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STUDIES ON WATER UPTAKE BY ROOT (WILT) DISEASED COCONUT PALMS

V. RAJAGOPAL, CHACKO MATHEW, K. D. PATIL and JOSE ABRAHAM
Central Plantation Crops Research Institute
Regional Station, Kayangulam 690 533, Kerala, India.

ABSTRACT

Investigations were carried out to study the uptake of water by the roots of apparently healthy and root (wilt) – affected coconut palms (*Cocos nucifera* L.). Feeding the cut end of roots with water indicated that diseased palms have lesser uptake than the healthy palms. Irrigating the palms during summer had beneficial effect on water uptake through roots of different maturity and by roots of healthy and diseased palms. Estimation of soil moisture content at different profiles in the basins of apparently healthy and diseased palms at one day interval for five days after irrigation indicated that the former had greater depletion of water than the latter. These results show that the root system of diseased palms is adversely affected.

INTRODUCTION

Among the derangements observed in diseased palms, root decay and the reduction in the number of active roots and bole diameter have been widely reported (Nagaraj and Menon, 1955, Menon and Pandalai, 1958, Michael, 1963 and Radha, Ravindran and George 1971). High percentage of dead roots and poor regeneration capacity of roots were the other characteristic features associated with the diseased palms. Further evidence in support of the above observations had come from the water uptake studies (Davis, 1964, Ramadasan, 1964 and Chacko Mathew, 1968), which showed that the diseased palms have lower uptake of water than the healthy palms. However, earlier studies were confined to uptake through the cut end of roots and not through natural root system. The present study was aimed at re-examining the uptake pattern between apparently healthy and diseased palms following the earlier method of cut root feeding. Studies on the influence of irrigation, if any, on the uptake pattern was also included. In addition, the soil moisture depletion pattern, which would actually reflect on the root function, by the apparently healthy and diseased palms was carried out.

MATERIALS AND METHODS

Coconut palms (Var. West Coast Tall), in the age group of 20 to 25 years, were used for the experiments. They were maintained with the usual cultural and agronomic practices which included basin cleaning and addition of N: P: K in the ratio of 500: 320: 1200 gms per palm per year and plant protection measures. A group of 60 palms received summer irrigation

at the rate of 250 litres per palm per week in the basins during January–May, while another 60 palms were maintained under rainfed conditions. The palms from these plots were used for all the experiments. Experiments 1 and 2 were carried out in 1981–82 while the experiment 3 was undertaken in 1983.

Experiment 1: After few weeks of irrigation during summer, 20 palms were selected each from irrigated and unirrigated plots for water uptake by roots. Three roots per palm from different sides were carefully traced horizontally upto one metre from the bole region and the colour of the root, which normally indicates its maturity (Menon and Pandalai, 1958), noted. After cleaning the root thoroughly with water, it was cut with a sharp knife under continuous supply of water from a wash bottle. Then, the cut end of the root was immediately inserted carefully into an amber coloured, narrow mouthed bottle (500 ml capacity) held in slanting position filled with 400 ml water. Care was taken to see that the cut end of the root was completely immersed in water to ensure effective uptake and then the mouth was tightly closed with cotton. The bottle covered with soil all around. At the end of 24 hours, the bottle was carefully removed and the quantity of water left behind was measured. The uptake was calculated from the difference between the initial supply of water and the left over after 24 hours.

Experiment 2: From the same plots, ten palms with the disease index (George and Radha, 1973) in the range of 0 to 10% (Apparently healthy) and ten diseased palms with the disease index 25 to 40% (middle stage of disease) were selected for uptake studies. The details of the experiment are the same in the previous one.

Experiment 3: Ten palms each from apparently healthy and diseased groups were selected in the irrigated plot alone. All the palms were irrigated uniformly with 250 litres per palm in the basin the previous day. Soil moisture content was determined gravimetrically one day after irrigation until five days at one day interval at three depths namely, 0–30, 30–60 and 60–120 cm with duplicate sampling at each depth. Soil samples were collected at a distance of 0.5 to 1.0 m and 1.0 to 1.5 m from the bole on different directions on the five days to represent the moisture profile in the entire basin area and also the root zone of differential activity. The experiment was repeated twice with ten palms (five each of apparently healthy and diseased palms) each time. Initial weight of soil samples was determined immediately after collection in the field itself and the dry weight was determined after five days in the oven maintained at 100°C. Likewise, a total of 600 soil samples were analysed.

The data collected under the three experiments was subjected to statistical analysis and results are discussed on the basis of significant differences.

RESULTS

Experiment 1: The uptake of water by roots of different maturity differed significantly (Table I). Old and matured roots (dark brown) showed a significantly lower uptake of water

compared to the relatively young (red) and fresh (cream) roots, while the latter to were at par. A two factor analysis with irrigation and maturity of roots indicated that there was no significant impact of irrigation on the uptake of water. However, the interaction between these two factors was significant. In this connection, it may be noted that irrigation had definitely enhanced the efficiency of water uptake both by fresh and young roots. In the case of matured roots irrigation had an opposite effect and perhaps was the reason why the beneficial effect of irrigation was not reflected when the overall mean of the three types of roots was considered.

Table I. *Water uptake by roots of different maturity under irrigated and unirrigated conditions. Values represent mean absorption by single root; three roots per palm and 20 palms used.*

Water uptake, ml. root^{-1} day^{-1}

Treatment (B)	Fresh	Root Maturity (A)		Mean
		Young	Mature	
Unirrigated	201.5	213.6	207.8	207.6
Irrigated	244.2	260.5	160.9	221.9
Mean	222.9	237.0	184.4	
C D. at 5%:	A=35.60;	B=N.S.;	C=50.34	

Experiment 2 : From the Table II it is evident that the uptake by the roots of apparently healthy palms was higher than that by the diseased palms. In other words, the intensity of disease has significantly adverse effect on the uptake of water (a reduction of 36.3% in the diseased compared to healthy palm). There was a significant impact of irrigation on water uptake, irrespective of the palm condition. It is of interest to note that the situation in the diseased palm could be significantly improved by irrigation. In fact, diseased palm had shown 25% more uptake with irrigation compared to unirrigated, as against 17.9% in the case of healthy palms.

Table II. *Water uptake by roots of palms with different disease intensities. Values represent mean absorption by three roots per palm; ten palms were used under each category.*

Water uptake, ml. root^{-1} day^{-1}

Treatment	Disease Index (%)		Mean
	(0 to 10) Apparently healthy)	(25 to 40) Middle Diseased	
Unirrigated	709.0	451.5	580.2
Irrigated	836.0	564.5	700.2
Mean	772.5	508.0	
C. D. at 5%:	Treatment:	80.19;	Disease index: 80.19

Experiment 3 : The differences in moisture depletion between healthy and diseased palms is represented in Table III. The soil moisture levels were significantly higher at the basins of the diseased palms at 30 and 120 cm depths than that at healthy palms. Though not significant, the same trend was noticed at 60 cm. This indicated that there was greater depletion of moisture (*i.e.*, higher uptake of water) by the apparently healthy than the diseased palms. Regarding the soil moisture level at one day interval after irrigation upto fifth day, it was significantly different only at 30 cm depth but not at lower depths. The fluctuations observed in some cases at one day interval could be due to the fact that the soil samples were collected

Table III. *The pattern of soil moisture depletion by the roots of apparently healthy and diseased palms at different soil depths*
Soil moisture content per cent dry weight

Soil depth cm	Palm condition	Days After irrigation					Mean
		1	2	3	4	5	
0 – 30	App. healthy	7.05	6.11	5.47	4.13	2.73	5.30
	Diseased	7.57	6.96	5.85	5.03	4.77	6.04
	Mean	7.31	6.54	5.66	4.58	4 25	
	C. D.	Palm condition: 0.74X ; Days: 1.17XX					
30 – 60	App. healthy	4.27	4.27	4.76	3.47	4.22	4.20
	Diseased	5.53	5.02	5.03	4.58	4.90	5.07
	Mean	4.90	4.80	4.90	4.02	4.56	
	C. D.	Palm condition: N. S.; Days: N. S.					
60 – 120	App. healthy	3.24	3.80	3.76	3.67	3.30	3.55
	Diseased	3.97	4.68	5.39	6.20	6.27	5.30
	Mean	3.61	4.24	4.58	4.94	4.79	
	C. D.	Palm condition: 0.70X , Days: N. S.					

at different locations on different days in the basins and secondly, the root mass would vary from one place to the other where the soil sample was collected. Another point which needs mention here is that in few cases the basins of palms were partially shaded by the adjacent huge trees and thus would have resulted in the retention of slightly higher moisture content at the surface compared to open basin where evaporation would be greater. All these factors might have contributed to daily fluctuations, which could not be eliminated.

Though the mean moisture content at 30 cm depth was at high level both in apparently healthy and diseased palms (5.30 and 6.04%) a gradual decline was found at 60 and 120 cm in the former, while in the diseased palms the moisture level remained more or less the same. For instance, at 120 cm it was 3.55% in the healthy as against 5.30% in the diseased palms. This substantiates our contention that the water uptake is more by apparently healthy as compared to the diseased palms.

DISCUSSION

Earlier workers demonstrated a drastic reduction in the number of active roots, a decrease in the bole diameter and poor root regeneration capacity in the diseased palms (Nagaraj and Menon, 1955, Menon and Pandalai, 1958, Michael, 1963 and Radha et al. 1971). All these reflected on the activity of roots in terms of uptake of water. In 1964 Davis showed that the mean uptake of water by a single root of a healthy palm was 250 ml per day as against only 150 ml by that of a diseased palm. Ramadasan (1964) found 35% reduction in the uptake of

and transport of water through the trunk of diseased palms compared to that in the healthy palm. Even the excised root tissues of diseased palms exhibited poor water absorption capacity (Chacko Mathew, 1968). The data from the experiments in the present study also indicated that the root (wilt) disease of coconut adversely affected water uptake.

The additional information collected here pertains to the influence of irrigation not only on the uptake pattern through roots of different maturity, expressed through colour differences (Menon and Pandalai, 1958), but also on the trend in the uptake between the apparently healthy and diseased palms. Irrespective of the palm condition, the summer irrigation had a favourable effect on the uptake of water, particularly through young and active (cream coloured) and some-what matured (red coloured) roots. This would indicate that irrigation had resulted in greater activation and/or regeneration of roots compared to unirrigated conditions. The adverse effect of irrigation on the uptake by old and matured (dark brown coloured) roots might be attributed to the greater proportion of degenerating tissues in these roots, which when flooded with water would result in further decay and thus poor absorption.

The moisture content will not be uniform at any time of measurement in the entire profile for the following reasons. The retention of water will be regulated by soil organic matter content, finer fraction in soil and arrangement of soil particles. As surface will have higher organic carbon content due to routine application of organic matter, it retains more water as it happened at 0 to 30 cm depth in the present study, than the lower depths. The rhizosphere addition of organic matter influences the middle layer as the concentration of roots will be maximum (Martin, 1977), but as the nature of the organic matter is of mostly non-humic nature, the effect is not so prominent. The last layer definitely will have much lower carbon content. Further evidence for the poor uptake of water by the roots of diseased palms was provided by the data on soil moisture depletion pattern. Again, the dysfunction of roots of diseased palms was highlighted. Two other related aspects, which had direct bearing on the function of roots, namely the uptake of ^{32} P by roots and the activity of pectinlyase in the roots of diseased palms (Dwivedi, Ray and Ninan 1979 and Sumathykutty amma and Patil, 1984) also indicated that greater damages were caused to the roots of diseased palms than those of healthy palms.

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REFERENCES

CHACKO MATHEW. 1968. Annual Report, Central Coconut Research Station, Kayangulam. p. 14.

DAVIS. T. A. 1964. Contribution to the physiology of the coconut palm. 2nd Session, FAO Tech. Working Party on coconut production, protection, processing, Colombo, pp. 150–174.

DWIVEDI, R. S., RAY, P. K., and SUNNY NINAN, 1979. Absorption, distribution and utilization of radioactive phosphorus in healthy and root (wilt) diseased coconut palms. *J. Nuclear agric. biol.* **8**: 33–35.

GEORGE, M. V. and RADHA, K. 1973. Computation of disease index of root (wilt) disease of coconut. *Indian J. agric. sci.* **43**: 366–370.

MARTIN, J. K. 1977. The chemical nature of ^{14}C labelled organic matter released into soil from growing wheat roots. In: *Soil Organic Matter Studies*. Vol. I, 197–203. I. A. E. A.

MENON, K. P. V. and PANDALAI, K. M. 1958. *The Coconut Palm-A Monograph*. Indian Central Coconut Committee, Ernakulam, India. pp. 384.

MICHAEL, K. J. 1963. Studies on the root system of coconut palm. *Indian Coconut J.* **17**: 85–92.

NAGARAJ, A. N. and MENON, K. P. V. 1955. Observations on the root decay in coconut, its cause and its relation to the foliar symptoms of the disease in the disease belt of Travancore-Cochin. *Indian coconut J.* 8: 97–105.

RADHA, K., RAVINDRAN, P. S. and GEORGE, M. V. 1971. *Annual Report of 1969 and 1970. C. P. C. R. I.*, Kasaragod, pp. 198.

RAMADASAN, A. 1964. Physiology of the wilt disease in coconut palm. Proc. 2nd Session FAO Tech. Working Party on coconut production and processing Colombo, pp. 257–272.

SUMATHYKUTTY AMMA, B. and PATIL, K. D. 1984. Pectinlyase activity in the coconut palm affected by the root (wilt) disease. *J. Plant. Crops.* **12**: 182–184.