

EFFECT OF PLANTING DISTANCE AND TRAINING SYSTEM ON FRUIT QUALITY OF MANFALOUTY POMEGRANATES

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Abstract: This investigation was carried out in the experimental orchard of Assiut University throughout 1992 and 1993. The main objective was to study the effect of certain planting distances i.e. 5.0, 3.5 and 2.5 m and number of main stems (trunks) per plant i.e. one, two, three and four on fruit quality of Manfalouty pomegranate trees (*Punica granatum*, L.) such as fresh weight per fruit and percentage of grains (arils) relative to whole fruit weight as well as splitting and sunburn fruit percentages. The chemical composition of the juice of fruit samples includes: total soluble solids (TSS) as percent, total acidity as percent and reducing sugars. The results of this experiment could be summarized in the following:

- 1- The physical fruit properties of Manfalouty pomegranate were not influenced significantly with spacing treatments, training systems or the combination of both.
- 2- The chemical fruit properties of Manfalouty pomegranate were statistically influenced with planting distance, number of main stems/plant and combination of both. The moderately planting distance (3.5 m) gave slightly but significant highest values of total soluble solids, reducing sugars and lower total acidity. The multiple-trunk system (three or four main stems/tree) had pronounced influences on increasing the total soluble solids and reducing sugars.

The combined effects of planting distances and number of main stems/tree on their chemical fruit properties was significant also.

From this study it could be recommended to make the widest spacing (3.5 m) together with the training into 3 or 4 main stems/tree.

Introduction

Manfalouty (*Punica granatum*, L.) is considered the most principal cultivar grown in Assiut governorate where pomegranate culture is

commercially grown. Recently, there has been an increasing demand for this to meet the needs of local as well as the foreign markets. The actual planting distances and number of

main stems of pomegranate plant in the orchard are of great importance factors which control the successful growth and the productivity of the orchard. Faiziev (1973) and Popenoe (1974) reported that the highest yields were obtained from the closest spacing. Planting density had no appreciably adverse effect on fruit weight. Similarly, Kutuzova (1984) tested 5 spacing densities for some pomegranate cvs. and found that spacing of 3x2.5 or 4x2 m produced high and economic yields of good quality fruits. Aradski and Gvozdenovic (1978) found that the planting density did not influence fruit size of apples.

As training systems Takhmazov and Aliev (1975) on some pomegranate cvs found that the most economic method were the 6-branch trees owing to high yield and ease of picking. Pareek (1978) worked on trees of 22 pomegranate cvs. and found that in most cultivars, best results were obtained from trees trained to 25 cm tall stem.

Materials and Methods

This investigation was carried out during 1992 and 993 seasons on 6 years-old on Manfalouty pomegranate trees (*Punica granatum*, L.) grown on clay soil in the experimental orchard of Assiut University.

Planted 108 trees at spacing of (5x5, 3.5x3.5 or 2.5x2.5 m) were chosen according to their vegetative growth. Each planting distance was divided into four training system according to number of main trunks (1, 2, 3 or 4 trunks/tree). Thus, this experiment was set up in a split plot design including 3 main planting distances (as main plots), and 4 training systems (as sub-plot). Both the main plots and sub plots were replicated three times giving a total actual number of 108 trees (3x3x4x3 = 108 trees).

The effect of these treatments of planting density and multiple-trunk systems on fruit quality was studied.

All fruits were harvested in bulk at once as the recommended maturity standard outlined by El-Kassas (1984) and El-Kassas *et al.* (1989). The picking date under the condition of the present study was at the second week of October. Accordingly, the percentages of fruit splitted and sunburned relative to total number of fruits/tree were evaluated. To study both physical and chemical fruit properties, five fruits were taken from each replicate. The physical fruit properties were:

- Fresh weight per fruit in g.
- Percentage of grains (arils) relative to whole fruit weight.

The chemical composition of the juice of fruit samples includes:

- Total soluble solids (TSS) as percent was determined by a hand refractometer.
- Total acidity as percent, was estimated as citric acid, by titrating of 0.1 N sodium hydroxide against 5 ml juice using phenolphthalein as an indicator.
- Reducing sugars were determined in juice according to the method of Lane & Eynon, Official Titrimetric Method outlined in the Official Methods of Analysis as described in the A.O.A.C. (1985).

Statistical analysis was carried out according to Snedecor and Cochran (1980). Treatment means were compared according to Duncan's multiple range test at 0.05 level of probability.

Results and Discussion

The discussion of data obtained deals with the specific effect of each of planting distances, multiple-trunk systems and their possible combinations on fruit quality of Manfalouty pomegranate under Assiut environmental conditions:

1. Physical fruit properties:

1.a. Fresh weight per fruit:

The effect of planting distance, number of main stems per plant and their combination on the fresh weight per fruit of Manfalouty pomegranate are presented in Table 1.

The specific effect of planting distance on fresh weight per fruit was not statistically significant during 1992 and 1993 seasons. Nevertheless, the widest spacing appears to produce the largest fruit weight as compared with those of moderate or closest spacings. These results due to the widest spacings increased the efficiency of photosynthesis and consequently increased the amount of stored carbohydrates that required for flower bud formation as well as for increased the fresh weight per fruit.

These findings are in line with Palmer *et al.* (1992) who reported that the percentage of light interception increased as tree density increased in apple.

The specific effect of number of main stems per tree had slight influence on fresh weight per fruit especially during 1992 season. Nevertheless, the one single or two multiple trunk tree appear to produce the largest fresh weight per fruit. This could be attributed to their lower number of fruits production as compared with 3 or 4 multiple-trunk trees.

The combined effect of spacing treatments and number of main stems per plant on fresh weight per fruit indicated that the largest fruits were observed under the widest spacing together with single trunk tree followed by 2 main stems per plant.

Such finding was obvious during 1993 season.

Numerous investigators have shown that planting density had no appreciably adverse effect on fruit weight, Faiziev (1973) on pomegranate, On apple, Aradski and Gvozdenovic (1978) found that the planting density did not influence fruit size. Other investigators have shown that fruits from closest spacing were smaller than those from

the widest spacing, Boswell *et al.* (1970) on Washington navel orange, Schneider *et al.* (1978) on apple and Tsereteli (1990) on mandarin. However, Kamelia (1987) on fig, Martinez and Castillo (1988) on March grapefruit found that fruit weight or fruit size was greater at closest spacing than at widest spacing.

Table (1):Effect of planting distance and number of main stems per bush on fruit weight (in g) of Manfalouty pomegranate during 1992 and 1993 seasons.

Main stems per bush	Spacing treatments			
	5.0 m	3.5 m	2.5 m	Mean
1992 season				
1	401.60 a	391.60 a	372.40 a	388.53 A
2	399.80 a	364.80 a	365.80 a	376.80 A
3	362.80 a	428.40 a	317.60 a	369.60 A
4	400.80 a	420.20 a	367.60 a	396.20 A
Mean	391.25 A	401.25 A	355.85 A	
1993 season				
1	614.60 a	549.00 abc	510.64 bc	558.08 AB
2	587.00 ab	565.20 abc	574.96 ab	575.72 A
3	564.60 abc	542.20 abc	495.64 bc	534.15 AB
4	552.60 abc	519.20 bc	476.20 c	516.00 B
Mean	579.70 A	543.90 A	514.36 A	

1.b. Percentage of arils:

According to Table 2, the percentage of arils relative to whole

fruit weight was not significantly influenced with different planting distances, number of main stems per plant, or their combination.

Nevertheless, the closest spacing (2.5 m apart) gave slightly lower percentage of arils, and this was true during only 1993 season. Such closest spacing could produce the

relatively smallest fruit weight of slightly highest aril percentage. Similarly, the more the number of main stems per plant, the high the percentage of arils was acquired. This finding emphasized the fact that the smaller the fruit, the higher the percentage of arils was noticed. Martinez and Castillo (1988) found that average peel thickness of March grapefruit was greater at 4x6 m or 5x8 m than at 5x10 m. However, Boswell *et al.* (1970) in Washington

Table (2):Effect of planting distance and number of main stems per bush on the percentage of arils (relative to whole fruit weight) of Manfalouty pomegranate during 1992 and 1993 seasons.

Main stems Per bush	Spacing treatments			
	5.0 m	3.5 m	2.5 m	Mean
1992 season				
1	45.54 b	54.74 a	52.70 ab	50.99 A
2	54.20 ab	49.64 ab	52.44 ab	52.09 A
3	52.02 ab	53.24 ab	52.80 ab	52.69 A
4	57.56 a	51.72 ab	50.72 ab	53.33 A
Mean	52.33 A	52.33 A	52.17 A	
1993 season				
1	60.06 ab	54.04 b	63.32 a	59.14 A
2	55.62 ab	59.56 ab	57.60 ab	57.59 A
3	58.30 ab	56.68 ab	57.24 ab	57.41 A
4	61.10 ab	56.14 ab	60.30 ab	59.18 A
Mean	58.77 A	56.60 A	59.62 A	

Navel orange did not find any differences in peel thickness regarding planting distances.

1.c. Percentage of fruit splitting:

The effect of planting distance, number of main stems per tree or combination of both on fruit cracking are presented in Table 3. Statistical analysis of data obtained indicated that none of these previous factors have any significant influence on the percentage of cracking relative to whole number of fruits/tree.

Nevertheless, the closest spacing (2.5 m apart) gave the lowest percentage of fruit splitting during 1992 and 1993 seasons. This trend could be attributed to the smallest fruits were accompanied with low percentage of cracking as compared with biggest fruit weight. Similarly, training pomegranate tree to two main trunks was found to produce slightly highest percentage of fruit cracking as compared with the other training systems. Such trend was not in line with the fresh weight per fruit.

Table (3):Effect of planting distance and number of main stems per bush on the percentage of fruit cracking (from total number of fruits/tree) of Manfalouty pomegranate during 1992 and 1993 seasons.

Main stems per bush	Spacing treatments			
	5.0 m	3.5 m	2.5 m	Mean
	1992 season			
1	2.63 a	8.83 a	1.27 a	4.24 A
2	5.90 a	8.00 a	9.80 a	7.90 A
3	4.50 a	5.13 a	0.67 a	3.43 A
4	7.10 a	5.07 a	1.73 a	4.63 A
Mean	5.03 A	6.76 A	3.37 A	
	1993 season			
1	2.10 a	6.64 a	2.42 a	3.72 A
2	6.26 a	8.26 a	7.50 a	7.34 A
3	6.64 a	7.06 a	1.30 a	5.00 A
4	6.14 a	5.48 a	2.80 a	4.81 A
Mean	5.28 AB	6.86 A	3.51 B	

1.d. Percentage of sunburned fruits:

According to Table 4, the percentage of sunburned fruits relative to total number of fruits per tree was not influenced significantly with planting distance, multiple-trunk systems or their combination.

Nevertheless, it could be observed that, the more the wide of planting distance, the high the percentage of sunburned fruits during 1992 and 1993 seasons. This finding might be due to low percentage of light interception together with exposing fruits to higher temperature. Temperatures fluctuation during

relatively cold nights and warm days when fruits are exposed to direct sunlight could be explained the higher percentage of sunburn fruits under widest planting distance. Approximately similar findings are observed under different training systems. However, two-trunk system was found to induce the highest percentage of sunburned fruits as compared with the trunk system.

2. Chemical fruit properties:

The effect of planting distance, number of main stems/tree and combination of both on some chemical properties are presented in Tables 5, 6 and 7.

Table (4): Effect of planting distance and number of main stems per bush on the percentage of sunburned fruits (from total number of fruits/tree) of Manfalouty pomegranate during 1992 and 1993 seasons.

Main stems per bush	Spacing treatments			
	5.0 m	3.5 m	2.5 m	Mean
1992 season				
1	15.33 ab	10.17 ab	13.62 ab	13.04 A
2	15.92 ab	14.87 ab	21.27 a	17.35 A
3	18.53 ab	12.30 ab	12.80 ab	14.54 A
4	15.17 ab	14.62 ab	7.72 b	12.50 A
Mean	16.24 A	12.99 A	13.85 A	
1993 season				
1	15.78 abc	12.66 abc	15.01 abc	14.48 AB
2	16.65 ab	18.18 ab	16.00 abc	16.94 A
3	19.69 a	12.60 abc	10.44 bc	14.24 AB
4	13.14 abc	15.39 abc	7.61 c	12.05 B
Mean	16.32 A	14.71 A	12.27 A	

2.a. Total soluble solids (TSS) of juice:

According to Table 5, the percentage of TSS in Manfalouty pomegranate juice was slightly but significantly influenced with planting distances used. The TSS was highest under moderately wide spacing (3.5 m apart) as compared with either widest or closest spacings. Such trend was true during both 1992 and 1993 season. The moderately fruit yield as number of fruits or their weight per tree was found to be accompanied with highest percentage of TSS. Boswell *et al.* (1970) on Washington navel orange and Amarjct and Daulta (1990) on grapes showed no difference in juice TSS in response to planting density. However, Kamelia (1987) on fig found that TSS was decreased under closest spacing (1.7 m) as compared with widest spacing (5 m).

Regarding the influence of number of main stems per tree on the percentage of TSS in the juice, it could be mentioned that the 2 or 3 main trunk system, gave the highest values especially during 1993 season. This find could be attributed to moderately vigor growth which accompanied with highest values of TSS.

The combined effect of planting distance and number of main stems/tree on juice TSS content indicated that the TSS was statistically significant with such combination. The moderately wide spacing (3.5 m apart) in conjunction with 2 or 3 main stems per plant gave fruits of highest juice TSS content. Such TSS trend followed the separate effect of either planting distance or number of stems per tree.

2.b. Total acidity of juice:

According to Table 6, the closest planting distance (2.5 m apart) produced fruits of high citric acid content as compared with the widest (5 m) or moderately (3.5 m) planting distances. Such trend is true during 1992 and 1993 seasons. This finding is in line with those found with TSS in response to different spacing treatments. Boswell *et al.* (1970) showed no difference in percent of acid of Washington navel orange in response to planting density.

The specific effect of number of main stems/tree on total acidity (as per cent citric acid) has significant influence on such content. However, no definite trend is acquired regarding the number of main stems/tree. Nevertheless, the 2 main stems/tree has the highest total juice acidity during 1992 season and lowest content during 1993 season.

Table (5):Effect of planting distance and number of main stems per bush on the percentage of total soluble solids in Manfalouty pomegranate juice during 1992 and 1993 seasons.

Main stems per bush	Spacing treatments			
	5.0 m	3.5 m	2.5 m	Mean
1992 season				
1	14.40 bc	14.76 abc	15.56 a	14.91 A
2	14.44 abc	15.32 abc	14.84 abc	14.87 A
3	14.20 c	15.16 abc	15.04 abc	14.80 A
4	15.56 a	15.52 ab	14.92 abc	15.33 A
Mean	14.65 B	15.19 A	15.09 A	
1993 season				
1	14.96 cd	15.08 bcd	15.88 ab	15.31 B
2	15.72 abc	16.40 a	16.00 a	16.04 A
3	16.36 a	16.48 a	14.88 cd	15.91 A
4	15.96 a	16.32 a	14.68 d	15.65 AB
Mean	15.75 AB	16.07 A	15.36 B	

Table (6):Effect of planting distance and number of main stems per bush on the percentage of total acidity (as citric acid) in juice of Manfalouty pomegranate fruits during 1992 and 1993 seasons.

Main stems per bush	Spacing treatments			
	5.0 m	3.5 m	2.5 m	Mean
1992 season				
1	0.96 c	1.06 bc	1.21 ab	1.08 AB
2	1.40 a	1.09 bc	1.06 bc	1.18 A
3	1.10 bc	1.14 bc	1.18 bc	1.14 AB
4	0.99 bc	1.04 bc	1.12 bc	1.05 B
Mean	1.11 A	1.09 A	1.14 A	
1993 season				
1	0.93 cd	0.94 cd	1.14 b	1.00 AB
2	0.91 cd	0.87 cd	1.00 c	0.93 B
3	0.93 cd	0.87 cd	1.38 a	1.06 A
4	0.85 d	0.90 cd	1.19 b	0.98 B
Mean	0.90 B	0.90 B	1.18 A	

The lowest values of juice acidity were found under the widest spacing treatment (5 m apart) together with any number of main stems/plant. This means, that spacing treatments

ad pronounced effects on juice acidity rather than training systems.

2.c. Reducing sugars of juice:

According to El-Kassas *et al.* (1993), the total sugars of Manfalouty pomegranate juice constitute more than 85% from TSS, and reducing sugars represent more than 90% of the total sugars. Thus, reducing sugars could be used as an index for total sugar in pomegranate juice.

According to Table 7, the percentage of reducing sugars was slightly but significantly influenced with the tested planting distances. Similar response as total soluble solids in response to different spacing treatments was acquired. The highest values of reducing sugars are shown under moderately wide spacing (3.5 m) as compared with either widest (5 m) or closest (2.5 m) spacings. It could be expected that the widest spacing would produce fruits of higher reducing sugars, but the more yield obtained and larger fresh weight per fruit might explain the dilution effect on TSS or reducing sugars content. Amarjeet and Daulta (1990) found on grapes that reducing sugars was not affected by wider spacing. However, Kamelia (1987) on fig recorded that reducing sugars was

decreased under closest spacing (1.7 m) as compared with widest spacing (5 m).

Regarding the specific effect of training systems on reducing sugars content, it could be observed such factor did not significantly affect reducing sugars of juice. Nevertheless, the reducing sugars appeared to increase gradually with increasing the number of main stems per plant. However, such increases were not statistically significant. It could be observed also that the fresh weight per fruit and tree load could affect either TSS or reducing sugars of the juice.

Thus, planting pomegranate trees at 3.5 m apart and leaving 3 main stems/tree produced fruits of highest reducing sugars of their juice.

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Table (7):Effect of planting distance and number of main stems per bush on the percentage of reducing sugars in Manfalouty pomegranate juice during 1992 and 1993 seasons.

Main stems per bush	Spacing treatments			
	5.0 m	3.5 m	2.5 m	Mean
1992 season				
1	8.84 abc	9.75 ab	8.22 c	8.94 A
2	9.20 abc	9.23 abc	8.64 bc	9.02 A
3	8.60 bc	9.94 ab	9.04 abc	9.19 A
4	10.19 a	9.34 abc	7.96 c	9.16 A
Mean	9.20 A	9.56 A	8.47 B	
1993 season				
1	9.58 b	9.54 b	11.37 ab	10.16 A
2	10.26 ab	11.02 ab	12.62 ab	11.30 A
3	10.98 ab	13.04 a	10.23 ab	11.42 A
4	11.09 ab	10.88 ab	10.27 ab	10.75 A
Mean	10.48 A	11.12 A	11.12 A	

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تأثير أبعاد الغرس وطريقة التربية على خصائص ثمار الرمان المنفلوطي

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أجريت هذه الدراسة في مزرعة كلية الزراعة جامعة أسيوط على أشجار الرمان المنفلوطي موسمي ١٩٩٢ و١٩٩٣ وكانت أبعاد الغرس بها ٥ ، ٣,٥ ، ٢,٥ متر وداخل كل معاملة كانت الأشجار مرياه على ساق واحدة أو ٢ أو ٣ أو ٤ سيقان لمعرفة أثر ذلك على : صفات الجودة الطبيعية للثمار وهي متوسط وزن الثمرة ونسبة الحب بالنسبة لوزن الثمرة الكلي ونسبة التشقق ولفحة الشمس بالنسبة للثمار الكلية / شجرة وكذلك الصفات الكيماوية للعصير وهي محتوى العصير من المواد الصلبة الذائبة والحموضة الكلية وكذا السكريات المختزلة . وكانت النتائج كالاتي :

(١) لم تتأثر الصفات الطبيعية للثمار معنويا بأبعاد الزراعة أو طريقة التربية أو التأثير المتبادل بينهما .

(٢) تأثرت الصفات الكيماوية للثمار تأثر معنويا بأبعاد الزراعة وطريقة التربية والتأثير المتبادل بينهما، فلقد كانت لأبعاد الزراعة المعتدلة ٣,٥ م الأثر المعنوي في قلة الحموضة الكلية بينما زادت المواد الصلبة الذائبة الكلية وكذا السكريات المختزلة . أما طريقة التربية على ٣ أو ٤ سيقان فقد أدت الى زيادة المواد الصلبة الذائبة والسكريات المختزلة مع قلة الحموضة الكلية .

وسلكت الصفات الكيماوية للثمار بالنسبة للتأثير المتبادل بين العوامل المختبرة نفس السلوك الفردي لكل عامل على حده .

ولذا يمكن التوصية بالزراعة على مسافات زراعة ٣,٥ متر والتربية على ٣ و ٤ سيقان لكل نبات .