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Evaluation of Haied and Amal Apricot Cultivars Under EL-Khattatba Environmental Conditions in Egypt

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Abstract: This study was conducted to evaluate two apricot cultivars (Hayed and Amal) under the Egyptian climatic conditions for two successive seasons (2016 and 2017) in a private farm in El-Khattatba on the Cairo-Alexandria Desert Road. These cultivars are 5 years old and planted 5×4 in sandy soil and irrigated by drip irrigation system. The study showed that, The "Haied" cultivar is earlier (10-12 days) than "Amal" cultivar however, the percentage of the fruit set especially spurs, fruit yield and yield/fed (ton) in "Amal" cv higher than "Haied" cv. "Haied" cv was characterized by the upright canopy, trunk, vegetative growth reddish in color, leaves with stipules not found in "Amal" cv leaves, an increase in fruit and seed weight, diameter, TSS%, length of the shoot, number of leaves and large leaf area. On the other hand, "Amal" cultivar was distinguished by trunk Pale gray with cracks trunk, spreading canopy, cling fruits with a red cheek, red spots that were not detected in the "Haied"cv and high fruit firmness, fruit length . The shelf life study showed that fruit firmness and TSS% of "Amal" cv are higher than "Haied"cv, fruit weight loss of "Amal" cv less than "Haied"cv especially in the second season. Total income/fed LE of "Amal" cv higher than "Haied"cv in both seasons. The histological studies of the buds proved differences between the two cultivars in the dates of the onset of flowering induction until the completion of the ovary development. The genetic evaluation among "Haied" and "Amal" apricot cultivars was estimated by using RAPD and ISSR molecular analysis for PCR reactions. The tested primers showed reproducible polymorphic patterns. These primers produced 117 bands and 67 bands as monomorphic, out of which 50 were polymorphic with polymorphic % 44.44% and the polymorphic bands were scored as 50 unique markers. Out of these results it possible to concluded that ISSR marker is generate from the functional region of the genome and the genetic analysis using this marker would be more useful for crop improvement programs. In final, we recommend expanding the cultivars of "Haied"and "Amal" because they are suitable for cultivation under Egyptian conditions and they are early-ripening cultivars, which increases the period of supply, marketing ability and circulation of apricots in the markets.

Key words: Apricot · Haied · Amal · Stipules · Income · Histological · RAPD and ISSR Molecular Markers

INTRODUCTION

Apricot is one of the most important deciduous fruit trees planted in Egypt a long time ago. 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. Apricot tree (*Prunus armeniaca* L.; 2n = 2x = 16) is one of the most important deciduous fruit which grown in Egypt. Total planted area of apricot trees in 2020 is 10896 feddan (4578.15 h), with productivity 65511 ton although in 2003 it was about 21000 feddan (8823.53 h) according to Agriculture Statistics of Ministry of Agriculture and Land Reclaimed Areas [1]. The reasons for the decrease in this area because the widespread cultivars in Egypt, have ceased to be planted and multiplied, such as the cultivars (Balady, Amar and Hamawy). so new apricot have high fruit quality attributes which satisfy the consumers [2]. Which are affected by a number of pomological traits Milosevic, *et al*. [3] that cannot be studied separately from the biological properties of the fruit tree and the yield

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obtained [4-6]. These cultivars had a short and weak marketing ability due to their lack of hardness, juicy fruits and their display period in the market does not exceed two weeks [7].

Therefore, many cultivars were introduced to Egypt to obtain high-quality apricot specifications for local consumption and export, long marketing ability, early ripening, to prolong the period of apricot presentation but thes cultivars had to be studied and evaluated under the Egyptian conditions and lands, such as (Canino, Amal, Haied and others) cultivars. Some of them was evaluated like (Canino, Amal (at desert road in Giza governorate. “Canino” is characterized by large, fleshy fruits, but it is a late-ripening cultivar because high chilling requirement (570 hr. below 7.2°C). On the other hand, “Amal” is characterized by early ripening, good vegetative growth [8]. Fruit quality, high fruit yield and total income [9, 10]. While "Haied" cultivar has not been evaluated under the Egyptian conditions.

The major factors limiting shelf life of fruits are their softening, fungi decay, reduced flavor quality (too low acidity, no aroma) and less favorable appearance like shriveling or bruising [11].

The histological studies of the buds it important to appears differences between cultivars from the beginning of flowering induction until the completion of the ovary development. Whereas, bud differentiation is closely with phenological stages. However, bud differentiation occur just leaves defoliation time (the late of September) and continues almost until onset of flowering time [12].

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 [13-15]. SCoT is superior over other dominant DNA marker systems like RAPD and ISSR in higher polymorphism and better marker resolvability Gorji, *et al*. [16]; Mohamed, *et al*. [17] in EL-Amar apricot strains Abd El-Aziz and Habiba [18] in canolla; Abd El-Aziz, *et al*. [19] in tomato and Abd El-Hadi, *et al*. [20] in squash; Awad, *et al.* [21] in some local Apricot lines; Safaa, *et al.* [22] in deciduous rootstocks and Abd El-Aziz *et al.* [23] in apricot rootstocks.

The aim of this study is to evaluate phenological, physical, chemicals, histological and molecular genetic characters and study the behavior, compared between the two cultivars "Haied and Amal" apricot in time of phenological dates, vegetative growth, flowering, physical and chemical characteristics of fruits, fruit yield and shelf life under the conditions of El-Khatatba at the Desert Road of Cairo Alex in Egypt, because they have not been evaluated in this region, in order to compare them and to identify which of the two cultivars is earlier than the other and which one has good fruit and marketing.

MATERIALS AND METHODS

The present work was performed during 2016 and 2017 seasons on two cultivars trees named “Haied and Amal " apricot trees budded on apricot seedlings grown on sandy soil at 5 x 4 meters apart (210 tree / fed; 500 tree/ h) and drip irrigated in a private orchard at El-Khattatba at the Desert Road of Cairo Alex. The age of the trees was 4 years in 2016 and 5 years in 2017. Selected three trees for each cultivar were nearly uniform in growth vigor treated with normal agricultural practices and studied the following measurements:

Experimental Measurements

Chilling Requirements (Meteorological Data): Chill units from leaves defoliation till beginning of flowering were recorded as follows:

- Number of hours at >7.2°C (>44.96°F)
- Number of hours at >10°C (>50°F)

From leaves defoliation till beginning of flowering (1Nov. to 15/2/2016 , 23/2/2017) for “Haied” cultivar and (1Nov. to 26/2/2016 , 6/3/2017) for “Amal” cultivar.

Heat Units: Growing degree hours were also estimated for fruit growth from beginning of flowering till harvest date) 15/2/2016 to 1/5/2016 , 23/2/2017 to 10/5/2017) for “Haied” cultivar and (26/2/2016 to 12/5/2016 , 6/3/2017 to 20/5/2017) for “Amal” cultivar according to Shallenberger, *et al*. [24].

$$GDH= \Sigma 2\ (T_m-7.5)12$$

when T_m = temperature at a given hour in the day and 7.2°C = base temperature.

Chill Units and Heat Units: According to Egyptian Ministry of Agricultural & Land Reclamation- Agricultural Research Center - Central Laboratory for Agricultural Climate (CLAC) [25].

Morphological Description: The morphological differences between the two cultivars in (trunk, canopy, vegetative growth, shoot and spurs color, buds, leaves, leaf petiole color, fruit shape, stone color and stone) were taken by eye.

Fruit Color: It was determined by using color chart of Royal Horticultural Society, London part I and II according to Robert [26].

Time of Phenological Dates: (onset of floral bud burst, onset of vegetative bud burst, full bloom, onset of fruit set, onset of pit hardening and fruit harvest) were recorded periodically.

Fruit Set (%): Was calculated after two weeks from full bloom by:

$$\text{Fruit set percent} = \frac{\text{Number of fruit set}}{\text{Total number of flowers}} X100$$

Increasing in Fruit Diameter (cm): The diameters of fruits were measured weekly and taken on the trees in the field after fruit set stage from fruit let (peas size) to harvest.

Fruit yield (kg /tree): At harvest time was calculated by number of fruits per tree x average fruit weight in the mature stage.

Yield (ton / feddan) = Fruit yield kg/tree x No. of trees / fed (210 tree).

Fruit Quality: Ten fruits from each tree were picked to assess the physical and chemical properties of mature fruits that carried out when fruits of control attained maturity. Physical and chemical characteristics were evaluated as following:

Physical Characteristics of Fruit

Fruit Weight (g): Average of 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 displace meter method.

Fruit Dimensions (cm): Fruit length and diameter in cm were measured by using a vernier caliper.

Fruit L/D Ratio: It was measured by separating the fruit length on fruit diameter.

Fruit Firmness ($lb/inch^2$): 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 calculated.

Seed Thickness (cm): Was measured by using a vernier caliper.

Seed Weight (g): Average of seeds was determined by weight a sample seeds from each replicate and the average seed was calculated.

Chemical Characteristics of Fruit

Total Soluble Solids Percentage (TSS%): It was determined in fruit juice sample of fruits by hand refractometer model (Portable Refractometer ATC).

Total Acidity (Titratable Acidity) Percentage (%): It was determined as anhydrous malic acid as a percentage after titration by 0.1 N sodium hydroxide using phenolphthalein as an indicator A.O.A.C., [27].

TSS/Acid Ratio: It was calculated by dividing total soluble solids on total acidity.

Vegetative Growth Characteristics

Trunk Circumference (cm): Was measured for each tree with a tap at a fixed point above 2 cm from graft union.

3 new shoots (one year old) were selected from each replicate for each cultivar and vegetative measurements were taken on 1 July for two cultivars, the following vegetative measurements were taken:

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

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

The number of leaves/shoot: Was measured by counting the number of leaves per each shoot.

Leaf area (cm^2): Was measured in mature leaves by using a leaf area meter.

Shelf Life: Thirty six mature apricot fruits were harvested from each replicate for each cultivar and placed in a box at room temperature and studying the changes in:

Fruit weight loss (%): Was assessed as the equation = (Fruit weight at harvest – Fruit weight after 6 days x 100) / Fruit weight at harvest.
Fruit decay (%): per box was calculated according to the equation (Number of fruit decay after 6 days x 100 / The initial fruit number of box.
Fruit firmness (lb/inch^2).
Juice TSS (%).
Juice acidity (%).
TSS/acid ratio.

Economic Study: Total income/fed LE = Price of one kg apricot in the farm x fruits yield ton/fed.

The farm gate price of one kg apricot (7 & 7.5 LE) in the first and second season.

Histological Studies

Sampling Period: Five buds were taken in the second season at random from the fourth node from the base of shoots for both cultivars "Haied and Amal ". The buds were taken at weekly intervals beginning from (28 may) till floral bud burst stage (at pink tips appearance).

Buds were excised and fixed in FAA solution (Formalin, acetic acid and alcohol (95%) as 5:5:90, respectively). The buds were transferred from FAA and were dehydrated in a graded series of alcohol (Tertiary butyl alcohol (TBA) and Ethanol) according to the method of Sass, [28]. Then buds were embedded in paraffin wax at 60^{o}C for three days. Series paraffin blocks were cut into section of 7-10 µm in thickness were prepared using hand microtome. Section were stained with (Safranine) according to the method El-Agamy, *et al* .[29].

Molecular Genetic Markers: For this purpose, genomic DNA was isolated from fresh leaves of the two cultivars of apricot under investigation. Genomic DNA was used for molecular genetic markers by RAPD and ISSR techniques.

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 ethidium bromide.

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

Data Analysis: 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.* [31].

Statistical Analysis: Statistical analysis was carried out according to Snedecor, [32] using analysis of variance. The significance was determined using LSD values at 0.05 level Gomez and Gomez, [33].

RESULT AND DISCUSSION

Accumulated Chilling Units: Table (1) show accumulated chilling units and growth degree hours that were taken at El-Khattatba (the Desert Road of Cairo Alex.) calculated by two different methods during two seasons. The highest accumulated chilling units to break bud dormancy of "Haied" and "Amal" cultivars at < 10°C in first and second season . Also the highest G.D.H (1872) in first season for two cultivars and it is important to help flower bud to start begin to burst and open, after the bud have fulfilled their chilling requirement. On the other hand, G.D.H is important at the beginning of the season for the vegetative buds burst to open [34]. Lowest G.D.H in second season especially in "Amal" cv followed by "Haied" cv.

Morphological Description: The morphological description between "Haied" and "Amal" cultivars in (Table 2) clear fundamental differences proved between the two cultivars. Where the "Haied"cv was distinguished by the upright canopy, trunk, shoots, spurs, leaves petioles are reddish in color, fruits with stone free and leaves with stipules (Fig. 1) not found in "Amal" cv leaves. While the "Amal" cv was characterized by trunk Pale gray with Cracks trunk, the spreading canopy and semi cling fruits with a red cheek and red spots that were not found in the "Haied"cv. However, the fruits bearing for the two varieties is more on spurs (Table 4), because the percentage of fruit set on spurs is more than the shoots [35].

Table 1: Accumulated chilling units and G.D.H for "Haied" and "Amal" cultivars during 2015/2016 and 2016/2017 seasons

	>7.2°C	>10°C	>7.2°C	>10°C	G.D.H	
	---		---		---	
Cultivars	2015/2016		2016/2017		2016	2017
Haied	174	362	205	692	1872	1848
Amal	177	373	208	719	1872	1824

Table 2: Morphological description for "Haied" and "Amal" cultivars.

	Haied	Amal
Trunk	Reddish with prominent white spots	Pale gray with Cracks
Canopy	Upright	Spread
Fruits bearing	Most on spurs	Most on spurs
Shoot and Spurs color	Reddish	Brown
buds	Thin	Thick
Leaves	Hearty toothed with stipules	Hearty toothed
Leaf petiole color	Reddish	Brown
Fruit skin color	Orange Buff 507/1 part I	Cadmium Orange 8/2 part I
With red cheek and red spots		
Fruit shape	Round	Round
Stone color	Brown	Brown
Stone	Free	Free

Fig. 1: The morphological description of "Haied" and "Amal" cultivars

Phenological Studies: Table (3) showed the differences between the two cultivars "Haied" cv and "Amal" cv in dates of Onset of floral bud burst, onset of vegetative bud burst, full bloom, onset of fruit set, onset of pit hardening and fruit harvest during the two seasons.Onset of floral bud burst of "Haied" cv was earlier thirteen day in the first season, eleven day in the second season and also harvest date was earlier twelve day in 2016, ten day in 2017 than "Amal" cv. The early blooming of buds and fruit harvest in "Haied" than "Amal" cv may be due to genotypic differences and the chilling units requirement of this cultivar, less than the "Amal" cv cultivar (Table 1) to end and break dormancy period of trees [34].

Fruit Set (%): Data in Table (4) reveal that fruit set percentage for "Amal" cv higher (81.07 and 78.16 %) than "Haied" cv (78.22 and 60.18 %) during two seasons. The results also showed that the fruit set on the spurs was higher than the fruit set on the shoots of both cultivars in the two seasons, so fruits bear mainly on spurs and a little on shoots for the two cultivars on spurs, (Table 2). This results agreement with Guirguis *et al.* [9] and Costes *et al.* [36].

Increasing in Fruit Diameter (cm): The development of fruit growth in diameter (Table 5) showed significant differences in the "Haied" cv between shoots and spurs, where increase in the fruit diameter of spurs greater (2.508 cm) than shoots (2.005 cm), while not significant in fruits diameter of the "Amal" cv between fruits of shoots and spurs. But in both cultivars, the diameters of the fruits for shoots and spurs increased with approach harvest date.

Table 3: Date of onset of floral bud burst, onset of vegetative bud burst, full bloom, onset of fruit set, onset of pit hardening and fruit harvest for "Haied" and "Amal" cultivars during 2016 and 2017 seasons

	Onset of floral bud burst		Onset of vegetative bud burst		Full bloom		Onset of fruit set		Onset of pit hardening		Fruit harvest	
Cultivars	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Haied	15/2	23/2	1/3	10/3	3/3	10/3	9/3	15/3	6/4	13/4	1/5	10/5
Amal	26/2	6/3	8/3	15/3	13/3	20/3	15/3	23/3	13/4	20/4	12/5	20/5

Table 4: Fruit set (%) for "Haied" and "Amal" cultivars during 2016 and 2017 seasons

	Fruit set (%)					
	Shoots	Spurs	Shoots	Spurs	Mean (A)	
Cultivars	2016		2017		2016	2017
Haied	69.27 C	87.17 B	42.93 D	77.43 B	78.22 B	60.18 B
Amal	71.42 C	90.71 A	64.66 C	89.73 A	81.07 A	78.16 A
Mean (B)	70.35 B	88.94 A	54.76 B	83.58 A	-	-

*Mean followed by the same letter (s) within the same column was not significantly different (P ≤ 0.05; LSD test)

** Mean A (Cultivars) and Mean B (Fruit set Shoots or spurs)

Table 5: Increasing in fruit diameter (cm) on (shoots and spurs) for "Haied" and "Amal" apricot trees

Cultivar	Haied						
Date	6/4	13/4	21/4	4/5	10/5	17/5	Mean (A)
Shoots	1.24 E	1.68 D	1.93 D	2.37 C	2.80 B	-	2.005 B
Spurs	1.86 B	2.05 CD	2.36 C	2.85 B	3.42 A	-	2.508 A
Mean (B)	1.55 D	1.86 C	2.14 C	2.61 B	3.11 A	-	-
Cultivar	Amal						Mean (A)
Shoots	1.43 G	1.90 E-G	2.23 DE	2.60 B-D	2.93 A-C	3.00 A-C	2.34 A
Spurs	1.53 FG	2.13 D-F	2.53 C-E	2.93 A-C	3.23 AB	3.40 A	2.62 A
Mean (B)	1.48 D	2.01 C	2.38 BC	2.76 AB	3.08 A	3.20 A	-

*Mean followed by the same letter (s) within the same column was not significantly different (P = 0.05; LSD test).

** Mean A (Fruits diameter Shoots or Spurs) and Mean B (date).

Table 6: Yield (Kg/tree) and Yield/fed (Ton) for "Haied" and "Amal" cultivars during 2016 and 2017 seasons

	Yield (Kg/tree)		Yield/fed (Ton)	
Cultivars	2016	2017	2016	2017
Haied	27 B	31 B	5.670 B	6.510 B
Amal	30 A	38 A	6.300 A	7.980 A

*Mean followed by the same letter (s) within the same column was not significantly different (P ≤ 0.05; LSD test)

Yield (kg/tree) and Yield/fed (ton): "Amal" cultivar had significant highest value of yield (30 and 38kg/tree) and (6300 and 7980 Ton/fed), whereas "Haied" cultivar had significant lowest in both seasons respectively (Table 6). This is due to the increase in fruit set in "Amal" cv than "Haied" cv (Table 4(, these results are in agreement with Guirguis *et al.* [9] and Guirguis *et al.* [10].

Fruit Characteristics

Physical Characteristics: Table (7) showed, "Haied" cultivar attained the highest significant value of fruit weight (18.43 and 27.66 g), while "Amal" cv gave significant lowest value (16.84 and 25.53 g) due to decrease fruit set and yield for "Haied" cv than "Amal" cv (Table 4, 6) [37]. On the other hand fruit length, diameter and L/D ratio gave non-significant for two cultivars during first and second season.

The result in (Table 8) indicated an increase in fruit firmness of "Amal" cultivar (8.66 and 8.48 lb/inch^2) compared to "Haied" cultivar (4.30 and 5.23 lb/inch^2) and the presence of significant differences between them during the both seasons. Also pulp weight was higher in "Haied" cv than "Amal" cv this is may be due to increase in the fruits size in the first cultivar over the second (Table 7). It was also observed that the diameter and weight of the seed were increased in the "Haied" cv than "Amal" cv (1.23 cm and 2.77 g) (1.1 cm and 2.46 g), respectively especially in the second season.

Table 7: Physical characteristics (fruit weight (g), size (cm^3), length (cm), diameter (cm) and shape index) for "Haied" and "Amal" cultivars during 2016 and 2017 seasons

	Fruit weight (g)		Fruit size (cm^3)		Fruit length (cm)		Fruit diameter (cm)		Fruit shape index (L/D ratio)	
Cultivars	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Haied	18.43 A	27.66 A	21 A	30 A	2.83 A	3.36 A	3 A	3.39 A	0.94 A	0.99 A
Amal	16.84 B	25.53 B	20.5 A	27.5 B	3 A	3.49 A	2.96 A	3.37 A	1.01 A	1.03 A

*Mean followed by the same letter (s) within the same column was not significantly different ($P \leq 0.05$; LSD test)

Table 8: Physical characteristics (fruit firmness ($lb/inch^2$), pulp thickness (cm), pulp weight (g), seed diameter (cm) and seed weight (g)) for "Haied" and "Amal" cultivars during 2016 and 2017 seasons

	Fruit firmness ($lb/inch^2$)		Pulp thickness (cm)		Pulp weight (g)		Seed diameter (cm)		Seed weight (g)	
Cultivars	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Haied	4.30 B	5.23 B	1.00 A	1.00 A	16.37 A	24.68 A	1.09 A	1.23 A	2.38 A	2.77 A
Amal	8.66 A	8.48 A	0.95A	0.95 A	14.81 B	21.99 B	1.1 A	1.1 B	2.07 A	2.46 B

*Mean followed by the same letter (s) within the same column was not significantly different ($P \leq 0.05$; LSD test)

Table 9: Chemical characteristics for "Haied" and "Amal" cultivars during 2016 and 2017 seasons

	TSS %		Acidity%		TSS/ Acidity	
Cultivars	2016	2017	2016	2017	2016	2017
Haied	11 A	11.25 A	0.161 A	0.151 A	69.82 A	74.03 B
Amal	10 B	10 A	0.224 A	0.127 A	44.64 B	76.45 A

*Mean followed by the same letter (s) within the same column was not significantly different ($P \leq 0.05$; LSD test)

Chemical Characteristics: In (Table 9) the data reveal that "Haied" cv attained significantly highest percentages of juice TSS than "Amal" cv (11 and 10 %) in the first season agreement with [9, 10]. While non-significant in juice acidity for both cultivars during two seasons. On the other hand, the TSS/acidity gave higher percentage for "Haied" cv in the first season compared with "Amal" cv gave lowest value (69.82 and 44.64) while in the second season, higher in "Amal" cv than "Haied" cv. The increase in TSS% of the "Haied" cultivar over the "Amal" cultivar may be due to the increase in the number of leaves and the leaf area (Table 10, 11), which gave the rate of increase in the photosynthesis products of the leaves and thus an increase TSS% [38].

Vegetative Growth Measurements: The data of Vegetative growth measurements in (Table 10) show trunk circumference in "Amal" cv bigger than "Haied" cv in both seasons. It showed significant differences with increase in one-year-old Shoot length (16 and 17.6 cm) and number of leaves /shoot (21.6 and 27) for "Haied" cv compared to "Amal" cv had short shoot length (12 and 11.33 cm) and decrease in number of leaves/shoot (14.66 and 17) while non-significant between the two cultivars in shoot thickness during two seasons.

The data in (Table 11) show "Haied" cv gave significant highest value with increase in leaf area (57.38 and 57.89 cm^2) than "Amal" cv (49.38 and 50.00 cm^2) it may be due to a genotypic differences or low fruit yield on tree in "Haied" cv than "Amal" cv (Table 6) because 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 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 (Table 2, 4). The increase in the number of leaves (Table 10) and the leaf area of "Haied" over "Amal" 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 [39]. This benefit from the food led to the trees producing strong leaves.

Results in (Table 12) showed no significant differences in fruit weight loss and acidity in both cultivars during two seasons through shelf life at room temperature. While found fruit decay decreased (0.86 %) for "Amal" than "Haied" cv (1.66%) in second seasons and fruit firmness(1.32 and 1.87 $lb/inch^2$) and TSS% (16.33 and 15%) increased during both seasons in "Amal" cv compared with "Haied" cv. Changes have been observed during Shelf life at room temperature compared to the time of fresh harvest and this is due to the major factors limiting shelf life of fruits are their softening, fungi decay, reduced flavor quality (acidity, no aroma) and less favorable appearance like shriveling or bruising [11].

Table 10: Vegetative growth measurements for "Haied" and "Amal" cultivars during 2016 and 2017 seasons

	Trunk circumference (cm)		Shoot length (cm)	Shoot thickness (cm)	Number of leaves /shoot	Shoot length (cm)	Shoot thickness (cm)	Number of leaves /shoot
Cultivars	2016	2017		2016			2017	
Haied	37.00 B	40.83 B	16.00 A	0.4 A	21.6 A	17.6 A	0.4 A	27 A
Amal	43.16 A	45.33 A	12.00 B	0.4 A	14.66 B	11.33 B	0.4 A	17 B

*Mean followed by the same letter (s) within the same column was not significantly different (P ≤ 0.05; LSD test)

Table 11: Leaf area (cm^2) on shoots and spurs for "Haied" and "Amal" cultivars during 2016 and 2017 seasons

	Leaf area (cm^2)		Leaf area (cm^2)			
	Shoots	Spurs	Shoots	Spurs	Mean (A)	
Cultivars	2016		2017		2016	2017
Haied	61.32 A	53.43 B	63.17 A	52.61 B	57.38 A	57.89 A
Amal	53.09 B	45.66 C	53.55 B	46.44 B	49.38 B	50.00 B
Mean (B)	57.21 A	49.54 B	58.36 A	49.53 B	-	-

*Mean followed by the same letter (s) within the same column was not significantly different (P ≤ 0.05; LSD test)

** Mean A (Cultivars) and Mean B (Leaf area shoots or spurs)

Table 12: Changes in fruit characteristics of "Haied" and "Amal" apricot cultivars during shelf life at room temperature (2016 and 2017 seasons)

	Fruit weight loss (%)		Fruit decay (%)		Fruit firmness ($lb/inch^2$)		TSS (%)		Acidity (%)		TSS/acid ratio	
Cultivars	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Haied	28.06 A	21.29 A	1.73 A	1.66 A	0.81 B	1.24 A	14.0 B	15 A	0.204 A	0.294 A	69.23 A	51.05 B
Amal	28.37 A	22.22 A	1.76 A	0.86 B	1.32 A	1.87 A	16.33 A	15 A	0.266 A	0.231 A	61.88 B	60.73 A

*Mean followed by the same letter (s) within the same column was not significantly different (P ≤ 0.05; LSD test)

Table 13: The economic study for "Haied" and "Amal" cultivars during 2016 and 2017 seasons

	Yield/fed (Ton)		Total income/fed LE	
Cultivars	2016	2017	2016	2017
Haied	5670	6510	39690	48825
Amal	6300	7980	44100	59850

The Economic Study: The economic study in Table (13) showed Total income/fed LE of "Amal" cv (44100 and 59850) higher than "Haied"cv (39690 and 48825) in both seasons. This result is due to an increase in yield (kg/tree))Table 6), which eventually led to an increase in yield/fed (ton) and Total income/fed LE [9, 10].

Histology Studies: This study was done to detect the different stages floral initiation and differentiation. Microscopic synchronization of longitudinal section out from (28 may) till onset of floral bud burst, emphasized the presence of seven distinct stages which could be distinguished by the following characters:-

Stage 0: Apical meristem was round in shape (dome) (Fig. 2).

Stage I: Apical meristem turned from round to flat shape. It appears that, initiation of floral bud formation of floral bud formation occurs in this time occurred on 9 July for "Haied" and 1 August for "Amal" (Fig.3).

Stage II: Sepal and petals primordia began to form occurred on 10 September for "Haied" and 9 November for "Amal" (Fig.4).

Stage III: In this stage, further sepals and petals increase in length. The initiation of stamen primordia occurred on 1 October for "Haied" and 6 December for "Amal" (Fig.5).

Stage IV: Pistil primordia and anther more development occurred on 19 November for "Haied" and 26 December for "Amal" (Fig.6).

Stage V: The pistil become more elongated. Sepals, petals and anthers grow more in size occurred on 6 December for "Haied" and 7January for "Amal" (Fig.7).

Stage VI: The initiation of the ovarian cavity inside the pistil occurred on 26 December for "Haied" and 15 January for "Amal" (Fig. 8).

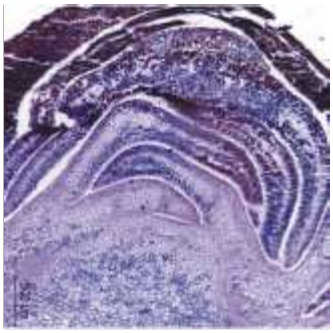


Fig. 2: Stage 0

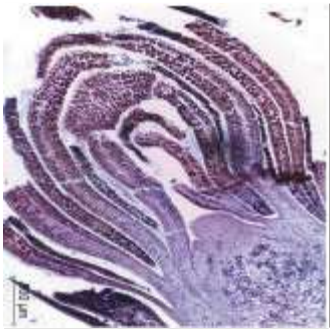


Fig. 3: Stage I

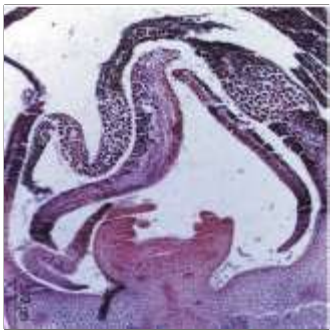


Fig. 4: Stage II

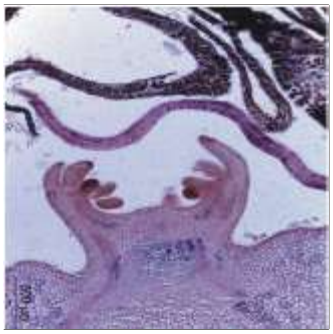


Fig. 5: Stage III

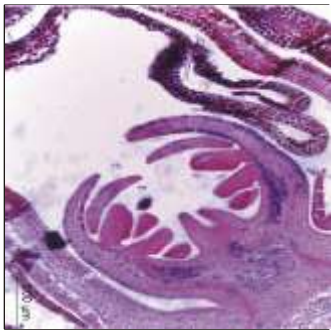


Fig. 6: Stage IV

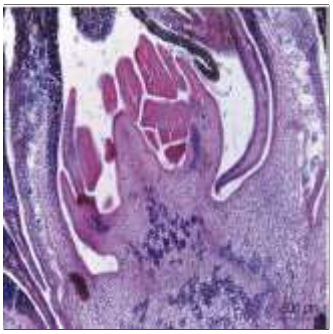


Fig. 7: Stage V

Fig. 8: Stage VI

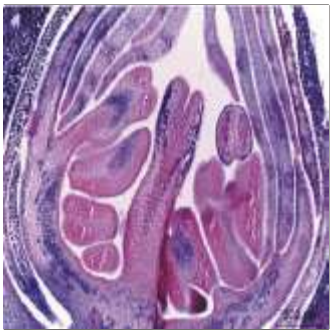
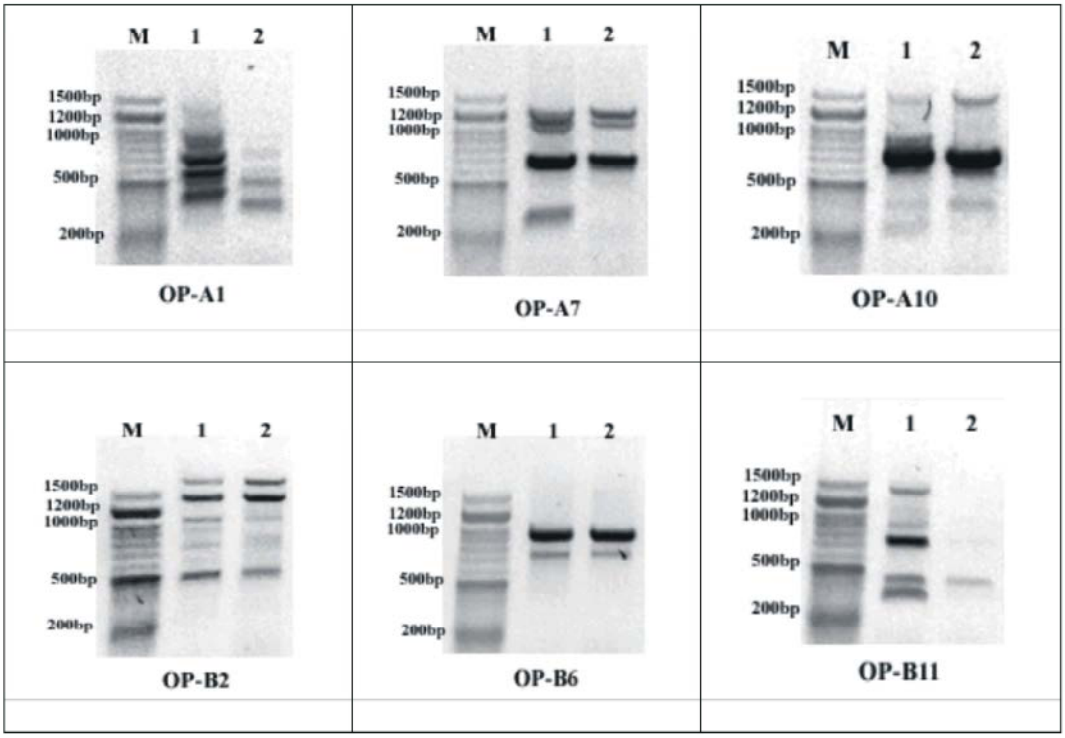


Fig. 9: Stage VII

Stage VII: The stigma and style can be clearly noticed and anther locales can be distinguished and pollen mother cells are noticeable occurred on 10 January for "Haied" and 1 February for "Amal" (Fig. 9).

Similar results for flower bud differentiation were observed in previous studies of El-Agamy, *et al.* [29] on "San Pedro", "Y9/106" and "Rubidoux" peach cultivars and Khalifa, *et al*. [40] on De "Wet", "Desert Pearl", "Hermosillo" and "Bokkeveld" peach cultivars.



1. "Amal" cultivar & 2. "Haied" cultivar.

Fig. 10: Banding patterns of RAPD -PCR products for two Apricot cultivars : "Amal" and "Haied" produced with six primers

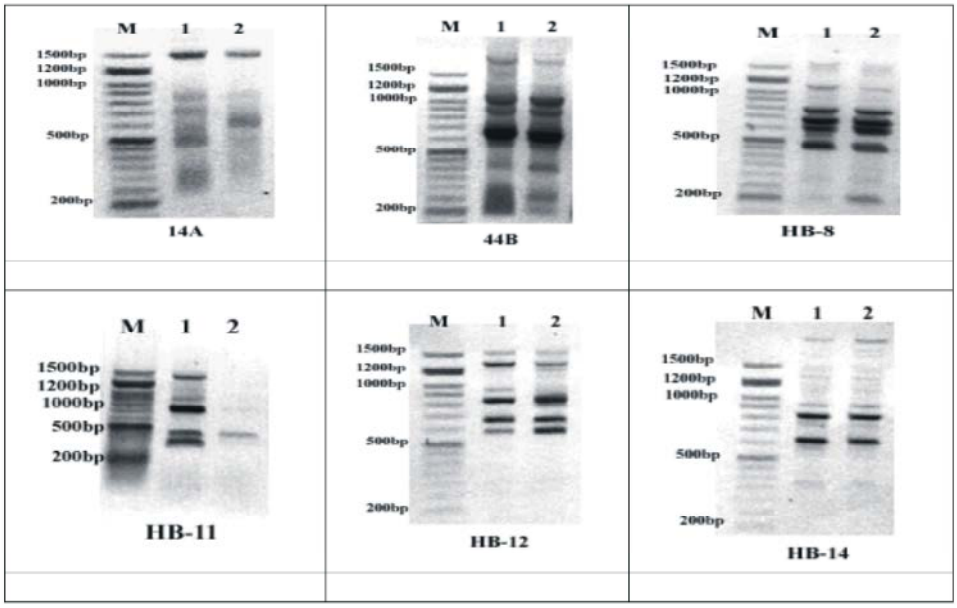
Table 14: Banding patterns data as estimated for two apricot cultivars: "Amal" and "Haied" using RAPD technique

Primer Name	M.W Range(bp)	Sequence	Total Band	Monomorphic Band	Polymorphic band	Unique Markers	Polymorphic %
OP-A1	415-1200	CAG GCC CTT C	10	5	5	5	50%
OP-A7	370-1180	GAA AGG GGT G	6	4	2	2	33.33%
OP-A10	300-1435	GGG TAA CGC C	9	6	3	3	33.33%
OP-B2	590-1730	TCG GGG ATA G	9	6	3	3	33.33%
OP-B6	550-970	TGC GCC CTT C	5	3	2	2	40%
OP-B11	415-1250	GTA GAC CCG T	10	2	8	8	80%
Total			49	26	23	23	46.93%

Molecular Genetic Evaluation of Apricot Cultivars: Studying the genetic molecular markers for two cultivars of Apricot using RAPD and ISSR markers. six RAPD and six ISSR primers gave reproducible bands and these primers were selected for final amplification and data analysis. Banding patterns and DNA profiles of these techniques were shown in Fig. (1 and 2) and Tables (1-3).

RAPD-PCR Molecular Genetic Evaluation: Molecular genetic analysis of the "Amal" and "Haied" apricot cultivars under investigation, RAPD primers were illustrated (Fig. 1 and Table 1) 49 bands as a total number with molecular sizes ranged from 300 to 1750 bp. The results obtained 23 total polymorphic bands with polymorphic percentage of (46.93%) and the highest polymorphic percentage was recorded (80 %) produced with primer OP-B11and the lowest polymorphic percentage was (33.33%) with primers (OP-A7, OP-A10 and OP-B2). While, primers (OP-A1 and OP-B11) were the highest in amplified bands (10 bands) and primer OP-B2 was the lowest in amplified bands (5 bands). On the other hand, the results showed 26 of monomorphic bands and 23 unique bands over all the six primers and these results agreed with Awad, *et al.* [21] in some local apricot lines, Safaa *et al.* [22] in deciduous rootstocks and Abd El-Aziz, *et al.* [23] in apricot rootstocks.

ISSR-PCR Molecular Genetic Evaluation: Fig. 2 and Table 2 represented ISSR molecular genetic analysis of the "Amal" and "Haied" apricot cultivars which were



1. "Amal" cultivar & 2. "Haied" cultivar.
Fig. 11: Banding patterns of ISSR-PCR products for two apricot cultivars: "Amal" and "Haied" produced with six primers

Table 15: Molecular banding patterns data estimated for two apricot cultivars: "Amal" and "Haied" using ISSR technique

Primer Name	M.W Range(bp)	Sequence	Total Band	Monomorphic Band	Polymorphic band	Unique Markers	Polymorphic %
14A	240-1755	CTC TCT CTC TCT CTC TTG	12	4	8	8	66.66%
44B	180-2260	CTC TCT CTC TCT CTC TGC	15	11	4	4	33.33%
HB-8	170-1675	GAG AGA GAG AGA GG	15	11	4	4	33.33%
HB-11	435-1780	GTG TGT GTG TGT TGT CC	9	5	4	4	44.44%
HB-12	620-2800	CAC CAC CAC GC	4	-	4	4	100%
HB-14	295-2450	CTC CTC CTC GC	13	10	3	3	23.07%
Total			68	41	27	27	39.70%

Table 16: Polymorphic, monomorphic, specific markers and polymorphic percentage generated by the (RAPD and ISSR) analysis for two apricot cultivars: "Amal" and "Haied"

Primer Name	Total Band	Monomorphic Band	Polymorphic band	Unique Markers	Polymorphic %
RAPD	49	26	23	23	46.93%
ISSR	68	41	27	27	39.70%
Total	117	67	50	50	44.44%

obtained as a total number of bands 68 bands with molecular sizes ranged from 170 to 2800 bp. The results obtained 27 total polymorphic bands with polymorphic percentage of (39.70%) and the highest polymorphic percentage was recorded (100 %) produced with primer HB-12and the lowest polymorphic percentage was (23.07%) present with primerHB-14. While, primers (44B and HB-8 were the highest in amplified bands (15 bands) and primer HB-12 was the lowest in amplified bands (4 bands). On the other hand, the results showed 41 of monomorphic bands and 27 unique bands over all the six primers and these results in agreement with the finding of Gorji, *et al.* [16] in Potato, Mohamed, *et al.* [17] in EL Amar Apricot strains and Etminan, *et al.* [14] in Durum wheat and Safaa, *et al.* [22] in Deciduous Rootstock.

Combination Evaluation of RAPD and ISSR Data Analysis: The two apricot cultivars (Amal and Haied) combination data of RAPD and ISSR primers were showed in Table (3) revealed a sum of 117 band. These bands were identified as 67 monomorphic and 50 polymorphic ones with polymorphic % (44.44%) and the polymorphic bands were scored as 50 unique markers. It possible to concluded that ISSR marker is generate from the

functional region of the genome, the genetic analyses using this marker would be more useful for crop improvement programs.

CONCLUSION

The results showed that, The chilling units of "Haied" and "Amal" cultivars are suitable for the climate in Egypt, early ripening cultivars. The "Haied" cultivar is earlier (10-12 days) than "Amal" cultivar but the percentage of the fruit set, fruit yield and total income of "Amal" cv higher than "Haied" cv. There are differences between the two cultivars in morphological, fruiting and anatomical characteristics, as a result of the genetic differences between the two cultivars.

In the end, the auther recommend expanding the cultivation of "Haied" and "Amal" cultivars, for what characterized by early ripening cultivars and good fruiting except small size of the fruits and the concentration of cultivation of the cultivars "Haied" and "Amal" in areas with warm winters especially "Haied" cv, because their needs few chilling compared to other apricot cultivars such as "Canino" cv, which their needs high chilling units and are late ripening [8].

We also recommend conducting breeding and crossbreeding programs to take advantage of the genetic differences between the two cultivars.

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