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Effects Of Suckering On Vegetative Growth, Yield And Fruits Quality Of Manfalouty Pomegranate Under Assiut Environments

Hassan Abdel-Kawi Abdel-Galil

Horticultural Department, Fac. Agric., Assiut University, Egypt.

Abstract: This study was carried out at the experimental orchard, Faculty of Agriculture, Assiut University, on Manfalouty pomegranate trees, during 2004 to 2007 seasons.

The main objective of this research was to study the effect of removing suckers and/or water-sprouts (suckering) throughout the year [every 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 and 12 months (the untreated control)] on sucker's growth, watersprouts, yield and fruit quality. The results could be summarized as follows:

There was a negative relationship between suckering frequency and total fresh weight of suckers or watersprouts. Average weight of single sucker or watersprout also exhibited the same relationship. This relationship was positive with number of the accumulated weight of removed suckers and/or watersprout per tree.

Suckering monthly or bimonthly resulted in significant decrease in total fresh weight of suckers and or watersprouts. These reductions were expressed as 85.30 and 70.71%, respectively, compared to the untreated control (4026.46 g). It also significantly increased upper shoots length, number of leaves per shoot and leaf area as well as the carbohydrate/ nitrogen (C/N) ratio. Additionally, it induced significant increase in fruit set, fruit yield/tree and enhanced commercial yield percentage/tree, compared to the untreated control. Moreover, comprehensive suckering not only decreased significantly fruit splitting, but also increased fruit weight as well as grain weight percentage, total soluble solids (TSS) contents, TSS/acid ratio and reducing sugars percentage.

Conclusion and findings revealed that comprehensive suckering monthly or bimonthly is highly recommended for Manfalouty pomegranate tree vigour with high yield of fruits characterized by excellent qualities.

Key words: Manfalouty pomegranate, suckering, sucker, watersprouts, carbohydrate/nitrogen ratio.

Introduction

Manfalouty pomegranate is considered one of the most popular fruit tree grown in Assiut governorate. The process of fruit bud initiation and differentiation, flowering and fruiting are influenced by orchard practices such as pruning. Most trees are pruned in the winter (winter pruning), but on certain occasions summer pruning is beneficial. Summer pruning is the practice of removing or partially removing these current-season shoots. Early summer pruning rarely shows positive effects and is generally discourage.

Pruning is the judicious removal of limbs, branches, twigs, shoots, or roots to increase the usefulness of plants. A good rule to follow in pruning is to have a logical reason or purpose for making each cut. Allied with effective pruning is the follow-up observation of plant response, to note whether the desired effect is being accomplished. Thus, pruning is a skill acquired through knowledge, practice and observation (Denisen, 1979).

Mika *et al.,* (1983) demonstrated that removing parts of apple trees that may produce the essential hormones greatly influenced the growth and development of the tree. As a result of pruning, hormone content increased in the resulting shoots. The results indicated that hormones produced by young leaves are essential for development of the tree.

Summer pruning is than necessary to promote flower initiation for the following season (Ryugo, 1988).

Trees can be pruned either during the winter season or during the growth season. Results differ according to the time the tree is pruned. Trees also can be pruned lightly or heavily depending on the amount of wood cut away. Pruning produces different results corresponding to the location of the cut that has been made and the type of time removed. If the cut takes away the terminal bud or young tissues at the tip of the shoot, the tree responds differently than if the entire shoot is removed. Various species, and often different cultivars within the species, react differently to the same pruning procedure (Faust, 1989).

Pruning and tree training are only two pieces in the large and complex view of commercial tree fruit production. But these are the two areas of orchard management which are commonly least understood (Warren, 1996).

Summer pruning is known to promote flowering of fruit crop that bloom on spurs on 2-year-old or older wood, providing the pruning is restricted to removing the current season's shoots. This practice exposes these flowering sets and the leaves surrounding

them. It may also reduce competition from developing shoot tips during a critical period when flower initiation is taking place (Jackson and Looney, 1999).

The primary aim of all pruning in fruit growing is to create, maintain and equilibrium between shoot growth and yield (physiological equilibrium) as a basis for early, high, regular and high-quality yields. There is physiological equilibrium if, in addition to a heavy fruit crop, a tree also shows a necessary minimum growth. Only trees in this state of equilibrium regularly give fruit of the highest external and internal quality (size, shape, colour and composition) with good storage life (Lind *et al.* 2003).

Therefore, the objective of this investigation was to study the effect of suckering on vegetative growth, yield and fruit quality of Manfalouty pomegranate.

Materials and Methods

This study was carried out during three successive seasons, from 2004 to 2007 at the Experimental Orchard, Assiut University, Egypt on Manfalouty pomegranate (*Punica granatum* L.). Thirty-six trees of thirty one years old, established at spacing of 5x5 meters were chosen at uniform vigour as possible. All trees received the ordinary management horticultural practices applied at the pomegranate orchard. The experiment was conducted as a complete randomized design with three replicates, one tree each.

Suckering is a term given to the practice of removing suckers and/or watersprouts. Twelve suckering treatments were carried out, per year. Removing all suckers and/or watersprouts in March 1st from all trees. Then treatments were as follows:

T_1- Suckering monthly per year up the 1st of April until the 1st of March of the next year (twelve time suckering).

T_2- Suckering bimonthly per year (at 1/5, 1/7, 1/9, 1/11, 1/1, 1/3, six times suckering).

T_3- Suckering every three months/year (at 1/6, 1/9, 1/12, 1/3, four times suckering/ year).

T_4- Suckering every four months/year (at 1/7, 1/1, 1/3, three times suckering/ year).

T_5- Suckering every five months/year (at 1/8, 1/1, twice suckering/year).

T_6- Suckering every six months/year (at 1/9, 1/3, twice suckering/year).

T_7- Suckering every seven months/year (at 1/10, once suckering/year).

T_8- Suckering every eight months/year (at 1/11, once suckering/year).

T_9- Suckering every nine months/year (at 1/12, once suckering/year).

T_{10}- Suckering every ten months/year (at 1/1, once suckering/year).

T_{11}- Suckering every eleven months/year (at 1/2, once suckering/year).

T_{12}- Suckering every twelve months/year (at 1/3, once suckering/year) (control).

The following measurements were determined during the three studied seasons as follows:

Total fresh weight (g) of suckers and/or water-sprouts/tree.

Suckers and/or watersprouts number and average weight/tree

Ten spring new shoots were chosen and labeled per tree to measure some vegetative parameters at the middle of October including.

Upper Shoot length:

The average length of shoots (cm) were recorded by measuring the length of labeled shoots per tree and then the average shoot length was calculated.

Leaf number/shoot:

Average number of leaves/shoot.

Leaf area:

The average leaf area was estimated by picking and weighing 20 full mature leaves/tree (from the third and fourth basal nodes of shoot) and weighing 40 sections of 1 cm^2 (2 sections of 1 cm^2/leaf), then the average leaf area (cm^2) $= \frac{Leaves\ weight\ (g)\ x\ 2}{Sections\ weight\ (g)}$

Carbohydrate/Nitrogen Ratio in Shoots:

To determine the shoot carbohydrate (C) and nitrogen (N) contents, twenty shoots were randomly taken from each replication in mid of October and defoliated. Shoot samples were washed several times in distilled water, then they were oven dried at 70°C to a constant weight, then ground in a stainless steel mill and kept for chemical analysis (Nijjar, 1985). Samples were analysed for total nitrogen by the semi-microkjeldahl technique (Wilde *et al*., 1985). Whereas total carbohydrates were determined according to Smith *et al*. (1956).

Fruit set percentage:

The number of perfect flowers which succeeded to set fruits were counted at the end of flowering season, then, the fruit set was estimated relative to total number of such complete flowers.

Fruits of each treatment were harvested in 1st of October to determine the following:

Yield components:

- Yield (kg) per tree.

- Commercial yield percentage from total yield (the fruits free of undesirable characteristics as cracking and sunburn) was calculated.

- Percentage of fruit splitting from total yield per tree was calculated.

Fruit characteristics:

To study physical and chemical fruit properties, ten fruits were randomly taken from each replicate. Average fruit weight (g), then the grains weight percentage to whole fruit weight was calculated. The following chemical fruit juice constituents were estimated:

- Percentage of total soluble solids by using a hand refractometer.

- Total acidity (expressed as g of citric acid per 100 ml of juice) by titration with 0.1 NaOH using phenolphthaline as an indicator.

- Total soluble solids/acid ratio was calculated.

- Reducing sugars percentage according to Lane and Eynon procedure as outlined in A.O.A.C. (1985).

All the obtained data were tabulated and analyzed according to Snedecor and Cochran, 1990 using t-Dunnett test for distinguishing the significance differences between various treatment means.

Results and Discussion

1- Effect of suckering on some vegetative traits:

1.1- Effect of suckering on suckers and/or watersprouts growth properties:

Total fresh weight, number and average weight (suckers and/or watersprout).

Results represented in Table (1) showed that the obtained total fresh weight values of suckers and watersprouts were 591.70, 1179.41, 2176.31, 2637.40, 2773.23 and 4026.46 g (av. three studied seasons) as affected by suckering every one (T_1), two (T_2), three (T_3), four (T_4), five (T_5) and (T_{12}) (12 months untreated) trees as control), respectively. This means that suckering every one, two, three, four and five months along the year caused a significantly decrease in the total fresh weight/year of suckers and/or watersprouts to 85.30, 70.71, 45.95, 34.50 and 31.12% respectively compared to control (suckering every 12 months). Whereas a significant increase was obtained in the number of growing sucker and/or watersprouts per year per tree (257.0, 201.67, 112.33, 110.0 and 101.56 av. three studied seasons) as affected by suckering every one, two, three, four and five, respectively compared to 40.11 for control (12 months). Meanwhile, the average weight of sucker or watersrpout significantly was decreased due to suckering every one, two, three, four and five month than 12 months. The obtained sucker weights were (2.46, 6.13, 19.47,

24.21, and 27.38 g av. the three studied seasons due to T_1, T_2, T_3, T_4 and T_5, against 97.91 g due to 12 month (T_{12}), respectively.

The reduction in total fresh weight of suckers and/or watersprouts as a result of suckering treatments at one, two, three, four and five months could be attributed to its inhibiting effect on growth. This effect may be due to the protrusion of an increase in number of adventitious buds turn of new suckers and or watersprouts that their premature removal allowed enhancing accumulation and transporation of mineral nutrients for other parts of the tree.

1.2- Effect of suckering on upper shoot length:

Data presented in Table (2) revealed that suckering every one, two, three, four and five months along the year significantly increased the upper shoots length compared with suckering every 12 months (control). The obtained shoot length values were 68.11, 65.33, 64.22, 61.11, 58.00 and 46.78 cm av. three studied seasons due to T_1, T_2, T_3, T_4, T_5 and T_{12}, respectively.

1.3- Leaf number/Shoot and Leaf area:

In addition, there was an increase in number of the leaves per shoot and leaf area (cm^2). The corresponding number of leaves and leaf area were (115.84, 111.06, 109.18, 103.89, 98.61 & 75.18 leaf) and (7.50, 7.39, 6.98, 6.73, 6.66 & 6.46 cm^2), respectively.

For such results, suckering could allow for the utilization of mineral nutrients for increasing in the upper shoot growing and length, leaf number and leaf area instead of its utility for the development of new active suckers and/or watersprouts. The practice of summer pruning was formerly confined mainly to older bearing trees with open center for removing watersprouts (Ryugo, 1988).

1.4- Carbohydrate/Nitrogen ratio in Upper Shoots

Data presented in Table (3), showed that the effect of suckering every one, two, three, four and five months significantly increased total carbohydrate % in pomegranate shoots, whereas total carbohydrate percentage were 16.42, 15.99, 15.22, 14.12 and 13.85% versus to 13.29% in control trees av. three studied seasons, respectively. The corresponding values of wood N % were 2.67, 2.63, 2.60, 2.53 and 2.52% compared to 2.50% in control trees (av. three studied seasons, respectively).

Hence, the C/N ratio was estimated to 6.16, 6.07, 5.85, 5.58 and 5.53% (av. three studied seasons) due to abovementioned practice respectively, comparing to 5.31 in suckering every 12 months (control).

The increment percentage of C/N ratio due to accumulation of carbohydrate and transporation of mineral nutrients causing favorable condition to obtaining increase in the upper shoot growing and length, leaf number and leaf area instead of its utility for the development of new active suckers and watersprouts that were removed early.

2- Effect of suckering on yield and its components:

2.1- Fruit set percentage and yield weight (kg)/tree:

Data in Table (4) showed that suckering every one, two, three, four and five months leads to a significant increase in fruit set % and yield weight per tree compared to control trees (12 months). The recorded values of fruit set percentage were 52.65, 52.14, 51.05, 45.20, 41.96 and 35.26% av. three studied seasons, due to T_1, T_2, T_3, T_4, T_5 and T_{12}. The effectiveness of early suckering could be attributed to its effect in increasing the accumulation of carbohydrates and mineral nutrients causing favorable condition for obtaining high fruit set percentage.

Summer pruning is necessary to promote flower initiation for the following season (Ryugo, 1988). These results were in agreement with those of Mohsen (2004) who found that the summer pruning treatments (head suckering, pinching main shoots + maintaining laterals, pinching main shoots + removing laterals and topping) improved the fruit set of Thompson Seedless and Flame Seedless grapevines. The obtained results indicated that yield weight/tree in response to suckering every one, two, three, four, five and 12 months (control) were attained to 85.67, 78.89, 70.89, 60.67, 53.89 and 44.44 kg/tree av. three studied seasons, respectively. The increment percentage of yield weight % per tree due to suckering every one, two, three, four and five month over control (12 month) were 92.78, 77.52, 59.52, 36.52 and 21.26% av. three studied seasons, respectively. Such an increase of yield per tree was mainly due to improving fruit set which in turn contributed to the suckers and watersprouts that stimulate the growth of trees via allowing more assimilation and mineral nutrients to more toward the formed retained buds in the next year. Mika *et al*. (1983) demonstrated that removing parts of apple trees that may produce the essential hormones greatly influenced the growth and development of the tree. As a result of pruning, hormone content increased in the resulting shoots. The results indicated that hormones produced by young leaves are essential for development of the tree.

2.2- Commercial yield percentage per tree:

Data in Table (4) indicated that suckering every one, two, three, four and five months significantly increased the commercial yield percentage as a class I comparable to every 12 months (control). The obtained commercial yield percentage were (85.49, 82.99, 78.32, 69.73 and 70.06% comparing to (64.84%) in control, respectively. These improvements occurred might be attributed to the role of suckering which allowing more assimilates and mineral nutrients to move to other parts of tree which is of sound quality (Jackson and Looney, 1999).

3- Effect of suckering on physical and chemical properties of fruits:

3.1- Fruit splitting percentage:

Data concerning splitting percentage of fruits as influenced by suckering were mentioned in Table (5). It can be noticed that suckering every one, two, three, four and five months caused a significant decrease in fruit splitting percentage, compared to every 12 months (control) the recorded values of fruit splitting percentage were attained to 7.50, 7.74, 7.81, 9.09, 9.30 and 11.50% av. three studied seasons respectively,. Such results could be due to decreasing the loss of mineral nutrients which used in suckering and watersprouts were removed. Also, suckering may cause suitable condition for fruit growth and increases the fruit peel thickness.

3.2- Fruit weight and grain weight percentage/fruit:

The results presented in Table (5) showed that the fruit weight and grain weight percentage/fruit significantly increased by suckering every one, two, three, four and five months compared to carrying out it every 12 months. Fruit weight values of treated trees were 558.33, 548.56, 498.89, 428.89 and 398.33 g versus to 353.78g for untreated trees (control trees), respectively. The corresponding increment percentage were 57.82, 55.06, 41.02, 21.23 and 12.59%, respectively. Such the increment of fruit weight may be due to the accumulation of carbohydrates and mineral nutrients in the part above the tree causing suitable condition for obtaining heavy fruit weight. The increase in fruit weight and decrease the fruit splitting are most target than total yield as pomegranate quality since the increase in fruit weight combined reduce splitting result an increase in packable yield.

Whereas, the grain weight percentage to whole fruits were attained to 61.77, 61.19, 60.62, 58.77 and 58.98% (av. three studied seasons) due to T_1, T_2, T_3, T_4 and T_5, respectively compared to 56.61% in suckering every 12 months (control trees). The corresponding increment values

due T_1, T_2, T_3, T_4 and T_5 over T_{12} were 9.31, 8.28, 7.27, 4.00 and 4.37% (av. three studied seasons), respectively.

These results could be due to the effect of early suckering which enhancing accumulation and transporation of mineral nutrients causing suitable condition for fruit growth and increasing the grain weight percentage.

3.3- Chemical constituents of juice:

Data in Table (6) showed that suckering every one, two, three, four and five months improved the fruit quality in terms increasing the TSS % and reducing sugar % and decreasing titratable acidity %. Hence, TSS/acid ratio was significantly increased compared to suckering every 12 months (T_{12} control). The recorded values of TSS % were 17.12, 16.69, 16.36, 15.40 and 15.20% (av. three studied seasons), respectively against to 14.09% in suckering every 12 months (control trees).

Whereas, the recorded values of titratable acidity percentage were 1.07, 1.11, 1.17, 1.16 and 1.18% av. three studied seasons due to T_1, T_2, T_3, T_4 and T_5, respectively against to 1.25% in suckering every 12 months (T_{12} control trees)

Hence, the percentage of TSS/acid ratio due to abovementioned treatments were attained to 16.07, 15.02, 13.99, 13.25, 12.81 and 11.29% (control trees) av. three seasons, respectively. These results could be due to effect of removing of suckers and watersprouts and allowing more assimilates and mineral nutrients to move those retained and increasing fruit quality as decrease of acidity and increase of TSS/acid ratio.

This finding may be attributed to early suckering enhanced the endogenous contents of the hormones, carbohydrates and nutritional status of the tree consequently hastening the maturity and raising TSS % of grain juice. Also, the obtained values of reducing sugars % were 11.75, 11.72, 11.69, 11.50 and 11.44% av. three studied seasons due to T_1, T_2, T_3, T_4 and T_5, respectively compared with suckering every 12 months (T_{12} control) was (11.07). The increment of reducing sugar % in response to T_1 to T_5 over T_{12} attained to 6.14, 5.87, 5.60, 3.88 and 3.34% av. three studied seasons, respectively.

The improving effect achieved in sugar contents as result of suckering may be attributed to accumulation of organic compounds in the part of the tree and resulted in good conditions for fruit growth and its quality. These results were in agreement with Cus *et al*. (2004) who found that commonly used canopy management practices, consisting of shoot positioning, suckering, lateral removal and topping,

significantly increased the must sugar content of grape cultivars Sipon, Zametovka.

Finally, it is worth notable that suckering either monthly, bimonthly or per three months will lead to accomplish many horticultural advantages. These advantages will eventually enable growers to obtain highly marketable yield. It will also very useful to get healthy and pest damage free trees, consequently saving production cost and reducing environmental pollution.

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تأثير السرطنة على النمو الخضرى والمحصول وخصائص الثمار للرمان المنفلوطى تحت ظروف أسيوط البيئية

حسن عبد القوى عبد الجليل

قسم البساتين – كلية الزراعة – جامعة أسيوط – أسيوط

أجرى هذا البحث بمزرعة كلية الزراعة – جامعة أسيوط خلال ا لمواسم من 2004 وحتى 2007 على أشجار الرمان المنفلوطى وذلك لدراسة تأثير السرطنة (إزالة السرطانات و/أو الأفرخ المائية) على نمو السرطانات والأفرخ المائية والمحصول وخصائص الثمار حيث تم إزالة السرطانات طوال السنة كالآتى : كل شهر ، شهرين، ثلاثة ، أربعة ، خمسة ، ستة ، سبعة ، ثمانية ، تسعة ، عشرة ، احدى عشر ثم اثنى عشر شهراً (الكنترول) وكانت النتائج كالآتى :

1.كانت هناك علاقة عكسية بين عدد مرات السرطنة / سنة وكل من الوزن الرطب للسرطانات والأفرخ المائية / سنة ومتوسط وزن السرطان الواحد أو الفرخ المائى النامى بينما كانت هذه العلاقة طردية مع عدد السرطانات أو الأفرخ المائية النامية/سنة .

2.أدت السرطنة كل شهر أو شهرين إلى تقليل الوزن الرطب للسرطانات والأفرخ المائية حيث كانت 85.30 ، 70.71 % على التوالى بالمقارنة بالكنترول (4026.46 جرام) . كما أدت إلى زيادة معنوية فى طول الأفرع العلوية وعدد الأوراق/فرع ومساحة سطح الورقة وكذلك نسبة الكربوهيدرات إلى النيتروجين . وزيادة نسبة العقد وكمية المحصول والمحصول التجارى بالمقارنة بالكنترول .

3.أدت زيادة عدد مرات السرطنة إلى تحسين خواص الثمار الطبيعية والكيميائية حيث حدث نقص فى نسبة تشقق الثمار ونسبة الحموضة مع زيادة وزن الثمرة ونسبة اللب ونسبة المواد الصلبة الذائبة والسكريات المختزلة .

من نتائج الدراسة نوصى بأهمية إجراء عملية السرطنة شهرياً أو كل شهرين ابتداء من شهر مارس حيث يؤدى ذلك إلى تحسين النمو الخضرى ونسبة الكربوهيدرات إلى النيتروجين وبالتالى زيادة نسبة العقد والمحصول مع تقليل نسبة التشقق وتحسين جودة ثمار الرمان المنفلوطى وذلك تحت ظروف هذا البحث .