

Salinity Tolerance Screening in Iranian and Afghan Melons (*Cucumis melon*) Based on Several Associated Morphological and Physiological Traits

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ABSTRACT

This study aimed to investigate the effect of salinity on morphological and physiological traits of native Iranian melon landrace and Afghan melon cultivars using a split-plot experiment with a Randomized Complete Block Design in three replications. Two salinity levels (2 and 8 dSm⁻¹ NaCl) and 39 cultivars from Iran and Afghanistan were used in this study. PCA comparisons were done between morphological and physiological parameters. The sensitive and tolerant cultivars were chosen based on proximity to high yield, morphological characteristics, and distance from stress indices. The biplot results showed a high correlation between vitamin C traits with soluble solids, proline, and relative water content and a negative correlation with Fv/Fm ratio. These indices are good indicators for identifying saline resistance cultivars. Salinity stress increased electrolyte leakage, proline concentration, total antioxidant activity, sodium content, vitamin C, organic acid, and total soluble solids. In addition, salinity decreased the yield, mean fruit weight, firmness, fruit length, fruit width, internal cavity length, internal cavity width, flesh thickness and fruit peel thickness, Fv/Fm ratio, greenness index, relative water content, leaf potassium. The highest concentrations of sodium were found in the Gorgi Shirdan Jorgeaval cultivar under salinity, while the highest concentrations of potassium were found in the Torkamani cultivar under non-saline conditions. Analysis revealed two types of Torkamani and Zanki melon which are recommended to plant in saline conditions.

Keywords: Abiotic stress, Genetic diversity, Melon yield, Resistance cultivar, Salinity, Total antioxidant activity

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INTRODUCTION

Melon (*Cucumis melo* L.) is one of the world's significant horticultural crops, growing extensively in arid and semiarid regions (Akrami and Arzani, 2018). Iran plays a significant role in global melon production, with an annual output of approximately 854,000 tons from a cultivated area of 40,500 hectares. (Sarabi and Ghashghaie, 2022).

Salinity in the growing environment is one of the limiting factors in crop production. Due to the use of excessive fertilizers and excessively saline water, saline environments are a significant contributor to the rise in agricultural stress conditions (Dias *et al.*, 2018). The salt ratio in the environment has a significant impact on various biochemical and physiological processes in plants (Tarchoun *et al.*, 2022). High salinity levels can have negative effects on seed germination and disrupt several physiological and metabolic processes, including changes in enzymatic activities (Tarchoun *et al.*, 2022). It is important to identify the ideal conditions to determine stable genotypes that can withstand different types of stress. The performance and productivity of genotypes are influenced by multiple factors, including abiotic stresses (Yaşar, 2023).

Under salt stress, osmotic potential due to limited water uptake from the soil and ion toxicity cause cell dysfunction and damage to physiological activities, such as photosynthesis and respiration, resulting in diminished plant growth and development at various growth stages (Deinlein *et al.*, 2014). Plants, being unable to move, have developed complex systems and adaptive responses to cope with salt stress. When the soil contains high levels of salinity, sodium and chloride ions accumulate, leading to a decrease in the availability of essential nutrients and water for plants (Van Zelm *et al.*, 2020). Maintaining a balance between potassium (K⁺) and sodium (Na⁺) is crucial for plants to tolerate salt stress. Therefore, effective regulation and compartmentalization of Na⁺ and K⁺ homeostasis play a critical role in enhancing salt stress tolerance in plants (Almeida Almeida *et al.*, 2017; Sheikhalipour *et al.*, 2022).

The salinity tolerance threshold for melon is 2.2 dSm⁻¹. Melon is a salt-sensitive crop (Silva *et al.*, 2020). The electric conductivity (EC) value of 3.31 dSm⁻¹ has no significant effect on melon production, according to Silva *et al.* (2020). In contrast, when the soil is irrigated with water and a high percentage of salt, a decrease in productivity is typically observed. According to Silva *et al.* (2020), to correct the osmotic potential within the cell, melon eliminates Na⁺ and Cl⁻ ions and synthesizes suitable solutes, such as proline and citrulline. According to Pereira *et al.* (2017), increasing irrigation water salinity lowers the growth, dry mass, and physiological attributes of

60 melon cultivars. However, extensive research on the reaction of melons to salinity has revealed
61 that melons' tolerance to salinity is cultivar-dependent (Dias *et al.*, 2018). Some melon cultivars
62 are tolerant of salinity because they have more effective mechanisms for stress resistance, allowing
63 them to be grown in salinized environments (Silva *et al.*, 2020). Pereira *et al.* (2017) investigated
64 five melon cultivars and identified Sancho as most salinity-tolerant, followed by Mandacaru,
65 Medelln, Sedna, and Néctar.

66 The comparison between Iranian and Afghan melons in this study was conducted to examine the
67 physiological differences and similarities between these two populations. This comparison can
68 contribute to a better understanding of salt tolerance traits in melons and help improve their
69 performance and select suitable varieties for saline and harsh environmental conditions.
70 Additionally, comparing with Iranian melon populations can provide insights into the genetic
71 diversity and improvement potential in Iranian melon populations. Generally this study
72 investigated the responses of Iranian melon landrace and Afghan melon to salinity to determine: i)
73 the effect of salinity stress on growth and yield; ii) the identification of some physiological markers
74 of salinity tolerance, and iii) the selection of salinity-tolerant cultivars for future study and
75 recommended to cultivate in the saline region.

76

77 MATERIALS AND METHODS

78 Experimental Design (First Experiment)

79 The study involved using different types of melons from Iran and Afghanistan. These melons were
80 grown with two different levels of salt in the irrigation water including , $S1=2 \text{ dSm}^{-1}$ of NaCl as
81 the control and $S2=8 \text{ dSm}^{-1}$ of NaCl as the salinity stress. Every three weeks, plants were irrigated
82 with control water to prevent excessive accumulation of salts. The experimental design was
83 performed as split-plot randomized blocks, with two irrigation levels, melon genotypes, and three
84 replications consisting of three biological replicates. The experiment was conducted at the Isfahan
85 University of Technology Lavark Research Farm Station, located in Najaf Abad ($32^{\circ}32'N$,
86 $51^{\circ}23'E$, 1630 m above mean sea level), Iran. The soil texture was clay loam, thermic Typic,
87 Haploargids with a bulk density of 1.4 g cm^{-3} and an average pH of 7.5. Based on initial
88 investigation, plowing, animal manure, and chemical fertilizers were applied to the soil. In the
89 supplementary file, Table 1 and Figure 1 describe 39 types of melons from Iran and Afghanistan,
90 including 14 varieties landrace from central Iran and 26 from the southwest of Afghanistan. These
91 melons were cultivated in fourteen rows, with seven rows serving as control treatments and the

92 other seven rows as salinity treatments. The rows were spaced 2 meters apart and 36 meters in
93 length.

94 The plants were spaced apart by 50 cm. At the four-leaf stage of the melon seedling, two salinity
95 levels of 2 and 8 dSm⁻¹ were applied. The plants were irrigated (once every 4-6 days) using drip
96 irrigation systems with a dripper distance of 50 cm, based on its water requirements. At the time
97 of harvest the fruit Morpho-physiological characteristics were evaluated and described according
98 to descriptor (ECPGR, 2008).

99

100 Measured Parameters

101 After harvesting, each fruit was individually tallied and weighed. The average quantity and weight
102 of fruits were determined. The yield per plant per square meter was estimated using the average
103 plant weights.

104 A ruler and caliper were used to determine the length, width, flesh thickness, peel thickness,
105 length and width of the fruit's internal cavity, and length and diameter of its seeds. In addition, the
106 weight of the seeds was determined using a digital balance (g).

107 The relative leaf water content (RWC) was determined using the method of Filella *et al.* (1998).
108 To accomplish this, 0.5 g of fresh leaves from the youngest mature leaves (FW) were extracted
109 from each sample and replication and placed in distilled water for 24 hours. The samples were then
110 cleaned for surface moisture and weighed once more (TW). The leaf samples were dried for 48
111 hours at 75 °C, and their dry weight (DW) was determined. The relative water content of the leaves
112 was determined by the following formula:

$$RWC = (FW - DW) / (TW - DW) \times 100 \quad (1)$$

113 The chlorophyll index in the leaves were evaluated by employing a non-destructive method using
114 the Minolta SPAD-502 (SPAD 502 plus, Japan) leaf chlorophyll meter. Three readings of each
115 sample were taken in each treatment replication, and their mean was then calculated (Franco *et al.*,
116 1993).

117 The determination of proline concentrations can be assessed through the application of the
118 ninhydrin test, as stated by Bates *et al.* as explained by Haghghi *et al.* (2022). in their seminal
119 work published in 1973. The leaf samples were subjected to homogenization at a temperature of 4
120 °C, utilizing a solution of sulfosalicylic acid with a concentration of 3%. Following this, the
121 resulting solution was subjected to incubation and centrifugation at a speed of 5000 rpm for 20

122 minutes. The supernatant was combined with a solution comprising ninhydrin (2.5%
123 concentration), phosphoric acid (60% concentration, v/v), and glacial acetic acid (100%
124 concentration, 1 mL). The absorbance was measured at a wavelength of 518 nm.

125 The proportion of [electrolyte leakage \(EL\)](#) was determined using the method of Lutts *et al.* (1996).
126 From the plant leaves, ten one-centimeter-diameter discs were made. The samples were cleaned
127 three times with distilled water and once with deionized water before being placed in tubes
128 containing 10 mL of deionized water and shaken. Using a conductometer, the initial electrical
129 conductivity (EC_1) of the solution was measured after 24 hours. The tubes were then placed in an
130 autoclave for 20 minutes at a temperature of 120 °C. After removing the test tubes from the
131 autoclave and bringing them to room temperature, the final electrical conductivity (EC_2) of the
132 solutions was determined. Following this, the proportion of leaf electrolyte loss was calculated:

$$\text{Electrolyte leakage (\%)} = (EC_1 / EC_2) \times 100 \quad (2)$$

133 Leaves extract is made with diluted nitric acid, [potassium and sodium concentrations determined](#)
134 [using a flame photometer](#) (Model PFP7, Jenway, England) (Haghighi *et al.*, 2022).

135 To assess the firmness of the fruit, a penetrometer ([model OSK-I-10,576, Ogawa Seiki Co. Ltd.,](#)
136 [Tokyo, Japan](#)) was used to measure the skin puncture strength of fresh intact fruit. The firmness of
137 each fruit was measured twice at equidistant points, with the two measurements taken at a 90-
138 degree angle to each other. These values were then averaged and recorded as the firmness values
139 in Newton (Gholamnejad *et al.*, 2023).

140 Total dissolved solids were measured with a refractometer (Japan K-0032 model), a small amount
141 of juice was applied onto the lens, and the measurement was obtained in degrees Brix (°Bx),
142 representing the percentage of soluble solids content in the fruit. Prior to each sample, calibration
143 was performed using distilled water, and the lens was thoroughly rinsed with distilled water twice.
144 Utilizing the titration method and monitoring the pH of the juice, organic acids were determined
145 and the percentage of malic acid was used to calculate the amount of titratable organic acid.

146 147 **Statistical Analysis**

148 Analysis of variance and mean's comparison were performed based on LSD tests at 1 and 5%
149 probability levels using Statistix 8 (Tallahassee FL, USA). Biplot analysis were also done using
150 [Statgraphics Centurion, Version 18.](#)

151 **Second Experiment**

152 Based on the findings from the initial experiment, which included yield cluster analysis and
153 principal component analysis, two tolerant melon cultivars (Tork: Torkamani, Zank: Zanki) and
154 two sensitive cultivars (G-IVA: Gorgi Ivan, G-SHI: Gorgi Shirdan Jorgeaval) were chosen and
155 grown. The experimental design was a split-plot randomized complete block design with three
156 replications, 2 m row spacing, and 36 m length. All cultivation, irrigation and salinity conditions
157 were similar to the first experiment. Data were analyzed using Statistix 8 (Tallahassee FL, USA).
158 All data were analyzed using two-way ANOVA, and significance was determined by comparing
159 the means at $P \leq 0.05$ using the least significant difference (LSD) test.

160

161 RESULTS

162 The results main effects of melon types and interaction effect of salinity× melon cultivars on all
163 measured parameters was presented in supplementary (Tables 2, 3..., 15). Also some Iranian melon
164 landrace and Afghan melon in (Figure 2) and analyze of Cluster in (Figures 3, 4 and 5)
165 supplementary file was showed.

166

167 The Result of the First Experiment

168 PCA comparisons between biochemical and morphological parameters were presented in Figures
169 1 and 2. The sensitive and tolerant cultivars were chosen based on proximity to high yield and
170 improved morphological characteristics, and distance from stress indices in PCA analysis for
171 biochemical parameters and stress indices. Additionally, we utilized ANOVA on all cultivars
172 exposed to salinity in the supplementary file to identify the most sensitive and tolerant cultivar. For
173 the second experiment, tolerant (Tork and Zank) and sensitive (G-IVA and G-SHI) cultivars under
174 salinity stress were separated between all cultivars (Iranian and Afghan) for a more in-depth
175 investigation. The biplot results showed a high correlation between vitamin C traits with soluble
176 solids, proline, and relative water content while a negative correlation with Fv/Fm ratio. Naki
177 Johari, Hatchke Daroneh, Ghatori, Ghandak Tanabisefid, Hatchke Johari, Talebi Tanbalemax, and
178 Zanki are classified as salinity stress-tolerant cultivars due to their high concentration of proline,
179 soluble solids, vitamin C, and relative leaf water content under salinity stress conditions.
180 Furthermore, these cultivars have a strong correlation with stress resistance and the related traits.

181 The cluster analysis of the 18 melon cultivars based on biochemical traits produced two main
182 clusters, including Naki Johari, Gezgi, Bandi Boyak, Hachkeh Drone, Kale Gorfi, Gorgab, Talebi
183 Tanbalmax, Ghatori, Bargeney, Ghandake Tanabisefid, Hachkeh Johari, AbuJahl, Taki, Kalegorgi

184 Droneh, Zanaki, and Chini, which were classified in the first group and as stress-tolerant cultivars.
185 The cluster analysis of the 18 melon cultivars based on morphological traits also produced three
186 groups: Kaleh Gorgi, Hachkeh Johari, Torkamani, Gorgi Shirdan Jorjeaval, and Gezgi cultivars are
187 morphologically more prominent in their peel than other cultivars. There are Ghatori, Gorgi Ivan,
188 Kadoei, and AbuJahl watermelons in the second group, which are better than other cultivars in
189 terms of spots on the peel. The biplot diagram of these traits also confirms this issue.

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193 **The Result of the Second Experiment**

194 Fruit hardness, length, flesh thickness, and seed hole length were enhanced in Tork and Zank,
195 particularly under control. However, neither fruit width nor cavity width differed significantly
196 between tolerant and sensitive cultivars (Figure 3 A-F). Fruit skin thickness, seed mass weight,
197 yield per plant, and fruit weight followed the same pattern and were greatest in Tork, followed by
198 Zank, when compared to salinity-sensitive cultivars (G-IVA and G-SHI). Seed length and diameter
199 were similar between Tork and Zank. Seed length was substantially greater in tolerant cultivars
200 compared to sensitive cultivars, although seed diameter was significantly the same. **In the**
201 **conditions of salt stress, G-IVA had a 72% and 63% decrease in yield compared to the tolerant**
202 **varieties (Tork and Zank), respectively, and in G-SHI, the yield decreased by 75% and 67%**
203 **compared to Tork and Zank, respectively (Figures 4 A-F).**

204 Vitamin C and TSS rose in all cultivars due to salt. The Zank in salinity contained the highest
205 levels of Vitamin C. The TA content of the tolerance cultivar increased in both salinity conditions.
206 The cultivar with the greatest TSS was tolerant of salinity. **sodium** increased, and **potassium**
207 decreased by salinity. However, it was not statistically different by the nonsaline condition in each
208 cultivar. The highest **sodium** was in G-SHI salinity, and the highest **potassium** Conc. was in Tork
209 at non-saline conditions (Figures 5 A-F).

210 Chlorophyll fluorescence was similar across all treatments and was unaffected by cultivar. The
211 chlorophyll index increased in the tolerance cultivar in control and it was significantly the same in
212 Tork and Zank and G-SHI cultivar in salinity. G-IVA had the lowest Chlorophyll index in both
213 saline conditions. RWC was greater in tolerant cultivars (Tork and Zank) in both saline conditions,
214 but it was lower in sensitive cultivars (G-IVA and G-SHI) under salt stress. EL decreased in

215 tolerance cultivars (Tork and Zank) and increased in sensitive cultivars (G-IVA and G-SHI) in both
216 saline conditions. All cultivars exhibited a rise in DPPH in response to salt, with G-IVA in non-
217 saline conditions exhibiting the lowest DPPH (Figures 6 A-F).

218
219 **DISCUSSION**
220 **The Effect of Salinity on Some Morphological Parameters in a Tolerance and Sensitive**
221 **Cultivar of Studied Melons**

222 Due to a significant correlation with stress-related features such as proline and soluble solids, the
223 relative water content of the leaf, and vitamin C, melon cultivars that are tolerant to salinity stress
224 are ideal for field cultivation in saline soil. Turkmeni and Zenki melon cultivars based on most of
225 the quantitative and qualitative traits investigated in this research are the most suitable for the field.
226

227 **The Effect of Salinity on Yield, Chlorophyll Index, the Water Content of Tolerance and**
228 **Sensitive Cultivars of Studied Melons**

229 All characteristics reduced as salinity increased. Under salinity stress, a low fruit yield was caused
230 by a decrease in fruit number and fruit weight, as these are the two most essential yield components.
231 Multiple research demonstrated that [melons are categorized as being relatively salt tolerant](#)
232 (Shannon and Francois, 1978). Dias *et al.* (2018) demonstrated that Fruit length and diameter, as
233 well as peel and pulp thickness, decreased when subjected to EC values greater than 3.8 dSm⁻¹.
234 Photosynthesis is the most critical physiological function of the plant, determining plant growth
235 and yield to the greatest extent (Mobin and Khan, 2007). [The growth of plants is limited by the](#)
236 [decrease of photosynthesis](#). The absence of stomatal conductance, which diminishes under stress,
237 is responsible for the decline in photosynthesis (Ashraf and Harris, 2004). The decrease in yield
238 and fruit weight of sensitive cultivars is correlated with the expansion of the fruit's cavity and its
239 pulp's reducing diameter. In the confirmation of these results, fruit length, fruit width, fresh weight
240 of pulp, fresh weight of skin, fresh and dry seed weight, dry weight of 100 g pulp, and skin
241 decreased significantly in the sensitive cultivar. As the number of epidermal cells increases, the
242 stomata become narrower and retain cell moisture more effectively. According to Colla *et al.*
243 (2006), the decrease in fruit yield is primarily attributable to the lower mean fruit weight in the
244 salinity condition.

245 In conditions of mild stress, the chlorophyll content of a plant could increase by reducing leaf
246 area. In other words, the rise in chlorophyll content under stress is the result of the reduction in leaf

247 area and the thickening of cells, which causes the leaf cells to shrink (Zhou *et al.*, 2023). In contrast,
248 high stress inhibits chlorophyll synthesis, corresponding with the findings of this experiment. The
249 drop in SPAD value at salinity can be linked to the degradation of chloroplast structure, which
250 reduces chlorophyll content. The chlorophyll concentration in pumpkins has been found to
251 decrease due to salt, which aligns with our observations (Sevengor *et al.*, 2011). Due to sodium ion
252 buildup in the leaves, chlorophyll concentration dropped (Molazem *et al.*, 2010).

253 In the present experiment, the cultivar with the highest and lowest relative leaf water content was
254 determined to be the cultivar with tolerance and sensitivity, respectively. The high relative water
255 content in stress-tolerant cultivars may be attributable to processes that limit water loss by closing
256 the stomata or increasing water uptake through root growth (Kaya *et al.*, 2001).

257 258 **The Effect of Salinity on sodium, potassium, and Tss in a Tolerance and Sensitive Cultivar** 259 **of Studied Melons**

260 By applying salinity stress, the amount of sodium in the shoot of melon increased, and the amount
261 of sodium in the shoot was influenced. During salinity stress, the high sodium concentration in the
262 rhizosphere and its subsequent replacement by potassium leads to a decrease in sodium content in
263 the shoot. Under salinity stress, sodium competes with potassium and decreases the absorption of
264 other ions, particularly potassium (Parida *et al.*, 2005). This study revealed that sensitive cultivars
265 had the most sodium rise in response to salt stress compared to the tolerance cultivars. Increasing
266 salinity increases sodium absorption while decreasing potassium absorption. potassium is a vital
267 plant element, and as its concentration decreases, stomata close and photosynthesis slows, resulting
268 in a decline in plant development (Mirmohammadi Meybodi and Ghareh yazi, 2002).

269 In the present study, a decrease in potassium content in salinity was detected in melons. According
270 to Ou *et al.* (2011) and Polacik and Maricle, (2013) the most probable explanation for this
271 controversy involves root-to-shoot nutrient translocation, species features, and duration of stress.
272 Salt creates a 'physiological drought' by decreasing stomatal conductivity (Ou *et al.*, 2011; Polacik
273 and Maricle, 2013), so reducing the flow of nutrients to the shoot; may result in a drop in potassium
274 concentration with extended salinity exposure (Jackson *et al.*, 1996). Root growth is unaffected by
275 the shock stress; this may result in a substantial uptake of potassium by the shoot (Wang and Wu,
276 2013).

277 The greatest soluble solid is found in cultivars with tolerance. The existence of a higher TSS in
278 the salinity-tolerant cultivar may aid in maintaining osmotic control in fruits, hence preserving

279 photosynthesis under stress, preventing a decrease in assimilate production in leaves and
280 preventing a decrease in fruit weight. The results of this experiment prove their validity. In sensitive
281 cultivars, salinity lowered fruit quality in terms of firmness and acidity. Melons irrigated with saline
282 water exhibited improved fruit quality, as evidenced by a rise in TSS and a decrease in pH (Botia
283 *et al.*, 2005).

284 The salinity stress treatment decreased fruit firmness relative to the control treatment. Changes in
285 fruit tissue stiffness caused by salt stress are directly connected to cell wall composition (Sato *et*
286 *al.*, 2006). Due to salt stress, calcium absorption is diminished, and calcium's involvement in cell
287 wall strength causes fruit tissue to soften.

288
289 **The Effect of Salinity on Some Stress Indices of Tolerance and Sensitive Cultivars of Studied**
290 **Melons**

291 The Fv/Fm ratio can indicate the plant's resistance to environmental pressures and the extent of
292 its damage. Salinity stress increases variable fluorescence (Fv), maximum fluorescence (Fm), and
293 beginning fluorescence (Fo) while decreasing photosystem II's maximal quantum performance
294 under dark conditions (Fv/Fm) (Zhao *et al.*, 2007).

295 Proline was increased in tolerance melon more than in sensitive cultivars. Proline accumulation
296 in tissues is the result of proline synthesis under stress conditions and its protection from oxidation,
297 as demonstrated by multiple studies (Misra and Gupta, 2005). Increasing proline concentration
298 under salt conditions may be the result of biosynthesis or a decrease in proline oxidation to
299 glutamate conversion protein to proline. Proline concentration increased simultaneously with the
300 decrease in leaf water content and the severity of salt stress. Given the importance of proline amino
301 acids in moderating the harmful effects of environmental stressors, particularly salinity and osmotic
302 control, this rise seems justifiable (Flowers *et al.*, 1977).

303 DPPH% increased in all melons under salinity but is greater increase was seen in tolerance
304 cultivars. Similar to other abiotic stresses, salinity exposure induces oxidative damage via reactive
305 oxygen species. Oxidative stress caused by salinity leads to peroxidation of membrane lipid and
306 loss of selectivity, resulting in increased permeability of cell membranes to ions and electrolytes;
307 thus, salinity indirectly reduces membrane cohesion and increases the percentage of ion electrolyte
308 leakage from leaves (Wu *et al.*, 1998).

309 Significant increases in electrolyte leakage produced by free radical generation in a chain reaction
310 beginning with photosynthesis were triggered by salinity (Ghoulam *et al.*, 2002). In addition, ion

311 imbalance with salinity, particularly sodium in salinity, increases phenol content and antioxidant
312 activity above EL %. However, a substantial correlation between sodium accumulation and EL
313 increase was seen in the biplot test.

314
315 **CONCLUSION**
316 By enhancing osmolytes such as proline, TSS and potassium, antioxidant activity, vitamin C as a
317 radical scavenger, and TA, the fully tolerant cultivar was able to achieve better commercial yield.

318 It appears that melons, through osmoregulation with proline, TSS, and potassium, attempt to reduce
319 the negative effects of saline stress, however further physiological studies are required for
320 confirmation. So between the Afghan and Iranian genotypes tested in this experiment, Tork and
321 Zank were advised to be grown in saline conditions because they are better than other genotypes
322 in terms of yield traits (flesh thickness, fruit skin thickness, yield, fruit weight) and quality (vitamin
323 C, TA and TSS). In future studies, this tolerant cultivar can be used for breeding objectives. Given
324 that salt-tolerant cultivars exhibit better morphological traits, can yield superior quality fruit when
325 subjected to salty conditions.

326
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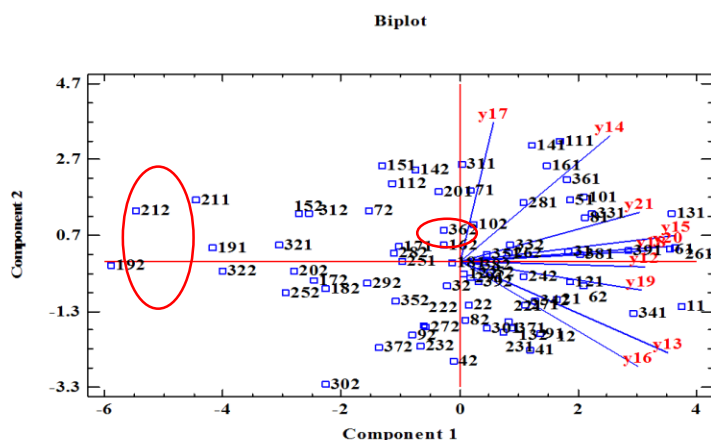
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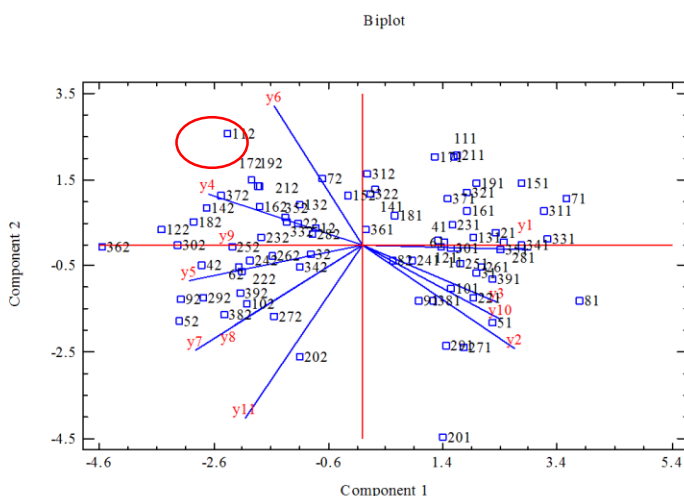
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433
 434 **Figure 1.** The scatter plot of the PC1/PC2 plane shows the relationships between the 39 studied Iranian
 435 and Afghan melon cultivars on **morphological** traits under saline conditions (Each number ending with 1
 436 represents control, while each number ending with 2 represents salinity stress). The numbers correspond to
 437 the cultivars including (1): Abbasi, (2): Saderati Iran, (3): Nazokcheh Nasvari, (4): Taki Johari, (5): Gezgi,
 438 (6): Banidi Boyak, (7): Talebi Saveh, (8): Mashhadi Irani, (9): Hachke Daroneh, (10): Kale Gorgi, (11):
 439 Talebi Shahabadi, (12): Gorgab, (13): Ivanaki Zard, (14): Talebi Varamini, (15): Garmak Isfahan, (16):
 440 Bandi Siah, (17): Zardak, (18): Potk Johari, (19): Gorgi Ivan, (20): Talebi Tanbalemax, (21): Gorgi Shirdan
 441 Jorjeaval, (22): Dronak, (23): Tanabi Bandi, (24): Bandi Pizali, (25): Ghatori, (26): Torkamani, (27):
 442 Bargeney, (28): Kadoei, (29): Ghandak Tanabi sefid, (30): Hachke johari, (31): Garmak Habibabadi, (32):
 443 Hendavaneh Abujahl, (33): Mashhadi Afghani, (34): Naki, (35): Ghandak Zard, (36): Kale Gorgidoroneh,
 444 (37): Golzardak, (38): Zanki, (39): Chini, Fruit firmness (y12), Fruit length (y13), Fruit width (y14), Flesh
 445 thickness (y15) Seed cavity length (y16), Cavity width (y17), Fruit skin thickness (y18), Seed length (y19),
 446 Seed mass weight (y20), Seed diameter (y21).

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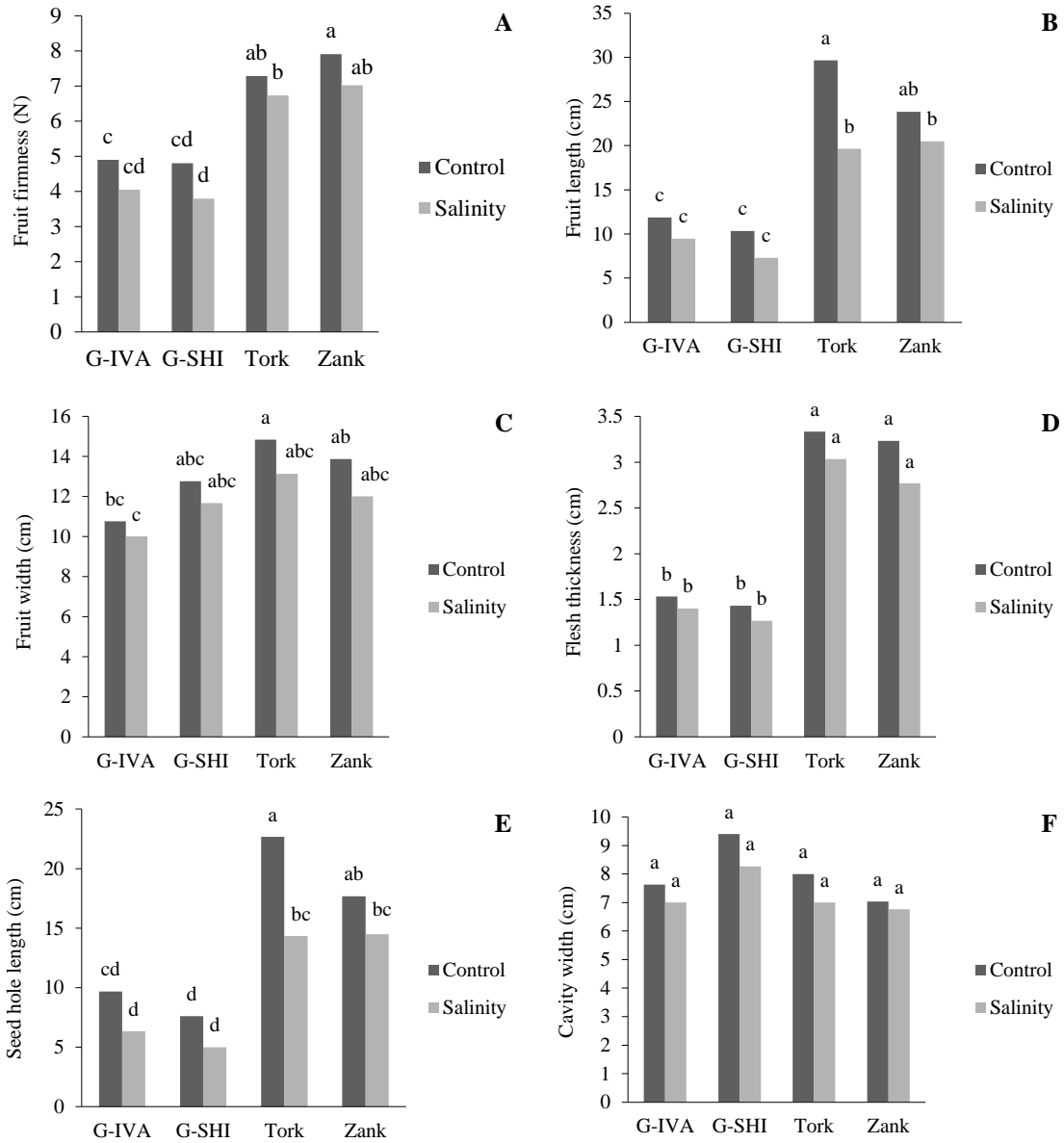
457 **Figure 2.** The scatter plot of the PC1/PC2 plane shows the relationships between the 39 studied
 458 Iranian and Afghan melon cultivars on **physiological traits and some mineral elements** (Each
 459 number ending with 1 represents control, while each number ending with 2 represents salinity
 460 stress) traits under saline conditions. The numbers correspond to the cultivars including (1):
 461 Abbasi, (2): Saderati Iran, (3): Nazokcheh Nasvari, (4): Taki Johari, (5): Gezgi, (6): Banidi Boyak,
 462 (7): Talebi Saveh, (8): Mashhadi Irani, (9): Hachke Daroneh, (10): Kale Gorgi, (11): Talebi
 463 Shahabadi, (12): Gorgab, (13): Ivanaki Zard, (14): Talebi Varamini, (15): Garmak Isfahan, (16):
 464 Bandi Siah, (17): Zardak, (18): Potk Johari, (19): Gorgi Ivan, (20): Talebi Tanbalemax, (21): Gorgi
 465 Shirdan Jorjeaval, (22): Dronak, (23): Tanabi Bandi, (24): Bandi Pizali, (25): Ghatori, (26):
 466 Torkamani, (27): Bargeney, (28): Kadoei, (29): Ghandak Tanabi sefid, (30): Hachke johari, (31):
 467 Garmak Habibabadi, (32): Hendavaneh Abujahl, (33): Mashhadi Afghani, (34): Naki, (35):
 468 Ghandak Zard, (36): Kale Gorgidoroneh, (37): Golzardak, (38): Zanki, (39): Chini, (y1:
 469 Chlorophyll fluorescence, y2: SPAD, y3: Relative water content, y4: Electrolite leakage, y5:
 470 Proline, y6: DPPH, y7: Vitamin C, y8: Total acidity, y9: Sodium, y10: Potassium, y11: Total
 471 soluble solids).

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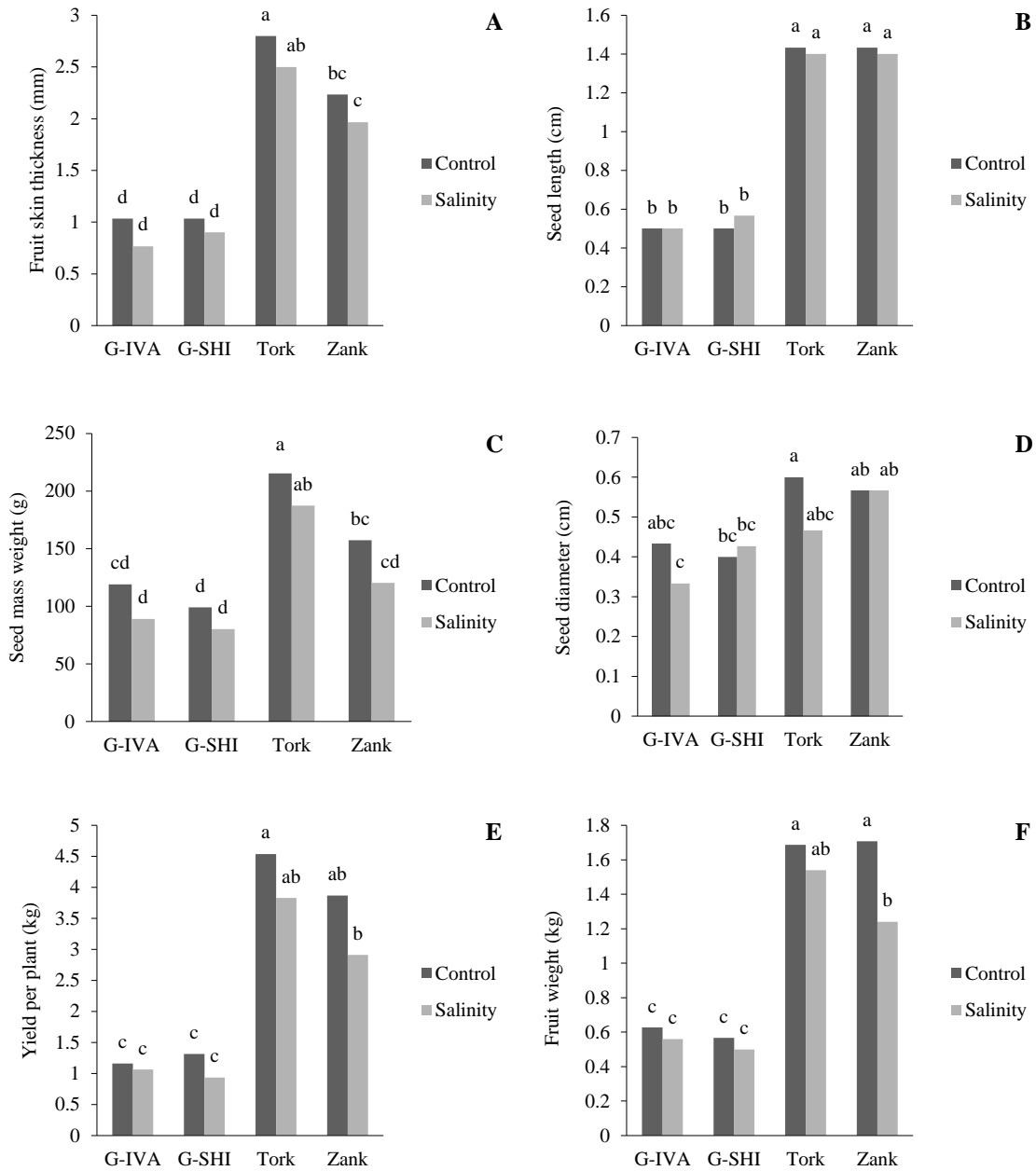
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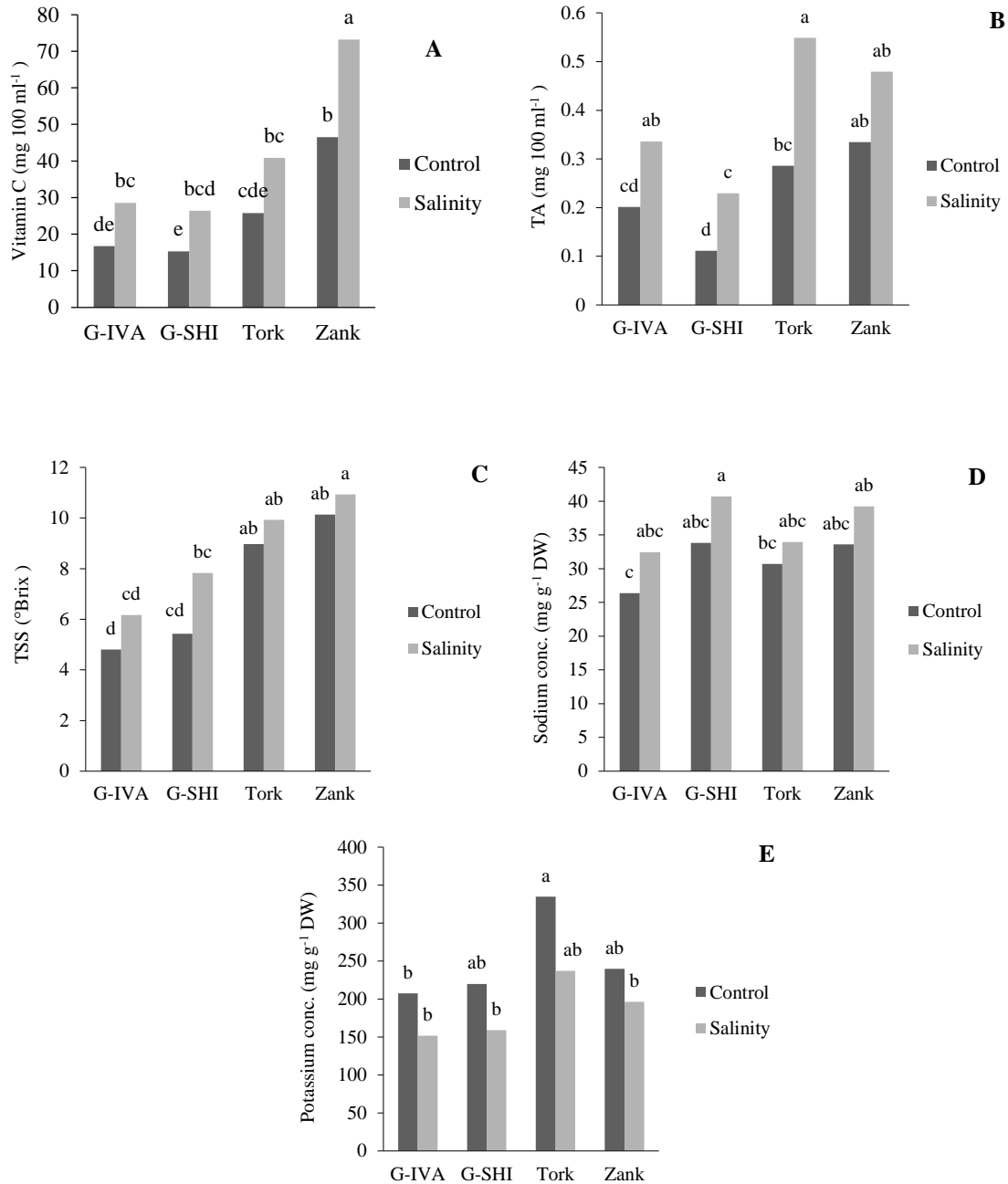
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476 **Figure 3.** The effect of some morphological changes between tolerate (Tork and Zank) and
 477 sensitive (G-IVA and G-SHI) cultivars under salinity stress. G-IVA: Gorgi Ivan, G-SHI: Gorgi
 478 Shirdan Jorgeaval, Tork: Torkamani, Zank: Zanki.
 479



480 **Figure 4.** The effect of some morphological and yield parameter between tolerate (Tork and
 481 Zank) and sensitive (G-IVA and G-SHI) cultivare under salinity stress. G-IVA: Gorgi Ivan, G-SHI:
 482 Gorgi Shirdan Jorgeaval, Tork: Torkamani, Zank: Zanki



483 **Figure 5.** The effect of some qualitative changes between tolerate (Tork and Zank) and sensitive
 484 (G-IVA and G-SHI) cultivare under salinity stress. G-IVA: Gorgi Ivan, G-SHI: Gorgi Shirدان
 485 Jorgeaval, Tork: Torkamani, Zank: Zanki.

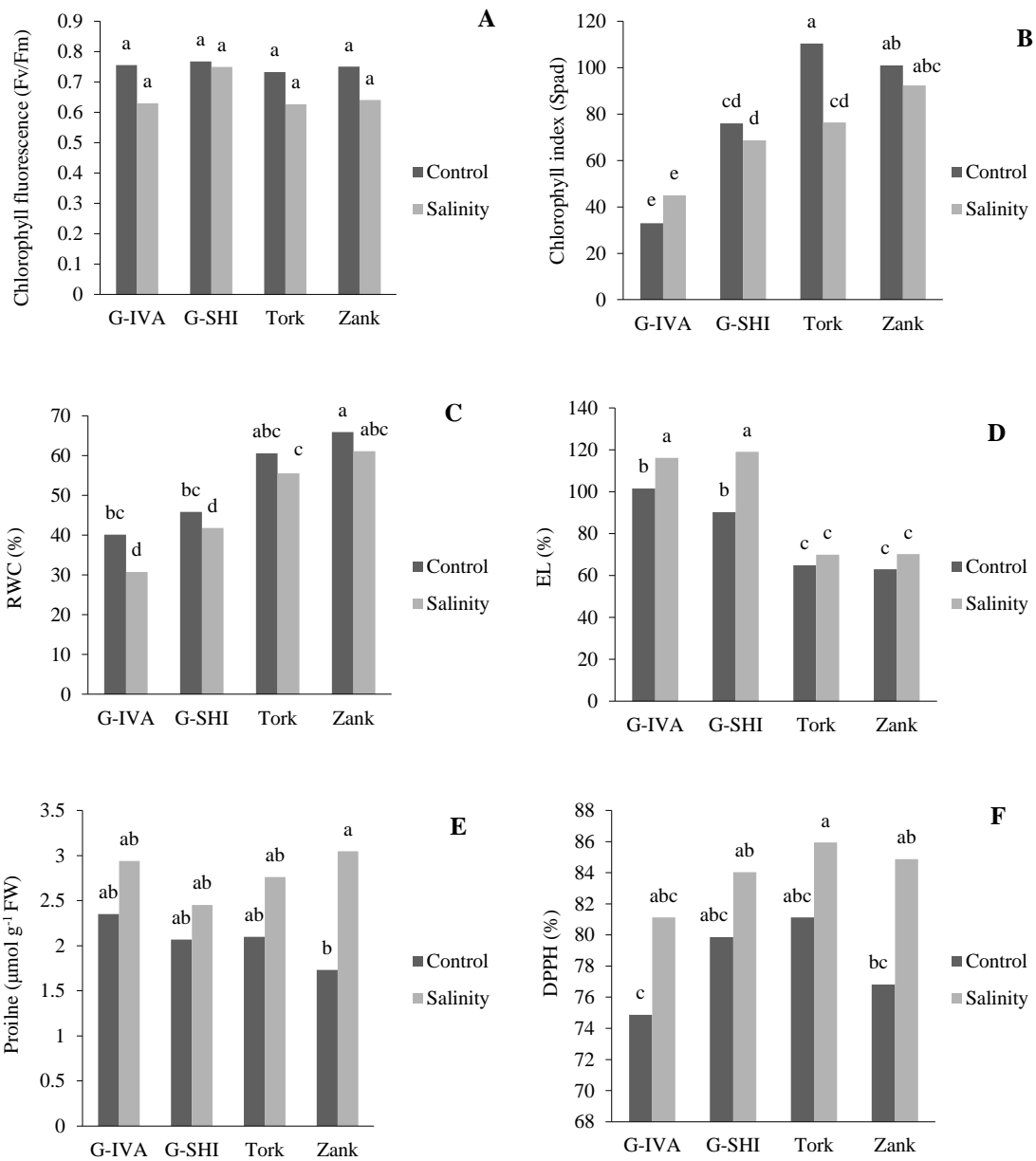


Figure 6. The effect of some stress indices changes between tolerate (Tork and Zank) and sensitive (G-IVA and G-SHI) cultivars under salinity stress. G-IVA: Gorgi Ivan, G-SHI: Gorgi Shirdan Jorgeaval, Tork: Torkamani, Zank: Zanki

487 غربالگری خربزه ایرانی و افغانستانی (*Cucumis melon*) در تحمل به شوری براساس برخی از صفات
488 مورفولوژیکی و فیزیولوژیکی

489

490 ح. حکمت، م. حقیقی، ح. ر. عشقی زاده و گ. بنی طالبی

491

492

چکیده

493 این تحقیق به منظور بررسی اثر شوری بر برخی از صفات فیزیولوژیکی و مورفولوژیکی ارقام خربزه بومی ایرانی و افغانی در قالب طرح
494 بلوک‌های کامل تصادفی در سه تکرار انجام شد. تیمارها شامل: دو سطح شوری (2 و 8 دسی زیمنس بر متر NaCl) و 39 رقم خربزه از
495 ایران و افغانستان استفاده شد. مقایسه PCA بین پارامترهای بیوشیمیایی و مورفولوژیکی انجام گرفت. ارقام حساس و متحمل براساس
496 نزدیکی به عملکرد بالا، خصوصیات مورفولوژیکی و فاصله از شاخص‌های تنش انتخاب شدند. نتایج بای پلات همبستگی بالایی بین
497 صفات ویتامین C با مواد جامد محلول، پرولین و محتوای نسبی آب و همبستگی منفی با نسبت Fv/Fm نشان داد. این شاخص‌ها،
498 پارامترهای خوبی برای شناسایی ارقام مقاوم به شوری هستند. تنش شوری نشأت الکترولیت، غلظت پرولین، فعالیت آنتی اکسیدانی کل،
499 محتوای سدیم، ویتامین C، اسید آلی و کل مواد جامد محلول را افزایش داد. همچنین شوری باعث کاهش عملکرد، میانگین وزن میوه،
500 سفتی، طول میوه، عرض میوه، طول حفره داخلی، عرض حفره داخلی، ضخامت گوشت، ضخامت پوست، نسبت Fv/Fm، شاخص
501 سبزی، محتوای آب نسبی و میزان پتاسیم برگ شد. بیشترین غلظت سدیم در رقم Gorgi Shirdan Jorgeaval در شرایط شور
502 و بیشترین غلظت پتاسیم در رقم Torkamani در شرایط غیر شور مشاهده شد. بر اساس نتایج، دو نوع خربزه Torkamani و Zanki
503 برای کاشت در شرایط شور توصیه شد.

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