

Flowering and Fruiting Characteristics of Some Local and Introduced Pomegranate Cultivars Grown in the Riyadh Region of Saudi Arabia

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ABSTRACT. This investigation was carried out at the College of Agriculture, King Saud University on six pomegranate (*Punica granatum* L.) cultivars, four local namely Ahmer Balady, Hamid Abiod, Khob El-Jamil and Al-Madina, and two introduced from Spain namely Molar and De Jativa during 1989 and 1990 seasons. Flowering habits, yield and both physical and chemical properties of the fruits were determined.

Data showed that flowering habits differed from one cultivar to another. The flowers could be carried on new shoots (terminally or axillary) or on one-year old or two-year old branches. The percentage of perfect flowers ranged from 18 to 53% in the different cultivars. Yield differed from one cultivar to another and it ranged from 6.7 to 38.6 kg/tree during both seasons. Physical properties of the fruits (weight, length, diameter and fruit juice) and chemical properties (total soluble solids [TSS], acidity, vitamin C and total soluble solids [TSS]/acidity ratio) differed among cultivars.

Seasonal changes in the physical and the chemical properties of the fruits also were studied during fruit growth and ripening. They all changed from one stage to another with trends, generally, similar in all cultivars. Generally, all pomegranate cultivars studied in this investigation were adapted to Riyadh region of Saudi Arabia.

Introduction

In 1979, research commenced at the College of Agriculture, King Saud University to evaluate the adaptability of some tree fruit species including the pomegranate

(*Punica granatum* L.) to Riyadh region. The pomegranate, cultivated extensively in Spain, Iran and India, also is one of the most important fruit trees cultivated in Saudi Arabia and other Arab countries.

Although grown for thousands of years, little information is available on flowering and fruiting habits and fruit properties of local and introduced cultivars in Saudi Arabia. Shaheen (1985, 1986) previously studied the suitability of some introduced pomegranate cultivars in Saudi Arabia. He stated that no consistent trend was noted for fruit weight, fruit dimensions, pulp % and TSS. Acidity was lower in the Spanish than in the Egyptian pomegranate cultivars.

Information on the morphology and structure of plants is useful for developing cultural procedures. For example, pruning methods depend upon growth and fruiting habits of the species and of individual cultivars. Pomegranate trees bear both hermaphrodite and staminate flowers on the same tree. Only hermaphrodite flowers set fruits, the staminate flowers, which are smaller in size and have rudimentary pistils, abscise soon after opening (Singh *et al.*, 1967).

Our research compared flowering and fruiting habits, as well as yield and fruit properties of 4 local and 2 Spanish cultivars when grown in the Riyadh region.

Materials and Methods

The present investigation was carried out during the growing seasons of 1989 and 1990 on four local pomegranate cultivars namely Ahmer Balady, Hamid Abiod, Khob El-Jamil and Ai-Madina and two cultivars introduced from Spain namely Molar and De Jativa. Trees of all cultivars were planted in 1979 season at the Experimental Research Station of the College of Agriculture, King Saud University at Deirab (about 25 km south of Riyadh). The soil was sandy loam and the trees were planted at 5 × 5 meter apart. Cultural practices were the same as those used in the region for pomegranate trees. From each cultivar, 5 trees of similar vigor were selected and each tree was used as one replicate. In order to obtain information on flowering and fruiting habits, one scaffold branch approximately 5 cm in diameter was selected and tagged on each tree in March of each season. The number of perfect and staminate flowers formed on these tagged branches was counted. The flowers that formed on shoots (axillary or terminally), one year old or more branches (axillary) were counted to determine the flowering habits (as percentage). After fruit setting (4 weeks after full bloom), fruits formed on the above vegetative growth were counted to determine the fruiting habits (as percentage).

At harvest time (September 1 in both seasons), the yield of each of the above selected trees (5 trees from each cultivar) was determined as number of fruits per tree and as weight in kilograms. Fruit properties were determined using 10 fruits at the ripening stage taken at random from each tree (replicate). Physical properties including fruit weight, length, diameter and fruit juice were determined in each sample. Chemical properties including total soluble solids (TSS), and acidity and vitamin C were determined. Total soluble solids (TSS) were determined by the use of Abbe refractometer. Acidity (as citric acid) was determined by titration (A.O.A.C., 1980).

Vitamin C (ascorbic acid) was determined by the use of 2, 6 dichlorophenol indophenol dye (Cox and Pearson, 1962).

To study seasonal changes of the physical and chemical properties of the fruits, samples were taken at 14 days intervals from another 5 trees taken at random from each cultivar. Fruit samples were taken from fruit setting till fruit ripening. Each sample was composed of 25 fruits taken at random from each tree. Fruit properties were determined as mentioned above.

The data were statistically analyzed using the analysis of variance and the differences between the means were estimated according to the L.S.D. method (Steel and Torrie, 1980).

Results and Discussion

A – Flowering and Fruiting Habitats

Pomegranate flowers were borne on: shoots (axillary or terminally), one-year old branch (axillary) and two-year or more branches (axillary) (Fig. 1). The percentages of these types of flowering habits differed according to the cultivar as indicated in Table 1. The highest percentage of flowers were borne terminally on shoots in the six cultivars. These values ranged from 33.90 to 59.70% in the different cultivars. Furthermore, the Spanish cultivars (Molar and De Jativa) had a higher average number of flowers borne on shoots as compared with the four local cultivars.

The highest percentage of fruits was found on two-year old branches in all cultivars (Table 2 and Fig. 2). The average percentage of fruits borne on two-year old branches ranged from 46.50 to 55.90% in the different cultivars. Generally, these percentages were lower in the Spanish cultivars than in the local cultivars.

Concerning the flowers type, it was noted that all cultivars had the two types of flowers, *i.e.* the perfect and the staminate flowers (Fig. 3). The average percentage of the perfect flowers ranged between 18.00 to 53.00% in different cultivars (Table 3). Statistical analysis revealed significant differences among the cultivars in both seasons. Besides, the perfect flower percentage was higher in Hamid Abiod cultivar than in the other five cultivars. The other three local cultivars had low perfect flower % than the Spanish cultivars.

B – Yield

The results indicated that yield (as no. of fruits and kg per tree) differed among cultivars (Table 4). The average yield ranged from 33 to 127 fruits per tree and from 6.7 to 38.6 kg per tree in different pomegranate cultivars (Table 4). The local cultivars, except that of Hamid Abiod, had significantly greater yields compared with the Spanish cultivars in both seasons. Misra *et al.* (1985) in India stated that yield of 10 pomegranate cultivars differed from one cultivar to another and the highest yield was 18.45 kg per tree.

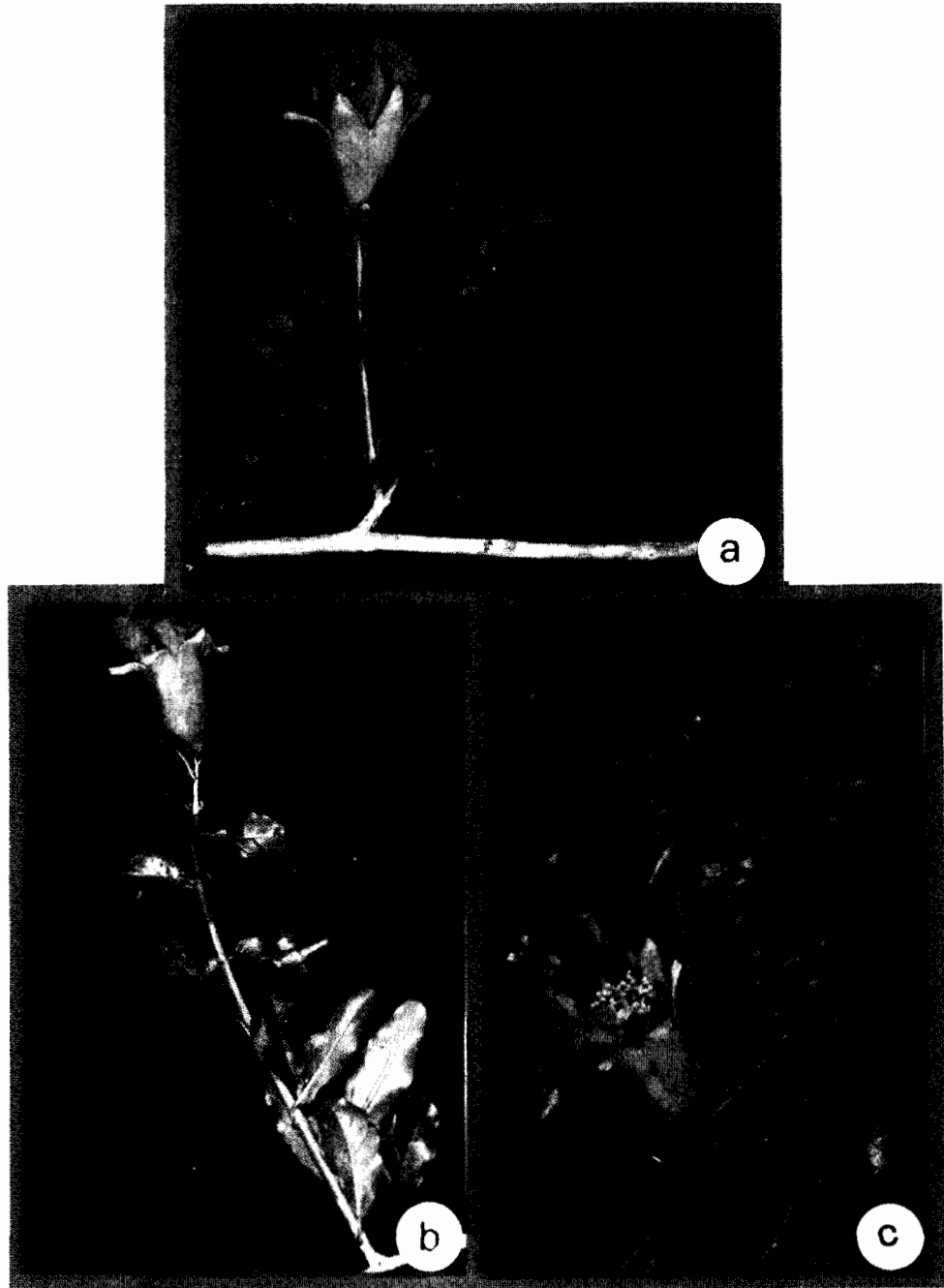


FIG. 1. Flowering habits in pomegranate trees.
(a) Shoots (terminally)
(b) One-year old branch (axillary)
(c) One-year old branch (axillary).

TABLE 1. Percentages of flowers borne terminally (T) and axillary (A) on shoots, and 1-year and 2-year branches of 6 pomegranate cultivars grown in the Riyadh region.

Cultivars	Shoot (T)			Shoot (A)			1-Year branch (A)			2-Year branch (A)		
	1989	1990	Mean	1989	1990	Mean	1989	1990	Mean	1989	1990	Mean
Ahmer Balady	44.0	40.4	42.2	4.6	15.8	10.2	25.6	21.6	23.6	25.8	22.2	24.0
Hamid Abiod	33.6	42.2	37.9	7.4	5.2	6.3	14.0	12.0	13.0	45.0	40.6	42.8
Khob El-Jamil	38.2	35.2	36.7	2.2	5.0	3.6	23.0	22.2	22.6	36.6	37.6	37.1
Al-Madina	33.2	34.6	33.9	6.8	6.0	6.4	33.2	31.2	32.2	26.8	28.2	27.5
Molar	57.4	50.5	54.0	4.7	7.4	6.0	21.9	20.2	21.0	16.0	21.9	19.0
De Jativa	59.0	60.4	59.7	3.0	13.6	8.3	12.2	17.4	14.8	25.8	8.6	17.2

T : Terminally A : Axillary

TABLE 2. Percentages of fruits borne terminally (T) and axillary (A) on shoots and 1-year and 2-year branches of 6 pomegranate cultivars grown in the Riyadh region..

Cultivars	Shoot (T)			Shoot (A)			1-Year branch (A)			2-Year branch (A)		
	1989	1990	Mean	1989	1990	Mean	1989	1990	Mean	1989	1990	Mean
Ahmer Balady	12.8	13.2	13.0	1.0	0.0	0.5	37.4	39.0	38.2	48.8	47.8	48.3
Hamid Abiod	20.0	36.2	28.1	4.0	1.0	2.5	7.8	19.2	13.5	68.2	43.6	55.9
Khob El-Jamil	23.2	25.8	24.5	2.2	1.8	2.0	27.0	27.0	27.0	47.6	45.4	46.5
Al-Madina	20.2	10.4	15.3	2.2	1.0	1.6	27.2	34.6	30.9	50.4	54.0	52.2
Molar	15.5	21.2	18.3	2.0	1.2	1.6	43.2	30.4	36.8	39.4	47.2	43.3
De Jativa	15.2	16.0	15.6	1.4	2.8	2.1	23.0	48.6	35.8	60.4	32.6	46.5

T : Terminally A : Axillary

C – Fruit Properties

Regarding the physical properties, it is clear from Table 5 that fruit weight differed from one cultivar to another and the differences among cultivars were only significant in the first season. Also, fruit weight differed in each cultivar between the two seasons. The average fruit weight ranged from 205.00 to 301.50 g in different cultivars. Also, the results indicated that there was no consistent trend between the local and the Spanish cultivars with regard to fruit weight. Pomegranate cultivars used in this investigation ranked with regard to the fruit weight (as an average of the two seasons) in a descending order as follows: Khob El-Jamil, Al-Madina, Molar, Ahmer Balady, De Jativa and Hamid Abiod (Table 5).

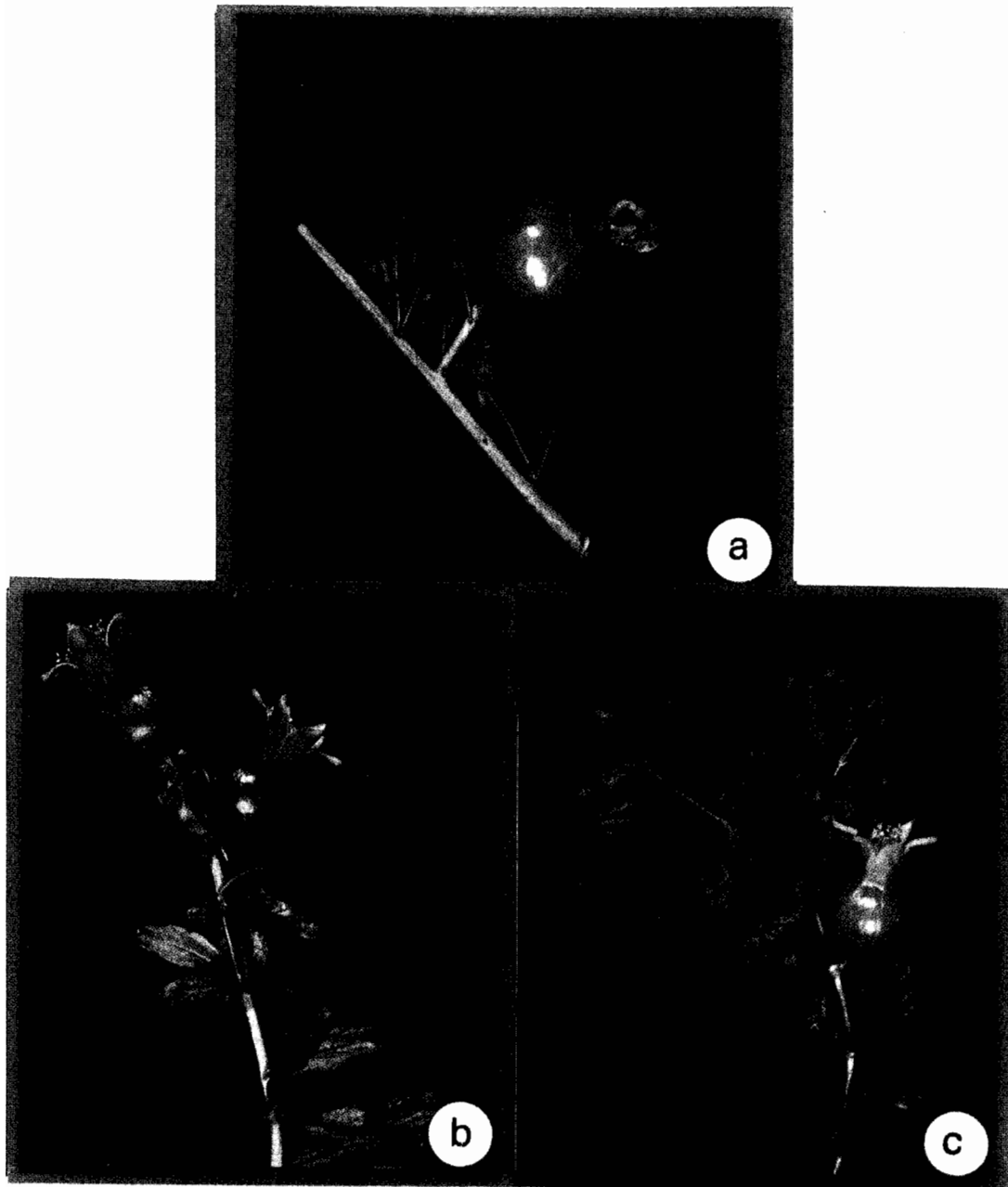


FIG. 2. Types of fruiting habits in pomegranate trees.
(a) Two-year old branch (axillary)
(b) & (c) One-year old branch (axillary).

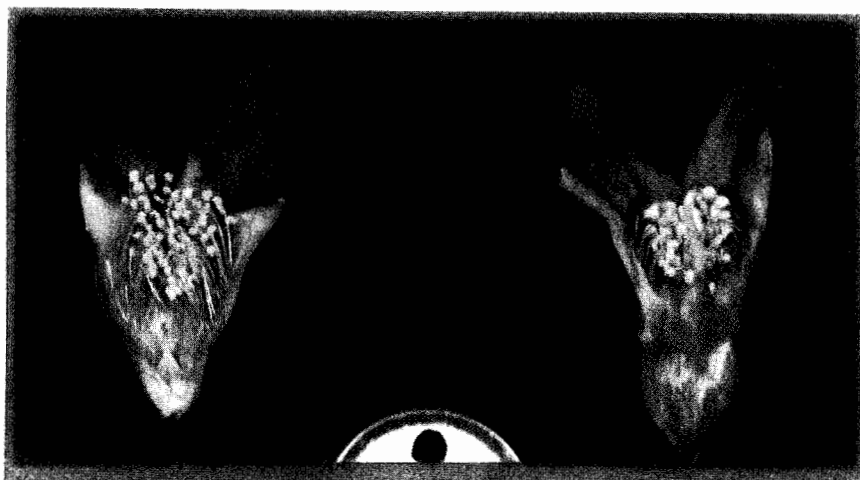


FIG. 3. Types of pomegranate flowers hermaphrodite flower (right) and staminate flower (left).

TABLE 3. Percentages of perfect flowers in the 6 pomegranate cultivars grown in the Riyadh region.

Cultivars	Perfect flowers (%)		
	1989	1990	Mean
Ahmer Balady	26.0	30.0	28.0
Hamid Abiod	54.0	52.0	53.0
Khob El-Jamil	18.0	18.0	18.0
Al-Madina	32.0	22.0	27.0
Molar	37.0	43.0	40.0
De Jativa	39.0	30.0	34.5
L.S.D. 5%	7.8	8.1	—

Fruit diameter, length and fruit juice differed also from one cultivar to another and the differences were statistically significant in some cases. In addition, no consistent trend was observed between local and Spanish cultivars with regard to these parameters (Table 5).

Concerning the chemical properties, data in Table 6 revealed that the TSS% ranged from 15.00 to 16.0 (as an average of the two seasons). Differences between cultivars were statistically significant in most cases. The local cultivars had high TSS% as compared with the Spanish cultivars. Values of the TSS% in the present study were generally similar to those obtained by Shaheen (1985) and higher than those obtained by Choudhari and Shirsath (1976) and Bacha and Ibrahim (1981) working with different pomegranate cultivars.

TABLE 4. Yield of the 6 pomegranate cultivars grown in the Riyadh region.

Cultivars	No. of fruits/tree			Kg/tree		
	1989	1990	Mean	1989	1990	Mean
Ahmer Balady	94	97	96	22.5	24.5	23.5
Hamid Abiod	30	35	33	6.0	7.4	6.7
Khob El-Jamil	125	129	127	41.3	35.8	38.6
Al-Madina	109	120	115	34.3	26.6	30.5
Molar	48	77	63	13.0	19.1	16.1
De Jativa	52	65	59	10.3	15.0	12.7
L.S.D. 5%	26	19	–	10.3	7.2	–

TABLE 5. Physical properties of the 6 pomegranate cultivars grown in the Riyadh region.

Cultivars	Fruit weight (g)			Fruit length (cm)			Fruit diameter (cm)			Fruit juice (cc)		
	1989	1990	Mean	1989	1990	Mean	1989	1990	Mean	1989	1990	Mean
Ahmer Balady	238	253	245.5	7.3	8.3	7.8	7.9	8.4	8.2	106	100	103
Hamid Abiod	200	210	205.0	6.8	7.1	7.0	7.5	7.2	7.4	86	120	103
Khob El-Jamil	324	279	301.5	7.3	8.6	8.0	8.6	8.8	8.7	135	165	150
Al-Madina	315	238	276.5	7.5	8.0	7.8	8.5	8.4	8.5	130	110	120
Molar	270	248	259.5	7.6	7.2	7.4	8.3	8.0	8.2	112	124	118
De Jativa	206	230	218.0	6.9	7.6	7.3	7.4	8.0	7.7	96	300	113
L.S.D. 5%	59	NS	–	NS	NS	–	0.6	0.6	–	28	NS	–

Acidity % ranged from 0.70 to 1.89 (as an average of the two seasons) in different cultivars (Table 6). The local cultivars had high values of acidity % as compared with the Spanish cultivars. Similar results were obtained by Shaheen (1985) working on some Egyptian and Spanish cultivars.

Vitamin C content fluctuated from 1.77 to 8.07 mg/100 ml fruit juice (as an average of the two seasons). The local cultivars, except that of Hamid Abiod, had significantly higher vitamin C content than the Spanish cultivars (Table 6). Values of vitamin C obtained in this study were similar to those reported by Watt and Merril (1963) and lower than those obtained by Bach and Ibrahim (1981).

TSS/acidity ratio ranged from 9.04 to 25.15 in the different cultivars. It is significantly higher in the Spanish cultivars than that in the local cultivars (Table 6). This is in line with that found by Shaheen (1986).

TABLE 6. Chemical properties of the 6 pomegranate cultivars grown in the Riyadh region.

Cultivars	T.S.S. (%)			Acidity (%)			Vitamin C (mg/100 ml)			TSS/ Acidity		
	1989	1990	Mean	1989	1990	Mean	1989	1990	Mean	1989	1990	Mean
Ahmer Balady	17.0	14.8	15.9	2.08	1.24	1.66	7.20	8.94	8.07	8.2	11.9	10.1
Hamid Abiod	16.0	16.0	16.0	1.48	1.28	1.38	2.66	2.98	2.82	10.8	12.5	11.7
Khob El-Jamil	17.1	16.7	16.9	2.10	1.68	1.89	5.80	6.88	6.34	8.1	9.9	9.0
Al-Madina	17.7	15.9	16.8	0.83	0.60	0.72	4.22	4.86	5.50	21.3	26.5	23.9
Molar	16.8	14.3	15.6	0.76	0.63	0.70	3.77	3.43	3.60	22.1	22.6	22.4
De Jativa	15.9	14.0	15.0	1.04	0.40	0.70	2.34	1.24	1.77	15.3	35.0	25.2
L.S.D. 5%	1.0	1.7	-	0.15	0.19	-	1.64	1.92	-	3.14	6.21	-

D – Seasonal Changes

The present results are interpreted as an average of both seasons of study, since the seasonal changes that occurred in the fruit properties followed almost the same trend.

The physical properties of the fruits including fruit weight and fruit juice were gradually increased during fruit growth and ripening in all cultivars (Fig. 4 and 5). With regard to the chemical properties, data showed that TSS% gradually increased during fruit development and ripening in the six cultivars (Fig. 6). Seasonal changes in acidity differed from one cultivar to another. In the two Spanish cultivars (Molar and De Jativa) and Hamid Abiod, it decreased during fruit growth and then increase at the end of the ripening stage (Fig. 7). In the remaining cultivars, it increased during fruit growth and development and then decreased at the end of the ripening stage (Fig. 7). Vitamin C content increased during fruit growth and ripening in all cultivars (Fig. 8).

Little information is available concerning the seasonal changes of fruit properties of the pomegranate tree. More or less similar results were obtained on the seasonal changes of some physical and chemical properties of the fruits of other trees such as grapes (Kliewer, 1965), figs (Saad *et al.* 1979), and dates (Bacha *et al.* 1987).

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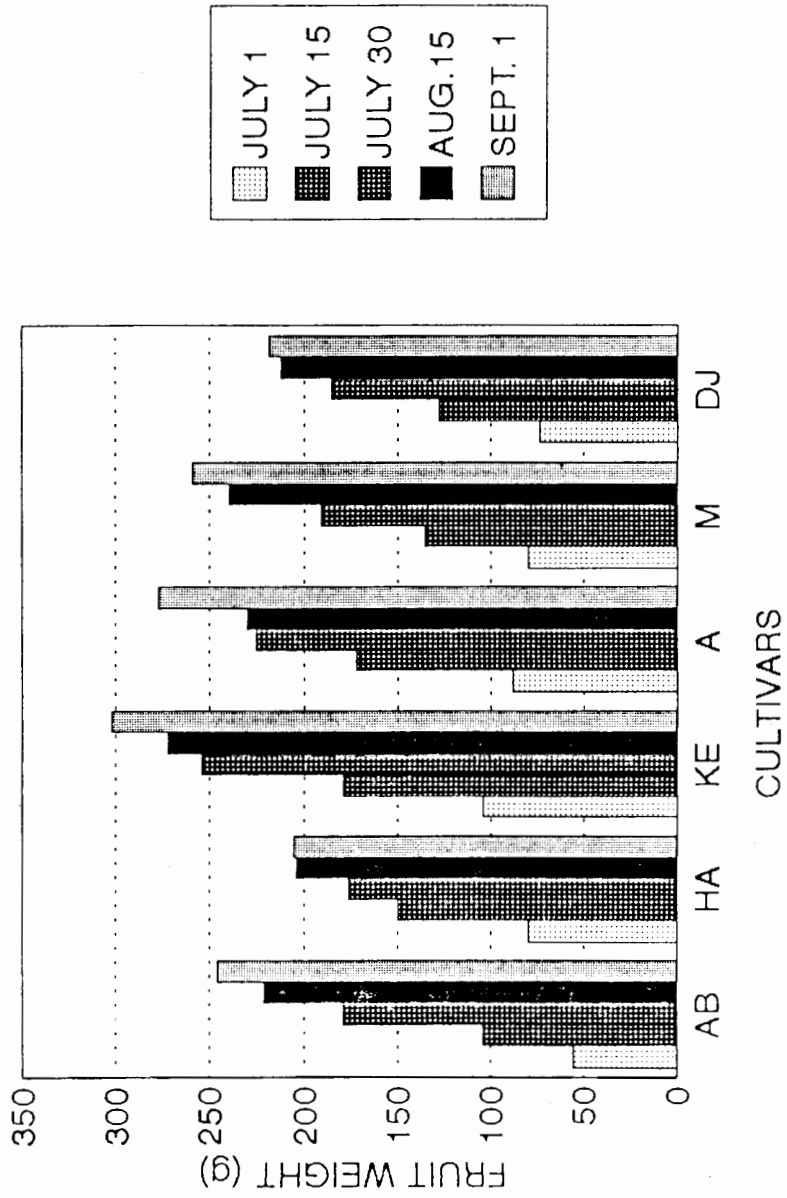


FIG. 4. Seasonal changes of fruit weight of different pomegranate cultivars (as an average of 1989 and 1990 seasons).

(AB: Ahmer Balady, HA: Hamid Abiod, KE: Khob El-Jamil, A: Al-Madina, M: Molar, DJ: De Jativa).

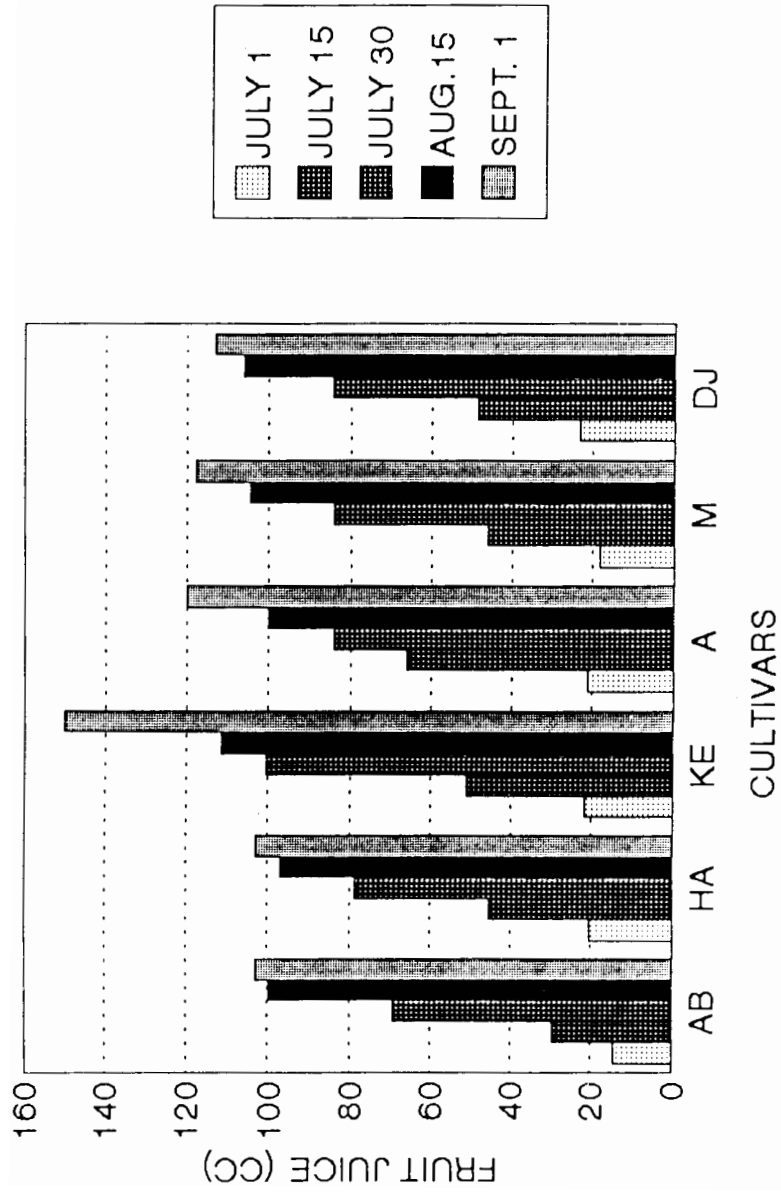


FIG. 5. Seasonal changes of fruit juice of different pomegranate cultivars (as an average of 1989 and 1990 seasons).

(AB: Ahmer Balady, HA: Hamid Abiod, KE: Khob El-Jamil, A: Al-Madina, M: Molar, DJ: De Jativa).

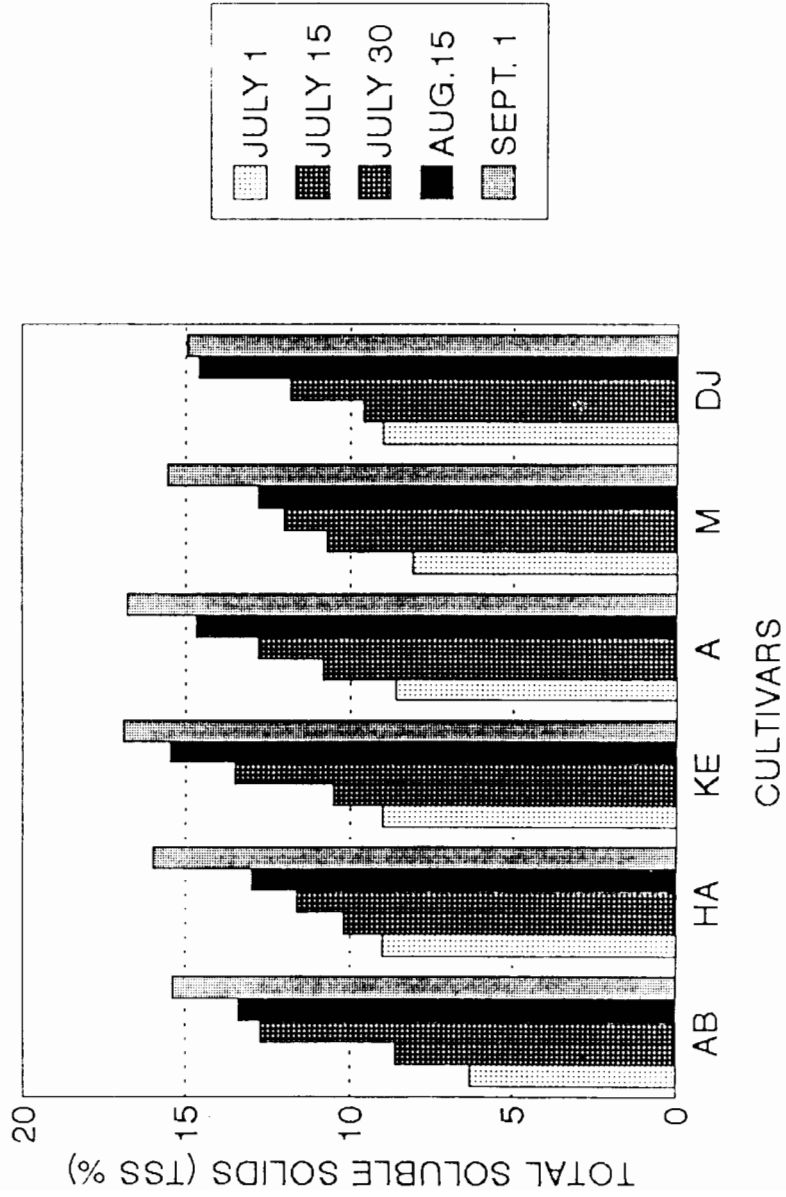


FIG. 6. Seasonal changes of total soluble solids (TSS %) of different pomegranate cultivars (as an average of 1989 and 1990 seasons).

(AB: Ahmer Balady, HA: Hamid Abiod, KE: Khob El-Jamil, A: Al-Madina, M: Molar, DJ: De-Jativa).

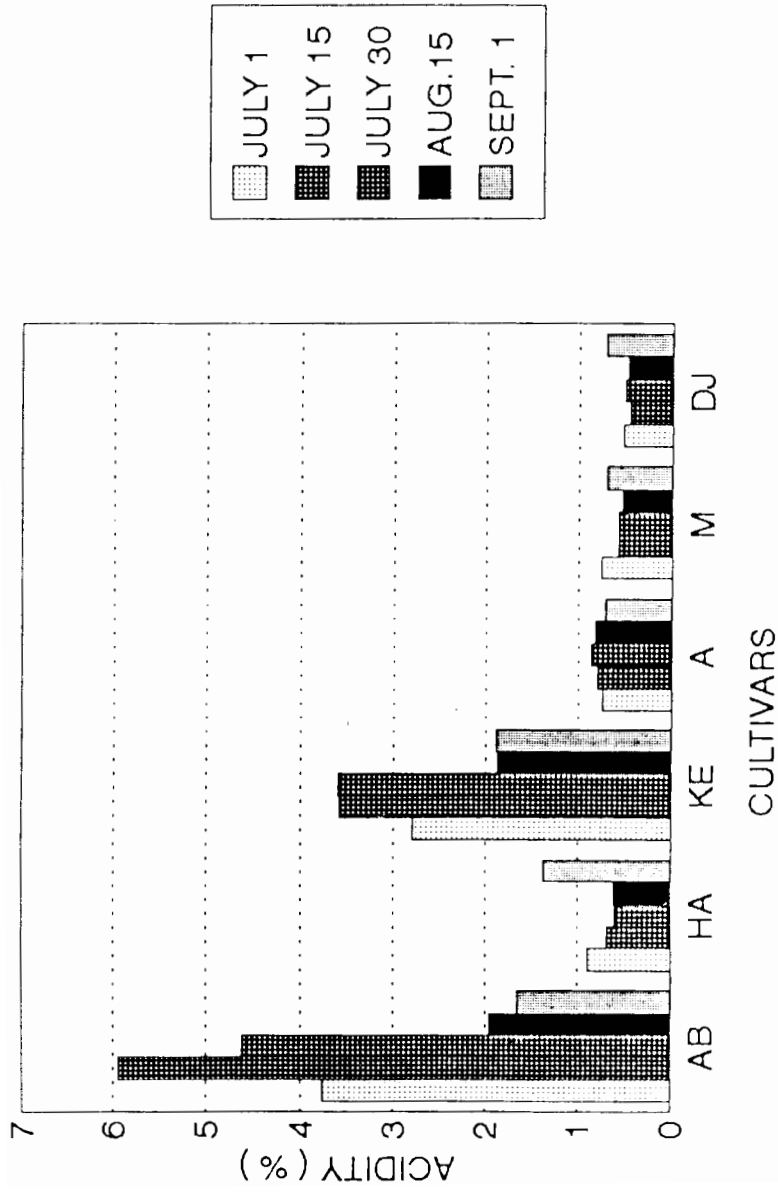


FIG. 7. Seasonal changes of acidity (%) of different pomegranate cultivars (as an average of 1989 and 1990 seasons).

(AB: Ahmer Balady, HA: Hamid Abiod, KE: Khob El-Jamil, A: Al-Madina, M: Molar, DJ: De Jativa).

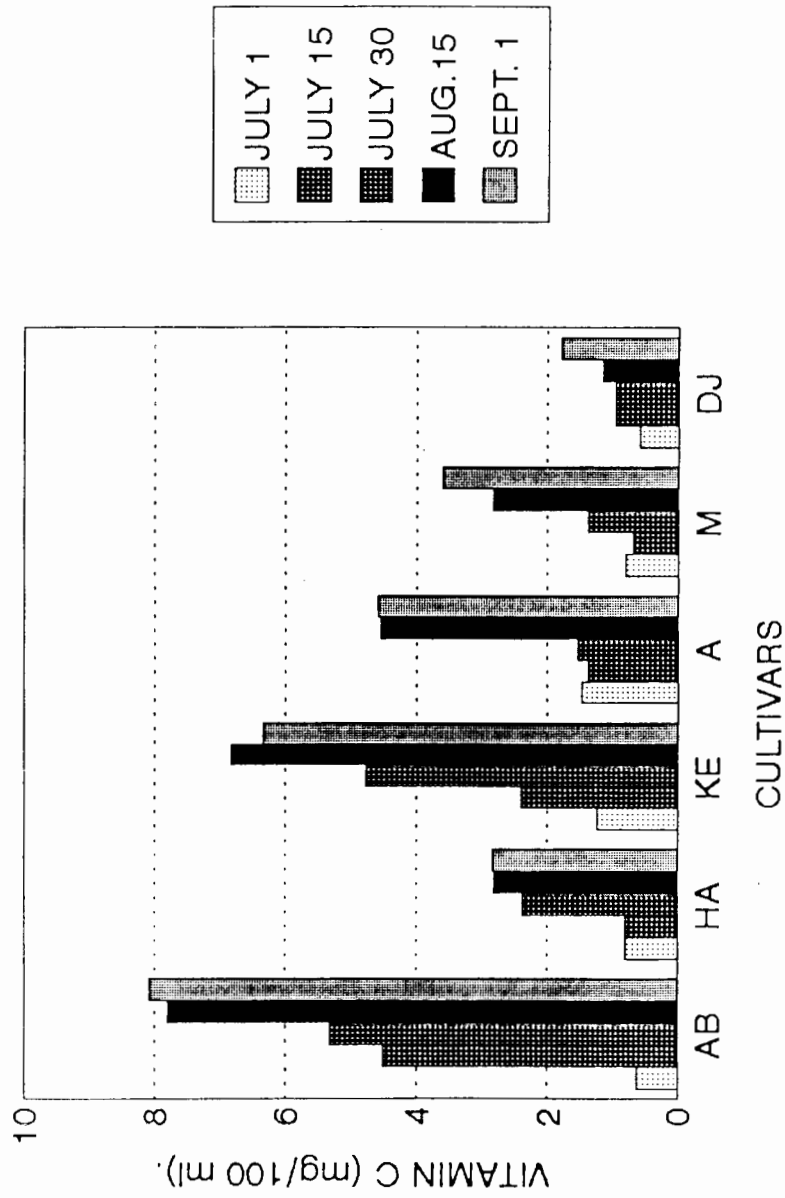


FIG. 8. Seasonal changes of vitamin C (mg/100 ml) of different pomegranate cultivars (as an average of 1989 and 1990 seasons).

(AB: Ahmer Balady, HA: Hamid Abiod, KE: Khob El-Jamil, A: Al-Madina, M: Molar, DJ: De.Jativa).

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دراسات على إزهار وإثمار بعض أصناف الرمان المحلية والمستوردة

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المستخلص : أجرى هذا البحث بكلية الزراعة - جامعة الملك سعود على ستة أصناف من الرمان ، أربعة منها محلية وهي : أحمر بلدي ، حامض أبيض ، خب الجميل والمدينة واتان مستوردان من أسبانيا هما : مولر وديجاتيفا وذلك خلال موسمي ١٩٨٩ و ١٩٩٠ م . وقد تم دراسة طبيعة حمل الأزهار والنار وتقدير المحصول والصفات الطبيعية والكيميائية للثمار في هذه الأصناف .

وقد أوضحت النتائج المتحصل عليها أن طبيعة حمل البراعم الزهرية تختلف من صنف إلى آخر حيث يمكن أن تحمل الأزهار على أفرع حديثة النمو أو أفرع عمرها سنة أو أكثر (طرفيا أو جانبيا) . كما وجد أن النسبة المثوية للأزهار التامة تختلف من صنف لآخر حيث تراوحت هذه النسبة بين ١٨ إلى ٥٣٪ في الأصناف المختلفة ، كما اختلف متوسط محصول الأشجار من صنف لآخر حيث تراوح من ٦,٤٩ إلى ٣٦,١٢ كجم لكل شجرة خلال موسم الدراسة . بالإضافة إلى ذلك وجد أن الصفات الطبيعية للثمار (الوزن ، الطول ، القطر ، حجم العصير) والصفات الكيميائية (المواد الصلبة الذائبة الكلية ، الحموضة ، فيتامين ج والنسبة بين المواد الصلبة الذائبة الكلية إلى الحموضة) قد اختلفت من صنف إلى آخر .

وقد درست أيضا المتغيرات الموسمية للصفات الطبيعية والكيميائية للثمار خلال مراحل نموها ونضجها ووجد أن جميع هذه الصفات تتغير من مرحلة لأخرى وكان الاتجاه الغالب لهذه التغيرات متشابه تقريبا في جميع الأصناف .