

RELATIONSHIP BETWEEN PHYSIOLOGICAL PARAMETERS AND NUT YIELD IN RAINFED COCONUT GENOTYPES

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ABSTRACT

Physiological parameters like leaf diffusive resistance (SR), transpiration rate (TR), leaf water potential (WP) and epicuticular wax content (ECW) were employed in screening for drought tolerance in coconut genotypes comprising 10 tallis, 6 dwarfs and 7 hybrids. The nut yield of these genotypes recorded over a period of four consecutive years was plotted against each of the above characters. There was significant correlation between the physiological parameters and yield performance in that some of the genotypes which were identified as drought tolerant also proved to be good yielders. The present investigation thus highlights the significance of using the physiological characters in screening for drought tolerant varieties with the ultimate objective of aiding the breeding programme in coconut.

INTRODUCTION

Weather factors are known to influence coconut production especially under rainfed condition. During unfavorable weather the palms are unable to achieve their full yield potential. Prolonged droughts have been common in the recent past resulting sometimes in bending and breaking of leaves, poor spathe development and shedding of buttons (Pomier and de Taffin, 1982; Prasada Rao, 1985; Ramadasan *et al.* 1991). As the crop is mainly grown in the coastal sandy loam soil under rainfed condition, the palms undergo water stress during the summer months (Rajagopal *et al.* 1988. Voleti *et al.* in press).

Even though cultivar differences are reported in respect of drought tolerance (Todd and Webster, 1965; Keim and Kronstad, 1979; Sammons *et al.*, 1979; Raghavendra *et al.*, 1984; Balasimha *et al.*, 1988; Rajagopal *et al.*, 1990). the mechanisms controlling these differences are not well defined. Hence, screening for drought resistance has been one of the major goals of crop breeding, as the drought stress is one of the most limiting factors to crop production (Hurd, 1976; Keim and Kronstad, 1981).

There are innumerable references in literature on the screening of annual crops for drought resistance.

Yet there is no consensus on the utility of the water relation parameters as selection criteria for drought resistance. For a successful selection, the criteria that are associated with improved yield under condition of drought stress must be identified (Sullivan, 1972, O'Toole and Chang 1977; Keim and Kronstad, 1979, Khalfaoui, 1985; Winter *et al.*, 1988). In coconut, Pomier and de Taffin (1982) have worked out an index for drought tolerance based on the reduction in the number of leaves and nuts during the dry period. Rajagopal *et al.*(1990) have screened 23 coconut genotypes using sensitive parameters like stomatal resistance, leaf water potential and epicuticular wax content. Based on the parametric relationship with moisture stress, the genotypes are classified as drought tolerant or susceptible. The present paper aims at evaluating the yield potential of the genotypes differing in drought tolerance so as to understand the utility of the water relation components in the selection of drought tolerant cultivars.

MATERIALS AND METHODS

Twenty three coconut genotypes comprising 10 tallis, 6 dwarfs and 7 hybrids (Table I) screened earlier for drought tolerance (Rajagopal *et al.*, 1990) were used for the evaluation of nut yield. The palms were well maintained under rainfed condition following the

Table I. Genotypes (talls, dwarfs* and hybrids) and their nut yield palm⁻¹ year⁻¹

Sandy loam			Laterite		
S. No.	Genotypes	Yield	S.No.	Genotypes	Yield
1	WCT	78.3	1	WCT	66.1
2	COD x WCT	57.7	2	COD x WCT	101.1
3	WCT x COD	112.9	3	WCT x COD	102.7
4	WCT x WCT	52.7	4	WCT x GB	86.6
5	COD x COD	47.2	5	LO x COD	139.2
6	Andaman Ordinary	53.5	6	LO x GB	146.8
7	Laccadive Micro	149.5	7	COD*	44.5
8	Philippines Ordinary	33.7			
9	Andaman Giant	36.8			
10	FMS	39.7			
11	Fiji	48.1			
12	Cochin China	52.9			
13	Java Giant	46.2			
14	SS Apricot	63.4			
15	MGD*	78.6			
16	MOD*	48.1			
17	MYD*	65.4			
18	GB*	41.5			
19	SSG*	56.3			

normal cultural and agronomic practices both in sandy loam and laterite soil types. Although the age of the palms varied in the two soil types (18 and 25 years old in the sandy and lateritic soils respectively) they had attained stabilized yield stage and hence comparable. Six palms/genotype were taken for the observations. The stress parameters were determined during the months of March and April 1986 and the yield data recorded for four years from 1986 to 1989, representing both normal and drought years.

RESULTS AND DISCUSSION

The impact of agrometeorological variables and soil moisture regimes on the water relations of coconut palm has been reported by Milburn and Zimmermann (1977), Rajagopal *et al.* (1986 and 1989), and Kasturi Bai *et al.* (1988). Significant differences in the physiological parameters have been reported among the genotypes (Rajagopal *et al.*, 1990). A high stomatal resistance with low transpiration rate, high leaf water potential and high epicuticular wax content under dry conditions

are found to be associated with drought tolerance. Ranking of the genotypes revealed that WCT as well as its hybrids with dwarf as the male parent are relatively more tolerant to stress compared to dwarfs. The importance of selection of parental material to improve the level of drought resistance prior to yield testing has been emphasized by Hurd (1976).

As the selection for adaptation to drought was made directly based on its yield under drought condition (Sullivan 1972; O'Toole and Chang, 1977), a correlation was worked out between the physiological parameters and nut yield. Table-I gives the mean nut yield palm⁻¹ year⁻¹ in talls, dwarfs and hybrids grown under the sandy loam and laterite soils. In general, the nut yield was higher in palms under lateritic than in sandy loam soils. However, the genotypes showed wide variability in nut production among the groups as well as between the genotypes within a group. Among the tall genotypes, the nut yield palm⁻¹ year⁻¹ ranged from 34 (Philippines Ordinary) to 78 (WCT), and from 42 (GB) to 79 (MGD) among the

dwarfs, and 47 (COD x COD) to 147 (LO x GB) among the hybrids. It may, however, be noted that only three genotypes namely WCT, WCT x COD and COD x WCT were grown in both the soils. The WCT and the WCT x COD hybrid showed only marginal difference in nut yield between sandy loam and lateritic soil, whereas COD x WCT exhibited significant difference between the soil types, in that the yield was higher in laterite (101.1) than in the sandy loam (57.7). This indicates the relative sensitivity of the genotypes to moisture stress which is in support of the observations made by Voleti *et al.* (1992) on water relation components of WCT and the two hybrids.

The relationship between the stress parameters and mean yield for four years representing both the normal and drought years has been computed. The results are summarized in Figures 1 to 4 where the sensitive parameters like stomatal resistance, transpiration rate, epicuticular wax content and leaf water potential are plotted against the nut yield. The figures are divided into four quadrants by marker lines corresponding to the mean values of the observed range

of the stress parameters and yield in two soil types separately (Hanson *et al.*, 1979). It is clear that some of the genotypes viz. LO x GB, LO x COD, COD x WCT in laterite and WCT x COD in sandy loam which had the desirable physiological traits, also had high yield potential. This is in agreement with an earlier report of high yield performance of LO x GB and LO x COD over the years under the rainfed condition (Bavappa, 1986). According to Bhaskara Rao *et al.* (1991) the drought tolerance in these hybrids was due to the contribution from the female parent, Lakshadweep Ordinary.

The correlation between physiological parameters and yield for four consecutive years worked out separately for sandy loam and laterite soil (Table II), indicated higher correlation between stress parameters and yield under laterite as compared to sandy loam soil. A positive correlation between two of the stress parameters namely stomatal resistance, epicuticular wax content, and nut yield was observed only in laterite soil. Transpiration rate and leaf water potential failed to show direct relationship with yield

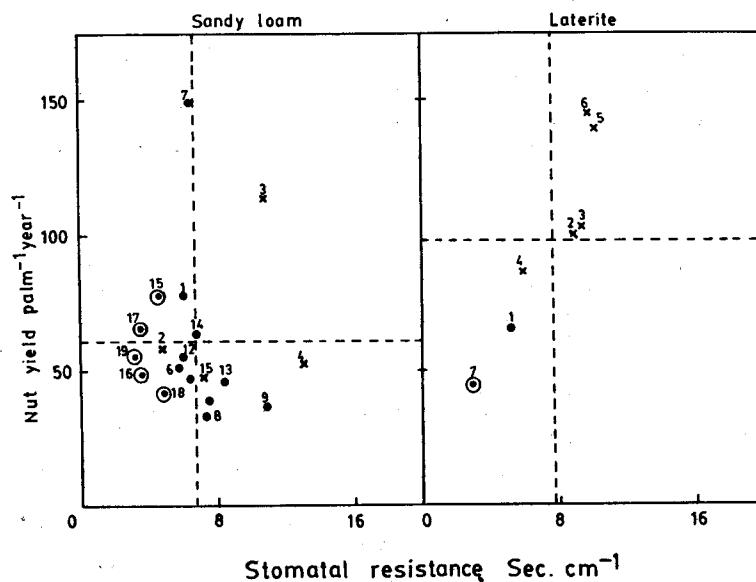


Fig. 1 Scatter diagram of stomatal resistance vs. yield (Talls ●, Dwarfs ○, hybrids x; The serial numbers represent the genotypes as in Table I)

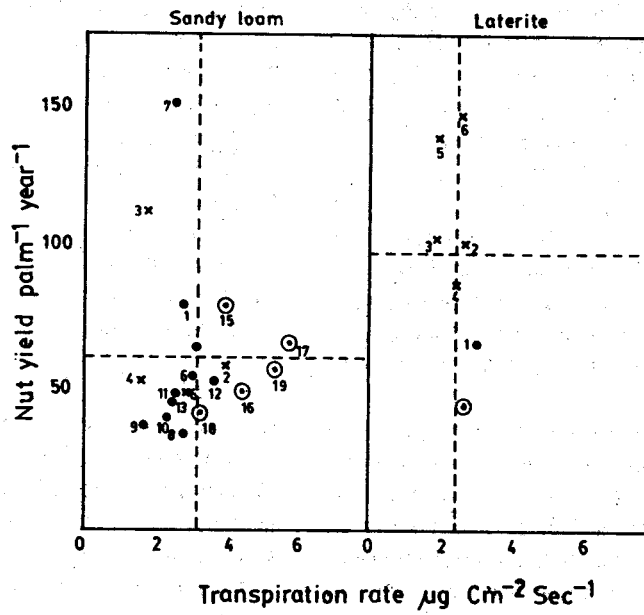


Fig. 2 Scatter diagram of transpiration rate vs. yield (Talls ●, Dwarfs ○, hybrids x; The serial numbers represent the genotypes as in Table 1)

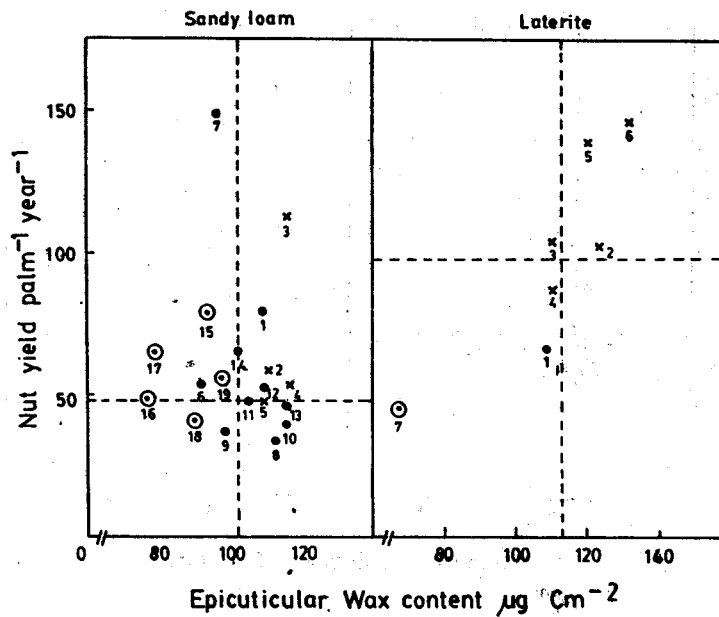


Fig. 3 Scatter diagram of Epicuticular wax content vs. yield (Talls ●, Dwarfs ○, hybrids x; The serial numbers represent the genotypes as in Table I)

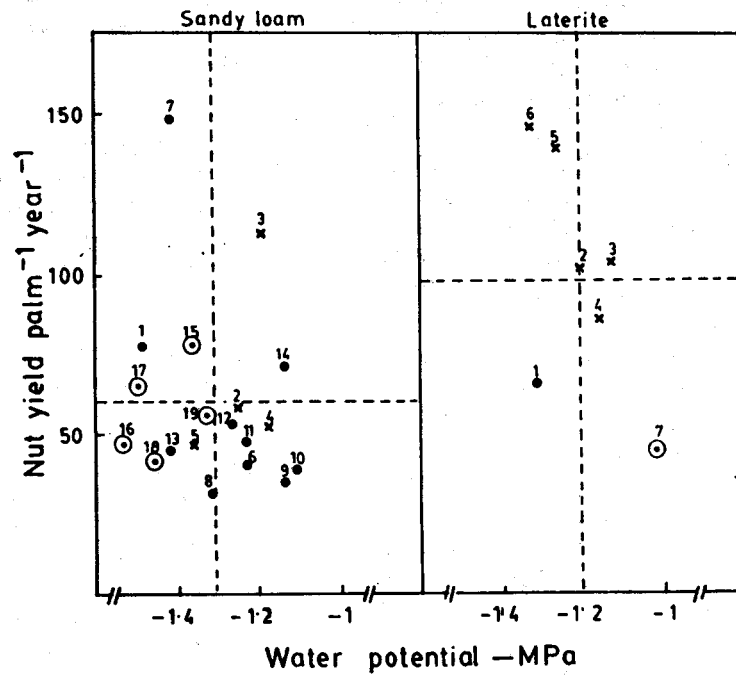


Fig. 4 Scatter diagram of water potential vs. yield
 (The genotypes are depicted by the symbols "●" (talls) "○" (dwarfs) and "x" (hybrids). The serial numbers represent the genotypes as in Table I.)

Table II. Correlation matrix (yield and stress parameters)

Yield (year)	SANDY LOAM SOIL			
	Stress parameters			
	SR	TR	WP	ECW
1986	-0.0185	-0.1179	-0.1934*	-0.1022
1987	-0.0813	-0.0571	-0.0445	-0.0876
1988	-0.1179	-0.0061	-0.2336*	-0.1124
1989	-0.0882	-0.0925	-0.0128	-0.1210
	LATERITE SOIL			
1986	0.4980**	-0.2540	-0.2168	0.3671*
1987	0.1864	0.1228	-0.2841	0.4523**
1988	0.3962*	-0.1938	-0.1867	0.3150
1989	0.2732	-0.0782	-0.1503	0.2945
1986-1989	0.5537**	-0.1789	-0.3307*	0.5639**

* Significant at 5% ** Significant at 1%

in both the soils. Apparently, the stomatal regulation plays a major role in maintaining not only the water balance (Milburn and Zimmermann, 1977) but also the CO₂ exchange reflecting on photosynthesis. The absence of positive correlation in sandy loam might be attributed to poor nut yield. Physiological parameters like stomatal resistance help the plants during adverse conditions of moisture stress but may or may not directly influence yield. In annual crops yield prediction under water stress was made by using different concepts like stress-degree-day concept (Idso *et al.*, 1977), crop water stress index (Idso, 1982 and Hattendorf *et al.*, 1988) and cultivars were developed by testing yield performance in a range of environments from fully irrigated to severely drought stressed. But in a perennial tree crop like coconut, breeding for drought resistance based on yield evaluation is a difficult and long-term process. Based on rainfall pattern Abeywardena, (1971) and Mathew *et al.* (1988) predicted the yield in the rainfed areas. Prasada Rao (1985,1986) has worked out an aridity index based on the water balance procedure along with the visual symptoms and assessed the effect of both soil and atmospheric drought on coconut yield. From the present study, it is clear that a proper understanding of the basis for differences in drought resistance can help in using the physiological characteristics such as stomatal regulation (Jones, 1979) and epicuticular wax content (Parsons, 1979) as selection criteria prior to yield evaluation, as also reported recently in cocoa (Balasimha *et al.*, 1988).

ACKNOWLEDGEMENT

We sincerely thank Dr. M.K. Nair, Director, for the facilities and encouragement and Dr. R.D. Iyer, Head, Crop Improvement Division for critically going through the manuscript and offering suggestions.

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