Effect of soil drying on rate of stress development, leaf gas exchange and proline accumulation in Robusta coffee (Coffea canephora pierre ex froehner) clones

ABSTRACT

Seasonal drought stresses as a result of changes in global climate and local weather conditions are among the major factors adversely affecting growth and productivity of Robusta coffee (Coffea canephora pierre ex froehner) in many areas producing the crop. It is believed that there exists a wide range of genetic variability among Robusta coffee clones for traits associated with drought tolerance. Therefore, in an attempt to determine differences among Robusta coffee clones for some growth, physiological and biochemical parameters and identify drought-tolerant materials, 12 months old seedlings of six clones (IC-2, IC-3, IC-4, IC-6, IC-8 and R-4) were subjected to two treatments: well-watered control and drought-stressed (soil drying) by withholding irrigation for three weeks in a rain shelter at University Putra Malaysia, Malaysia. The rate of stress development, expressed as extent of wilting and damage to leaves, was considerably higher for clones IC-8, IC-4, R-4 and IC-2 than for IC-3 and IC-6 during the stress period. Leaf water potential (LWP), stomatal conductance (gs) and rate of net photosynthesis (PN) progressively decreased but leaf proline (LP) concentration substantially increased with time of exposure of the plants to soil drying. There was a considerable difference between coffee clones for the rate of change in these parameters. All the clones except IC-6 and IC-8 showed a negative carbon balance with the most negative value for R-4 at the end of the stress period. Six days after rewatering, LWP, gs and PN increased rapidly while LP concentration decreased and reached a level equivalent to those of well-watered plants, especially for clones IC-3 and IC-6. Among the drought-stressed plants, IC-6 and IC-3 had still significantly higher shoot growth, total dry matter yield and root to shoot ratio than did IC-2, IC-4, IC-8 and R-4. In general, clones IC-6 and IC-3 exhibited quite a better performance in almost all the parameters considered in this study and seemed to be less sensitive to drought stress. Hence, drought tolerance attributes in these clones could be linked to a more effective osmotic adjustment due to more rapid accumulation of LP and probably some morphological parameters, such as increased root-to-shoot ratio. However, further analyses at molecular level, detail biochemical studies and observations under diverse field conditions are required to come up with more conclusive recommendations.

Keyword: Coffea canephora pierre ex froehner; Drought; Robusta coffee clones; Soil drying