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Comparative Study of some Pomegranate Cultivars (*Punica granatum* L.) Under Assiut Climatic Conditions

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Abstract

This study was carried out during two successive seasons of 2017 and 2018 to evaluate some pomegranate cultivars grown at Assiut Governorate, Egypt. Three local Egyptian pomegranate (*Punica granatum* L.) cultivars, namely Assiuty, Assiuty-1 and Nab-Elgamal compared to Manfalouty cv. which is one of the commercial cultivars in Egypt. Vegetative growth' traits, yield components and fruit quality as well as numerical evaluation were investigated.

Growth traits were determined (shoot and leaf traits) and yield components (fruit set percentage, yield/tree (kg) and fruit cracking percentage) as well as physical fruit traits (weight, dimension, grains percentage and juice percentage). The chemical traits such as total soluble solids, titratable acidity, reducing sugars as well as vitamin C and anthocyanin contents were assessed.

The obtained results indicated that there is a wide variation in each of these traits among the studied cultivars. Assiuty-1 cultivar had the highest values of most studied traits compared to the other studied cultivars, respectively. On other hand, the least values of these traits were recorded of Nab-Elgamal cultivar. As the numerical evaluation of these studied cultivars, it could be arranged in a descendingly order as follows: Manfalouty, Assiuty, Assiuty-1 and Nab-El-gamal cultivar.

The inter simple sequence repeats (ISSR) marker was used to assess the genetic relationship among the pomegranate cultivars. UPGMA-cluster analysis discriminated the four tested cultivars based on data of ISSR at 0.76 similarity. Assiuty and Assiuty-1 cultivars showed the highest value of similarity (0.87) on the dendrogram, both cultivars showed a good relationship with Nab Elgamal cultivar by showing an average value of similarity (0.82). While, Manfalouty cultivar showed low similarity (0.76) with the rest of cultivars and was separated in a single branch on the dendrogram. This grouping showed a clear genetic relationship among the tested cultivars, which could be used in breeding and improvement programs of pomegranate.

These results revealed that Assiuty and Assiuty-1 are considered promising cultivars to obtain a high yield with good fruit quality compared to Nab-El-Gamal.

Keywords: *Pomegranate, Yield, Fruit quality, Vegetative growth, genetic relationship.*

Introduction

Pomegranate (*Punica granatum* L.) is considered one of the ancient and sacred fruit trees in the Mediterranean zone (Stover and Mercure, 2007), It is believed that the center of origin of pomegranate is the region extended from Iran to the Himalayas in northern India, and then it spread to other parts of the world (Levin, 1994). Pomegranate are native to central Asia and are adaptable to a wide

range of climate and soil conditions. Thus, it is grown in many different geographical regions including the Mediterranean basin, Asia and California (Morton, 1987 and Holland *et al*., 2009).

The area planted with this fruit crop is increasing in the world due to its hardy nature, high yield, low maintenance cost and good keeping quality (Khodade *et al*., 1990).

Pomegranate fruits (*Punica granatum* L.) are consumed directly as fresh arils as well as fresh juice. They are also used in the food and beverage industry for flavouring and as colouring agents as well as jellies (Al-Said *et al*., 2009; Opara *et al*., 2009) and can even be processed into powders (Sagar and Islam, 2006). The fruit is rich in phenolic antioxidants hence its receiving great attention with the demand expected to increase in future. Juice content ranged from 75.0 to 43.0, total soluble solids ranged from 20.33 to 12.27 (°Brix) and titratable acidity (TA) ranged between 2.81% and 0.30% in pomegranate juice, respectively. The pH and vitamin C content also ranged between 4.53-2.91 and 9.48-2.77 mg/100 ml, respectively (Eccles,2009 and Arjmand, 2011).

The composition of pomegranate juice depends on cultivar type, growing region, climate, maturity, cultural practice, storage and processing factors (Melgarejo *et al*., 2000 and Ozkan, 2003).

Successful cultivation of any fruit crop requires selection of a suitable cultivar for a particular climatic condition. Within this province, there is variability in agro-climatic conditions, such that cultivars which perform well in one locality may not perform in the same way under different climatic conditions.

Determination of the pomological characteristics of fruits is an important aspect for producers, packers, juice producers, marketers and consumers. It is also important for the engineers to design equipment and processes for harvesting, handling, sorting, sizing, packing, storing and processing. Several researches reported a great variation in pomological characteristics among the pomegranate cultivars.

Many pomegranate cultivars are in production, cultivation preferences are mostly based amongst other things, on climatic conditions (Prasad and Bankar, 2000; Prasad *et al*. 2003) and physicochemical qualities of the cultivar (Al-Said *et al*. 2009, Opara *et al*. 2009; Shwartz *et al*. 2009; Tehranifar *et al*. 2010; Zhuang *et al*. 2011, Khathutshelo *et al*., 2014) which would further determine maturity and markets.

The Egyptian cultivars of pomegranate have a wide variation in the morpho-logical and chemical characteristic for many uses of fresh fruit and of industry purpose (Ismail Omayma *et al*., 2014). Molecular markers have been overcoming limitations of morphological and biochemical markers due to the influence of environment on the performance of genotypes. A wide range of molecular markers have been used to assess genetic diversity of pomegranate cultivars as well as wild genotypes from different parts of the world. Inter-Simple Sequence Repeats (ISSR) analysis is considered as an efficient molecular marker, showing genetic

variation in the wild pomegranate populations (Zahra *et al*., 2012). ISSR and AFLP analyses were used to assess the genetic variability and relationships among different Egyptian pomegranate cultivars (Ismail *et al*., 2014). Eldessoky *et al*., (2017) used ISSR markers to screen the genetic diversity in pomegranate cultivars from Egypt and Kingdom of Saudi Arabia and concluded that ISSR are important in strategies for revealing molecular relationships among pomegranate cultivars.

So, the present investigation was carried out to assess the performance of some pomegranate (*Punica granatum* L.) cultivars and to select the suitable cultivars for commercial cultivation.

Materials and Methods

This study was carried out throughout 2017 and 2018 seasons to evaluate four cultivars of pomegranate grown at Assiut Governorate, Egypt.

Pomegranate cultivars were Manfalouty, Nab-El-gamal, Assiuty and Assiuty-1.

All horticultural practices were carried out as recommended. Ten trees from each cultivar were chosen and each tree was represented as a replicate in a randomized complete block design Commercially ripe fresh fruits were randomly harvested on September to October from mature trees (14 years old) from a Private Orchard located at Assiut, Egypt.

The following parameters were measured during the two studied seasons.

A- Vegetative growth:

Four main branches which nearly uniform in growth, diameter and foliage density and distribution around the periphery of each tree were chosen and labeled in April, Data of the vegetative characteristics included

1– Tree trunk girth at 0.5 meter above the soil service.

2– Shoot length (cm).

3– Leaf number/shoot.

4– Leaf area (cm2), where thirty full mature leaves/ tree of the labeled shoot were randomly taken and weighing 90 sections of 1 cm2 and then the average leaf area determined as follows:

$$\text{Leaf area } (\text{cm}^2) = \frac{\text{Leaves weight (g)}}{\text{Sections weight (g)}}$$

5– Leaf chlorophyll content was recorded by using chlorophyll meter (Minolta SPAD 502 plus). Using ten leaves from the fourth terminal expended leaf of the shoot.

B – Yield components:

1- Fruit set percentage.

2- Date of harvest: the date of each cultivar was recorded

3- Yield/tree (kg), at harvest time of each cultivar, the fruits per each tree were harvested and weighed and then the yield/tree (kg) was recorded.

4- Fruit cracking percentage was calculated as follows:

$$\text{Cracking } \% = \frac{\text{No. of cracked fruits/tree}}{\text{Total number of fruits/tree}} \text{ x}100$$

C- Fruit physical properties:

1- Fruit weight (g): At mature stage a sample of ten fruits per replicate was weighed.

2- Fruit height and diameter (cm) were measured by using vernier caliper.

3- Fruit peel and aril were weighed by digital balance.

4- Grains percentage was calculated as follows:

$$\text{Grains percentage} = \frac{\text{Grains weight (g)}}{\text{Fruit weight (g)}} \times 100$$

5- Fruit juice volume (cm^2) was measured using graduated cylinder and juice percentage to whole the fruit was calculated.

D- Fruit chemical properties:

1- Total soluble solids percentage (TSS%) was determined in fruit juice using the hand refractometer.

2- Total acidity using titration by NaOH at 0.1 N and phenolphthalene as an indicator then expressed as citric acid, according to A.O.A.C. (1985) and then TSS/acid ratio was calculated.

3- Percentage of reducing sugars in juice was determined, according to Lane and Eynon procedure which outlined in A.O.A.C. (1985).

4- Vitamin C content (mg ascorbic acid/100 mL juice): It was determined by titration against 2,6 dichlorophenol indophenol dye according to A.O.A.C. (1985).

5- Total anthocyanin content of juice was calculated according to Rabino and Mancinelli (1986).

E- General evaluation:

General evaluation of the tested of pomegranate cultivars was calculated on the basis of 100 units which were divided among the vegetative growth and fruiting. Hundred units were shared among the studied cultivars 30 units for girth of tree, shoot length and total leaves. 30 units for the yield per tree cracking % and earliest and 40 units for fruit weight, soluble solids, anthocyanin and V.C. content. Each tree that gave the best results in any character was tested and took lower units equal to their quantities.

DNA isolation procedure

Fresh pomegranate leaf tissues were collected separately from different cultivars. The bulked DNA extraction from each cultivar was performed using DNeasy plant Mini Kit (QIAGEN).

DNA quantification

DNA concentration and purity were detected using spectrophotometer and agarose gel electrophoresis according to Stuling and Amerger (1994).

Inter Simple Sequence Repeat (ISSR-PCR) procedure

ISSR amplification was performed according to Gupta *et al*. (1994). ISSR-PCR products were separated on 2% agarose gel, stained with ethidium bromide and captured by a gel documentation system. Seven ISSR primers were used in the study, i.e. 14-A $(CT)_8TG$, 49-A $(CA)_6$ AG, HB-8 $(GA)_6GG$, HB-10 $(GA)_6CC$, HB-12 $(CAC)_3GC$, HB-15 $(GTG)_3GC$ and UBC-807 $(AG)_8T$.

Molecular data analysis

The software NTSYSpc ver. 2.20s was used, and genetic similarities were computed using Jaccard's coefficient (1908) of similarity. Cluster analysis was performed on similarity estimates using the unweighted pair-group method with arithmetic averages (UPGMA). One thousand repetition counts were used to generate the bootstrapping using the FreeTree program.

Statistical analysis:

Data were tabulated and statistically analyzed according to Snedecor and Cochran (1972) and Mead *et al*. (1993). Means were compared using

the least significant differences (L.S.D.) values at 5% levels of the probability.

Results and Discussion

The traits of the studied pomegranate cultivars involved vegetative characteristics and fruiting as well as molecular evaluation.

1- Vegetative characteristics:

Data in Tables (1 & 2) described the vegetative traits of the four studied pomegranate cultivars during 2017 and 2018 seasons. It is obvious from the data that the results took similar trend during the two studied seasons. Data declared that there was great variability in vegetative growth of different studied cultivars during the two studied seasons. Assiuty-1 cultivar had the highest values of most studied vegetative traits compared to the other studied cultivar. Moreover, the results show that the tree girth and number of leaves/shoot of Manfalouty and Nab-el-gamal trees occupy the following rank with insignificant values.

Also, data showed that Manfalouty trees was superior regarding the leaf area (7.10 & 7.62 cm^2) and total leaf/area shoot (4054.53 & 4018.92 cm^2). On the other side, the least values of such leaf traits were recorded for Assiuty-1 (6.03 & 6.32 cm2) and total leaf area/shoot (3083.79 & 3384.80 cm2) on Assiuty trees. Leaf area of Assiuty and Nab-el-gamal trees came in the following rank with insignificant values. Moreover, the highest values of number of branch/shoot (17.85 & 17.20 branch) and chlorophyll content (66.63 & 69.04 SPAD value) were recorded in Assiuty trees. On other hand, the least values of these traits were recorded in Nab-el-gamal and Assiuty-1 trees, respectively. While the intermediate values were recorded in Assiuty-1 and Manfalouty trees. The data showed that the most intermediate values had insignificant decreased compared to the highest values and significantly increased compared to the least recorded values.

These results indicated that there is a positive relationship between the total leaf area/shoot and the leaf area and their number. Also, there is an inverse relationship between the leaf area and its content of chlorophyll.

These data indicated that Assiuty-1 and Manfalouty cultivars were the biggest trees, whereas, the Nab-el-gamal cultivar was the smallest ones in comparison to the other studied pomegranate cultivars, in addition to the least, total leaf area related to the leaf number and its area.

2- Yield components:

The results obtained from the evaluation of some pomegranate cultivars during 2017 and 2018 seasons are presented in Table 3. It is obvious from the data that the results took similar trend during the two studied seasons. The data showed significant variations in fruit set, yield/tree, fruit cracking % and harvest date. Fruit set % ranged from 27.79 to 32.43% (as an av. of the two studied seasons) in the different pomegranate cultivars. Yield/tree ranged from 54.63 to 89.17 kg (as an av. of the two studied seasons) and the fruit cracking % attained 5.12 to 20.22%. The highest fruit set percentage (32.43 & 31.60%) was recorded on Assiuty-1 and Manfalouty cultivars, followed in descending order by Assiuty (29.89% as

an av. of the two studied season). Then, the Manfalouty cultivar gave the heaviest yield/tree (89.17 kg) followed in descending order by Assiuty-1 cultivar (87.81 kg/tree as an av. of the two studied seasons). Also, it could be arranged the yield in descending order as follow (89.17, 87.81, 71.34 and 54.62 kg/tree as an av. of the two studied seasons) for Manfalouty, Assiuty-1, Nab-el-gamal and Assiuty, respectively. Then, the increment percentage of yield/tree attained (63.26, 60.77 and 30.61% as an av. of the two studied seasons) for Manfalouty, Assiuty-1 and Nab-el-gamal cultivars compared to Assiuty, respectively.

On the other hand, Assiuty and Manfalouty cultivar gave the lest fruit cracking (5.12 & 9.80% as an av. of the two studied seasons). The recorded fruit cracking % were (5.61, 9.35, 17.36 and 20.43% as an av. of the two studied seasons) for Assiuty, Manfalouty, Assiuty-1 and Nab-el-gamal cultivars, respectively. Then, the decrement fruit cracking percentage attained (51.53, 75.68 & 7.02%) for Manfalouty, Assiuty and Assiuty-1 cultivars compared to Nab-el-gamal cultivar, respectively. It is noticed that there are unsignificant differences among fruit set percentage and yield/tree of Manfalouty and Assiuty-1.

These results showed that Manfalouty and Assiuty-1 gave the highest yield, whereas, Assiuty recorded the least values of fruit cracking percentage. Also, there is a positive correlation between the fruit set percentage and yield weight except in Assiuty cultivar. The last observation in abnormality of linear relationship between fruit set and yield/tree of Assiuty cultivar may be due to an increase in the fruit drop in such cultivar.

Also, regardling the harvest dates, results show that Assiuty cv. is the earliest one (about late of July) followed by Manfalouty (first September), and Nab-el-gamal (mid of September) and the Assiuty-1 cames in the least rank (mid of October). The delay in the fruit maturity due to about one to two and half months. So, it can arrange the date of harvest in terms of early as follow Assiuty, Manfalouty, Nab-el-gamal and Assiuty-1 cultivar, with a period ranging for one to two and half months. These results may represent a comparative advantage of marketing and export in terms of early, regulation of handling and control of price.

3- Fruit quality:

Data of various fruit characteristics of some pomegranate cultivars grown under Assiut condition during 2017 and 2018 seasons are presented in Tables 4 to 7. It was obvious from the data that results took a similar trend during the two studied seasons. Data indicated that most studied pomegranate cultivars were significant varied in fruit quality. The fruit weight, fruit height, fruit diameter and grains percentage were ranged from 390.75 to 445.30 g, (6.56 & 7.26 to 7.16 cm, 7.26 to 8.05 cm and 57.45 to 62.85% (as an av. of the two studied seasons), respectively. Assiuty-1 and Manfalouty fruits had the heaviest 445.3 & 416.65 g and heighest 7.16 & 7.03 cm fruit, among the tested cultivars. On the other hand, Nab-el-gamal fruits was the lightest 390.75 g and smallest fruit 6.56 cm compared to the studied cultivars, respectively.

Other studied cultivars recorded intermediate value for these studied fruit traits. It is noticed that no significant differences in fruit weight among Assiuty-1 (445.3), Manfalouty 416.65 g and Assiuty 410.55 g. On the other side, Assiuty fruit was the highest pulp percentage 62.85%, while Manfalouty and Assiuty-1 had equal grains percentage 58.35 and 58.30%, respectively compared the least one 57.45% of Nab-el-gamal fruit. The recorded fruit weighs were 416.65, 410.55, 445.30 & 390.75 (as an av. of the two studied seasons) for Manfalouty, Assiuty, Assiuty-1 and Nab-el-gamal cultivar, respectively. Hence, the increment percentage attained 6.62, 5.06 and 13.96% for Manfalouty, Assiuty, Assiuty-1 compared to Nab-el-gamal, respectively.

In respect to the chemical fruit characteristics, data in the previous tables indicated that most studied cultivar fruits were significantly varied in chemical fruit characteristics. Data showed that juice %, total soluble solids, reducing sugars, anthocyanin and V.C. contents were ranged from 61-69.6%, 13.77-16.07%, 11.48-13.16%, 21.03-66.51 mg/100 ml juice and 14.34-23.12 mg/100 ml juice (as an av. of the two studied seasons), respectively. Manfalouty fruits had the highest juice content, TSS % and V.C. content and intermediate values of other chemical characteristics compared to the other studied pomegranate cultivars. On the other hand, Nab-el-gamal fruits had the least values of most studied chemical characteristics and highest values of grain weight and TSS/acid ratio.

The recorded TSS values were 16.07, 15.09, 15.24 and 13.77%, V.C. 23.12, 17.6, 17.7 & 14.34 and anthocyanin of juice 56.7, 72.94, 73.04 &

50.48 mg/100 ml juice for Manfalouty, Assiuty, Assiuty-1 and Nab-el-gamal fruits, respectively. Hence, the increment of TSS attained 16.70, 9.62 & 10.67%, V.C 61.17, 23.31 & 23.49% and anthocyanin 61.62, 95.69 & 16.28% (as an av. of the two studied seasons) for Manfalouty, Assiuty and Assiuty-1 compared to Nab-el-gamal fruits, respectively.

Such results indicated that Assiuty-1 and Manfalouty had the best chemical fruit quality compared to Nab-el-gamal cultivar.

Such results emphasized the fact that vegetative and fruiting traits depend on cultivar. The differences found between cultivars may be due to either cytological differences between them or to the genotypes that are transmitted via seeds. These results are in line with those obtained by Melgarejo *et al*. (2000), Ozkan (2003), Martinez *et al*. (2006), Borachov-Neori *et al*. (2009), Shwartz *et al*. (2009), Tehranifar *et al*. (2010), Ismail-Omayma *et al*. (2014), Khathutshelo *et al*. (2014) and Abdel-Ghany (2015). Who mentioned that there was a wide and great variation on vegetative growth and fruiting of most pomegranate strains or cultivars.

4-General evaluation of the studied pomegranate cultivars:

The numerical evaluation of pomegranate cultivars Table 8 showed that, Manfalouty and Assiuty recorded the highest units according to the general evaluation, as it attained the uppermost score units (87.94 & 86.51) followed by Assiuty-1 which occupied the third ranked (85.08), followed by Nab-el-gamal, (73.98) which comes the last ranked. Assiuty and Assiuty-1 are equal with Manfalouty cultivar which is one of the best cultivars in Assiut.

The numerical evaluation of these cultivars (average two seasons) showed that; they were in a descending order as follows: Manfalouty (87.94), Assiuty (86.51), Assiuty-1 (85.08) and Nabel-gamal (73.98) on total units including vegetative growth, yield components and fruit quality.

The total score (30 units) for growth traits significantly differed between the studied cultivars under this study. Assiuty-1 and Manfalouty cultivars had the highest values compared to two other studied cultivars. The tested cultivars could be arranged ascending order as follow. Assiuty (26.06), Nab-el-gamal (27.51), Manfalouty (28.31) and Assiuty-1 (28.94).

The total score (40 units) for fruit quality of pomegranate (fruit weight, TSS and V.C. and anthocyanin contents) was significantly varied according to some pomegranate cultivars. All cultivars gave the highest values compared to Nab-el-gamal cultivar. The tested cultivars could be arranged descendingly based on total score (40) for fruit quality as follows:

Assiuty-1 (37.16), Manfalouty (37.13), Assiuty (36.28) and nab-el-gamal (30.49).

Such results showed clearly that Assiuty and Assiuty-1 are considered promising to be new cultivars which are grown under Assiut conditions. .

5- ISSR molecular analysis

Out of the 7 ISSR primers used in this study, five primers (49-A, HB-10, HB-12, HB-15 and UBC-807) gave polymorphism (Table 9). The total number of bands generated by the 7 primers of ISSR was 39 of which 13 (33.33%) bands were polymorphic. The number of bands per primer ranged from 4 to 10 bands, with an average of 6 bands per primer. In addition, the highest percentage of polymorphism (%P) was 66.67% that generated by HB-15. ISSR markers showed a polymorphism information content ranged from 0.01 to 0.19 with an average of 0.04. In addition, the averaged primer resolving power generated by ISSR was 1.14, ranged from 0.50 to 3.00, while the diversity index ranged from 1.39 to 4.45 with an average of 2.12. ISSR primers used in this study clearly illustrated the difference among the tested cultivars.

Table 9. A survey of total number of bands, number of polymorphic bands, percentage of polymorphism, polymorphism information content, primer resolving power, diversity index and marker index of seven ISSR primers.

Primer	TNB	NPB	%P	PIC	PRp	DI	MI
14-A	4	0	0.00	0.00	0.00	0.00	0.00
49-A	4	1	25.00	0.01	0.50	1.39	0.01
HB-08	4	0	0.00	0.00	0.00	0.00	0.00
HB-10	5	2	40.00	0.19	1.00	2.77	0.38
HB-12	6	2	33.33	0.02	1.50	2.08	0.04
HB-15	6	4	66.67	0.04	3.00	4.16	0.18
UBC-807	10	4	40.00	0.04	2.00	4.45	0.15
All	39	13	33.33	0.04	1.14	2.12	0.11

TNB: Total number of bands, NPB: number of polymorphic bands, %P: percentage of polymorphism, PIC: polymorphism information content, PRp: primer resolving power, DI: diversity index, MI: marker index.

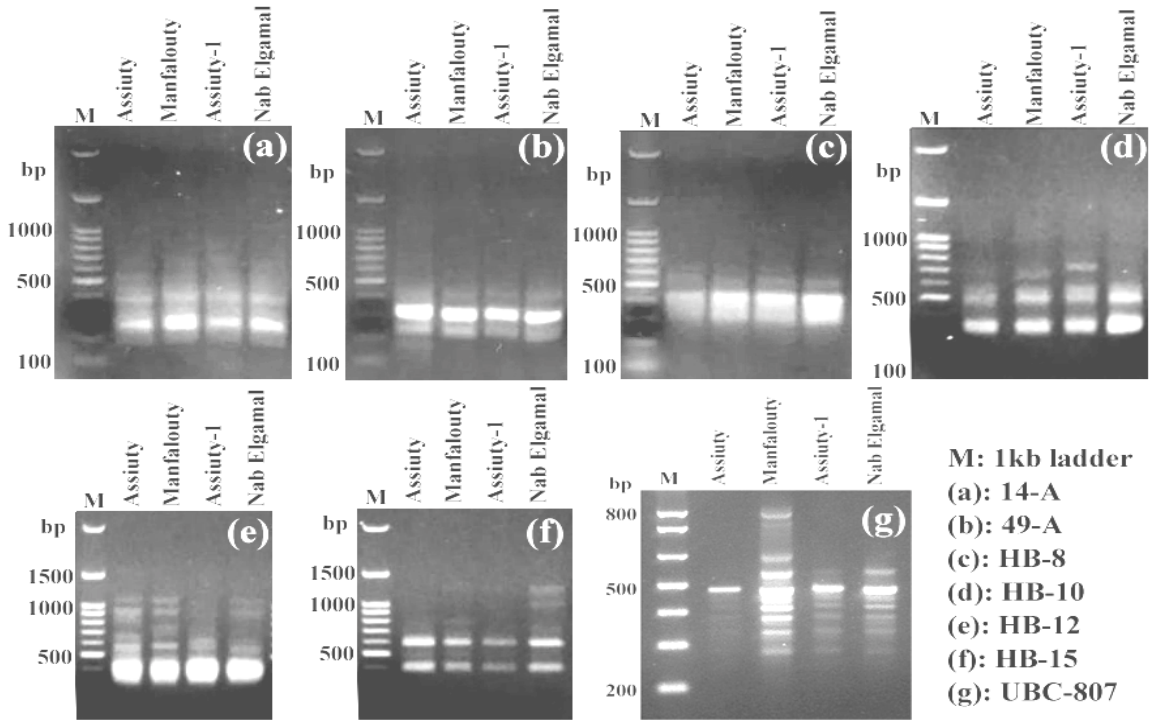

Figure 1. Gel profiles of seven ISSR primers (a-g) discriminating the four tested pomegranate cultivars.

ISSR markers used in the present study was able to assess the genetic relationship among the tested pomegranate cultivars. UPGMA-cluster analysis discriminated the four tested cultivars based on data of ISSR at 0.76 similarity. Assiuty and Assiuty-1 cultivars showed the highest value of similarity (0.87) on the dendrogram, both cultivars showed a good relationship with Nab Elgamal cultivar by showing an average value of similarity (0.82). While, Manfalouty cultivar showed low similarity (0.76) with the rest of cultivars and was separated in a single branch on the dendrogram (Fig. 6). This grouping showed a clear genetic relationship among the tested cultivars, which could be used in breeding and improvement programs of pomegranate.

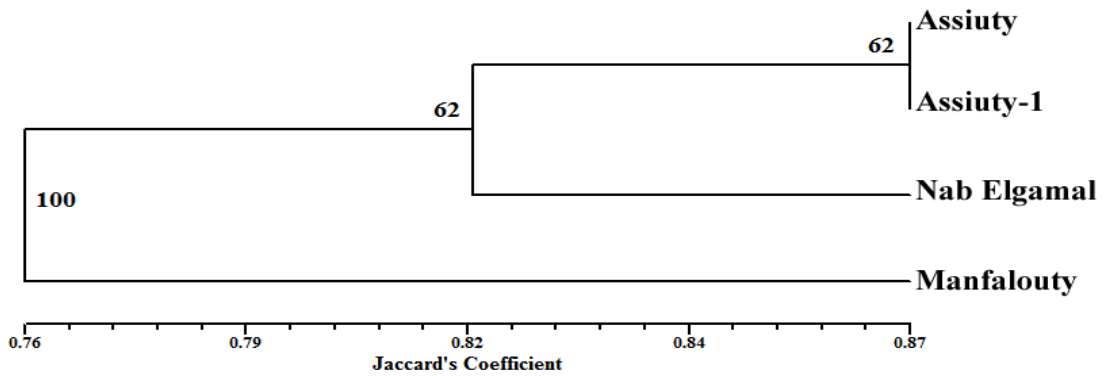

Figure 2. UPGMA cluster analysis discriminating four tested cultivars based on data of five ISSR primers using Jaccard's coefficient, numbers over branches indicate the bootstrapping.

In general, the pomegranate cultivars under the present study were widely differed in their growth, yield and physiochemical properties. Variations among these cultivars could be mainly due to their genetically and adaptability differences. Hence these results are important for economic and horticultural point of view. The best one must be selected for vegetative propagation and planting.

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دراسة مقارنة على بعض أصناف الرمان تحت ظروف أسيوط المناخية

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الملخص

أجريت هذه الدراسة خلال موسمي ٢٠١٧-٢٠١٨ لتقييم بعض أصناف الرمان النامية تحت ظروف أسيوط المناخية، حيث تم اختيار لبعض أصناف تزرع بأسيوط وقد تم اختيار ثلاثة أصناف تسمي أسيوطي واسيوطي ١ وناب الجمل لمقارنتها مع الصنف المنفلوطي الواسع الانتشار والأهم تجارياً.

وقد تم التقييم لهذه الأصناف من حيث دراسة بعض صفات النمو الخضري ومكونات المحصول وخصائص الثمار الطبيعية والكيميائية وكذلك عمل تقييم رقمي لهذه الأصناف.

وقد أظهرت النتائج:

- أوضحت النتائج وجود فروق جوهرية بين الأصناف تحت الدراسة.
- تفوق الصنف أسيوطي ١ في أغلب الصفات المدروسة سواء خضرية أو ثمريه.
- سجلت أعلي قراءات لصفات النمو الخضري وصفات المحصول وخصائص الثمار للصنف أسيوطي بينما سجلت اقل قراءة للصنف ناب الجمل مقارنة بالأصناف الأخرى.
- طبقاً للتقييم الرقمي للصفات تحت الدراسة يمكن ترتيب الأصناف تنازلياً كالتالي: منفلوطي، أسيوطي أسيوطي ١ ثم ناب الجمل علي التوالي.
- تم استخدام الواسم الجزيئي ISSR لتقدير درجة التماثل الوراثي والعلاقة بين أصناف الرمان. أظهر التحليل العنقودي علاقة أصناف الرمان معاً على مستوى تماثل كلي بمقدار ٠,٧٦. وأظهر الصنفان أسيوطي وأسيوطي-١ أعلى قيمة تماثل (٠,٨٧) على الشجرة العنقودية، كما أظهرا هذان الصنفان علاقة وراثية جيدة بالصنف ناب الجمل وذلك بدرجة تماثل مقدارها ٠,٨٢. بينما أظهر الصنف منفلوطي أقل درجة تماثل (٠,٧٦) بين باقي الأصناف المدروسة وتم فصله في فرع مستقل في الشجرة العنقودية. ويقدم هذا التقسيم علاقة وراثية واضحة بين أصناف الرمان الأربعة في هذه الدراسة، حيث يمكن استخدام هذه المعلومات في برامج تربية وتحسين الرمان.

تظهر نتائج هذه الدراسة أفضلية صنفي أسيوطي وأسيوطي ١ حيث تتفوق في معظم الصفات تحت الدراسة. وعليه يمكن التوصية بأهمية التوسع في زراعة هذين الصنفين تحت ظروف أسيوط وذلك لإنتاج محصول عال ذو خصائص ثمريه جيدة.