

Productivity and Quality of Sugar Beet (*Beta Vulgaris* L.) under Different Environmental Conditions in Syria

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Abstract

Field experiment was carried out in three locations, (Agricultural Research Centers in Homs, Hama, and Al-Ghab), Syria, during two growing seasons (2019/2020 and 2020/2021), in order to study the performance of six monogerm sugar beet varieties (Vico, Dita, Semper, SR305, Osma and Rosella) under three locations for yield and yield components along with technological traits. The experiment was laid out according to a randomized complete block design with three replicates at each location. The results of statistical analysis showed significant differences ($P \leq 0.05$) among all studied treatments and interactions among them for all investigated traits. The highest value of total soluble solids (TSS) percentage was attained by variety SR305 at Hama location in second season (23.50%). Meantime, Osma and Semper varieties achieved the highest value of sucrose percentage under Hama location conditions in second season (18.70, 18.30%) respectively. For purity percentage the highest value of purity percentage was produced by growing Semper variety at Hama location in second season (93.06%). Regarding root yield and extractable sugar yield the highest value of these traits was given by Semper variety at Homs location in second season (156.12, 23.97 ton/ ha) respectively. The obtained results also showed that growing seasons had a significant effect on all studied traits except for sucrose percentage, where second season surpassed the first one in purity percentage, root yield and extractable sugar yield recording (84.39 %, 106.32 and 15.43 ton/ ha) respectively. With respect to locations, Hama location recorded the highest value of root yield and extractable sugar yield (118.26, 16.92 ton/ ha) respectively compared to Homs and Al-Ghab locations, while no significant differences were found among locations with regard to quality traits. Also results indicated that varieties significantly differed in the studied traits except for TSS (%). Variety Semper performed best in relation to all studied traits and in all locations.

Keywords: Sugar beet, Locations, Varieties, Sucrose, Juice quality, Productivity.

Introduction

Sugar beet (*Beta vulgaris* L.) is an industrial crop grown commercially as hybrid, with sucrose refined from the root as the plant constituent of interest. In addition, the whole beet with its co-products of greens, molasses, and pulp residue could be utilized as an animal feed or a feedstock for alcohol production (Bonnina *et al.*, 2012). Sugar beet is an important sugar crop supplying approximately 35% of the world's sugar, and it is widely cultivated in arid and semi-arid regions (Wu *et al.*, 2013). The sugar content in sugar beet root is usually 13–20% (Hoffmann, 2010). More than 98% of total root sugar is sucrose, but fructose and glucose are present in very small amounts (Turesson *et al.*, 2014). The Russian Federation, France, the United States, Germany, Turkey, Poland, and Ukraine are the greatest sugar beet producer countries of the world (FAO, 2019). The global cultivated area of sugar beet in 2019 was 4.63 million ha with a total root yield of 264.56 million tons (FAO, 2020).

The growth of agricultural crops is influenced by a multitude of factors such as climate, soil, texture, nutrient availability, and their interactions. But the yield potential of sugar beet depends primarily on site and year effects, whereas the influence of agronomic practices is much lower. The effect of the site can be attributed mainly to its rather constant characteristics of soil and climate and their interaction. The effect of the year reflects the weather conditions during the vegetation period, which directly influence plant growth, and also affects the dates of sowing and harvest and thus the length of the growing season (Kenter and Märländer, 2006).

Six field experiments were carried out in 2015 -16 and 2016 -17 seasons at three locations (Giza Experiment Station, Fayoum Governorate, and Ismailia Governorate), Egypt, in order to estimate the performance of six sugar beet varieties under three environmental conditions for sugar yield and its contributing traits as well juice quality traits. The obtained results showed that growing seasons had a significant effect on impurities (K, Na and α -amino N), some technological characteristics (purity, extractable sugar, sucrose and sugar lost to molasses percentages) as well as sugar yields/fed, results also showed that the effect of varieties and locations factors significantly affected sugar percentage, extractable and sugar yield (Khalil *et al.*, 2018). Hanan *et al.*, (2018) found that Ismailia location surpassed the other two locations, producing roots with high content of sucrose (%) and less content of impurities (%) compared with Faiyum and Alexandria. They added that varieties significantly differed in the studied traits except quality index (%) and impurities (%). Hozayn *et al.*, (2013) recorded significant differences among the tested cultivars in all studied characters of sugar beet grown under newly reclaimed soil. Further, Hozayn *et al.*, (2014) found that all sugar beet varieties showed diversity behavior with respect to sucrose %, fresh root and sugar yield/fed under three locations. Aly *et al.*, (2015) found that sugar beet varieties (Top, Sultan and Kawemira) significantly differed in root length, diameter and root fresh weight (g/plant), as well as sucrose%, quality index % and yields of root and sugar/fed. Enan *et al.*, (2016) indicated that the tested three beet varieties differed significantly in the studied traits, they added that Polat variety showed the superiority over the other two tested varieties and recorded the highest values of root diameter, fresh and top weights/plant in both seasons.

The aim of this investigation is to evaluate the performance of six sugar beet varieties under three locations (Agricultural Research Centers in Homs, Hama and Al-Ghab) for yield and yield components along with technological traits.

Materials and Methods

Experimental site: The locations included Homs Agricultural Research Center (latitude of 34.77° N, and longitude of 36.71° E with an altitude of 485 meters above sea level), Hama Agricultural

Research Center (latitude of 35.08° N, and longitude of 36.45° E with an altitude of 316 meters above sea level, and AL-Ghab Agricultural Research Center (site latitude of 36.19° N, and longitude of 35.23° E with an altitude of 174 meters above sea level). Table (1) shows the meteorological data during the growing seasons 2019/2020 and 2020/2021 in studied locations. The results of physical and chemical analysis of the field soil in locations are shown in Table (2).

Table (1): Temperatures and Rainfall Distribution in Three Locations

2019/ 2020									
Location	Homs			Hama			AL-Ghab		
Month	Max. Temp. °C	Min. Temp. °C	Rainfall mm	Max. Temp. °C	Min. Temp. °C	Rainfall mm	Max. Temp. °C	Min. Temp. °C	Rainfall mm
October	28.30	16.09	0	29.9	16.2	27.9	30	15.00	37
November	21.82	8.44	43.8	23	8.3	24.7	21.6	7.2	42
December	14.41	6.32	96.8	15.2	6.5	94.1	13.00	4.7	285
January	11.7	4.45	115	12.4	4.7	95.2	12.4	3.8	195
February	12.34	4.66	69.7	13.4	4.6	28.3	12.7	4.1	83
March	18.10	8.52	59.2	19.9	9.2	64.3	18.9	7.7	127
April	21.31	11.14	47.3	11.8	23.7	16.8	21.1	9.5	65
May	27.29	14.64	11.3	16.1	30.7	0.7	29.2	19.4	14.00
June	30.82	18.52	-	19.2	33.3	-	32.7	17.9	7.00
2020/ 2021									
October	31.4	17.4	-	32.6	16.8	-	35.00	19.6	-
November	19.6	10.2	0.7	19.9	9.9	43.8	18.8	8.2	27.00
December	14.48	5.48	37.9	15.1	5.6	29.2	12.4	4.4	77.5
January	14.24	8.69	180.8	14.9	4.1	138.7	13.7	1.9	196
February	16.08	4.81	24.2	17.6	5.1	7.4	16.00	1.5	35
March	16.78	6.80	32.9	18.8	7.5	17.3	17.1	4.4	105
April	23.62	10.35	53.6	26.3	11.4	9.8	23.6	7.5	19
May	30.10	16.38	-	33.5	17.4	-	32.1	12.8	-
June	30.24	18.36	-	33.9	19.7	-	33.00	18.3	-

Source: Meteorology stations in (Homs, Hama and LA-Ghab) agricultural research centers.

Table (2): Physical and Chemical Analysis of the Experiment Field Soil in Three Locations.

Electrical conductivity	Acidity	Organic matter	Nitrogen	Phosphorous	Potassium	Sand	Silt	Clay
Ec (ds.cm-1)	pH	%	ppm			%		
Homs								
0.12	8.04	1.37	32.89	23.00	191.1	25.4	14.1	60.5
Hama								
0.4	8.00	2.29	12	62.1	423	18	17	65
Al-Ghab								
7.3	0.3	3.22	12.7	31.6	270	42	10	48

Experimental material: Six monogerm (exotic) sugar beet cultivars were evaluated in 3 locations in Syria during two growing seasons 2019/2020 and 2020/2021. Cultivars used in this study were shown in Table (3).

Table (3): Cultivars and Their Country of Origin.

No.	Monogerm	Source
1	Vico	Belgium
2	Dita	Belgium
3	Semper	Belgium
4	SR305	Belgium
5	Osma	Belgium
6	Isella	Belgium

Agricultural practices:

Beet seed was planted on 15th of October ± 3 days among locations. Each plot size was 14 m², consisted of 4 rows, 7 meters long and 50 cm apart, spaced 20 cm between the plants in each row. Phosphorous was applied in the form of superphosphate (P₂O₅ 46%) at 347 kg/ ha before sowing, and potassium was applied also before sowing in the form of potassium sulfate (K₂O 50%) at 250 kg/ha K₂O. Moreover, Nitrogen fertilizer was added in the form of urea (N 46 %) at rate of 434 kg/ha, in two equal doses: the first was added at sowing and the second was added after thinning (at 4-leaf stage). All culture practices such as irrigation, weeds control, insects control etc. were applied in the same manner, as usually done.

Experimental design and statistical analysis

The experiment was laid out according to a randomized complete block design (RCBD) with three replicates at each location. A combined analysis for the studied seasons, locations, and varieties was done. The treatment means were compared using LSD values at 5% level of significance. All statistical analysis was performed using Gen Stat.v12 computer software.

Data collection

1-Total soluble solids (TSS) (%): Which was calculated by Refractometer (AOAC, 2000).

2- Sucrose percentage (%): Which was determined by Sacharimeter according to Le-Docte (1927) method.

3- Purity percentage (%): Was calculated according to the equation of Carruthers and Oldfield (1961) as follows:

$$\text{Purity (\%)} = \frac{\text{sucrose (\%)}}{\text{TSS}} \times 100$$

4- Root yield (ton/ha): At harvest all plants in two inner rows in each plot were uprooted, separated into roots and tops and weighed to estimate root yield.

5- Extractable sugar yield: Which was calculated according to the following equation:

$$\text{Extractable sugar yield (ton/ha)} = \frac{\text{Purity (\%)}}{\text{theoretical sugar yield}} \times 100$$

$$\text{Theoretical sugar yield (ton/ha)} = \frac{\text{Sucrose (\%)}}{\text{root yield}} \times 100$$

Results and Discussion

1-Total Soluble Solids (TSS) (%): Statistical analysis of the results revealed that differences either among locations or varieties were insignificant (Table, 4). Such results agree with Hanan *et al.*,

(2018). How found that varieties significantly differed in the studied traits except for quality index (%) and impurities. Data in Table 4 showed a significant difference in TSS% in two seasons, the TSS% in the first season was significantly higher (22.169%) than that of the second season (21.899%). These results are in line with Khalil *et al.*, (2018), who reported that growing seasons had a significant effect on impurities (K, Na and α -amino N), and some technological characteristics. Obtained data in Table 4 also revealed that the interaction between seasons and locations significantly affected TSS%. The highest value of TSS% was (22.68%) obtained from Al-Ghab location during first season, while the lowest value of TSS% was (21.55%) obtained from Al-Ghab location during second season, the variance between two seasons may be due to the differences in soil types and weather conditions. Moreover, results in Table 4 exhibited that TSS% significantly affected by the interaction between seasons and sugar beet varieties. Vico variety gave the highest value of TSS% in first season (22.73 %), whereas the lowest value of TSS% was recorded by Vico and SR305 varieties in second season (21.46, 21.51%) respectively. Further, results in Table 4 pointed to a significant effect on TSS% due to the interaction between varieties and locations. The highest value of TSS% was given by growing Rosella variety at Hama location (22.47 %). In contrast, Semper variety exhibited the lowest value of TSS% under Hama location conditions (21.41%). Data in Table 4 also cleared that the interaction of seasons, locations, and varieties affected significantly TSS%. SR305 variety showed the highest value of TSS% at Hama location in the second season (23.50%); meanwhile SR305 variety had the lowest value of TSS% at Homs location in the second season (20.35%).

Table (4): Total Soluble Solids (%) of Six Sugar Beet Varieties as Affected by Location Conditions in 2019-2020 and 2020-2021 Seasons.

2019 and 2020-2021 Seasons									
Seasons (S)	First growing season 2019-2020				Second growing season 2020-2021				General mean
Locations (Loc)	Homs	Hama	Al-Ghab	Mean	Homs	Hama	Al-Ghab	Mean	
Varieties (Var)									
Vico	23.353	21.693	23.133	22.727	20.520	22.227	21.627	21.458	22.09a
Dita	21.927	21.753	22.747	22.142	21.787	23.173	21.497	22.152	22.15a
Semper	21.407	21.433	21.783	21.541	22.927	21.377	22.183	22.162	21.85a
SR305	22.853	21.387	22.637	22.292	20.353	23.503	20.660	21.506	21.90a
Osma	22.287	21.857	22.970	22.371	21.687	21.840	21.773	21.767	22.07a
Rosella	21.190	21.840	22.793	21.941	22.367	23.110	21.573	22.350	22.15a
Mean	22.169	21.661	22.677	22.169a	21.607	22.538	21.552	21.899b	22.034
Variables	S	Loc	Var	S×Loc	S×Var	Loc×Var	S×Loc×Var		
LSD(0.05)	0.2265	0.2775	0.3924	0.3924	0.5549	0.6796	0.9612		
CV%	2.7								
Means within the same column or row followed by the same letter(s) are not significantly different at the probability level of 0.05 according to LSD.									

2- Sucrose percentage (%): Statistical analysis of the results indicated that differences either between seasons or locations were insignificant (Table, 5). Results in Table 5 showed that the tested sugar beet varieties differed significantly in sucrose percentage. Osma and Semper varieties exhibited the highest sucrose percentage (17.228, 17.21 %) respectively, whereas SR305 variety recorded the

lowest value of the above trait (16.42%). The variation in sucrose percentage of the studied varieties mainly may be due to variation in their genetic constituents and environmental conditions (Khalil *et al.*, 2018). similar results were reviewed by Refay (2010), Enan *et al.*, (2011), El-Sheikh (2012), Mohamed *et al.*, (2012) and Osman *et al.*, (2014), who reported that there were significant differences among varieties in sucrose percentage. Results in Table 5 also indicated that sucrose percentage significantly affected by interaction between seasons and locations. The highest value of sucrose percentage was achieved in second season at Hama location and in first season at Al-Ghab location (17.66, 17.41%) respectively, while the lowest value of mentioned trait was obtained from Hama location in first season (16.43%). The obtained data in Table 5 cleared that the interaction between seasons and varieties significantly affected sucrose percentage. The highest value of sucrose percentage was given by Semper variety in second season (17.77 %), on the other hand SR305 variety had the lowest value of this trait in the same season (16.09%). Further, Data in Table 5 indicated that sucrose percentage was significantly affected by the interaction between locations and varieties. Osma variety showed the highest value of sucrose percentage at Hama location (17.73 %), while SR305 variety gave the lowest value of sucrose percentage at the same location (16.02%). Results in Table 5 also revealed that the interaction of seasons, locations, and varieties significantly affected sucrose percentage. Osma variety showed the highest value of sucrose percentage at Hama location in second season (18.70%), whereas SR305 variety exhibited the lowest value of sucrose percentage at the same location in first season (15.50%). Such results agree with Khalil *et al.*, (2018); Hanan *et al.*, (2018); Aly *et al.*, (2015); Hozayn *et al.*, (2014).

Table (5): Sucrose (%) of Six Sugar Beet Varieties as Affected by Location Conditions in 2019-2020 and 2020-2021 Seasons.

Seasons (S)	First growing season 2019-2020				Second growing season 2020-2021				General mean
Location (Loc) Varieties (Var)	Homs	Hama	Al-Ghab	Mean	Homs	Hama	Al-Ghab	Mean	
Vico	17.400	16.033	18.133	17.189	16.700	17.000	17.000	16.900	17.044a
Dita	16.800	16.767	17.733	17.100	17.133	17.333	16.633	17.033	17.067a
Semper	16.633	16.700	16.633	16.656	17.967	18.300	17.033	17.767	17.21a
SR305	16.967	15.500	17.767	16.744	16.167	16.533	15.567	16.089	16.417b
Osma	17.300	16.767	17.267	17.111	16.733	18.700	16.600	17.344	17.228a

Rosella	16.333	16.800	16.900	16.678	17.300	18.100	16.500	17.300	16.989a
Mean	16.906	16.428	17.406	16.913a	17.000	17.661	16.556	17.072a	16.993
Variables	S	Loc	Var	S×Loc	S×Var	Loc×Var	S×Loc×Var		
LSD_(0.05)	0.2061	0.2524	0.3569	0.3569	0.5047	0.6182	0.8742		
CV%	3.2								
Means within the same column or row followed by the same letter(s) are not significantly different at the probability level of 0.05 according to LSD.									

3-Purity percentage (%): Statistical analysis of the results showed that differences among locations were insignificant (Table, 6). data in Table 6 pointed to a significant difference in purity percentage in two seasons, the purity percentage in the second season was significantly higher (84.39%) than that of the first season (83.18%). Results in Table 6 also revealed that the studied sugar beet varieties were differing significantly in purity percentage. Semper variety attained the highest value of purity percentage (85.83%). In contrast the lowest value of purity percentage was given by SR305 variety (81.51%). Differences among varieties in juice purity percentage as well as sucrose percentage is due to the weather conditions (Ulrich, 1954 and Forkes, 1972), whereas there is a positive correlation between juice purity and sucrose content (Khalil *et al.*, 2018), these findings are in accordance with Shalaby *et al.*, (2008), El-Sheikh *et al.*, (2009) and Aly and Khalil (2017). Further, data in Table 6 indicated that the interaction between seasons and locations exhibited significant effects on purity percentage. The highest value of purity percentage was obtained from Homs location in second season (85.33%), while the lowest value of this trait was recorded in second season at Al-Ghab location (82.87%). Results in Table 6 also indicated that the interaction between seasons and varieties significantly influenced purity percentage, the highest value of purity percentage was produced by Semper variety in second season (87.30%), while the lowest value of studied trait was observed in SR305 variety in the same season. (81.09%). Obtained results in Table 6 showed that purity percentage of juice was significantly affected by the interaction between locations and varieties. These results could be indicating to the relative importance of the act between the prevailing condition in terms of weather and soil in their influence on juice quality, the highest value of purity percentage was recorded by semper variety at Hama location (88.85%), whereas the lowest value of purity percentage was given by SR305 variety under Hama location conditions (78.84%). Data in Table 6 also cleared that purity percentage significantly affected by the interaction of seasons, locations, and varieties, Semper variety showed the highest value of purity percentage at Hama location in second season (93.06%), on the other hand SR305 variety had the lowest value of above trait at Hama location in second season (76.79%). Such results obtained by Khalil *et al.*, (2018); Hanan *et al.*, (2018).

Table (6): Purity (%) of Six Sugar Beet Varieties as Affected by Location Conditions in 2019-2020 and 2020-2021 Seasons.

Seasons (S)	First growing season 2019-2020				Second growing season 2020-2021				General mean
Locations (Loc)	Homs	Hama	Al-Ghab	Mean	Homs	Hama	Al-Ghab	Mean	

Varieties (Var)									
Vico	82.35	83.89	84.49	83.58	87.78	84.91	84.39	85.69	84.63a b
Dita	84.70	83.53	83.72	83.98	84.72	81.83	83.28	83.28	83.63b c
Semper	84.25	84.63	84.18	84.35	85.45	93.06	83.39	87.30	85.83a
SR305	80.21	80.89	84.69	81.93	85.66	76.79	80.83	81.09	81.51d
Osma	84.62	82.86	81.41	82.96	84.58	90.50	83.74	86.28	84.62a b
Rosella	82.69	83.02	81.16	82.29	83.81	82.77	81.58	82.72	82.50c d
Mean	83.14	83.14	83.27	83.18b	85.33	84.97	82.87	84.39a	83.79
Variables	S	Loc	Var	S×Loc	S×Var	Loc×Var	S×Loc×Var		
LSD _(0.05)	0.988	1.210	1.711	1.711	2.419	2.963	4.190		
CV%	3.1								
Means within the same column or row followed by the same letter(s) are not significantly different at the probability level of 0.05 according to LSD.									

Root yield (ton/ha): Results in Table 7 showed that the root yield significantly affected by growing seasons. The root yield in the second season was significantly higher (106.32 ton/ha) than that of the first season (83.86 ton/ha). Results in Table 7 also cleared that there was a significant influence on the values of root yield due to the growing locations. Hama location gave the highest value of root yield (118.26 ton/ha) followed by Homs location (103.83 ton/ha), while the lowest value of above trait was obtained from Al-Ghab location (63.17 ton/ha). These differences in root yield among the three locations may be due to their soil properties and meteorological factors in these locations (Tables 1 and 2). Similar results are obtained by El-Sheikh (2012), Abd El-Razek and Ghonema (2016). With regard to varieties variance, results in Table 7 appeared significant differences in the values of root yield due to the tested six sugar beet varieties. Semper variety gave the highest value of this trait (100.64 ton/ha), while Dita variety exhibited the lowest value of root yield (90.52 ton/ha). The differences among the tested sugar beet varieties in root yield could be due to their root characters, this attributed to their genetic structure (Khalil *et al.*, 2018). These results are in line with those obtained by Abd El-Razek (2012), El-Sheikh (2012), Mohamed *et al.*, (2012), Hozayn *et al.*, (2013), Osman *et al.*, (2014) and Okasha and Mubarak (2018), they found significant differences among the varieties in root yield ton/fed. Concerning the interaction effect, data in Table 7 showed that the interaction between seasons and locations affected root yield significantly. The highest value of root yield was recorded by sowing in second season at Homs location (135.32 ton/ha), while the lowest value was achieved in first season at Al-Ghab location (52.34 ton/ha). Results also pointed that the interaction between seasons and tested varieties affected root yield significantly. The highest

value of root yield was produced by sowing Semper variety in second season (113.50 ton/ha), whereas the lowest value of this trait was observed in Dita variety in first season (77.74 ton/ha). The obtained results in Table 7 also showed that root yield was significantly affected by the interaction between locations and varieties. The highest root yield was given by grown Rosella and Semper varieties at Hama location (124.67, 124.39 ton/ha) respectively, while the lowest value of this trait was attained by sowing Vico and SR305 varieties at Al-Ghab location (60.11, 60.95 ton/ha) respectively. Moreover, data in Table 7 revealed that the interaction of seasons, locations, and sugar beet varieties exhibited significant effects on root yield per hectare. Semper variety showed the highest value of root yield in second season at Homs location (156.12ton/ha), on the other hand Dita, Semper and Osma varieties had the lowest value of studied trait in first seasons, at Al-Ghab location (51.09, 51.37, 51.56 ton/ha) respectively. Such results agree with Hanan *et al.*, (2018).

Table (7): Root Yield (ton/ha) of Six Sugar Beet Varieties as Affected by Location Conditions in 2019-2020 and 2020-2021 Seasons.

Seasons (S)	First growing season 2019-2020				Second growing season 2020-2021				General mean
Locations (Loc)	Homs	Hama	Al-Ghab	Mean	Homs	Hama	Al-Ghab	Mean	
Varieties (Var)									
Vico	69.26	129.95	52.48	83.90	132.99	108.01	67.75	102.92	93.41bc
Dita	70.50	111.62	51.09	77.74	127.78	104.96	77.19	103.31	90.52c
Semper	71.73	140.22	51.37	87.77	156.12	108.57	75.80	113.50	100.64a
SR305	72.96	113.84	54.15	80.32	131.91	114.12	67.75	104.59	92.46bc
Osma	74.20	126.89	51.65	84.24	138.54	111.62	79.41	109.86	97.05ab
Rosella	75.43	138.83	53.31	89.19	124.57	110.51	76.08	103.72	96.46ab
Mean	72.35	126.89	52.34	83.86b	135.32	109.63	74.00	106.32a	95.09
Variables	S	Loc	Var	S×Loc	S×Var	Loc×Var	S×Loc×Var		
LSD _(0.05)	2.874	3.520	4.979	4.979	7.041	8.623	12.195		
CV%	7.9								
Means within the same column or row followed by the same letter(s) are not significantly different at the probability level of 0.05 according to LSD.									

Extractable sugar yield (ton/ha): Results in Table 8 revealed that extractable sugar yield significantly affected by growing seasons. The extractable sugar yield in the second season (15.43 ton/ha) was significantly higher than that of the first season (11.61 ton/ha). Results in Table 8 also showed that extractable sugar yield was significantly affected by studied locations conditions. Sowing sugar beet at Hama location resulted in higher value of extractable sugar yield (16.92 ton/ha) than that gained by sowing it at Al-Ghab and Homs locations (8.88, 14.76 ton/ha) respectively. These results are in line with Abd El-Razek (2012), El-Sheikh (2012) and Abd El-Razek and Ghonema (2016). Moreover, results in Table 8 exhibited significant differences among the evaluated sugar beet varieties in extractable sugar yield. Semper variety recorded the highest value of this trait (15.17 ton/ha). On the other hand, SR305 variety had the lowest value of extractable sugar yield (12.28 ton/ha). The superiority of Semper variety in sugar yield is result of producing highest root yield/ha

and recording the greatest value of sucrose percentage and purity percentage in juice. The differences among the tested sugar beet varieties in sugar yield could be due to their root yield amount which attributed to their quality structure *i.e.* (Na, K and Alfa amino nitrogen percentage) and environmental conditions as a suitable to all of varieties. These results disagree with Enan *et al.*, (2016) who found insignificant differences among studied varieties, but Similar results were obtained by Enan *et al.*, (2011), Abd El-Razek (2012), El-Sheikh (2012), Mohamed *et al.*, (2012) and Okasha and Mubarak (2018), Khalil *et al.*, (2018) they found that the influence of environmental was very high as shown by statistically significant differences in root yield and sugar content and technological sugar yield. With respect to the interaction, data in Table 8 indicated that the interaction between seasons and locations affected extractable sugar yield significantly. The highest value of extractable sugar yield was obtained from Homs location in second season (19.66 ton/ha), whereas the lowest value of mentioned trait was recorded in first season at Al-Ghab location (7.59 ton/ha). Furthermore, results in Table 8 cleared that the interaction between locations and sugar beet varieties showed significant effects on extractable sugar yield. Semper variety showed the highest value of extractable sugar yield, at Hama location (19.18 ton/ha). in contrast, SR305, Vico, and Rosella varieties gave the lowest value of this trait (8.33, 8.80, 8.88 ton/ha) respectively under Al-Ghab location. Obtained results in Table 8 referred to a significant effect on sugar yield due to the interaction between seasons and varieties. Semper variety had the highest value of extractable sugar yield in second season (17.76 ton/ha), whereas SR305 and Dita varieties achieved the lowest value of extractable sugar yield in first season (10.81, 11.0 ton/ha) respectively. The results in Table 8 also revealed that extractable sugar yield significantly affected by the interaction of season, locations, and varieties. Semper variety recorded the highest value of this trait at Homs location in the second season (23.97ton/ha); meanwhile Semper, Osma, and Rosella varieties produced the lowest value of extractable sugar yield at Al-Ghab location in the first season (7.17, 7.27, 7.34 ton/ha) respectively. Such results agree with Khalil *et al.*, (2018); Hanan *et al.*, (2018); Aly *et al.*, (2015); Hozayn *et al.*, (2014).

Table 8. Extractable Sugar Yield (ton/ha) of Six Sugar Beet Varieties as Affected by Location Conditions in 2019-2020 and 2020-2021 Seasons.

Seasons (S)	First growing season 2019-2020				Second growing season 2020-2021				General mean
Locations (Loc)	Homs	Hama	Al-Ghab	Mean	Homs	Hama	Al-Ghab	Mean	
Varieties (Var)									
Vico	9.99	17.49	8.04	11.84	19.50	15.46	9.72	14.90	13.37 ^{bc}
Dita	9.76	15.63	7.59	11.00	18.53	14.92	10.69	14.71	12.85 ^{cd}
Semper	10.74	19.84	7.17	12.58	23.97	18.53	10.77	17.76	15.17 ^a
SR305	10.03	14.27	8.14	10.81	18.25	14.48	8.53	13.75	12.28 ^d
Osma	10.26	17.65	7.27	11.73	19.66	18.88	11.04	16.53	14.13 ^b
Rosella	8.42	19.36	7.34	11.71	18.05	16.47	10.25	14.92	13.32 ^{bc}
Mean	9.87	17.38	7.59	11.61 ^b	19.66	16.46	10.16	15.43 ^a	13.52
Variables	S	Loc	Var	S×Loc	S×Var	Loc×Var	S×Loc×Var		
LSD _(0.05)	0.454	0.556	0.786	0.786	1.112	1.361	1.925		
CV%	8.7								

Means within the same column or row followed by the same letter(s) are not significantly different at the probability level of 0.05 according LSD.

Conclusions: Growing seasons had a significant effect on all studied traits except for sucrose percentage, where second season surpassed the first one in purity percentage, root yield and extractable sugar yield. The location Hama recorded the highest root yield and the highest extractable sugar yield compared to Homs and Al-Ghab. The variety Semper performed best in relation to all studied traits in all locations. Hence, this variety can be cultivated as commercial variety in Homs, Hama, and Al-Ghab.

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إنتاجية ونوعية الشوندر السكري (*Beta Vulgaris L.*) تحت ظروف بيئية

متباينة في سورية

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الملخص

نفذت تجربة حقلية في ثلاثة مواقع (مراكز البحوث العلمية الزراعية في حمص، حماة، والغاب) خلال موسمين زراعيين 2020/2019 و 2021/2020 لدراسة أداء ستة أصناف من الشوندر السكري وحيد الجنين (فيكو، ديتا، سيمبر، SR305، أوسما، روزيلا) في بيئات متباينة من سورية. وضعت التجربة وفق تصميم القطاعات العشوائية الكاملة بثلاثة مكررات في كل موقع. أظهرت نتائج التحليل الإحصائي وجود فروقات معنوية ($P \leq 0.05$) بين جميع المعاملات المدروسة والتفاعلات المتبادلة بينها. حيث حقق الصنف SR305 أعلى نسبة للمواد الصلبة الذائبة (23.50%)، بينما أعلى نسبة للسكروز حققته الأصناف أوسما وسيمبر وذلك في موقع حماة خلال الموسم الزراعي الثاني (18.70 و 18.30 %) على التوالي. كما سجل الصنف سيمبر أعلى نسبة للنقاوة في موقع حماة خلال الموسم الزراعي نفسه (93.06%). وكذلك سجل الصنف سيمبر أعلى قيم للإنتاج الجذري وناتج السكر الفعلي في موقع حمص خلال الموسم الزراعي الثاني (156.12، 23.97 طن/هـ) على التوالي. بالنسبة إلى المواسم الزراعية أشارت النتائج إلى وجود فروقات معنوية بين موسمي الزراعة في جميع الصفات المدروسة باستثناء نسبة السكر (%). حيث تفوق الموسم الثاني معنوياً على الموسم الأول في نسبة النقاوة والإنتاج الجذري وناتج السكر الفعلي (84.39، 106.32 و 15.34 طن/هـ) على التوالي. أما بالنسبة إلى المواقع فقد تفوق موقع حماة معنوياً على موقعي حمص والغاب في الإنتاج الجذري وناتج السكر الفعلي (118.26، 16.92 طن/هـ على التوالي)، بينما لم تكن هناك أية فروقات معنوية بين المواقع في الصفات النوعية. وكذلك بينت النتائج وجود فروقات معنوية بين الأصناف في جميع الصفات المدروسة باستثناء نسبة المواد الصلبة الذائبة (%). حيث تفوق الصنف سيمبر في كافة الصفات الإنتاجية والنوعية المدروسة وفي المواقع الثلاثة.

الكلمات المفتاحية: الشوندر السكري، المواقع، الأصناف، نسبة السكر، نقاوة العصير، الإنتاجية.