Determination of Stomatal Resistance and Transpiration Rate in the Leaves of Coconut (*Cocos nucifera* L.) Using the Steady State Porometer*

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ABSTRACT

A study has been carried out to determine the stomatal resistace and transpiration rate in the leaves of young and adult coconut palms. A comparative study made between the 'intact' and 'excised' leaflets indicated that there was no significant difference between the two in their leaf diffusive resistance until five or six minutes after excision, but increased with time. Determination of the stomatal resistance within two minutes after excision of the leaflets, from different whorls of leaves in large number of adult palms revealed the accuracy of the values. Thus, a rapid method for the determination of diffusive resistance and transpiration rate in coconut, especially adult palms has been standardized. Results are discussed with particular reference to the practical difficulties encountered with srudies on adult palms.

INTRODUCTION

In studies on water relations of crop plants, the determination of stomatal resistance assumes great significance as it indicates the transpiration rate in different crops and varieties grown under field conditions with different moisture regimes. The relationship between the leaf diffusive resistance and the leaf water potential components like the turgor potential has been studied in crops like sorghum (Blum, 1974), wheat (Jones, 1977), beans (Turner, 1974) and other crops. Several studies indicated the threshold leaf water potential for stomatal resistance in different crops (Turner and Begg, 1978; Kassam, 1973),

In 1969, Kanemasu and others were the first to design the porometer for studying various aspects of stomatal regulation. During the years that followed further developments have resulted in the more sensitive approach for determining the stomatal resistance taking into account the interaction of factors. Several papers have appeared in literature dealing with the methodology adopted for different crops (Beardsell et al. 1972; Campbell, 1975; Bingham and Coyne, 1977). The recent fabrication of the steady state porometer by the Li-Cor Instruments Corporation, Nebraska, U. S. A., helps in recording, besides the stomatal resistance, the environmental factors closely associated with transpiration rate like light, temperature and relative humidity. While it is fairly easy to study the stomatal regulation in annual crops under field conditions, several difficulties are encountered with tree crops, wherein the determination of stomatal resistance need to be standardized depending on the canopy size and nature of the crops. Report in the literature in this regard are scanty. The present paper describes the development of a rapid method for the determination of leaf diffusive resistance in coconut leaves.

MATERIALS AND METHODS

Coconunt (*Cocos nucifera* L.) palms in the age group of 10 to 12 years were selected for determining the stomatal resistance in the 'intact' and 'excised' leaflets, whereas adult palms in the age group of 30 to 35 years were taken up for studying the diffusive resistance in the 'excised' leaflets from different whorls of leaves. These palms were grown in the Institute Farm with the usual cultural and agronomic practices.

Using the steady state porometer (Model 1600, Li-Cor Ltd., Nebraska, U. S. A.) the stomatal resistance and transpiration rate, as also leaf temperature were determined in the abaxial surface of the leaflets as coconut is hypostomatous type. Measurement of ambient temperature, light quantum and relative humidity represented the microclimate near the experimental palms. In the first experiment with young palms, the determinations were made at 6 positions along the length of the lamina on either side of the midrib of each leaflet from the middle whorl of leaves. Likewise, from fifteen palms and two leaflets per palm were subjected to study the changes in diffusive resistance- Immediately after determing the parameters in the 'intact' leaflet, the same leaflet was 'excised' and the surface was cleaned thoroughly with dry filter paper pads, and within two minutes the stomatal resistance and transpiration were determined at the same 6 positions along the lamina. The second experiment consisted of the determination of these parameters in 'excised' leaflets of ten palms, with two leaflets each, at intervals of two minutes after excision until ten minutes and with five minutes interval until thirty minutes to investigate the degree of stomatal closure.

In the third experiment, the 'excised' leaflets from the fully open (1st), middle (14th) and outer (30th) leaves of twentyfour adult palms were used. All the studies were made between 9.30 and 11.30 a. m. each day. The data were statistically analysed.

RESULTS AND DISCUSSION

There was no significant difference between the 'intact' and 'excised' leaflets in their stomatal resistance and transpiration within two minutes after excision of leafleft. Thus, the rapid determinations in the 'excised' leaflets almost represented the condition obtained with the normal i. e. 'intact' ones (Table 1). However, it was of interest to know the rapidity of stomatal closure in the 'excised' leaves. Hence, the time course study was carried out to establish the interval required between the excision of a leaflet from the leaf and the measurement of diffusive resistance and transpiration rate. Stomata remained widely open until four or five

Table 1 Stomatal resistance and transpiration rate in the 'intact' and 'excised' leaflets of coconut. Values are means of 15 palms with 2 leaflets each six observations on each leaflet.

		Stomatal ressitance (sec cm^{-1})	Transpiration rate ($\mu g\ cm^{-2}\ sec^{-1}$)
'Intact'		2.83	0.19
'Excised'		3.02	0.18
	t_l	0.72 (N. S.)	1.09 (N. S.)

minutes after excision, as exemplified by low diffusive resistance and high transpiration; however, with increase in time stomata started closing rapidly. (Fig 1) This trend was consistently

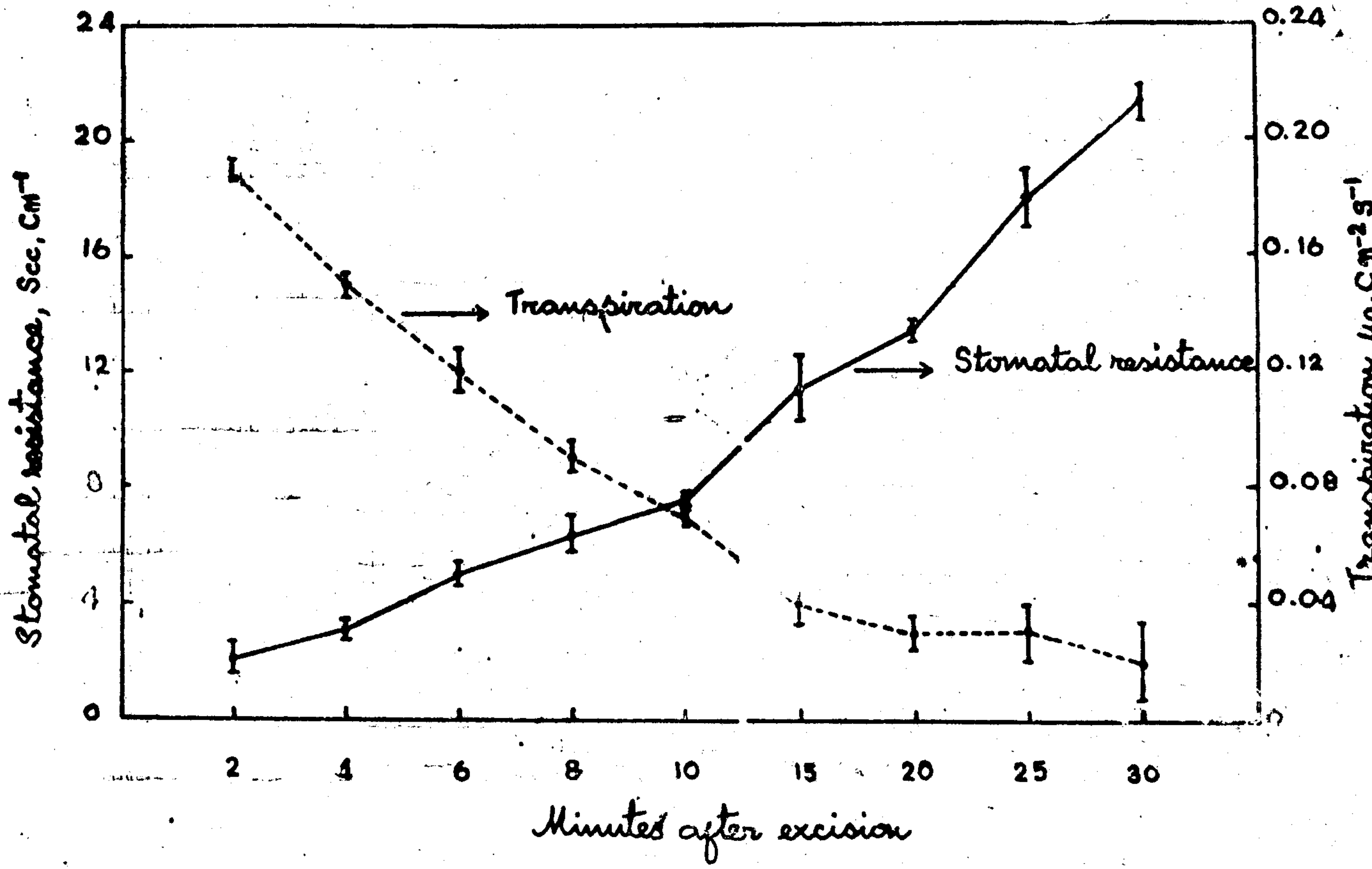

Fig. 1. Time course study of the stomatal resistance and transpiration rate in the 'excised' leaflets of Coconut. Values are means of ten palms with two leaflets per palm and six observations per leaflet. Vertical bars indicate the S. E. of the mean.

seen in all the palms studied. Thus, it could be established that the stomatal closure was negligible within two or three minutes after excision and it became significant only after five or six minutes. From this, it became clear that the estimations should be completed within two minutes, when the diffusive resistance was the minimum and the transpiration rate very high and wers comparable to intact leaflets (Table 1). Repeated experiments have shown that it is possible to achieve this if all the operations are carried out fairly quickly, i. e. excising the leaflets and cleaning the same. Sufficient precaution was taken not to excise all the leaflets at once, but only one by one after completing the measurements at six to eight positions on the lamina. This helped in maintaining uniform timings for each sample and in avoiding possible errors.

Though it was possible to study the diffusive resistance in the 'intact' leaves of young palms, the major difficulty arose for determining the same in adult palms of 30 to 40 feet high. Even if the adjustable ladder is provided, it is often difficult to reach all the adult palms in view of their scattered distribution in the gardens and that too within and in between inter-crop systems. Because of very stiff nature of leaflets it was found difficult to insert the sensor of the porometer at different heights. Moreover, working of the sophisticated equipment at such involved great operational risk. Lastly, the determination of the parameters in the 'intact' heights leaves of tall palms would be time-consuming, whereas the 'excised' leaf study offers a quick method, without sacrificing the accuracy of the results thus obtained (Table 1).

Thus, the method of determining the stomatal resistance in 'excised' leaflets within two minutes after excision was resorted to for twentyfour adult palms. The results, which were reproducible, indicated that the stomatal resistance did not differ much between the first and middle whorl, whereas in the outer whorl there was a threefold increase in the diffusive resistance with a concomittant decrease in transpiration rate. (Table II). The day fluctuations

Table II. Stomatal resistance and transpiration rate in coconut leaves of different whorls. Values are means 24 palms $\pm$ standard error of the mean. The leaflets from the 'first', 'middle' and 'outer' leaves were used. On each leaflet six observations were recorded.

Leaf position	Stomatal resistance (sac cm^{-1})	Transpiration rate ($\mu g\ cm^{-2}\ s^{-1}$)
First	2.97 $\pm$ 0.160	0.18 $\pm$ 0.088
Middle	3.35 $\pm$ 0.264	0.17 $\pm$ 0.009
Outer	10.16 $\pm$ 0.815	0.07 $\pm$ 0.005

in the leaf diffusive resistance and transpiration rate were determined along with the changes in light, temperature and relative humidity. The data revealed the mid-day closure of stomata with high light intensity and temperature a low relative humidity.

The rapid and accurate method described above was soon applied to monitor 54 young palms affected by the root (wilt) disease in the Institute Farm during different times of the day, and also different seasons. A comparative study of stomatal resistance between the healthy, apparently healthy, and diseased palms was also undertaken.

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