Setting up a Selection Method for Drought Tolerance in Melon Seedlings

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Introduction

Climate change causes serious concerns to growers and breeders. Drought affects a significant proportion of the global population, particularly those living in semi-arid and arid regions.

Melon is one of the most important fruit crops. Approximately 42 million tons of melons were produced in 2020 worldwide, with more than 1.4 million ha harvested. Development of melon cultivars adapted to abiotic stress and with high quality standards is required by global markets. This includes tolerance or resistance to drought, particularly in the Mediterranean region where there is predicted an important increase of arid areas (Turral et al., 2011).

Although plants can be adversely affected by drought at any time of their life, some of the most critical stages are during seedling growth. Previous observations (Sarria-Villada, personal communication) pointed to the existence of certain drought tolerance in the Zimbabwean accession TGR1551 during that stage.

With the aim of setting up a method that allows the confirmation of drought tolerance in TGR1551 and the reliable subsequent selection of genotypes with tolerance to drought in a RIL population derived from this melon accession, we carried out a pilot experiment in 2022, based on the work done by Zhang et al. (2016) in watermelon.

Material and Methods

The Spanish cultivar Bola de Oro and the accessions TGR1551 and C278 were included in the present study to determine their drought tolerance responses during the seedling stage under extreme water stress conditions in a temperature-controlled greenhouse.

To ensure a minimum number of seedlings (14) per entry, two to three seeds were sown in each nursery tray cell; two types of trays were used, standard trays (5 cm diameter x 5 cm tall cells) routinely used in melon nurseries, and forest trays (6x6 cm square x12 cm tall cells). Trays were placed in an insect-free greenhouse where the temperature ranged from 17-27 ºC and the natural lighting period was 14/10h day/night. When the first true leaf appeared, seedlings were thinned to one per cell. After sowing, two water regimes were applied: half of the trays were watered daily and the other half every other day (alternating), until the seedlings reached the stage of two or three true leaves. Seedlings were then subjected to two consecutive water-stress periods as follows: trays were placed in a water container for 2 min and no watering was applied for 4-days, when they were again placed in a water container for two 2 min and left without watering until the end of the experiment.

Drought tolerance evaluations were done on the fourth and the seventh day after the second water stress period by careful examination of each individual seedling for their drought-induced injury symptoms on each accession. Following Zhang et al. (2016) the following rating scale was used: 0 = cotyledons and first true leaf remained in a normal horizontal position; 1 = cotyledons pointed upward while the first true leaf remained horizontal; 3 = cotyledons curled downward and the first true leaf pointed upward; 5 = cotyledons curled downward and the first true leaf curled upward; 7 = whole plant showed wilting. Mean drought responses for each combination of genotypes, trays and watering regimes were compared by using Tukey-b post-hoc test after one-way ANOVA.

Results and discussion

Four days after last watering, several plants of C278 growing in standard trays showed mild symptoms of sensitivity to drought regardless of water regime (Fig.1). In these trays, plants of 'Bola de Oro' showed low or mild symptoms of sensitivity to drought, when the water applied was daily or alternate, respectively. All plants of TGR1551 growing in standard trays showed tolerance regardless of the water regime. Plants of any of the genotypes growing in forest trays showed no drought symptoms under daily water regime but they showed some level of sensitivity when the water regime was alternate.

Seven days after last watering, plants of C278 showed drought sensitivity when growing in standard trays and mild symptoms when growing in forest trays. 'Bola de Oro' only showed high drought sensitivity when growing in standard trays with alternate watering. Plants of TGR1551 showed drought tolerance response in all cases.

Accession C278 was the most susceptible to drought. It was the accession with the highest mean score and plants showing serious injuries or wilting regardless of treatment. 'Bola de Oro' also showed a susceptible response, though the mean score was significantly lower than in C278.

Although four days after last watering significant differences between TGR1551 and 'Bola de Oro' and C278 were observed, the drought responses of the two latter genotypes were mild. Seven days after last watering, significant differences among the three genotypes were observed but the highest mean score was observed for standard trays and alternate watering regime. Under these severe conditions, significant and clear differences among susceptible and tolerant genotypes were observed (Fig 1).

The combination of sowing in standard trays, watering every two days, and evaluating plant responses seven days after the last watering appears to be the most suitable technique for selection of melon genotypes to study tolerance to drought. We expect this technique to be useful in establishing the genetic basis of drought tolerance in the TGR1551 x Bola de Oro RIL population we are evaluating.

Acknowledgement

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Literature Cited

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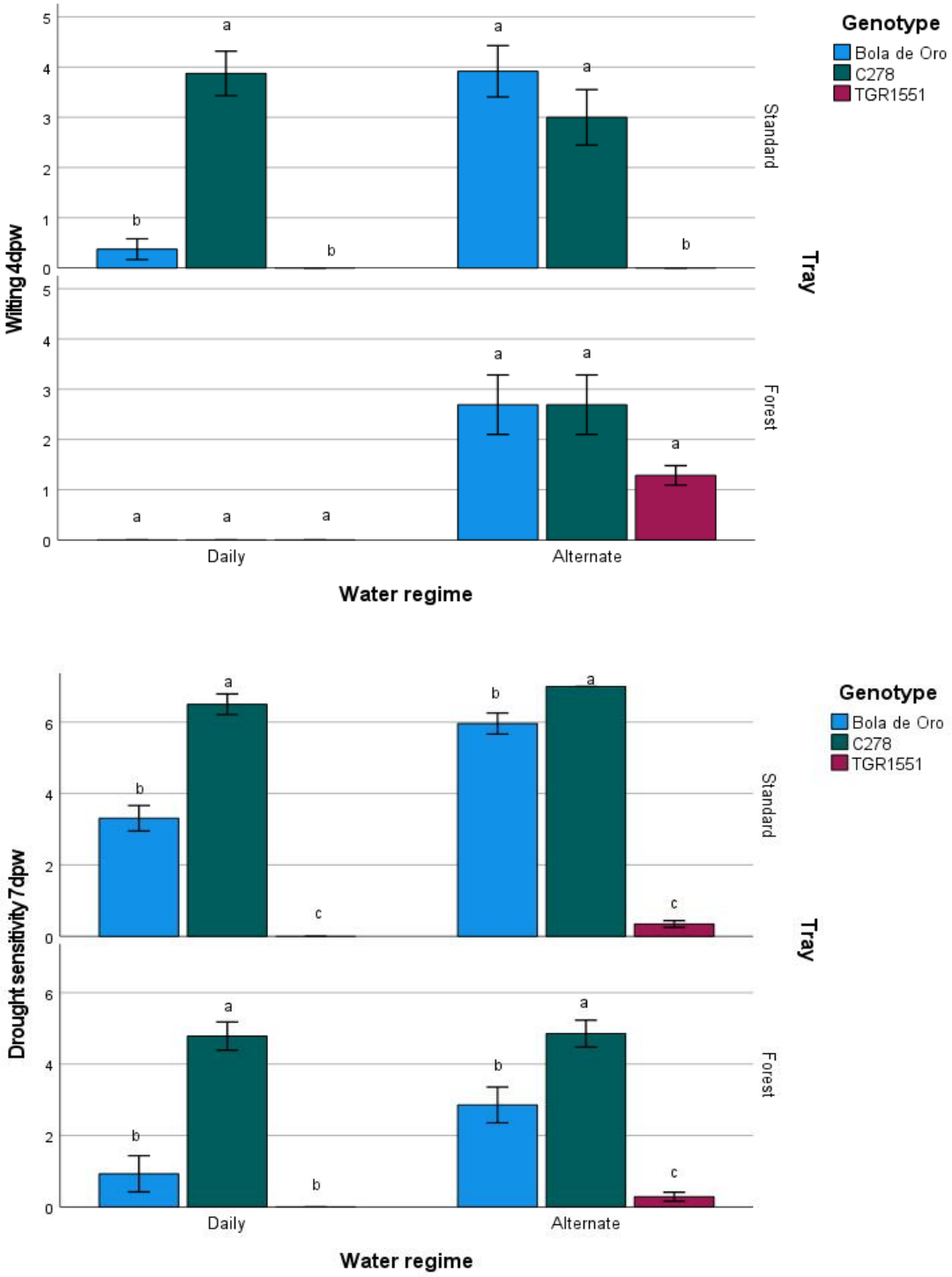

Figure 1. Drought sensitivity means (± SE) of plants from the Spanish cultivar Bola de Oro, and accessions C278 and TGR1551 at the 4th day (top) and 7th day (bottom) evaluations after last watering in standard trays (5 x 5 cm/cell) or forest trays (6 x 12 cm/cell) and watered daily or on alternate days from sowing to two-three leaves stage. Means with the same letter are not significantly different (Tukey-b test, *P*<0.01)