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INCREASED LEAF PEROXIDASE ACTIVITY ASSOCIATED WITH DROUGHT TOLERANCE IN *HEVEA BRASILIENSIS*

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Leaf peroxidase activity in polyclonal *Hevea brasiliensis* trees showing high and low biomass were monitored along with the soil moisture availability in deeper layers (1.5 m) during the summer season of 2001. Out of seven trees with high girth monitored, four received very low soil moisture, similar to low girth trees. These high girth trees showed a higher peroxidase activity in their leaves than the low girth trees, which had similar drought stress. The peroxidase activity in the leaves of high biomass trees with higher moisture availability was on par with either of the other two categories. These results suggest that high peroxidase activity in the leaves may be a suitable marker for drought tolerance in *H. brasiliensis* in terms of biomass production.

Key words: Drought tolerance, *Hevea brasiliensis*, Peroxidase, Soil moisture.

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INTRODUCTION

The possible association of drought tolerance with increased activities of peroxidase and ascorbate peroxidase in the leaves and low polyphenol oxidase activity in the bark of polyclonal trees of *Hevea brasiliensis* have been reported earlier (Sreelatha *et al.*, 2003). The success of using a marker for drought tolerance depends on the reliability of the association between that marker and drought tolerance. In a heterogeneous population like a polyclonal plantation of *H. brasiliensis*, it is difficult to identify such reliable markers because of large tree-to-tree variations (Thomas *et al.*, 2000).

Although the earlier results (Sreelatha *et al.*, 2003) have been reproducible with a fair degree of accuracy, the likelihood of some of the trees belonging to high girth or high yield categories having deep root systems and thus obtaining moisture from the deeper layers of the soil, cannot be ruled out. In the present study, this possibility has been investigated in the high and low biomass trees that were grown in the North Konkan region, a drought-prone area in India.

The objectives of the present investigation were to examine whether the high biomass trees had better access to soil moisture than the others and if leaf peroxidase activity could be a reliable marker for drought tolerance in polyclonal trees of *H. brasiliensis*.

MATERIALS AND METHODS

The experiment was conducted in a polyclonal plantation at the Regional Research Station, Rubber Research Institute of India, at Dapchari, situated in the severely drought –prone (Jacob *et al.*, 1999) North Konkan region of India, during the summer of 2001. Seven trees belonging to high girth and five trees of low girth categories out of the ten trees each belonging to these categories selected in an earlier study (Sreelatha *et al.*, 2003) were examined for their access to deep soil moisture. The peroxidase activity in the leaves of these trees was determined in order to confirm the earlier finding that drought tolerant (i.e., high biomass types) polyclonal trees had an increased leaf peroxidase activity.

The soil moisture content was continuously monitored at a distance of about 1 m from the base of the tree and 0.75 and 1.5 m below the soil surface for the last 14 continuous rain-free days (the most severe summer

days) using a novel remote soil moisture meter (Emcon Ltd., Kochi, India) non-invasively (Sivadas and Varma, 1992) with the sensors buried in the soil permanently. Measurements were recorded at 8.00 and 16.00 hrs every day from each of the probes consecutively for 18 days, of which the first 14 days were continuous rain-free days at the fag end of the peak summer season. There was a shower on the 14th day evening that relieved the drought. Leaf samples were collected as described earlier (Sreelatha *et al.*, 2003) on the fourth day of the experiment and peroxidase activity was determined as described by Amako *et al.* (1994).

As the trees belonging to the high girth category received either very low or fairly higher soil moisture, they were regrouped into two. Thus there were three categories namely low girth (LG) trees with low soil moisture availability (n=5), high girth trees with low soil moisture (HG-1, n=4) and high girth trees with high soil moisture (HG-2, n=3). The peroxidase activity in the leaves were determined four days after installing the soil moisture probes.

RESULTS AND DISCUSSION

The remote soil moisture meters that were used in the present study recorded highly reliable data (Fig. 1). For example, the soil moisture measurements made at 8.00 and 16.00 hrs near tree No.48 (which belonged to the high girth type) remained fairly constant (8-9%) between day 1 and day 14 when it did not rain. Between days 15 and 18 the soil moisture near this tree increased to 39-40 per cent due to the rain on the evening of the 14th day. These readings from the instrument agreed well with gravimetric measurements (data not shown).

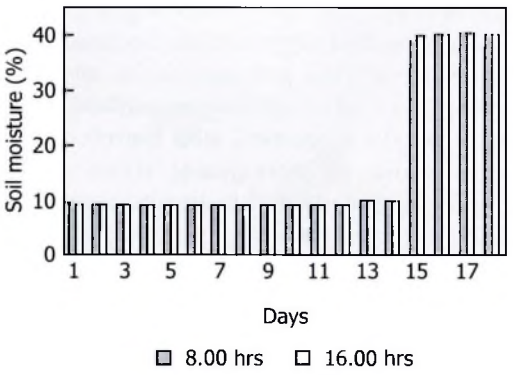


Fig. 1. Soil moisture at 1.5 m depth near high girth tree grown at Dapchari

The soil moisture measured at 0.75 m and 1.5 m depths were identical for a given tree and hence only the latter data are presented here. All the low girth trees examined had very low soil moisture availability ranging from 7-9 per cent during the dry spell (Fig. 2). Among the seven high girth trees examined, four trees had soil moisture similar to low girth trees (8-9%) during the dry spell. However, three trees belonging to the high girth category had higher soil moisture availability (19-22%). After the rain on day14, the soil moisture levels increased and there were no marked difference among the different categories.

Trees belonging to the high girth cat-

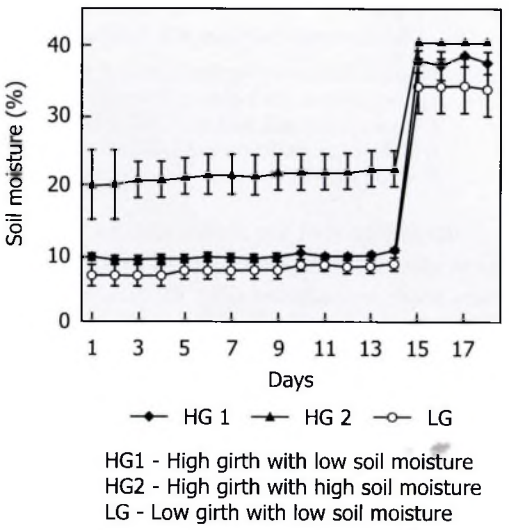
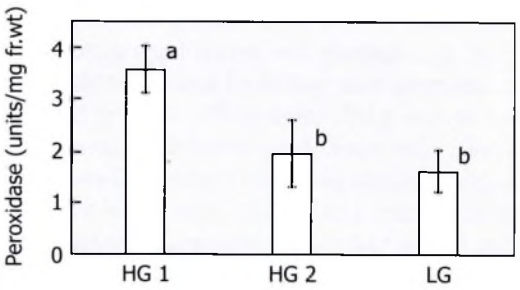


Fig. 2. Soil moisture data of three categories of polyclonal trees. HG-1 High girth with low soil moisture, HG-2 High girth with high soil moisture and LG-Low girth with low soil moisture.

egory that received low soil moisture showed significantly greater peroxidase activity than the low girth trees that received equally low soil moisture (Fig. 3). This result is entirely in conformity with the earlier findings that high girth trees (drought tolerant) had greater leaf peroxidase activity than the low girth trees that are drought susceptible (Sreelatha *et al.*, 2003). However, the high girth trees that received higher soil moisture behaved differently from their counterparts that received less moisture as far as leaf peroxidase activity is concerned.



HG 1 - High girth with low soil moisture
HG 2 - High girth with high soil moisture
LG - Low girth with low soil moisture

Fig. 3. Peroxidase activity in the leaves of three categories of trees (Summer of 2001). HG-1 High girth with low soil moisture, HG-2 High girth with high soil moisture and LG- Low girth with low soil moisture.

In the light of the above results, the leaf peroxidase activity determined in the earlier years were reanalysed (Fig. 4). In the previous study leaf samples collected during October 1996 and 1997 (post monsoon), April 1997 and 1998 (stress season) were analysed. The reanalysis of the data on leaf peroxidase activity also indicated significantly greater enzyme activity in the high girth category. During two sampling periods (April 1997 and 1998) the high girth trees that received less soil moisture had significantly more leaf peroxidase activity than the low girth trees as noticed during the summer 2001. During

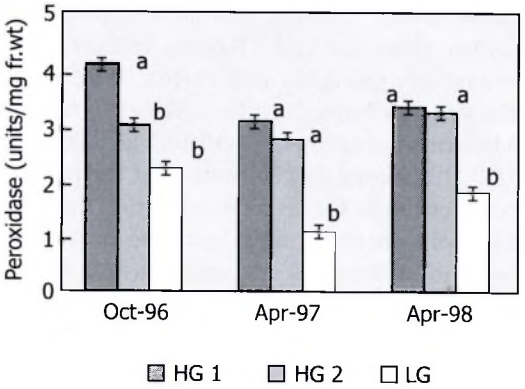


Fig. 4. Peroxidase activity in the leaves of three categories (October 1996, April 1997 and 1998). HG-1 High girth with low soil moisture, HG-2 High girth with high soil moisture and LG- Low girth with low soil moisture.

the other sampling periods the activities were comparable in the high girth trees that received low and high moisture.

Thus, the present results showed that while all the low biomass trees had very poor soil moisture availability, some of the high biomass type also received similar low soil moisture. The low biomass category always maintained much lower leaf peroxidase activity than the high girth trees that received equally low soil moisture. The high girth trees that received high soil moisture had leaf peroxidase activities comparable with either of the other two groups during the different sampling years. While this erratic behaviour of the high girth trees receiving high soil moisture is difficult to explain because of its inconsistency, the present results categorically prove that a high leaf peroxidase activity is always associated with high biomass production in polyclonal trees of *H. brasiliensis* grown for 15 years under extreme drought conditions.

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