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Determination of Yield and Fruit Quality Characteristics of Some Beef Type Tomato Lines

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Abstract: This study was conducted to determine the yield and some quality characteristics of 20 beef tomato lines at the F6 stage. As a result, the total yield, average fruit weight, fruit length, and fruit width of the lines varied between 6.60-14.93 t/da, 200.80-384.00 g, 53.68-75.05 mm, and 71.95-98.29 mm respectively. Furthermore, it was found that the fruit flesh firmness values of the tomato lines used in the study varied between 0.41-1.32 kg/cm^2; brix values between 6.10-9.60%; vitamin C values between 20.03-25.57 mg/100 g; total phenolic contents between 13.28-30.72 mg/100 g; lycopene contents between 4.69-9.68 mg/100 g and beta-carotene contents between 0.83-2.17 mg/100 g.

Keywords: Tomato, yield, quality

Bazı Beef Tipi Domates Hatlarının Verim ve Meyve Kalite Özelliklerinin Belirlenmesi

Öz: Bu çalışma 20 adet F6 kademesindeki beef tipi domates hattının verim ve bazı kalite özelliklerinin ortaya konulması amacıyla gerçekleştirilmiştir. Çalışmanın sonucunda hatların toplam verim, ortalama meyve ağırlığı, meyve boyu ve meyve eni değerlerinin sırasıyla; 6.60-14.93 t/da, 200.80-384.00 g, 53.68-75.05 mm ve 71.95-98.29 mm arasında değişim gösterdikleri tespit edilmiştir. Çalışmada kullanılan domates hatlarının meyve eti sertlik değerlerinin 0.41-1.32 kg/cm^2, sçkm değerlerinin %6.10-9.60, vitamin C değerlerinin 20.03-25.57 mg/100 g, toplam fenolik madde miktarlarının 13.28-30.72 mg/100 g, likopen içeriklerinin 4.69-9.68 mg/100 g ve beta karoten içeriklerinin 0.83-2.17 mg/100 g arasında değişim gösterdikleri saptanmıştır.

Anahtar Kelimeler: Domates, verim, kalite

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1. Introduction

Tomato (*Solanum lycopersicum*), a member of the Solanaceae family, is one of the world's most important vegetables. Its relatively short growing season and high yield make it an economically attractive crop, and its area under cultivation is increasing daily. The tomato originated in the South American Andes. Cultivated tomatoes were brought to Europe by the Spanish conquistadors in the 16th century. They were later introduced from Europe to eastern and southern Asia, the Middle and East Africa. Wild tomatoes have spread to other parts of South America and Mexico in more recent times (Dam et al., 2005).

Since the 20th century, many tomato varieties have been morphologically bred from *S. lycopersicum* through plant breeding (Bai and Lindhout, 2007). Recent breeding efforts have focused on developing varieties that are high-yielding, early-maturing, resistant to various stresses, resistant to fruit cracking, suitable for the growing season, resistant to diseases and pests, and resistant to transport and storage (Çelik and Kabaş, 2021).

According to FAO (2024), the total global production of tomatoes in 2022 was 186.1 million tonnes, with China leading at 68.3 million tonnes. India ranks 2nd with 20.7 million tonnes, Türkiye 3rd with 13 million tonnes, and the USA 4th with 12 million tonnes.

The yield values of tomato plants are influenced by factors such as the length of the growing season, environmental conditions (humidity, light, temperature), and cultural practices (fertilization, maintenance, growing environment). Tomato yield values generally vary between 4-10 t/da (Heuvelink and Dorais, 2005).

Tomatoes are consumed fresh and processed in large quantities in the world and make important contributions to human nutrition and health. Its fruits are not a rich source of macronutrients. However, they contain high levels of many minerals and vitamins. Tomatoes are an important source of vitamin A, which helps to boost the immune system and prevent eye disease (Caicedo and Peralta, 2013). Tomato fruit is mainly composed of sugars and organic substances. Acids constitute 60% of the dry matter content. The main acids in ripe tomatoes are malic acid and citric acid; sugars are fructose and glucose (Causse et al., 2004).

The components that make up the taste and nutritional value of tomatoes are lycopene, an important antioxidant, vitamins B1, B2, C, and A, protein, carbohydrates, iron, and phosphorus (Koç, 2002). Tomatoes are rich in lycopene, which is known to reduce the risk of cancer and cardiovascular diseases (Böhm, 2018).

The use of hybrid seeds in covered vegetable production has reached 100% in our country. On the other hand, the use of hybrid seeds is quite common in open field production of tomatoes, onions, cucumbers, cabbages, broccoli, and carrots (Yanmaz et al., 2020). Hybrid varieties are preferred due to their high adaptability, disease/pest resistance, strong plant formation, high yield, and quality characteristics (Balkaya, 2008).

This study aimed to evaluate the yield and fruit quality characteristics of 20 F6 beef tomato lines, hypothesizing that these lines will exhibit superior traits suitable for future breeding programs. Therefore, fruit width, fruit length, mean fruit weight, total yield, fruit flesh firmness, soluble solids content, pH, color, titratable acidity, ascorbic acid, lycopene, β-carotene and total phenolic content of tomato lines were determined.

2. Material and Method

The study was carried out in the plastic greenhouse of Anamas Seed Company (Aksu-Antalya) in 2020. Twenty beef-type tomato lines were used in the study. These were selected for their color, size, and yield at the F6 stage. In the first phase of the formation of the gene pool, the seeds obtained at the F2 stage were purified by the method of single plant selection and were brought to the F6 stage. At each stage of the breeding program, selections were made for phenotypic characteristics and a gene pool was created.

On 07 February 2020, the seeds of the genotypes were sown. The seedlings that reached the planting stage were planted on 17 March 2020 with a spacing of 130 cm between wide rows, 70 cm between narrow rows, and 40 cm in the row. The experiment was conducted using a randomized design with 3 replicates and 20 plants per replicate.

In this study, the fruits of beef-type tomato lines were regularly harvested at maturity and measured for yield and fruit quality analysis. Fruit length was measured in mm using a digital caliper. To determine the mean fruit weights of the genotypes, the fruits were weighed with a precision balance with a sensitivity of 0.1 g and calculated in g. The fruits of the tomato lines that reached maturity were harvested and the total fruit weights were recorded. From the data obtained, the yield per plant was calculated in kg by dividing the total fruit weight by the number of plants. The yield per decare (t/da) was determined using the yield value obtained per plant. The quality analyses of the tomato fruits were carried out at the Horticulture Laboratory of the Isparta University of Applied Sciences.

Fruit flesh firmness was measured using the Ft 327 penetrometer and values were expressed in kg/cm². To measure the soluble solids content (SSC) (°Brix) of tomato fruit, 2 drops of tomato juice were dropped into the digital refractometer, read, and the results were expressed in %. The method described by Cemeroğlu (2007) was used to determine the titratable acidity. For this, 10 ml of juice was taken and titrated with 0.1 N sodium hydroxide (NaOH) solution to a pH of 8.1. The results were calculated as citric acid and expressed in %.

The Minolta CR-400 color meter was used to determine the color of tomato fruit, and measurements were taken from two opposite surfaces in the equatorial region of the fruit. The results were determined in terms of CIE L^*, a^*, b^*. Chroma (C^*) and hue angle (h°) were calculated using the formulae $C^*=\sqrt{(a*2+b*2\ )}$ $h°=\arctan\ (b^*/a^*)$. The L^* value indicates brightness, the $+a^*$ value indicates redness, the $-a^*$ value indicates greenness, the $+b^*$ value indicates yellowness and the $-b^*$ value indicates blueness. The C^* value indicates the freshness of the color and the Hue° angle value indicates the quality of the color (McGuire, 1992).

Ascorbic acid (vitamin C) was determined in fresh samples according to Cemeroğlu (2013). 2.6% dichlorophenolindophenol solution was used to titrate the samples and the values obtained from the calculation of the data were expressed in mg/100 g.

For lycopene and β-carotene measurements, samples were first homogenized in acetone:hexane mixture (4:6) for extraction. Measurements were then taken at different wavelengths (663, 645, 505 and 453 nm) in a spectrophotometer. The amounts of lycopene and ß-carotene were calculated according to the formulae given in Nagata and Yamashita (1992) and the results were expressed as mg/100g.

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For total phenolic content measurements, 5 g of each fruit sample was weighed, and 10 ml of 95% ethanol was added and homogenized in a homogenizer. After boiling for 10 minutes, the samples were centrifuged at 8000 rpm and filtered through filter paper. To the filtrate, 10 ml of 80% ethanol was added and boiled for 10 minutes. After boiling, the samples were made up to 100 ml with 80% ethanol. The post-extraction steps were carried out according to Coseteng and Lee (1987) using the Folin-Ciocalteu reagent and the results were expressed as mg/100 g.

The data obtained from the study were subjected to analysis of variance using the MINITAB Inc. package (17). Differences between significant means were determined by the Tukey multiple comparison test and indicated by different letters.

3. Results and Discussion

Fruit width, fruit length, mean fruit weight, and total yield values of tomato lines are given in Table 1. The differences between the lines for fruit width, fruit length, mean fruit weight, and total yield were found to be significant (P<0.05). When analyzing the results of the fruit length measurements, it was found that line Bd 13 (53.68 mm) had the lowest value and line Bd 19 (75.05 mm) had the highest value. The fruit width measurements of the tomato lines varied between 71.95 mm and 98.29 mm. According to the results, lines Bd 5 (71.95 mm), Bd 12 (76.95 mm), and Bd 23 (77.97 mm) had the lowest values, while Bd 9 (98.29 mm), Bd 18 (93.58 mm) and Bd 3 (92.41 mm) had the highest values. Kabaş et al. (2018) reported that fruit width and fruit length values varied between 77.34-102.17 mm and 60.83-91.08 mm, respectively, due to a study on ripening time for transport in beef-type tomatoes. As a result of a study they conducted on 40 beef-type tomato lines, Toksöz (2019) reported that the fruit width values of the lines varied between 70.39-104.51 mm and the fruit length values varied between 55.65-79.83 mm.

While the total tomato yield values varied from 6.60 t/da to 14.93 t/da, the highest yield was measured in Bd 3 and the lowest yield was measured in Bd 9 line. The highest yield was recorded in Bd 3 (14.93 t/da), followed by Bd 13 (14.10 t/da), Bd 20 (13.12 t/da), Bd 18 (13.10 t/da), Bd 15 (13.09 t/da) and Bd 21 (13.07 t/da). Sevgican (1999) reported that tomato yields vary according to variety, number of plants per unit area, cultural practices, and the climate of the greenhouse where cultivation is carried out. Ünal (2021) reported that in a study with 228 beef-type hybrid tomatoes and 11 standard tomato varieties, the yield values obtained at 2 locations varied between 3 108.76 and 9 996.67 kg/da. In a study conducted by Topçu and Aktaş (2020) on the grafting of beef type tomatoes, the yield values ranged from 8.83 to 14.43 kg/m². These findings support our findings.

The mean fruit weight of the tomato lines varied between 200.8 g and 384.0 g. The lowest fruit weights were determined in lines Bd 5 (200.8 g), Bd 10 (208.0 g), Bd 23 (212.0 g), and Bd 12 (214.8 g) and the highest fruit weights in lines Bd 3 (384.0 g), Bd 18 (377.2 g), Bd 9 (330.4 g) and Bd 24 (322.4 g). Şalk et al. (2008) report that fruit size in tomatoes can vary widely between varieties. Ünal (2021)

Table 1. Fruit length, fruit width, total yield and mean fruit weight of tomato lines

Lines	Fruit length (mm)	Fruit width (mm)	Total Yield (t/da)	Mean fruit weight (g)
Bd 1	63.86 gh	87.44 de	12.94 bc	292.40 cd
Bd 2	67.58 ef	82.44 hı	7.49 fg	254.40 ef
Bd 3	61.51 hı	92.41 bc	14.93 a	384.00 a
Bd 5	62.46 hı	71.95 l	12.39 bc	200.80 ı
Bd 6	66.78 fg	81.10 ıj	8.72 ef	237.00 fgh
Bd 8	66.61 fg	84.07 gh	8.31 efg	236.40 fgh
Bd 9	71.00 bcd	98.29 a	6.60 g	330.40 b
Bd 10	67.86 def	85.16 fg	11.22 cd	208.00 hı
Bd 11	62.33 hı	81.71 ıj	12.88 bc	246.00 efg
Bd 12	59.23 ıjk	76.95 k	9.81 de	214.80 hı
Bd 13	53.68 l	81.08 ıj	14.10 ab	224.40 ghı
Bd 15	73.95 ab	91.70 c	13.09 b	268.80 de
Bd 16	61.20 hıj	86.74 ef	6.86 g	312.00 bc
Bd 17	61.01 hıj	81.41 ıj	9.54 de	265.60 def
Bd 18	71.56 bc	93.58 b	13.10 b	377.20 a
Bd 19	75.05 a	80.08 j	9.78 de	236.40 fgh
Bd 20	56.28 kl	78.26 k	13.12 b	290.40 cd
Bd 21	63.84 gh	78.40 k	13.07 b	237.20 fgh
Bd 23	58.07 jk	77.97 k	9.38 e	212.00 hı
Bd 24	70.56 cde	88.65 d	9.32 e	322.40 b

*: Differences between means with the same letter are insignificant at P<0.05 level

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reported that as a result of a study conducted on beef-type tomatoes in 2 locations, the fruit weight values varied between 125.48-252.48 g in the 1st location and 150.59-296.29 g in the 2nd location. Gölükcü et al. (2018), as a result of a study they conducted to determine the changes in some physical and chemical quality characteristics of tomatoes due to hybridization; report that fruit weights of tomatoes with large fruit structures vary between 225.51-557.52 g. Topçu and Aktaş (2020) reported that as a result of a study on grafting in tomato, they determined the fruit weight to be 209.75 g in the beef-type tomato variety grown as ungrafted (control). All of these reports support our findings.

The differences between the lines for fruit flesh firmness, soluble solids content, pH, titratable acidity, vitamin C and total phenolic content were found to be significant ($P<0.05$) (Table 2). The results of the fruit flesh firmness analysis showed that the lines with the highest values were Bd 15 (1.32 kg/cm²), Bd 9 (1.17 kg/cm²), and Bd 5 (1.07 kg/cm²), respectively. Lines Bd 13 (0.41 kg/cm²), Bd 23 (0.44 kg/cm²) and Bd 21 (0.46 kg/cm²) were found to have the lowest values. Studies on tomato cultivation under protected conditions conducted by different researchers have reported that the fruit flesh firmness of tomatoes varies between 0.50–1.07 kg/cm² (Kandel et al., 2020) and 1.39-3.66 kg/cm² (Prakash et al., 2019).

The soluble solids content of tomato lines varied between 6.10% (Bd 21) and 9.60% (Bd 24). Hanson et al. (2004), in a study on antioxidant activity in tomato, reported that brix values varied between 3.6%-8.6% in 50 *L. esculutum*, 3 *L. pipinellifolium* and 2 control groups. Flores et al. (2017) conducted a study to compare the carotenoids of 53 traditional tomato genotypes and found that brix values varied between 3.81% and 8.8%. The pH values of the fruits of the lines varied between 4.31 (Bd 12) and 4.93 (Bd 2). In the studies conducted by different researchers on tomato, pH values were found to vary between 4.2-4.6 (Zengin, 2010), 4.23-4.47 (Murariu et al., 2021), 4.40-4.48 (Rouphael et al., 2017) and 4.53-5.17 (Adeniji et al., 2020). The results of the titratable acidity showed that the lines with the highest values were Bd 12 (0.46%), Bd 13 (0.42%), Bd 3 (0.41%) and Bd 11 (0.40%). The lowest titratable acidity is found in line Bd 2 with 0.17%. This is followed by lines Bd 17 (0.20%) Bd 23 (0.23%) and Bd 10 (0.25%). In various studies using different cultivars and genotypes in protected tomato cultivation, it has been reported that titratable acidity values vary between %0.26-%0.51 (Murariu et al., 2021), %0.12-%0.28 (Gemechu and Beyene, 2019), and %0.49-%0.67 (Dhillon et al., 2019). All these reports are in parallel with the results of our study.

In terms of total phenolic content, it was determined that the Bd 8 line stood out with a value of 30.72 mg/100 g, while the lowest total phenolic content was obtained from the Bd 3 line with 13.28 mg/100 g. Kavitha et al. (2013) reported that the total phenolic content of 54 different tomatoes, consisting of commercial varieties, cherry tomatoes, wild species and different breeding lines, ranged from 20.32 to 133.80 mg/100 g. Francesca et al. (2020), in a study on the use of biostimulants in protected

Table 2. Fruit flesh firmness, SSC, titratable acidity, total phenolic content and vitamin C values of tomato lines

Lines	Fruit flesh firmness (kg/cm²)	SSC (°Brix)	pH	Titratable Acidity (%)	Total phenolic content (mg/100 g)	Vitamin C (mg/100 g)
Bd 1	1.03 cd	6.33 hı	4.51 d-g	0.26 ıj	13.51 j	21.83 h
Bd 2	0.75 hı	7.40 fg	4.93 a	0.17 l	19.02 efgh	25.37 ab
Bd 3	1.01 cde	9.50 a	4.33 ıj	0.41 bc	13.28 j	24.53 cd
Bd 5	1.07 c	7.70 ef	4.51 d-g	0.31 gh	26.85 b	24.53 cd
Bd 6	1.00 cde	6.87 gh	4.62 bcd	0.29 hı	16.92 ı	24.30 de
Bd 8	0.94 def	8.63 bc	4.40 g-j	0.37 cde	30.72 a	23.80 ef
Bd 9	1.17 b	8.03 de	4.55 c-f	0.31gh	22.58 d	21.53 hı
Bd 10	0.79 gh	8.67 b	4.64 bc	0.25 ıj	18.16 gh	22.97 g
Bd 11	0.93 ef	7.90 def	4.40 g-j	0.40 bcd	19.64 ef	25.07 ab
Bd 12	0.85 fg	8.10 cde	4.31 j	0.46 a	24.91 c	22.97 g
Bd 13	0.41 k	8.10 cde	4.35 hıj	0.42 ab	23.12 d	25.57 a
Bd 15	1.32 a	7.37 fg	4.47 efg	0.33 efgh	19.17 efg	20.03 j
Bd 16	0.67 ı	8.27 bcd	4.59 cde	0.33 efgh	19.33 ef	21.27 ı
Bd 17	0.55 j	8.03 de	4.71 b	0.20 kl	19.10 efgh	21.40 hı
Bd 18	0.95 def	9.43 a	4.41 g-j	0.36 def	22.97 d	21.73 hı
Bd 19	0.81gh	6.60 hı	4.46 fgh	0.37 cdef	18.01 hı	23.77 f
Bd 20	0.95 def	8.17 b-e	4.45 f-ı	0.36 def	18.63 fgh	25.03 bc
Bd 21	0.46 jk	6.10 ı	4.47 efg	0.33 fgh	24.98 c	23.17 g
Bd 23	0.44 k	8.17 b-e	4.66 bc	0.23 jk	20.10 e	21.47 hı
Bd 24	0.49 jk	9.60 a	4.43 f-ı	0.34 efg	13.98 j	23.47 fg

*: Differences between means with the same letter are insignificant at $P<0.05$ level

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tomato cultivation, found that the total phenolic content of 4 genotypes used as plant material varied between 9.62-22.35 mg/100 g in the control application.

It was found that the vitamin C values of the tomato lines used in the study varied between 20.03 (line Bd 15) - 25.57 (line Bd 13) mg/100 g. The highest vitamin C content was obtained from line Bd 13, followed by lines Bd 2 and Bd 20 with 25.37 and 25.03 mg/100 g, respectively (Table 2). In 100 g of tomato; Karaçalı (1993) reported 15-30 mg, Dar and Sharma (2011) 19.77-37.80 mg and Nour et al. (2013) 9.19-32.97 mg vitamin C. Radzevicius et al. (2009) reported that vitamin C levels in tomato may vary depending on variety characteristics as well as environmental and growing conditions.

Table 3 shows the L^*, a^*, b^*, C^*, Hue, lycopene, and beta-carotene values of the tomato lines. An analysis of Table 3 shows that the effects of the lines on these parameters are significant ($P<0.05$). In terms of L^* values, the lines varied between 37.52 and 42.25. According to the values obtained, Bd 2 (42.25), Bd 24 (41.88), and Bd 9 (41.87) had high L^* values. Bd 13 (37.52) and Bd 6 (37.72) were the lines with the lowest L^* values. When the a^* values, which determine the red color, were examined, the lowest a^* value of the tomato lines was 19.17 and the highest a^* value was 27.42. The lines with the highest a^* values were Bd 12 (27.42), Bd 2 (26.48), and Bd 11 (26.27) and the lines with the lowest a^* values were Bd 21 (19.17) and Bd 6 (19.39). The b^* values, which determine the yellow color of the tomato lines used in the study, were highest in Bd 2 (29.11), Bd 1 (27.96), Bd 9 (27.52), and Bd 12 (27.22) and lowest in Bd 24 (18.33). The chroma values of the tomato lines varied between 29.12 and 39.35. Bd 2 (39.35), Bd 12 (38.63), Bd 9 (37.14) and Bd 1 (37.02) were the lines with the highest chroma values. The lines with the lowest chroma values among the tomato lines were Bd 24 (29.12), Bd 6 (29.19), and Bd 21 (29.79). Hue angle values vary between 39.01 and 51.11. The tomato line with the highest hue angle value was Bd 5 (51.11), while the tomato line with the lowest value was Bd 24 (39.01). Ünal (2021) reported that L^*, a^*, b^*, C^*, and hue angle values of standard and hybrid beef type tomatoes varied between 31.84-38.12, 27.06-38.17, 24.71-38.06, 37.25-53.93 and 39.38-47.40 for both locations, respectively. Oluk et al. (2012) investigated the color characteristics of nine different tomato varieties at the ripening stage. They reported that the L value varied between 29.87 and 34.97. The a^* values varied between 13.04 and 24.41 and the b values varied between 12.15 and 15.91. The h° values of the tomato varieties varied between 33.13 and 43.78 and the chroma values between 17.90 and 29.14.

The lycopene and β-carotene contents of the tomato lines used varied between 4.69 (Bd 5)-9.68 (Bd 12) mg/100 g and 0.83 (Bd 24)-2.17 (Bd 1) mg/100 g, respectively. Dariva et al. (2021) reported that lycopene values of genotypes varied between 4.53-15.36 mg/100 g at optimum irrigation level as a result of their study on irrigation in 5 tomato genotypes. Lekshmi and Celine

Table 3. L, a^*, b^*, C^* and Hue angle, lycopene and β-carotene values

Lines	L^*	a^*	b^*	C^*	Hue (h°)	β-Carotene (mg/100g)	Lycopene (mg/100g)
Bd 1	41.38 abc	24.250 cd	27.96 b	37.02 bc	49.07 bc	2.17 a	6.69 def
Bd 2	42.25 a	26.48 b	29.11 a	39.35 a	47.71 cde	1.52 bcde	8.39 b
Bd 3	39.65 defg	23.24 ef	24.88 f	34.04 ef	46.96 def	1.50 bcde	6.95 de
Bd 5	40.01 cdef	20.11 j	24.93 f	32.03 gh	51.11 a	1.49 bcde	4.69 g
Bd 6	37.72 ı	19.39 jk	21.81 h	29.19 j	48.37 c	1.66 abcd	8.62 ab
Bd 8	40.24 cde	21.07 ı	23.62 g	31.66 hı	48.27 cd	1.42 cdef	7.09 de
Bd 9	41.87 ab	24.93 c	27.52 b	37.14 b	47.83 cde	1.39 cdef	7.58 bcd
Bd 10	38.59 fghı	21.79 ghı	23.00 g	31.69 hı	46.55 efgh	1.34 cdefg	7.50 bcd
Bd 11	39.81 defg	26.27 b	25.15 f	36.37 c	43.75 k	1.23 cdefg	8.35 bc
Bd 12	40.72 bcd	27.42 a	27.22 bc	38.63 a	44.79 ıjk	1.76 abc	9.68 a
Bd 13	37.52 ı	22.41 fgh	21.68 h	31.18 ı	44.05 jk	1.37 cdefg	7.04 de
Bd 15	40.38 cde	21.26 ı	26.09 de	33.65 f	50.82 a	1.62 bcd	7.66 bcd
Bd 16	40.17 cde	24.56 c	25.40 ef	35.34 d	45.97 fghı	1.41 cdef	8.48 ab
Bd 17	38.50 ghı	23.04 ef	23.18 g	32.68 g	45.17 ıj	0.89 fg	6.53 def
Bd 18	39.98 cdef	23.57 de	25.16 f	34.47 e	46.86 efg	0.91 fg	7.00 de
Bd 19	40.78 bcd	25.88 b	26.42 cd	36.98 bc	45.58 ghı	1.16 defg	5.52 fg
Bd 20	39.53 d-h	24.25 cd	24.62 f	34.56 e	45.43 hı	1.07 efg	5.98 ef
Bd 21	38.92 e-ı	19.17 k	22.80 g	29.79 j	49.95 ab	2.03 ab	7.18 cde
Bd 23	38.10 hı	21.61 hı	23.10 g	31.63 hı	46.92 defg	0.99 efg	6.50 def
Bd 24	41.88 ab	22.63 fg	18.33 ı	29.12 j	39.01 l	0.83 g	6.12 ef

*: Differences between means with the same letter are insignificant at $P<0.05$ level.

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(2017) conducted a study to determine the genetic variation in 40 tomato genotypes and found that the lycopene content of the genotypes varied between 4.77-13.86 mg/100g. Gölükcü et al. (2018) investigated the changes in some physical and chemical quality characteristics of tomato by hybridization and found that the lycopene content in the fruit was in the range of 3.75-8.58 mg/100g. Doğan (2019) reported that the β-carotene content of genotypes varied between 1.07-1.90 mg/100 g, as a result of a study conducted on 20 early tomato genotypes. Junior et al. (2022) found that β-carotene levels varied between 0.04-1.33 mg/100 g in 8 heat-tolerant tomato cultivars. Sinha et al. (2020) reported that β-carotene content varied between 0.14-1.33 mg/100 g in 14 lines suitable for greenhouse tomato cultivation and that β-carotene content may vary depending on genotype and environmental conditions. All of these reports support our findings.

4. Conclusion

Among the tomato genotypes examined in this study, Bd 3 (384.00 g), Bd 18 (377.20 g), Bd 9 (330.40 g), Bd 24 (322.40 g), and Bd 16 (312.00 g) exhibited the highest mean fruit weights. Regarding yield values, Bd 3 (14.93 t/da), Bd 13 (14.10 t/da), Bd 20 (13.12 t/da), Bd 18 (13.10 t/da), and Bd 15 (13.09 t/da) were the most noteworthy genotypes. The highest lycopene levels were observed in genotypes Bd 12, Bd 6, and Bd 16, while the highest β-carotene levels were found in Bd 1, Bd 21, and Bd 12 genotypes. Furthermore, our findings indicated that Bd 8, Bd 5, and Bd 21 lines exhibited remarkable total phenolic content, whereas Bd 13, Bd 2, and Bd 11 lines demonstrated notable vitamin C content.

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Author Contributions

The authors equally contributed to the preparation of this paper.

Conflict of Interest

As the authors of this study, we declare that we do not have any conflict of interest statement.

Ethics Committee Approval

As the authors of this study, we declare that we do not have any ethics committee approval.

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