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Fast and Reliable Non-Destructive Indicators for Identifying Drought-Tolerant Pistachio Interspecific Hybrids

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Abstract

Drought stress is a major limitation to pistachio production in arid regions. Six interspecific Pistacia hybrids and the commercial rootstock ‘UCB1’ were evaluated under prolonged drought and recovery using chlorophyll fluorescence (Fv/Fm, Fv/F0), leaf color (Lab*), and plant vitality. Sensitive hybrids (C8-3, C4-2, C16-1) showed reduced PSII efficiency, leaf discoloration, and lower vitality, while tolerant genotypes (Arota, C2, C9-4) maintained higher fluorescence, stable leaf color, and faster recovery. Leaf color was strongly correlated with vitality. Combined assessment of chlorophyll fluorescence, leaf color, and vitality provides a rapid and non-destructive method for screening drought-tolerant pistachio rootstocks.

Introduction

Drought is the main factor limiting pistachio production in arid regions of Iran, requiring rapid identification of tolerant rootstocks. This study evaluates drought response and recovery using non-destructive indicators, including chlorophyll fluorescence (Fv/Fm, Fv/F0), leaf color (Lab*), and plant vitality, to provide an efficient method for screening drought tolerance.

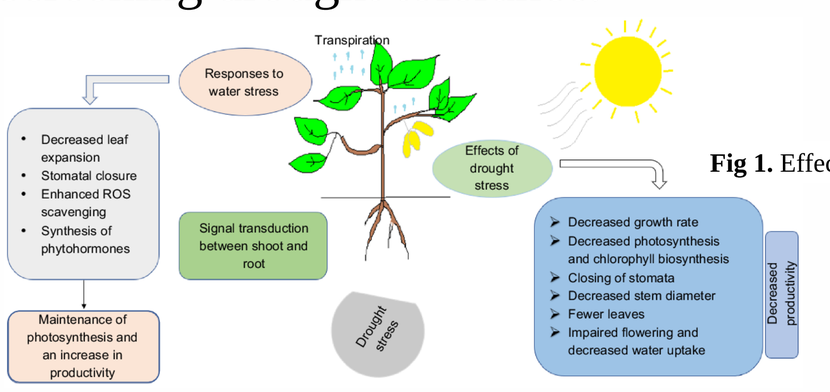

Fig 1. Effects of drought stress on plant

Materials and Methods

Nine-month-old plants of six interspecific Pistacia hybrids and the commercial rootstock ‘UCB1’ were grown under greenhouse conditions in a randomized complete block design. Plants were subjected to 30 days of drought followed by 30 days of recovery. Drought responses were evaluated using chlorophyll fluorescence (Fv/Fm, Fv/F0), leaf color parameters (Lab*) from image analysis, and visual plant vitality.

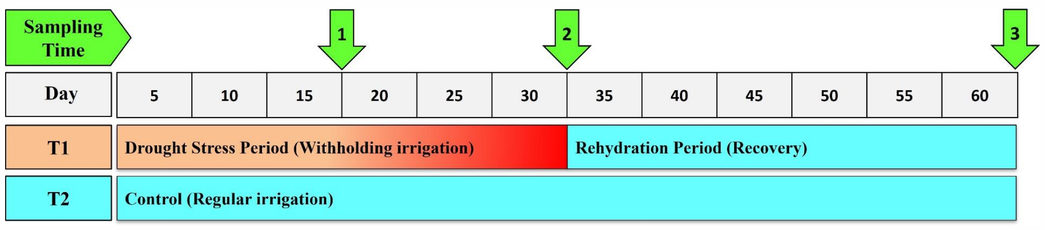

Fig 2. Schematic representation of the experimental design

Results and Discussion

- Drought significantly decreased Fv/Fm and Fv/F0 in all clones, with the greatest reductions in ‘C8-3’, ‘C4-2’, and ‘C16-1’. After recovery, fluorescence increased but did not fully recover in ‘C8-3’ and ‘C4-2’. ‘Arota’ and ‘C9-4’ maintained higher PSII efficiency and showed greater drought tolerance.

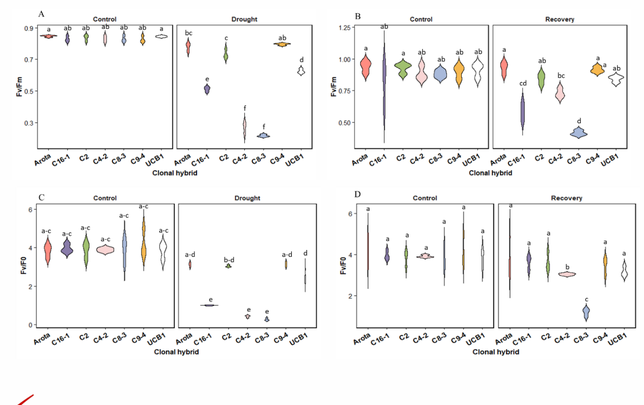

Fig 3. Effects of drought stress and recovery on the maximum quantum yield of PSII (Fv/Fm) and the maximum efficiency of water-splitting reactions (Fv/F0).

- Drought reduced leaf lightness (L*) and shifted color toward red and yellow in sensitive clones (‘C8-3’, ‘C16-1’), indicating pigment degradation. Tolerant genotypes (‘Arota’, ‘C2’, ‘C9-4’, ‘UCB1’) maintained more stable color and showed faster recovery after rewatering.
- Drought significantly reduced vitality, especially in ‘C8-3’, ‘C4-2’, ‘C16-1’, and ‘UCB1’. ‘C9-4’ showed the smallest decline, while ‘Arota’ and ‘C2’ maintained relatively high vitality. After recovery, most clones partially restored vitality, except ‘C8-3’, which showed a significant reduction.

Fig 4. Visual comparison of plant vitality in pistachio clones

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