
CHARACTERISATION OF DROUGHT TOLERANCE IN COCONUT

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ABSTRACT

Coconut palms experience moisture stress of different magnitudes depending upon the extent of dry spell. Investigations on drought tolerance centred around the morphological observations on leaf and inflorescence characters, the physiological parameters like stomatal regulation and water potential components and biochemical aspects such as epicuticular wax and assay of certain sensitive enzymes.

Out of the 23 genotypes screened, ten were found to possess desirable traits to withstand moisture stress. These included high stomatal resistance with low transpiration rate, high leaf water potential, high leaf-wax content, and relatively stable enzyme activities during moisture stress. Based on the above features, the released hybrids like LO × GB, LO × COD, WCT × COD are classified as drought tolerant. A rapid screening method has been developed to evaluate a large number of samples.

Occurrence of Drought

Kerala accounts for 58.8 per cent of the total area of 1.47 M ha under coconut in India. Coconut is generally cultivated under rainfed conditions. Despite a mean annual rainfall of 3000 mm or more there is frequent occurrence of drought in Kerala. High evaporative demand between January and May leads to both soil and atmospheric droughts. When exposed to such severe moisture stress, coconut palms exhibit adverse effects like dry and broken leaves, poor spathe development, empty spikes in some bunches and heavy shedding of buttons (Ramadasan *et al.*, 1991). The investigations at CPCRI were concerned with the impact of weather variables, critical soil moisture level for the stress, the response of genotypes to soil types and the biochemical changes during stress development in coconut (Kasturi Bai *et al.*, 1988; Rajagopal *et al.*, 1989; Voleti *et al.*, 1990; Shivashankar *et al.*, 1991). The extent of damage to coconut palms by drought was assessed on the basis of aridity index (Rao, 1985). The occurrence of drought and its impact on

morphological and yield characters have also been reported in Sri Lanka (Abeyawardena, 1968) and Ivory Coast (Ollagnier *et al.*, 1983).

Drought-Tolerant Characters

A survey of literature indicates that the essential features of drought resistance/tolerance in crop plants are attributed to morphological, anatomical, physiological or biochemical adaptations (Kramer, 1983). At morphological level, the rooting pattern, leaf area development and reproductive structures like awns, and at anatomical level the cuticular thickness and epidermal/guard cells, assume importance in withstanding drought (Parsons, 1979). The physiological attributes in drought studies include the stomatal regulation and leaf water potential components (Milburn and Zimmermann, 1977), whereas the changes in the activities of certain important enzymes (Shivashankar, 1990), accumulation of proline (Sinha and Rajagopal, 1978) and abscisic acid (Alvim *et al.*, 1979) are some of the characteristic features from the biochemical viewpoint. There is genetic variability in the above characters among different crop species (Keim and Kronstad, 1979), the degree of variation thus reflecting on the extent of drought resistance/tolerance. The work on drought research in annual crops has been well documented (Hall and Jones, 1961) while there are limited reports on tree crops (Raghavendra *et al.*, 1984; Balasimha *et al.*, 1988; Rajagopal *et al.*, 1990 a).

Screening Methods and Identification

i) *Morphological characters*: The drooping and drying of leaves are generally noticed in coconut palms during severe summer months in rainfed plots. Pomier and de Taffin (1982) used the drought tolerance index, expressed as the percentage of dry leaves compared to the number of living or functional leaves, to screen five coconut hybrids. Accordingly, the hybrid PB 121 (MYD × WAT) was reported to be most tolerant, while the hybrid RT × WAT the most sensitive to drought. A similar approach was made by Ramadasan *et al.* (1991) which revealed the relative tolerance of WCT × COD and LO × COD to drought. The genotype Tiptur Tall had more dry or dropping leaves with less functional leaves as compared to WCT and WCT × COD during the unprecedented drought of 1982 (Rajagopal *et al.*, 1990 a). Recent studies showed that among the three hybrids, MYD × WCT had more functional leaves than either MOD × WCT or COD × WCT, during the stress period (unpublished). These findings thus indicate that the counts recorded on the dry over functional leaves may be simple but a useful method of screening for drought tolerance in coconut. An indirect approach on root characteristic was made by determining the soil moisture depletion pattern in coconut genotypes between non-stress and stress periods, which revealed the proper water balance in tolerant genotypes (Rajagopal *et al.*, 1991).

ii) *Physiological characters*: The basic physiological principle in drought studies is to look for the genotype which can conserve water and maintain leaf turgidity during adverse conditions. This can be assessed through the

determination of leaf diffusive (stomatal) resistance, reflecting on the degree of transpiration rate and leaf water potential or the relative water content. Based on this principle, Rajagopal *et al.* (1990 b) screened 23 coconut genotypes both during non-stress and stress periods (1987–88). It is evident that genotypes like WCT × WCT, FMS, Java Giant, Andaman Giant, LO × GB, LO × COD, WCT × COD and WCT had higher stomatal resistance with lower rate of transpiration (lower right quadrant in Fig. 29.1), a desirable character, than the other genotypes (upper left quadrant). This indicates the effective control of stomata on the water balance of palms, as reported earlier (Milburn and Zimmermann, 1977). Balasimha *et al.* (1988) found a similar influence of stomata in checking transpirational loss of water in cocoa. There are a number of reports on the stomatal regulation in annual crops. Jones (1979) had viewed the relevance of stomatal studies on breeding for drought tolerance in crop plants.

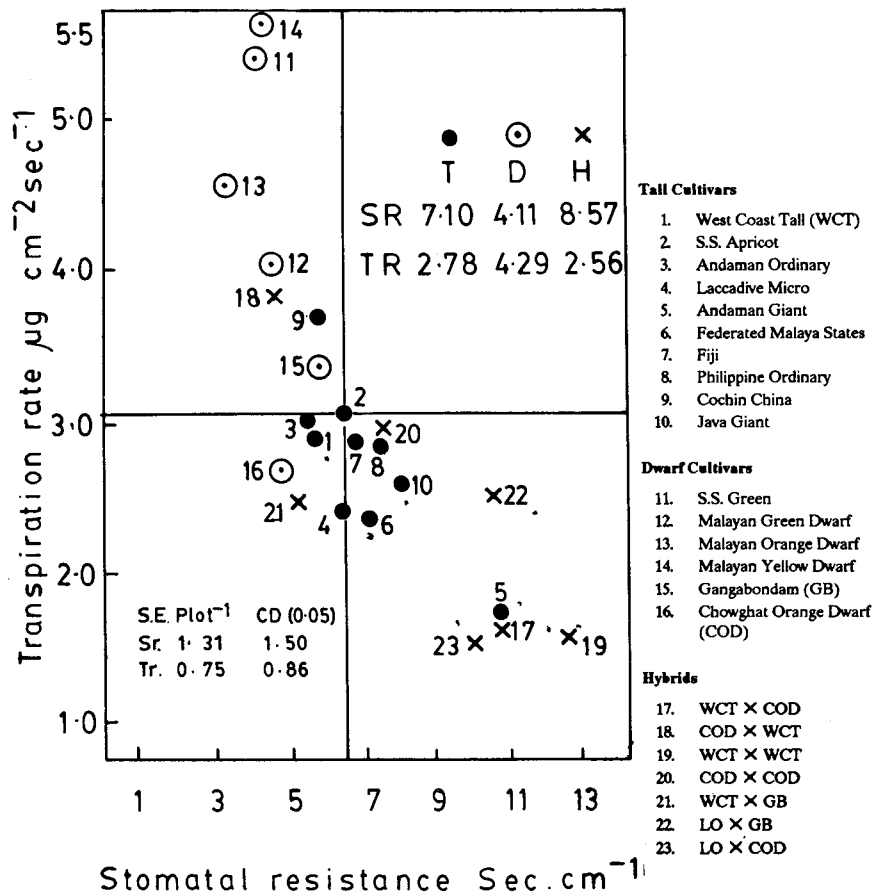


Fig. 29.1: Relationship between stomatal resistance and transpiration rate in tall '●', dwarfs '○' and hybrids 'X' during stress period.

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DISCUSSION

- TSG Peiris*: How do you define 'drought index'? Don't you think you have to consider the daily measurements rather than averages over the periods?
- V. Rajagopal*: Drought index is defined as the ratio between functional leaves and dry leaves, as proposed by Pomier and de Taffin (1983). Daily measurements were taken on physiological parameters during the given season.