

STOMATAL DENSITY IN VARIETIES AND FORMS OF THE COCONUT *COCOS NUCIFERA* L.

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SUMMARY

An assessment of stomatal densities of varieties and forms of the coconut palm (*Cocos nucifera* L.), indicates that this may be a varietal characteristic. Variations due to the environment are negligible. All three colour forms of the self-pollinating *nana* variety have more stomata per unit area of leaf surface than the varieties *typica* and *aurantiaca*. Stomatal density may be of use in identifying *typica* × *pumila* F₁ hybrids.

INTRODUCTION

Studies on leaf anatomy of several plant species have revealed that the number of stomata per unit area of the leaf surface is, within certain limits, a characteristic of the particular species or variety under consideration. Observations have also been made that the environment can influence stomatal size and frequency.

The estimation of stomatal size and frequency is a useful tool in plant breeding, particularly, in screening diploids from tetraploids (Speckmann *et. al.* 1965). In tree crops, stomatal density has also been used to identify different races and clones of forest trees (Muhle Larsen, 1957), as well as apple cultivars, (Lihonas & Bolasova 1964). Studies carried out on *Hevea* species (Senanayake & Samaranayaka 1970), revealed differences in the density of stomata per unit area among twenty-five cultivars and breeders clones. They further report that there is no detectable relationship between stomatal density and yield. According to Menon & Pandalai (1958), nearly 200 stomata occur in each square millimetre of leaf surface of the coconut palm each stoma being approximately 38μ × 40μ including the subsidiary cells.

The object of the present investigation is to determine whether the stomatal density of varieties and forms of the coconut is a varietal character and also to study the relationships (if any) between stomatal density and the environment.

MATERIALS AND METHOD

(a) Stomatal densities in varieties and forms of the coconut

The coconut varieties block at Bandirippuwa Estate provided the material for this investigation. Five palms from each of the twelve forms belonging to the three varieties (Table 1) were sampled. A single leaflet was taken from the mid-region of the most mature green leaf from each of the selected palms.

(b) Stomatal densities in the *typica* and *nana* varieties from different agro-climatic regions

From each location, five palms from each of the two varieties were taken at random. Five leaflets from the middle of the most mature green leaf were sampled from each of the five palms representing a variety.

(c) Stomatal densities in *typica* × *pumila* (F₁) hybrids

15 palms from the Demonstration Block, Bandirippuwa Estate were sampled using the same sampling procedure as in (b) above.

(d) Procedure

Epidermal peels were taken from the abaxial surface of each leaflet, and these were immersed in absolute alcohol. Five epidermal peels taken at random were mounted in Heath's Reagent on a microscope slide. Stomatal density was scored within the field of view of the microscope, keeping the eye-piece, objective and tube length constant.

RESULTS AND DISCUSSION

The stomatal densities of the varieties and forms of the coconut growing in Ceylon are given in Table 1. It will be observed that all three colour forms of the *nana* variety have more stomata per unit area of leaf surface than the variety *typica*. Differences between forms with regard to stomatal density are significant ($P < 0.001$, Table 2).

TABLE 1

Average stomatal density per unit area of leaf of varieties and forms of coconut

<i>Variety</i>	<i>Form</i>	<i>No. of stomata</i>
<i>Typica</i>	<i>typica</i>	24.3
	<i>navasi</i>	25.3
	<i>ranthembili</i>	28.5
	<i>gon thembili</i>	26.2
	<i>bodiri</i>	26.3
	<i>kamandala</i>	25.7
	<i>pora pol</i>	21.2
<i>Nana</i>	<i>pumila</i>	30.7
	<i>eburnea</i>	31.0
	<i>regia</i>	31.7
<i>Aurantiaca</i>	<i>thembilli</i>	25.0
	<i>nawasi thembili</i>	27.9

TABLE 2

Analysis of variance—stomatal density of varieties and forms of coconut

<i>Source</i>	<i>d.f.</i>	<i>S.S.</i>	<i>M.S.</i>	<i>V.R.</i>
Bn. forms	11	2473		
Bn. trees	52	2647		
Bn. samples	264	3079		
Bn. forms	11	2473	224.82	53.02***
Bn. trees wn. forms	41	174	4.24	2.08***
Bn. samples wn. trees	212	432	2.04	

For breeding purposes, interest is mainly focussed on the form *typica* of the variety *typica* and form *pumila* of the variety *nana*, and some features of botanical interest in these two have been reported (Liyanage, 1958).

Table 3 gives the stomatal densities per unit area of leaf surface of *typica* and *pumila* palms grown in different agro-climatic regions. The *pumila* palms have a higher stomatal density than the *typica* palms at all four locations, and this value is remarkably constant. An analysis of variance for this character (Table 4) indicates that differences between the two varieties are highly significant, ($P < 0.05$). There are no significant differences between palms within a variety. Furthermore, differences in the environment do not alter stomatal density to any appreciable extent. In this regard, the existence of "ecolines" for stomatal frequency with respect to annual rainfall gradients has been reported for Indian cotton (Gadkari, 1964).

TABLE 3

Average stomatal density per unit area of leaf of *typica* and *pumila* palms

Location	<i>typica</i>	<i>pumila</i>
Bandirippuwa	24.2	30.3
Ambakelle	26.5	30.5
Ratmalagara	26.8	30.4
Pothukulama	24.4	30.4

TABLE 4

Analysis of variance. stomatal density in different environments

Source	d.f.	S.S.	M.S.	V.R.
Bn. places	3	369	123.00	1.11
Bn. varieties	1	6037	6037.00	54.30**
Error	3	333	111.00	
Total	7	6739		
Bn. palms wn. varieties	32	100	3.12	1.14
Bn.-leaflet wn. Palms	160	438	2.74	1.68*
Bn. samples wn. leaflets	800	1307	1.63	

The different locations described in this experiment are within the same coconut growing district, and although there are differences in temperature and rainfall, these are probably not of sufficient magnitude to appreciably alter the stomatal densities. Wood (1934) considered the variations in stomatal frequency to be genetically determined, and attributed a lesser role to the environment. The dwarf (*nana*) variety is self-pollinating, and the population of 'dwarfs' in Ceylon is probably the result of several generations of in-breeding. It will be observed that stomatal densities of the self-pollinated form *pumila* palms of the *nana* variety are remarkably constant in the different environments indicating the degree of genetic control for this character. The observed differences between leaflets within palms may be attributed to the fact that the number of stomata per unit area varies not only with different leaves of the same plant but on different parts of the same leaf as well (Salisbury 1927). In general, stomatal density in most plants increases from the base of the leaf to the apex and from the midrib to the margin. It is reasonable to suppose that the situation is the same with the coconut palm although this aspect was not studied in very great detail.

The *typica* × *pumila* F₁ hybrids have on an average 27 stomata (range 25-29) per unit area of leaf surface, which is therefore the mid-parental value for this character. This may be a useful index in identifying these palms when in doubt. This aspect will be studied further together with any possible relationships of stomatal density and yield of palms.

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REFERENCES

- Gadkari, P. D. (1964). *Cotton Growers Rev.* 18: 222-247.
- Lihonas, F. D. and Bolasova, E. V. (1964). *Pl. Breed. Abstr.* 37 Abstr. 4878.
- Liyanage, D. V. (1958). *Ceylon Cocon. Q.* 9: 1-10.
- Menon, K. P. V. and Pandalai, K. M. (1958). *The Coconut Palm. A Monograph* 384 pp. Ernakulam. Indian Central Coconut Committee.
- Muhle Larsen, C. (1957). *Pl. Breed. Abstr.* 27 Abstr. 2289.
- Salisbury, E. J. (1927). *Phil Trans. R. Soc. B.* 216. 1-65.
- Senanayake, Y. D. A. and Samaranyake, P. (1970). *Q. J. Rubb. Res. Inst. (Ceylon)* 46: 61-68.
- Speckmann, G. J. Post, J., and Dijkstra, H. (1965). *Euphytica* 14: 225-230.
- Wood, J. G. (1934) *J. Ecol.* 22: 69-87.