

Evaluating Root Degeneration in Coconut in Relation to Root (Wilt) Disease

THOMAS JOSEPH, Scientist S-1, and N. P. JAYASANKAR, Joint Director, Central Plantation Crops Research Institute, Regional Station, Kayangulam, Krishnapuram-690 533, Kerala, India

ABSTRACT

Joseph, T., and Jayasankar, N. P. 1982. Evaluating root degeneration in coconut in relation to root (wilt) disease. *Plant Disease* 66:667-669.

Neither root degeneration nor root regeneration in healthy and root (wilt)-affected coconut palms was statistically significant. Eight, 11, and 6% of roots in West Coast Tall palms and 3, 3, and 4% of roots in locally grown Philippine palms were decayed in healthy trees, trees in the middle stage of the disease, and trees in the advanced stage of the disease, respectively. Observations confined to any sector of the root system were not representative of root characteristics.

The etiology of coconut root (wilt) disease remains elusive, but the disease syndrome strongly indicates a characteristic wilting. Studies have indicated that transmission of the causal agent occurs largely through the soil (5-7). It would be logical to suppose that the root system is the portal of infection and hence that roots degenerate considerably with the progress of the disease. Critical examination, however, reveals that reports of root degeneration associated with this disease remain controversial (12,13,15). We examined the condition of the root systems of coconut palms (*Cocos nucifera* L.) in relation to root (wilt) disease.

MATERIALS AND METHODS

Root systems of 18 coconut palms were examined. Nine were 35-yr-old West Coast Tall (WCT) cultivar; the other nine were 20-yr-old Philippine cultivar. Of the nine palms in each group, three were healthy, three were in the middle stage of the disease (disease index between 35 and 50), and three were in the advanced stage of the disease (disease index above 50). They were categorized on the basis of foliar condition (2).

Four consecutive concentric zones 1 m wide were marked on the soil surface around the bole of each palm. A trench

was dug by removing the soil and the roots in the fourth zone to a depth of 2 m. Soil from the third zone to a depth of 2 m was washed into the trench already dug at the fourth zone with force-driven water. After being thoroughly washed (Fig. 1), the main roots were cut and sorted into four categories: healthy young roots, healthy old roots, regenerated roots, and decayed roots. Young and old roots were differentiated on the basis of color (7). Roots with one or more stout branches emerging near a damaged tip (1) were

regarded as regenerated. Roots demonstrating drying, cracks, blotches, etc. (7) were classified as decayed. Counts in each category for each zone were recorded separately. The data were analyzed with analysis of variance (ANOVA), after square root transformations were made.

RESULTS

Average number of roots recorded in each category in the WCT palms is presented in Table 1 and in the Philippine palms in Table 2. Healthy WCT palms had significantly more roots than those in the middle and advanced stages of the disease. In the Philippine palms, total number of roots was uniform in healthy trees and trees in different stages of the disease.

Fifty to 55% of the roots in the WCT palms belonged in the healthy old category. In the Philippine palms, this category ranged from 60 to 75%. The difference between the number of healthy

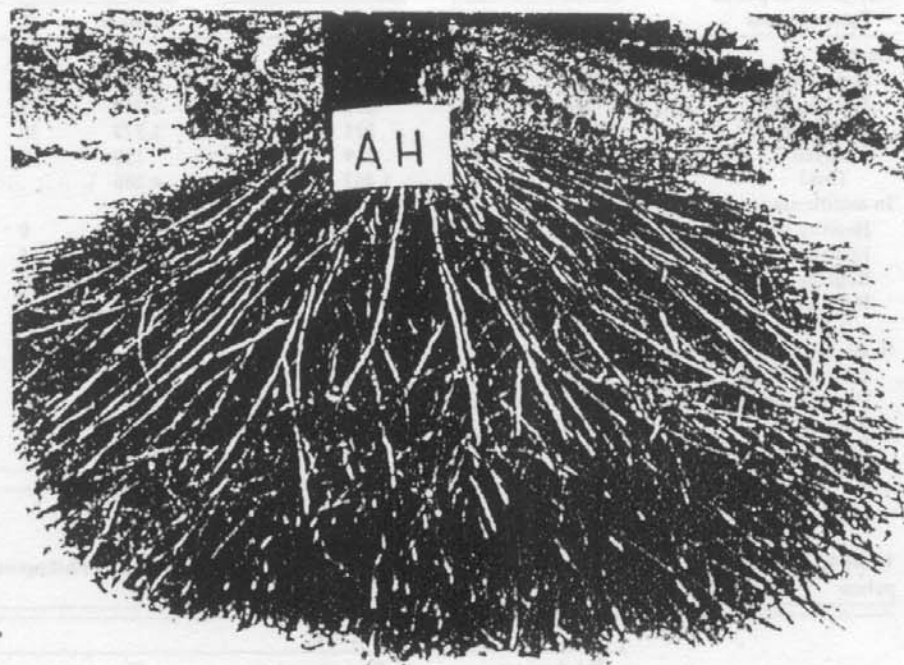


Fig. 1. Root system of apparently healthy (AH) Philippine palm in the first concentric zone (0-1 m from the bole).

Accepted for publication 28 September 1981.

The publication costs of this article were defrayed in part by page charge payment. This article must therefore be hereby marked "advertisement" in accordance with 18 U.S.C. § 1734 solely to indicate this fact.

0191-2917/82/08066703\$03.00/0
©1982 American Phytopathological Society

young and healthy old roots was significant ($P = 0.01$) for both types of palm.

Number of roots of WCT averaged 3,429, 1,072, and 628 in the first, second, and third concentric zones, respectively. Corresponding numbers for the Philippine palms were 3,663, 977, and 655. Root concentration in the first concentric zone of both cultivars was significant ($P = 0.01$).

Number of regenerated roots did not differ significantly either between types of palm or among the categories of healthy and diseased. Regenerated roots were distributed proportionately among the concentric zones.

Number of decayed roots averaged 159, 147, and 120 for WCT and 57, 64, and 47 for Philippine palms, in the first, second, and third concentric zones, respectively. This lack of concentration

proportional to the corresponding total number of roots in each zone makes the interaction between the number of decayed roots and the concentric zones significant ($P = 0.01$). However, the interaction between the number of decayed roots and the condition of palms was not significant for either type of palm. Percentage of decayed roots in WCT palms was 8, 11, and 6 and in the Philippine palms 3, 3, and 4 for healthy, middle, and advanced stages of the disease, respectively.

Average number of roots in eight equal sectors of the root system in the first and second concentric zones of five palms ranged from 355 to 598 and from 86 to 188, respectively. The corresponding ranges of the coefficient of variation were 16-27 and 17-36. Evidently, the number of eighth sectors required to minimize the "margin of error" in sampling to within

20% ranged from two to four and five for the first and second concentric zones, respectively. Corresponding figures restricting the margin of error within 10% are four to six and five to seven.

DISCUSSION

Under normal management conditions the roots of an adult, bearing coconut palm growing in sandy loam soil concentrated within a radius of about 85% are less than 120 cm (3,10). This amply justifies our attempt to expose the root system within a radius of 3 m and 2 m deep.

The root habits of coconut palms greatly, depending on the nature of seed nuts they were raised from. Moreover, the total number of roots per palm ranges from 1,500 to 7,000 (1). Therefore, the observation that healthy WCT palms had significantly more roots may not be relevant to the condition of health or disease. Uniformity in the number of roots observed in Philippine palms irrespective of the condition further substantiates the reported role of seed nuts in determining the total number of roots of the palm (1). The fact that all the Philippine palms were 20 yr old may also contribute to uniformity in the total number of roots.

Our observation that most roots in WCT palms (50-55%) and in Philippine palms (60-75%) were healthy old roots corroborates an earlier observation (7) in which the age of roots was determined on the basis of their color. In 15-yr-old palms, most roots were dark brown, and their number increased as the palm aged. However, neither color nor age of roots is indicative of their functional nature, because there are no dead roots and only some of them could be dormant (14). Our observations on the maximum concentration of roots in the first concentric zone agree with earlier ones (3,10).

Our data on the ability of trees to regenerate roots and the rate of root decay in healthy and diseased palms necessitate a reexamination of earlier reports on the root symptoms. One study reported considerable deterioration of the root system and decrease in production after infection by the root (wilt) disease (7). Root systems of diseased palms were reported to be inferior in the number of roots, their distribution, length, etc. (8). Another study reported root decay up to 92% for root (wilt) disease (13). Other reports, however, showed that root symptoms (root rot) did not correspond with the symptoms of the root (wilt) disease (4). The reported symptom of drying of main roots and rootlets was hardly present when fresh holes were dug for examination (5). Roots did not rot except when in contact with water, although there is no reason to think that the roots would

Table 1. Average number of roots in different zones of healthy and root (wilt)-affected West Coast Tall palms

Condition of palms Type of roots	Zone					
	Third meter		Second meter		First meter	
	Number	%	Number	%	Number	%
Healthy						
Healthy young	210	27	334	23	644	15
Healthy old	351	44	638	44	2,219	52
Regenerated	44	6	271	18	1,273	30
Decayed	186	24	219	15	130	3
Total	791		1,462		4,266	
In middle stage of disease						
Healthy young	71	20	160	24	312	9
Healthy old	199	57	283	43	2,002	55
Regenerated	16	5	66	10	1,041	29
Decayed	66	19	143	22	281	8
Total	352		652		3,636	
In advanced stage of disease						
Healthy young	194	26	238	22	361	15
Healthy old	413	56	722	65	1,372	58
Regenerated	24	3	63	6	586	25
Decayed	109	15	80	7	65	3
Total	740		1,103		2,384	

Table 2. Average number of roots in different zones of healthy and root (wilt)-affected Philippine palms

Condition of palms Type of roots	Zone					
	Third meter		Second meter		First meter	
	Number	%	Number	%	Number	%
Healthy						
Healthy young	53	8	161	17	592	13
Healthy old	531	82	669	71	2,608	59
Regenerated	27	4	42	4	1,157	26
Decayed	33	5	64	7	60	1
Total	644		936		4,417	
In middle stage of disease						
Healthy young	71	11	70	7	394	11
Healthy old	466	74	756	81	2,602	75
Regenerated	39	6	58	6	442	13
Decayed	57	9	55	6	40	1
Total	633		939		3,478	
In advanced stage of disease						
Healthy young	96	14	125	12	370	12
Healthy old	499	73	801	76	1,978	64
Regenerated	40	6	58	5	676	22
Decayed	52	8	73	7	71	2
Total	687		1,057		3,095	

dysfunctional (15). Another study found that root decay was insignificant in palms in the early stage of the disease (9). Our observation that root decay was not statistically significant in either type of palm in different stages of disease substantiates the view that root decay does not form part of the characteristic symptoms of the root (wilt) disease.

Earlier reports of a high percentage of root rot were based on observation of the condition of roots in one-eighth of the root system. Our data show that the margin of error when only one-eighth of the root system is sampled is high. The practice of calculating the total number of roots of a palm after counting the roots in one-fourth or one-fifth of the system gave erratic results (11). The relevance of the observation that the branch roots of coconut are short-lived and are replaced frequently (14) cannot be overlooked when the degree of root rot associated with root (wilt) disease is assessed. Misinterpretation of this natural

phenomenon may also make the assessment erroneous.

ACKNOWLEDGMENT

We thank Jacob Mathew, Statistician, Central Plantation Crops Research Institute, Kasaragod-670 124, Kerala, India, for statistical analysis.

LITERATURE CITED

1. Copeland, F. B. 1921. *The Coconut*. Macmillan & Co., London. 225 pp.
2. George, M. V., and Radha, K. 1973. Computation of disease index of root (wilt) disease of coconut. *Indian J. Agric. Sci.* 43:366-370.
3. Kushwa, B. L., Nelliath, E. V., Markose, V. T., and Sunny, A. F. 1973. Rooting pattern of coconut (*Cocos nucifera* L.). *Indian J. Agron.* 18:71-74.
4. Lal, S. B. 1969. Root (wilt) disease—Resume of work done since 1964. FAO Technical Working Party on Coconut Production, Protection, and Processing. Working papers presented at the third session in Jogjakarta, Indonesia. United Nations, Rome. 11 pp.
5. Maramorosch, K. 1964. A survey of coconut diseases of uncertain etiology. FAO, United Nations, Rome. 39 pp.
6. Mathen, K., Gopinathan Pillai, N., Mathew, A. S., and Shanta, P. 1976. Reproduction of

symptoms of root (wilt) disease of coconut in potted coconut seedlings. *J. Plantation Crops* 4:78-79.

7. Menon, K. P. V., and Pandalai, K. M. 1958. *The Coconut Palm—A Monograph*. Indian Central Coconut Committee, Ernakulam, India. 384 pp.
8. Michael, K. J. 1963. Studies on the root system of coconut palm. *Indian Coconut J.* 17:85-92.
9. Nagaraj, A. N., and Menon, K. P. V. 1955. Observations on the root decay in coconuts, its cause and its relation to the foliar symptoms of disease in the disease belt of Travancore Cochin. *Indian Coconut J.* 8:97-105.
10. Nair, P. K. R. 1979. *Intensive Multiple Cropping with Coconuts in India: Principles, Programmes, and Prospects*. Verlag Paul Parey, Berlin. 147 pp.
11. Patel, J. S. 1938. *The Coconut—A Monograph*. Government Press, Madras, India. 313 pp.
12. Radha, K., and Lal, S. B. 1967. Annual Report of the Central Coconut Research Station, Kayangulam, India. 64 pp.
13. Radha, K., Ravindran, P. S., and George, V. 1971. Annual Report of 1969 and 1970. Central Plantation Crops Research Institute, Kasaragod, India. 198 pp.
14. Sampson, H. C. 1923. *The Coconut Palm*. Cited in: *The Coconut—A Monograph*. J. S. Patel, ed. Government Press, Madras, India. 313 pp.
15. Vaghese, M. K. 1934. *Diseases of the Coconut Palm*. Government Press, Trivandrum, India. 105 pp.