Evaluation of Two Newly-introduced Apricot Cultivars under Egyptian Conditions

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ABSTRACT

This investigation was carried out for two successive seasons (2021 and 2022) on Solitaire and Charisma apricot cultivars four years old trees budded on Nemguard Rootstock grown in sandy soil at private orchard, in Assiut governorate, Egypt to evaluate the vegetative, flowering, yield, fruit characters and Molecular Genetic Markers. Data showed that Solitaire was superior than Charisma in total opening number of flower buds, yield in kg/tree, fruit and flesh weight, while shoot length, vegetative bud number, trunk circumference, fruit firmness and harvesting period were longer in Charisma during two studied seasons. The Molecular genetic evaluations were determined by using SCoT and ISSR molecular analysis for PCR reactions. Results revealed a sum of 43 band and these bands were identified as 28 monomorphic and 15 polymorphic ones with polymorphic % (34.88 %) and the polymorphic bands were scored as 18 specific markers, only six of them were positive markers were detected with both of Charisma and Solitaire cvs. By the way, there were genetic variation between both cultivars and also, data were obtained specific markers for each cultivar may be linked to specific traits for each cultivar and this results would be more useful for crop improvement programs. On the other hand, Heterostyly phenomenon for Solitaire cv. was observed during the flower study so, this cultivar needs to cultivar with another apricot cv. blooms at the same time or spread beehives for cross pollination to solve this problem. Finally, we can recommended with spreading of these cultivars under our Egyptian conditions.

Keywords: Apricot- Evaluation- Solitaire- Charisma- Molecular Markers.

INTRODUCTION

Apricot, (*Prunus armeniaca* L.) is one of the most important deciduous fruit trees cultivated in Egypt. The total cultivated area with apricot reached about 10829 Feddans in 2021 (Statistics of 2021, Ministry of Agriculture, Egypt).

The family Rosaceae involves many species of great economic importance, between them the genus Prunus which includes apricot. Stone fruits such as Apricot are very important because they displayed in the market early in summer to cover the requests of the consumers in the time between winter and summer fruits.

In Egypt, it is known that some of the cultivated areas of apricot are planted by seeds and named Balady, Amar, and Hamawy as local cultivars. Trees vary greatly in size, yield, quality of fruit and date of maturity (Bakr et al., 1985 and Seif and Hassan, 1992) and these seedling trees have a short marketing ability and therefore, many attempts were made in order to increase the marketing ability period of the apricot fruits. This can be achieved by selecting the early, middle and late harvest apricot cultivars from locally grown trees or introducing new varieties. Therefore, several new apricot varieties had been introduced to Egypt by the Ministry of Agriculture and private sector such as Solitaire & Charisma and some other cultivars. Some cultivars are adaptable to subtropical conditions due to their low chilling requirements (Ruck, 1975, Mehlenbacher et al., 1991 and Kuden et al., 1995).

On the other hand, Paydas and Kaska (1995) evaluated the pomological characteristics (fruit weight, seed weight, TSS, acidity and the earliness) of Beliana and Feriana apricot cultivars. They found that, the yield and quality characteristics of both cultivars are the most recommendable for the whole Mediterranean coastal line of Turkey.

Fruit quality is a combination of both physical and chemical characteristics accompanied by sensory properties (appearance, texture, taste and aroma nutritional values, chemicals compounds,

chemical compounds mechanical properties and functional properties (Maklad et al., 2005, Valesk and Cejpe, 2007 and Awad et al., 2018). Therefore new apricot cultivars or genotypes must be characterized by high fruit quality attributes which satisfy the consumers (Ruiz and Egea, 2008). On the other hand according to Milosevic et al. (2010), there are several pomological features that influence fruit quality attributes, and these traits cannot be examined in isolation from the biological characteristics of the fruit tree and the yield (Balta et al., 2002, Asma and Ozturk, 2005 and Asma et al., 2007).

Molecular markers provide premium sources of genetic diversity assessment which help breeders to select economical traits and therefore improved the productivity of economical plants. It was shown that molecular marker data are very important for any breeding program to select promising varieties. These markers such as ISSR and RAPD are used efficiently for genetic diversity assessment of plants (Zhang et al., 2015, Etminan et al., 2016 and Aswathy et al., 2017).SCoT is superior to other widely used DNA marker systems such as RAPD and ISSR in terms of improved marker resolvability and increased polymorphism (Gorji et al., 2011).On the other hand, Mohamed et al. (2015) in El-Amar Apricot strains Abd El-Aziz and Habiba (2016) in canolla; Abd El-Aziz et al. (2016) in tomato and Abd El-Hadi et al. (2017) in squash; Awad et al. (2018) in some local Apricot lines; Safaa et al. (2018) in Deciduous Rootstocks and (Abd El-Aziz et al., 2019) in Apricot Rootstocks.

This study aimed to evaluate phonological, physical, chemicals and molecular genetic markers of Charisma and Solitaire as newly introduced Apricot cultivars.

MATERIALS AND METHODS

This investigation was conducted during two seasons of 2020- 2021 and 2021- 2022 on four years old trees of two apricot cultivars Solitaire and Charisma, nearly uniform in growth vigor. This new apricot cultivars were grafted on Nemguard Rootstock, planted at 4*5 m apart (210 trees/feddan) the trees were grown in sandy soil at private orchard, in Assiut governorate, Egypt. In a randomized block design with three replication of three trees per plot. The orchard is irrigated by drip irrigation system and trees were treated with normal agricultural practices. Nine trees were selected nearly equal in growth (three trees for each replicate) and the following records were taken:

Experimental measurements:

(I) Meteorological data

(1) Chilling requirements: Chill units from leaves defoliation till beginning of flowering were recorded as follows:

a) Number of hours at <7.2 ˚C.

b) Number of hours at <10 ˚C.

(2) Heat units: Growing degree hours were determined for fruit growth from start of first sign of flowering (swelling bud) till harvesting date as has been mentioned by Shallenberger et al., (1959): GDH= ∑2 (Tm-7.5)12

When Tm = temperature at a given hour in the day, and 7.2 oC = base temperature.

According to Egyptian Ministry of Agric. and Land Reclamation- Agric. Res. Center-Central Lab. for Agric. Climate (CLAC)

(II) Morphological Data

(A) Vegetative growth characteristics:

(1) Trunk circumference: Was measured for each tree with a tap at a fixed point above graft union.

- For each cultivar, three new, one-year-old branches were chosen from each replication. On June 24 for the "Solitaire" cultivar and July 1 for the " Charisma" cultivar, the following vegetative measurements were taken:

(2) Shoot length (cm): Was measured by using ruler.

(3) Shoot thickness (cm): At the point 5cm base of new shoot by using a vernier caliper.

(4) The number of leaves/shoot: Was measured by counting the number of leaves per each new shoot.

(5) Leaf area (cm^2): Was determined in mature leaves by using leaf area meter equipment.

(B) Flowering:

(1) Bud behaviour: At the beginning of the subsequent season, 4 one year old shoots at the quadrilateral directions of each tree were tagged and the following were assed

- Vegetative buds burst % = (No. of burst vegetative buds /No. of total buds) x 100.
- Flowering buds % = (No. of floral buds/No. of total buds) x 100

(2) Flowering measurements: Numbers of flower bud, opening percentage of flower bud, the beginning of flowering, full bloom date and flowering duration (days) were calculated and recorded. Morphological Characters for flowers were studied.

(C) Fruiting and Yield:

(1) Fruit set (%): Was calculated by:

Fruit set percent =Number of fruit set/ Total number of flowering x 100

(2) Yield (Kg /tree): At harvest time was calculated by number of fruits per tree x Average fruit weight in the mature stage.

(3) Fruit and Endocarp Characteristics:

(a) Qualitative Characteristics: According UPOV (2021).

(b) Quantative Characteristics: Ten fruits per tree were picked to determine the Physical and chemical characteristics of mature fruits that carried out when fruits of control reached maturity. Physical and chemical characteristics were evaluated as following:

- **Physical characteristics of fruit**:
  - **Fruit weight (g):** Average fruit weight was determined by weight a sample of fruits from each replicate and the mean fruit weight was calculated.
  - **Fruit size (cm^3):** Using water displaces meter method.
  - **Fruit dimensions (cm):** Fruit length and diameter were measured by using a vernier caliper.
  - **Fruit L/D ratio:** It was calculated as fruit length/fruit diameter.
  - **Fruit firmness (Lb/Inch2):** It was determined from the two sides of fruits by using a pressure tester **(Advance Force Gorge RH13, UK).**
  - **Flesh thickness (cm):** Was measured by using a vernier caliper.
  - **Flesh Weight (g):** Average of fruits pulp was determined by weight a sample of fruits pulp from each replicate and the average fruit pulp was determined.
  - **Seed Weight (g):** Average of seeds was determined by weight a sample seeds from each replicate and the average seed weight was calculated.
- **Chemical characteristics of fruit:**
  - **Total soluble solids (TSS %):** It was determined in fruit juice sample of fruits by hand refractometer model **(Portable Refractometer ATC).**
  - **Total acidity (%):** It was determined as anhydrous malic acid as a percentage after titration by 0.1 Nsodium hydroxide using phenolphthalein as an indicator (A.O.A.C., 2000).
  - TSS/**acid ratio:** It was calculated by dividing total soluble solids on total acidity.

(III) Molecular Genetic Markers:

For this purpose genomic, fresh leaves of the two apricot cultivars under study were used to isolate DNA. Molecular genetic markers were identified from genomic DNA using RAPD and ISSR methods.

(1) DNA isolation: Genomic DNA was isolated using DNeasy plant mini kit (bio basic). DNA purify was checked by means of absorbance ratios A_{260}/A_{280} through a UV-spectrophotometer where DNA is pure with a ratio A_{260}/A_{280} from 1.8- 2.0. Moreover, DNA quantity was tested

using electrophoresis in 1% agarose gel with ethidumebromide.

(2) Polymerase Chain Reaction: Genomic DNA of the seven genotypes was used as a template for Polymerase Chain Reaction (PCR) amplification using five SCoT and five ISSR primersby Collard and Mackill (2009) and procured from Biobasic Com. PCR products were loaded and separated on a 1.5% agarose gel and developed using ethidumebromide, 100bp DNA Ladder marker ranged from 100bp to 1500bp ladder marker was used. The separation was carried out for about 30 min at 100 V in mini submarine gel BioRad.

(IV) Statistical analysis:

Three replicates, each consisting of a single tree, were used to organize the experimental treatments in a randomized complete block design. Analysis of variance was used to the obtained data in accordance with (Snedecor, 1990). The Duncan multiple range test was used to compare means at the 5% significance level (Duncan, 1955).

DNA banding patterns were photographed using Bio-1D Gel Documentation system and were analyzed by GelAnalyzer3 software which scoring present fragments as (1) or absent (0) for each primer and entered in the form of a binary data matrix. From this matrix, DNA-profiles were performed for SCoT and ISSR techniques according to Adhikari et al. (2015).

RESULTS AND DISCUSSION

(I) Meteorological data:

(1) Chilling requirements:

Table (1) show accumulated Chilling units and growth degree hours measured over two seasons at the Assiut Governorate in Egypt, computed using two distinct methodologies. The maximum total chilling units needed to thwart the dormant buds of Solitaire and Charisma cultivars in the first and second seasons at temperatures below 10°C. Additionally, the first season's highest G.D.H. "1875" for two cultivars, and it's critical to assist flower buds in starting to burst and open once they had completed their chilling requirement. On the other hand, for the vegetative buds to burst open at the start of the season, G.D.H. is crucial. The second season had the lowest G.D.H., particularly in Charisma and Solitaire.

Table (1). Accumulated chilling units and G.D.H from leaves defoliation till beginning of flowering of new tow cultivars Solitaire & Charisma Apricot trees (2020/ 2021 and 2021/ 2022).

		Solitaire		Charisma	
From leave defoliation till beginning of flowering (1 December 2021 to 1 January)		1st season	2nd Season	1st season	2nd Season
	<10 °C	360	692	375	719
	<7°C	173	205	175	208
G.D.H		1875	1848	1875	1824

(II) Morphological Data

(A) Vegetative growth characteristics:

Vegetative Growth Measurements: The data of vegetative growth measurements in **Table (2)** show trunk circumference in “Charisma” cv. bigger than “Solitaire” cv in both seasons. It showed significant differences with increasing in one-year-old Shoot length (48.91 and 49.69 cm) and number of leaves/shoot (55.64 and 70.63) for “Charisma” cv compared to “Solitaire” cv had short shoot length (46.19 and 47.33 cm) and decreased in number of leaves/shoot (61.1 and 65.13) while non-significant between the two cultivars in Leaf area (cm^2) on spurs during two seasons.

The data in **Table (2)** show “Charisma” cv gave significant highest value with increase in leaf area(32.43 and 36.11 cm2) than “Solitaire” cv (30.55 and 33 cm2) it may be due to a genotypic differences or low fruit yield the lower yield led to the availability of higher food storage, which led to an increase in the leaf area. Leaf area in shoot was bigger than spurs and gave significant in shoot was

bigger than spurs and gave significant differences for both cultivars during two seasons may be due to low fruit bearing on shoot because the fruits bearing for the two cultivars on spurs. The increase in the number of leaves **(Table 2)** and the leaf area of "Charisma" over "Solitaire" cultivar may be due to the lack of competition of leaves and flowers for the stored food during the beginning of flowering for deciduous trees. This benefit from the food led to the trees producing strong leaves.

These above mentioned cultivars are contradiction in shoot length with Gebally (1975) who found that, the average shoot length in Hamawy was ranged be-tween 48.8 cm to 54.6 cm in 1972 and 1973 seasons and ranged between 44.8 cm to 50.4 cm in Amar apricot cultivar. Similar findings concerning spure length was obtained, whereas, the average spure length ranged between 4.6 cm to 6.1cm in Hamawy and ranged between 5,5 cm to 6.3 cm in Amar in 1972 and 1973 seasons, respectively. On the other hand, Asfour, (1960) found that, the spurs length of Hamaway and Balady apricot cultivars (one year old) ranged 0between 1.3–2.3 cm and 1–2.3 cm, respectively and the length of the spurs (more than one year old) was ranged between 2–3.7 cm and 0.9–2.3 cm respectively.

It could be concluded that Charisma and Solitaire apricot varieties could be considered as promising varieties under Egypt conditions due to their precocity, minimum fruit abscission, high yield and early fruit ripening and good pomological characteristics with the exception of size.

Table (2). Vegetative growth of new two cultivars Solitaire and Charisma Apricot trees (2020/2021 and 2021/ 2022).

Cultivar	Trunk circumference (cm)	Shoot length (cm)	Shoot thickness (cm)	Number of leaves/shoot	Leaf area (cm^2) on shoots	Leaf area ($cm^{2)}$ on spurs
			Season; 2021			
Solitaire	27.27 b	46.19 b	0.45 a	61.1 a	30.55 a	30.55 a
Charisma	31.20 a	48.91a	0.47 a	55.64 a	32.43 a	32.43 a
LSD 0.05	0.92	1.255	(0.19) N.F	10.91	5.14	5.14
			Season; 2022			
Solitaire	30.26 a	47.33	0.56a	65.13	33	32.65
Charisma	34.10 a	49.69	0.58a	70.63	36.11	35.21
LSD 0.05	6.16	1.255	(0.29) N.F	9.848	1.8382	3.4263

(B) Flowering:

Data in **Table (3)** presented significant differences the highest percentage of Vegetative bud occur in the second season of Charisma cultivar compare with the first season for the same cultivar (38.2 and 44.16). Flower bud revealed the highest percentage at Solitaire in tow successive seasons (65.62 and 66.37) followed by Charisma (42.8 and 51.38)in both seasons. On the other hand, fruit set was insignificant in both cultivars in two seasons.

Table (3). Vegetative bud percentage opening, flower bud opening percentage and fruit set percentage of new tow cultivars Solitaire & Charisma Apricot trees (2020/ 2021 and 2021/ 2022).

Cultivar	Vegetative bud %	Flower bud %	Fruit set %
		Season; 2021	
Solitaire	32.09 b	65.62 a	25.36 a
Charisma	38.20 a	42.80 b	23.00 a
LSD 0.05	2.75	5.46	4.96
		Season; 2022	
Solitaire	40.33 b	66.37 a	30.25 a
Charisma	44.16 a	51.38 b	27.66 a
LSD 0.05	3.10	2.45	3.23

(C) Fruiting, yield, qualitative, quantative Characteristics:

Data in **Tables (4 and 5)** and **Fig (1)** describe the morphological description by test guidelines UPOV and Date of different Phenological growth stages (flowering) of Solitaire & Charisma apricot tree.

Table (4). Morphological description for Solitaire and Charisma cultivars .

Parameter	Solitaire	Charisma
(1) **Tree**		
- Vigour	Strong	Strong
- Growth habit	Semi spreading	Spreading
- Bearing habit	On both spurs and shoots	Spurs
- Shoot and spurs color	Reddish	Brown
- Trunk	Reddish with whit spots	Pale gray
(2) **Leaves**		
- Leaves Shape	Hearty toothed	Hearty toothed
- Leaf petiole colore	Reddish blush	Brown
(3) **Buds**	Thin	Thick
(4) **Fruit and Stone**		
- Fruit shape	Oblong	Oval
- Skin colour	Yellow 20% red	Orange- yellow with red blush
- Texture	Medium to fine	Melting
- Stone	Free	Free
- Stone color	Brown	Brown
- Flesh colour	Yellow	Orange
- Storage ability	Good	Very good
(5) **Others**		
- Intensity of flower	High	Medum
- Fruit set	Very good	Good
- Production (Kg/tree)	Excellent	Good
- Root stocks evaluated	Nemagard	Nemagard
- Pollinator	Self- compatible	Self- compatible

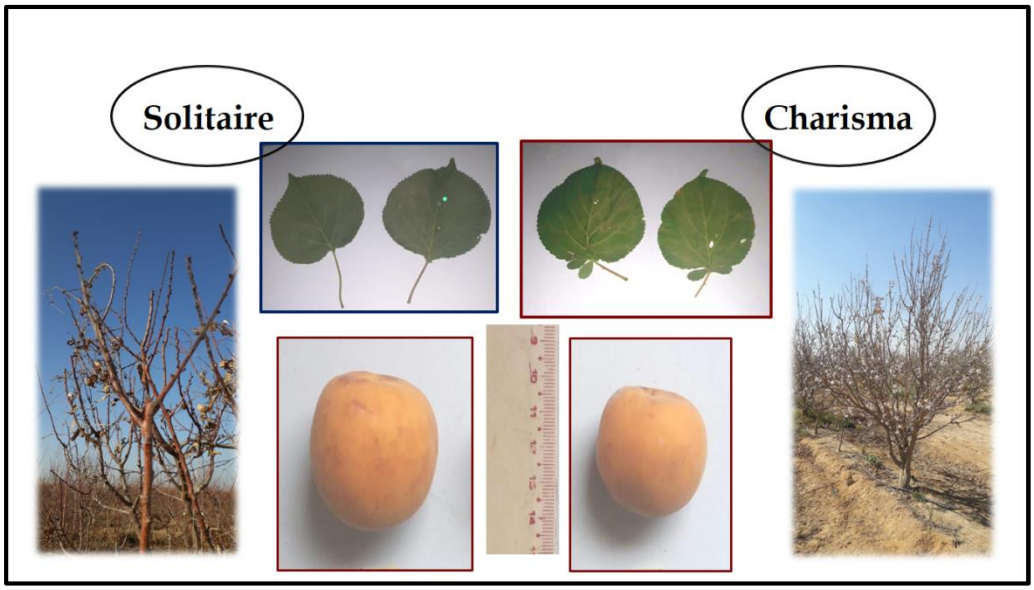


Fig. (1): The morphological description of new two cultivars Solitaire & Charisma Apricot trees (2020/ 2021 and 2021/ 2022).

Table (5). Date of different flowering stages dates of Solitaire and Charisma apricot tree.

Periods – February

Stage		15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Dormant	Sol.	■														
	Char.	■														
Flower bud swelling	Sol.	■	■	■	■	■	■	■	■	■	■	■				
	Char.						■	■	■	■	■	■				
Bud burst (green tip)	Sol.						■	■	■	■	■	■				
	Char.											■	■	■	■	■
Tight cluster	Sol.												■	■	■	■
	Char.															
Open cluster	Sol.															
	Char.															
White bud	Sol.															
	Char.															
Pink balloon	Sol.															
	Char.															
Full blloon	Sol.															
	Char.															
Petal fall	Sol.															
	Char.															

Periods – March

Stage		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Dormant	Sol.																														
	Char.																														
Flower bud swelling	Sol.																														
	Char.																														
Bud burst (green tip)	Sol.																														
	Char.																														
Tight cluster	Sol.	■	■	■	■	■																									
	Char.	■	■	■	■	■	■	■																							
Open cluster	Sol.	■	■	■	■	■																									
	Char.							■	■	■	■																				
White bud	Sol.				■	■																									
	Char.											■	■	■	■																
Pink balloon	Sol.						■	■	■	■																					
	Char.														■	■	■														
Full blloon	Sol.							■	■	■	■																				
	Char.																■	■	■	■	■										
Petal fall	Sol.										■	■	■	■	■	■															
	Char.																					■	■	■	■	■	■	■	■	■	■

Solitaire **Charisma**

Physical characteristics of fruit:

Data in **Table (6)** showed that all fruit physical characteristics were higher in Solitaire fruit size, weight, diameter, seeds weight, yield/tree, flesh thickness; yield/tree and flesh observed significant differences the highest values were in Solitaire at both seasons. It could be noticed that there was appositive response of fruit firmness in two seasons observed in Charisma cultivar.

Concerning the differences of fruit length and L/D ratio it were insignificant for two seasons respectively in both cultivars.

The weights of fruits for the tested varieties were in harmony with Gebally (1975) on Hamawy, Amar and Balady with Khaliel et al. (1999) and Shakweer (2003) on Canino apricot trees. Also, Paydas et al. (1995) found that, the average fruit weight of Beliana and Feriana apricot fruits were ranged from 35.02 g to 42.69 g and from 29.86 g to 43.35 g, respectively. On the other hand, their seed weigh changed from 2.88 g to 3.34 g and from 2.58 g to 3.24 g, respectively. Also, the same authers found that the average fruit and seed weight for Beliana and Feriana were 25.69 g, 24.47 g and 2.30 g and 2.31 g, respectively. In addition, Kuden and Kaska (1995) cleared that, the average fruit weight for Feriana cultivar was ranged from 26.53 g to 28.73 g during 1992 and 1993 seasons, respectively. In addition, the same trend of fruit weight of Feriana cultivar was achieved by Polat et al. (2004).

Fruit firmness for Australia1 and Australia2 varieties was similar to those found by Abdel-Hamid et al (1998) on Canino fruits who indicated that firmness was 9.1, 8.7, 9.2 lb/inch2 and 8.9, 8.9, 8.7 lb/inch2 under three different irrigation treatments in 1996 and 1997 seasons respectively. While, the firmness of both Beliana and Feriana fruits were agree with the obtained results by Papanikolaou and Poulis et al. (1999) in 14 apricot varieties which ranged between 2.71–11.45 (Ibs) .

Fruit size of experimental varieties are in contradiction with those found by Gebally (1975) on Hamawy, Amar and Balady selections and seedling trees and with Khaliel and El-Sheikh (2000) on Amal and Canino apricot trees .

Marini (1996) found that, in Chinese, Hungarian Rose, Blenheim, Veecot, Rival, Goldrich, Perfection, Wilson Delicious, Goldcot, Tilton, Harlayne, and Hargrand apricot varieties the length/diameter ratio ranged from 0,94 to 1,11 during 1993 - 1995 seasons .

Table (6). Some physical characteristics of fruit of new two cultivars Solitaire and Charisma Apricot trees (2020/2021 and 2021/2022).

Cultivar	Fruit weight (gm)	Fruit size (cm^3)	Fruit length (cm)	Fruit diameter (cm)	L/D Ratio	Flesh (%)	Flesh thickness (cm)	Fruit firmness (lb/in^2)	Seeds weight (gm)	Yield/tree (kg)
Season; 2021										
Solitaire	46.02	47.30	4.20	4.37	0.96	84.42	1.17	1.52	7.17	33.20
Charisma	34.85	35.15	3.75	3.80	1.01	92.94	0.93	2.37	2.46	22.20
L.S.D. at 0.05	5.33	4.27	0.45	0.287	0.138	2.94	0.759	0.4159	1.095	1.49
Season; 2022										
Solitaire	41.20	42.17	4.50	4.13	1.09	83.53	1.15	1.38	6.79	35.20
Charisma	35.01	36.46	3.60	3.87	0.93	92.69	0.90	2.08	2.56	24.57
L.S.D. at 0.05	4.26	3.358	1.1384	0.143	0.311	2.19	0.124	0.0124	2.8443	1.5

Chemical characteristics of fruit:

In **Table (7)** the data reveal that "Solitaire" cv. attained significantly highest percentages of TSS than "Charisma" cv. (17.67 and 14.5 %) in the first season and (18.33 and 14.67) in the second season. While non-significant in acidity for both cultivars during 2021 and 2022 seasons. On the other hand, the TSS/acidity hasn't significant results in both seasons in two cultivars. Increasing in TSS% of the Solitaire cultivar over the Charisma cultivars might be due to the increasing in number of leaves and leaf area, which gave the rate of increasing in the photosynthesis carbohydrates products of the leaves and thus an increase TSS%

These results are similar with the results obtained by Paydas et al. (1995) who found that in Beliana and Feriana fruits the TSS content was 10.29 % and 9.21% or 10.93% and 12.13%, respectively. The highest acidity was found in Beliana apricot fruits (2.21% and 1.57%) while, the acidity of Feriana was about (1.44% and 1.48%) in 1992 and 1993 seasons, respectively. The same authors found that the TSS% was 12.67% and 9.27% and the acidity percentage of Feriana apricot fruits (1.49%) was higher than Beliana fruits (0.38%) under Adana region–Turkey conditions. On the other hand, the acidity value for the tested fruits are in contrary with the findings of Khaliel et al., (1999), who found that acidity percentage of Canino fruits was 0.45% and 0.63% in 1995 and 1996 seasons respectively. In addition, Guleryuz and Bolat (1999) found that in five apricot cultivars the acidity percentage was ranged between 0.45–0.63% in 1995 and 1996 seasons. Moreover, the same trend of TSS% for Feriana fruits was achieved by Polat et al. (2004).

Table (7). Some chemical characteristics of fruit of new tow cultivars Solitaire and Charisma apricot trees (2020/ 2021 and 2021/ 2022).

Cultivar	TSS (%)	Acidity (%)	TSS/ acidity ratio
		Season; 2021	
Solitaire	17.67 a	3.33 a	5.31a
Charisma	14.50 b	2.90 a	5.00a
LSD 0.05	5.171	1.41	1.656
		Season; 2022	
Solitaire	18.33 a	2.75 a	6.67 a
Charisma	14.67 b	2.90 a	5.06 a
LSD 0.05	1.4342	1.506	3.889

Molecular genetic evaluation of apricot cultivars:

Molecular genetic assessment of apricot cultivars: Using SCoT and ISSR markers, the genetic molecular markers for the two recently introduced apricot cultivars are investigated. Reproducible bands were produced by five SCoT and five ISSR primers, which were then chosen for further amplification and data processing. **(Figs. 2 and 3)** and **(Tables 8, 9, 10 and 11**) displayed the banding patterns and DNA profiles of these methods.

SCoT-PCR molecular genetic evaluation:

SCoT primers were used in the molecular genetic analysis of the recently introduced apricot cultivars Charisma and Solitaire, as shown in **Fig. (2)** and **Table (8)** there were 26 bands in all, ranging in molecular size from 220 to 970 bp. The results showed that there were 12 total polymorphic bands with a polymorphism percentage of (46.15%).

The polymorphic percentage that was produced with primer SCoT7 was

the highest at 100%, while the polymorphic percentage present with primer SCoT14 was the lowest at 16.16%. On the other hand, primers SCoT2 and SCoT7 had the lowest amplified band (2 bands) and the most amplified band (6 bands). However, over all five primers, the data revealed 12 distinct markers and 14 monomorphic bands and these results in harmony with Awad et al. (2018) in some local Apricot cultivars; Safaa et al. (2018) in Deciduous Rootstocks and (Abd El-Aziz et al., 2019) in apricot rootstocks. A total number of 12 Specific markers were identified by using SCoT primers as showed in **Table (9)** These markers ranged in size from 210 to 570 bp., only six of them were positive markers which detected with *Charisma* cultivar [SCoT2 450, SCoT7 360 and 220, SCoT9 570 and 485], while, seven were negative markers [(SCoT1 400, SCoT2 450, SCoT7 (410, 380, 340, and 280) and SCoT12 320)]. On the other hand, Six primers were selected positive markers with Solitaire cultivar [(ScoT2 470, SCoT7 (410, 380, 340, and 280) and SCoT12 320]. While, five selected negative markers with Solitaire cultivar [(ScoT2 450, SCoT7 (360, and 220) and SCoT9 (570 and 485)].

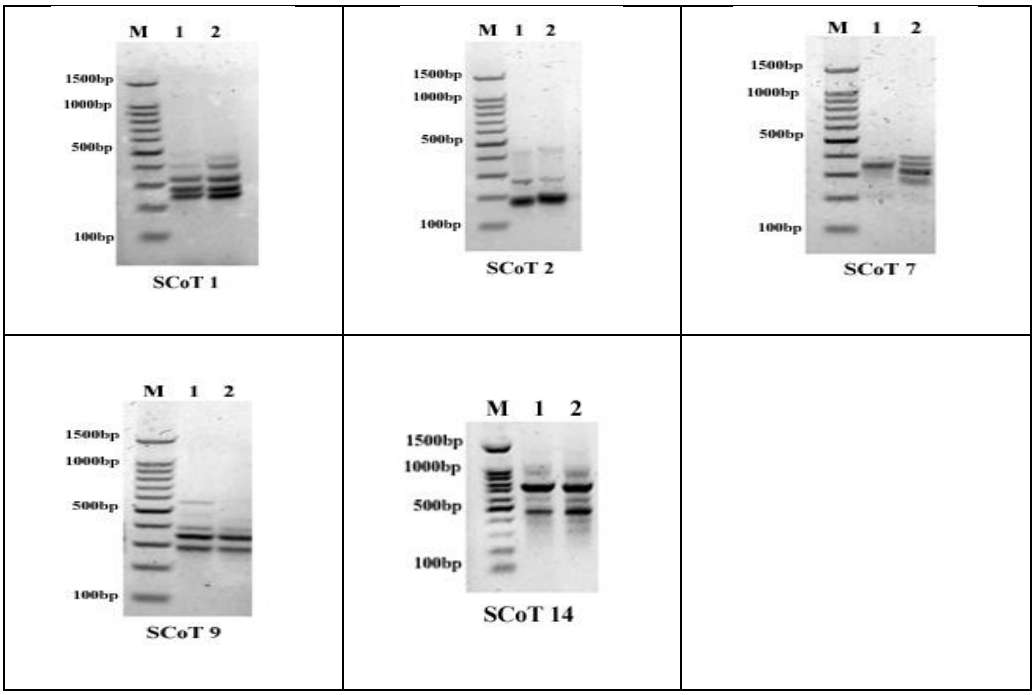


Fig. (2). Banding patterns of SCoT-PCR products for Charisma and Solitaire newly introduced Apricot cultivars produced with five primers.

Table (8). Banding patterns data as estimated for Charisma and Solitaire newly introduced Apricot cultivars using SCoT technique.

Primer Name	M.W Range (bp)	Sequence	Total Band	Monomorphic Band	Polymorphic Band	Specific Markers	Polymorphic %
SCoT1	220-460	ACG ACA TGG CGA CCA CGC	5	4	1	1	20 %
SCoT2	280-470	ACC ATG GCT ACC ACC GGC	4	2	2	**2**	50%
SCoT7	220-410	ACA ATG GCT ACC ACT GAC	6	-	6	6	100 %
SCoT9	285-570	ACA ATG GCT ACC ACT GCC	5	3	2	2	40 %
SCoT14	320-970	ACC ATG GCT ACC AGC GCG	6	5	1	**1**	16.16 %
Total			26	14	12	12	45.23%

Table (9). Apricot cultivars characterized by positive and negative specific markers with their molecular sizes (bp) and total number of markers for each cultivar using SCoT analysis.

Cultivars	Marker Type	Positive Specific Markers			Negative Specific Markers		
		Primer	Mol. Size(bp)	No	Primer	Mol. Size(bp)	No
Charisma	**SCoT**	-	-	-	SCoT 1	400	1
		SCoT2	450	1	SCoT 2	450	1
		SCoT7	360, 210	2	**SCoT 7**	410, 380, 340, 280	4
		SCoT9	570, 480	2	-	-	-
		SCoT12	320	1	-	-	-
Solitaire		**SCoT2**	470	1	SCoT 2	450	1
		SCoT7	41`0, 380, 340, 280	4	SCoT 7	**360, 220**	2
		-	-	-	SCoT 9	**570, 485**	2
		SCoT12	320	1	-	-	-
Total			12				12

ISSR-PCR molecular genetic evaluation:

Fig. (3) and **Table (10)** reported the results of an ISSR molecular genetic investigation of the recently released Apricot cultivars Charisma and Solitaire. A total of 17 bands with molecular sizes ranging from 200 to 720 bp were obtained. The results showed that there were three total polymorphic bands with a polymorphism percentage of 17.64%. The polymorphic percentage that was produced with primer HB-11 was the highest at 40%, while the polymorphic percentage present with primer HB-8 was the lowest at 16.16%. In contrast, primers HB-8 and 14 A had the highest and lowest amplified bands, at six and two bands, respectively. However, using all five primers, the data revealed 14 monomorphic bands and 3 distinct markers. All the previous were in agreement with the finding of Gorji et al. (2011) in Potato, Mohamed et al. (2015) in EL Amar Apricot strains and Etminan et al. (2016) in durum wheat, and Safaa et al. (2018) in deciduous rootstocks.

Using ISSR primers, a total of three distinct markers were found, as indicated in **Table (11)** only three of these markers, which had sizes ranging from 510 to 560 bp, were found to be negative.

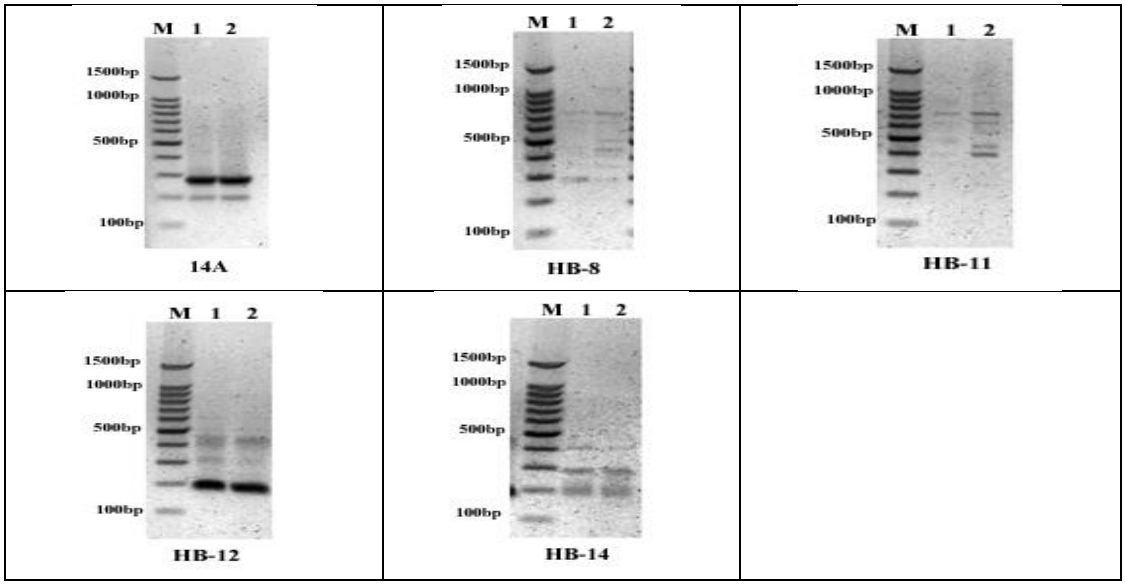


Fig. (3). Banding patterns of ISSR-PCR products for Charisma and Solitaire newly introduced Apricot cultivars produced with five primers.

Table (10). Molecular banding patterns data estimated for Charisma and Solitaire newly introduced Apricot cultivars using ISSR technique.

Primer Name	M.W Range(bp)	Sequence	Total Band	Monomorphic Band	Polymorphic band	Specific Markers	Polymorphic %
14A	200-285	CTC TCT CTC TCT CTC TTG	2	-	-	-	-
HB-8	285-720	GAG AGA GAG AGA GG	6	5	1	1	16.16 %
HB-11	400-700	GTG TGT GTG TGT TGT CC	5	3	2	2	40 %
HB-12	200-460	CAC CACCAC GC	3	3	-	-	-
HB-14	200-415	CTC CTCCTC GC	3	3	-	-	-
Total			17	14	3	3	11.23 %

Table (11). Apricot cultivars characterized by positive and negative specific markers with their molecular sizes (bp) and total number of markers for each cultivar using SCoT analysis

Cultivar	Marker Type	Positive Specific Markers			Negative Specific Markers		
		Primer	Mol. Size(bp)	No	Primer	Mol. Size(bp)	No
Charisma	**ISSR**	-	-	-	**HB-8**	510	1
		-	-	-	HB-11	540, 460	2
Solitaire		HB-8	**510**	1	-	-	-
		HB-11	**540, 460**	2	-	-	-
Total				3			3

Combination evaluation of SCoT and ISSR data analysis:-

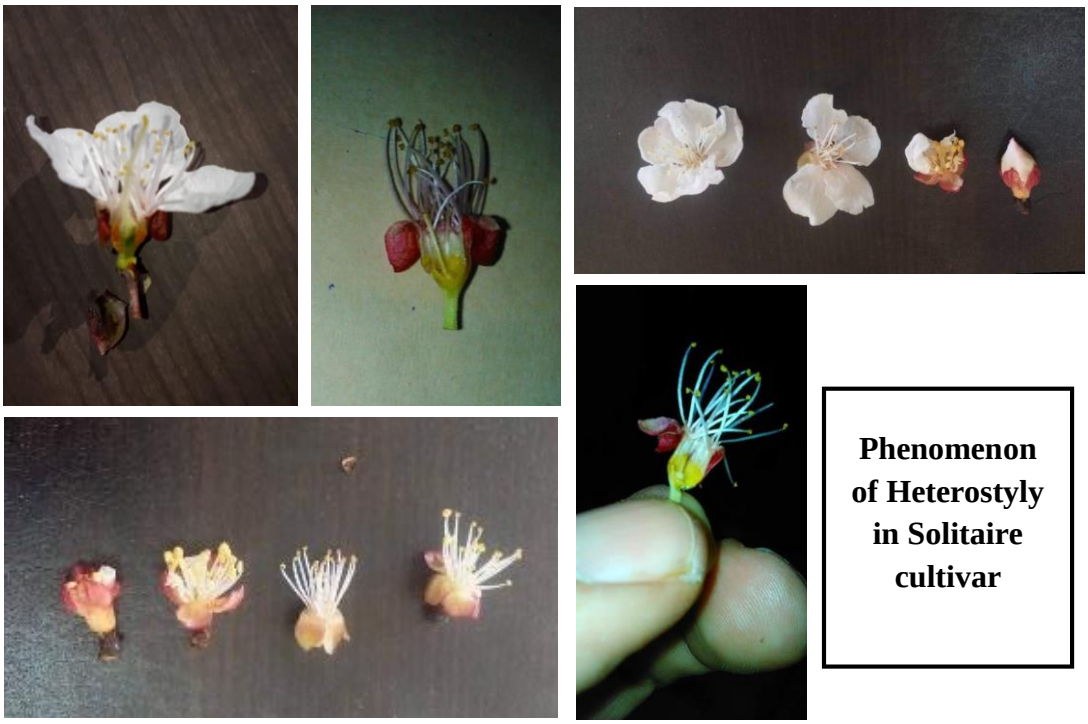
The Charisma and Solitaire newly introduced apricot cultivars combination data of SCoT and ISSR primers were showed in **Table (12)** revealed a sum of 43 band. These bands were identified as 28 monomorphic and 15 polymorphic ones with polymorphic % (34.88%) and the polymorphic bands were scored as 18specific markers. It possible to concluded that SCoT marker is generate from the functional region of the genome, the genetic analyses using this marker would be more useful for crop improvement programs.

Table (12). Polymorphic, Monomorphic, specific Markers and Polymorphic percentage generated by the (SCoT and ISSR) analysis for Charisma and Solitaire newly introduced apricot cultivars.

Primer Name	Total Band	Monomorphic Band	Polymorphic band	specific Markers	Polymorphic %
SCoT	26	14	12	12	46.15 %
ISSR	17	14	3	3	17.64 %
Total	43	28	15	15	63.79 %

Conclusion:

The present study recommended Apricot growers cultivate both cultivars Solitaire and Charisma for enhancing fruit set, yield and quality under Egyptian conditions. Taken into consideration the phenomenon of Heterostyly as a unique form of polymorphism and herkogamy in flowers which was existed in 65% (fruit set) and 35% (fruit drop), for Solitaire cultivar. Therefore, we recommend use pollinators or spread beehives for cross pollination to solve this problem for these cultivars.



Phenomenon of Heterostyly in Solitaire cultivar

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الملخص العربى

تقييم صنفين من المشمش المستوردة حديثا تحت الظروف المصرية

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تم إجراء هذا البحث لمدة موسمين متتاليين (2021 و2022) على أشجار المشمش صنفي (سوليتير وكاريزما) عمر 4 سنوات مزروعه على أصل نيماجارد المزروعة في تربة رملية في مزرعه خاصه بمحافظة أسيوط، لوصف صفات كلا الصنفين. وتضمنت معايير التقييم خصائص الأشجار وقياسات الإزهار وصفات الثمر والصفات الوراثية الجزيئية. أظهرت البيانات التي تم الحصول عليها أن صنف السوليتير تفوق على الكاريزما في العدد الإجمالي لنسبه البراعم الزهريه المتفتحه، ومحصول الشجره بالكيلو جرام ووزن اللحم للثمار مقارنه بالكاريزما. بينما محيط الجذع وطول الفرع وعدد البراعم الخضرية وصلابة الثمار وطول فترة الحصاد كانت اعلى معنويا مع صنف الكاريزما مقارنه بصنف السوليتير.

بدراسة تركيب زهرة صنف السولينير نلاحظ ارتفاع مستوى القلم والميسم عن طول خيوط المتك مما يؤدى لانخفاض نسبة العقد (ظاهرة الـ Heterostyly) ولذا يوصى بزراعه صنف اخر كملقح أو توفير خلايا نحل لحل هذة المشكلة.

اشارت دراسات التقييم الوراثي الجزيئي لصنفي كاريزما وسوليتير باستخدام التحليل الجزيئي SCoT وISSR باستخدام تقنيه الـ PCR. كشفت النتائج عن مجموع 43 حزمه وتم تحديد هذه الحزم على أنها 28 حزمه متشابهه و15 متباينه الأشكال بنسبة متباينة الأشكال (34.88%) وسجلت الطريقه الاخرى 18 حزمه كليه، ستة منها فقط كانت متباينه بشكل ايجابي تم اكتشافها مع صنف كاريزما، وكما تم اختيار ستة بادئات كعلامات إيجابية متباينه مع الصنف سوليتير. بينما تم اختيار ثلاثة بادئات ذات علامات إيجابية مع صنف السوليتير. ومن بين هذه النتائج كان هناك تباين وراثي بين صنفي كاريزما وسوليتير وأيضاً تم الحصول على بيانات دلالات محددة لكل صنف يمكن ربطها بصفات محددة لكلا منهم صنف وهذه النتائج اوضحت زياده فرص نجاحهم فى برامج التربيه للاستفاده بها فى التحسين الوراثي لتلك الاصناف. وأخيرا يمكن التوصية بنشر هذا الصنف في ظل ظروفنا المصرية.