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Evaluation of Locally-Grown Pumpkin Genotypes in the Central Region of Saudi Arabia

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Abstract. Local pumpkin (*Cucurbita moschata* Poir.) landraces spread over a wide range of environments in the Kingdom of Saudi Arabia and they are utilized in many local dishes and food industries. Fruits of the five common genotypes; Hasawi-1, Hasawi-2, Masri, Najdi, and Skaka were collected from different regions of the Kingdom. An evaluation trial was conducted near Riyadh in the central region where vegetative traits, yield, and yield components were studied. The evaluated genotypes showed variation for most of these traits; whereas their differences in yield appeared insignificant. Average fruit weight was the highest in Najdi and the lowest in Skaka, which had the highest seed number and seed weight. Hasawi-1, Masri and Najdi showed the highest total soluble solids (TSS) and reducing sugars content. Significant correlation coefficients among vegetative traits, yield and yield components and fruit compositions were found. The results of this study could be useful in breeding programs for improving local pumpkin cultivars under arid area conditions.

Additional index words: Population, yield component, cultivars, cucurbit germplasm, vegetative growth, squash.

Introduction

Saudi Arabia comprises a major part of the Arabian Peninsula with an estimated area of 2,250,000 km^2. The climate varies from one region to another. Saudi Arabia is located between 16 and 32 degrees north latitudes, which means that it is mostly located in the dry tropical desert region [1]. In Saudi Arabia, local pumpkin (*Cucurbita moschata* Poir.) has been grown widely for many decades and can be considered one of the major vegetable crops. It is consumed in different local dishes and some food industries such as jams, purees and cakes. The total area of pumpkin and squash, harvested in 1998, was 7,850 hectare with total production of 75,350 ton [2] and average yield of 9.6 ton ha^{-1}.

Variations among cucurbit species in vegetative and yield characteristics have been reported. Examples are the studies on cucumber , muskmelon , watermelon , and pumpkin [3-9].

Researchers and farmers have noticed unstable fruit characteristics of local pumpkin genotypes grown in Saudi Arabia [10]. In general, there has been a limited work on the improvement of cucurbits in Saudi Arabia. Ibrahim and co-workers were among the pioneers to initiate the cucurbitaceae improvement program. They have released two sour-sweet melon [11] and two desert-adapted winter squash [12] cultivars. The objectives of this study were: (a) to evaluate the performance of five local pumpkin genotypes for their growth, yield and fruit composition and (b) to determine the phenotypic correlation's among vegetative, yield and fruit composition characteristics of the local pumpkin genotypes.

Materials and Methods

Plant materials

Fruits of five locally grown pumpkin genotypes were collected from November 1996 to February 1997 from three different regions of Saudi Arabia where they have been commonly grown for several decades (Fig.1). Hasawi-1 and Hasawi-2 were collected from the eastern region, Masri and Najdi from the central region and Skaka from the northern region. The distinction between Hasawi -1 and Hasawi–2 is based on fruit shape, fruit size, skin color and seed size. The locally grown pumpkin genotypes exhibit various fruit size and shape. Fruit characteristics are shown in Table 1 and Fig. 2.

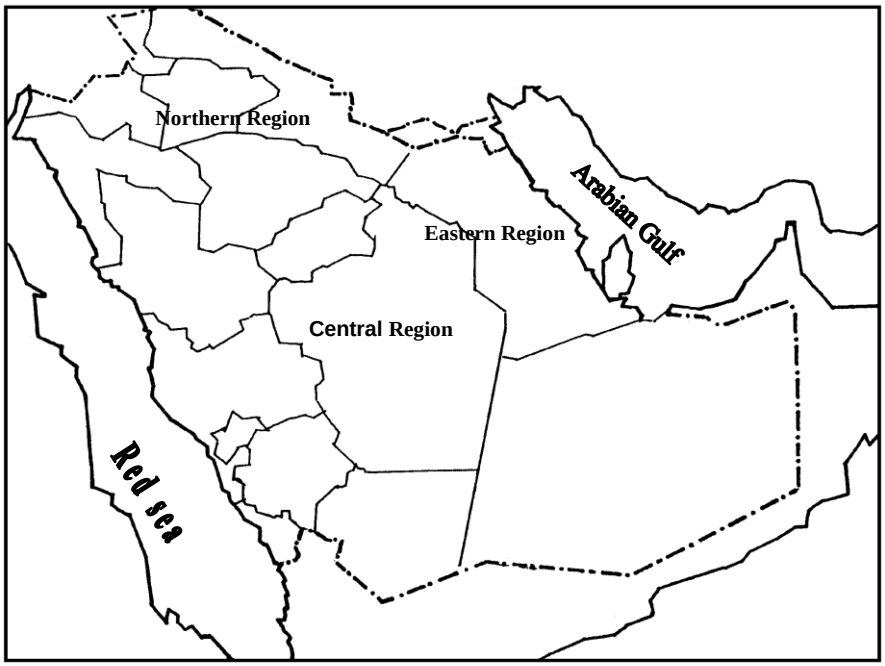

Fig. 1. Map of Saudi Arabia showing the different regions from which fruits of local pumpkin genotypes have been collected.

Table 1. Fruit characteristics of five local pumpkin genotypes grown in the central region of Saudi Arabia

Genotype	Skin color	Size	Shape	Shell	Flesh color
Hasawi-1	Yellow	Medium (1-2 kg)	Pyriform-globular	Semi-grooved	Yellow
Hasawi-2	White	Large (> 2kg)	Globular	Semi-grooved	White
Masri	Light yellow	Large (> 2kg)	Pyriform	Grooved	Light yellow
Najdi	Light yellow	Large (> 2kg)	Pyriform	Grooved	Light yellow
Skaka	Orange	Small (< 1kg)	Globular	Semi-grooved	Yellow

Fig. 2. Fruit characteristics of five local pumpkin genotypes grown in the central region of Saudi Arabia.

Seeds were collected, washed with water, air-dried and kept at room temperature until the time of planting. Seeds were planted in JV-7 pellets on 28 March 1997 and were placed in a greenhouse (average day and night temperatures were 24/18 ºC).

Field layout

Five hundred seedlings, 14 days old, representing five different genotypes were transplanted into the field on 9 Apr. 1997. The field plot was located at the Agricultural

Research and Experiment Station, King Saud University at Dirab near Riyadh, Saudi Arabia. The soil type was Torriorthents sandy loam with a pH of 7.6 and EC of 4.9 dS m^{-1}. The experimental plot consisted of two rows, each 12 m long and 0.8 m wide. The spacing between seedlings within a row was 1 m. The experimental design was a randomized complete block with 5 replications. Fertilization, furrow irrigation and other cultural practices were carried out as recommended for commercial production. The average temperature and relative humidity data during the growing season are shown in Table 2.

Table 2. Temperature and relative humidity data during the growing season[z]

Period	Temperature (°C)				Relative humidity (%)			
	Max		Min		Max		Min	
	Mean	Range	Mean	Range	Mean	Range	Mean	Range
April 1997	34	27-42	15	9-24	33	13-70	9	6-15
May 1997	40	31-45	22	15-29	16	11-68	7	5-10
June 1997	45	41-48	23	20-27	13	11-19	5	4-6
July 1997	44	42-47	23	20-29	12	11-16	5	4-6

[z] Data were collected by the weather station of the Agricultural Research and Experiment Station. Data cover the period from transplanting to harvest.

Vegetative growth and yield characteristics

Plant length (longest vine) , number of leaves per plant, number of vines per plant and leaf area were measured at 30, 45 and 60 days after transplanting. Ten representing leaves were randomly collected and their length (L) and width (W) were recorded. The actual leaf area of the ten leaves was then measured by the Li-Cor 3000 Leaf area meter. The total plant leaf area was then determined by the formula:

$$\text{Leaf area} = f\ (L \times W \times N)$$

where

f : a constant factor (0.976), and

N : number of leaves per plant.

Fruits were harvested at full maturity, transferred to the laboratory and kept at room temperature until they were evaluated. Number of fruits/plant, fruit weight (g), fruit length (cm), fruit diameter (cm), flesh thickness at the middle of the fruit (cm), number of seeds/fruit, seed weight/fruit (g) and weight of 100 seeds (g) were assessed. Total soluble solids (TSS) were measured using a hand held refractometer (HRN- 32, Kruss, Germany). Analysis of total and reducing sugars was performed using a Shimadzu HPLC (Shimadzu LC-10, Shimadzu, Kyoto, Japan) according to the AOAC [13] method. Determination of total sugars was carried out according to the Lane-Eynon method in AOAC [13].

Statistical analysis

Data were analyzed using SAS [14] software at the Computer Center of the College of Agriculture, King Saud University. Correlation coefficients and mean separation were done as described by Steel and Torrie [15, pp.172-194, 272-278].

Results and Discussion

Most of the vegetative and yield characteristics showed high variability within each of the five studied populations. The lowest coefficient of variation (CV, 25.2%) was obtained for yield per plant within the populations of Hasawi–2. Fruit characteristics such as average fruit weight, fruit length and diameter showed moderate variability, with the exception of average fruit weight of Masri and Najdi populations which showed relatively high values. The flesh thickness trait showed the lowest variability with CV values ranging from 8.0–28.6 % for the five populations (Table 3).

Table 3. Statistical parameters of vegetative, fruit, seed and quality characteristics of five local pumpkin genotypes grown in the central region of Saudi Arabia

Characteristics	Parameter [z]	Hasawi–1	Hasawi- 2	Masri	Najdi	Skaka
Plant length (cm)	Mean	132.08	126.50	125.82	141.01	59.92
	Range	241.75	203.81	188.81	197.20	122.75
	CV	62.2	58.06	52.39	52.28	70.23
No. of leaves/plant	Mean	74.64	73.04	66.48	79.36	57.45
	Range	181.63	180.37	141.38	155.81	114.81
	CV	84.3	80.71	80.59	71.34	65.09
No. of vines / plant	Mean	6.26	4.82	5.86	6.87	4.62
	Range	15.88	9.78	12.16	12.75	8.90
	CV	85.0	64.25	75.15	64.54	67.79
Leaf area (cm^2)	Mean	16454	20580	14656	18137	22367
	Range	39243	53744	36382	42646	50393
	CV	90	86	88	77	75
Yield / (g $plant^{-1}$)	Mean	746.75	542.02	842.50	659.39	221.71
	Range	1,960.00	361.43	2,562.50	1,394.44	316.54
	CV	108.4	25.22	127.31	87.01	54.51
No. of fruits / plant	Mean	0.36	0.25	0.46	0.18	0.23
	Range	0.90	0.11	1.20	0.33	0.26
	CV	99.3	17.67	99.10	84.46	42.48
Yield (ton ha^{-1})	Mean	7.78	5.65	8.78	6.87	2.31
	Range	20.42	3.76	26.69	14.53	3.30
	CV	108.4	25.22	127.31	87.01	54.51
Avg. fruit wt. (g)	Mean	1,970.25	2,230.50	2,099.17	2,859.17	952.37
	Range	675.00	2,300.00	5,125.00	4,250.00	334.17
	CV	14.3	37.56	104.83	60.29	13.85

Table 3. (Contd.)

Characteristics	Parameter [z]	Hasawi–1	Hasawi- 2	Masri	Najdi	Skaka
Fruit length (cm)	Mean	21.31	12.78	34.06	37.19	15.45
	Range	8.75	6.00	6.67	6.50	4.33
	CV	16.3	19.14	9.85	7.94	10.37
Fruit diameter (cm)	Mean	13.19	18.96	10.07	11.44	14.73
	Range	4.45	5.83	4.63	8.00	6.00
	CV	15.2	11.43	23.82	33.22	16.40
Flesh thickness (cm)	Mean	2.18	2.59	2.06	2.19	1.86
	Range	0.40	1.22	0.75	1.50	1.15
	CV	8.0	17.50	19.16	28.57	25.05
No. of seeds / fruit	Mean	144.80	216.55	63.4	91.83	308.75
	Range	139.20	140.30	57.87	148.00	127.50
	CV	35.3	31.21	52.01	67.39	19.08
Seed weight / fruit (g)	Mean	10.67	10.17	5.59	8.60	12.24
	Range	12.97	5.00	5.90	16.35	5.12
	CV	49.5	23.16	55.35	85.03	18.45
Weight 100-seed (g)	Mean	7.04	5.21	8.67	10.14	4.16
	Range	4.67	2.60	2.7	11.84	2.76
	CV	27.8	20.68	16.46	50.44	29.11
Total soluble solids (%)	Mean	14.89	10.43	16.22	15.45	12.05
	Range	3.65	4.50	0.5	3.25	1.00
	CV	9.5	17.43	1.75	9.54	3.57
Reducing sugars (mg/100g fresh weight)	Mean	1.50	0.08	1.75	2.42	0.21
	Range	1.78	0.25	0.51	1.70	0.47
	CV	48.2	133.20	14.69	28.88	84.58
Non-reducing sugars (mg/100g fresh weight)	Mean	2.46	2.23	2.43	2.03	0.80
	Range	1.85	2.01	0.78	1.30	2.15
	CV	32.6	35.19	17.27	26.33	99.86
Total sugars (mg/100g fresh weight)	Mean	3.97	2.30	4.18	4.45	1.02
	Range	2.01	2.00	0.85	1.58	2.45
	CV	20.9	34.10	10.17	18.42	88.66

[z] CV: Coefficient of variation.

Seed number, seed weight/fruit and weight of 100-seed showed moderate variability. The magnitude of variability within the original populations for TSS was the lowest among all traits (1.8-17.4 %). Total sugars and non-reducing sugars showed greater variation within the Skaka population. Higher variability for vegetative and yield traits within cucurbit species were also reported. Kasarawi [16] evaluated 41 half–sib families of summer squash (*Cucurbita pepo* L.) for 17 morphological and horticultural traits and observed large diversity for many traits, within and among families, including fruit shape and fruit number per plant. Mondal *et al.* [5] showed wide range of variability in watermelon for fruit length, fruit diameter, number of fruits/plant, flesh thickness and fruit yield.

Vegetative growth characteristics

Plant length, number of vines/plant and number of leaves/plant exhibited significant differences among genotypes at 60 days after transplanting (Fig. 3). There were significant differences in leaf area at 30 and 45 days after transplanting. Skaka, the earliest maturing genotype, had the highest leaf area at 30 and 45 days. However, these differences diminished at 60 days. Rahman *et al.* [17] evaluated vegetative growth traits in sweet gourd and reported significant variation for the different studied traits. Similar findings were also reported in pumpkin by Doijode *et al.* [7].

Yield and yield components

There were significant differences among pumpkin genotypes for average fruit weight, seed number/fruit and weight of 100-seed (Table 4). Although Masri and Hasawi-1 outyielded other genotypes, the differences among them were not significant. The yield of Skaka was the lowest. Hasawi–2 and Najdi had a moderate yield response.

The low yield of these genotypes might be attributed to the prevailing environmental conditions during the growth period and to the high salinity level in the field plot. Average fruit number/plant was not significantly different among genotypes. On the contrary, Rahman, *et al.* [17] reported significant differences in fruit number, length and weight of several gourd genotypes.

Average fruit weight was the highest in Najdi followed by Hasawi-2, Masri, and Hasawi-1 genotypes, but the differences among them were not significant. Masri had the largest fruit number/plant, while Najdi had the lowest. Average fruit weight differed significantly among the studied genotypes.

Average fruit weight was the highest in Najdi and the lowest in Skaka fruit, which resulted in non-significant yield differences. Masri and Najdi had the lowest seed number/fruit and seed weight/fruit but the highest weight of 100seeds.

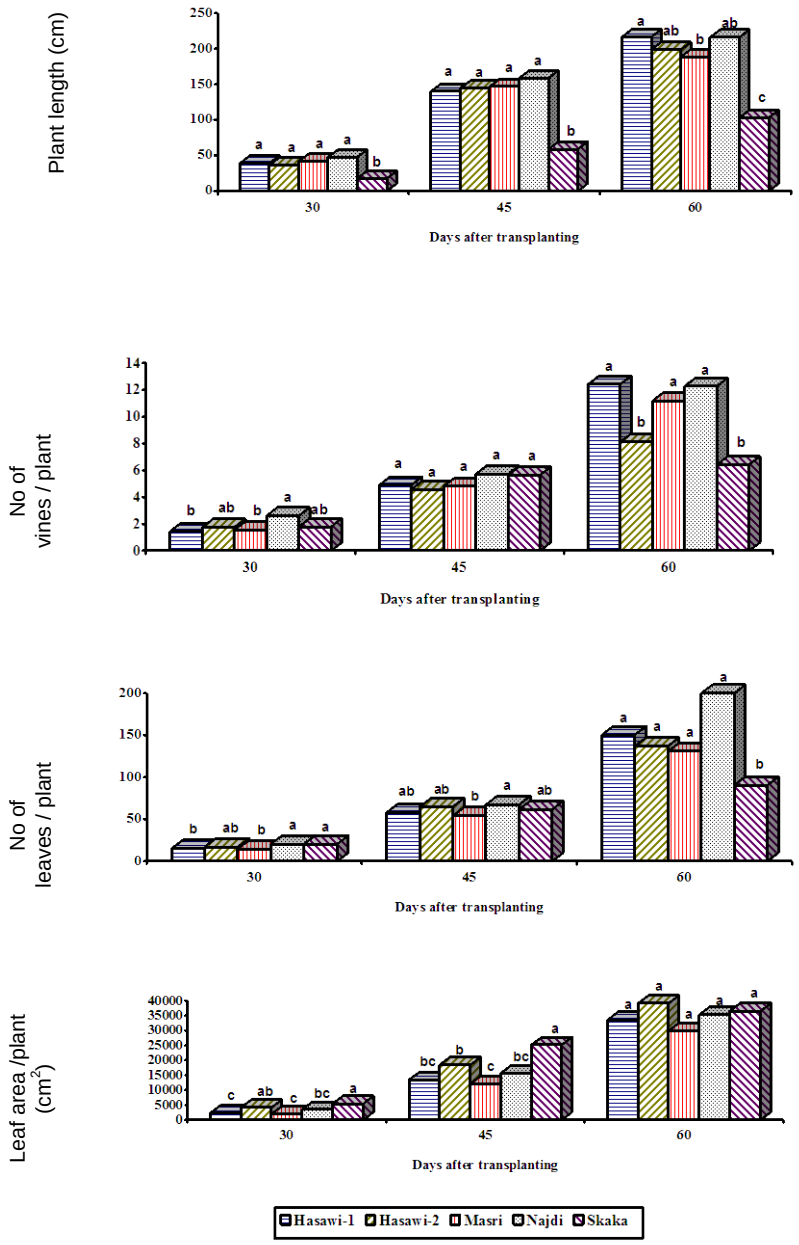

Fig. 3. Development of vegetative growth characteristics of five local pumpkin genotypes grown in the central region of Saudi Arabia. Mean separation within each period by least significant difference. Means within each period followed by the same letter do not differ at $P \leq 0.05$.

Table 4. Yield and yield components of five local pumpkin genotypes grown in the central region of Saudi Arabia[z]

Genotype	No. of fruits / plant	Fruit wt. (g)	Yield		No. of seeds / Fruit	Seed weight/ fruit (g)	100-seed wt. (g)
			(g/plant)	(ton ha^{-1})			
Hasawi-1	0.364a	1970.3 ab	746.8 a	7.779 a	144.80 bc	10.67a	7.04abc
Hasawi-2	0.254a	2230.5ab	542.0a	5.646 a	216.55ab	10.17a	5.21bc
Masri	0.458a	2099.2ab	842.5a	8.776 a	63.40c	5.59a	8.67ab
Najdi	0.180a	2859.2a	659.4a	6.869 a	91.83c	8.60a	10.14a
Skaka	0.229a	952.4b	222.7a	2.309 a	308.75a	12.24a	4.16c
LSD 00.05	N.S.	1697.8	NS	NS	97.42	NS	3.85

[z] Mean separation within a column by least significant difference. Means followed by the same letter within a column do not differ at $P \leq 0.05$.
NS = Non significant.

Fruit composition

Fruit quality measured as TSS, total sugars, reducing and non-reducing sugars varied significantly among genotypes (Table 5). Najdi and Masri fruits had the highest TSS, total and reducing sugars. Skaka yielded the lowest content of total, reducing and non-reducing sugars, while Hasawi-2 had the lowest TSS. Both a short vegetative growth period and a low TSS content characterized Skaka. This result is in agreement with the positive association between the two traits as reported by Welles and Buitelaar [18].

Table 5. Fruit composition of five local pumpkin genotypes grown in central region of Saudi Arabia

Genotype	Total soluble solids (%)[z]	Sugars (mg/100 g FW)[z]		
		Total	Reducing	Non-reducing
Hasawi-1	14.89 b	3.38 bc	1.20 b	2.17 a
Hasawi-2	10.43 d	2.38 c	0.061 c	2.32 a
Masri	16.22 a	4.24 ab	1.79 b	2.46 a
Najdi	15.45 ab	4.72 a	2.50 a	2.22 a
Skaka	12.05 c	1.05 d	0.23 c	0.82 b
$L.S.D._{0.05}$	1.31	1.06	0.66	0.76

[z] Mean separation within a column by least significant difference. Means followed by the same letter within a column do not differ at $P \leq 0.05$.

Correlations

In general, correlation coefficients were positively significant between vegetative and fruit characteristics (Table 6). Yield significantly correlated with each of plant length, leaf number, leaf area and number of vines/plant. Swamy and Dutta [4] found that yield in muskmelon correlated with main stem length and number of primary branches. Significant ($r = 0.43$) and highly significant ($r = 0.73$) correlations were found

between yield and each of number of fruits /plant and average fruit weight, respectively. Results of this study indicated that for increasing fruit yield, selection might be directed towards plants having higher number of fruits with larger fruit size. These results agree with Rastogi and Deep [19] and Dehua et al. [20] in cucumber, Swamy and Dutta [4] in muskmelon; Mondal et al. [5] in watermelon, and Rana et al., [9] in pumpkin. Seed weight/fruit was positively correlated with fruit length and fruit diameter. Mao et al. [21] found similar results in pumpkin. It is concluded that fruit length and diameter could be used as selection criteria in breeding pumpkin for seed production.

Fruit quality measured as TSS and total sugars (reducing and non- reducing sugars) correlated significantly and positively with vegetative growth characteristics such as number of vines/plant and with seed characteristics such as average seed weight and weight of 100 seeds. These findings are in agreement with results obtained by Swamy and Dutta [4]. On the other hand, highly significant and negative correlation coefficients were found among fruit quality traits; seed number/fruit with TSS (r = - 0.833), with reducing sugars (r = - 0.696) and with total sugars (- 0.681). Fruit diameter also correlated negatively with fruit quality traits. Seeds are known to withdraw sugars from fruit reserves to utilize it for their development. Total soluble solids are related with sugar contents and are important quality components in cucurbit fruits [22]. Generally, *Cucurbita maxima* and *C. moschata* plants produce fruits with highest solids and deepest flesh color, which make them preferred for commercial canning [22].

Fruit quality is an important criterion in the production of pumpkin. The high values of TSS and total sugars in Hasawi-1, Masri and Najdi genotypes indicated their high quality attributes. Maintaining fruit quality, while at the same time increasing yield has been one of the primary goals of plant breeders. Jaradat [23] and Singh *et al*. [24] reported that population improvement through selection could be performed, to varying degrees, according to the amount of variation present in each population, selection intensity and heritability of these traits. The obtained results for the studied traits of vegetative growth, yield, seed weight/fruit and fruit composition indicated that these traits within Skaka population could be improved through selection.

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تقييم السلالات المحلية من القرع العسلي في المنطقة الوسطى من المملكة العربية السعودية

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ص.ب: ٢٤٦٠، الرياض ١١٤٥١ المملكة العربية السعودية

(قدم للنشر في ١٤٢١/٦/٢٥ هـ، وقبل للنشر في ١٤٢٢/٣/١٧هـ)

ملخص البحث. تنتشر سلالات كثيرة من القرع العسلي (*Cucurbita moschata* Poir.) في بيئات متعددة من المملكة العربية السعودية وتستخدم في عدد من الأطباق والصناعات الغذائية. جمعت ثمار خمس سلالات محلية من القرع العسلي وهي حساوي-١ وحساوي-٢ والمصري والنجدي وسكاكا من مناطق مختلفة من المملكة. وقد أجريت الدراسة قرب الرياض بالمنطقة الوسطى من المملكة لتقييم صفات النمو الخضري والمحصول ومكوناته وجودة الثمار. ولقد أظهرت السلالات اختلافات فيما بينها لعدد كبير من الصفات، لكن لم تكن الفروق معنوية في صفات المحصول. وكان متوسط وزن الثمرة أعلى ما يمكن في سلالة النجدي وأقل ما يمكن في سلالة سكاكا التي احتوت ثمارها على عدد أكبر من البذور ذات الوزن الأثقل. وبالمقابل وجد أن ثمار سلالات حساوي-١ والمصري والنجدي أظهرت أعلى محتوى من المواد الصلبة الذائبة الكلية والسكريات المختزلة. كما وجدت ارتباطات معنوية عديدة بين عدد من صفات النمو الخضري والمحصول ومكوناته. ولنتائج هذه الدراسة أهمية في برامج تربية وتحسين سلالات القرع العسلي المحلي تحت ظروف المناطق الجافة.