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Screening of Freezing Tolerance in Eucalyptus Genotypes (Eucalyptus spp.) Using Chlorophyll Fluorescence, Ionic Leakage, Proline Accumulation and Stomatal Density

Authors : S. Lahijanian, M. Mobli, B. Baninasab, N. Etemadi

Abstract : Low temperature extremes are amongst the major stresses that adversely affect the plant growth and productivity. Cold stress causes oxidative stress, physiological, morphological and biochemical changes in plant cells. Generally, low temperatures similar to salinity and drought exert their negative effects mainly by disrupting the ionic and osmotic equilibrium of the plant cells. Changes in climatic condition leading to more frequent extreme conditions will require adapted crop species on a larger scale in order to sustain agricultural production. Eucalyptus is a diverse genus of flowering trees (and a few shrubs) in the myrtle family, Myrtaceae. Members of this genus dominate the tree flora of Australia. The eucalyptus genus contains more than 580 species and large number of cultivars, which are native to Australia. Large distribution and diversity of compatible eucalyptus cultivars reflect the fact of ecological flexibility of eucalyptus. Some eucalyptus cultivars can sustain hard environmental conditions like high and low temperature, salinity, high level of PH, drought, chilling and freezing which are intensively effective on crops with tropical and subtropical origin. In this study, we tried to evaluate freezing tolerance of 12 eucalyptus genotypes by means of four different morphological and physiological methods: Chlorophyll fluorescence, electrolyte leakage, proline and stomatal density. The studied cultivars include Eucalyptus camaldulensis, E. coccifera, E. darlympleana, E. erythrocorys, E. glaucescens, E. globulus, E. gunnii, E. macrocorpa, E. microtheca, E. rubida, E. tereticornis, and E. urnigera. Except for stomatal density recording, in other methods, plants were exposed to five gradual temperature drops: zero, -5, -10, -15 and -20 degree of centigrade and they remained in these temperatures for at least one hour. Experiment for measuring chlorophyll fluorescence showed that genotypes E. erythrocorys and E. camaldulensis were the most resistant genotypes and E. gunnii and E.coccifera were more sensitive than other genotypes to freezing stress effects. In electrolyte leakage experiment with regard to significant interaction between cultivar and temperature, genotypes E. erythrocorys and E.macrocorpa were shown to be the most tolerant genotypes and E. gunnii, E. urnigera, E. microtheca and E. tereticornis with the more ionic leakage percentage showed to be more sensitive to low temperatures. Results of Proline experiment approved that the most resistant genotype to freezing stress is E. erythrocorys. In the stomatal density experiment, the numbers of stomata under microscopic field were totally counted and the results showed that the E. erythrocorys and E. macrocorpa genotypes had the maximum and E. coccifera and E. darlympleana genotypes had minimum number of stomata under microscopic field (0.0605 mm2). In conclusion, E. erythrocorys identified as the most tolerant genotype; meanwhile E. gunnii classified as the most freezing susceptible genotype in this investigation. Further, remarkable correlation was not obtained between the stomatal density and other cold stress measures.

Keywords : chlorophyll fluorescence, cold stress, ionic leakage, proline, stomatal density
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