Studies on Phloem Sap Collection from Healthy and Root (wilt) Diseased Coconut Palms (*Cocos nucifera* L.)

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ABSTRACT

Studies on Phloem sap collection from healthy and root (wilt) diseased coconut palms (*Cocos nucifera* L.). Rajagopal, V., Chempakam, B., Robert Cecil, S. and Kamalakshy Amma, P.G. Central Plantation Crops Research Institute, Regional Station, Kayangulam 690 533, Kerala, India, Pl. Physiol. & Biochem., 16(1) : 52-56, 1989.—The rate of flow of phloem sap from the inflorescences of coconut depends on the nature of the palms. While healthy palms yielded sap for longer duration in large quantities, root (wilt) diseased palms had less sap flow for restricted period. There were differences between healthy and diseased palms in the day and night collection of sap and its chemical composition. Sap flow varied between successive inflorescences of the same palm.

Key Word : Cocos nucifera *L, Inflorescence., Pholem sap, Root (wilt) disease.*

INTRODUCTION

In palms the inflorescence is the main source for the collection of sugar for production of toddy, the fermented sap of commercial value. Tapping depends on various factors, one of which is the health and vigour of the palms. Variations in the sap flow reflect the function of the phloem tissues and also physiological processes like photosynthesis.

Root (wilt) disease of coconut, a major disease in Kerala, is caused by Mycoplasma like organisms (MLOs). These organisms, restricted to the phloem sieve elements, are observed in greater numbers and in variable forms in the sink areas such as apical meristems, petioles of developing leaves, inflorescence axis and root tips (1-3). Phloem tissues harbour MLOs, and that phloem sap has been considered as a potential medium for the growth of MLOs (4). In the present study it was intended to examine the physiological and biochemical nature of the sap from the apparently healthy and diseased coconut palms.

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MATERIALS AND METHODS

Coconut palms (*Cocos nucifera* L. cv. West Coast Tall) grown in the Institute Farm with the normal cultural and agronomic practices, including fertilizer dose of 500 g N, 320 g P, 1200 g K per palm per year were selected for the studies. Using the disease index (DI) scoring method (5), seven apparently healthy (DI 0-10), seven early diseased (DI 11-25) and one moderately diseased (DI 26-50) palms were earmarked for the collection of the sap.

From each palm, the youngest inflorescence was tapped following the traditional method of systematic beating and slicing thrice a day. The process of sap collection was initiated when the sap oozate was noticed on the cut surface which normally took 2 to 3 days, with increased flow by 7 to 10 days after tapping was commenced. For day collection of vascular sap, the set up was mounted on the palm at 09.30 h and removed at 15.30 h, and for night collection, it was kept from 17.00 h to 09.00 h on the following day with 500 ml container in a larger jar. In some cases, successive inflorescences from the same palm were also processed for sap collection. At the end of the collection period, sap samples were subjected to fermentation test by measuring the pH (Beckman pH meter), osmotic concentration and total sugar content. Only the unfermented sap was then preserved in a deep freeze for further analysis.

The experiments were conducted between May and October 1983 and May and August 1984. The same palms were tapped in both the years and the mean of two years is persented.

RESULTS AND DISCUSSION

The unfermented sap was a clear straw coloured liquid with sweet odour, pH ranging from 6.8 to 7.5, high osmotic concentration (750–900 m mol kg^{-1}) and rich in sugars (0.27–0.29 g g^{-1} sap).

Apparently healthy palms had a rate of flow of 5 ml h^{-1} until 25 days, but shot up at 32 days with a rate of flow of about 22–25 ml. h^{-1} (Figure 1). This trend continued for 70 days followed by a rapid decline. Early diseased palm yielded a small quantity of sap initially (less than 5 ml h^{-1}), but registered a peak by 22 days with about 24 ml. h^{-1}. This was followed by a rapid decline in sap flow which ultimately ceased by 35 days. With the intensity of the disease, rate of sap flow decreased which did not last beyond 23 days.

In general, four to five inflorescences from the same palm yielded the sap (Table 1). However, the rate of sap flow decreased when the successive inflorescences were tapped. As observed earlier, sap collection from diseased

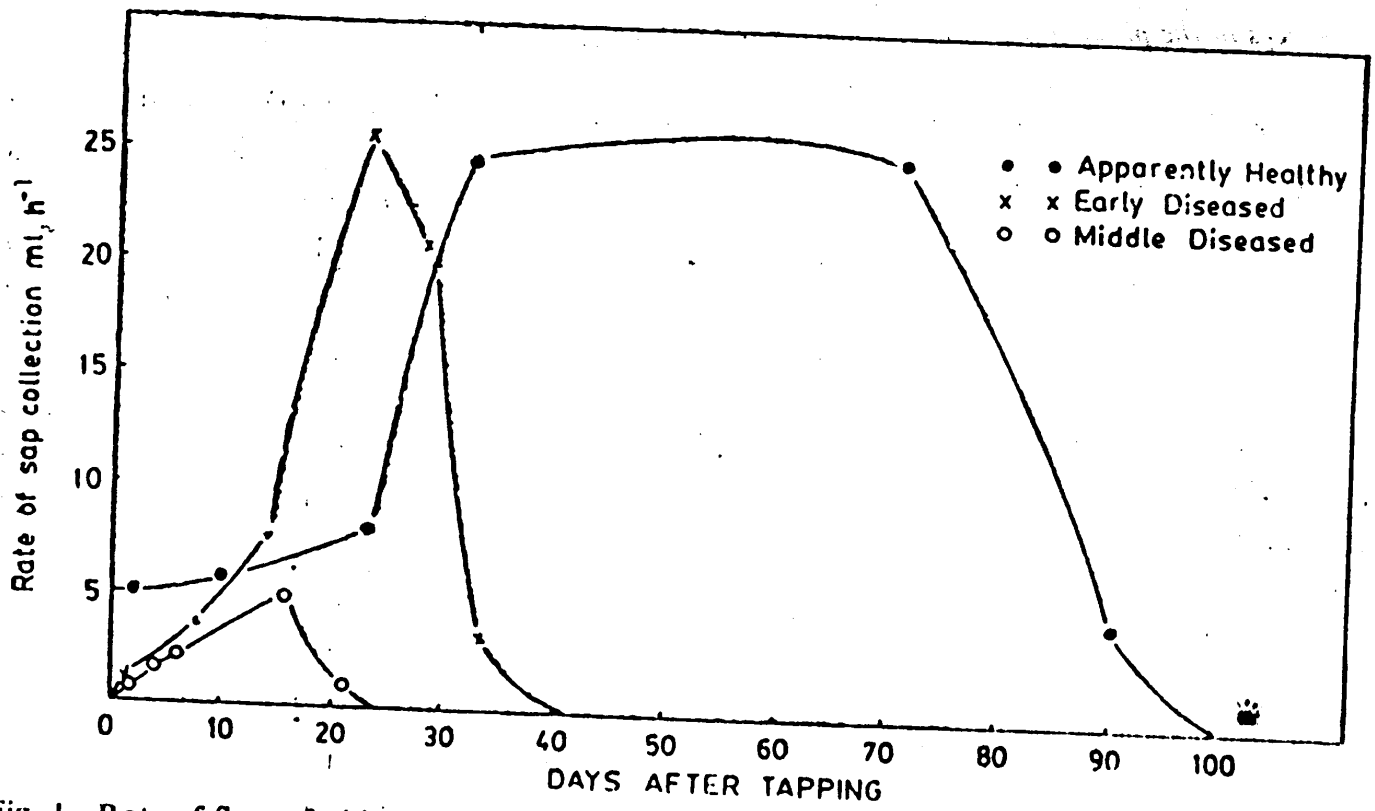

Fig. 1. Rate of flow of phloem sap from the inflorescences of apparently healthy and root (wilt) diseased (early and middle) coconut palms during development. Each point is mean of three determinations on four apparently healty, three early diseased and one moderately diseased palms.

TABLE 1

Rate of flow of phloem sap (ml h^{-1}) from successive inflorescences

Palm condition	Inflorescence number				
	1	2	3	4	5
Apparently healthy	19.5	13.9	7.5	6.3	1.3
Early diseased	9.6	4.2	2.3	0.3	—
Moderately diseased	1.3	1.3	0.7	0.6	—

palms was less, irrespective of the inflorescence tapped, than that from the apparently healthy palms.

The rate of sap collection differed between day and night, in that the flow was greater during the day than during the night, irrespective of the condition of the palm (Table 2). The pH of the sap from the day collection was higher than that from the night collection in both categories of palms. The sap from healthy palm had higher osmotic concentration than that from the diseased ones, with day concentration being lower than the night in both categories. There were changes

TABLE 2

Differences in the phloem sap collected during the day and night from the inflorescences of coconut palms

	Apparently healthy		Diseased	
	Day	Night	Day	Night
Rate of sap flow (ml. h^{-1})	17.8	11.4	9.9	4.1
pH	6.9	6.1	7.2	6.5
Osmotic concentration (m mol Kg^{-1})	720	765	660	690
Total sugars (mg g^{-1} sap solid)	250	180	180	190
Reducing sugars (mg g^{-1} sap solid)	52.0	45.8	51.1	24.6

in sugar concentrations also. Irrespective of the condition of the palm, the reducing sugar content was less in the sap collected during night than during the day, the difference between the day and night being marked in the diseased palms.

Exudation of sap from successive inflorescences of the same palm also indicated that root (wilt) disease affected the sap flow. What prevents the flow of sap at later stages of inflorescence development in diseased palms is most baffling. The role of turgor pressure in the sap flow has been emphasized by Milburn and Zimmermann (6) and recent studies have revealed the disturbed water potential components in the root (wilt) affected palms (8). Coconut palms affected by Lethal Yellowing disease in Jamaica also had poor sap flow (9).

Restricted flow of sap from the inflorescences of diseased palms indicates that the phloem transport system was hindered. Higher concentrations of MLOs are reported at sink sites both in lethal yellowing[3] and root (wilt) disease of coconut[1]. Whether such a blockage of sieve elements by MLOs could account for impeded sap flow in diseased palms is a pertinent question.

That the rate of sap flow is a complicated process and depends on environmental factors is evident from the differences in the flow rate between the day and night collection. Larger quantities of sap with higher sugar content is favourable for commercial purposes. This might be the reason for the tappers to select only the healthy palms, which exhibited relatively high level of reducing sugars and avoid the diseased ones.

The present investigation highlights the influence of root (wilt) disease on the flow of phloem sap from the inflorescence of coconut palms. Direct analysis of unfermented sap for the biochemical constituents viz. sugars, protein, free

amino acids, lipids and sterols showed the significance of collecting the sap under aseptic conditions (11).

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REFERENCES

1. SOLOMON, JJ, GOVINDANKUTTY, MP & NIENHAUS, F, *Z. Pflanzenkrankenheiten* 99 : 295 (1983).
2. PARTHASARATHY, MV & FISCHER, JB, *Principes J. Palm Soc.* 17 : 39 (1973).
3. PLASVIC-BENJAC, B, HUNT, P & MARAMOROSCH, K, *Phytopathology* 62 : 298 (1972).
4. MC COY, RE. *Proc. Amer. Phytopath. Soc.* 4 : 108 (1977).
5. GEORGE, MV & RADHA, K, *Indian J. Agric. Sci.* 43 : 366 (1973).
6. MILBURN, JA & ZIMMERMANN, MH, *New Phytologist* 79 : 543 (1977).
7. DUBOIS, M, GILES, K, HAMILTON, JK, REBERS, PA & SMITH, F, *Nature* 168 : 167 (1951).
8. RAJAGOPAL, V, SUMATHYKUTYAMMA, B & PATIL, KD, *New Phytologist* 105 : 289 (1987).
9. EDEN-GREEN, SJ, & WATERS, H, *Phytopathology* 72 : 667 (1982).
10. BEAKBANE, AP, SLALER, CHW & PONSETTE, AF, *J. Hort. Sci.* 47 : 265 (1972).
11. CHEMPAKAM, B & RAJAGOPAL, V, *J. Plantation Crops*, (1989) in press.

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