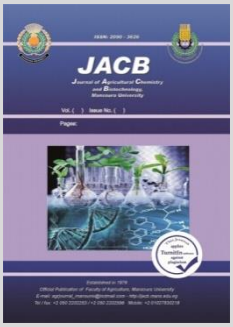
Journal of Agricultural Chemistry and Biotechnology

Journal homepage: www.jacb.mans.edu.eg
Available online at: www.jacb.journals.ekb.eg

Description and Evaluation of Some Newly Introduced Grape Cultivars Under Egyptian Conditions

Ola A. Ahmed[1] and M. H. Abd EL-Aziz[2*]

[1]Viticulture Res. Dept., Hort. Res. Instit., Agric. Res. Center, Giza, EGYPT
[2]Dept. of Genetics, Fac. of Agric., Mansoura University. EGYPT



ABSTRACT

This research was conducted for two consecutive seasons (2017 and 2018) in a private vineyard located at El-Sadat city, Menofia governorate to describe and evaluate three grape seedless cultivars namely: Early Sweet, Prime and Star light grape cultivars under Egyptian conditions. The results revealed that Early Sweet grape cultivar was the earliest cultivars concerning the phenological dates include bud burst, full bloom, fruit set, veraison and physiological ripening followed by Prime grape cultivar, whereas Star light grape cultivar was the latest in this respect through the two seasons of the study. All the studied cultivars succeeded under Egyptian conditions and characterized by high quality of bunch and berries. Genetic diversity among the three cultivars was assessed using SCoT and ISSR molecular marker techniques. Cluster analysis showed molecular and phenotypic variation among cultivars, which divided into three groups, each group was contained one cultivar. These cultivars were distinguished by 36 molecular markers 27 out of them were from SCoT markers which proved successful to target generic regions across the grape genome. These markers after deciphering their structure may help to evolve reliable molecular markers to select desirable traits in these cultivars. So, we recommend expansion in the cultivation of these cultivars under Egyptian conditions and benefit of our molecular results to elicit reliable molecular markers characterizing desirable traits in these cultivars to use in Egyptian grape cultivars improving programs.

Keywords: Grape cultivars, Phenotypic description, Genetic diversity, SCoT, ISSR, Egyptian conditions

INTRODUCTION

Grape is the one of most important fruit crops in the world and it ranked in Egypt after Citrus. According to the latest Ministry of Agriculture statistics (2018), Egypt's total grape area reached 202655 feddans, with a production of 1892993 tons. Forty years ago, most vineyards were occupied by two major cultivars namely Thompson Seedless and Roumi Ahmer in addition to a small area cultivated with some native cultivars. After the 1981 season, some new table grape cultivars were introduced, which were cultivated in various cultivation areas in the desert and delta regions; various morphological characteristics and bunch performance were recognized in these cultivars.

Ampelography is a well-established scientific method for characterizing grapevine genotypes based on the description of various morphological, phonological, and pomological characteristics. Many scientists have standardized and extended this approach in order to provide a more rational and reliable identification of Vitis material (Alleweldt and Dettweiler, 1986; Dettweiler, 1991; Soylemezoglu *et al.*, 2001 and Santiago *et al.*, 2007).

However, the obtained results often including the environmental effects too (Kumar, 1999). Therefore, in recent years, molecular markers have been used as premium tools for genetic diversity identification. They are neutral, feasible, do not depend on age and tissue type, and also are not influenced by environmental conditions. (Zietkiewicz *et al.*, 1994). Among these molecular markers, Inter Simple Sequence Repeats (ISSRs) and Start Codon Targeted polymorphism (SCoT) are used efficiently for genetic diversity assessment of plants (Etminan *et al.*, 2016). Many studies found that SCoT is might be more effective than other dominant DNA molecular markers like RAPD and ISSR because it is gene-targeted (Gupta *et al.*, 2018). Also, SCoT is superior over these markers in higher polymorphism and better marker resolvability (Gorji *et al.*, 2011). Moreover, SCoT can generate co-dominant markers caused by insertions and deletions, as well as they can generate dominant markers caused by sequence variations like RAPD and ISSR (Aswathy *et al.*, 2017). However, using ISSR and SCoT markers together gives very effective, reliable, and more superior results in genetic diversity study than the use of single markers (Mao *et al.*, 2018).

Previous studies were focused on describing and evaluating grape cultivars (Brooks and Olmo 1972; Watt, 1983; Walker and Boursiquote, 1992; Abd El-Kawi and El-Yam, 1992 a, b and c; Abd El-Fattah and Kastor, 1993 a and b; Morrison, 1994; Tourky *et al.*, 1995; El-Sharkawy 1995; Fawzy 1998; Marwad, 2002 a and b; Gaser, 2006; Girgis 2007; Sabry *et al.*, 2009; Abd El-Rahman, 2016; Mohamed and Tarbia, 2017 and El-Morsy *et al.*, 2017). Recently, some studies have used SCoT and ISSR markers successfully together successfully in the molecular diversity assessment of grape varieties, such as Abdel-Hameed *et al.* (2020) and Bashandy *et al.* (2020). Whereas they explain that both

* **Corresponding author.**
E-mail address: mohahassan2005@gmail.com - mohahassan@mans.edu.eg
DOI: 10.21608/jacb.2021.187453

methods were effectively efficient for studying the genetic diversity in grape until between closely related cultivars.

Therefore, the main objective of this investigation is to describe and evaluate three grape cultivars namely: Early Sweet, Prime and Star light grape cultivars were studied under Egyptian conditions, with stress on some special morphological characteristics and molecular diversity assessment, which may serve in distinguishing these cultivars.

MATERIALS AND METHODS

This research was conducted for two consecutive seasons (2017 and 2018) in a private vineyard located at El-Sadat city, Menofia governorate to description and evaluation three grape seedless cultivars namely: Early Sweet, Prime and Star light grape cultivars under Egyptian conditions. The selected vines were five years old, grown in a sandy loam soil, irrigated by the drip system and spaced at 2 X 3 meters apart. The vines were cane pruned during the fourth week of December with maintain a load of 72 buds/vine (10 canes x 6buds) plus (6spurs x 2buds) and trellised by the Spanish Parron system. Four replicates for each cultivar were taken where each replicate consisted of six vines.

Botanical characteristics:

The following characteristics were studied:

1) Phenological dates

Phenological dates include bud burst, full bloom, fruit set, veraison and physiological ripening; the last date was harvested when the TSS reaches 16-17% in accordance with Tourky *et al.* (1995).

2) Descriptive measurements

The morphological studies were carried out according to the International Amelographic Registered Schedule (Dalmasso and Cosmo, 1952 and Cosmo *et al*., 1958).

The following assessments were classified in accordance with many authors (Bioletti, 1938; Singh & Singh, 1940; Kolenati, 1946; Kolenati 1946; Breider, 1950; Rodrigues, 1959 and Watt 1983) and focused on the growing tip (hairs and colour), the tendril sequence and tip shape), the leaf (size, shape, surface, colour, thickness, pubescence, number of lobes, sinuses, margin and petiole), the bunch (weight, length, shape, density and peduncle) and the berry (weight, size, shape and colour).

3) Bunch physical characteristics

Average bunch weight (g), bunch dimensions (cm) and shot berries (%) were determined.

4) Berry physical characteristics

Average berry weight (g), berry size (cm3), berry dimensions (cm) and berry shape index were determined.

5) Berry chemical characteristics

Total soluble solids in berry juice (T.S.S.) (%) by hand refractometer, total titratable acidity as tartaric acid (%) (A.O.A.C. 1985) and TSS/acid ratio were calculated.

Experimental design and statistical analysis

The completely randomized design was adopted for the experiment. The statistical analysis of the present data was carried out according to Snedecor and Cochran (1980). Averages were compared using the new L.S.D. values at 5% level (Steel and Torrie, 1980).

Phenotypic distance

Based on quantitative data of studied characteristics, Phenotypic distances PD were calculated and agglomerative hierarchical clustering (AHC) dendrogram was drawn by Euclidian method using XLSTAT.7 software statistical approach according to Abd El-Aziz *et al.* (2019).

Molecular diversity assessment: -

Genomic DNA was isolated from juvenile grape leaves using a DNeasy plant mini kit (bio basic). The purity and concentration were measured by UV spectrophotometer. The PCR reaction was carried out using isolated genomic DNA from each cultivar as a template for PCR amplification using seven ISSR primers and nine SCoT primers (Table 1) according to Abd El-Aziz *et al.* (2019). PCR products for each primer were loaded on a 1.3 % agarose gel mixed with ethidium bromide and electrophoresed against a DNA ladder (0.1 to 3.0 kbp). The run was performed at 100 V for about 30 min in BioRad mini-submarine gel.

DNA banding patterns were photographed using a UV light on the Bio-1D Gel Documentation system. All photos were analyzed by GelAnalyzer 3 software. Also, cluster analysis was carried out agglomerative hierarchical clustering (AHC) according to Abd El-Aziz et al. (2019) using XLSTAT.7 software. Polymorphic Information Content (PIC) and DI (Diversity Index) were calculated according (Gorji *et al.*, 2011). Also, from binary data, the Resolving power (Rp) values were calculated as described in Prevost & Wilkinson (1999). Molecular distances MD were calculated by Dice coefficient (Nei and Li, 1979).

To verify the nature of the relationships between molecular distances ($MD_{ISSR,\ SCoT\ and\ All}$) and Phenotypic distances (PD), simple correlation coefficients were estimated using the computational software Minitab 17 (El-Zanaty et al., 2013).

Table 1. List of all ISSR and SCoT Primers used in the study.

SCoT Primers		ISSR-Primers	
Name	**Sequence (5´→ 3`)**	**Name**	**Sequence (5´→ 3`)**
SCoT-1	CAACAATGGCTACCACCA	14A	$(CT)_8TG$
SCoT-2	CAACAATGGCTACCACCC	44B	$(CT)_8GC$
SCoT-3	CAACAATGGCTACCACCG	HB-09	$(GT)_6GC$
SCoT-4	CAACAATGGCTACCACCT	HB-10	$(GA)_6CC$
SCoT-6	CAACAATGGCTACCACGC	HB-11	$(GT)_6CC$
SCoT-8	CAACAATGGCTACCACGT	HB-12	$(CAC)_3GC$
SCoT-10	CAACAATGGCTACCAGCC	HB-15	$(GTG)_3GC$
SCoT-11	AAGCAATGGCTACCACCA		
SCoT-12	ACGACATGGCTACCAACG		

The underlines of ATG codon in the primer sequence were fixed.

RESULTS AND DISCUSSION

Botanical description and evaluation:

1) Phenological dates

Early Sweet grape cultivar was the earliest cultivars with regard to the phenological dates represented in bud burst, full bloom, fruit set and grape maturity followed by Prime grape cultivar, whereas Star light grape cultivar was the latest in this respect through the two seasons Table (2).

These findings are consistent with those recorded by Abd El-Fattah and Kasstor (1993a) on Beauty Seedless and

Black Monukka grape cultivars; Abd El-Fattah and Kasstor (1993b) on Black Rose and Ribier grape cultivars; Marwad (2002a) on Black Rose and Ribier grape cultivars; Marwad (2002b) on Beauty Seedless and Black Monukka grape cultivars; Abd El-Rahman, (2016) on Princess and Autumn Royal grape cultivars and Mohamed and Tarbia (2017) on Sable, Midnight Beauty and Desert Red grape cultivars.

Table 2. Dates of bud burst, full bloom, fruit set and maturity of Early Sweet, Prime and Star light grape cultivars in 2017 & 2018 seasons

Cultivar	50% bud burst date		70% full bloom date		Fruit set date		Maturity date	
	2017	2018	2017	2018	2017	2018	2017	2018
Early Sweet	11-Mar	14-Mar	6-Apr	8-Apr	21-Apr	24-Apr	31-May	3-Jun
Prime	14-Mar	16-Mar	9-Apr	12-Apr	23-Apr	27-Apr	6-Jun	11-Jun
Star light	19-Mar	22-Mar	17-Apr	19-Apr	29-Apr	1-May	15-Jun	19-Jun

2) Descriptive measurements

The data related to the evaluation and morphological description of the studied items are shown in Table (3) and illustrated in Figure (1).

- **Growing tip:**

- **Hairs and colour:**

All studied grape cultivars were cob-webby hairs with green colour with the exception of the Star light grape cultivar, which was green with purple.

- **Tendrils:**

- **Sequence and tip shape**

The sequence of tendrils was intermittent with di-tri-fid shape in all studied grape cultivars.

- **Leaf:**

- **Leaf size and shape:**

All studied grape cultivars were large leaf area (more than 125 cm^2) with Orbicular shape.

- **Leaf surface and colour:**

All studied grape cultivars were smooth leaf surface with green colour.

- **Leaf thickness and pubescence:**

All studied grape cultivars were medium leaf thickness with Cob-webby.

- **Leaf lobes:**

Number of leaf lobes was five in all studied grape cultivars.

- **Leaf sinuses:**

Regarding depth of leaf sinuses, it was shallow in depth, when folding the lobe, the sinus reached less than one third of the way to petiole in all studied grape cultivars. As for the form of sinuses, it was narrow in all studied grape cultivars.

- **Leaf margin:**

With respect to the types of margin, it was dentate in all studied grape cultivars. Concerning teeth size, it was medium *i.e.* breadth was equal to length in all studied grape cultivars. As for the apical tooth, it was pointed in Early Sweet grape cultivar, whereas Prime and Star light grape cultivars were convex. Regarding number of teeth, it noticed that Early Sweet, Prime and Star light grape cultivars were medium (58, 54 and 66) respectively.

Table 3. Description and evaluation of Early Sweet, Prime and Star light grape cultivars

		Early Sweet	Prime	Star light
Growing tip	Hairs	Cob-webby	Cob-webby	Cob-webby
	Colour	Green	Green	Green with purple
Tendrils	Sequence	Intermittent	Intermittent	Intermittent
	Tip shape	Di-tri-fid	Di-tri-fid	Di-tri-fid
Leaf	Size	Large(179.4cm^2) cm2)	Large (187.1 cm^2)	Large(174.9cm^2) cm2)
	Shape	Orbicular	Orbicular	Orbicular
	Surface	Smooth	Smooth	Smooth
	Colour	Green	Green	Green
	Thickness	Medium	Medium	Medium
	Pubescence	Cob-webby	Cob-webby	Cob-webby
	Number of lobes	5	5	5
	Leaf sinuses			
	Depth	Shallow	Shallow	Shallow
	Form	Narrow	Narrow	Narrow
	Leaf margin			
	Type	Dentate	Dentate	Dentate
	Teeth size	Medium	Medium	Medium
	Apical tooth	Pointed	Convex	Convex
	Number of teeth	Medium (58)	Medium (54)	Medium (66)
	Petiole			
	Shape	U -shaped	U-shaped	U -shaped
	Sinus	Wide	Wide	Wide
	Petiole length (P)	6.6	9.3	8.4
	Leaf length (L)	8.1	9.8	11.1
	Petiole P/L	0.81 (Long)	0.95 (Long)	0.76 (Medium)
Bunch	Weight	Medium (440.8g) (440.8g)	Big (557.5g)	Big (601.9g)
	Length	Medium (16.5)	Long (19.7)	Medium (17.0)
	Shape	Shouldered	Winged	Conical
	Density	Well-filled	Well-filled	Compact
	Peduncle	Medium (3.1cm)	Medium (3.4cm)	Medium (2.6cm)
Berry	Weight	Big (4.87g)	Big (4.90g)	Big (4.95g)
	Size	Large (4.82cm^3)	Large (4.87 cm^3)	Large (4.91cm^3)
	Shape	Ovoid	Ovoid	Oblate
	Colour	Yellowish green	Yellowish green	Bright red

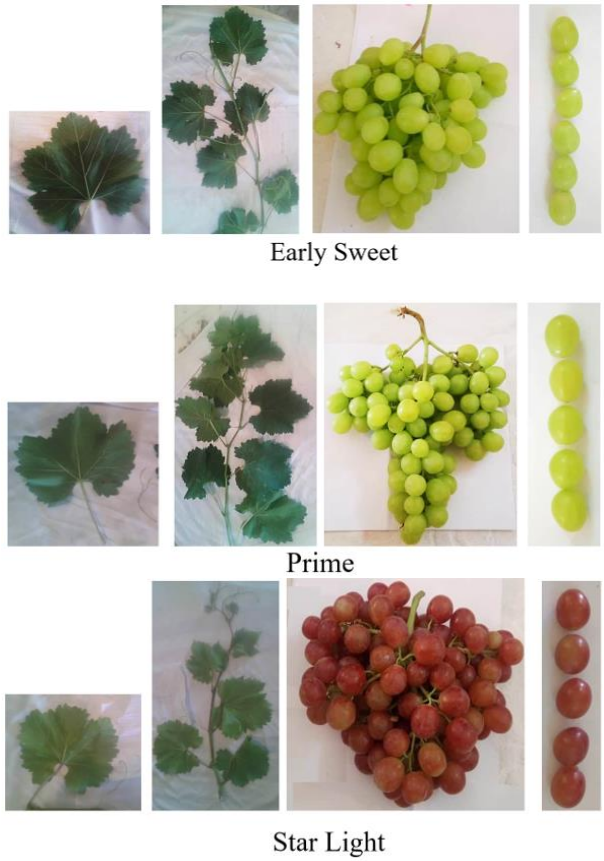


Figure 1. Leaf, bunch and berry of some grape cultivars

- **Petiole:**

With regard to petiole shape, it was U-shaped in all studied grape cultivars. As for petiole sinus, all studied grape cultivars had wide. Concerning the ratio between petiole length to leaf length P/L, Early Sweet and Prime grape cultivars were long, while it was medium in Star light grape cultivar.

- **Bunch:**

With regard to bunch weight, it is clear that Early Sweet grape cultivar was medium (251-500g), whereas Prime and Star light grape cultivars were big (501-1000g).

As for bunch length, it was found that in Prime grape cultivar was long (18-24cm), while Early Sweet and Star light grape cultivars were medium (12-18cm).

Concerning the bunch shape, it was noticed that Early Sweet grape cultivar was shouldered, Prime grape cultivar was winged and Star light grape cultivar was conical.

As for bunch density, it was found that Early Sweet and Prime grape cultivars were well-filled, while Star light grape cultivar was compact.

With respect to peduncle of bunches, it was noticed that all studied grape cultivars were medium (2.5-3.5 cm).

- **Berries:**

As for berry weight, all studied grape cultivars were big (3.3-7.0g).

Concerning berry size, all studied grape cultivars were large (3.3-7.0 cm^3).

With regard to berry shape, it was noticed that Early Sweet and Prime grape cultivars were ovoid, while Star light grape cultivar was oblate.

With respect to berry colour, it is clear that Early Sweet and Prime grape cultivars were yellowish green, while Star light grape cultivar was bright red.

The findings obtained are in accordance with those of many investigators working on different cultivars (Ismail, 1989, Tourky *et al*., 1995; Fawzy, 1998; Marwad 2002 a and b; Mohamed and Tarbia, 2017 and El-Morsy *et al*., 2017).

3) Bunch physical characteristics

As shown in Table (4), data concerning bunch physical characteristics of Early Sweet, Prime and Star light grape cultivars in both seasons was record.

With respect to bunch weight, it was noticed that Star light grape cultivar had significantly the highest values followed by Prime, while Early Sweet grape cultivar resulted in the least values in both seasons.

As for bunch dimensions, it was found that Prime grape cultivar significantly attained the highest values of bunch length and width, whereas Early Sweet and Star light grape cultivars had the lowest values of these ones, which insignificant differences between them in both seasons.

With respect to shot berries percentage, Early Sweet grape cultivar had significantly the highest percentage followed by Prime grape cultivar, whereas Star light grape cultivar did not contain shot berries in both seasons.

Table 4. Bunch physical characteristics of Early Sweet, Prime and Star light grape cultivars in 2017 & 2018 seasons

Cultivars	Bunch weight (g)	Bunch length (cm)	Bunch width (cm)	Shot berries (%)
First season				
Early Sweet	437.9	16.23	19.41	22.61
Prime	553.6	19.57	21.17	13.17
Star light	596.5	16.74	19.54	0
New LSD (5%)	31.9	1.43	1.17	7.54
Second season				
Early Sweet	443.7	16.81	19.76	21.43
Prime	561.3	19.92	21.29	14.68
Star light	607.2	17.36	19.83	0
New LSD (5%)	37.4	1.51	1.24	5.92

4) Berry physical characteristics

Data presented in Table (5) revealed that Early Sweet, Prime and Star light grape cultivars were differing among them concerning berry physical characteristics in both seasons.

As for average berry weight and size, no significant differences were observed among Early Sweet, Prime and Star light grape cultivars of these ones in both seasons.

With regard to berry length, Early Sweet grape cultivar had significantly the highest values, followed by Star light grape cultivar with no significant differences were noticed between them, whereas Prime grape cultivar resulted in the least values in both seasons of the study.

As for average berry diameter, Star light grape cultivar attained significantly the highest values followed by Prime, grape cultivar, while Early Sweet grape cultivar resulted in the least values in both seasons of the study.

Regarding berry shape index; Early Sweet grape cultivar had significantly the highest values (more elongation) followed by Prime grape cultivar, whereas Star light grape cultivar resulted in the least values in both seasons.

Table 5. Berry physical characteristics of Early Sweet, Prime and Star light grape cultivars in 2017 & 2018 seasons

Cultivars	Berry weight (g)	Berry Size (cm^3)	Berry length (cm)	Berry diameter (cm)	Berry Shape index
First season					
Early Sweet	4.84	4.79	2.41	1.91	1.26
Prime	4.88	4.85	2.35	1.94	1.21
Star light	4.93	4.89	2.39	2.05	1.17
New LSD (5%)	N.S.	N.S.	0.03	0.04	0.03
Second season					
Early Sweet	4.89	4.85	2.43	1.93	1.26
Prime	4.91	4.88	2.36	1.95	1.21
Star light	4.97	4.93	2.42	2.08	1.16
New LSD (5%)	N.S.	N.S.	0.02	0.03	0.02

5) Berry chemical characteristics

As shown in Table (6), data concerning berry chemical characteristics of Early Sweet, Prime and Star light grape cultivars in both seasons was record.

With respect to total soluble solids in berry juice, insignificant differences was observed among Early Sweet, Prime and Star light grape cultivars of this parameter in both seasons.

Regarding acidity in berry juice, it was noticed that Star light grape cultivar had significantly the least percentages followed in an ascending order by Prime grape cultivar, whereas Early Sweet grape cultivar resulted in the highest percentages in both seasons.

Concerning berry TSS/acid ratio, the highest significant values of this parameter were attained by Star light grape cultivar followed by Prime grape cultivar, while Early Sweet grape cultivar had the least values in both seasons.

The findings obtained are in accordance with those of many investigators working on different cultivars (El-Sharkawy 1995; Fawzy 1998; Marwad, 2002 a and b; Gaser, 2006; Girgis, 2007; Sabry *et al*., 2009; Mohamed and Tarbia, 2017 and El-Morsy *et al*., 2017).

Table 6. Berry chemical characteristics of Early Sweet, Prime and Star light grape cultivars in 2017 & 2018 seasons

Cultivars	TSS (%)	Acidity (%)	TSS/acid ratio
First season			
Early Sweet	16.7	0.49	34.1
Prime	16.5	0.48	34.4
Star light	16.4	0.46	35.7
New LSD (5%)	N.S.	0.02	0.7
Second season			
Early Sweet	16.9	0.48	35.2
Prime	16.6	0.45	36.9
Star light	16.5	0.44	37.5
New LSD (5%)	N.S.	0.01	0.4

Molecular assessment

To assess the genetic diversity among Early Sweet, Prime and Star light grape cultivars, banding patterns and DNA profile (Figures. 2: 4) of seven ISSR and nine SCoT primers were screened to investigate the genetic diversity. Except for HB-12, the other primers revealed polymorphic patterns and illustrated them to be valid with an acceptable degree in discriminating among these cultivars.

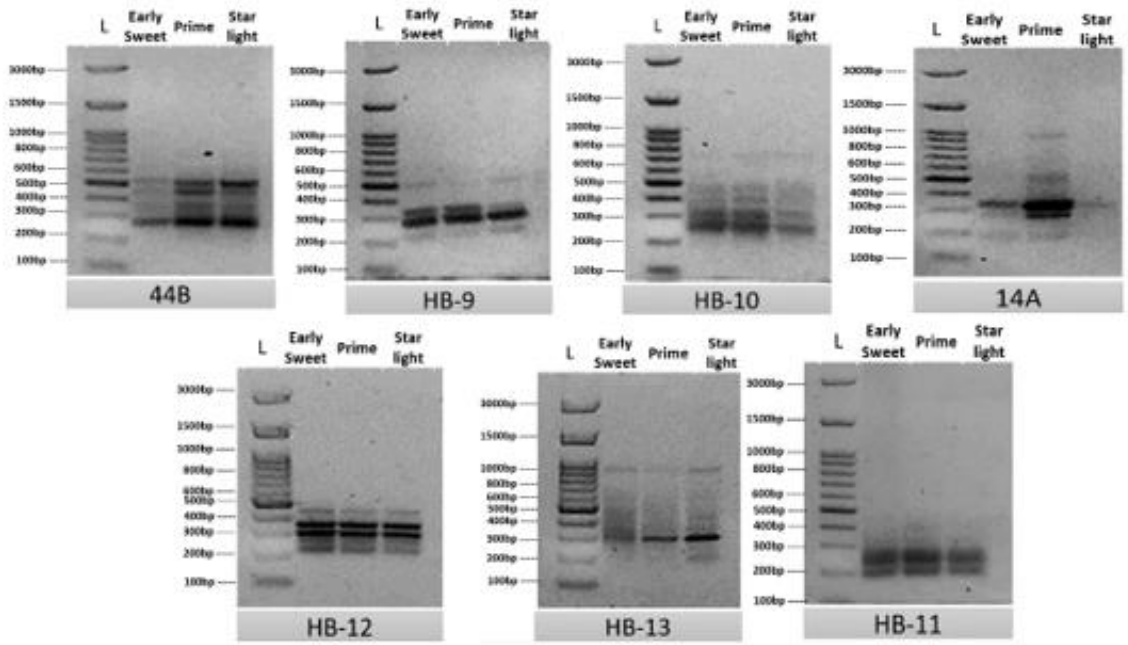


Figure 2. ISSR banding patterns of Early Sweet, Prime and Star light grape cultivars, for nine primers. L, ladder (0.1: 3 kbp) and lanes 2 to 4 represent the three cultivars.

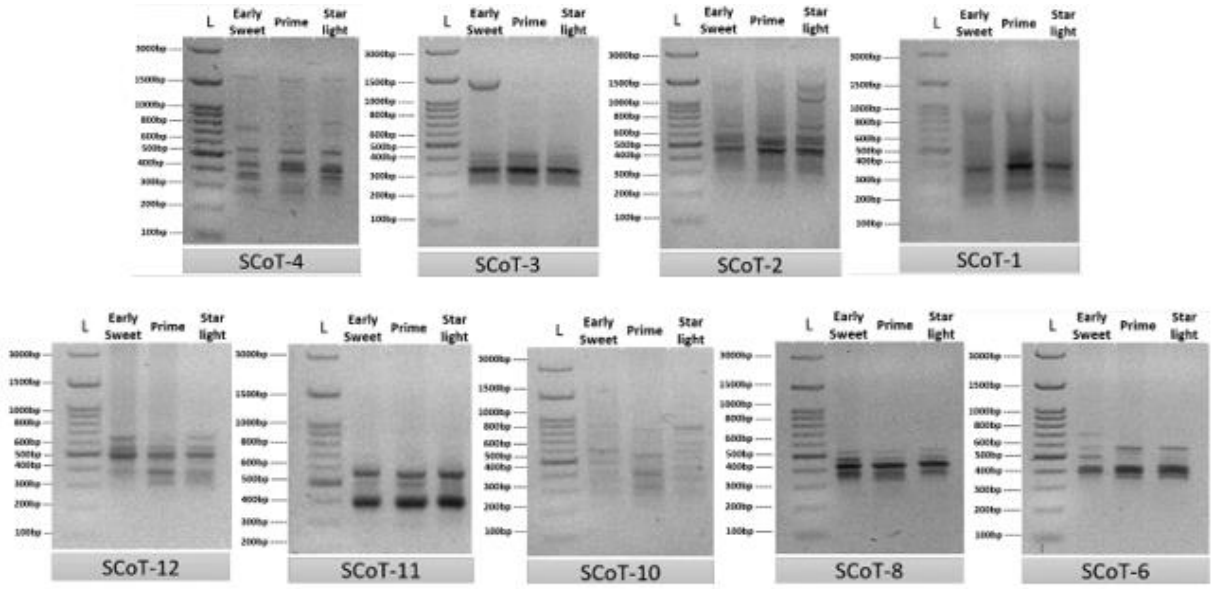


Figure 3. SCoT banding patterns of Early Sweet, Prime and Star light grape cultivars, for nine primers. L, ladder (0.1: 3 kbp) and lanes 2 to 4 represent the three cultivars.

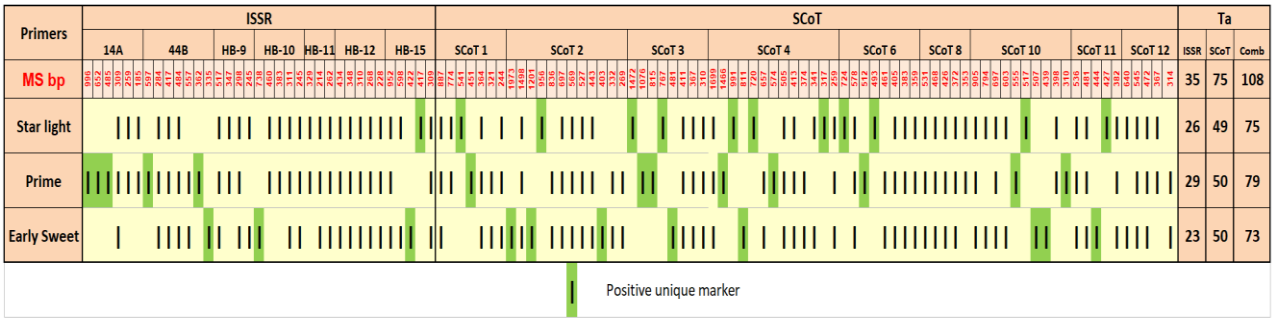


Figure 4. DNA-profile representation of ISSR & SCoT fingerprints of Early Sweet, Prime and Star light grape cultivars based on 108 amplicons, 36 of them were positive marker loci.

From ISSR banding patterns, the molecular data were estimated (Table 7) detected that the 14A & 44B primers which contain the repetitive motif (CT) showed the highest number of polymorphic amplicons 5 & 4 with 25.7 % from all ISSR amplicons. Also, these primers targeted generating 6 unique amplicons with 66.67% from all ISSR unique amplicons. Indicating that this microsatellite is more contribution in generating reliable markers in grape. Moreover, these primers showed the highest Rp values were 3.33 and 2.67 with polymorphism % and PIC of (83.33, 0.370) and (57.14, 0.254), respectively. Suggesting the high discriminatory potential of these primers compared to other ISSR primers used in this study according to Prevost & Wilkinson (1999).

Table 7. Molecular data of ISSR molecular marker technique.

Primer Name	Amplicons					Polymorphism %	Polymorphic index content (PIC)	Resolving power Rp
	Molecular size range	Monomorphic	Polymorphic		Total			
			Without unique	Unique				
14A	185:996	1	2	3	6	83.33	0.370	3.333
44B	335:597	3	1	3	7	57.14	0.254	2.665
HB-09	245:517	2	2	0	4	50.00	0.222	1.332
HB-10	245:738	2	2	1	5	60.00	0.267	1.998
HB-11	262:329	2	1	0	3	33.33	0.148	0.666
HB-12	228:434	5	0	0	5	0.00	0.000	0.000
HB-15	309:952	2	1	2	5	60.00	0.267	1.998

On the other hand, Table 8 illustrated molecular data of SCoT primers used in this study. All these primers were from the Dataset-I type which targets highly expressed genes in plant tissues as described by Sawant *et al.* (1999). The first seven SCoT primers targeted generating of a total of 38 polymorphic amplicons. These primers were similar in the last five nucleotides at the 5´end and different in the last three nucleotides at the 3´end. These primers targeted generating of a total of 25 from 27 unique amplicons with 92.6 %. Where, the SCoT-4, SCoT-10 and SCoT-2 primers which differ only in one out of the last three nucleotides at the 3´end showed the highest Rp values were 5.99, 5.33 and 4.66 with polymorphism % and PIC of (69.23, 0.342), (80.00, 0.355), and (58.33, 0.222) respectively. Indicating

the high discriminatory potential for this type of SCoT markers and which may be more successful in generating reliable markers in grape as previously indicated by Prevost & Wilkinson (1999).

Table 8. Molecular data of SCoT molecular marker technique.

Primer Name	Amplicons					Polymorphism %	Polymorphic index content (PIC)	Resolving power Rp
	Molecular size range	Monomorphic	Polymorphic		Total			
			Without unique	Unique				
SCoT-1	224:887	3	2	2	7	57.14	0.254	2.664
SCoT-2	269:1973	5	3	4	12	58.33	0.222	4.662
SCoT-3	310:1472	3	0	5	8	62.50	0.278	3.330
SCoT-4	259:1699	4	3	6	13	69.23	0.342	5.994
SCoT-6	359:724	4	1	3	8	50.00	0.22	2.664
SCoT-8	353:531	4	1	0	5	20.00	0.089	0.666
SCoT-10	310:905	2	3	5	10	80.00	0.355	5.328
SCoT-11	382:536	3	0	2	5	40.00	0.178	1.332
SCoT-12	314:640	2	3	0	5	60.00	0.267	1.998

In comparison between combined molecular data for both SCoT and ISSR primers, it is evident from Table 9 that the total number of scorable ISSR amplicons was 35 with an average of 5.0 amplicons/primer, with a product size ranged from185 and 996 bp. While the total number of scorable SCoT amplicons was 75 with an average of 8.3 amplicons/primer, with a product size ranged from 224 and 1973 bp. Also, through better discrimination capabilities compared with ISSR, SCoT primers targeted generating 43 polymorphic amplicons with an average of 4.8/primer and 27 unique markers with an average of 3.0/primer. While ISSR primers except HB-12 targeted generating 18 polymorphic amplicons with an average of 2.6 /primer and 9 unique markers with an average of 1.3 /primer. This discrimination capability for the SCoT technique confirmed by P%, UM%, DI, and Rp values which were 55.24, 37.0, 0.25 and 3.18 respectively, compared with the same values for ISSR-technique which were 49.11, 25.7. 0.22 and 1.71, respectively. This indicates the high discriminatory potential of using SCoT primers compared with ISSR primers. Where, SCoT markers were more discriminating, provided more informative data. Also, confirms that it can be relying on the SCoT technique to evaluate the genetic diversity among the grape cultivars better than ISSR markers. More importantly, SCoT marker is generated from the functional region of the genome, so genetic analyses such as genetic diversity, genotype identification, construction of linkage maps and QTL mapping using this marker would be more useful (Hajibarat *et al.*, 2015).

Table 9. Comparison of discriminating capacity between ISSR and SCoT Molecular markers techniques.

Technique	MS	SA		PA		UA		P %	UM %	DI	Rp
		Total	Mean	Total	Mean	Total	Mean				
ISSR	185:996	35	5.0	18	2.6	9	1.3	49.11	25.7	0.22	1.71
SCoT	224: 1973	73	8.3	43	4.8	27	3.0	55.24	37.0	0.25	3.18

MS: Molecular size; SA: Scorable Amplicons; PA: Polymorphic Amplicons; UA: Unique Amplicons; P%: Polymorphism % ; UM%: Unique Marker %; DI: Diversity Index; Rp: Resolving power.

This result agrees with Gorji *et al.* (2011) in Potato and Etminan *et al.* (2016) in durum wheat, Abdel-Hameed *et al.* (2020), and Bashandy *et al.* (2020) in grape. They found that the SCoT marker was more informative and effective than the ISSR marker to estimate the genetic diversity and perform fingerprinting in these plants. While this result disagrees with Ramadan *et al.* (2019), who found that the ISSR marker is more discriminating and provides more informative data than SCoT in fennel cultivars.

While Baghizadeha and Dehghan (2018), and other researchers, recommend that it is preferable to use these molecular marker techniques in combination with each other for distinctive fingerprinting. Also, indicated that cluster analysis based on ISSR and SCoT data obviously discriminated among the Iranian pistachio cultivars. This was confirmed by Abd El-Aziz *et al.* (2019), who reported that the combined data of ISSR and SCoT molecular marker techniques were suitable and more informative for assessing the genetic relationships and genetic diversity among apricot strains.

Genetic distances estimation and cluster analysis

Genetic distances were estimated as Molecular and Phenotypic distances (MD & PD) based on the combined molecular data and quantitative data of studied characteristics respectively (Table 10). These data exhibited that the highest MD & PD were between Early Sweet and Star light grape cultivars. Whereas the lowest PD was between Prime and Early Sweet strain cultivars, the other molecular distances between Prime with Early Sweet or Star light cultivars were very close.

Table 10. Distances matrix between Early Sweet, Prime and Star light grape cultivars based on combined molecular data and Phenotypic (physical and Chemical characteristics) data.

Distances matrix		Star light	Prime
Prime	Combined molecular data	0.260	
	Phenotypic data	202.5	
Early Sweet	Combined molecular data	0.284	0.263
	Phenotypic data	280.0	80.4

Also, from this matrix, the dendrograms of cluster analysis were performed using molecular and phenotypic distances (Figure 5). These dendrograms are divided into three groups according to the truncated line at a coefficient of dissimilarity= 0.13 & 40.18, respectively. Whereas each group was contained one cultivar in the two AHC dendrograms.

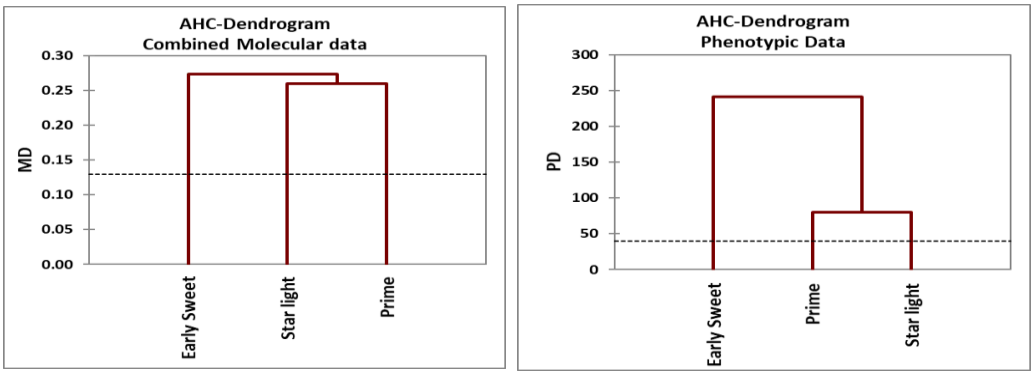


Figure 5. Agglomerative hierarchical clustering (AHC) dendrograms derived by UPGMA method using combined molecular data and phenotypic data of Early Sweet, Prime and Star light grape cultivars.

Legend: TL represents truncated lines at a coefficient of dissimilarity or distance for molecular combined data of =0.13 & 40.18, respectively.

Association between molecular markers and distinguishing traits

Finally, by calculating the correlation coefficient between combined MD and PD, positive correlation with coefficient r=0.708 was found. This indicates that the unique markers which were most of them from SCoT markers (27 out of 36) can be associated with the distinguished traits of each cultivar as shown in Table 11 according to Abd El-Aziz *et al.* (2019). This is evidenced by Ibrahim *et al.* (2016), who explained that the SCoT markers were plausibly proved successful to target generic regions across the grape genome, suggesting future studies are needed to decipher the structure of markers which shown in Table 11. These markers after deciphering their structure may help to evolve more reliable molecular markers for the selection of the desirable traits in these cultivars. considering the results of the molecular techniques a distinctive genetic fingerprint for each cultivar. Hence the results of the molecular techniques especially SCoT can be considered a distinctive genetic fingerprint for these cultivars.

Table 11. The relationship between molecular markers and distinguished traits for each cultivar.

Cultivars	Unique markers				Distinguished traits	
	Technique	Primer	Molecular size bp	Total	Trait	Mean performance
Star light	ISSR	HB-15	417	1	Bunch shape Berry shape Berry color	Conical Oblate Bright red
	SCoT	SCoT 1	541	11 (12)		
		SCoT 2	956			
		SCoT 3	767,1472			
		SCoT 4	317, 720, 991			
		SCoT 6	493,724			
		SCoT 10	517			
		SCoT 11	427			
Prime	ISSR	14A	485,652,996	5	Bunch shape	Winged
		44B	362, 567			
	SCoT	SCoT 1	451	8 (13)		
		SCoT 3	815,1076			
		SCoT 4	574,1466			
		SCoT 6	512			
		SCoT 10	310, 555			
Early Sweet	ISSR	44B	335	3	Maturity date Shot berries Bunch shape	Early (1st week of June) High (22.61%) Shouldered
		HB-10	738			
		HB-15	422			
	SCoT	SCoT 2	403,1201,1973	8 (11)		
		SCoT 3	481			
		SCoT 4	811			
		SCoT 10	507,517			
		SCoT 11	444			

In conclusion, it is clear from the results that the Early Sweet, Prime and Star light grape cultivars succeeded under Egyptian conditions, which characterized by the high quality of bunch and berries. SCoT markers were more discriminating, provided more informative data, and evaluated the genetic diversity among the grape cultivars better than ISSR markers. So, we recommend expansion in the cultivation of these cultivars under Egyptian conditions and benefit from the results of the molecular techniques applied in this study to elicit reliable molecular markers characterizing desirable traits in these cultivars to use in Egyptian grape cultivars improving programs.

- Author Contributions: Conceptualization and methodology, Ola A. Ahmed and M. H. Abd EL-Aziz; Phenotypic description and evaluation, Ola A. Ahmed; Molecular assessment, M. H. Abd EL-Aziz; writing original draft preparation, Ola A. Ahmed and M. H. Abd EL-Aziz; writing—review and editing, M. H. Abd EL-Aziz; All authors have read and agreed to the published version of the manuscript.

- Conflicts of Interest: The authors declare no conflict of interest.
- Ethical approval: Not applicable

REFERENCES

A.O.A.C. (Association of Official Agricultural Chemists) (1985). Official Methods of Analysis Published by A.O.A.C., Benjamin Franklin Station, Washington DC, USA.

Abd El-Aziz, M. H.; S. Y. Mohamed and Hadeer E. Magwaid (2019). Molecular and phytochemical assessment for some seedy strains of Alamar apricot rootstock under salinity stress. Egyptian Journal of Basic and Applied Sciences, 6 (1): 173–186.

Abd El-Fattah, S.E. and S. Kasstor (1993a). Evaluation of some introduced grapevine cultivars. (A) Seedless cultivars. Minia. J. Agric. Research and Development, 30, 477-491.

Abd El-Fattah, S.E. and S. Kasstor (1993b). Evaluation of some introduced grapevine cultivars. (B) Seeded cultivars. Minia. J. Agric. Research and Development, 31, 493-505.

Abd El-Kawi, A. and S.A. El-Yami (1992a). Bud behaviour of four grape cultivars in Taif Region. S.A.J. Agric. Sci. Mansoura. Univ. 17 (7): 2451-2456.

Abd El-Kawi, A. and S.A. El-Yami (1992b). Vegetative characters of grape cultivars in Taif Region. S.A.J. Agric. Sci. Mansoura. Univ. 17 (7): 2457.

Abd El-Kawi, A. and S.A. El-Yami (1992c). Evaluation of grapes in Taif Region. S.A.J. Agric. Sci. Mansoura. Univ. 17 (7): 2463-2468.

Abd El-Rahman, A.S. (2016). Description and evaluation of two newly introduced grape cultivars under Egyptian condition. Journal of Biol Chem Environ Sci., 11(2): 37-53.

Abdel-Hameed, U. K.; K. Abdelaziz and Nahla El-Sherif (2020). Genetic diversity of grapevine (*vitis vinifera* l.) Cultivars in al-madinah al-munawara based on molecular markers and morphological traits. Bangladesh J. Plant Taxon., 27(1): 113–127.

Alleweldt, G. and E. Dettweiler (1986). Ampelographic studies to characterize grapevine varieties. Vignevini, 13: 56-59.

Aswathy, L.; R.S. Jisha and V. H. Masand (2017). Computational strategies to antimalarial thiazine alkaloid lead compounds based on an Australian marine sponge *Plakortislita*. J Biomol Struct Dyn., 35(11): 2407-2429.

Baghizadeha, A. and E. Dehghanb (2018). Efficacy of SCoT and ISSR markers in assessment of genetic diversity in some Iranian pistachio (*Pistaciavera L.*) cultivars. Pistachio and Health Journal, 1(1): 37-43

Bashandy, T.; S. Kamel and H. Ferweez (2020). Evaluation of Yield, Fruit Quality and Molecular Diversity for Three Grape Cultivars under New Valley Conditions. J. of Agricultural Chemistry and Biotechnology, Mansoura Univ.,11 (7): 229-233.

Bioletti, F.T. (1938). Outline of Ampelography for vinifera grapes in California. Hilgardia, 11: 227-93.

Breider, H. (1950): Morphological characteristics of resistance of grape leaves. Zuchter, 20 (7/8): 210-212.

Brooks, R.M. and H.P. Olmo (1972). Register of new fruit and nut cultivars 2nd Univ. of California Press. USA.

Cosmo, I.; A. Comuzzi and M. Polsinelli (1958): Portnnesti Della Vite Ediziom Agricole. Bologna. Ltaly (pp 27-45).

Dalmasso, G. and L. Cosmo (1952): Investigation of the cultivated wine varieties in Italia. Accad. Ital. Vite. Vino. Roma, Stez. Sper. Vite. Enol. Conegliano.

Dettweiler, E. (1991). Preliminar minimal descriptor list for grapevine varieties. Institute for Grapevine breeding Geilweilerhof, Siebeldingen, FRG.

El-Morsy, F.M.; A.S.A. Gaser and M.N. Mohamed (2017). Morphological description and evaluation of six newly- introduced grape cultivars under Egyptian conditions. J. Plant Production, Mansoura Univ., 8(11): 1059 – 1070.

El-Sharkawy, I.G.M. (1995): Comparative studies and evaluation of fourteen grape cultivars in Egypt. M. Sci. These. Fac. Agric. Alexandria Univ. Egypt.

El-Zanaty, A. M.; Mona H. El-Hadary; M. Ismail and A. A. ElGammal (2013). Genetic diversity of wheat genotypes based on RAPD relative to F1 hybrid performance. Inter. J. of Agron. and Plant Production, 4 (5):1098-1107.

Etminan, A.; A. Pour-Aboughadareh; R. Mohammadi; A. Ahmadi-Rad; A Noori; Z. Mahdavian and Z. Moradi (2016). Applicability of start codon targeted (SCoT) and inter-simple sequence repeat (ISSR) markers for genetic diversity analysis in durum wheat genotypes. Biotechnology & Equipment, 30 (6):1075-1081.

Fawzy, M.E.F. (1998): Studies on growth and fruiting of some new grape cultivars Ph. D. thesis. Fac. of Agric. Cairo- Univ. Egypt.

Gaser, A.S. (2006). Evaluation of some newly introduced grape cultivars under Egyptian conditions with special stress on some Morphological characteristics. J. Agric. Sci. Mansoura Univ., 31(11): 7305-7320.

Girgis, V.H. (2007). Comparative studies on four grape cultivars, under conditions of El-Behera governorate, Egypt. J. Agric. Sci. Mansoura Univ., 32 (10): 9699-9713.

Gorji, A. M.; P. Poczai; Z. Polgar and J. Taller (2011). Efficiency of Arbitrarily Amplified Dominant Markers (SCOT, ISSR and RAPD) for Diagnostic Fingerprinting in Tetraploid Potato. Am. J. Pot. Res., 88:226–237.

Gupta, D.D.; Hui, P.K. and Tag, H. (2018). Genotypic variation in Acmella paniculata across different phytogeographical ranges of Northeast India inferred through ISSR & SCoT based markers. J. Appl. Res. Med. Aromat. Plants, 11:3–11.

Hajibarat, Z.; A. Saidi; Z. Hajibarat and R. Talebi (2015). Characterization of genetic diversity in chickpea using SSR markers, Start Codon Targeted Polymorphism (SCoT) and Conserved DNA-Derived Polymorphism (CDDP). Physiology and Molecular Biology of Plants, 21(3):365-373.

Ibrahim, S. D.; S. S. Adawy; M. A. M Atia; A. M. Alsamman and M. M. Mokhtar (2016). Genetic diversity, variety identification and gene detection in some Egyptian grape varieties by SSR and SCoT markers. POJ 9(5): 311-318.

Ismail, M.A. (1989). Studies on growth productivity and quality of some grape cultivars. M. Sci. Thesis. Fac. Agric. Cairo. Univ. Egypt.

Kolenati, I. (1946). Bull Soc Imp Nat Moscow PP 229 quoted by Candoll, de to Vigne 63: 6-23. (C.F. Fawzy, 1998).

Kumar, L.S. (1999). DNA markers in plant improvement. Biotechnology advances, 17, 143-183.

Mao, R.; Xia, P.; J. Liu; X. Li; R. Han; F. Liu; H. Zhao and Z. Liang (2018). Genetic diversity and population structure assessment of Chinese Senna obtusifolia L. by molecular markers and morphological traits of seed. Acta Physiol. Plant. 40. https:// doi. Org /10.1007/s11738-017-2586-3

Marwad, I.A. (2002a). Comparative studies of five seedless grape cultivars under conditions of Qalubia governorate, Egypt. Egypt. J. Appl. Sci., 17 (1) 285-306.

Marwad, I.A. (2002b). Comparative studies on seven seedless grape cultivars under conditions of Qalubia governorate, Egypt. Egypt. J. Appl. Sci., 17 (1) 307-326.

Ministry of Agriculture, A.R.E., (2018): Economic Agriculture, Department of Economic Agriculture and Statistics.

Mohamed, G.A. and Kh.A. Tarbia, (2017). Description and evaluation of Sable, Midnight Beauty and Desert Red grape cultivars under Egyptian conditions. Middle East Journal of Applied Sciences, 7(4): 1101-1109.

Morrison, J.C. (1994). Bud development in *vitis vinfera*. L. Botanical Gazette of viticulture and Enology. Univ. of California. Davis C.A. (Hort Abst., 645:72668).

Nei, M. and W. H. Li (1979). Mathematical model for studing genetic variation in terms of restriction endonucleases. Proc. Natl. Acad .Sci., USA,76: 5269- 5273.

Prevost, A. and M. J. Wilkinson (1999). A new system of comparing PCR primers applied to ISSR fingerprinting of potato cultivars. TAG Theoretical and Applied Genetics, 98:107-112.

Ramadan, Walaa A.; R. M. Shoaib, Rania T. Ali and N. S. Abdel-Samea (2019). Assessment of genetic diversity among some fennel cultivars (*Foeniculum vulgare* Mill.) by ISSR and SCoT Markers. African J. Biol. Sci., 15 (1): 219-234.

Rodrigues, A. (1959). The characterization of vine rootstocks by leaf measurements and the use of discriminate equations. Agro. Lusity 21: 259-98 Bible 8 IIIUS. (C.F. Fawzy, 1998).

Sabry, G. H. M.; M. S. Rizk-Alla and S.Y. Mohamed (2009). Horticultural and molecular genetic characterization of some grape cultivars under desert land conditions. J. Biol. Chem. Environ. Sci., 4(1):519-544.

Santiago, J.L.; S. Boso; P. Gago; V. Alonso-Villaverde and M. C. Martinez (2007). Molecular and ampelographic characterization of *Vitis vinifera* L.'Albarino', 'Savagnin Blanc' and 'Caino Blanco' shows that they are different cultivars. Spanish Journal of Agricultural Research, 5: 333-340.

Sawant, S.V.; P. K. Singhl; S. K. Gupta; R. Madnala and R. Tuli (1999). Conserved nucleotide sequences in highly expressed genes in plants. J. Genet., 78:123-131.

Singh, L. and S. Singh (1940). The distinguishing characters and behaviour of some grape vine cultivars introduced at Lyallpur Punjab. Ind. J. Agric. Sci. 10:551-600.

Snedecor, G. W. and W.G. Cochran (1980). Statistical Methods. 7th ed., The Iowa State Univ. Press. Ames., Iowa, U.S.A., pp. 593.

Soylemezoglu, G.; Y.S. Agaoglu and H.I. Uzun (2001). Ampelographic characteristics and isozymic analysis of Vitis vinifera spp. sylvestris gmel. In:Southwestern Turkey. Biotechnology and Biotechnologycal Equipment, 15 (2): 106-113.

Steel, R.G. and J.H. Torrie (1980). Reproduced from principles and procedures of statistics. Printed with the permission of C. I. Bliss, pp: 448-449.

Tourky, M.N.; S.S. El-Shahat and M.H. Rizk (1995). Evaluation of some new grape cultivars in relation to growth, yield, berry quality and storage life. J Agric. Sci. Mansoura Univ. 29 (12):153-5167.

Walker, M.A. and J.M. Boursiquote (1992). Ampelographic and isozyme data correcting the misnaming of the grape rootstock SO4 at the univesity of Californa Amer. J. Enology and Viticulture 43 (3): 261-265. (C.F. Hort. Abst. 64:4387).

Watt, G. (1983): Dictionary of the economic products of India Vol. Vi. Part 4: 251-79. Govt. of India. Central printing office Calcutta.

Zietkiewicz, E.; A. Rafalski, and D. Labuda (1994). Genome fingerprinting by simple sequence repeat (SSR)-anchored polymerase chain reaction amplification', Genomics, 20:176–183.

وصف وتقييم بعض أصناف العنب المستوردة حديثاً تحت الظروف المصرية

علا عبد الرحيم أحمد[1] و محمد حسن عبد العزيز[2]

[1]قسم بحوث العنب – معهد بحوث البساتين – مركز البحوث الزراعية بالجيزة – مصر

[2]قسم الوراثة – كلية الزراعة – جامعة المنصورة- مصر

أجرى هذا البحث لمدة موسمين متتاليين (2017، 2018) بأحد المزارع الخاصة بمدينة السادات التابعة لمحافظة المنوفية لدراسة وصف وتقييم ثلاثة أصناف من العنب اللابذرية وهى: الإيرلى سويت، البرايم، الإستارلايت تحت الظروف المصرية. أظهرت النتائج أن صنف عنب الإيرلى سويت من أبكر الأصناف فيما يتعلق بالمواعيد الفينولوجية متمثلة فى (تفتح البراعم، اكتمال التزهير، عقد الثمار ، نضج الحبات)، يليها صنف عنب البرايم، بينما صنف عنب إستارلايت كان من الأصناف المتأخرة في هذا الصدد خلال موسمى الدراسة، كما أظهرت الدراسة نجاح هذه الأصناف تحت الظروف المصرية، حيث تميزت بصفات جودة عالية من العناقيد والحبات. تم تقييم التنوع الوراثى بين الأصناف الثلاثة باستخدام تقنيات الواسمات الجزيئية SCoT و ISSR. حيث قدمت علامات SCoT بيانات أكثر إفادة وكانت أكثر تمييزًا مع قيم عالية لنسبة تباين حزم ونسبة العلامات جزيئية متفرده و ودليل تنوع و القدرة التميزية مقارنةً بعلامات ISSR. أظهر التحليل العنقودي تباينًا جزيئيًا وظاهريًا واضحاً بين الأصناف الثلاثة، حيث تم تقسيمها إلى ثلاث مجموعات ، كل مجموعة تحتوي على صنف واحد. أيضاً تميزت هذه الأصناف بـ 36 علامة جزيئية متفرده ، 27 منها كانت من علامات SCoT والتي أثبتت نجاحها في استهداف مناطق جينية متنوعة من جينوم العنب. قد تساعد هذه العلامات الجزيئية المتفرده بعد فك تشفير تتابعاتها في تطوير علامات جزيئية موثوقة للإنتخاب للصفات المرغوبة في هذه الأصناف. لذلك ، نوصي بالتوسع في زراعة هذه الأصناف تحت الظروف المصرية والاستفادة من نتائجنا الجزيئية لاستنباط علامات جزيئية موثوقة تُميز الصفات المرغوبة في هذه الأصناف لاستخدامها في برامج تحسين أصناف العنب المصرية.