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WATER RELATIONS OF COCONUT PALM AFFECTED BY ROOT (WILT) DISEASE

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ABSTRACT

An investigation was undertaken to determine the status of transpiration, water content of leaves and cell and stomata frequencies per unit area of epidermis in coconut palms affected by root (wilt) disease. Significant increases in transpiration rate and water content of leaves were noticed in diseased palms. The frequency of epidermal cells and stomata per unit area of leaf was greater in diseased palms, though the stomatal index did not differ significantly between healthy and diseased palms. The existence of an internal water deficit in diseased palms has been indicated.

INTRODUCTION

Root (wilt) disease of coconut is suspected to be the combined effect of pathogenic microorganisms, nutrient imbalance and water stress. Various physiological disorders associated with the disease have been reported (Pillai and Shanta, 1965; Varkey, Michael and Ramadasan, 1969; Mathew, 1977; Michael, 1978). A general wilting of leaves, with abnormal bending or ribbing of leaflets (flaccidity) is the characteristic external symptom of the disease. preliminary studies have indicated an imbalance in the water economy of the diseased palm (Ramadasan, 1970). The present study has been undertaken to determine the status of transpiration, water content of leaves, frequencies of epidermal cells and stomata and stomatal index in root (wilt) disease affected palms.

MATERIALS AND METHODS

Twenty healthy and 20 root (wilt) disease affected 15–25 year old coconut palms were selected for the study at CPCRI Regional Station, Kayangulam. Palms, which clearly showed all the three characteristic symptoms of the disease, *viz.*, flaccidity, foliar yellowing and leaf necrosis were marked as diseased and palms which showed none of these symptoms were marked as healthy. Healthy palms were also subjected to biochemical test of Dwivedi et al. (1977) to confirm that they were free from the disease.

For estimation of transpiration, a pair of leaflets, from either side of the petiole in the central region of the leaf were excised between 10 a.m. and 11 a.m. on bright sunny day. The measurement of transpiration was by the "quick weighing" method (Slavik, 1974), in which transpiration was determined from the loss in weight of excised leaflets within a short specified period. Transpiration was assessed immediately after the leaflets were detached so that their water content reflected that of the normal state. The exposure interval (i.e., the time between initial and final

weighing) was maintained at two minutes. The rates were expressed as rate of water loss per unit area of leaf. Transpiration was determined from leaves collected from three different positions of the crown, *viz.*, first fully opened, middle and outer leaf, representing three different stages of maturity.

The water content of the leaf was determined by the procedure described by Slavik (1974). Fresh weight of leaflets, collected one each from either side of the mid-region of the petiole was recorded, placed in a pre-heated oven (80°C) and dried to constant weights. Water content was determined and expressed as percentage of fresh weight.

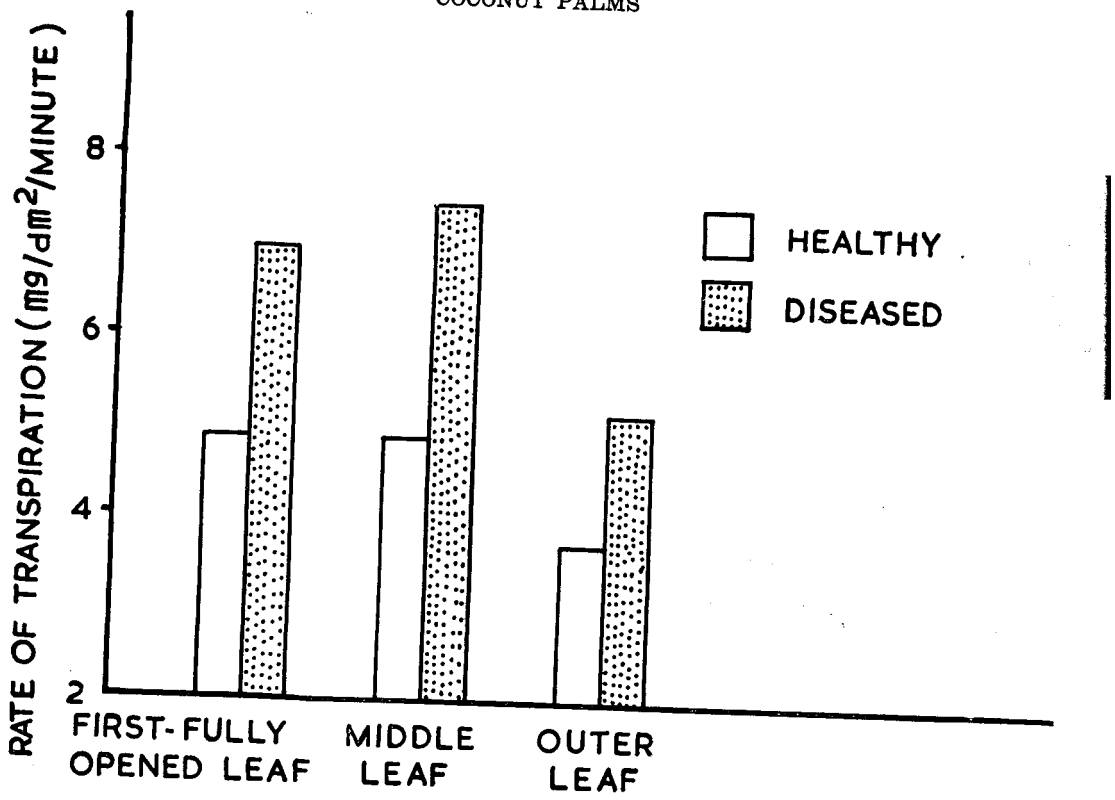
Frequencies of epidermal cell and stomata in the leaf were determined by examination of 'cuticular replicas' prepared by the method of Jayasingh (1976). Because of the difficulties in getting clear replicas of the outer old leaf, only first fully opened and middle leaves were examined in these studies. Stomatal index was calculated using the general formula:

$$\frac{\text{Number of cells (including stomata)} \times 100}{\text{Number of stomata}}$$

RESULTS AND DISCUSSION

Data presented in Fig 1. showed that there was significant increase in transpiration rate in all the leaves of the

FIG. 1. RATE OF TRANSPIRATION IN THE LEAVES OF HEALTHY AND DISEASED COCONUT PALMS



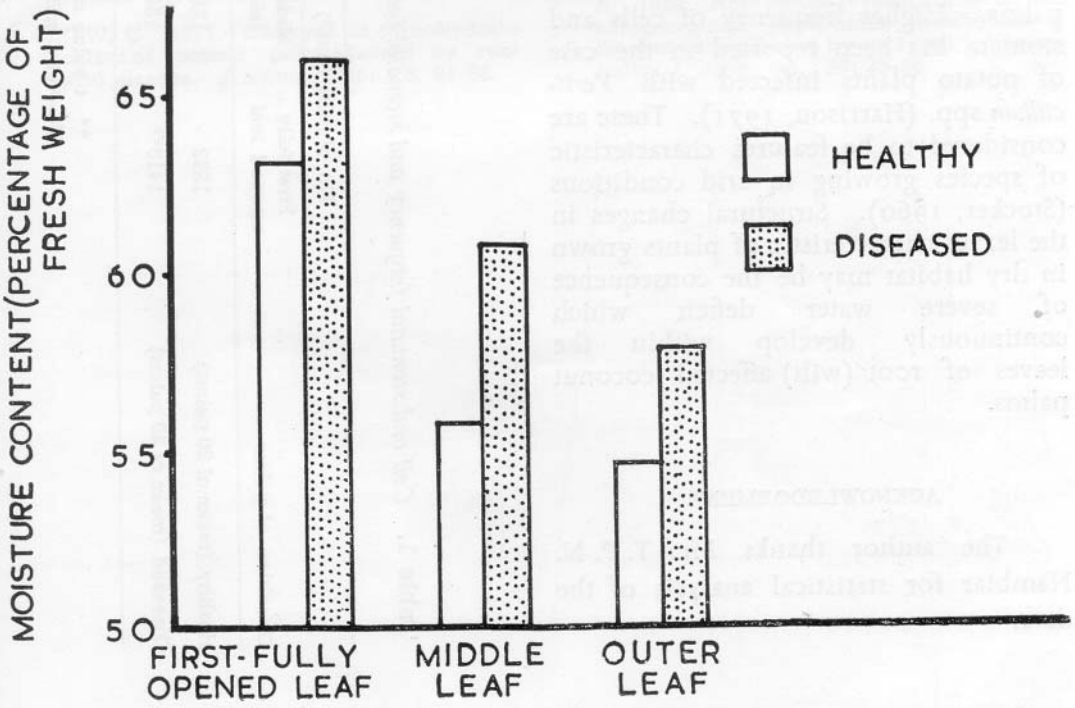
(t-values significant at P=0.01 in all cases)

diseased palms. Enhanced transpiration is a phenomenon often accompanying pathogenesis. Increased transpiration rate has been reported in tomato plants infected with *Fusarium* (Gaüman, 1958), tobacco mosaic virus and tomato spotted wilt virus (Subramanian and Saraswathy Devi, 1959). Rust infection have generally been found to increase the rate of transpirational loss from plants (Duniway, 1973).

Increased loss of water from diseased plants may be brought about by the removal of natural protection afforded by the cuticle and by the loss of sensitivity of stomata to respond to changes in leaf water content. Besides, changes in cell permeability are likely to increase the rate of water loss from the leaf tissue by affecting easy availability of water to the evaporating surfaces. Ionic imbalance is also known to produce protoplasmic shrinkage resulting in water loss (Osterhout, 1956). Thin cuticle and reduced staining reaction for suberin in the walls of hypodermal cells (Joseph and Shanta, 1963) and increased permeability of leaf cells (Anon, 1979) have been reported in root (wilt) affected coconut palms. An ionic imbalance in the leaf tissue has also been implicated in the disease (Anonymous, 1976).

An excess of transpiration often leads to progressive decrease in the water content of leaf tissues. But, this does not appear to be the situation in root (wilt) affected palms, which showed increased water content in the leaves (Fig. 2). Simonis (cited by Subramanian

FIG. 2. MOISTURE CONTENT IN THE LEAVES OF HEALTHY AND DISEASED COCONUT PALMS



(t-values significant at P=0.01 in all cases)

and Saraswathy Devi, 1959) reported that shortage of water might reduce the leaf area but often increased the water content of leaves, possibly by changes in the protoplasmic structure which enabled it to bind more water. Loss of turgor and consequent wilting under pathogenesis appear to be caused not by *excess of water loss* but by changes leading to the destruction of osmoregulatory mechanism of leaf cells. Derangement in the osmoregulation of leaf cells may bring about release of cellular components into the outer medium which appear to cause pathological wilting in plants (Gaüman, 1958).

The frequency of cells and stomata per unit area of leaf was greater in the diseased palms (Table 1). Despite differences in cell and stomatal frequencies, stomatal index did not differ significantly between healthy and diseased palms. Higher frequency of cells and stomata has been reported in the case of potato plants infected with *Verticillium* spp. (Harrison, 1971). These are considered to be features characteristic of species growing in arid conditions (Stocker, 1960). Structural changes in the leaves characteristic of plants grown in dry habitat may be the consequence of severe water deficit which continuously develop within the leaves of root (wilt) affected coconut palms.

Table 1. *Cell and stomatal frequency and stomatal index in the leaves of healthy and root (wilt) diseased coconut palms*

Condition of palms	No. of cells (mm²)		No. of stomata (mm²)		Stomatal index	
	First fully opened leaf	Middle leaf	First fully opened leaf	Middle leaf	First fully opened leaf	Middle leaf
Healthy (mean of 20 palms)	1272	1280	182	171	13.5	13.0
Diseased (mean of 20 palms)	1413**	1398**	228**	219**	15.1 NS	14.8 NS

** t value significant at P=0.01
NS-Not significant

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