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Screening of Seventeen Sweet Pepper (*Capsicum annuum* L.) Genotypes for Earliness, Yield and Some Quality Characteristics under Sohag Conditions

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Abstract

Seventeen genotypes of sweet pepper (*Capsicum annuum* L.) were assessed for earliness, yield, and some fruit quality characteristics at the Experimental Farm, Faculty of Agriculture, Sohag University, El-Kawamel region, Sohag Governorate, Egypt, during two successive fall seasons, 2022 and 2023. The experiment was conducted using a Randomized Complete Block Design with three replicates. There were significant differences among genotypes for all studied characteristics. 'Al-Ashraf' genotype was the earliest to flower and the highest chlorophyll content in both seasons, while 'Farz on W4' genotype was the latest to flower in both seasons. 'Romy 1010 W3' genotype had the tallest plant in both seasons. 'Dar El-Salam 5' genotype had the highest No. of branches plant-1 in both seasons. Long Romy W1' genotype had the longest fruit length and the highest No. of fruits plant-1 in both seasons. 'Akhmim-Neda and Dar El-Salam 1' genotypes had the highest fruit diameter in both seasons, while 'Long Romy W1' genotype had the lowest fruit diameter in both seasons. '41 W6' genotype had the highest fruit weight (g) in both seasons. Fruits of 'Dar El-Salam 2' genotype had the highest TSS in both seasons, while 'Romy 1010 W3' genotype had the lowest TSS (%) in both seasons. 'Farz on W4' genotype exceeded all other genotypes in early fruit yield feddan-1 (ton) and total fruit yield feddan-1 (ton). The results of this study could be useful in breeding programs for improving sweet pepper production in Upper Egypt.

Key words: Screening, Genotypes, assessed, Yield, Earliness

INTRODUCTION

Pepper (*Capsicum annuum* L., 2n = 24), a member of the *Solanaceae* family, is one of the most important vegetable crops cultivated in Egypt for both local consumption and export. It is grown extensively worldwide as a major vegetable. In Egypt, pepper occupies a prominent place in the agricultural sector due to its substantial economic returns and its high nutritional value, which plays a crucial role in promoting human health (Ghoname *et al.,* 2010). Sweet pepper fruits are well recognized for their high nutritional value, as they are rich in essential vitamins, pigments (such as lycopene, carotenoids, and xanthophylls), dietary fibre, and a variety of vital minerals. This nutritional richness has contributed to a significant increase in their consumption worldwide (Ghasemnezhad *et al.,* 2011). Notably, sweet peppers contain high concentrations of antioxidant vitamins, including vitamin C (ascorbic acid), vitamin E (alpha-tocopherol), and provitamin A (β-carotene), which are known to play a protective role against cancer and cardiovascular diseases (Palevitch and Craker, 1995). Concerning a nutritional perspective, pepper consider an excellent source of Ascorbic acid content (63–243 mg), Vitamin A (carotenoids, 8493 IU), Potassium (263.7 mg), Calcium (13.4 mg), Phosphorous (28.3 mg) and Magnesium (14.9 mg) per 100 g of fresh weight (Howard *et al.,* 1994). Screening of genotypes is a key strategy for enhancing genetic improvement and serves as a preliminary step in plant breeding programs, relying on observed phenotypic and genotypic traits to guide selection decisions (Abdelkader and Elsayed, 2022). The availability of diverse genetic resources provides plant breeders with valuable opportunities to develop improved cultivars that incorporate both breeder- and farmer-preferred traits (Govindaraj *et al.,* 2015). This genetic diversity has enabled the development of pepper varieties with a wide range of fruit colours, shapes, and other desirable characteristics. Nevertheless, despite the progress made, it remains essential to reinforce traditional pepper breeding efforts, promote the conservation of genetic resources, and support farmer involvement in the processes of seed selection and preservation (Rodríguez *et al.,* 2024).

In Egypt, the cultivated area of pepper reached approximately 134,000 feddans, yielding a total production of 1,100,000 tons, with an average productivity of 8.21 tons per feddan (Department of Agricultural Economics and Statistics, Ministry of Agriculture and Land Reclamation, Egypt, 2024). This yield level is relatively low, highlighting the need to enhance pepper productivity through the development of improved cultivars or hybrids via well-structured breeding programs. Therefore, the current focus is on identifying pepper genotypes that combine high yield potential with superior fruit quality and are well-adapted to the prevailing climatic changes in Egypt. This can be achieved through genetic improvement efforts within well-planned breeding programs. The scope of this investigation was to:

1. Assessed the performance of sweet pepper genotypes under the environmental conditions of Sohag Governorate.
2. Identify and select the most promising genotypes exhibiting superior agronomic and fruit quality traits, which can be utilized in the development of new varieties or hybrids adapted to the prevailing conditions of the study area.

MATERIALS AND METHODS

The present study was conducted during the two consecutive fall seasons of 2022 and 2023 at the Experimental Farm, Faculty of Agriculture, Sohag University, El-Kawamel region, Sohag Governorate, Egypt. The experimental soil was sandy loam, and its physical and chemical properties were analyzed before planting (Table 1).

Table 1. The physical and chemical properties of the soil at the experimental site.

Properties	Seasons	
	Season 2022	Season 2023
Physical analysis		
Particle size distribution (%):		
Sand	75.93	75.86
Silt	14.79	15.79
Clay	9.28	9.36
Textural class:	Sandy loam	Sandy loam
Chemical analysis		
Organic matter (%)	0.60	0.51
pH (1:1)	8.11	8.09
EC (dSm^{-1})	1.62	1.74
$CaCo_3$	6.45	6.39
Soluble ions (meq/L):		
Ca^{+2}	5.65	5.10
Mg^{+2}	2.65	2.80
Na^{+}	9.00	9.36
K^{+}	0.39	0.31
HCO_{-3}	5.48	5.43
Cl^{-}	9.35	9.85
SO_4^{-2}	1.60	1.40
Available macronutrients (mg kg^{-1}):		
N	243.75	232.50
P	4.82	5.10
K	127.98	125.68

Genotypes Sources:

Seventeen sweet pepper genotypes were used in the present study. Out of the 17 sweet pepper genotypes, 7 were collected from Sohag Governorate, Egypt, 4 from Qena Governorate, Egypt and 6 from the Horticulture Research Institute, Agricultural Research Center, Giza, Egypt. (Table 2)

Table 2. Name and source of 17 sweet pepper genotypes grown at the Faculty of Agriculture, Sohag University, El-Kawamel, Sohag, Egypt

Code No.	Genotypes	Source
1	**Long Romy W1**	Horticulture Research Institute, Egypt
2	**Abu Hezam W2**	Horticulture Research Institute, Egypt
3	**Romy 1010 W3**	Horticulture Research Institute, Egypt
4	**Farz on W4**	Horticulture Research Institute, Egypt
5	**Bohoos W5**	Horticulture Research Institute, Egypt
6	**41 W6**	Horticulture Research Institute, Egypt
7	**Qeft1**	Qena Governorate, Egypt
8	**Dandara**	Qena Governorate, Egypt
9	**Al-Ashraf**	Qena Governorate, Egypt
10	**Qeft2**	Qena Governorate, Egypt
11	**Dar El-Salam 1**	Sohag Governorate, Egypt
12	**Dar El-Salam 2**	Sohag Governorate, Egypt
13	**Dar El-Salam 3**	Sohag Governorate, Egypt
14	**Dar El-Salam 4**	Sohag Governorate, Egypt
15	**Dar El-Salam 5**	Sohag Governorate, Egypt
16	**Dar El-Salam 6**	Sohag Governorate, Egypt
17	**Akhmim-Neda**	Sohag Governorate, Egypt

Field Trial Layout

A two-year field trial (2022 and 2023) was executed at the Experimental Farm of the Faculty of Agriculture, Sohag University, Sohag, Egypt, to assess the 17 sweet pepper genotypes for earliness, fruit yield and quality characteristics. The two-year trial was conducted using seeds from the same seed lots. The seeds of tested genotypes were sown in seedling trays (209 cells) under a high tunnel covered with 63% shading material and treated with thiram. All good agricultural practices for commercial pepper transplant production under high tunnel were done as usual. After 45 days, the seedlings were transplanted on the 7th and 10th of September in the first and second seasons, respectively. The experimental design was a randomized complete block with 3 replications. Each experimental unit (plot) consisted of five ridges, each 3 m long and 3.5 m wide, with plants 35 cm apart. Standard cultural practices for commercial pepper production, aside from the applied treatments, were followed throughout the study.

The recorded data of the experiment were as follow:

(A) Flowering characteristic:

No. of days from transplanting to 50% flower anthesis:

The number of days to anthesis of 50% of flowers refers to the duration from the seedling date until 50% of the plants in the plot had reached the flowering stage, marked by the appearance of the first flower.

(B) Vegetative growth characteristics:

1. Plant height (cm):

Five plants were randomly selected from each plot at 90 days after the seedling date to measure plant height (cm). The height was recorded from the soil surface to the top of the plant.

2. No. of branches plant^{-1}:

Five plants were randomly taken from each plot at the end of the harvesting stage.

(C) Fresh fruit yield and its component characteristics:

1. Fruit length (cm):

Ten fruits from each plot were taken randomly from the third picking to determine fruit length (cm).

2. Fruit diameter (cm):

Ten fruits from each plot were taken randomly from the third picking to determine fruit diameter. The diameter was measured from the beginning, middle and end of the fruit using slide callipers, and then the mean was calculated.

3. No. of fruits plant^{-1}:

Ten plants were randomly taken from each experimental unit at every picking, and the mean of the ten plants was used to determine the No. of fruits plant^{-1}.

4. Average fruit weight (g):

Average fruit weight plant^{-1} in every picking was calculated, then the weight was divided by the No. of fruits plant^{-1} and the mean was calculated.

5. Early fruit yield feddan^{-1} (ton):

The first three fruit pickings from each plot were used to calculate the early fruit yield feddan^{-1} (ton).

6. Total fruit yield feddan^{-1} (ton):

All the fruits picked from each plot throughout the season were used to measure the total fruit yield feddan^{-1} (ton). The average weight of fruits per experimental unit was calculated and then multiplied by 400 to obtain the fruit yield feddan^{-1} (ton).

(D) Quality characteristics:

1. Total soluble solids (TSS %):

A sample of 10 sweet pepper fruits from each experimental unit was collected from the third harvest for the determination of total soluble solids (TSS). The TSS content was measured using a hand refractometer.

2. **Relative chlorophyll content (SPAD):**

Chlorophyll content was determined using a chlorophyll meter (Minolta SPAD-502 meter) on the second fully expanded leaf of five plants per plot, 70 days after transplanting, following the method described by Ahmed *et al.,* (2013).

Statistical analysis:

All data from this study were statistically analysed using Analysis of Variance (ANOVA) for a Randomized Complete Block Design (RCBD), as outlined by Gomez and Gomez (1984). The analysis was performed using the "MSTAT-C" computer software package. Treatment means were compared using Duncan's Multiple Range Test, as described by Waller and Duncan (1969).

RESULT AND DISCUSSION

(A) Flowering characteristic:

No. of days from transplanting to 50% flower anthesis:

The data presented in Table 3 indicate that there are significant differences among sweet pepper genotypes in the No. of days to 50% flower anthesis. The results show that genotype (Al-Ashraf) exhibited the shortest time to 50% flowering, with (32.33 and 36.00 days) in the first and second seasons, respectively. In contrast, genotypes (Farz on W4) took the longest time to reach 50% flowering, with (43.67 and 42.00 days) in the first and second seasons, respectively. The variation observed in flowering anthesis could be attributed to genotype differences as well as environmental factors within the experimental region. These findings are consistent with those reported by Law-Ogbomo and Law-Ogbomo (2010).

Table 3. Means No. of days from transplanting to 50% flower anthesis (day), plant height (cm) and No. of branches-plant^{-1} of sweet pepper genotypes during the 2022 and 2023 seasons.

No. Codes	Genotypes	Characteristics					
		No. of days from transplanting to 50% flower anthesis (day)		Plant height (cm)		No. of branches plant^{-1}	
		1st season	2nd season	1st season	2nd season	1st season	2nd season
1	**Long Romy W1**	38.33^{de}	39.00^{c-f}	54.90^{c}	54.75^{c}	12.13^{c}	12.15^{c}
2	**Abu Hezam W2**	40.67^{c}	39.67^{b-f}	52.65^{e}	51.85^{e}	10.93^{d}	10.65^{e}
3	**Romy 1010 W3**	36.00^{gh}	39.00^{c-f}	56.15^{a}	56.65^{a}	9.20^{f}	9.00^{h}
4	**Farz on W4**	43.67^{a}	42.00^{a}	55.00^{c}	54.85^{c}	9.30^{f}	9.50^{g}
5	**Bohoos W5**	34.33^{i}	38.00^{efg}	38.15^{n}	38.40^{k}	7.40^{i}	7.10^{l}
6	**41 W6**	34.33^{i}	37.33^{fg}	46.60^{i}	46.50^{gh}	8.50^{g}	8.70^{i}
7	**Qeft1**	35.33^{hi}	41.33^{ab}	54.45^{d}	53.75^{d}	12.80^{b}	12.60^{b}
8	**Dandara**	34.33^{i}	39.67^{b-f}	44.70^{k}	46.20^{gh}	6.50^{j}	6.60^{m}
9	**Al-Ashraf**	32.33^{j}	36.00^{g}	51.00^{g}	51.65^{e}	7.60^{i}	7.70^{k}
10	**Qeft2**	39.33^{d}	40.00^{a-e}	45.90^{j}	46.15^{h}	10.00^{e}	10.10^{f}
11	**Dar El-Salam 1**	34.33^{i}	39.67^{b-f}	43.90^{l}	44.00^{i}	7.50^{i}	7.65^{k}
12	**Dar El-Salam 2**	41.00^{c}	40.33^{a-d}	42.90^{m}	43.35^{j}	10.10^{e}	10.00^{f}
13	**Dar El-Salam 3**	36.33^{fg}	38.33^{def}	48.75^{h}	49.10^{f}	11.03^{d}	11.10^{d}
14	**Dar El-Salam 4**	37.33^{ef}	40.33^{a-d}	54.90^{c}	53.95^{d}	13.00^{b}	12.80^{b}
15	**Dar El-Salam 5**	42.67^{b}	41.00^{abc}	55.80^{b}	56.00^{b}	15.10^{a}	15.20^{a}
16	**Dar El-Salam 6**	36.33^{gh}	39.67^{b-f}	46.20^{j}	46.75^{g}	8.20^{h}	8.00^{j}
17	**Akhmim-Neda**	34.33^{i}	37.33^{fg}	51.70^{f}	51.45^{e}	7.50^{i}	7.55^{k}
Mean		**37.12^{B}**	**39.33^{A}**	**49.63^{A}**	**49.73^{A}**	**9.81^{A}**	**9.79^{A}**

*Means followed by the same letter or letters within columns are not significantly different of the 5% significance level.

(B) Vegetative growth characteristics:

1. Plant height (cm):

The data presented in Table 3 indicate that there are significant differences among sweet pepper genotypes in the plant height. The tallest plants, measuring 56.15 cm and 56.65 cm, were recorded by genotype (Romy 1010 W3) in the two consecutive seasons. In contrast, the shortest plants, with heights of 38.15 cm and 38.40 cm, were observed in genotype (Bohoos W5) during the first and second seasons, respectively. The observed variation in plant height may be attributed to the genetic control of this trait, which is influenced by two to three genes, with the environment exerting a stronger effect than genetic factors, as noted by Todorov (1992). These findings align with the results reported by Law-Ogbomo and Law-Ogbomo (2010), Bagheri *et al.* (2017), Chouikhi *et al.* (2023), Montejo *et al.* (2024), and Rawal *et al.* (2024).

2. No. of branches plant^{-1}:

Table 3 presents the average No of branches plant^{-1} for the sweet pepper genotypes. Genotype (Dar El-Salam 5) exhibited the highest number of branches per plant, with 15.10 and 15.20 branches in the first and second seasons, respectively. In contrast, genotype (Dandara) displayed the lowest number of branches per plant, with 6.50 and 6.60 branches in the two seasons, respectively. These results can be attributed to the fact that each genotype has a distinct effect on yield and its components, with specific traits influencing various crop parameters, such as the number of branches, as noted by Lemma *et al.* (2008). These findings are consistent with those reported by Law-Ogbomo and Law-Ogbomo (2010).

(C) Fresh fruit yield and its component characteristics:

1. Fruit length (cm):

Data in Table 4 show significant differences among the 17 sweet pepper genotypes in terms of fruit length (cm). The results indicate that genotype (Long Romy W1) gave the longest fruits, measuring 11.11 cm and 12.57 cm in the first and second seasons, respectively with no significant difference with genotype (41 W6) in the first season. In contrast, genotype (Bohoos W5) produced the shortest fruits, with measurements of 6.95 cm and 6.46 cm in the two seasons, respectively. The observed variation in fruit length can be attributed to the genotypic traits inherited by the lines or the influence of the growing environment, as noted by Delelegn (2011). These findings are consistent with the results reported by Delelegn (2011), Montejo *et al.* (2024), Rawal *et al.* (2024) and Yayman *et al.* (2024).

Table 4. Means of fruit length (cm) and fruit diameter (cm) of sweet pepper genotypes during the 2022 and 2023 seasons.

No. Codes	Genotypes	Characteristics			
		Fruit length (cm)		Fruit diameter (cm)	
		1st season	2nd season	1st season	2nd season
1	**Long Romy W1**	11.11^{a}	12.57^{a}	2.60^{j}	2.56^{j}
2	**Abu Hezam W2**	9.68^{b}	10.34^{bc}	3.01^{hi}	2.93^{hi}
3	**Romy 1010 W3**	9.31^{bc}	9.25^{d}	3.48^{f}	3.94^{bc}
4	**Farz on W4**	8.32^{f}	8.54^{ef}	3.82^{bc}	3.99^{b}
5	**Bohoos W5**	6.95^{i}	6.46^{h}	3.81^{bcd}	3.76^{cde}
6	**41 W6**	10.85^{a}	10.49^{b}	3.63^{def}	3.74^{de}
7	**Qeft1**	9.17^{cd}	9.13^{d}	3.60^{ef}	3.52^{ef}
8	**Dandara**	7.59^{gh}	7.28^{g}	3.69^{b-e}	3.60^{ef}
9	**Al-Ashraf**	8.83^{de}	8.70^{e}	3.72^{b-e}	3.76^{cde}
10	**Qeft2**	8.37^{f}	8.17^{f}	3.82^{b}	3.93^{bcd}
11	**Dar El-Salam 1**	7.81^{g}	7.58^{g}	4.13^{a}	4.35^{a}
12	**Dar El-Salam 2**	7.24^{hi}	7.47^{g}	3.16^{gh}	3.01^{h}
13	**Dar El-Salam 3**	9.53^{bc}	10.44^{b}	3.04^{hi}	3.05^{h}
14	**Dar El-Salam 4**	8.42^{f}	8.33^{ef}	2.95^{i}	2.75^{i}
15	**Dar El-Salam 5**	8.52^{ef}	8.49^{ef}	3.64^{c-f}	3.64^{ef}
16	**Dar El-Salam 6**	9.42^{bc}	10.00^{c}	3.29^{g}	3.34^{g}
17	**Akhmim-Neda**	7.46^{gh}	7.39^{g}	4.19^{a}	4.40^{a}
Mean		**8.74^{A}**	**8.86^{A}**	**3.50^{A}**	**3.54^{A}**

*Means followed by the same letter or letters within columns are not significantly different of the 5% significance level.

2. Fruit Diameter (cm):

The results presented in Table 4 for the pepper genotypes indicate significant differences in fruit diameter across the two successive seasons. Genotype (Akhmim-Neda and Dar El-Salam 1) exhibited the highest fruit diameter, with values of (4.19, 4.40 cm and 4.13, 4.35 cm) with no significant differences between them in the first and second seasons, respectively. On the other hand, the lowest fruit diameter was recorded by genotype (Long Romy W1), with values of 2.60 cm and 2.56 cm in the two seasons, respectively. The observed variations in fruit diameter could be attributed to differences in the inherited traits of the genotypes and/or environmental conditions in the growing areas, as suggested by Delelegn (2011). These results align with those reported by Delelegn (2011) and Montejo *et al.* (2024).

Table 5. Means of No. fruits plant^{-1}, average fruit weight (g), early fruit yield feddan^{-1} (ton) and total fruit yield feddan^{-1} (ton) of sweet pepper genotypes during the 2022 and 2023 seasons.

No. Codes	Genotypes	Characteristics							
		No. of fruits plant^{-1}		Average fruit weight (g)		Early fruit yield feddan^{-1} (ton)		Total fruit yield feddan^{-1} (ton)	
		1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
1	Long Romy W1	14.91^{a}	15.57^{a}	37.14^{j}	33.00^{k}	1.84^{f}	1.87^{g}	8.86^{e}	8.22^{g}
2	Abu Hezam W2	12.29^{c}	12.11^{d}	38.80^{j}	37.23^{j}	1.49^{i}	1.57^{j}	7.63^{g}	7.21^{j}
3	Romy 1010 W3	8.70^{g}	8.18^{i}	73.71^{c}	78.93^{b}	2.55^{b}	2.50^{abc}	10.26^{c}	10.32^{abc}
4	Farz on W4	9.59^{ef}	8.66^{hi}	75.00^{b}	75.55^{c}	2.67^{a}	2.54^{a}	11.51^{a}	10.47^{a}
5	Bohoos W5	12.74^{c}	12.33^{cd}	51.46^{f}	51.56^{g}	2.23^{d}	2.45^{c}	10.49^{c}	10.17^{c}
6	41 W6	7.49^{h}	7.18^{j}	77.27^{a}	83.44^{a}	1.89^{f}	2.28^{e}	9.26^{d}	9.58^{e}
7	Qeft1	11.00^{d}	11.66^{d}	34.77^{k}	36.98^{i}	1.97^{e}	1.47^{k}	6.12^{i}	6.90^{k}
8	Dandara	8.51^{g}	9.14^{fgh}	51.12^{fg}	53.76^{fg}	1.28^{j}	1.76^{h}	6.96^{h}	7.86^{h}
9	Al-Ashraf	11.19^{d}	12.09^{d}	51.33^{fg}	53.65^{fg}	2.33^{c}	2.52^{ab}	9.19^{d}	10.38^{ab}
10	Qeft2	14.07^{b}	13.04^{c}	48.95^{g}	48.95^{h}	1.99^{e}	2.47^{bc}	11.02^{b}	10.21^{bc}
11	Dar El-Salam 1	8.52^{g}	8.39^{hi}	54.28^{e}	56.76^{f}	1.77^{g}	1.69^{i}	7.40^{g}	7.62^{i}
12	Dar El-Salam 2	14.38^{ab}	14.53^{b}	26.16^{l}	26.93^{l}	1.20^{k}	1.28^{l}	6.02^{i}	6.26^{l}
13	Dar El-Salam 3	11.02^{d}	10.16^{e}	53.31^{ef}	61.20^{e}	1.95^{e}	2.39^{d}	9.40^{d}	9.94^{d}
14	Dar El-Salam 4	10.10^{e}	9.61^{efg}	43.63^{i}	47.95^{h}	1.60^{h}	1.61^{j}	7.05^{h}	7.37^{j}
15	Dar El-Salam 5	12.41^{c}	12.03^{d}	46.48^{h}	50.89^{g}	2.01^{e}	2.34^{d}	9.23^{d}	9.79^{d}
16	Dar El-Salam 6	9.68^{ef}	9.89^{ef}	38.48^{j}	43.00^{i}	1.21^{k}	1.44^{k}	5.96^{i}	6.81^{k}
17	Akhmim-Neda	9.12^{fg}	8.89^{ghi}	56.74^{d}	65.59^{d}	1.77^{g}	2.20^{f}	8.28^{f}	9.32^{f}
Mean		**10.92^{A}**	**10.79^{A}**	**50.51^{A}**	**53.26^{A}**	**1.87^{B}**	**2.02^{A}**	**8.51^{A}**	**8.73^{A}**

*Means followed by the same letter or letters within columns are not significantly different of the 5% significance level.

3. No. of fruits plant^{-1}:

Data in Table 5 shows significant differences among the sweet pepper genotypes in terms of the No. of fruits plant^{-1}. The highest No. of fruits plant^{-1}, recorded in the two successive seasons, was achieved by genotype (Long Romy W1), with values of 14.91 and 15.57, respectively. In contrast, the lowest No. of fruits plant^{-1} was recorded by genotype (41 W6), with values of 7.49 and 7.18 in the first and second seasons, respectively. These findings are consistent with those reported by **Sattar *et*** *al.* (2018), who found that the number of fruits per plant ranged from 5.07 to 22.97 among eight sweet pepper genotypes. Additionally, the results align with those reported by Montejo *et al.* (2024), Rawal *et al.* (2024) and Yayman *et al.* (2024).

4. Average fruit weight (g):

The data presented in Table 5 indicate significant differences in average fruit weight among the evaluated sweet pepper genotypes. The highest average fruit weights were observed in genotype (41 W6), recording values of 77.27 and 83.44 g in the first and second seasons, respectively. Conversely, the lowest average fruit weights were recorded by genotype (Dar El-Salam 2), with values of 26.16 and 26.93 g across the two consecutive seasons. These findings are consistent with those reported by Anonymous (2010), who observed variability in average fruit weight (ranging from 65–77 g) among eight sweet pepper lines. The results also align with studies conducted by Chouikhi *et al.* (2023), Montejo *et al.* (2024) and Yayman *et al.* (2024).

5. Early fruit yield feddan^{-1} (ton):

The results presented in Table 5 reveal that genotype (Farz on W4) exhibited the highest early fruit yield feddan^{-1} (ton), recording 2.67 and 2.54 tons in the first and second seasons, respectively. In contrast, genotype (Dar El-Salam 2) produced the lowest early fruit yield feddan^{-1} (ton), with values of 1.20 and 1.28 tons in the two successive seasons. It is worth noting that, in the second season, no significant differences were observed among genotypes (Romy 1010 W3, Farz on W4 and Al-Ashraf), as they all achieved similarly high early yield values.

6. Total fruit yield feddan^{-1} (ton):

According to the data presented in Table 5, there were highly significant differences in total fruit yield per feddan among the evaluated sweet pepper genotypes. Genotype (Farz on W4) exhibited the highest yield, producing 11.51 and 10.47 tons in the first and second seasons, respectively. In the second season, this performance was statistically comparable to that of genotypes (Romy 1010 W3) and (Al-Ashraf). In contrast, the lowest yields were recorded by genotype (Dar El-Salam 6) in the first season (5.96 tons feddan^{-1}) and genotype (Dar El-Salam 2) in the second season (6.26 tons=feddan^{-1}). These results align with findings reported by Law-Ogbomo and Law-Ogbomo (2010), as well as by Bagheri *et al.* (2017), Islam *et al.* (2020), Chouikhi *et al.* (2023), Montejo *et al.* (2024) and Rawal *et al.* (2024), all of whom emphasized significant genotypic variability in yield performance. Such variations are likely attributed to inherent genetic differences among the tested genotypes and their interactions with environmental conditions. Moreover, the positive and significant increments in total fruit yield feddan^{-1} (ton) produced by genotype (Farz on W4) could be explained in the light of increments induced in fruit weight plant^{-1} (g) and early fruit yield feddan^{-1} (ton) previously discussed and achieved by the same genotype.

(D) Quality Characteristics:

1. Total Soluble Solids (TSS):

As shown in the Table 6, genotype (Dar El-Salam 2) demonstrated the highest total soluble solids (TSS) values in sweet pepper fruits, with measurements of 4.93 and 4.81% in the first and second seasons, respectively. In contrast, the lowest TSS values were recorded by genotype (Romy 1010 W3), which had values of 3.46 and 3.41% in the two consecutive seasons. There was no significant difference in TSS content between genotype (Dar El-Salam 2) and genotype (Dar El-Salam 3) in the first season, as both exhibited the highest TSS values. Similarly, no significant difference was observed between genotype (Romy 1010 W3) and genotype (41 W6), both of which showed the lowest TSS values in the two studied seasons. The variation in TSS content among sweet pepper genotypes is influenced by genetic factors, as noted by El-Sayed (2004) and Geleta and Labuschagne (2006). These findings align with previous studies by Bagheri *et al.* (2017), Montejo *et al.* (2024) and Yayman *et al.* (2024).

2. Relative Chlorophyll Content:

Table 6 presents the mean values of relative chlorophyll content for 17 pepper genotypes, revealing significant differences among genotypes in both studied seasons. The results indicate that genotype (Al-Ashraf) exhibited the highest chlorophyll content, with values of 68.54 and 69.69 in the first and second seasons, respectively. In contrast, genotype (Dandara) recorded the lowest chlorophyll content, with values of 48.07 in the first season and 51.49 in the second season, respectively. These findings are consistent with those reported by Chouikhi *et al.* (2023), who suggested that the variation in chlorophyll content could be attributed to differences among genotypes, environmental conditions, and/or their interactions.

Table 6. Means of Total soluble solids (TSS%) and Relative Chlorophyll Content (SPAD) of sweet pepper genotypes during the 2022 and 2023 seasons.

No. Codes	Genotypes	Characteristics			
		TSS (%)		Relative Chlorophyll Content (SPAD)	
		1st season	2nd season	1st season	2nd season
1	Long Romy W1	4.05e	3.98g	61.99cd	62.67cd
2	Abu Hezam W2	4.30d	4.12f	59.48d	60.05de
3	Romy 1010 W3	3.46j	3.41k	61.73cd	61.28cde
4	Farz on W4	3.88fgh	3.81h	62.71bc	63.63bc
5	Bohoos W5	4.43cd	4.29e	59.64d	59.03e
6	41 W6	3.51j	3.44k	64.01bc	63.63bc
7	Qeft1	3.68i	3.70i	53.19fg	51.75g
8	Dandara	3.90fg	3.90g	48.07h	51.49g
9	Al-Ashraf	3.78ghi	3.56j	68.54a	69.69a
10	Qeft2	4.00ef	3.92g	64.44b	65.85b
11	Dar El-Salam 1	4.46c	4.43d	63.82bc	62.83bcd
12	Dar El-Salam 2	4.93a	4.81a	56.64e	62.07cde
13	Dar El-Salam 3	4.86a	4.70b	50.78g	52.08g
14	Dar El-Salam 4	4.49bc	4.43d	55.45ef	54.41fg
15	Dar El-Salam 5	4.60b	4.58c	59.71d	60.33de
16	Dar El-Salam 6	3.75hi	3.60j	63.49bc	62.50cd
17	Akhmim-Neda	3.77ghi	3.72i	51.72g	56.01f
Mean		**4.11A**	**4.02A**	**59.12A**	**59.96A**

*Means followed by the same letter or letters within columns are not significantly different of the 5% significance level.

CONCLUSION

The observed genetic diversity among the studied pepper genotypes is sufficient to support breeding and improvement programs aimed at enhancing fruit yield, fruit quality, and other agronomic traits. This diversity can be effectively exploited for the selection and development of high-yielding genotypes in future breeding efforts.

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