Studies on the root system of the coconut palm

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The wilt disease of coconuts has usually been found to be associated with root damage. Thus 'Bronze leaf wilt' and 'Tapering stem wilt' of coconuts in West Indies (Briton Jones, 1928 and Bain 1937), the 'Unknown disease' of the coconut in Jamaica (Leach, 1946) 'Diseases of coconut in New Guinea' (Bryce, 1924 and Dwyer 1937), Root disease of coconuts in Ceylon (Petch 1928; Park, 1928 Small 1927; Cooke 1950), the 'Cadang-cadang' disease of coconut in Philippines (Ocfemia, 1937) etc., have been traced among other things to the damaged root-system.

Menon and Nair (1949) found root damage in trees affected by the Root (wilt) disease of coconut in Travancore-Cochin. According to them conspicuous breakdown is noticed in the root system of most of the diseased palms. Rotting of the root tip or major portion of the root, drying in patches and forming necrotic streaks, cracking along the mature region etc., are some of the different types of symptoms seen on the roots of the diseased trees. Detailed studies on the root system of coconut palms of different ages, both healthy and diseased, have been formulated in the Plant Physiology Section, Central Coconut Research Station, Kayangulam. with a view to assess the extent of root damage in the diseased trees as compared to that in the healthy ones. The results obtained from a study of healthy and diseased five-year old coconut palms are presented in this paper.

MATERIALS AND METHODS

The palms for the study were selected at random from the coconut garden attached to the Research Station. Five healthy and five diseased palms were

selected for the purpose. Palms in the early and advanced stages of disease were included.

Detailed morphological observations on the condition of the seedlings were recorded. These observations included an assessment of their healthy or diseased condition. In the case of diseased palms the extent of disease incidence as indicated by disease symptoms such as distortion in size, drying, yellowing, bronzing, puckering flaccidity and reduction in growing parts were noted. Measurement of quantitative vegetative characters relating to growth, viz., height of the shoot, circumference of the trunk, number of leaves and leaf-lets were also noted.

Detailed studies of the root system were then undertaken. In estimating the number of roots in the palms under study, the method of Sampson (1923) was followed. Though this method was criticised by Patel (1938), later work at Central Coconut Research Station, Kayangulam (Davis & Michael unpublished data 1958-59) proved that this method is quite correct and dependable. Roots from one fourth sector of the bole portion were therefore exposed to the entire length and horizontal spread, position and depth of the roots from the soil surface were measured. Positions of the roots were sketched on graph and also on art paper. The roots were then separated carefully and removed to the laboratory. The condition of the roots, their length, thickness, colour and other characters were then studied in detail.

RESULTS AND DISCUSSION

Vegetative characters

Data on the quantitative vegetative characters of the healthy and diseased palms are presented in Table I. With regard to the vegetative characters studied, the healthy palms are more outstanding. The average percentage increase in respect of height of shoot, circumference of the trunk and the number of leaves and leaflets of the healthy palms over the diseased are respectively 94,25,20 and 12. The structure of the above ground portion of the diseased palms is very much affected. Most of the leaves are coloured yellow or bronze, partially or completely dried and very much distorted in size. It is obvious that the stunted growth of the shoot system is due to the disease and may probably be the effect of damaged root system since a close correlation exists between the growth of roots and tops of most plant species as pointed out by Weaver and Clements (1938) Humphries (1938) Sampson (1923) and others.

Spread of roots

The characters of the healthy and diseased palms with regard to the spread of the main roots are shown in Table II. From a scrutiny of data presented in Table II and the sketches of the positions (lateral spread and

downward penetration) *in situ* of roots of the ten palms drawn on graph and art paper, it was found that there is no variation in this respect, probably because the palms are of very young stage. There was however, considerable reduction in the rate of new root production in the diseased palms. The capacity of the healthy palms to produce new roots is remarkable.

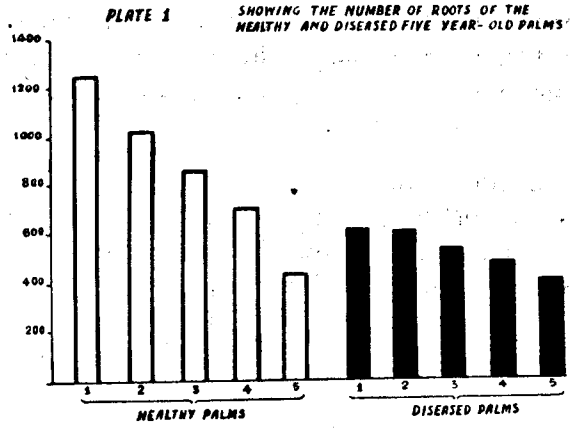
In this connection it may be noted that in a perennial crop plant like the coconut a well-developed root system is an indispensable factor for the healthy growth of the palms. An extensive and deep-seated root system covering a greater area and soil mass helps the plant to get a good supply of moisture and nutrients and enables it to withstand draught and effect of cyclonic winds.

Bole and root characters

It may be noted that fibrous roots constitute the root system of monocotyledons. In the case of the coconut, these roots are produced from the lowermost portion of the stem known as the bole. A big sized bole will afford abundant surface area for root development. In fact, healthy palms with a much bigger bole portion can produce a large number of main roots, rootlets and breathing roots. That, such is the condition with regard to the palms now under investigation is borne out by data presented in Table II. It is found that the healthy and diseased palms show wide differences in respect of bole size. On an average there is 30 per cent increase in the maximum circumference of the boles of the healty palms over the diseased.

Main roots and rootlets

The production and growth of the main roots in the diseased palms are much lower than that of healthy palms (Table II). The average number of main roots in a diseased palm is 527 while that of the healthy palm is 856, an increase of 62 per cent over the diseased (Plate 1.) and the average length of the main roots of diseased palm is 821.8 metres while that of the healthy one is 1002.6 metres, an increase of 22 per cent over the diseased. The roots of the diseased palms are brittle and with lesser thickness. Maximum as well as the average thickness of the main roots of the healthy palms is greater than that of the diseased palms with an average increase of 25 and 16 per cent respectively over the diseased. Further most of the roots of the diseased palms are deeper in colour, very few of them having the white and cream colours, characteristic of healthy growing roots. Whether colour difference is a positive symptom of disease, only further observation can show. Each of the five diseased palms possesses certain number of dead roots while in the healthy palms three are having root systems with no dead roots. The total number of dead roots in the diseased palms is more than six times as many as in the healthy palms.



The production of rootlets also is greater in the case of the healthy palms. The rootlets are largely concerned with the absorption of water and dissolved nutrients and on account of this Sampson (1923) characterises them as feeding roots. The average increase in the number of rootlets in the healthy palms over the diseased ones is 20 per cent. Though Sampson (1923) found that the main roots "in themselves are of little use in absorbing plant food from the soil" later work by Menon and Pandalai (1958) showed the absorbing power of the main roots to be very considerable. All the workers, however, agree on the absorptive capacity of the rootlets. As already stated, the number, distribution, length etc., of the main roots and the number of rootlets of the diseased palms are remarkably low. The power for absorbing nutrients must also be necessarily low.

Breathing roots

Breathing roots play a vital role in the physiology of the coconut palm. These roots are observed as the numerous small lentical-like white, pointed out growths formed mostly on the main roots and sparely on the rootlets. They help in the exchange of gases. The healthy palms under study have on an average 34788 such roots as against 25392 found in the diseased. The low capacity of the diseased palms for the absorption of useful gases and getting rid of toxic gaseous products is evident.

The data presented above appear to show that the diseased palms have a very poorly developed or defective root system. Whether this is a cause or effect of the disease is under investigation.

SUMMARY

The root system of the five-year old seedlings, five healthy and five affected by the root (wilt) disease, were studied in detail. The diseased palms were found

to give considerably lower values for all the characters studied viz., the number, thickness, colour etc., of the main roots, and number of rootlets and breathing roots. Percentage of dead roots is greater in the diseased palms. Quantitative vagetative characters of the shoot, length and circumference of the bole were also low in diseased palms. The root and shoot characters in relation to the health and diseased condition of the palms are discussed.

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TABLE I

Quantitative vegetative characters of the healthy & diseased palm

Sl. No.	Condition of palm	Height of the shoot (metres)	Circumference of the shoot (metres)	No. of leaves	Condition of leaves		Number of leaflets on one side of the leaf																Total
					Healthy	Diseased	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
1.	Healthy	6.1	1.3	13	13	Nil	35	108	105	113	109	122	122	123	124	123	124	123	124					1455
2.	,,	6.7	1.2	17	17	,,	99	90	111	118	120	123	121	126	124	125	126	124	124	127	128	127	126	2039
3.	,,	5.9	1.09	11	11	,,	30	96	100	102	101	104	101	103	100	104	109							1050
4.	,,	7.0	1.01	9	9	,,	88	90	92	101	100	99	97	103	106									876
5.	,,	5.5	0.91	9	9	,,	80	97	91	96	108	108	110	108	110									908
6.	Diseased	2.4	0.99	13	Nil	13	51	86	90	118	116	118	114	110	90	106	106	108	108					1231
7.	,,	3.4	0.91	9	,,	9	94	96	95	98	96	97	97	99	96									868
8.	,,	3.9	0.91	11	,,	11	30	96	100	102	101	100	103	102	100	104	106							1044
9.	,,	3.8	0.92	8	2	6	98	90	92	101	100	105	107	104										787
10.	Diseased	2.5	0.71	8	Nil	8	98	92	28	79	106	106	106	70										685
	Average % increase of the healthy over the diseased	95	25	20																				12

TABLE II

Showing characters of the boles and roots of the healthy & diseased palms

Sl. No.	Age of the tree	Condition	Circumference of the bole	Main Roots								
				Total No.	Total length	Maximum length	Maximum horizontal spread	Maximum depth	Dead roots	Diameter (1) Maximum (2) Average	Rootlets	Breathing roots
			metres		metres	metres	metres	metres	No. %	m.m.		
1	5	Healthy	1.18	1256	1259	6.7	6.7	4.3	101 8	(1) 13.2 (2) 6.9	19908	28620
2	,,	,,	1.10	1024	1263	10.1	8.8	3.2	10 1	(1) 9.6 (2) 6.2	26312	43908
3	,,	,,	1.0	860	1096	11.8	10.7	3.9	Nil	(1) 9.6 (2) 6.5	29920	55488
4	,,	,,	0.95	700	815	7.6	7.6	5.7	,,	(1) 11.2 (2) 7.8	17800	30536
5	,,	,,	0.84	440	580	8.0	7.8	2.3	,,	(1) 11.1 (2) 6.8	12700	15392
6	,,	Diseased	0.88	624	967	11.0	10.7	4.8	81 13	(1) 9.4 (2) 6.4	20263	32531
7	,,	,,	0.84	612	985	7.8	7.6	4.0	465 76	(1) 8.8 (2) 5.1	20732	27472
8	,,	,,	0.75	515	1019	8.1	7.9	4.2	21 04	(1) 9.1 (2) 5.7	21376	29264
9	,,	,,	0.76	481	537	8.0	7.2	2.0	4 08	(1) 7.4 (2) 6.0	11736	15392
10	,,	,,	0.66	404	601	9.8	9.5	3.8	156 39	(1) 9.2 (2) 6.2	14580	22308