Effect of Water Supply Regimes on Physiological Parameters and Productivity in Eggplant grown under Mediterranean Climate Conditions.

Maachi Dina[a], Toppino Laura[b], Ezquer Ignacio[c], Cebeci Esra[d], Boyaci Hatice Filiz[e], Rotino Giuseppe Leonardo[b], Aberkani Kamal[a]*

[a]Research Team on Applied Biology and Biotechnology, Laboratory of Bioresources, Biotechnologies, Ethnopharmacology and Health, Multidisciplinary Faculty of Nador, University Mohammed First, Selouane, Maroc

[b] CREA Research Centre for Genomics and Bioinformatics, Montanaso Lombardo, Italy

[c]Departments of Life Sciences, University of Milan, Milan, Italy

[d]Bati Akdeniz Agricultural Research Institute, Muratpasa/Antalya, Türkiye

[e]Recep Tayyip Erdogan University, Faculty of Agriculture, Department of Horticulture, Rize, Türkiye

[f]Departments of Life Sciences, University of Milan, Milan, Italy

ABSTRACT:

Drought caused by climate change has affected the agriculture and aggravated water scarcity. The effect of two irrigation regimes was evaluated on 13 eggplant genotypes selected as diverging for several fruit/plant qualitative traits, plant habitus, yield and drought tolerance. In addition, two commercial varieties commonly used by growers in Morocco were employed to comparison. The irrigation treatments consisted of two different conditions: (i) control irrigation (Tr-C) adopted by the grower; (ii) water shortage of 50% of the amount of this irrigation (Tr-50%). For Tr-C, an irrigation tape line was used an interval of 10 cm between drippers was used, while for Tr-50% an equal tape line with 20 cm interval between drippers was used. The same (1.5 l/h) debit per dripper was applied for both treatments and the interval between drippers marked the difference between Tr-C and Tr-50% in terms of the amount of water saved and estimated by 50%. Results showed that Tr-50% water supply had a significant effect on growth parameters of each genotype/variety. Water stress reduced both quality and number of fruits, as also yield per plants. Non-significant differences between treatments were observed for the chlorophyll-a fluorescence parameters such as F_v/F_m, DI_0/CS_0 and ABS/CS_0 ratios.

Keywords: Solanaceae, crops resilience, crop production, chlorophyll a fluorescence, drought, irrigation, photosynthesis, quality, relative water content.

Introduction

Climate change is currently one of the main issues/concern in the world, because of its effects on the elevation of average temperature and for causing drought in many areas of the world (Malhi et al., 2021). In recent years, agricultural sector has been suffering from water scarcity caused by climate change (Frona et al., 2021). It provokes significant changes in air temperature, precipitation, gas emission and seasonal mutation which heavily affected the productivity of all crops (Vicente, 2022; Malhi et al., 2021). For this reason, global agricultural production is expected to decrease between 3% and 16% by 2080 (IPCC, 2007). In the Mediterranean area, it is estimated that agricultural productivity will also significantly decrease (Jat et al., 2018; Muñoz-Rojas et al., 2017) due to the lack of water resources and reduction in annual precipitations. Water scarcity and drought are the most significant limiting factors for crop production in semi-arid agricultural zones (Janáček and Wilhite, 1993). Therefore, increasing food production raising the need to ensure future food security represents an important challenge because of the rapid growth of world population and the contemporary reduction of the fertile area caused by the progressive desertification of some productive lands as an effect of drought (Yadav et al., 2018; Anderson et al., 2020;). Many research reported that water scarcity reduces plant growth and development (Dash & Mohanty, 2001; Sánchez-Rodríguez et al., 2010; Noorka & Tabasum, 2013) and induces morphological, biochemical, physiological, and molecular changes including photosynthetic efficiency, thus hampering productivity, yield and quality of crops (Fahad et al., 2017).

Annual crops, particularly vegetables, are severely affected from water deficiency. The reduction in irrigation water quantity is reported to mostly impact, total yield and fruit weight (Akhoundnejad and Dasgan, 2019). Reducing water irrigation by 50% and 25% significantly decreased the fruit size, fruit diameter, chlorophyll content, fruit number and yield of many varieties of tomato (*Solanum lycopersicum* L.), melon (*Cucumis melo*) and eggplants (*Solanum melongena* L.). Drought can restrict plant growth by preventing the division of leaf meristematic tissue cells and cell expansion in elongation areas (Nelissen et al., 2018). The 40% of PC (Percentage of water added to a pot relative to the 100% control) of severe drought stress applied to tomato plants is able to induce a reduction in plant height by

24% and stem diameter by 18% (Sibomana et al., 2013). Under drought stress, significant reduction was also noted as compared to control in terms of shoot fresh and dry weight, leaf area and relative water content in tomato (Zhou et al., 2017). Similar results were found by Bismillah Khan et al. (2015) for maize which water stress limited, the plant height, leaf size, and stem diameter. Also, it was reported that water stress restricts plant growth and development by decreasing relative water content (RWC), photosynthetic rate in potato (*Solanum tuberosum* L.) and wheat (*Triticum aestivum* L.) (Zhang et al., 2018; Mustafa et al., 2021; Wasaya et al., 2021). In plants, the photosynthetic response to drought is extremely complicated. During drought stress, the increase of plant evapotranspiration causes stomatal closure and decreases photosynthetic activity and yield (Rasouli et al., 2023). The photosynthetic rate is delayed because the captured light cannot be completely transformed into chemical energy (Chatterjee & Solankey, 2015; Jamalluddin et al., 2019). Chlorophyll fluorescence is an effective and non-destructive method for measuring the photochemical efficiency of PSII, and detecting the damage of stress in PSII (Mathur et al., 2013). The maximal quantum efficiency of PSII is estimated by its maximum potential quantum efficiency (Fv/Fm), which is predominantly impacted by drought stress (Ahmed et al., 2002). Several investigations have been reported on the impact of water stress on chlorophyll fluorescence in different horticultural crops. The tomato Fv/Fm ratio was considerably greater for 10-day, 20-day, and 30-day intervals (Bahadur et al., 2015). In a study by Yuan et al., (2016) on tomato, Fv/Fm decreased significantly in response to severe water stress. In another study in cucumber, Li et al., (2008) reported that severe water stress decreased significantly the Fv/Fm ratio. Biochemical activities are similarly affected by prolonged drought stress, such as the efficiency of carboxylation, the regeneration of Rubisco, and the suppression of PS II activity (Giordano et al., 2021), proteins degradation, inactivate enzymes and destroying membranes (Zlatev & Lidon, 2012), high proline levels and ABA accumulation, oxidative damage and ROS production (Seleiman et al., 2021).

Eggplant (*Solanum melongena* L.) is one of the common vegetable crop, mostly cultivated in tropical and subtropical regions (Hanifah et al., 2018; Plazas et al., 2019). The total world production has been estimated at 58.64 million tons in 2021, ranking 6th as the most vegetable production after tomatoes, onions, cucumbers, gherkins and cabbages (FAO, 2021). Eggplant is one of the most popular crops in the Mediterranean area, with major producers being Egypt (1.28MT), Turkey (832,938T) and Italy (306,440T) (Tani et al., 2018; FAO, 2021). Africa represents 3.5% of global eggplant production. In Morocco total

production of eggplant was 81,044 tons from the total harvested area of 2.910 hectares with an average yield of 278.50 (100g/Ha). Eggplants require water during their plant growth and the entire productive phase (Fu et al., 2013). Although, it is considered among the plant species generally affected by environmental conditions (Setyadi et al., 2020) impacting its quality, productivity and post-harvest (Sękara et al., 2012; Toppino et al., 2022), eggplants have been considered moderately tolerant to drought stress (Carlos Díaz-P Erez & Eaton, 2015). The water stress affects photosynthetic rate in eggplant when compared to full irrigation regime (Mohawesh 2016). Moreover, increasing the water deficit rate from 20% to 40% was reported to cause up to 60% decrease in eggplant yield (Karam et al., 2011).

Understanding the genetic basis of adaptive traits in eggplant's wild relatives has long been the main goal of the breeding effort for eggplant (Oladosu et al., 2021). Breeders are currently focusing their effort on (genotype x environment) interactions with variation in morpho-physiological variables to identify breeding methods to create more drought tolerant crops (Czyczyło-Mysza et al., 2019; Toppino et al., 2022). Plant breeding of eggplant and other crops has focused on developing high yield production with good fruit quality and tolerance to environmental stress (Daunay and Hazra, 2012). Therefore, major objectives of eggplant breeding efforts were finalized to enhance agronomic characteristics such as, high adaptation to climatic conditions and improvement of resistance to biotic and abiotic stresses (Kashyap et al., 2003; Kumar et al., 2014; Tani et al., 2018) by exploring the available germplasm aimed at identifying new potential sources of adaptation traits. Finding the best method for maximizing genetic gain presents a significant difficulty for breeders working in arid conditions (Mohammadi, 2018). Although drought tolerance is a quantitative trait, some single genes, such as those that regulate flowering time, plant height, spike type, and osmotic adjustment, may be crucial in helping adaptation to drought situations as suggested by Forester et al., (2004). Additionally, research has been conducted to enhance seed germination and improve seedling emergence (Forti et al., 2020). In a study by (Guo et al., 2019), the activation of genes in tomato plants demonstrated drought tolerance by maintaining their photosynthetic apparatus and antioxidant defense system under drought conditions. In another study, numerous genetic factors affecting root architecture were identified, some of them which may be able to reduce crop loss caused by unfavorable environmental conditions (Jung & McCouch, 2013).

The objective of this study was to determine the effects of a shortage in water irrigation on physiological and agronomical parameters of different eggplant genotypes

displaying phenotypic and genetic variability for productivity, and plant/fruit phenotypic traits (Cericola et al., 2014; Portis et al., 2015) of interest for breeding in the Mediterranean area. These selected accessions have been shared among partners in the framework of the ERANET-FOSC C4C project and have been grown along with two common commercial varieties in field under the Mediterranean climate conditions in the northeast of Morocco, and characterized for their phenotypic, physiological response to drought.

Materials and methods

Plant material

Fifteen genotypes including inbred lines and varieties of eggplants as detailed in Table 1 were used. Thirteen genotypes selected for their expected drought tolerance, and high genetic and phonotypical diversity: 9 genotypes (C6, C7, C8, C10, C11, C12 C13, C14 and C15) were selected from the collection at the Research Centre for Genomics and Bioinformatics, Montanaso, Italy (CREA-GB); and 4 genotypes (B1, B2, B3 and B5) were selected from Bati Akdeniz Agricultural Research Institute, Antalya, Turkey (BATEM). Two commercial varieties Vernal (V) (Vilmorin, Paris, France) and Aswab (A) (Seminis, Missouri, USA) were used as control (Fig.1). The fifteen lines are diverging for many plant/fruit/growth parameters most of them were previously described (Cericola et al., 2014; Portis et al., 2015).

Experimental design

Seeds were sowed on June 25th, 2021 in seed cell-multi-pots filled with peat substrate KlasmanTS3 (Klasmann-Deilmann GmbH, Germany), irrigated twice per day according to the climate conditions of the greenhouse. Seedlings of the fifteen genotypes/varieties were transplanted in the field 8 weeks later (August 21st). Field experiment was conducted in "Arid" area, Nador (35◦08*0*52.6" N 2◦57*0*40.3" W) northeast of Morocco. This region is characterized by semi-arid and Mediterranean climate with average precipitation of 200-300 mm per year. The soil is 39.17% clay, 21.25% sand and 39.58% silt with a pH of 8.53 electrical conductivity of 716.91 µS/cm at 20 °C and ratio C/N of 6.99 (AGQ Laboratory, El Mohammadia, Morocco). The distance between rows was 1.2 m and plants were spaced 0.72 m on the same row and the length of each row was 50 m. Treatments consisted of two different irrigations: control irrigation (Tr-C) adopted by the grower and water shortage by 50% of the amount of this irrigation (Tr-50%). A tape line irrigation with 10 cm distance between two drippers was used for Tr-C and another tape line with same characteristic of the

one with Tr-C, but, with 20 cm distance between two drippers was used for Tr-50%. The same debit (1.5 l/h) for dripper was used for both treatments and the distance between each dripper made the difference between Tr-C and Tr-50% in terms of the amount of water saved and estimated by 50%. An experimental design of randomized blocks was set up, with six replicates for each of the 15 genotypes/variety, each composed by 4 plants.

Measurements

Water consumption

This parameter was taken considering two measurements. First, the water regime supplied was measured by installing containers at the bottom of the dripper and for both treatments, and then it was verified that the flow rate of the dripper was the same for Tr-C and Tr-50% after each irrigation (Table 2). Three containers were used for each treatment and the objective of this method was to ensure that each dripper gave the same flow rate and that the interval (10 cm vs. 20 cm) between drippers was the only variable that determined the 50% of water saved. Then, water flow meters were installed at the start of some lines of each treatment (tape line of 10 and 20 cm) and then weekly readings were recorded for each irrigation line (of the same 50m length but with drippers interval of 10 or 20cm) and then determining the percentage of water saved for the 20 cm tape line compared to the 10 cm tape line.

Plants growth

Growth parameters were measured every week, from end of August 2021 until the beginning of December 2021, for the 2 central plants of each replication. The measured parameters were: plant height, number of flowers, number of leaves, leaf length and width, stem diameter, petiole length, and number of ramifications. For leaf measurements, the fifth expanded leaf from the apex of the plant was chosen.

Relative water content (RWC)

Leaves were used for measuring RWC according to Barrs and Weatherley (1962) method. Measurements were recorded on November 01st, 2021 on the fifth expanded leaf from the apex of one representative plant per each replication of the 15 genotypes/varieties and for each treatment. The fresh weight (FW) of leaf samples were weighed immediately after excision, rinsed and kept in distilled water for 24 h, then turgid leaves were weighted (TW).

The dry weight (DW) was recorded after drying the turgid leaves at 80 °C for 48h until reaching a constant weight. The relative water content was calculated using the following equation (Eq. 1):

$$\mathbf{RWC\ (\%) = (FW - DW)/\ (TW - DW) \times 100}\ \text{(Eq. 1)}$$

Chlorophyll fluorescence

This indicates the transfer of electrons during the light phase of photosynthesis from the excitation of chlorophyll by light energy to the transfer of electrons for the dark phase and they are good indicators of plant stress (Tsimilli-Michael & Strasser, 2001). Parameters were measured by a Handy Plant Efficiency Analyzer HPEA (Handey PEA, Hansatech, UK). The flowing indexes were recorded: maximum PSII efficiency (F_v/F_m), efficiency of light absorption per cross section (ABS/CS_0), heat dissipation per cross-section of PSII (DI_0/CS_0). Measurements were recorded during clear sky conditions ($T._{max}$= 29 °C; RH_{max}= 80%), on September 17th, 2021 and were taken on one representative plant per each replication, on the fifth expanded leaf from the apex of the plants. To achieve these measurements, leaves were dark-adapted for 30 min using a clip. The minimal fluorescence (F_0) was recorded with modulated low intensity light (<0.1 µmol·m-2·s-1) without affecting the variable fluorescence. After the 30 min of darkness, a saturating light flash of 3000 µmol/m^2/s (650 nm) during 1 s (gain = x1) was applied on leaves in order to determine the maximal fluorescence (F_m). Five repetitions were used for each genotype/variety.

Yield

It was determined by harvesting the total fruits from all plants of each replication for all genetic materials. Fruit harvest was carried out weekly starting from October 7th, 2021 and ended on January 8th, 2022 by recording the number and weight of fruits.

Fruit quality

Six representative fruit samples were selected for each genotype/variety and for each treatment and replication. Fruits samples were harvested on December 24th, 2021. All fruits were weighted and cut into two sections considering their length. Length and width were measured for the first half of the fruit. The other half was weighed (FW), and dried at 80°C until reached a constant weight (DW). The percentage of dry matter (DM %) was determined according to Martínez-Ispizua et al. (2021) (Eq.2):

DM%= 100 x [Dry weight (DW)/ Fresh weight (FW)] (Eq. 2)

Statistical Analysis

The plots were produced using the ggplot2 package in logiciel R. The significant differences between treatments or genotypes were calculated with JASP software (JASP Team (2024). JASP (Version 0.18.3) [Computer software]) following a one-way analysis of variance (ANOVA) including the genotypes × treatment interaction effect. Post-hoc means comparisons were made using the Tukey's multiple range tests at $p < 0.05$. All the statistical data was shown as the mean ± standard error. The Student's t-test was used to determine the differences between the mean values of water consumption. The results of the statistical ANOVA test performed for all parameters considered, (genotypes, treatment and their interaction "genotypes × treatment") is detailed in Supp. table 1. The subsequent Post-hoc Tukey test performed, (when Anova results were significant), for all parameters considered are detailed in supplementary tables (2-6).

Results

Water consumption

To standardize the drought stress tests, water quantity values were calculated as shown in Table 2 where it is shown that the water quantity values of each dripper line with 10 cm and 20 cm were similar and the percentage of variation between 10 cm and 20 cm drippers was non-significant. Therefore, the distance between irrigation lines was the factor that determined the theoretical water shortage of about 50% with the measurements made (see water consumption protocol in methods). Furthermore, the confirmation of the stress impact was confirmed by the flow meter measurement which reported around 50% soil water shortage with the Tr-50% treatment compared to Tr-C, during typical periods as shown in Fig. 2.

Analysis of variance

Watering regimes had significant ($P < 0.05$) effect on the morphological and physiological parameters of the fifteen genotypes as detected by ANOVA analysis (Table 3, Supp. table 1). For the comparison between Tr-C and Tr-50% treatments, highly significant differences ($P < 0.001$) were found for the majority of parameters, except for chlorophyll fluorescence parameters (Table 3) the effect of "genotypes" was significant for most of the parameters, except RWC and number of ramification (growth parameter). For the interaction, non-

significant differences were obtained for the three parameters of chlorophyll fluorescence, yield per plant and total yield of yield parameters, and for fruit weight and DM% for fruit quality parameters.

Plant growth

All the morphological traits recorded were significantly affected ($p < 0.001$) by the treatment (Table 4, Supp. table 1) and, generally, the Tr-50% determined a reduction of all the recorded traits. Significant effects were evidenced also for genotypes and for the interaction "treatment x genotype". The highest value of plant height was recorded for the variety V (46.2 cm) under Tr-C and for the genotype C10 under Tr-50% (41.1 cm). The genotype C12 registered the lowest plant height in both irrigation treatments, and its height significantly decreased by 21.12% under Tr-50% with respect to the control treatment (Fig. 3A, Supp. table 2). For number of leaves, the values decreased significantly ($p < 0.001$) for all the genotypes (1.83% - 25.63%) under Tr-50% compared to their control treatment. The highest decrease was observed for C12 and V, with 24.06% and 25.63% of reduction, respectively. Genotypes V (28.0), C15 (26.8), C12. (27,3), C10 (26.1) and B1 (26.2) had the greatest number of leaves in Tr-C conditions. In Tr-50%, only C10 (22.7), C15 (21.8), B1 and C8 (21.2) maintained the same high values compared to the rest of genotypes. The genotype C7 disclosed the smallest value in the two treatments (Fig. 3B, Supp. table 2). Also, the shortage in irrigation treatment significantly decreased the number of ramifications ($p < 0.01$), while for the genotypes and the interaction « treatment x genotype » were not significant. The lowest value was recorded for C7 in non-stress and stress condition (Fig. 3C, Supp. table 2); the reduction was between (2.40% - 29.89%) compared to control treatment with the largest reduction of 29.89% being for the genotype B3.

Regarding the flowering attitude, the number of flowers significantly decreased ($p < 0.001$) between treatments, and among genotypes, but also the interaction « treatment x genotype » resulted statistically significant. The genotypes C10, C14 and C15 preserved the greatest number of flowers than the other genotypes under both treatments (Table 3, Supp. table 1). Compared to control, the genotypes reduced their number of flowers from 7.99% to 48.10% under Tr-50% (Fig. 3D, Supp. table 2). The greatest reduction was noted for C14 (48.10%). Furthermore, the irrigation reduction had a significant decreasing effect ($p < 0.001$) on stem diameter with significant ($p < 0.01$) difference among the genotypes which showed a reduction between 2.99% and 19.72%. The highest value was noted for the genotypes C10

(7.5mm) and C11 (7.6mm) in the control treatment and for B2, C10 and C13 under Tr-50%. The lowest value was obtained for the genotype C15 (6.3 mm) under Tr-C, while for B1 and C8 (5.7 mm) in Tr-50% (Fig. 3E, Supp. table 2). B1 noted the highest decrease with 19.72% in stem diameter. Leaf length significantly decreased ($p < 0.001$) for most of genotypes (2.02% - 21.98%). Under Tr-C, the shortest leaf length was scored for B2 (16.2cm), while the highest one was recorded in the genotype C15 (19.9 cm), which also displayed the largest reduction of (21.98%) in Tr-50%. For the stress treatment, genotypes C13, C6 and the commercial hybrids A, whilst V had a higher leaf length than other genotypes (17.4 cm, 17.2 and 18.1cm respectively, Table 4). The lower value was revealed for C7 (Fig. 3F, Supp. table 2).

Still, leaf width decreased significantly for the genotypes and treatments ($p < 0.001$). C6 displayed the greatest value (12.5 cm) in Tr-C, with a 17.87% of reduction in Tr-50%. C13 illustrated the highest value (10.6cm) under stress condition (Fig.3G, Supp. table 2). Likewise, water stress causes a significant difference ($p < 0.05$) on the petiole length. The genotype C7 displayed the highest petiole length under control and stress treatments. Also, C10 (6.3 cm) and B3 (7.8cm) in Tr-50% (Fig. 3H). However, also an increase in the petiole length was observed in the genotype B3 under irrigation shortage compared to Tr-C. Among genotypes, B3 was significantly different from B2 and C12.

RWC

Under water shortage, RWC significantly decreased for most of the genotypes compared to the control treatment ($p < 0.001$), while non-significant difference was obtained between genotypes and in the interaction "treatment x genotype" (Table 5, detailed Statistical ANOVA and post-hoc test performed for RWC traits available in Supp. tables 1 and 3).

All the genotypes present a slight tolerance in the control treatment (values ranged from 70.64% to 81.0%). RWC reductions fluctuated between 4.12% - 21.40% under irrigation shortage. It was observed that the genotypes C15 (81.00%) and B5 (80.92%) maintained the highest values of RWC compared to the other genotypes in non-stress conditions (Fig.4, (Supp. table 3). while their response to water shortage conditions was significantly different. The genotypes C10 (69.99%) and B5 (70.06%) interestingly preserved the greatest values of RWC under water shortage and were therefore assigned as more tolerant to stressing conditions; on the contrary, C13 (58.90%) and C15 (60.95%) displayed the lowest values of RWC and considered to be more sensitive. The results showed that the genotypes C13 and

C15 displayed the greatest reduction by 20.72% and 21.40% respectively. C10 represent the more resilient genotype affected by water stress with only 4.12% of RWC reduction.

Chlorophyll a fluorescence

Non-significant difference between the treatments were highlighted for the ratio F_v/F_m (indicating the maximum efficiency of PSII), the ABS/CS_0 ratio, (which indicates the efficiency of light absorption per cross section) and the DI_0/CS_0 (indicating the dissipation per cross-section of the photosystem II), whereas the genotypes proved important different responses *($p < 0.001$)* for the three fluorescence parameters (Table 5, Supp. table 1). All the genetic material showed the stability of the F_v/F_m ratio when plants faced water shortage (Fig. 5A, Supp. table 4). The genotype B5 displayed the lowest values (0.59 and 0.55) of F_v/F_m for Tr-C and Tr-50%, respectively, while the genotype C10 the highest values (0.83 and 0.78) compared to the other genotypes. For the ratio ABS/CS_0 ratio, the B5 genotype showed a high value without any significant difference between the two treatments (Fig. 5B, Supp. table 4). B5 was statistically different respect C10, C13, C14, C15 and C6. Moreover, C14 revealed the lowest value when compared to the other genotypes regardless the two treatments, and it was significantly different from C7. In addition, the ratio (DI_0/CS_0) of the genotype B5 was highest and the genotype C14 had the lowest values compared to the other genotypes and treatments (Fig. 5B-C, statistical data analysis can be seen at Supp. table 4).

Yield

Regarding the parameters affecting yield (number of fruits/plants, kg/plant and total yield) the statistical analysis highlighted significant differences of recorded data between treatments *($p < 0.001$)*, between genotypes *($p < 0.001$)*, but a significant genotype x treatment effect was detected only for the number of fruit/plant (Table 6, Supp. table 1).

Regarding number of fruits/plants, in the control conditions it was higher in the genotypes C8 (19.00), B5 (15.17) and, as expected, in the commercial hybrids A (15.96) and V (16.79). The genotype C6 produced the significantly lowest number of fruits under both Tr-C (9.58 fruits/plant) and Tr-50% (6.42 fruits/plant) irrigation, but interestingly had a very low decrease (12.79%) in response to stress. The reduction of fruit number in all genotypes under Tr-50% conditions ranged between 2.23% and 49.58%. Under water shortage, the genotypes B5 (10.38), C8 (9.58), C14 (9.50) and C7 (9.21) resulted the best performing, exceptthe commercial hybrids A and V with displayed respectively 11.88 and 11.71 fruits/plant (Fig. 6A, Supp. table 5). C7 was the more “resilient” and decreased only (2.23%). This data

together with C6 seems to indicate that lower performing lines in control conditions can maintain better the production upon stress while “highly performing” lines like A, V or local lines like C8 have less “plasticity” to drought stress. For the yield (kg/plant), statistical analysis of the data revealed significant differences among genotypes and treatments *($p < 0.001$)*, However, there were no appreciable changes brought about by the "treatment x genotype" interaction (Table 6, Supp. table 1). The decreases in yield of fruit per plant (kg/plant) varied from 0.65% to 39.19%. The commercial hybrids A and V presented very high production as expected (2.49 and 2.7 kg/plant respectively) and this value resulted affected importantly upon stress (reduction of 20 and 31% respectively).

Regarding genotypes, C10, B5, B1, C12 and C8 were detected with higher values of yield in TR-C compared to the rest of the local genotypes (2.18 kg/plant, 1.88 kg/plant,1.84 kg/plant, 1.82 kg/plant and 1.63 kg/plant, respectively), significantly differing from to the “low performing” genotypes C6, C7, C13, C14 and C15. C7 displayed a very low impact under water shortage (10% reduction only) supporting the flexibility already reported for the number of fruits/plant analysis. Interestingly, C13 represent the more resilient genotype affected by water stress for kg/plant pattern and showed only a 0.65% of reduction indicating again that the local lines (like C6 and C7) that are targeted in certain cases the more resilient to water regime fluctuations. According to the results the highest reduction, (and therefore the greatest sensibility to drought stress), was reported for the genotype B1 (39.19%). Whereas, among the stress treatment genotypes C10 and C13 showed significantly higher yield of fruits per plant (kg/plant) (1.48kg/plant and 1.53 kg/plant, respectively), in contrast to the remaining genotypes, although lower respect the commercial lines A and V with 1,98kg/plant and 1,86 kg/plant, respectively). C14 had significantly lower yield in the two treatments and additionally, in contrast to the other genotypes (Fig. 6B, Table 6, Supp. table 5).

Overall, our data seems to indicate that the local lines that are targeted as “low performing”, respect the “high performing lines” or the “commercial lines” have more plasticity to water regime fluctuations.

Fruit quality

Fruit weights (g), length (cm), width (cm) and the percentage of dry matter of the fruits are presented in Fig. 7, Supp. table 6). Significant differences were observed between treatment and among genotypes *($p < 0.001$)*, while a non-significant interaction "treatment x genotype" was highlighted for average fruit weight (g) and dry matter % parameters (Table 7, Supp.

table 1). Higher fruit weight was observed in C13 (293.60g in Tr-C; 236.60g in Tr-50%) and C12 (284.30g in Tr-C; 239.80g in Tr-50%) (Fig. 7A, Supp. table 6). The lowest fruit weight was recorded for the genotypes C7 and C14 in the control treatment and C14, C8, C7 and C15 in stress treatment. The significant reduction was observed in all genotypes due to water shortage, ranging between 20.79% and 35.19%. Fruit length and width were significantly lower under Tr-50% than Tr-C for most of the genotypes ($p < 0.001$) (Fig. 7B-C, (Supp. table 6). Genotype C8 accounted for the highest fruit length 24.18 cm in case of Tr-C and 20.25 cm in Tr-50%, with significant reduction (16.25%), while the lowest fruit length was noted for C15 6.18 cm under Tr-C and 5.50 cm under Tr-50% when compared to other genotypes, with a notable decline of approximately 11.00% in the Tr-50% treatment. The genotype B2 resulted the most affected by water shortage, with a fruit length reduction of 27.20%. C12 had a comparably higher fruit width in contrast to other genotypes, (11.16 cm and 9.16 cm in control and water shortage treatments, respectively) with significant reduction of 17.92%, while the lowest values were recorded for C8 (2.71 and 2.43 cm, respectively). The highest reduction in fruit width due to Tr-50% was recorded for C14 (34.35%). In terms of dry matter content of the fruits, significant difference was observed both between treatments and among genotypes. The genotypes varied between 2.58% and 8.35% in the two treatments The C15 clearly had the highest significant DM when compared to the rest genotypes with a value of 7.90% in Tr-C and of 8.35% in Tr-50%. On the contrary, C12 genotype had significantly lower DM comparing to the remaining genotypes (Fig. 7B-C, Supp. table 6).

Discussion

Plant growth is one of the physiological processes most vulnerable to drought, and water scarcity is a well reported limiting factor for plant growth and development (Shao et al., 2008). The results obtained in this experiment indicate that the reduction of 50% of the irrigation regime affected the growth parameters of great part of eggplant genotypes and varieties selected for this study. We identified a general trend in our eggplant populations submitted to a 50% cut of the irrigation regime, showing an overall developmental reduction of the aerial structure and presenting a variable range of responsiveness among eggplant lines. Among the traits detected, we found that the most influenceable by the treatment were the reduction of i) number of ramifications (6 lines) ii) number of flowers (7 lines) iii) leaves length (6 lines), leaves width (4 lines) and petiole length (4 lines). In addition, parameter such as plant height or number of leaves seems to be even more proper indicators of stress and plants may have certain plasticity to maintain this phenotypic feature under different water availability. Signif-

icant difference on plant height was obtained for all genotypes compared with the control. These results are different to those found by Kamrun, et al., (2011) since they observed no difference in the height of some tomato cultivars when subjected to different water stress treatments. The significant differences encountered Tr-50% with respect to control of all the genotypes matched with the results obtained by Kirnak et al. (2001), therefore confirming that water limitation reduced significantly the plant height in eggplant. The decrease in plant height was also shown with tomato crops (Zhang et al., 2020) and potato (Pino et al., 2013). The number of flowers decreased significantly with Tr-50%, the most affected was noted for the C14 (48.10%), which is similar to the results found by Amiri Rodan et al. (2021) who demonstrated that 40% of water reduction decreased the number of flowers in eggplants. Numbers of leaves, leaf length and leaf width, number of ramifications, length of the petiole were significantly affected by Tr-50%. Our results align with those found by Rady et al. (2020) stating that the number of leaves decreased by approximately of 28% under water limitation with respect to normal irrigation. Also, previous studies reported that water stress decreased the number of ramifications (Limousin et al., 2012), and petiole length (Devkota and Jha, 2011). Medyouni et al. (2021) reported that length and width of leaves were reduced by 37% and by 36% respectively in tomato and under water scarcity. Also, stem diameter is another factor that is frequently impacted by water stress (Albert et al., 2016) and by reducing irrigation, stem diameter was significantly reduced (Zhang et al., 2020). This indicates that phenotypic monitoring of these values in commercially valuable lines may be a biomarker of field stress that may have practical utility in future agronomic practices to prevent irrigation problems in the field.

Relative water content (RWC) which is a measure of the physiological water status (Sekmen et al., 2014; Siddiqui et al., 2015) of a plant had a higher value for all genetic material at Tr-C compared to Tr-50%. In our study, genotypes C10 and B5 successfully maintained a constant RWC also when submitted to 50% irrigation reduction, thus, indicating their better ability to cope with drought stress tolerance. C10 represents the more resilient genotype affected by water stress with only 4.12% of RWC reduction. On the contrary, C13 and C14 meant to be the most sensitive to drought stress according to their greatest decrease under Tr-50%. Similar trend was observed with in the Mohawesh & Karajeh, (2014) study who observed that under greenhouse condition, leaf RWC significantly reduced with irrigation shortage both in tomato and eggplant. Also, Kirnak et al., (2001) and Bian et al. (2019) already reported that significant reductions in the amount of leaf relative water content

and vegetative growth could be caused by the water stress in case of eggplant and tomato, respectively. The genotype C10 and B5 were preserved as the most tolerant genotypes under stress water condition also considering the other phenotypic and physiological traits. The high value of Fv/Fm ratio obtained for C10 under water stress indicates that this genotype could be considered as a tolerant accession in this irrigation study. This result is consistent with other study indicating that tolerant varieties get better RWC under water stress (Cia et al., 2012). In conditions of stress, plants could maintain their physiological balance by increasing RWC, especially when the transpiration rate is high (Raja et al., 2020).

On the other side, the plant photosynthesis process is influenced by environmental factors. This may have an impact on each phase, including the absorption of solar energy, the transmission of electrons, and the final acceptors (Ripoll et al., 2016). Analyzing the parameters of the chlorophyll fluorescence is a specific and quick method for determining how effectively the photosynthetic apparatus's composition and function respond to abiotic stresses (Killi et al., 2020). The F_v/F_m ratio had no significant differences between the control irrigation and water shortage treatment. This research result agrees with the results of Penella et al. (2014), since no effect of water shortage was found on F_v/Fm ratio on different pepper genotypes. Interestingly, it was observed that, the F_v/F_m ratio was higher for C10 under water stress conditions, meaning that this genotype was more tolerant as reported by Poudyal et al. (2019) in tomato drought tolerant genotypes under high temperature conditions. In this study, under water stress, the majority of genotypes and particularly B5 had an increase in DI_0/CS_0 ratio under water stress. This increase could be the effect of the existence of less energy available for photochemistry, supported by an increase in energy dissipation at elevated temperatures (Mathur et al., 2013). In addition, the reduction in chlorophyll fluorescence of B5 under the two-treatments seemed to show that there is a loss in the yield of PSII photochemistry because of reduction of the photosynthetic rate (Hannachi et al., 2022). This can also suggest that the defensive mechanism (heat dissipation) is activated by the reaction centers in response to drought stress (Wang et al., 2019). For the ratio ABS/CS_0, no difference was recorded between both treatments, evidence already reported by Luo et al. (2023). This could mean that the number of electrons received with the chlorophyll antenna was the same with Tr-C and Tr-50%.

For plant yield, the Tr-50% condition caused a significant decrease in the fruit yield (g) and the number of fruits per plant and total yield (kg) on the majority of the eggplant genotypes. C8 represents the most affected genotype by water limitation (-49.58%), for the

number of fruits. These results agree with Lovelli et al. (2007) who reported that reducing irrigation by 50% in eggplant decreased the number of fruits per plant by 37%. The fruit yields per plant (kg/plant) of C10 and C13 were noticeably higher under stress treatment with respect to the other genotypes, so they might be regarded as the most tolerant genotypes in this panel of accessions. The same comparison revealed that C14 had lower yield in the two treatments, so it was considered as a sensitive genotype with water limitation. This matched with the results reported by Karam et al. (2011) and showed that eggplant yield was reduced by 33-35% by water scarcity; moreover, Carlos Díaz-P Erez and Eaton (2015) found that eggplant can tolerate water limitation, as plants watered at 33% reduction of evapotranspiration rate (ETc) had fruit yield similar to those irrigated at 100% ETc. Other research studies showed also that yield and fruit weight of various crops such as tomato and melon decreased as water limitation increased (Du et al., 2015; Akhoundnejad and Dasgan, 2019; Darko et al., 2019).

As reported previously, results showed that significant differences were observed in fruit weight, fruit length and width between Tr-C and Tr-50% for some genotypes and varieties. According to Çolak et al. (2015), changing in irrigation rate had a significant impact on quality parameters of eggplant including fruit weight, fruit length and width and yield per plant. Also, results of this work, on these quality parameters, matched with those reported by Mohawesh and Karajeh (2014). Semida et al. (2021) found that fruit length of eggplant was lowered by 9.2% when irrigation was reduced by 60% ETc. In the case of our study, water limitation increased the fruit dry matter content. These results are in agreement with those of Karam et al., (2011) and Serhat, (2017) stated that water limitation considerably increased fruit dry matter content in eggplant.

Conclusion

Phenotypic monitoring of easily scorable traits as plant height or number of plant leaves in commercially valuable lines may be considered an early biomarker of field stress that may have practical utility in future agronomic practices to prevent irrigation problems in the field. Regarding fruit yield, overall, our data seems to indicate that the local lower performing lines in control conditions can better maintain the production upon stress respect the “high performing lines” or the “commercial lines” because they have more plasticity to water regime fluctuations.

The fifteen genetic materials presented different morphological and physiological responses to the water shortage by Tr-50%. C10 and C13 genotypes were highlighted in the panel as the genotypes which could more tolerate water stress applied in our study better than the rest of genotypes in terms of yield. C10 preserved also highest ratio of F_v/F_m in the two treatments without significant differences, this mean that the response of this genotype was greatest than the rest of genotypes. Genotypic differences in eggplant's responses to stress are issues that should be considered in breeding studies of this species. Some of the genotypes here considered resistant to water stress maybe after further validation, good genitors for resistance breeding to this stress. Those results are still valid for the conditions of this current experiment (soil, water, microclimate, period of experiments, method of irrigation made by the grower, etc.). More field trials will be needed and the water shortage should be realized on the need of the eggplants which was not the case of this experiment (100% was the irrigation method made by the grower). Finally, the experiment will more informative when performed during even more stressful conditions as the hot summer conditions (June, July and August) instead of t late summer and beginning of fall, which was the case of this study.

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REFERENCES

Ahmed, S., Nawata, E., Hosokawa, M., Domae, Y., & Sakuratani, T. (2002). Alterations in photosynthesis and some antioxidant enzymatic activities of mungbean subjected to waterlogging. *Plant Science*, *163*(1), 117–123. https://doi.org/10.1016/S0168-9452(02)00080

Akhoundnejad, Y. (2020). Response of some tomato (Solanum lycopersicum) genotypes to drought stress in terms of yield and quality in Şırnak conditions. International Journal of Agriculture, Environment and Food Sciences, 76–80. https://doi.org/10.31015/jaefs.2020.1.12

Akhoundnejad, Y., & Dasgan, H. Y. (2019). Effect of different irrigation levels on physiological performance of some drought tolerant melon (Cucumis melo l.) genotypes. Applied Ecology and Environmental Research, 17(4), 9997–10012. https://doi.org/10.15666/aeer/1704_999710012

Albert, E., Segura, V., Gricourt, J., Bonnefoi, J., Derivot, L., & Causse, M. (2016). Association mapping reveals the genetic architecture of tomato response to water deficit: focus on major fruit quality traits. Journal of Experimental Botany, 67(22), 6413–6430. https://doi.org/10.1093/jxb/erw411

Amiri Rodan, M., Hassandokht, M. R., Sadeghzadeh-Ahari, D., & Musavi, A. (2021). Alleviating of Water Deficit in Eggplant by Two Different Mulches. Egyptian Journal of Horticulture, 48(1), 37–48. https://doi.org/10.21608/ejoh.2020.53012.1155

Anderson, R., Bayer, P. E., & Edwards, D. (2020). Climate change and the need for agricultural adaptation. Current Opinion in Plant Biology, 56, 197–202. https://doi.org/10.1016/j.pbi.2019.12.006

Bahadur, A., Lama, T. D., & Chaurasia, S. N. S. (2015). Gas exchange, chlorophyll fluorescence, biomass production, water use and yield response of tomato (Solanum lycopersicum) grown under deficit irrigation and varying nitrogen levels. *Indian Journal of Agricultural Sciences*, *85*(2), 224–228. https://doi.org/10.56093/ijas.v85i2.46506

Bahar, A. A., Faried, H. N., Razzaq, K., Ullah, S., Akhtar, G., Amin, M., Bashir, M., Ahmed, N., Wattoo, F. M., Ahmar, S., Javed, T., Siddiqui, M. H., Branca, F., & Dessoky, E. S. (2021). Potassium-induced drought tolerance of potato by improving morpho-physiological and biochemical attributes. Agronomy, 11(12), 1–14. https://doi.org/10.3390/agronomy11122573

Barrs, H. D., & Weatherley, P. E. (1962). A re-examination of the relative turgidity technique for estimating water deficits in leaves. *Australian journal of biological sciences*, *15*(3), 413-428.

Bian, Z., Zhang, X., Wang, Y., & Lu, C. (2019). Improving drought tolerance by altering the photosynthetic rate and stomatal aperture via green light in tomato (Solanum lycopersicum L.) seedlings under drought conditions. Environmental and Experimental Botany, 167(August), 103844. https://doi.org/10.1016/j.envexpbot.2019.103844

Bismillah Khan, M., Hussain, M., Raza, A., Farooq, S., & Jabran, K. (2015). Seed priming with CaCl2 and ridge planting for improved drought resistance in maize. Turkish Journal of Agriculture and Forestry, 39(2), 193–203. https://doi.org/10.3906/tar-1405-39

Carlos Díaz-P, Erez, J., & Eaton, T. E. (2015). Eggplant (Solanum melongena L.) Plant Growth and Fruit Yield as Affected by Drip Irrigation Rate. In HORTSCIENCE (Vol. 50, Issue 11).

Cia, M. C., Guimarães, A. C. R., Medici, L. O., Chabregas, S. M., & Azevedo, R. A. (2012). Antioxidant responses to water deficit by drought-tolerant and -sensitive sugarcane varieties. Annals of Applied Biology, 161(3), 313–324. https://doi.org/10.1111/j.1744-7348.2012.00575.x

Chatterjee, A., & Solankey, S. S. (2015). Functional Physiology in Drought Tolerance of Vegetable Crops: an Approach To Mitigate Climate Change Impact. *Climate Dynamics in Horticultural Science: Volume 1-2*, *1*, 149–171. https://doi.org/10.1201/b18252-18

Cericola, F., Portis, E., Lanteri, S., Toppino, L., Barchi, L., Acciarri, N., Pulcini, L., Sala, T.,

602 & Rotino, G. L. (2014). Linkage disequilibrium and genome-wide association analysis for
603 anthocyanin pigmentation and fruit color in eggplant. *BMC Genomics*, *15*(1), 1–15.
604 https://doi.org/10.1186/1471-2164-15-896

605

606 Çolak, Y. B., Yazar, A., Çolak, İ., Akça, H., & Duraktekin, G. (2015). Evaluation of Crop
607 Water Stress Index (CWSI) for Eggplant under Varying Irrigation Regimes Using Surface and
608 Subsurface Drip Systems. Agriculture and Agricultural Science Procedia, 4, 372–382.
609 https://doi.org/10.1016/j.aaspro.2015.03.042

610

611 Czyczyło-Mysza, I. M., Cyganek, K., Dziurka, K., Quarrie, S., Skrzypek, E., Marcińska, I.,
612 Myśków, B., Dziurka, M., Warchoł, M., Kapłoniak, K., & Bocianowski, J. (2019). Genetic
613 parameters and QTLs for total phenolic content and yield of wheat mapping population of
614 CSDH lines under drought stress. *International Journal of Molecular Sciences*, *20*(23).
615 https://doi.org/10.3390/ijms20236064

616

617 Darko, R.O., Yuan, S., Sekyere, J., Liu, J., 2019. Effect of deficit irrigation on yield and
618 quality of eggplant. Int. J. Environ. Agric. Biotechnol 4, 1325–1333. https://doi.org/
619 10.22161/ijeab.45.5

620

621 Dash, S., & Mohanty, N. (2001). Evaluation of assays for the analysis of thermo-tolerance
622 and recovery potentials of seedlings of wheat (Triticum aestivum L.) cultivars. Journal of
623 Plant Physiology, 158(9), 1153–1165. https://doi.org/10.1078/0176-1617-00243

624

625 Daunay, M. C., & Hazra, P. (2012). Eggplant, ‖ in Handbook of Vegetables, eds KV Peter and
626 P.

627

628 Devkota, A., & Jha, P. K. (2011). Influence of water stress on growth and yield of centella
629 asiatica. International Agrophysics, 25(3), 211–214.

630

631 Du, T., Kang, S., Zhang, J., & Davies, W. J. (2015). Deficit irrigation and sustainable water-
632 resource strategies in agriculture for China’s food security. Journal of Experimental Botany,
633 66(8), 2253–2269. https://doi.org/10.1093/jxb/erv034

Fahad, S., Bajwa, A. A., Nazir, U., Anjum, S. A., Farooq, A., Zohaib, A., Sadia, S., Nasim, W., Adkins, S., Saud, S., Ihsan, M. Z., Alharby, H., Wu, C., Wang, D., & Huang, J. (2017). Crop production under drought and heat stress: Plant responses and management options. Frontiers in Plant Science, 8(June), 1–16. https://doi.org/10.3389/fpls.2017.01147

FAO, 2021. Food and agriculture data. Available online at: http://www.fao.org/faostat/en/#data/QC.

Forester, B. P., Ellis, R. P., Moir, J., Talame, V., Sanguineti, M. C., Tuberosa, R., ... & Ben Salem, M. . (2004). Genotype and phenotype associations with drought tolerance in barley tested in North Africa. *Annals of Applied Biology*, *144*(2), 157–168. https://doi.org/10.1111/j.1744-7348.2004.tb00329.x

Frona, D., Szenderak, J., & Harangi-Rakos, M. (2021). Economic effects of climate change on global agricultural production. Nature Conservation, 44, 117–139. https://doi.org/10.3897/natureconservation.44.64296

Forti, C., Ottobrino, V., Bassolino, L., Toppino, L., Rotino, G. L., Pagano, A., Macovei, A., & Balestrazzi, A. (2020). Molecular dynamics of pre-germinative metabolism in primed eggplant (Solanum melongena L.) seeds. *Horticulture Research*, *7*(1). https://doi.org/10.1038/s41438-020-0310-8

Fu, Q. S., Yang, R. C., Wang, H. S., Zhao, B., Zhou, C. L., Ren, S. X., & Guo, Y. D. (2013). Leaf morphological and ultrastructural performance of eggplant (Solanum melongena L.) in response to water stress. Photosynthetica, 51(1), 109–114. https://doi.org/10.1007/s11099-013-0005-6

Giordano, M., Petropoulos, S. A., & Rouphael, Y. (2021). Response and defence mechanisms of vegetable crops against drought, heat and salinity stress. *Agriculture (Switzerland)*, *11*(5), 1–30. https://doi.org/10.3390/agriculture11050463

Guo, X., Zhang, L., Wang, X., Zhang, M., Xi, Y., Wang, A., & Zhu, J. (2019). Overexpression of Saussurea involucrata dehydrin gene SiDHN promotes cold and drought tolerance in transgenic tomato plants. *PLoS ONE*, *14*(11), 1–24. https://doi.org/10.1371/journal.pone.0225090

Hanifah, A., Maharijaya, A., Putri, S. P., Laviña, W. A., & Sobir. (2018). Untargeted metabolomics analysis of eggplant (Solanum melongena L.) fruit and its correlation to fruit morphologies. Metabolites, 8(3). https://doi.org/10.3390/metabo8030049

Hannachi, S., Signore, A., Adnan, M., & Mechi, L. (2022). Single and Associated Effects of Drought and Heat Stresses on Physiological, Biochemical and Antioxidant Machinery of Four Eggplant Cultivars. Plants, 11(18). https://doi.org/10.3390/plants11182404

IPCC, 2007. Summary of the Policy Makers, Climate Change 2007: Mitigation, Contributionof Working Group I to the Fourth Assessment Report of the IPCC. Cambridge University
Press, Cambridge, U.K

Jamalluddin, N., Massawe, F. J., & Symonds, R. C. (2019). Transpiration efficiency of Amaranth (Amaranthus sp.) in response to drought stress. *Journal of Horticultural Science and Biotechnology*, *94*(4), 448–459. https://doi.org/10.1080/14620316.2018.1537725

Janáček, J., & Wilhite, D. (1993). Drought assessment, management and planning: Theory and case studies. Kluwer Academic Publishers, Boston-Dordrecht-London 1993. 293 pp. 293 pp.

Jat, M. L., Bijay-Singh, Stirling, C. M., Jat, H. S., Tetarwal, J. P., Jat, R. K., Singh, R., Lopez-Ridaura, S., & Shirsath, P. B. (2018). Soil Processes and Wheat Cropping Under Emerging Climate Change Scenarios in South Asia. In Advances in Agronomy (1st ed., Vol. 148). Elsevier Inc. https://doi.org/10.1016/bs.agron.2017.11.006

Jung, J. K. H., & McCouch, S. (2013). Getting to the roots of it: Genetic and hormonal control of root architecture. *Frontiers in Plant Science*, *4*(JUN), 1–32. https://doi.org/10.3389/fpls.2013.00186

Kamrun, N., Shah, M. U. & Gretzmacher, R. (2011) Influence of Soil Moisture Stres s on Height, Dry Matter and Yield of Seven Tomato (Lycopersicon esculentum Mill) Cultivars. Canadian Journal on Scientific and Industrial Research, 2(4), 160-163.

Karam, F., Saliba, R., Skaf, S., Breidy, J., Rouphael, Y., & Balendonck, J. (2011). Yield and water use of eggplants (Solanum melongena L.) under full and deficit irrigation regimes. Agricultural Water Management, 98(8), 1307–1316. https://doi.org/10.1016/j.agwat.2011.03.012

Kashyap, V., Vinod Kumar, S., Collonnier, C., Fusari, F., Haicour, R., Rotino, G. L., Sihachakr, D., & Rajam, M. V. (2003). Biotechnology of eggplant. Scientia Horticulturae, 97(1), 1–25. https://doi.org/10.1016/S0304-4238(02)00140-1

Killi, D., Raschi, A., & Bussotti, F. (2020). Lipid peroxidation and chlorophyll fluorescence of photosystem ii performance during drought and heat stress is associated with the antioxidant capacities of C3 sunflower and C4 maize varieties. International Journal of Molecular Sciences, 21(14), 1–21. https://doi.org/10.3390/ijms21144846

Kirnak, H., Kaya, C., Tas, I., & Higgs, D. (2001). The Influence Of Water Deficit On Vegetative Growth, Physiology, Fruit Yield and Quality In Egg Plant. BULG. J . Plant Physiol, 27(3–4), 34–46. http://www.bio21.bas.bg/ipp/gapbfiles/v-27/01_3-4_34-46.pdf

Kumar, J., Srivastava, E., Singh, M., Mahto, D., Pratap, A., & Kumar, S. (2014). Lentil. Alien Gene Transfer in Crop Plants, Volume 2: Achievements and Impacts, 2, 191–205. https://doi.org/10.1007/978-1-4614-9572-7

Li, L., Gu, W., Li, C., Li, W., Li, C., Li, J., & Wei, S. (2018). Exogenous spermidine improves drought tolerance in maize by enhancing the antioxidant defence system and regulating endogenous polyamine metabolism. Crop and Pasture Science, 69(11), 1076–1091. https://doi.org/10.1071/CP18271

Li, Q. M., Liu, B. Bin, Wu, Y., & Zou, Z. R. (2008). Interactive effects of drought stresses and elevated CO2 concentration on photochemistry efficiency of cucumber seedlings. *Journal of Integrative Plant Biology*, *50*(10), 1307–1317. https://doi.org/10.1111/j.1744-7909.2008.00686.x

Li, Y., Ye, W., Wang, M., & Yan, X. (2009). Climate change and drought: a risk assessment of crop-yield impacts. Climate Research, 39(June), 31–46. https://doi.org/10.3354/cr00797

Limousin, J. M., Rambal, S., Ourcival, J. M., Rodríguez-Calcerrada, J., Pérez-Ramos, I. M., Rodríguez-Cortina, R., Misson, L., & Joffre, R. (2012). Morphological and phenological shoot plasticity in a Mediterranean evergreen oak facing long-term increased drought. Oecologia, 169(2), 565–577. https://doi.org/10.1007/s00442-011-2221-8

Lovelli, S., Perniola, M., Ferrara, A., & Di Tommaso, T. (2007). Yield response factor to water (Ky) and water use efficiency of Carthamus tinctorius L. and Solanum melongena L. Agricultural Water Management, 92(1–2), 73–80. https://doi.org/10.1016/j.agwat.2007.05.005

Luo, Y., Sun, M., Gao, Y., Lang, S. P., & Wang, Y. (2023). Exogenous trehalose protects photosystem II in heat-stressed wheat. Botanical Sciences, 101(1), 186–196. https://doi.org/10.17129/botsci.3038

Malhi, G. S., Kaur, M., & Kaushik, P. (2021). Impact of climate change on agriculture and its mitigation strategies: A review. Sustainability (Switzerland), 13(3), 1–21. https://doi.org/10.3390/su13031318

Martínez-Ispizua, E., Calatayud, Á., Marsal, J. I., Mateos-Fernández, R., Díez, M. J., Soler, S., Valcárcel, J. V., & Martínez-Cuenca, M. R. (2021). Phenotyping Local Eggplant Varieties: Commitment to Biodiversity and Nutritional Quality Preservation. Frontiers in Plant Science, 12(July). https://doi.org/10.3389/fpls.2021.696272

762 Mathur, S., Mehta, P., & Jajoo, A. (2013). Effects of dual stress (high salt and high
763 temperature) on the photochemical efficiency of wheat leaves (Triticum aestivum).
764 Physiology and Molecular Biology of Plants, 19(2), 179–188. https://doi.org/10.1007/s12298-
765 012-0151-5
766
767 Medyouni, I., Zouaoui, R., Rubio, E., Serino, S., Ahmed, H. Ben, & Bertin, N. (2021). Effects
768 of water deficit on leaves and fruit quality during the development period in tomato plant.
769 Food Science and Nutrition, 9(4), 1949–1960. https://doi.org/10.1002/fsn3.2160
770
771 Mohammadi, R. (2018). Breeding for increased drought tolerance in wheat: A review. *Crop
772 and Pasture Science*, *69*(3), 223–241. https://doi.org/10.1071/CP17387
773
774 Mohawesh, O. (2016). Utilizing deficit irrigation to enhance growth performance and water-
775 use efficiency of eggplant in arid environments. Journal of Agricultural Science and
776 Technology, 18(1), 265–276.
777
778 Mohawesh, O., & Karajeh, M. (2014). Effects of deficit irrigation on tomato and eggplant and
779 their infection with the root-knot nematode under controlled environmental conditions.
780 Archives of Agronomy and Soil Science, 60(8), 1091–1102.
781 https://doi.org/10.1080/03650340.2013.871385
782
783 Muñoz-Rojas, M., Abd-Elmabod, S. K., Zavala, L. M., De la Rosa, D., & Jordán, A. (2017).
784 Climate change impacts on soil organic carbon stocks of Mediterranean agricultural areas: A
785 case study in Northern Egypt. Agriculture, Ecosystems and Environment, 238, 142–152.
786 https://doi.org/10.1016/j.agee.2016.09.001
787
788 Mustafa, H., Ilyas, N., Akhtar, N., Raja, N. I., Zainab, T., Shah, T., Ahmad, A., & Ahmad, P.
789 (2021). Biosynthesis and characterization of titanium dioxide nanoparticles and its effects
790 along with calcium phosphate on physicochemical attributes of wheat under drought stress.
791 Ecotoxicology and Environmental Safety, 223, 112519.
792 https://doi.org/10.1016/j.ecoenv.2021.112519
793
794 Nelissen, H., Sun, X. H., Rymen, B., Jikumaru, Y., Kojima, M., Takebayashi, Y., Abbeloos,
795 R., Demuynck, K., Storme, V., Vuylsteke, M., De Block, J., Herman, D., Coppens, F., Maere,

S., Kamiya, Y., Sakakibara, H., Beemster, G. T. S., & Inzé, D. (2018). The reduction in maize leaf growth under mild drought affects the transition between cell division and cell expansion and cannot be restored by elevated gibberellic acid levels. *Plant Biotechnology Journal*, *16*(2), 615–627. https://doi.org/10.1111/pbi.1280

Noorka, I. R., & Tabasum, S. (2013). An Empirical Approach to Get the Vitality of a Genotype to Water Stress Tolerance in Yield and Yield Contributing Traits. American Journal of Plant Sciences, 04(05), 999–1003. https://doi.org/10.4236/ajps.2013.45123

Oladosu, Y., Rafii, M. Y., Arolu, F., Chukwu, S. C., Salisu, M. A., Olaniyan, B. A., Fagbohun, I. K., & Muftaudeen, T. K. (2021). Genetic diversity and utilization of cultivated eggplant germplasm in varietal improvement. *Plants*, *10*(8), 1–21. https://doi.org/10.3390/plants10081714

Penella, C., Nebauer, S. G., López-Galarza, S., San Bautista, A., Rodríguez-Burruezo, A., & Calatayud, A. (2014). Evaluation of some pepper genotypes as rootstocks in water stress conditions. Horticultural Science, 41(4), 192–200. https://doi.org/10.17221/163/2013-hortsci

Pino, M. T., Ávila, A., Molina, A., Jeknic, Z., & Chen, T. H. H. (2013). Enhanced in vitro drought tolerance of Solanum tuberosum and Solanum commersonii plants overexpressing the ScCBF1 gene. Ciencia e Investigacion Agraria, 40(1), 171–184. https://doi.org/10.4067/S0718-16202013000100015

Plazas, M., Nguyen, H. T., González-Orenga, S., Fita, A., Vicente, O., Prohens, J., & Boscaiu, M. (2019). Comparative analysis of the responses to water stress in eggplant (Solanum melongena) cultivars. Plant Physiology and Biochemistry, 143, 72–82. https://doi.org/10.1016/j.plaphy.2019.08.031

Portis, E., Cericola, F., Barchi, L., Toppino, L., Acciarri, N., Pulcini, L., Sala, T., Lanteri, S., & Rotino, G. L. (2015). Association mapping for fruit, plant and leaf morphology traits in eggplant. *PLoS ONE*, *10*(8), 1–23. https://doi.org/10.1371/journal.pone.0135200

828 Poudyal, D., Rosenqvist, E., & Ottosen, C. O. (2019). Phenotyping from lab to field -tomato
829 lines screened for heat stress using Fv/Fm maintain high fruit yield during thermal stress in
830 the field. Functional Plant Biology, 46(1), 44–55. https://doi.org/10.1071/FP17317
831
832 Rady, M. M., Belal, H. E. E., Gadallah, F. M., & Semida, W. M. (2020). Selenium application
833 in two methods promotes drought tolerance in Solanum lycopersicum plant by inducing the
834 antioxidant defense system. Scientia Horticulturae, 266(November 2019), 109290.
835 https://doi.org/10.1016/j.scienta.2020.109290
836
837 Raja V, Qadir SU, Alyemeni MN, Ahmad P. Impact of drought and heat stress individually
838 and in combination on physio-biochemical parameters, antioxidant responses, and gene
839 expression in *Solanum lycopersicum*. 3 Biotech. 2020 May;10(5):208. doi: 10.1007/s13205-
840 020-02206-4. Epub 2020 Apr 23. PMID: 32351866; PMCID: PMC7181466.
841
842 Rasouli, Farzad, Amini, T., Skrovankova, S., Asadi, M., Hassanpouraghdam, M. B., Ercisli,
843 S., Buckova, M., Mrazkova, M., & Mlcek, J. (2023). Influence of drought stress and
844 mycorrhizal (Funneliformis mosseae) symbiosis on growth parameters, chlorophyll
845 fluorescence, antioxidant activity, and essential oil composition of summer savory (Satureja
846 hortensis L.) plants. *Frontiers in Plant Science*, *14*, 1151467.
847 https://doi.org/10.3389/FPLS.2023.1151467/BIBTEX
848
849 Ripoll, J., Bertin, N., Bidel, L. P. R., & Urban, L. (2016). A user's view of the parameters
850 derived from the induction curves of maximal chlorophyll a fluorescence: Perspectives for
851 analyzing stress. Frontiers in Plant Science, 7(NOVEMBER2016), 1–6.
852 https://doi.org/10.3389/fpls.2016.01679
853
854 Sánchez-Rodríguez, E., Rubio-Wilhelmi, Mm., Cervilla, L. M., Blasco, B., Rios, J. J.,
855 Rosales, M. A., Romero, L., & Ruiz, J. M. (2010). Genotypic differences in some
856 physiological parameters symptomatic for oxidative stress under moderate drought in tomato
857 plants. Plant Science, 178(1), 30–40. https://doi.org/10.1016/j.plantsci.2009.10.001
858

Sankar, B., Jaleel, C. A., Manivannan, P., Kishorekumar, A., Somasundaram, R., & Panneerselvam, R. (2007). Drought-induced biochemical modifications and proline metabolism in Abelmoschus esculentus (L.) Moench. Acta Botanica Croatica, 66(1), 43–56.

Sękara, A., Bączek-Kwinta, R., Kalisz, A., & Cebula, S. (2012). Tolerance of eggplant (Solanum melongena L.) seedlings to stress factors. Acta Agrobotanica, 65(2), 83–92. https://doi.org/10.5586/aa.2012.061

Sekmen, A. H., Ozgur, R., Uzilday, B., & Turkan, I. (2014). Reactive oxygen species scavenging capacities of cotton (Gossypium hirsutum) cultivars under combined drought and heat induced oxidative stress. Environmental and Experimental Botany, 99, 141–149. https://doi.org/10.1016/j.envexpbot.2013.11.010

Seleiman, M. F., Al-suhaibani, N., Ali, N., Akmal, M., Alotaibi, M., Refay, Y., Dindaroglu, T., Abdul-wajid, H. H., & Battaglia, M. L. (2021). Alleviate Its Adverse Effects. *Plants*, *10*(2), 1–25.

Semida, W. M., Abdelkhalik, A., Mohamed, G. F., Abd El-Mageed, T. A., Abd El-Mageed, S. A., Rady, M. M., & Ali, E. F. (2021). Foliar application of zinc oxide nanoparticles promotes drought stress tolerance in eggplant (Solanum melongena l.). Plants, 10(2), 1–18. https://doi.org/10.3390/plants10020421

Serhat, A. (2017). The Effects of Irrigation Regimes on the Yield and Water Use of Eggplant (Solanum melongena L.). *Toprak Su Dergisi*, *6*(2), 49–58. https://doi.org/10.21657/topraksu.339835

Setyadi, D. B., Taryono, T., & Sayekti, R. S. (2020). Drought Tolerance of Some Eggplant Accessions (Solanum spp.). Agrotechnology Innovation (Agrinova), 3(1), 10. https://doi.org/10.22146/a.58348

Shao, H. B., Chu, L. Y., Jaleel, C. A., & Zhao, C. X. (2008). Water-deficit stress-induced anatomical changes in higher plants. Comptes Rendus - Biologies, 331(3), 215–225. https://doi.org/10.1016/j.crvi.2008.01.002

Sibomana, I. C., Aguyoh, J. N., & Opiyo, a M. (2013). Water stress affects growth and yield of container grown tomato (Lycopersicon esculentum Mill) plants. *Bangladesh Journal of Agricultural Research*, *2*(4), 461–466.

Siddiqui, M. H., Al-Khaishany, M. Y., Al-Qutami, M. A., Al-Whaibi, M. H., Grover, A., Ali, H. M., & Al-Wahibi, M. S. (2015). Morphological and physiological characterization of different genotypes of faba bean under heat stress. Saudi Journal of Biological Sciences, 22(5), 656–663. https://doi.org/10.1016/j.sjbs.2015.06.002

Sourour, A. (2017). A review: Morphological, physiological, biochemical and molecular plant responses to water deficit stress. The International Journal of Engineering and Science, 06(01), 01–04. https://doi.org/10.9790/1813-0601010104

Tani, E., Kizis, D., Markellou, E., Papadakis, I., Tsamadia, D., Leventis, G., Makrogianni, D., & Karapanos, I. (2018). Cultivar-dependent responses of eggplant (Solanum melongena L.) to simultaneous verticillium dahliae infection and drought. Frontiers in Plant Science, 9(August). https://doi.org/10.3389/fpls.2018.01181

Toppino, L., Barchi, L., & Rotino, G. L. (2022). Next Generation Breeding for Abiotic Stress Resistance in Eggplant. Genomic Designing for Abiotic Stress Resistant Vegetable Crops, 115–151. https://doi.org/10.1007/978-3-031-03964-5_4

Tsimilli-Michael, M., & Strasser, R. J. (2001). Fingerprints of climate changes on the photosynthetic apparatus' behaviour, monitored by the JIP-test. "Fingerprints" of Climate Change, 229–247. https://doi.org/10.1007/978-1-4419-8692-4_14

Vicente, O. (2022). Improving Agricultural Production and Food Security Under Climate Change Conditions. AgroLife Scientific Journal, 11(1), 241–252. https://doi.org/10.17930/agl2022128

Wang, Y., Yang, R., Zheng, J., Shen, Z., & Xu, X. (2019). Exogenous foliar application of fulvic acid alleviate cadmium toxicity in lettuce (Lactuca sativa L.). Ecotoxicology and Environmental Safety, 167(August 2018), 10–19. https://doi.org/10.1016/j.ecoenv.2018.08.064

Wasaya, A., Manzoor, S., Yasir, T. A., Sarwar, N., Mubeen, K., Ismail, I. A., Raza, A., Rehman, A., Hossain, A., & Sabagh, A. E. L. (2021). Evaluation of fourteen bread wheat (Triticum aestivum L.) genotypes by observing gas exchange parameters, relative water and chlorophyll content, and yield attributes under drought stress. Sustainability (Switzerland), 13(9). https://doi.org/10.3390/su13094799

Yadav, S. S., Hegde, V. S., Habibi, A. B., Dia, M., & Verma, S. (2018). Climate Change, Agriculture and Food Security. Food Security and Climate Change, December, 1–24. https://doi.org/10.1002/9781119180661.ch1

Yuan, X. K., Yang, Z. Q., Li, Y. X., Liu, Q., & Han, W. (2016). Effects of different levels of water stress on leaf photosynthetic characteristics and antioxidant enzyme activities of greenhouse tomato. *Photosynthetica*, *54*(1), 28–39. https://doi.org/10.1007/s11099-015-0122-5

Zhang, C., Li, X., Yan, H., Ullah, I., Zuo, Z., Li, L., & Yu, J. (2020). Effects of irrigation quantity and biochar on soil physical properties, growth characteristics, yield and quality of greenhouse tomato. Agricultural Water Management, 241(October 2019), 106263. https://doi.org/10.1016/j.agwat.2020.106263

Zhang, Shu-han, XU, X-feng, SUN, Y. min, Zhang, J. lian, & LI, C. zhou. (2018). Influence of drought hardening on the resistance physiology of potato seedlings under drought stress. Journal of Integrative Agriculture, 17(2), 336–347. https://doi.org/10.1016/S2095-3119(17)61758-1

Zhou, R., Yu, X., Ottosen, C. O., Rosenqvist, E., Zhao, L., Wang, Y., Yu, W., Zhao, T., & Wu, Z. (2017). Drought stress had a predominant effect over heat stress on three tomato

954 cultivars subjected to combined stress. *BMC Plant Biology*, *17*(1).
955 https://doi.org/10.1186/s12870-017-0974-x

956

957 Zlatev, Z., & Lidon, F. C. (2012). An overview on drought induced changes in plant growth,
958 water relations and photosynthesis. *Emirates Journal of Food and Agriculture*, *5*(3), 57–72.
959 https://doi.org/10.1039/ja9900500231

960

Table 1. Main fruit characteristic of the genetic materials (genotypes and varieties) used under two irrigations treatments (Tr-C and Tr-50%).

Genotypes/Varieties	Fruit typology
C6	Lilac round fruits
C7	Purple long fruits –green
C8	Lilac long fruits
C10	Black round fruits
C11	Long black fruits
C12	Purple small ribbed fruit
C13	White round fruits
C14	Little violet black fruits
C15	Little round white fruits
B1	Long- purple fruits
B2	Long- green fruits
B3	Dark purple- short fruits
B5	Green purple- long fruits
A*	Purple black oval fruits
V*	Purple black fruits

Codes with (*) present commercial varieties (A=Aswab; V=Vernal) and the other codes without (*) present genotypes; Genotypes with letter (C) and (B) were selected, respectively from the Research Centre for Genomics and Bioinformatics, Montanaso Lombardo, Italy (CREA) and from the Batı Akdeniz Agricultural Research Institute, Muratpasa, Antalya, Türkiye (BATEM).

Table 2. Water quantity measured during average amount of water dripped in 12 watering during the cultivation for each dripper of both treatments (Tr-C and Tr-50%) and percentage of variation of TR-C over TR-50%).

Date	Line 10cm (Tr-C) (l/dripper	Line 20cm (Tr-50%) (l/dripper)	Variation (%)
04/09/2021	6.50	6.66	2%
11/09/2021	6.83	6.33	7%
25/09/2021	6.50	6.16	5%
02/10/2021	6.83	7.00	-2%
09/10/2021	7.50	7.50	0%
16/10/2021	7.50	7.33	2%
30/10/2021	12.50	12.50	0%
06/11/2021	9.33	8,66	7%
13/11/2021	9.60	9.50	1%
20/11/2021	10.50	10.50	0%
09/12/2021	21.60	21.40	1%
16/12/2021	11.16	11.00	1%
Average	9.67 ± 1.22^{ns}	9.58 ± 1.25^{ns}	1%

Three containers per treatment were installed under drippers; Data are means of 3 drippers' ± standard error, based on Student's t-test at 5 % level. ^{ns} indicate non-significant differences,

Table 3. The percentage representing the sums of squares (SS) for every parameter, considering the effects of treatment, genotypes, their interaction "genotypes x treatment" and residual.

	Sums of squares[a]			
	Treatment	Genotypes	Genotypes x Treatment	Residual
Growth				
Plant height (cm)	10.1^{***}	73.4^{***}	2.7^{*}	13.7
Number of flowers	25.1^{***}	37.7^{***}	7.8^{***}	29.1
Number of leaves	22.4^{***}	29.2^{***}	6.8^{*}	41.4
Leaf length (cm)	25.9^{***}	19.7^{***}	8.6^{*}	45.6
Leaf width (cm)	7.8^{***}	34.9^{***}	11.1^{**}	46.1
Petiole length (cm)	1.8^{*}	21.6^{***}	14.7^{**}	61.6
Stem diameter (mm)	37.4^{***}	10.0^{**}	11.3^{***}	41.1
Number of ramifications.	4.7^{**}	8.9^{ns}	10.7^{ns}	75.4
RWC	38.8^{***}	8.8^{ns}	5.2^{ns}	47.0
Chlorophyll fluorescence				
F_v/F_m	0.8^{ns}	46.0^{***}	3.1^{ns}	50.0
ABS/CS_0	0.3^{ns}	37.6^{***}	5.5^{ns}	56.4
DI_0/CS_0	0.3^{ns}	43.5^{***}	2.2^{ns}	53.8
Yield				
Number of fruits (fruits/plant)	17.0^{***}	31.5^{***}	7.2^{*}	44.3
Yield per plant (kg/plant)	11.2^{***}	50.0^{***}	3.5^{ns}	35.3
Total yield (kg)	15.7^{***}	37.4^{***}	7.3^{ns}	39.4
Fruit quality				
Fruit weight (g)	5.5^{***}	74.5^{***}	1.8^{ns}	18.1
Fruit length (cm)	4.9^{***}	90.1^{***}	1.6^{***}	3.2
Fruit width (cm)	2.8^{***}	92.8^{***}	1.4^{***}	2.8
DM%	5.4^{***}	48.9^{***}	5.4^{ns}	40.1

[a] ^{ns}, *, **, and *** indicate, respectively, non-significant, and significant at $P < 0.05$, < 0.01, or < 0.001. For statistical data please see supplemental table (1).

Table 4. Effects of water treatments (Tr-C and Tr-50%) on growth parameters of the fifteen genotypes of eggplant.

Genotypes	Plant height (cm)		Number of leaves		Number of flowers		leaf length (cm)		leaf width (cm)		Stem diameter (mm)		Petiole length (cm)	
	TR-C	TR-50%	TR-C	TR-50%	TR-C	TR-50%	TR-C	TR-50%	TR-C	TR-50%	TR-C	TR-50%	TR-C	TR-50%
B1	33.5±1.44	29.1±1.21	26.2±0.89	21.2±1.27	2.2±0.22	1.8±0.08	18.5±0.44	16.8±0.52	10.6±0.25	10.4±0.39	7.1±0.13	5.7±0.17	6.3±0 .29	5.8±0.32
B2	33.3±0.72	31.3±0.84	21.9±1.45	18.3±0.36	2.4±0.26	1.7±0.20	16.2±0.46	14.8±0.59	9.1±0.27	8.7±0.26	6.7±0.15	6.5±0.16	5.5±0.34	5.1±0.16
B3	44.4±1.07	40.2±0.39	20.8±0.47	20.6±0.99	2.4±0.10	1.3±0.17	17.4±0.38	16.8±0.28	9.6±0.32	10.1±0.21	6.7±0.15	6.0±0.24	6.2±0.32	7.8±0.60
B5	38.8±1.08	33.9±1.14	23.7±1.64	19.7±1.00	3.1±0.36	1.9±0.08	18.4±0.62	16.2±0.41	10.2±0.44	9.5±0.27	7.0±0.20	6.0±0.12	5.8±034	5.6±0.11
C6	34.7±0.42	35.0±0.50	20.4±0.51	17.9±0.92	3.1±0.27	2.0±0.13	18.9±0.46	17.2±0.46	12.5±0.61	10.3±0.29	7.2±0.13	6.4 ±0.24	6.1±0.28	5.3±0.25
C7	42.3±1.47	37.9±0.97	18.0±1.26	17.8±0.82	2.1±0.36	2.1±0.33	17.6±0.46	14.7±0.48	9.6±0.39	8.4±0.38	6.9±0.16	6.0±0.33	6.7±0.31	6.3±0.18
C8	35.9±0.72	35.8±0.37	23.0±1.61	21.2±0.80	3.7±0.18	2.5±0.26	18.2±0.60	15.4±0.23	10.6±0.28	9.2±0.17	7.3±0.17	5.7±0.09	6.3±0.18	5.8±0.20
C10	43.8±0.83	41.1±1.16	26.1±0.92	22.7±0.96	5.5±0.40	2.9±0.19	18.8±0.39	16.2±0.43	11.2±0.30	10.2±0.14	7.5±0.34	6.5±0.26	5.1±0.82	6.3±0.44
C11	46.1±0.56	40.4±1.32	23.7±1.15	20.2±1.08	2.9±0.31	2.0±0.20	17.8±0.16	17.0±0.37	10.1±0.22	9.7±0.33	7.6±0.24	6.4±0.13	6.4±0.20	5.3±0.14
C12	31.2±0.59	24.8±0.79	27.3±1.07	20.8±0.88	3.1±0.47	1.9±0.29	17.6±0.66	16.3±0.58	10.4±0.26	9.6±0.33	7.4±0.16	6.3±0.10	5.9±0.25	4.8±0.32
C13	33.3±0.72	30.9±1.13	22.9±0.64	19.2±1.11	2.9±0.31	2.0±0.13	17.8±0.38	17.4±0.44	10.0±0.15	10.6±0.39	6.8±0.15	6.5±0.13	6.0±0.31	5.8±0.35
C14	33.4±0.47	29.8±1.05	20.7±0.24	18.8±1.18	5.0±0.36	2.5±0.49	17.5±0.32	16.8±0.48	10.2±0.26	10.3±0.47	6.6±0.10	6.3±0.30	6.2±0.26	6.0±0.36
C15	38.6±0.94	35.0±1.02	26.8±1.50	21.8±1.35	4.5±0.23	3.3±0.24	19.9±1.64	15.5±0.51	10.2±0.18	9.5±0.31	6.3±0.12	6.3 ±0.24	5.7±0.14	5.3±0.32
A	40.8±0.81	37.6±1.09	23.3±0.82	18.9±0.50	2.9±0.26	1.9±0.14	19.8±0.49	17.2±0.50	10.9±0.21	10.5±0.27	7.0±0.25	6.2±0.14	6.7±0 .22	6.2±0.37
V	46.1±0.58	40.4±0.66	28.0±1.65	20.8±0.94	3.4±0.26	2.4±0.17	19.4±0.38	18.1±0.30	10.8±0.20	10.4±0.18	7.1±0.14	6.0±0.10	6.3±0.27	5.6±0.24
Treatment (T)	***		***		***		***		***		***		*	
Genotypes (G)	***		***		***		***		***		**		***	
G*T	*		*		***		*		**		***		**	

^{ns}, *, **, and *** indicate, respectively, non-significant, and significant at $P < 0.05$, < 0.01, or < 0.001. For statistical data please, see supplemental tables (1 and 6).

Table 5. Effects of water treatments (Tr-C and Tr-50%) on chlorophyll fluorescence parameters (Fv/Fm, ABS/CSo and DIo/CSo) and RWC% of the fifteen genotypes of eggplant.

Genotypes	Fv/Fm		ABS/CSo		DIo/CSo		RWC%	
	TR-C	TR-50%	TR-C	TR-50%	TR-C	TR-50%	TR-C	TR-50%
B1	0.71±0.023	0.68±0.023	528.60±81.90	645.40±66.25	153.49±29.43	208.88±35.12	74.69±1.75	69.07±1.26
B2	0.71±0.013	0.76±0.011	636.60±32.59	505.00±46.89	184.04±17.80	119.76±14.88	76.32±1.32	63.54±1.19
B3	0.76±0.017	0.72±0.019	572.20±8.30	619.66±51.91	136.40±10.88	173.71±25.81	75,14±1,29	65,37±1,28
B5	0.59±0.051	0.55±0.062	830.40±70.92	798.40±135.47	354.10±68.62	388.72±105.53	80.92±1.11	70.06±1.02
C6	0.72±0.031	0.72±0.009	381.20±103.61	548.60±11.12	105.47±38.03	152.45±3.45	77.25±1.03	69.63±0.81
C7	0.65±0.057	0.59±0.071	757.40±78.53	698.40±131.34	281.30±74.06	313.50±113.06	74.68±0.86	68.14±0.77
C8	0.65±0.039	0.65±0.049	616.40±52.33	558.40±94.60	222.80±40.41	205.05±50.75	74.56±1.40	67.87±1.10
C10	0.83±0.042	0.78±0.010	406.80±103.30	455.20±53.43	85.03±21.63	101.71±14.83	73.00±1.32	69.99±2.19
C11	0.67±0.027	0.69±0.048	577.40±90.20	584.00±88.67	195.98±37.68	192.68±57.15	70.64±1.82	64.28±1.99
C12	0.65±0.043	0.66±0.015	597.20±84.39	512.20±91.69	218.50±56.29	176.21±35.27	70.70±2.99	64.05±1.24
C13	0.74±0.021	0.75±14.02	474.00±28.68	478.80±61.63	120.23±14.08	118.41±18.88	74.29±0.88	58.90±1.89
C14	0.74±0.023	0.73±0.015	284.00±14.39	326.60±40.15	71.58±5.19	86.81±13.53	73.68±2.29	60.95±0.91
C15	0.78±0.013	0.76±0.018	453.40±39.33	451.00±50.54	97.23±11.76	109.25±19.84	81.00±1.21	63.67±1.24
A	0.80±0.007	0.78±0.021	471.00±14.00	502.80±29.94	94.38±5.60	109.44±18.31	80.90±0.25	66.72±0.96
V	0.81±0.049	0.72±0.014	373.60±118.96	596.40±48.42	91.09±32.33	165.22±20.59	73.79±1.62	66.12±1.82
Treatment (T)	ns		ns		ns		***	
Genotypes (G)	***		***		***		ns	
G*T	ns		ns		ns		ns	

^{ns}, *, **, and *** indicate, respectively, non-significant, and significant at $P < 0.05$, < 0.01, or < 0.001.

(Details on statistic data are available at supplemental tables (1, 3 and 4)

Table 6. Effects of water treatments (Tr-C and Tr-50%) on number of fruit (fruits/plant) and yield per plant (kg/plant) of the fifteen genotypes of eggplant.

Genotypes	Number of fruits/plant			Yield per plant (kg/plant)		
	TR-C	**TR-50%**	**Ratio%**	**TR-C**	**TR-50%**	**Ratio%**
B1	13.29±1.75	8.96±1.38	**32.58%**	1.84±0.24	1.12±0.17	**39.13%**
B2	9.42±1.45	7.96±0.85	**15.50%**	1.25±0.15	0.98±0.15	**21.60%**
B3	12.71±1.25	8.79±1.07	**30.84%**	1.38±0.10	1.03±0.21	**25.36%**
B5	15.17±1.54	10.38±1.04	**31,58%**	1.88±0.22	1.29±0.12	**31.38%**
C6	7.08±1.13	6.21±0.38	**12.29%**	1.28±0.19	1.10±0.09	**14.06%**
C7	9.42±1.29	9.21±0.88	**2.23%**	1.01±0.10	0.90±0.07	**10.89%**
C8	19.00±2.28	9.58±2.19	**49.58%**	1.63±0.21	1.08±0.18	**33.74%**
C10	13.46±1.37	8.04±0.77	**40.27%**	2.18±0.24	1.48±0.17	**32.11%**
C11	7.96±1.16	6.42±0.18	**19.35%**	1.23±0.23	0.91±0.07	**26.02%**
C12	9.58±0.85	7.79±0.66	**18.68%**	1.82±0.16	1.33±0.12	**26.92%**
C13	10.46±1.23	7.92±0.47	**24.28%**	1.54±0.19	1.53±0.13	**0.65%**
C14	11.58±1.18	9.50±2.09	**19.96%**	0.86±0.07	0.57±0.10	**33.72%**
C15	11.17±1.01	6.79±1.17	**39.21%**	1.01±0.10	0.75±0.12	**25.74%**
A	15.96±0.87	11.88±0.56	**25.56%**	2.49±0.11	1.98±0.13	**20.48%**
V	16.79±1.33	11.71±1.20	**30.26%**	2.7±0.32	1.86±0.16	**31.11%**
Treatment (T)	***			***		
Genotypes (G)	***			***		
G*T	*			ns		

ns, *, **, and *** indicate, respectively, non-significant, and significant at $P < 0.05$, < 0.01, or < 0.001. Statistic details are available at supplemental tables (1 and 5)

Table 7: Effects of water treatments (Tr-C and Tr-50%) on fruit quality parameters (Fruit weight (g), Fruit length and width (cm) and Dry matter (%).

Genotypes	Fruit Weight (g)		Fruit Length (cm)		Fruit Width (cm)		Dry Matter (%)	
	TR-C	TR-50%	TR-C	TR-50%	TR-C	TR-50%	TR-C	TR-50%
B1	195.30±9.75	138.80±10.64	13.81±0.19	11.78±0.31	6.48±0.17	5.70±0.11	6.56±0.16	6.28±0.37
B2	173.00±9.75	122.00±11.24	17.65±0.33	12.85±0.36	4.55±0.15	4.08±0.07	6.15±0.33	7.62±0.54
B3	125.80±9.21	101,30±6.88	19.11±0.50	16.76±0.63	4.30±0.09	4.33±0.08	6.69±0.27	8.21±0.59
B5	139.00±14.29	118.80±9.86	19.66±0.77	17.63±0.33	4.45±0.11	3.95±0.22	6.69±0.22	7.97±0.40
C6	232.10±18.61	165.00±15.72	9.13±0.15	8.05±0.22	8.00±0.24	6.56±0.21	4.40±0.38	4.86±0.40
C7	88.60±5.00	89.30±4.47	16.93±0.32	14.70±0.50	3.55±0.11	2.96±0.10	6.35±0.98	7.96±0.69
C8	104.30±4.16	67.60±6.27	24.18±0.74	20.25±0.26	2.71±0.14	2.43±0.08	6.84±0.23	5.69±0.74
C10	206.00±19.71	178.10±23.46	9.03±0.32	7.58±0.18	7.15±0.14	6.50±0.25	5.38±0.34	5.81±0.83
C11	205.80±15.52	183.00±17.17	15.18±0.47	13.80±0.68	6.35±0.09	5.80±0.14	5.92±0.43	6.75±0.41
C12	284.30±23.66	239.80±16.07	8.03±0.24	6.80±0.14	11.16±0.31	9.16±0.21	2.58±0.34	3.80±0.36
C13	293.60±23.08	236.60±14.02	11.56±0.24	10.23±0.11	9.00±0.15	8.13±0.08	4.90±0.40	5.63±0.18
C14	88.80±6.05	59.60±7.71	11.86±0.29	11.18±0.13	3.93±0.14	2.58±0.15	5.34±0.22	7.27±0.72
C15	93.00±3.36	87.80±2.53	6.18±0.07	5.50±0.05	5.51±0.13	5.08±0.07	7.90±0.66	8.35±0.53
A	223.80±14.49	195.30±14.08	15.21±0.22	12.95±0.30	6.90±0.14	6.15±0.16	6.17±0.32	6.29±0.36
V	212.10±12.61	189.00±13.67	16.53±0.30	12.90±0.45	6.1±0.07	6.15±0.45	5.04±0.36	6.34±0.35
Treatment (T)	***		***		***		***	
Genotypes (G)	***		***		***		***	
G*T	ns		***		***		ns	

ns, *, **, and *** indicate, respectively, non-significant, and significant at $P < 0.05$, < 0.01, or < 0.001.

Statistic details are available at supplemental tables (1 and 6).

Figure 1. Diversity of fruit morphology in the fifteen eggplants genotypes or commercial varieties.

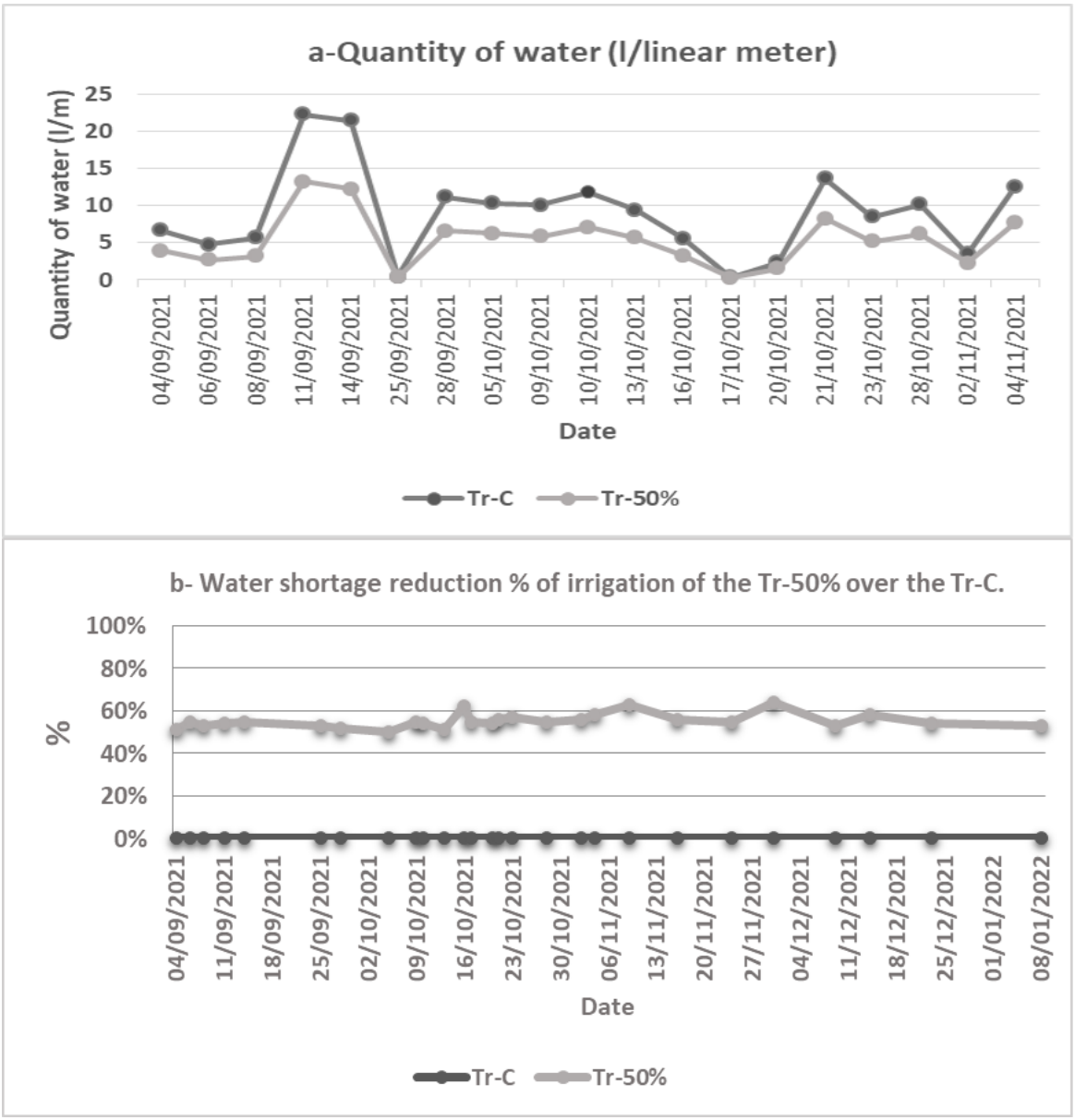

Figure 2. (a) Quantity of water (l/linear meter) measured over a few days for irrigation lines of each treatment (Tr-C and Tr-50%) and (b) water shortage reduction % of the Tr-50% over the Tr-C.

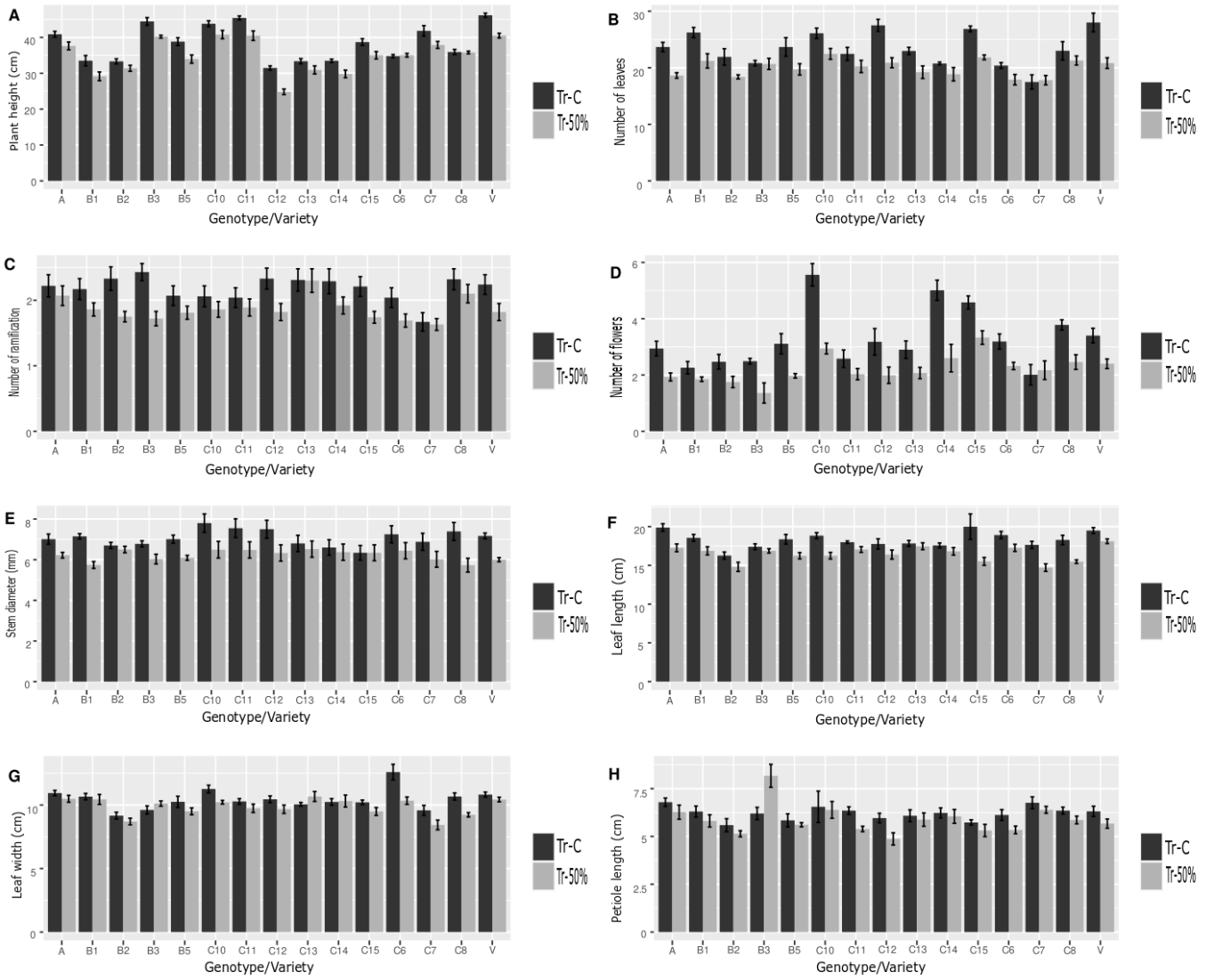

Figure 3. Growth parameters of the fifteen genetic materials grown under control irrigation treatments with 100% water (Tr-C- black columns) and under shortage in irrigation by 50% (Tr-50%- grey columns). (A) Plant height (cm), (B) number of leaves, (C) number of ramifications, (D) number of flowers, (E) stem diameter (mm), (F) leaf length, (G) leaf width (cm), (H) petiole length (cm). Data represent mean values of 24 repetitions ± standard error. Statistical analysis details are available at supplemental table (2).

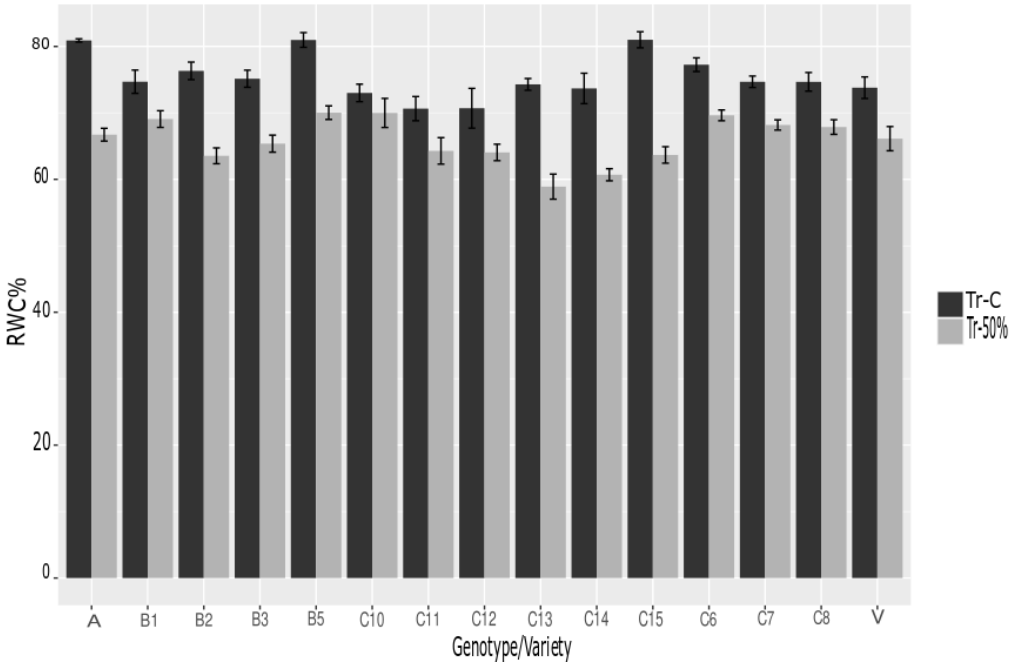

Figure 4. Relative water content (RWC %) measured on the fifth expanded leaf from the apex of the plant of the fifteen genetic materials grown under control irrigation treatments with 100% water (Tr-C- black columns) and under shortage in irrigation by 50% (Tr-50%- grey columns). Samples were taken on November 01st, 2021. Data represent mean values of 6 repetitions ± standard error. Statistical analysis details are available at supplemental table (3).

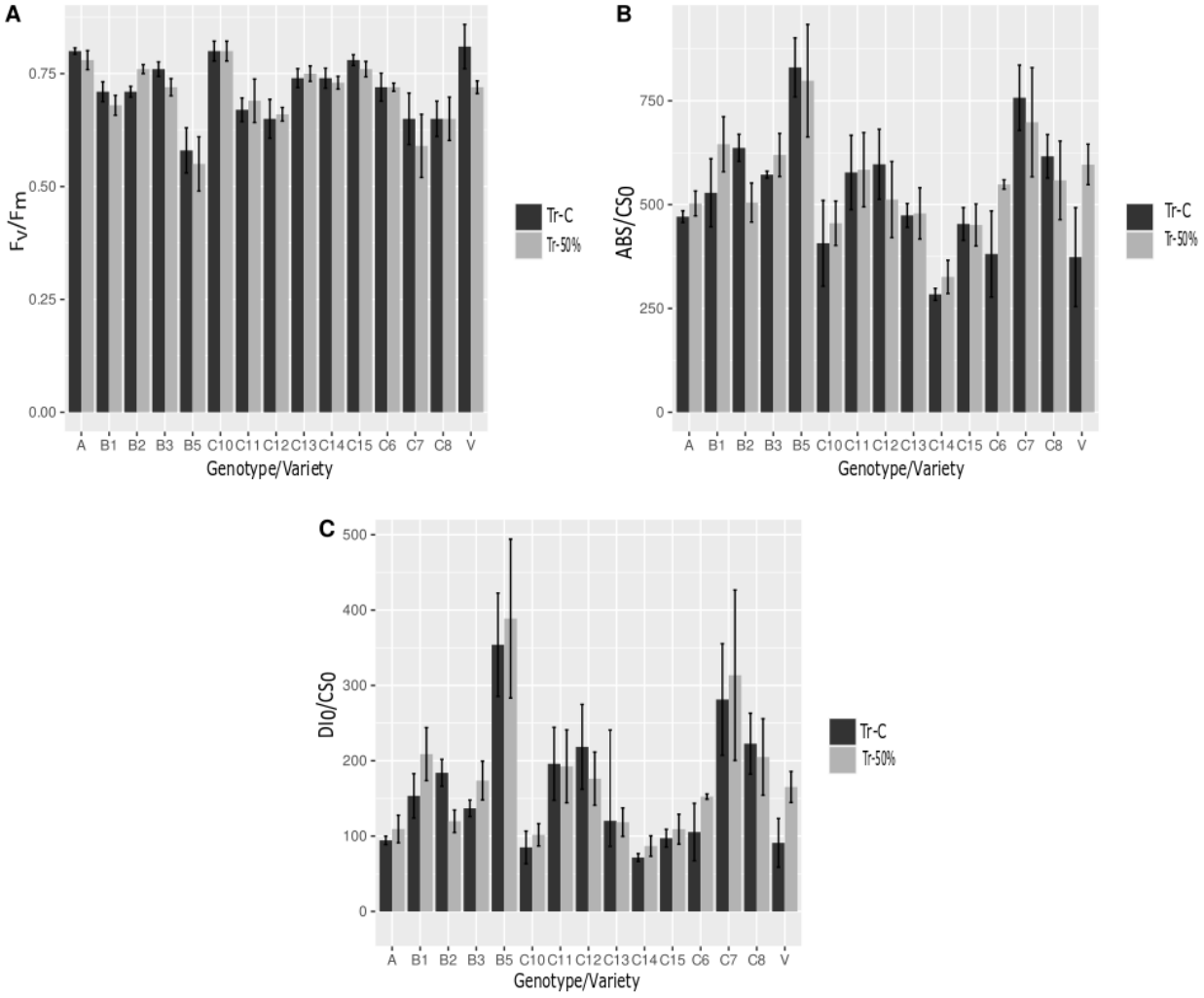

Figure 5. Chlorophyll-a fluorescence parameter measured on the fifth expanded leaf from the apex of the plant of the fifteen genetic materials grown under control irrigation treatments with 100% water (Tr-C- black columns) and under shortage in irrigation by 50% (Tr-50%- grey columns). (A) F_v/F_m maximum potential quantum efficiency of the photosystem II, (B) ABS/CS_0 efficiency of light absorption, (C) DI_0/CS_0 dissipation per cross-section of the photosystem II. Data represent mean values of 5 repetitions ± standard error. Statistical analysis details are available at supplemental table (4).

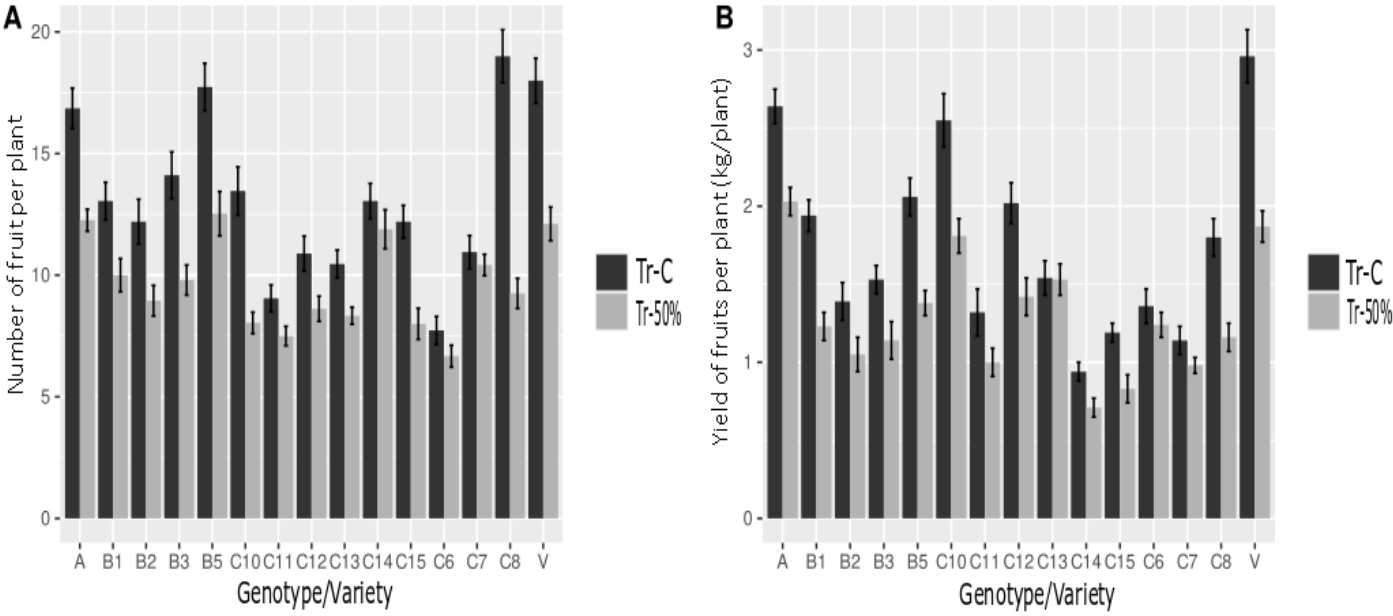

Figure 6. Crops yield of the fifteen genetic materials grown under control irrigation treatments with 100% water (Tr-C- black columns) and under shortage in irrigation by 50% (Tr-50%- grey columns). (A) number of fruits per plant; (B) yield of fruits per plant (kg/plant). Data represent mean values of 6 repetitions ± standard error. Statistical analysis details are available at supplemental table (5).

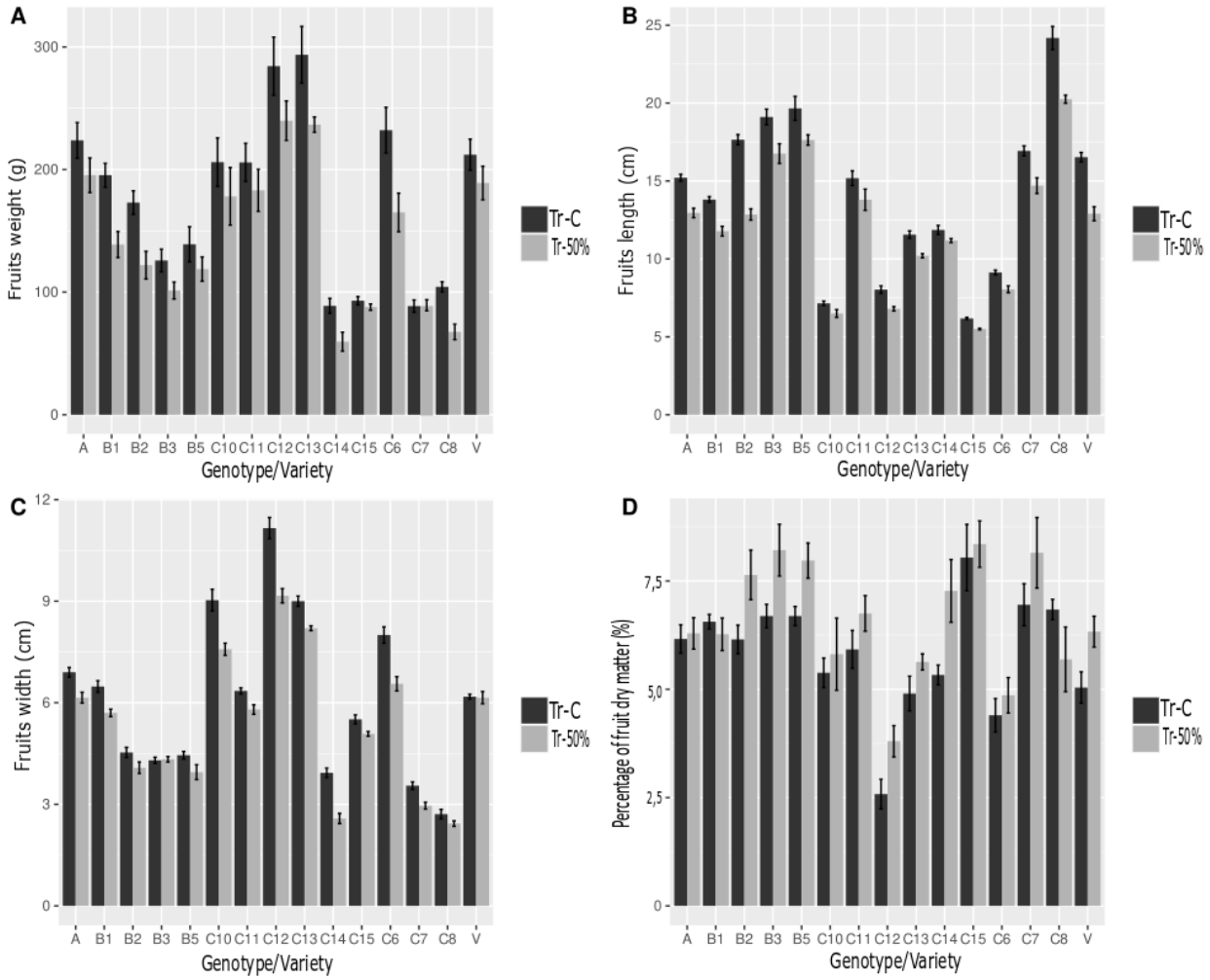

Figure 7. Fruit quality parameters the fifteen genetic materials grown under control irrigation treatments with 100% water (Tr-C- black columns) and under shortage in irrigation by 50% (Tr-50%- grey columns). (A) fruits weight (g), (B) fruits length (cm), (C) fruits width (cm), (D) Percentage of fruit dry matter (%). Fruits samples were harvested on December 24th, 2021. Data represent mean values of 6 repetitions ± standard error. Statistical analysis details are available at supplemental table (6).