

## PHYSIOLOGICAL STUDIES ON ROOT(WILT) DISEASED COCONUT PALMS UNDER DIFFERENT MANAGEMENT PRACTICES

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### ABSTRACT

Studies were undertaken in farmers' fields on root (wilt) diseased coconut palms maintained under well managed, moderately managed and poorly managed conditions. Physiomorphological characters and disease index were recorded at half yearly intervals for five years.

Diseased palms responded markedly to good management, as indicated by a decline in disease index (40% improvement over pre-treatment conditions). The overall improvement was brought about by decrease in the intensity of flaccidity symptom, enhanced greenness of leaves, reduction in leaf rot and necrosis and a fall in the rate of leaf senescence. There was only marginal improvement in palms under moderately managed conditions. while those under poor management had greater tendency of deterioration. The efficacy of scientific management practices in the root(wilt) affected garden is highlighted.

### INTRODUCTION

In Kerala, one of the reasons attributed to the decline in the yield of coconut is the prevalence of root(wilt) disease in eight districts (Anonymous 1985). The disease is characterised by the flaccidity of leaflets of middle and outer whorl of leaves as the primary symptom, while yellowing and necrosis are the associated symptoms (Radha and Lal, 1972). Based on the intensity of symptoms the disease index was worked out and palms categorized as apparently healthy, diseased early, middle and advanced (George and Radha, 1973). Reduction in nut yield in the disease affected palms was found to be proportionate to the intensity of the disease (Anonymous, 1976).

In the absence of specific measures for control of the disease, adoption of management practices gains significance. The importance of fertilizer management, inter and mixed cropping with compatible crops and mixed farming in root(wilt) affected gardens to check the loss due to the disease was highlighted (Pillai *et al.*, 1981). While most of the studies were carried out in the Institute's Farm with known history of palms, recommended spacing, cultural operations and fertilizer application, there was no information on the response of palms in the farmers' plots to the management practices. As the farmers field conditions with various limitations of cultivation, offer ideal situations to study the efficacy of scientific management, investigations were

undertaken for five years (1981-1985) in small landholdings. The main objective of this pilot experiment was to compare the performance of palms under the recommended practices of management like irrigation fertilizer application, and prophylactic spray with that of palms under farmer's practices, as this comparison would help to know the extent to which the yield potential of diseased palms could be enhanced. It was also intended to be a demonstration experiment for educating the farmers. This paper offers physiological explanation for the changes in disease index under different management practices.

#### MATERIALS AND METHODS

Coconut palms were selected from four farmers' plots in Memana, Krishnapuram village, 4 km from the Institute. Sixty palms (27 apparently healthy and 33 diseased) were selected in two farmers' plots for summer irrigation ( $I_1F_1$ ) and another sixty palms (14 and 46) in two other plots were maintained as rainfed ( $I_0F_0$ ). Twenty palms (6 and 14) were selected to represent farmers' own management practices without imposing any treatment ( $I_0F_0$ ). The palms were subjected to randomized selection for the treatments and indexed for the pre-treatment disease condition.

**Irrigation schedule:** Summer irrigation was given in the basins of sixty palms at weekly intervals at the rate of 250 litres per palm from January to May. Basins were covered with dry coconut leaves as much. Irrigation schedule was adjusted if there was rainfall during the period.

**Fertilizer treatment:** All the 120 palms (both irrigated and rainfed) received the

fertilizers at the rate of N:0.5 kg;  $P_2O_5$ : 0.32 kg;  $K_2O$ : 1.2 kg; CaO: 1.0 kg and  $MgSO_4$ : 2.0 kg per palm as split doses during May-June and October-November. Cowdung was added at the rate of 50 kg per palm during October-November. Cultural operations like cleaning the basins and weeding were carried out at intervals. All the 120 experimental palms were given prophylactic spray with Bordeaux mixture twice a year (pre and post monsoon).

**Physio-morphological observations:** At half yearly intervals (December-January and June-July) following physio-morphological characters were recorded for all the 140 palms (including 20 palms under control  $I_0F_0$ ); total number of leaves, rate of leaf production (by tagging first fully open leaf at each observation), number of flaccid leaves, number of yellow leaves, number of rotten leaves, number of senescent/dry leaves and condition of the spindle leaf.

Disease index of the palms was recorded at half yearly intervals based on flaccidity, yellowing and necrosis symptoms (George and Radha, 1973) for all the 140 palms. Data were statistically analysed using the 't' test.

As the paper deals with disease index, the results obtained with diseased palm (33, 46 and 14 respectively under the three treatments) alone are given in Table I. Since the preliminary analysis of data has shown that palms with disease index above 50% i.e. advanced stage of the disease did not respond to management practices, the index values for early and middle stages of disease are combined and the mean given in Table II.

Table I. *Effect of summer irrigation on the condition of root (wilt) diseased coconut palms (Final picture at the end of five years).*

Treatment	No. of palms observed	No. of palms showing		
		improvement*	deterioration**	No change
I <sub>1</sub> F <sub>1</sub>	33	23(69.7)	5(15.1)	5(15.1)
I <sub>0</sub> F <sub>1</sub>	46	14(30.4)	20(43.4)	12(26.2)
I <sub>0</sub> F <sub>0</sub>	14	2(14.3)	11(78.5)	1(17.2)

Values in brackets indicate the percentage on total number of palms observed.

\*Improvement refers to decline in disease index over pre-treatment.

\*\*Deterioration means increase in disease index over pre-treatment.

### RESULTS

The overall condition of the root(wilt) diseased coconut palms as a result of five years' irrigation treatment is given in Table I. It is evident that under well managed conditions (I<sub>1</sub>F<sub>1</sub>), 69% of the palms exhibited improvement in the health of the palm as indicated by a decline in disease index over pre-treated conditions. Even the fertilizer treatment alone (I<sub>0</sub>F<sub>1</sub>) brought about some improvement (30.4%), but it was less than that obtained when combined with irrigation. A natural improvement of 14.3% of palms was noticed even under farmers' practice of cultivation. That the adoption of

balanced management (I<sub>1</sub>F<sub>1</sub>) would ensure about five-fold improvement (69% as against 14%) in the condition of palms is evident. Deterioration of palms was more under farmers' practices (78.5%) than under fertilizer treatment alone (43.4%) and under well managed conditions (15.1%) treatments.

When the performance of palms under the three treatments was compared year-wise, it was clear that irrigation had brought about marked improvement of about 50% (i.e. decline in disease index from 22.1 in 1980 to 13.2 in 1985) from fourth year onwards, though there was

Table II. *Response of root (wilt) diseased coconut palms to management practices. (Comparison of disease index of palms between treatments over five years).*

Treatment	1980 Pre.	1981	1982	1983	1984	1985
I <sub>1</sub> F <sub>1</sub>	22.1 (100%)	18.3 (82.8)	22.3 (100.9)	19.9 (90.0)	11.4 (51.6)	13.2 (59.7)
I <sub>0</sub> F <sub>1</sub>	28.9 (100%)	26.5 (91.7%)	32.0 (110.7)	27.7 (95.8)	30.6 (105.9)	34.6 (119.7)
I <sub>0</sub> F <sub>0</sub>	36.3 (100%)	40.8 (112.4)	40.4 (111.3)	36.8 (101.4)	35.8 (98.9)	41.0 (113.3)

tendency for improvement (10 to 20%) even earlier (Table II). Management of palms only with fertilizers resulted in marginal improvement in the initial stages, but that was not sustained, as the palms tended to show deterioration (i.e. increase in disease index from 28.9 in 1980 to 34.6 in 1985). Under farmers' own practices the palms exhibited either status quo or declined further (36.3 in 1980 to 41.0 in 1985).

Table III gives a critical analysis on the factors contributing to the marked improvement in palms with  $1_1F_1$  treatment *vis a vis* other treatments. Comparison of the pre and post-treatment values showed that in the irrigated plot there was significant reduction in the number of leaves showing flaccidity (42.9%) yellowing (40.5%) rotting (59.2%) and senescence (39.5%) whereas in the other two

treatments except in the case of flaccidity, there was no improvement in other characters studied (Table IIIa).

When the disease intensity was quantified (i.e. disease index score) and examined, it became apparent that irrigation had resulted in improving all the three disease symptoms namely flaccidity (68.1%) yellowing (70.0%) and necrosis (42.9%) (Table IIIb). It may be noted that under both  $I_0F_1$  and  $I_0F_0$  treatments, the palms suffered most with necrosis, followed by yellowing whereas flaccidity appeared to improve either naturally or even with only fertilizer application.

#### DISCUSSION

It is well established that coconut palms respond favourably to summer irrigation, in as much as the frequency and quantity of water markedly influence the

Table IIIa. *Effect of management practices on the leaf condition (Mean of 15 palms).*

Treatment	Stage	Number of leaves with			
		Flaccidity	Yellowing	Rot	Senescence
$1_1F_1$	Pre. trt.	13.3	11.6	4.9	4.3
	Post. trt.	5.7	4.7	2.9	1.7
	Diff.	(42.9)	(40.5)	59.2)	39.5)
		7.7**	6.9**	2.0*	2.60**
$1_0F_1$	Pre. trt.	18.0	8.6	4.5	3.7
	Post. trt.	12.0	9.3	2.9	3.1
	Diff.	(66.7)	(108.1)	(64.4)	(83.8)
		6.0**	-0.7	1.5	0.6
$1_0F_0$	Pre. trt.	20.4	12.3	5.7	5.1
	Post. trt.	16.0	12.7	5.3	5.7
	Diff.	(78.4)	(103.2)	(92.9)	(11.7)
		4.4*	-0.4	0.4	-0.6

Values in brackets indicate percentage on pretreatment.

\*Significant at 5%

\*\*Significant at 1%

Table IIIb. *Effect of management practices on the disease intensity.*

Treatment	Stage	Disease index for		
		Flaccidity	Yellowing	Necrosis
1 <sub>1</sub> F <sub>1</sub>	Pre. trt.	6.9	5.0	2.1
	Post. trt.	2.2	1.5	1.2
	Diff.	(31.9) 4.7**	(30.0) 3.5**	(57.1) 0.9**
1 <sub>0</sub> F <sub>1</sub>	Pre. trt.	9.7	4.0	1.3
	Post. trt.	4.5	3.4	2.6
	Diff.	(46.4) 5.2*	(85.0) 0.6	(101.6) -1.3*
1 <sub>0</sub> F <sub>0</sub>	Pre. trt.	11.3	6.3	1.7
	Post. trt.	9.0	6.4	3.5
	Diff.	(79.6) 2.3	(101.6) -0.1	(205.9) -0.8*

Values in brackets indicate percentage on pretreatment.

\*Significant at 5%

\*\*Significant at 1%

female flower production and nut yield (Marar, 1963; Venkitesan, 1973, Padmanabhan, 1973, Nelliath and Padmaja 1978 and Bhaskaran and Leela, 1978). As regards the management of root(wilt) diseased coconut palms, Menon and Nayar (1978) reported a slight decrease in the disease index and increase in the mean yield of diseased palms when elephant foot yam was grown as an intercrop. Adoption of mixed farming practice was shown to result in 28% increase in nut yield in disease affected coconut plot (Sahasranaman *et al.*, 1983). The present investigation, with the emphasis on summer irrigation was the first one to be launched in 1980 in farmers' plots afflicted with the diseased palms. In 1982, the scope of the experiments were widened and extended to more farmers' plots (Muraleedharan *et al.* 1986).

That the disease intensity could be drastically reduced by superimposing summer irrigation over the fertilizer application is evident from Tables II and III. This may be due to the fact that irrigation favours the uptake and/or utilization of nutrients. The efficacy of irrigation could be noticed by way of improved water uptake through the newly regenerated roots and lesser transpiration rate in diseased plants (Rajagopal *et al.* 1986a, b).

The fact that all the disease symptoms were brought down by irrigation revealed that the photosynthetic area was considerably enhanced (more greenness), as compared to the situation obtained with other treatments (Table IV). A marked decline in the number of yellow leaves from 11.6 to 4.7 between pre and post-treatment stages (59.5%) improvement

Table IV. *Effective photosynthetic area in root (wilt) diseased coconut palms under different management practices.*

Leaf area, m<sup>2</sup> palm<sup>-1</sup>

Treatment	Stage	Yellowing	Rot	Senescence	Average
1 <sub>1</sub> F <sub>1</sub>	Pre-treatment	69.5	29.4	25.8	41.6
	Post treatment	28.6	17.4	10.2	18.6
	%	59.4	40.9	60.5	44.7
1 <sub>0</sub> F <sub>1</sub>	Pre-treatment	51.5	27.0	22.2	33.6
	Post-treatment	55.7	17.4	18.6	30.6
	%	108.2	35.6	16.2	91.1
1 <sub>0</sub> F <sub>0</sub>	Pre-treatment	73.7	34.1	30.6	46.1
	Post-treatment	76.1	31.8	34.1	47.3
	%	103.3	106.7	111.4	102.6

(Table IIIa) and a similar situation with rotten and senescent leaves would amount to an increase in all the components of photosynthesis namely chlorophyll content, CO<sub>2</sub> fixation and activities of enzymes. Table IV clearly reveals that there was about 55% improvement in the photosynthetic area between pre and post-treatment stages as a result of irrigation as against only about 10% in palms supplied only with fertilizers.

The persistence of yellowing and necrosis and also leaf rot in palms under I<sub>0</sub>F<sub>1</sub> and I<sub>0</sub>F<sub>0</sub> treatments over the years and their conspicuous decline with irrigation point out the fact that dry conditions probably weaken the tissues and expose them to attack by pathogens, while irrigation improves the health and vigour of palms and thus minimize their proneness to disease. In other words, prophylactic spray with Bordeaux mixture was more effective in controlling leaf rot/necrosis in palms which received summer irrigation than those exposed to rainfed conditions. Water deficit condition is known to be a

predisposing factor for certain of the plant diseases (Ayres, 1978).

It took four to five years for the transformation of whole canopy in diseased palms, as exemplified by steep reduction in the disease index (Table II). It would mean that until the disease-affected leaves complete the cycle of three years before shedding, the real impact of irrigation on the subsequently emerged leaves would not be fully revealed. Highlight of the study is the finding that yellowing and necrosis are the main culprits for the deterioration of the diseased palms and that they can be drastically reduced with suitable management practices (1<sub>1</sub>F<sub>1</sub>). The overall improvement in the diseased palms was reflected on the female flower production, fruit set (button retention) and nut yield (unpublished).

#### CONCLUSION

That the diseased palms responded significantly to well managed conditions (1<sub>1</sub>F<sub>1</sub>), as compared to those maintained

under farmers' practices ( $I_0F_0$ ) point out clearly the urgent need to popularize among the farmers the scientific management of affected palms to enhance their yield potential and to realize good economic returns.

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