## Short Communication

# Physiological Responses of Nursery Grown Tea (*Camellia sinensis* L.): A Preliminary Study

M M N Damayanthi[1], A J Mohotti[2] and S P Nissanka[2]

([1]*Agronomy Division, Tea Research Institute of Sri Lanka, Talawakelle, Sri Lanka*
[2]*Department of Crop Science, Faculty of Agriculture, University of Peradeniya, Peradeniya, Sri Lanka*)

Seasonal and prolonged dry spells that cause severe crop losses, are experienced in many tea growing areas of Sri Lanka. As an adaptive measure to climate changes and in maintaining productivity, development of drought tolerant tea cultivars for such areas is of prime importance. Hence, all the new cultivars that are developed in tea breeding programmes have to be subjected to screening for drought hardiness.

Drought stress brings about many physiological, biochemical and morphological changes in plants. Many of these changes are being used in screening programmes, of selecting drought tolerant varieties and cultivars in many crops *i.e* coconut (Nainanayake, 2004), coffee (Hugo *et al.*, 2005), sugarcane (Silva *et al.*, 2007), eucalyptus (Searson *et al.*, 2004) and pigeon pea (Keller and Ludlow, 1993).

With the objective of identifying the most important, precise and easily measurable physiological and biochemical parameters responsible for drought tolerance stress in tea plants, present study was carried out in a glass house using nursery tea plants. The four contrasting cultivars in terms of drought tolerance were used (*i.e.* TRI 2025 and DN: drought tolerant and TRI 2023 and TRI 2026: drought susceptible). Rate of photosynthesis, stomatal conductance, transpiration rate, relative water content, leaf water potential, stomatal density, total soluble sugar content and leaf chlorophyll content were measured using standard methods to evaluate the responses of tea plants to drought.

Twelve months old nursery plants transferred in to plastic pots (top diameter 23 cm, bottom diameter 18.5 cm and height 35 cm) were used for this experiment. Soils from Mattakelle estate, Talawakelle used for filling the pots had an initial field moisture content of about 28% (v/v). The plants were arranged in a Randomized Complete Block Design (RCBD) with four treatments and four blocks. The blocks were arranged perpendicular to the east-west direction. Measurements were taken one and half months after establishment in plastic pots. Plants were well watered up to field capacity and the first measurements were taken. Then plants were exposed over a drying cycle, by withholding water for 19 days. Measurements of plants and soil (soil moisture content-SMC) were taken at the initial stage field capacity and on $12^{th}$ and $19^{th}$ day, in a representative sample of randomly 10 selected plants from each treatment.

The drought susceptibility index (DSI) proposed by Fischer and Maurer (1978) was calculated using photosynthesis rate as a reference parameter. A similar approach has been used by Nainanayake, (2004). The following formula was used for the calculation.

$$DSI = [1-Y/Yp]/[1-X/Xp]$$

Where;

| | |
|---|---|
| Yp | = Photosynthesis under no stress |
| Y | = Photosynthesis under stressed condition |
| X | = Average photosynthesis over all genotypes under stressed conditions |
| Xp | = Average photosynthesis over all genotypes under non-stressed conditions) |

Identification of parameters responsible for drought tolerance was done by using cluster analysis, cultivar environment interaction and drought susceptibility index based on photosynthesis rate.

Cluster analysis was done by using photosynthesis rate, stomatal conductance, transpiration rate, relative water content, leaf water potential and total soluble sugar content. Only the parameters that were significantly different amongst cultivars and those that had significant interactions between cultivars and moisture levels were used for the cluster analysis and identify specific cultivar characters responsible for drought tolerance. With the analysis, the selected cultivars could be grouped into two clearly distinct clusters (Figure1). Known drought susceptible cultivars, TRI 2023 and TRI 2026 and the drought tolerant cultivars, DN and TRI 2025 were clustered into separate groups.

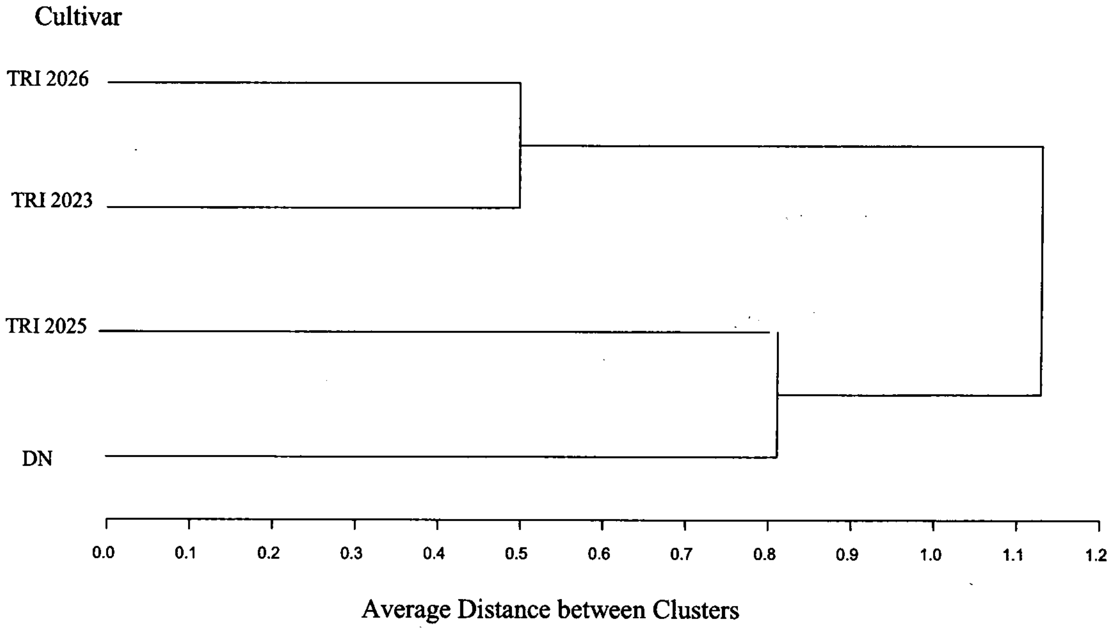


Figure 1. Dendrogram showing clustering pattern of tea cultivars based on selected key physiological and biochemical parameters at the highest moisture stress condition

The similarity of grouping of the known cultivars for drought susceptibility/ tolerance using the drought susceptibility index, cluster analysis and other physiological parameters indicates the possibility of using this method for screening of new tea cultivars for drought tolerance.

Based on the measurements, the tea cultivars could be clearly grouped as tolerant and susceptible, which agreed with the already available information. The drought tolerant cultivars maintained a higher water status with substantial Photosynthesis rate, as a result of osmotic adjustments, as indicated by elevated total soluble sugar. The drought susceptibility index was lower in drought tolerant cultivars than in drought susceptible cultivars. Based on the results of this study, photosynthesis rate, transpiration rate, stomatal conductance and total soluble sugar content, can be identified as the best parameters to be used in a screening programme of tea cultivars for drought tolerance. The new cultivars with consistent grouping in other experiments too, can be used as the reference cultivars for screening unknown cultivars in the future.

## ACKNOWLEDGEMENT

Co-operation extended by the staff of the Agronomy Division, Tea Research Institute of Sri Lanka during data collection are highly appreciated. Authors also wish to thank the Head and staff of the Plant Breeding Division and Ms. Ganesha Thotawattage of the Biochemistry Division of Tea Research Institute of Sri Lanka for their assistance in numerous ways.

## REFERENCES

Fischer R A and Maurer R 1978 Drought tolerance in spring wheat cultivars, 1. Grain yield responses. Australian Journal of Agricultural Research. 29, 897-912.

Hugo A P, DaMatta F M, Chaves A R M, Loureiro M E and Ducatti C (2005) Drought tolerance is associated with rooting depth and stomatal control of water use in clones of *Coffea canephora*. Annals of Botany. 96, 101-108.

Keller F and Ludlow M M 1993 Carbohydrate metabolism in drought stressed leaves of pigeon pea (*Cajans cajan*). Journal of Experimental Botany. 44(265), 1351-1359.

Nainanayake A D (2004) Impact of drought on coconut (*Cocos nucifera* L.): Screening germplasm for photosynthesis tolerance in the field, Ph D thesis, University of Essex, UK. 215pp.

Searson M J, Thomas D S, Montagu K D and Conroy J P (2004) Leaf water use efficiency differs between eucalyptus seedlings from contrasting rainfall environment. Functional Plant Biology. 31, 441-450.

Silva M D A, Jifon J L, Jorge A G D S and Sharma V (2007) Use of physiological parameters as fast tools to screen for drought tolerance in sugarcane. Brazilian Journal of Plant Physiology. 19 (3), 193-201.