India (Ratnambal, 2001), all of them are susceptible to coconut root (wilt) disease. One of the most important constraints for coconut production in the disease prevalent tract is the non-availability of a field resistant / tolerant variety/hybrid to root (wilt) disease.

From intensive surveys in farmers' plots and also from a screening trial, it was observed that Chowghat Green Dwarf (CGD) had higher level of resistance to the root (wilt) disease, compared to other varieties (Nair *et al.*, 2004). Besides, in the disease endemic areas, in the midst of heavily disease-affected coconut palms, disease-free

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and high yielding WCT palms are found. These disease-free palms of CGD and WCT were identified as the base material for the breeding programme, to evolve a hybrid with resistance / tolerance to coconut root (wilt) disease (Nair *et al.*, 1996).

Materials and Methods

The mother palms of WCT and CGD located in the farmer's plots in the root (wilt) prevalent areas were selected, based on strict selection criteria (Nair *et al.*, 1996). The mother palms were serologically tested to ascertain their freedom from disease (Solomon *et al.*, 1983b). Artificial pollination of CGD mother palms, with pollen of WCT, were carried out in 1989 for the production of F_1 hybrid. The mature seed nuts were harvested during 1990, and sown in the nursery. The selected one-year-old hybrid seedlings (31 nos.) were planted in the main campus at a spacing of 7.5 m during July 1991. Hybrid palms were evaluated for field resistance in the absence of an artificial screening technique. Highly diseased old palms were retained on all sides of the experimental palms to ensure adequate natural inoculum. Experimental palms were properly managed by following the recommended package of practices (Amma *et al.*, 1982).

For the study of important morphological and agronomic characteristics of WCT and CGD varieties, ten palms of WCT (>40 years old) and CGD (>20 years old) were randomly selected from the natural population in farmer's plots. Observations were recorded following standard procedures (Ratnambal *et al.*, 1995). Similarly, ten palms of CGD x WCT (11 year old) were randomly selected and studied for various morphological characteristics. For studies on nut characters including copra content, ten nuts each from ten palms were studied for WCT, CGD and the hybrid. Sweetness of tender-nut water and meat of 6-8 month old nuts were evaluated based on standard organoleptic test on a 1-5 scale, and mode was worked out for estimating the average. The data on various characters were statistically analyzed for estimation of mean and standard error.

During the initial years, the palms were removed as and when they contracted the disease and accordingly six palms showing disease symptoms were removed before they started bearing and two palms were removed after bearing for 1-2 years. Hence, yield data of only 23 palms are furnished in Table 3. Annual nut yield was calculated in accordance with the agricultural year (July-June).

For estimating the copra content, the split nut was sun dried to detach the kernel from the shell. The detached kernel was further sun dried for 6-7 days to bring down the moisture content to less than six percent and the weight of the copra per nut was measured in grams. Oil content was estimated from two samples each, from ten palms for CGD, WCT and hybrid by Soxlet method (AOAC, 1990) using diethyl ether as the solvent. Assessment of resistance was based on natural infection

Table 1. Morphological characters of CGD x WCT hybrid, CGD and WCT varieties

Characters	Hybrid		CGD		WCT	
	mean ± S.E	CV%	Mean ± S.E	CV%	mean ± S.E	CV%
Plant height (m)	3.3 ± 0.29	27.2	4.2 ± 0.19	10.6	15.3 ± 0.42	10.3
Number of leaves	30.3 ± 1.57	16.4	25.0 ± 1.70	15.2	29.2 ± 1.24	15.9
Length of petiole (cm)	115.3 ± 9.16	25.1	109.4 ± 4.81	9.8	107.8 ± 3.97	13.8
Length of leaflet bearing portion (cm)	375 ± 16.35	13.8	342.8+25.60	16.7	349.3 ± 8.17	8.8
Number of leaflet (right)	114.5 ± 1.44	4	99.4±1.03	2.3	114.7 ± 3.04	9.9
Number of leaflet (left)	115.8 ± 1.41	3.8	100.2±1.46	3.3	114.1 ± 2.19	7.2
Length of leaflet (cm)	113.8 ± 4.64	12.9	106.2±3.72	7.8	110.9 ± 4.13	13.9
Breadth of leaflet (cm)	5.2 ± 0.22	13.2	4.7±0.20	9.5	6.4 ± 0.17	10.1
Girth of trunk (cm)	78.7 ± 2.98	12	60.2±1.46	5.4	92.6 ± 1.90	7.7
Number of leaf scars in 1 m length	20.1 ± 1.28	20.1	35.8±8.54	53.4	10.1 ± 0.38	14.3
Length of inflorescence (cm)	112.0 ± 3.35	8.7	69.2±4.79	15.5	93.1 ± 3.17	12.8
Length of inflorescence with spikelet (cm)	59.1 ± 1.65	8.8	39.6±5.40	30.5	57.6 ± 2.38	15.44
Length of inflorescence without spikelet (cm)	62.9 ± 2.18	11	29.6±2.37	18	34.6 ± 1.87	20.24
Length of spikelet (cm)	39.5 ± 1.94	15.5	34.6±1.69	10.9	37.1 ± 1.60	16.13
Number of spikelet/inflorescence	38.7 ± 1.85	15.1	26.0±3.25	28	32.1 ± 1.19	13.92
Number of female flowers/ inflorescence	23.2 ± 3.06	41.7	11.6±3.94	76	6 .0± 0.71	23.57
Number of inflorescence per year	15.4 ± 1.54	31.7	7.4±0.67	20.5	14.3 ± 0.27	6.96
Number of bunches with button	4.6 ± 0.37	25.5	3.2±0.37	26.1	4.4 ± 0.25	21.32
Number of bunches with nut	10.8 ± 1.46	42.9	3.4±0.81	53.4	9.2 ± 0.52	20.93
Number of bunches per year	15.4 ± 1.54	31.7	7.8±0.86	24.7	14.3 ± 0.27	6.96

Table 2: Nut characteristics of CGD x WCT hybrid, CGD and WCT varieties

Fruit Characters	Hybrid		CGD		WCT	
	mean ± S.E	CV%	mean ± S.E	CV%	mean ± S.E	CV%
a. Mature Nut						
Length of fruit (cm)	18.7 ± 0.22	11.35	17.0 ± 0.142	5.83	20.5 ± 0.23	7.77
Breadth of fruit (cm)	14.3 ± 0.19	12.36	12.0 ± 0.112	6.57	14.2 ± 0.22	11.06
Weight of fruit (g)	839.2 ± 21.45	24.25	683.4 ± 18.46	18.91	1033.5 ± 21.91	14.99
Thickness of husk (cm)	4.4 ± 0.13	27.93	4.2±0.12	19.48	4.7 ± 0.12	17.98
Weight of dehusked nut (g)	527.8 ± 15.39	27.67	349.5±9.52	19.07	614.5 ± 16.86	19.40
% of husk to whole fruit weight	37.5 ± 0.62	15.67	47.8±1.50	3.14	40.3 ± 1.17	20.56
Thickness of kernel (cm)	1.18 ± 0.015	12.21	1.02±0.021	2.05	1.24 ± 0.025	15.64
Weight of kernel (g)	295.7 ± 7.59	24.37	171.2±10.00	36.95	347.1 ± 8.55	17.43
Thickness of shell (cm)	0.27 ± 0.007	26.32	0.23±0.010	29.63	0.32 ± 0.008	18.49
Weight of shell (g)	120.3 ± 3.26	25.72	85.2±3.45	25.62	137.2 ± 3.05	15.74
Quantity of water (ml)	111. 7 ± 6.55	55.67	82.2±5.98	50.90	130.2 ± 8.83	47.96
Copra weight	169.5± 4.97	29.32	104.0 ±5.23	23.24	177.0 ± 5.57	22.26
Oil content (%)	67.5 ±0.10	0.64	66.3 ± 0.13	0.61	67.6 ± 0.16	0.74
b. Tender Nut	**mean ± S.E**	**CV%**	**mean ± S.E**	**CV%**	**mean ± S.E**	**CV%**
Quantity of nut water (ml)	373.3±38.42	35.65	172.3 ± 10.73	20.66	260.4 ± 35.40	47.08
Sweetness of water	3		4		3	
Sweetness of meat	3		4		3	

by planting them inside the experimental farm where there is heavy natural incidence of the disease and observations were recorded as and when the experimental seedlings developed initial symptoms of the disease.

Results and Discussion

Only palms showing typical characters of West Coast Tall and Chowghat Green Dwarf (Ratnambal *et al.*, 1995) were selected for the crossing programme. Palms of WCT variety are characterized by high degree of variation, since they are cross-pollinated. CGD palms have high degree of self-pollination and they can be considered as a natural inbred with minimum variability (Rao and Koyamu, 1955). In general, palms of CGD and WCT showed contrasting characters for palm size, stem, leaf and nut characteristics.

(a) Morphological characters

Table-1 gives the data on growth / morphological characters of CGD x WCT hybrid and parental varieties viz. CGD and WCT. For almost all the morphological characters studied such as number of leaves, number of leaflets, number of female flowers and number of inflorescences produced per year, the hybrid showed high heterosis. This heterotic effect can be attributed to the inbred nature of CGD (Rao and Koyamu, 1955; Swaminathan and Nambiar, 1961).

(b) Fruit /nut characteristics

The observations recorded on fruit components are given in Table-2. The hybrid had intermediate values for characters like thickness of the husk, weight of the dehusked nut (Fig. 1), weight of kernel and weight of

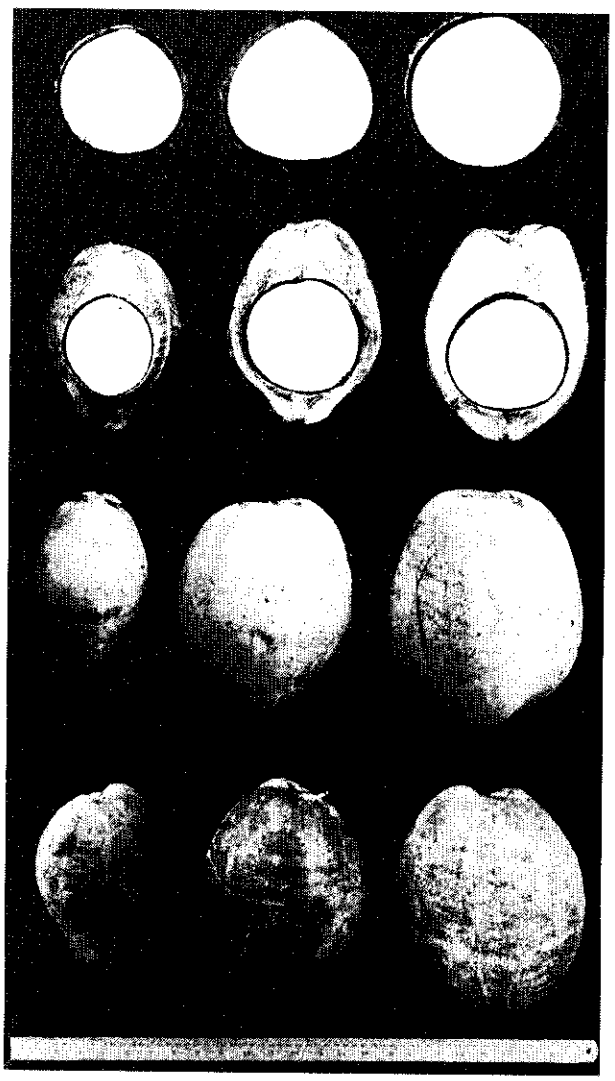

Fig. 1. Nut features of CGD, CGD x WCT hybrid and WCT

shell. Percentage of husk to whole fruit weight obtained for the hybrid was lower than that of both the parents. Besides, the percentage of the kernel to husked nut weight in the hybrid (56%) was equal to WCT (56.5%) and better than CGD (48%).

Hybrid also showed heterosis for quantity of tender nut water (373.3 ml) when compared to WCT (260.4 ml) and CGD (172.3 ml). Taste of the tender-nut water and meat of the hybrid was equal to WCT but was inferior to CGD, indicating that the hybrid will also serve as a variety suited for tender-nut water.

(c) Resistance/tolerance to root (wilt) disease and yield

Twenty-one out of the 31 hybrids planted during 1991 have taken up root (wilt) disease bringing the disease incidence to 67.7%, fourteen years after planting. In comparison, the open pollinated progenies raised from disease-free WCT palms located in the disease endemic areas showed 70% disease incidence, nine years after planting (Nair *et al.*, 2003).

Hybrid palm showed initiation of flowering during the first three to four years after planting (Jacob *et. al.*, 1998). Hybrid palms after the initiation of nut production, passed through an immature phase (first four years of production) at the end of which all the palms uniformly started producing nuts and subsequently it enters the mature phase during which the palms give regular yield (Sangare *et al.*, 1988). The average nut yield/palm/year of CGD x WCT hybrid (23 nos.) at both the immature phase and mature phase (subsequent five years) is given in Table-3. It can be seen that the hybrid gave an average yield of 60.5 nuts/palm/year during the immature phase and 82.5 nuts/palm/year during the mature phase (Table-3). Yield data of diseased and disease free CGD x WCT hybrid for nine years is given in Table-4. The disease-free hybrids gave a cumulative average yield of 82 nuts/palm/year for the past nine years and 94.5 nuts/palm/year during the mature phase. The diseased hybrid palms gave a cumulative average yield of 67.6 for the last nine years and 72 nuts/palm/years during the mature phase. The reduction in average yield recorded during 1998-99

Table 3. Palm wise nut yield of CGD x WCT hybrids*(23 nos.) Year of planting: 1991

	Immature phase				Mature phase							
Palm No.	1995-96	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	Total	Average	+CV (%)
02		09	56	57	152	138	153	164	90	819	102.4	21.0
04	14	83	50	87	199	112	160	123	108	936	104	27.54
05			**56**	**113**	**112**	**77**	**123**	**110**	**136**	**727**	**104**	**19.66**
06		**50**	**58**	**123**	**125**	**92**	**75**	**30**	**73**	**626**	**78**	**43.57**
07	**15**	**62**	**15**	**37**	**07**	**38**	**36**	**33**	**28**	**271**	**30**	**44.17**
10		**24**	**15**	**34**	**29**	**31**	**46**	**20**	**26**	**225**	**28**	**31.78**
11		**17**	**46**	**66**	**91**	**66**	**88**	**114**	**22**	**510**	**64**	**45.60**
12		11	94	67	166	95	171	77	150	831	104	32.63
13	18	225	119	110	321	121	213	154	137	1418	158	43.00
14	**81**	**71**	**171**	**26**	**148**	**04**	**01**	**48**	**38**	**588**	**65.3**	**124.85**
15		**60**	**63**	**84**	**121**	**123**	**72**	**12**	**36**	**571**	**71**	**68.32**
18	**57**	**47**	**50**	**27**	**118**	**03**	**77**	**54**	**111**	**544**	**60.4**	**64.40**
19	**38**	**193**	**90**	**174**	**164**	**144**	**139**	**45**	**46**	**1043**	**116**	**53.40**
20		**111**	**87**	**31**	**180**	**189**	**85**	**118**	**78**	**879**	**110**	**40.10**
21	**56**	61	31	0	14	44	32	23	68	329	37	57.90
22		107	59	83	147	56	106	105	42	705	88	46.47
23			04	08	106	49	57	25	54	303	43.3	46.00
24				**03**	**51**	**35**	**30**	**63**	**65**	**247**	**41.2**	**32.61**
25						38	25	80	24	167	42	62.96
28			10	19	84	35	112	64	83	407	58	37.61
31					36	13	20	111	59	239	48	82.65
32		**20**	**40**	**11**	**59**	**28**	**38**	**21**	**20**	**237**	**30**	**48.54**
33		**65**	**87**	**74**	**43**	**107**	**94**	**120**	**128**	**718**	**90**	**34.11**
Count	07	17	20	21	22	23	23	23	23	23	90	
Total	279	1216	1120	1234	2383	1638	1953	1714	1622			
Average	39.85	71.52	56.00	58.76	108.31	71.21	84.91	74.52	70.52			
Phase average		60.5					82.5					

Figures in **Bold** indicate the palm no. and yield of diseased palms

* 8 hybrid palms were cut and removed.

+ CV calculated for the mature phase (recent five years) yield data.

Table 4. Yield of CGD x WCT hybrids in the root (wilt) prevalent tract

Palms	Immature phase 1995-96	1996-97	1997-98	1998-99	Mature phase 1999-2000	2000-2001	2001-2002	2002-03	2003-04
	mean ± SE	mean ± SE	mean ± SE	mean ± SE	mean ± SE	mean ± SE	mean ± SE	mean ± SE	mean ± SE
Hybrids (23 nos)	40.0 ± 9.78	71.5 ± 14.63	60.1 ± 8.99	58.8 ± 10.04	112.5 ± 15.56	71.2 ± 10.44	84.9 ± 11.56	74.5 ± 9.60	70.5 ± 8.55
Healthy (10 nos)	29.3 ± 13.39	82.7 ± 32.60	53.0 ± 13.91	54.0 ± 14.34	136.1 ± 30.73	70.1 ± 13.51	105.0 ± 21.78	92.6 ± 15.25	81.5 ± 12.85
Diseased (13 nos)	47.8 ± 14.02	65.5 ± 15.12	64.8 ± 12.05	61.8 ± 13.98	96.0 ± 15.03	72.1 ± 15.75	69.5 ± 10.71	60.6 ± 11.28	62.1 ± 11.31

may be due to sudden and wide-spread outbreak of eriophyid mite (*Aceria guerreronis* (K)) in Kerala (Sathiamma *et al.*, 1998).

Hybrid palms together gave an average yield of 82.5 nuts/palm/year in the mature phase. In the root (wilt) disease prevalent tract, CGD x WCT hybrid gave a copra yield of 14 kg/palm/year and oil yield of 1.65 tonnes / hectare, estimated on the basis of 175 hybrid palms / hectare and the oil content is furnished in Table-2. It can be seen that during the mature phase, the disease-free hybrid palms gave an average yield of 96.3 nuts/palm/ year whereas diseased hybrid palms gave 72 nuts/palm/ year. A satisfactory yield (72 nuts/palm/year) obtained from the diseased hybrid palms, inspite of being diseased, indicated that they are tolerant to root (wilt) disease.

Data clearly revealed that the CGD x WCT hybrid is suitable for cultivation in the root (wilt) prevalent tract. In the case of Lethal Yellowing Disease, caused by phytoplasma, which is a serious disease of coconut in Jamaica, Florida, Ivory Coast and West Africa, identification of Malayan Yellow Dwarf as a resistant variety (Nutman and Roberts, 1955) and its subsequent exploitation through the development of Maypan (F_1) hybrid (Malayan Yellow Dwarf x Panama Tall) was a major turning point for the management of lethal yellowing disease in Jamaica (Harries and Romney, 1974). Large-scale cultivation of resistant varieties together with the integrated management practices helped in the successful management of Lethal Yellowing Disease in Jamaica (Steer, 1997).

The present studies also showed that an exactly identical situation prevails regarding resistance to root (wilt) disease of coconut. Confirmation of CGD's higher level of resistance and the resistance/tolerance of CGD x WCT hybrid, produced by crossing of resistant palms of CGD with WCT, are expected to play a major role for the successful management of this dreaded coconut disease in Kerala (Jacob *et al.*, 1999).

In general, West Coast Tall variety has some deficiencies such as late bearing habit, susceptibility to root (wilt) disease, even though they have the advantage of long life span and good quality nuts. Similarly, CGD has a few deficiencies such as small nut and copra size, shorter life span, though they have the advantage of early bearing and resistance to root (wilt) disease. Even though the parents namely WCT and CGD are deficient in one or the other characteristics, the hybrid was better in overall performance. The present study further showed that CGD x WCT hybrid is suitable for disease prevalent tract. Integrated management practices, centered on this hybrid variety, offer the best solution for the management of root (wilt) disease of Kerala.

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