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SEED AND ROOT TRAITS OF SOME SUGAR BEET GENOTYPES UNDER EGYPTIAN CONDITIONS

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Seed and root characteristics are crucial factors for selecting suitable sugar beet (*Beta vulgaris* L.) genotypes for future hybrid production. The Plant Breeding and Conservation Program at the Desert Research Center is responsible for evaluating the performance of chosen sugar beet genotypes under Egyptian conditions. The first seed production was for six sugar beet genotypes during 2022/2023 and 2023/2024 seasons at Bedouin local community gardens in Saint Catherine protected area, South Sinai. The second evaluation root traits were carried out for six genotypes and check variety of sugar beet during 2023/2024 season at El-Sharkia governorate. The experimental was carried out using randomized complete block design with three replicates. The results indicated that sugar beet genotypes mean squares were highly significant for all studied traits in both the two seasons of seed production and season of evaluation root. SKH44-11-6/1/3 (multigerm) genotype recorded highest value of seeds weight per plant (59.8 and 73.3 g) in the two seasons, respectively. SKG58-6/3/3 (monogerm), check variety (H.Poly 1) and SKT48-5/3/3 (multigerm) genotypes were the best in root traits. H.Poly 1 genotype gave the highest value of sucrose percentage (17.3%). SKG58-6/3/3 (monogerm) genotype recorded the highest purity (84.8%). This is a significant step towards developing sugar beet seeds under Egyptian conditions.

Keywords: *Beta vulgaris* L., seed production, sucrose %, purity %

INTRODUCTION

Sugar beet (*Beta vulgaris* L.) is a biennial plant belonging to the Chenopodiaceae family. Sugar beet now accounts for around 45% of global sugar production and is often regarded as Europe's primary source of sugar. Sugar is one of Egypt's most significant strategic commodities, and sugar beets are the country's primary source of sugar production before sugar cane (Sugar Crops Board in Egypt, 2023).

Before Saint Catherine, Farag (1997) studied the sugar beet flowering and seed production in Egypt and reported seed weight/plant in five different genotypes studied varied significantly and ranged from 37.2 to 74.7 g, 100 seed weight ranged from 1.36 to 2.70 g and root weight ranged from 800 to 2000 g. El-Talkhawy (1992) studied the flowering of sugar beet varieties and found that significant differences among eight sugar beet genotypes for seed weight /plant and in 100 seed weight /plant. Younan et al. (1997) exposing roots to temperature of 4°C with relative humidity of 90% for 5 months and found that 100 seed weight (g) means ranged from 1.57 to 4.06 g and seed weight per plant means ranged from 13.30 to 23.33 g of seeds/plant. El-Sheikh (2003) the nine Egyptian germplasm used in this study were exposed to chilling vernalization at 4-5°C and 90% relative humidity from the beginning of June to last week of December 1999, and found that 100 seed weight (g) means ranged from 2.00 to 3.57 g and seed weight per plant means ranged from 22.7 to 43.3 g of seeds/plant.

Summers in St. Catherine Town are relatively hot, with a mean maximum temperature of 36 degrees Celsius (August), while winters are relatively cool, with a mean low of -7.8 degrees Celsius (February). Precipitation is less than 50 mm per year, with rare winter snowfall (Grainger, 2003).

After Saint Catherine, Bayomi (2013) carried out a study on natural flowering and seed production at Bedouin local community gardens in Saint Catherine Protected area, South Sinai during 2009-2011 seasons. Found that tests of significance indicated that the mean squares of seven genotypes were significant for seed characters and root characters in both seasons. 100 seed weight means ranged from 2.46 g for EG6 multigerm to 0.69 g for FC723 O-type monogerm. Line FC723cms recorded the highest sucrose % (17.07 and 18.60%) in two locations. Saint Catherine area can be considered as a certified area for the production of sugar beet seeds in Egypt, due to its appropriate environmental conditions for a normal flowering of sugar beet. Bayomi (2018) studied response some sugar beet genotypes for flowering and seed production to different locations conditions in Saint Catherine. He found that 100 seed weight means ranged from 0.98 to 2.46 g and seed weight per plant means ranged from 18.84 to 30.16 g of seeds/plant. Bayomi et al. (2022) studied the effect of environment on ten genotypes of sugar beet under various regions in Egypt. Reported that root length was ranged from 12.42 to 16.29 cm, root diameter ranged from 7.37 to 10.0 cm and root weight ranged from 528.5 to 1078.7 g

The objective of this study was to evaluate six sugar beet genotypes (monogerm and multigerm) for seed production and root properties before selecting the best genotypes for hybrid development.

MATERIALS AND METHODS

The experiment was set up from 2022 to 2024 and divided into two sections. The first seed production for six sugar beet genotypes was done out at a garden community in the Protected Saint Catherine of South Sinai province. The second study of root properties to seven sugar beet genotypes was conducted in El-Sharkia province.

Sugar beet genotypes obtained from plant breeding and conservation program of Desert Research Center (DRC) were three monogerm (SKC59-5/3/3, SKC59-5/2/3 and SKG58-6/3/3) and three multigerm (SKG75-4/2/3, SKH44-11-6/1/3 and SKT48-5/3/3). H. Poly 1 multigerm variety (Denmark) was used as a check variety.

First part seed production: At Bedouin local community gardens in Saint Catherine protected area, South Sinai; the natural flowering was for six genotypes during 2022/2023 and 2023/2024 seasons. The six genotypes were planted on the 15^{th} September of both the two seasons in six locations isolated about 5km from each other to protect any contamination. The experimental design was a randomized complete blocks design, with three replicates. The Plot area was 4.5 m^2 (3 m long x 1.5m wide) and 30 cm between plants. The observation of four important traits was recorded from five randomly selected plants from each plot during harvest (15^{th} June of both the two seasons). Measurements were recorded on plant height (cm), number of branches, 100 seed weight and seed weight / plant (g).

Second part root traits: sugar beet genotypes were planted in a randomized complete blocks design with three replications. Each replicate contained 7 experimental plots. The plot area was 7.5 m^2 including 3rows (5m long and 50 cm wide) and 20 cm between plants. Seed drilling was done in the 15^{th} of September 2023 of El-Sharkia location. Normal agricultural treatments were applied. Harvesting was occurred after 210 days (15^{th} of April 2024). Root characters [root length (cm), root diameter (cm) and root weight (g)] and quality characters (sucrose %, potassium, sodium, alpha amino nitrogen and purity %) were recorded from five randomly selected plants from each genotype in plot. Sucrose percentage was determined by using Saccharimeter on a lead acetate basis according to the procedure of Delta Sugar Company (Le-Docte, 1927). Potassium and sodium were determined by using Flame photometer according to Brown and Lilliand (1964). Alpha-amino nitrogen according to Pergl (1945). Purity (%) calculated according to the following equation: Purity (%) = Sucrose (%)/T.S.S. (%) x 100.

Statistical Analysis

Statistical procedures were done according to the analysis of variance for a randomized complete block design as outlined by Cochran and Cox (1957). The treatment means were compared using least significant difference test at 5% and 1% levels of significance.

RESULTS AND DISCUSSION

Seed Production

Table (1) shows the results of the analysis of variance for all genotypes. Significant tests revealed that the mean squares of genotypes were significant for all tested parameters (plant height, number of branches, 100 seed weight and seed weight / plant) under Saint Catherine conditions for the two seasons. These results are in the same line with those obtained by El-Talkhawy (1992), Farag (1997), Younan et al. (1997), El-Sheikh (2003) and Bayomi (2013 and 2018).

Table (1). Analysis of variance for plant height, no. of branches, 100 seed weight and seed weight / plant of six sugar beet genotypes under Saint Catherine conditions during 2022/2023 and 2023/2024 seasons.

Source	d.f	Plant height (cm)		No. of branches		100 seed weight (g)		Seed weight / plant (g)	
		2023	2024	2023	2024	2023	2024	2023	2024
Replications	2	0.81	252.54	1.18	8.06	0.016	0.224	4.40	180.37
Genotypes	5	2318.25**	2497.44**	12.48**	14.87**	0.62**	0.809**	126.89**	387.58**
Error	10	9.19	13.97	0.92	0.96	0.013	0.011	0.93	14.02

**: significant at 0.01 level of probability.

The results presented in Table (2) indicate clearly that, significant differences were recorded among the different sugar beet genotypes in plant height. Average plant height was 141.1 and 145.0 cm for the two seasons, respectively. SKG75-4/2/3 genotype gave the highest value of plant height (164.4 and 167.5cm) for the two seasons, respectively. While, SKG58-6/3/3 genotype recorded the lowest value of plant height for the two seasons. The average number of branches was 16.5 and 17.4 for the two seasons, respectively. The highest value of number of branches was recorded for SKC59-5/3/3 genotype (19.7 and 20.9) for the two seasons, respectively. While, SKG75-4/2/3 genotype gave the lowest values of number of branches in the two seasons, respectively (14.3 and 15.0). The average 100 seed weight was 1.9 and 2.0 g in the two seasons, respectively. The highest value of 100 seed weight was recorded for SKH44-11-6/1/3 and SKT48-5/3/3 genotypes (2.4 and 2.6 g) in the two seasons, respectively. Genotype SKG58-6/3/3 gave the lowest values of 100 seed weight (1.4 and 1.5 g respectively) in the two seasons. In general, all monogrem genotypes exhibited the lowest values for 100 seed weight. The average seed weight per plant throughout the two seasons was 51.1 and 60 g, respectively. The highest value of seeds weight per plant was recorded for SKH44-11-6/1/3 genotype (59.8 and 73.3 g) in the two seasons, respectively. While, SKC59-5/2/3 genotype gave the lowest values of seed weight per plant (44.3 and 47.8 g) in the two seasons, respectively. Generally, SKC59-5/3/3 genotype was the best monogrem genotypes in all traits in the two seasons, respectively. While, SKH44-11-6/1/3 genotype was the best multigrem genotypes in all traits except plant height in the two seasons, respectively. These results are in conformity with those of El-Talkhawy (1992), Farag (1997), Younan et al. (1997), El-Bagoury et al. (2000), El-Sheikh (2003), Abo-Elwafa et al. (2006), Kasap and Altuntas (2006), Bayomi (2013 and 2018).

Table (2). Mean performance for plant height, no. of branches, 100 seed weight and seeds weight/plant of six sugar beet genotypes under Saint Catherine conditions during 2022/2023 and 2023/2024 seasons.

Genotypes	Plant height (cm)		No. of branches		100 seed weight (g)		Seed weight / plant (g)	
	2023	2024	2023	2024	2023	2024	2023	2024
Monogerm								
1-SKC59-5/3/3	156.1	163.3	19.7	20.9	1.6	1.6	47.5	51.4
2-SKC59-5/2/3	151.7	154.8	17.9	19.0	1.5	1.6	44.3	47.8
3-SKG58-6/3/3	98.2	100.3	16.3	16.9	1.4	1.5	46.3	50.8
Multigerm								
4-SKG75-4/2/3	164.4	167.5	14.3	15.5	2.2	2.4	50.1	65.0
5-SKH44-11-6/1/3	114.4	117.4	16.5	16.9	2.4	2.6	59.8	73.3
6-SKT48-5/3/3	161.8	166.7	14.6	15.0	2.4	2.6	58.3	71.7
Mean	141.1	145.0	16.5	17.4	1.9	2.0	51.1	60.0
LSD 0.05	5.39	6.65	1.71	1.75	0.203	0.188	1.713	6.66
LSD 0.01	7.56	9.32	2.39	2.45	0.284	0.264	2.402	9.34

Root Traits

The results of analysis of variance of all genotypes are presented in Table (3). Testes of significance indicated that the mean squares of genotypes were significant for all studied traits (Root length, Root diameter, Root weight, Sucrose %, Potassium, Sodium, Alpha Amino nitrogen and Purity %) under El-Sharkia season 2023-2024. Abd Alla (1992) found that the differences among sugar beet varieties were insignificant for root characters i.e., root weight/plant, root length and diameter. Nassar (1992) found that varieties exhibited significant differences in yield and quality traits. Abo El-Ghait (1993) concluded that location had a significant effect on root length, root diameter, TSS, and sucrose. Al-Jbawi (2000) found that location had a significant effect on root characteristics; weight, length and diameter, as well as on quality traits; TSS, sucrose and purity %, and yield traits: root, sugar and top yield (ton/fed).

Table (3). Analysis of variance for root and quality characters of seven sugar beet genotypes under El-Sharkia during 2023/2024 season.

Source	**d.f**	**Root length (cm)**	**Root diameter (cm)**	**Root weight (g)**	**Sucrose %**
Replications	2	16.55	0.003	3259.35	0.082
Genotypes	6	24.79**	0.159**	50118.52**	2.939**
Error	12	4.68	0.017	3285.61	0.037

Source	**d.f**	**Potassium**	**Sodium**	**Alpha Amino nitrogen**	**Purity %**
Replications	2	0.007	0.0003	0.004	0.004
Genotypes	6	0.666**	0.861**	0.71**	25.51**
Error	12	0.006	0.002	0.011	0.007

**: significant at 0.01 level of probability.

The results presented in Table (4) indicate clearly that, significant differences were recorded among the different sugar beet genotypes in root characters and quality characters. The average root length was 35.6 cm where, H.Poly 1 genotype gave the highest value of root length (40.9 cm). On the other hand, SKC59-5/2/3 genotype recorded the lowest value of root length (32.1 cm). The average root diameter was 12.96 cm where, both SKG58-6/3/3 and SKH44-11-6/1/3 genotypes gave the highest value of root diameter (13.3 cm). Genotype SKC59-5/2/3 recorded the lowest value of root diameter (12.7 cm). The average root weight was 1936.9 g where, H.Poly 1 genotype gave the highest value of root weight (2127 g). While, SKC59-5/2/3 genotype recorded the lowest value of root length weight (1776.8 g). The average sucrose percentage was 16.03%. H. Poly 1 genotype gave the highest value of sucrose percentage (17.3%). While, SKC59-5/2/3 genotype recorded the lowest value of sucrose percentage weight (14.7%). The average potassium was (5.9). SKG58-6/3/3 genotypes gave the lowest value of potassium (4.9). On the other SKC59-5/3/3 genotype recorded the highest value of potassium (6.4). The average sodium was (1.7). SKT48-5/3/3 genotypes gave the lowest value of sodium (1.1). Genotypes SKC59-5/3/3, SKC59-5/2/3 and H.Poly 1 recorded the highest value of sodium weight (2.2). The average alpha amino nitrogen was (2.8). SKG58-6/3/3 genotypes gave the lowest value of alpha amino nitrogen (2.3). While, SKH44-11-6/1/3 genotype recorded the highest value of alpha amino nitrogen weight (3.7). The average purity percentage was 80.2%. SKG58-6/3/3 genotype gave the highest value of purity percentage (84.8%). While, SKC59-5/3/3 genotype recorded the lowest value of purity percentage weight (76.2%). Generally, SKG58-6/3/3 genotype was the best monogrem genotypes in all traits. These results are in conformity with those of Younan et al. (1997), El-Sheikh (2003), Bayomi (2013, 2018) and Bayomi et al. (2022).

Table (4). Mean performance for root and quality characters of seven sugar beet genotypes under El-Sharkia during 2023/2024 season.

Genotypes	Root characters			Quality characters				
	Root length (cm)	Root diameter (cm)	Root weight (g)	Sucrose %	Potassium	Sodium	Alpha Amino nitrogen	Purity %
Monogerm								
1-SKC59-5/3/3	33.0	13.0	1822.4	15.0	6.4	2.2	3.1	76.2
2-SKC59-5/2/3	32.1	12.7	1776.8	14.7	6.0	2.2	3.1	76.9
3-SKG58-6/3/3	37.2	13.3	1901.5	17.1	4.9	1.2	2.3	84.8
Multigerm								
4-SKG75-4/2/3	35.6	12.8	1865.5	16.4	6.0	1.6	2.5	81.0
5-SKH44-11-6/1/3	35.0	13.3	2051.7	15.6	5.9	1.2	3.7	80.4
6-SKT48-5/3/3	35.2	12.8	2013.3	16.1	6.1	1.1	2.4	81.2
7-H.Poly 1	40.9	12.8	2127.0	17.3	6.0	2.2	2.8	80.6
Mean	35.6	12.96	1936.9	16.03	5.9	1.7	2.8	80.2
LSD 0.05	3.85	0.23	101.98	0.34	0.13	0.08	0.19	0.15
LSD 0.01	5.39	0.33	142.98	0.48	0.19	0.11	0.26	0.21

CONCLUSION

This work represents a major step forward for the Desert Research Center's Plant Breeding and Conservation Program in terms of hybrid generation. In general, the SKC59-5/3/3 and SKH44-11-6/1/3 genotypes performed the best in seed characteristics. The SKT48-5/3/3 genotype performed best in terms of root characteristics while; SKG58-6/3/3 genotype was the best in quality characters. Through this research, it is expected that the productivity of seeds will be in the range of 350:550 kg/fed, and by using good agricultural service operations; the yield/fed can be increased. All of this encourages the trend towards commercial production of sugar beet seeds to reduce imports.

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صفات محصول البذوروالجذر لبعض التراكيب الوراثية من بنجرالسكر تحت الظروف المصرية

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صفات محصول البذور والجذر للتراكيب الوراثية المنتخبة من بنجرالسكر عوامل مهمة لإنتاج الهجن فى المستقبل. يتولى برنامج تربية وصون النباتات بمركز بحوث الصحراء تقييم أداء التراكيب الوراثية المنتخبة من بنجر السكر تحت الظروف المصرية. تم زراعة ستة تراكيب وراثية من البنجر بمزارع المجتمع المحلى بسانت كاترين جنوب سيناء خلال موسمى النمو ٢٠٢٣/٢٠٢٢ و٢٠٢٤/٢٠٢٣ لإنتاج البذور. ثم تقييم البذور الناتجة للتراكيب الستة بالإضافة للصنف المنزرع تحت ظروف محافظة الشرقية للتعرف على صفات الجذر خلال موسم النمو ٢٠٢٤/٢٠٢٣. التصميم الإحصائي المستخدم هو القطاعات الكاملة العشوائية مع إستخدام ثلاث مكررات. وكانت النتائج تشير إلى وجود إختلافات معنوية بين التراكيب الوراثية لجميع الصفات فى كلا الموسمين لإنتاج البذور وموسم تقييم الجذور، واستنادًا إلى النتائج المتحصل عليها، التركيب SKH44-11-6/1/3 عديد الأجنة سجل أفضل النتائج لمحصول البذور للنبات (٥٩,٨ و ٧٣,٣ جم) لكلا الموسمين على الترتيب. التركيب SKG58-6/3/3 وحيد الأجنة والصنف المقارن والتركيب SKT48-5/3/3 عديدا الأجنة كانوا الأفضل لصفات الجذور. سجل التركيب SKG58-6/3/3 وحيد الأجنة أعلى نسبة نقاوة (84.8٪). يعد هذا البحث خطوة مهمة نحو تطوير تقاوى بنجر السكر تحت الظروف المصرية.