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EFFECT OF MANUAL FRUIT THINNING ON ALTERNATE BEARING, YIELD AND FRUIT QUALITY OF BALADY MANDARIN TREES.

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Abstract: The effect of fruit thinning rate on regulate bearing, yield and fruit quality of Balady mandarin trees was investigated during two successive seasons, 2006 and 2007. Fruit thinning were performed when the fruit diameter reached about 25-30 mm, as hand thinning by removing 20, 30, 40 or 50% of fruits number per tree. The experimental treatments were arranged in a complete randomized block design. The results of this investigation could be summarized as follow:

- Fruit thinning caused a significantly decreased in fruits number and yield/tree and relative yield during first season (on-year). Whereas, during the second year (off-year), all fruit thinning significantly increased the productivity of trees compared to unthinned ones.
- Removing 40% of fruits number/tree was the most effective thinning treatment in increasing and regulating the tree productivity.
- The fruit weight and dimension were significantly increased as a result of fruit thinning in either (on-year) or as average of two studied seasons.
- Such fruit traits were significantly decreased in (off-year) seasons compared to unthinning ones.
- All fruit thinning rates significantly increased fruit juice content of soluble solids, sugars and V.C and decreased total acidity.
- Fruit thinning as removing either 40 or 50% of fruits number/ tree gained the highest score record, 99.8 and 93.7 units, respectively as a general evaluation of treatments.

On the account of the present findings, it can be concluded that manual hand fruit thinning at 40% when the fruit diameter is about 25-30 mm was the best economic treatment for Balady mandarin trees to obtain the high yield with good fruit quality, furthermore, overcome the alternate bearing which the major problem for such cultivar.

Key words: Fruit thinning, Manual thinning, Alternate bearing yield , Fruit quality, Balady mandarin.

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Introduction

Citrus is one of the most important fruit crops all over the world. It ranks the third position between fruit crops and only preceded with grapes and apples. In Egypt, it is the most important fruit crop. Mandarin ranks second crop after oranges in Egyptian citrus industry. Balady mandarin fruits are superior quality and considered as one of the most popular fruits in local and exported markets owing to its nutritive values and it easy to peel (El-Salhy *et al*., 2006). Some citrus cultivars are prone to alternate bearing, in which trees produce very heavy crops of small fruit in "on" year and much smaller crops of larger fruit in the "off" year. This phenomenon seems to be related to the time of flower bud differentiation and crop load. Flower bud differentiation in citrus usually occurs at the time of initiation of new growth in spring. An extremely heavy set of small fruit was followed by a season with no blossom (Monseline and Goldschmidt, 1982). Balady mandarin is known for its alternate bearing tendency. Heavy crops of mandarins cause delayed maturity poorer external color and small sizes that are unmarketable or are sold only at a reduced price. Heavy crops of mandarins also are destructive to the health of the tree. It not only cause limb breakage of trees, but result in dieback or death of the tree (Kihara *et al*., 1995). Managing alternate bearing involves either increasing production during the "off" year, or decreasing crop load during the "on" year. The ability to increase yield during the "off" years is limited, although some increase in yield in the "off" year by girdling branches in the previous summer (Augusti *et al*., 1992). Several possibilities exist for decreasing yield during the "on" year including hand thinning, chemical thinning, mass removal by mechanical hedging or topping, and altering management practices (Wheaton, 1986).

Kinnow mandarin trees in a severe biennial bearing cycle were thinned by spraying with NAA and pruning, pruning alone, and hand thinning at three rates. Fruit size was increased approximately in direct ratio to the amount of thinning up to removal of 48% of the crop. The effect of NAA thinning on yield and fruit size were similar to effects produced by hand thinning. Fruit thinning more than 50% of the fruits on the tree in late June must be removed to overcome the biennial bearing cycle (Hilgeman *et al*., 1964).

Hand thinning during summer as many as 70%, ethephon at 200 ppm, NAA at 350 ppm were

considerable thinning during "on" year of Wilking mandarin trees. The yield was not affected due to large increase in individual fruit weight. The alternate bearing controlled by these treatments, where gave a satisfactory yield in the following year (Galliani *et al*., 1975).

Thinning in the early part of the "on" year reduced the alternate bearing habit. Early harvesting of large crop also, reduced alternate bearing. Carbohydrate reserves in the tree were reduced by an "on" crop, and an "off" crop followed this reduced level of carbohydrate reserves but the reduction was not sufficient to account for the "off" year (Jones *et al*., 1979).

In Wilking mandarin cv, the absence of fruit in the "off" year was due to lack of flower bud formation during the previously high yielding "on" year, rather than to poor set of flower. The "off" tree contained 13.26 kg starch and 10.66 kg soluble sugars, as against 2.95 kg starch and 6.75 kg soluble sugars in the "on" tree. The majority of this reserve pool would presumably be recycled and used for next year's crop (Goldshmdt and Golomb, 1982). NAA at 250 or 400 ppm and GA_3 at 100 ppm have tended to reduce the amplitude of alternate bearing of Balady mandarin trees. The improving in fresh weight per fruit was related to the degree of fruit thinning. Whereas, most of chemical fruit traits were not adversely affected by most of growth regulators used as fruit thinning. Such behaviour emphasized the possibility of inducing regular bearing in Balady mandarin trees by successful thinning heavy flowering trees with appropriate concentration of some growth regulators (Mohammed-Afkar, 1991). NAA spraying during physiological drop, when fruitlets averaged 8-16 mm in diameter reduced fruits number per tree, increased fruit size and decreased production of smallest size fruit. Although NAA has been labeled for thinning of many citrus varieties for more than twenty years, it has received little commercial use. Since annual spray material costs, high cost is likely to be a major limitation to more wide sprayed NAA thinning of citrus (Stover *et al*., 2006).

Hand thinning with retention of 600, 800, 1000, 1200 and 1400 fruits/tree and spraying of NAA at 300, 350 & 400 ppm and ethephon 200 ppm, 35 days after full bloom (pea-size fruits). Retention of the lower number of fruits/trees improved fruit weight and quality, with reduced peel percentage and higher juice content. The best results were obtained with the retention of 600 fruits/tree and spraying of NAA at 350 ppm (Sawale *et al*., 2006).

So, the aim of this work was to study the effect of hand fruit thinning on yield, fruit quality and alternate bearing of Balady mandarin trees.

Materials and Methods

This investigation was carried out during two successive seasons of 2006 and 2007 on fifteen years old Balady mandarin trees (*Citrus reticulate* L.). They were budded on sour orange; grown in a private orchard situated at Cairo/Alexandria, desert road (Km, 72) 6 October Governorate, Egypt.

Sixty trees were chosen according to their similarity in fruiting (on-year status) growth, vigour, uniform. They were planted at 5x5 m apart and irrigated via surface irrigation. The chosen trees divided into five treatments including the control as follow:

1- Fruit thinning by removing 20% of fruits number/tree.

2- Fruit thinning by removing 30% of fruits number/tree.

3- Fruit thinning by removing 40% of fruits number/tree.

4- Fruit thinning by removing 50% of fruits number/tree.

5- Unthinned ones (control).

The experimental treatments were arranged in a complete randomized block design with four replicates, three trees each. Hand thinning treatments were performed during second week of June when the fruit diameter ranked about 25-30 mm. All trees received the ordinary management practices usually applied in the citrus field. The tested treatments were evaluated through the following measurements.

1- Yield and its component:

- Yield of all treated trees was harvest at the same time in the two successive seasons at mid December, the yield was calculated either as fruit number per tree or as weight (kg/tree).

- The relative yield was calculated by dividing the yield/treatment by the yield of control.

- Alternate bearing value was calculated according to Singh (1948) as follows:

$$\frac{\text{Differences between successive yield}}{\text{Sum of successive yield}} \text{x100}$$

2 – Fruit quality:

Sample of 10 fruits were randomly taken from each tree to evaluate fruit quality, fruit weight, dimension and fruit shape index, as well as, chemical fruit quality such as total soluble solids, total acidity (expressed as g citric acid/100 ml/juice), ascorbic acid mg/100 ml juice and sugar contents were estimated according to A.O.A.C. methods (1985).

General evaluation of tested thinning treatments:

Scoring evaluation of the studied thinning treatments was calculated through their effects on yield/tree, biennial bearing index, fruit weight, total soluble solids and V.C. contents. Hundred units were shared between the previous main five characteristics (20 units for each). Within each of these parameters, the treatment that recorded the uppermost values received all the units specified for it, excepted the lowest for biennial bearing index. Relative values due to the other tested treatments were calculated. The following equation was used to determine these characters.

$$\text{Characters} = \sum \frac{B}{A} \times 20$$

A = the highest value recorded for studied character among all treatments (lowest for biennial bearing index).

B = value recorded for the specific character for considered treatments.

The obtained data were statistically analysed according to Mead *et al*. (1993) using L.S.D. test to define the significance of the differences among various treatments.

Results and Discussion

Effect of fruit thinning on yield components and biennial bearing index:

Data illustrated in Table (1) show Balady mandarin yield component as affected by certain fruit thinning during 2006 and 2007 seasons. Data revealed that fruit thinning caused significant decreases in fruits number and yield/tree and relative yield as compared to unthinning ones. Increasing the fruit thinning percentage caused a gradual decrement in such traits during the first season. The highest fruit number and yield/tree and relative yield were recorded on the unthinned trees during the first studied season. No difference could be noticed among fruit thinning by either removing 40 or 50% of fruits number/tree. The relative yield during the first season "on-year" was (0.88, 0.85, 0.76 and 0.73) due to fruits thinning by removing either 20%, 30%, 40% or 50% of fruits number/tree compared to (1.0) unthinning ones (control), respectively. Moreover, during the second season "off-year", it could be concluded that all fruit thinning had a significant increases on productivity of Balady mandarin trees expressed as fruit number and yield/tree and relative yield compared to unthinned ones (control). The promotion on such parameters were associated

with increasing the fruit thinning percentage tile 40% of fruit number/tree. The highest fruits number, yield/tree and relative yield were recorded on removing 40 or 50% of fruit number/tree. The relative yield during the second season (off-year) was (1.82, 2.05, 2.50 and 2.45) due to removing either 20, 30, 40 or 50% of fruits number/tree compared to (1.0) unthinning ones (control), respectively.

The most effective thinning treatment to increase the tree productivity was removing 40% of fruits number/tree during the second season or as average two studied seasons. Such findings may be due to the effect of removing the young fruits which encourage the return bloom of vegetative shoots. When fruits were removed early in the season, an increase in photosynthesis during the floral initiation period was occurred. This increase in the photosynthesis of the non-bearing branches is also correlated with enhancing flowering. Factors that influenced photosynthesis, including the levels of atmospheric carbon dioxide and solar radiation, are known to influence flowering, although a direct relationship between photosynthesis and flowering has yet to be proven (Okuda *et al*., 1996). Moreover, thinning by any level significantly, decreased the biennial bearing index compared to unthinning ones (control). The least biennial bearing index was observed as fruit thinning by removing 40% of fruits number/tree. The biennial bearing index was (20.0, 12.62, 2.80 and 3.84) due to removing 20, 30, 40 or 50% of the fruits number/tree, respectively, against 51.11 in the control. Such phenomenon decreased due to fruit thinning effects in minimizing the difference between the yield of the two following seasons as compared with unthinned ones (control).

These results emphasized the vital importance of fruit thinning in order to overcome the alternate bearing. Decreasing the yield/ unthinned/tree, in the (off-year) might be attributed to decreasing No. of fruit/tree as a result of decreasing flower bud formation since few supply of food material (carbohydrates that are manufactured in the leaves).

Moreover, the positive effect of fruit thinning to balance and improve the tree food material, surely reflected on increasing the floral bud formation, consequently, improved the fruits number and yield/treated tree. It is worth to mention that fruit thinning by removing 40% of fruits number per tree was very effective in improving the yield/tree and balanced the annual yield since overcome the alternate bearing where irregular the annual yield/tree. Similar results were in accordance with those obtained by Hilgeman *et al*. (1964), Galliani *et al*. (1975) and Mohammed-Afkar

(1991) who stated that hand thinning more than 50% of the fruits on the tree during "on" year overcame the alternate bearing, where gave a satisfactory yield in the following year.

Effect of fruit thinning on fruit properties:

A- Physical fruit properties:

Data concerning some physical fruit characters of Balady mandarin as influenced by fruit thinning during 2006 and 2007 seasons are mentioned in Table (2). The data declared that fruit weight and dimension were positively affected with hand fruit thinning compared to unthinned ones (control) during the first season "on-year". The promotion in these fruit traits were associated with increasing the level of fruit removing. Whereas, during "off-year" such fruit traits significantly decreased in response to removing 20 or 30% of fruits number per trees. Moreover, increasing fruit thinning levels from 40 to 50% of fruits number/tree failed to show any significant effect in fruit weight. The heaviest fruits were recorded on trees thinned by removing 50% of fruits number per trees during either the first season "on-year" or as an average of the two seasons, whereas, during the second seasons "off-year" the heaviest fruits were found on unthinned ones.

The recorded fruit weight during "on-year" were (180, 190, 202 and 206 g) due to fruit thinning as removing 20, 30, 40 or 50% of fruits number/tree against to 150 g in unthinned ones (control). The increment percentage of fruit weight due to thinning compared to unthinned ones were (20.00, 26.67, 34.67 and 37.33%) due to removing 20, 30, 40 or 50% of fruits number/tree, respectively. Such finding may be due to reducing the number of fruits per tree consequently improvement the ratio of leaves to fruits number, induce an increasing in the fruit growth rate since a better supply of food material (carbohydrates) that are manufactured in the leaves.

Furthermore, the fruit weights as average of the two studied seasons were found to be (182.5, 191.5, 202.5 and 204.0 g) due to removing 20, 30, 40 and 50% of fruits number/tree against 180.0 g, respectively. The increment percentage of fruit weight due to thinning treatments over unthinned ones were attained (1.38, 6.39, 12.50 and 13.33%) due to fruit thinning as removing 20, 30, 40 and 50% of fruits number/tree, respectively.

Also, it showed that fruit height (cm) and width (cm) reacted almost similarly and taking the same trend of fruit weight in response to effect of investigated hand fruit thinning

during the two studied seasons. Hence, fruit thinning failed to show any significantly alter in fruit shape index. Such result due to similar effects of fruit thinning on the dimension of fruit. It could be concluded that fruit thinning by removing 40 to 50% of fruits number/tree was very effective in improving the physical fruit quality.

The above mentioned results are in line with those reported by Hilgeman *et al*. (1964), Galliani *et al*. (1975), Mohammed-Afkar (1991) and Sawale (2006). They found that fruit thinning induced significant effects in improving the physical traits of mandarin fruits.

B- Chemical juice constituents:

It was evident from the obtained data shown in Tables (3 & 4) that all fruit thinning rates significantly improved the chemical juice constituents of fruits in terms of increasing % reducing and total sugars, total soluble solids and fruit content of juice V.C. and decreasing total acidity %. Also, it could be possibly to notice from such data that total sugars and total soluble solids/acid ratio were parallel to total soluble solids. Comparing the efficiency of different thinning treatments, it was found that thinning by removing either 40 or 50% of fruits number/tree gave the best chemical fruit juice quality compared to other thinning treatments. Moreover, the highest values of such traits were found as removing 40% of fruits number/tree, while unthinned ones gave the lowest values.

The total soluble solids percentage were (12.51, 12.65, 12.90 and 12.85% as an average of the two studied seasons) due to removing 20, 30, 40 or 50% of fruits number/tree compared with (11.60%) in unthinned ones (control), respectively. Therefore, the increment percentage of total soluble solids over unthinned ones were (7.84, 9.05, 11.21 and 10.77%) respectively. These results might be due to the adequate carbohydrates and other essential food for the remained fruits, consequently enhanced the fruit maturity and increase its content of total soluble solids and sugar contents. In general, it could be concluded that there was a positive relationship between the number of leaves/fruit and chemical constituents improving. In addition, removing 40% of fruits number per tree more effective in improving the fruit quality than other studied fruit thinning.

These results are in harmony with those of Mohammed-Afkar (1991), Stover *et al*. (2006) and Sawale *et al*. (2006).

General evaluation of thinning fruit treatments:

It is quite evident from Table (5) that general evaluation of the studied fruit thinning rates as an average of two studied seasons, according to yield/tree, biennial bearing index and fruit quality

emphasized the prementioned trends. Since fruit thinning by removing 40 or 50% of fruits number per trees gained the highest score recording (99.8 and 93.70 units), respectively. Such treatments recorded approximately similar values according to yield/tree and fruit quality evaluation (20.0 & 19.40 and 59.80 & 59.70 units), respectively.

The least total score was recorded to unthinned ones (control, 72.20 units), asendingly followed by removing 20 or 30% of fruits number per tree which gained total score (77.60 and 80.90 units), respectively. It could be arranged these score in a descending order as follows 99.80, 93.70, 80.90, 77.60 and 72.20 units due to fruit thinning by removing 40, 50, 30, 20% of fruits number per tree and unthinned ones (control), respectively. These findings attributed to the fruit thinning effects on improving the yield and fruit quality as well as overcoming the alternate bearing, and reducing the biennial bearing index. Such improvement was previously explained. Such results emphasized the importance role of fruit thinning to reduce the alternate bearing and regulate yield, in addition to improving the yield and fruit quality of Balady mandarin trees.

Table (5): General evaluation of fruit thinning rates according to yield and fruit quality of Balady mandarin average of two studied seasons.

Characters → Score (units)→ ↓Treatments	Yield			Fruit quality				
	Yield / tree (kg)	Biennial bearing index	Total	Fruit weight/ g	T.S.S.	V.C. mg/100 ml	Total	G. total
	20	20	40	20	20	20	60	100
Control	16.8	1.1	17.9	17.7	18.0	18.6	54.3	72.20
*Removing 20%	18.7	2.8	21.5	17.9	19.4	18.8	56.1	77.6
Removing 30%	19.1	4.4	23.5	18.8	19.6	19.0	57.4	80.9
Removing 40%	20.0	20.0	40.0	19.8	20.0	20.0	59.8	99.8
Removing 50%	19.4	14.6	34.0	20.0	19.9	19.8	59.7	93.7

Removing 20% …. 50% of fruits number/tree.

As a whole, it may be concluded that removing 40% of fruits number per tree as a hand fruit thinning when the fruit diameter was about 25-30 mm was the best economic treatment for Balady mandarin trees to obtain the high yield with good fruit quality, furthermore, overcoming the alternate bearing which is considered a major problem for such cultivar.

References

Association of Official Agricultural Chemists. 1985. Official Methods of Analysis (A.O.A.C.),12th ed., Benjamin Franklin Station Washington, DC, USA pp. 490-510.

Augusti, M.; V. Almela and J. Pons. 1992. Effect of girdling on alternate bearing in citrus. J. Hort. Sci. 67 (2): 203-210.

El-Salhy, A.M.; H.M. Marzouk and T.M. Ali. 2006. Physiological studies on the effect of active dry yeast application on Balady mandarin trees. II- Yield and fruit quality. Proceeding of the 3rd Int. Conf. for Develop and Env. In The Arab World, Assiut Univ., pp. 615-622.

Galliani, S.; S.P. Moselise and R. Goren. 1975. Improving fruit size and breaking alternate bearing in wilking mandarins by ethephon and other agents. Hort Science 10 (1): 68-69.

Goldschmidt, E.E. and A. Golomb. 1982. The carbohydrate balance of alternate-bearing citrus trees and the significance of reserves for flowering and fruiting. J. Amer. Soc. Hort. Sci. 107 (2): 206-208.

Hilgeman, R.H.; L. True and J.A. Dunlap. 1964. Effect of NAA spray and hand thinning on size of Kinnow mandarin fruit in Arizona. Proc. Florida State Horticulture Society 77: 84-87.

Jones, W.W.; C.W. Coggins and T.W. Embleton. 1979. Growth regulators and alternate bearing. Proc. Inter. Sas. Citriculture Abst. 49 (8): 6279.

Kihara, I.; I. Iwagaki; H. Okuda and K. Kawase. 1995. Alternate branch fruit cluster in Satsuma mandarin: New fruit control methods for biennial bearing prevention and quality improvement. Bulletin of the Fruit Tree Research Station, 27: 11-26.

Mead, R.; R.N. Currow and A.M. Harted. 1993. Statistical Methods in Agriculture and Experimental Biology 2nd Ed. Chapman and Hall, London.

Mohammed-Afkar, A. 1991. Physiological studies on some factors affecting alternate bearing in Balady mandarin. M.Sc. Thesis, Fac. of Agric., Assiut Univ., Egypt.

Monselise, S.P. and E.E. Goldschmidt. 1982. Alternate bearing in fruit trees. Hort. Rev. 4: 128-173.

Okuda, H.; T. Kihara and I. Iwagaki. 1996. Effect of fruit removal on phytosynthesis, stomated conductance and ABA level in the leaves of vegetative shoots in relation to flowering of Satsuma mandarin. J. of Japanese Society of Horticultural Science, 65: 15-20.

Sawale, A.; G. Tayde; S. Ghawade and S.M. Dadmal. 2006. Effect of fruit thinning on quality of Nagpur mandarin (*Citrus reticulate*, Blanca) under Akala conditions. Indian J. Agricultural Research, CAP.

Singh, L.B. 1948. Studies in biennial bearing. J. Hort. Sci. 24: 45-65.

Stover, E.W.; S. Ciliento; M. Myers; J. Jackson and M. Still. 2006. Fruit size and yield of mandarins as influenced by spray volume and surfactant use in NAA thinning. HortScience 41: 1435-1439.

Wheaton, T.A. 1986. Alternate bearing. In citrus flowering, fruit set and development. Univ. Fla. Citrus Short Course pp. 67-72.

تأثير خف الثمار يدوياً على تبادل الحمل والمحصول وخصائص ثمار اليوسفى البلدى

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أجريت هذه الدراسة على أشجار اليوسفى البلدى عمر 15 سنة بمزرعة خاصة تقع بالكيلو 72 بطريق مصر / الاسكندرية الصحراوى بمحافظة 6 أكتوبر – مصر خلال موسمى 2006 ، 2007 وذلك بهدف دراسة تأثير معدل الخف اليدوى بنسب (صفر ، 20 ، 30 ، 40 ، 50%) على المحصول وتبادل الحمل وصفات الثمار . وقد تم إجراء الخف عندما كان قطر الثمار يتراوح ما بين 25–30 مم (الأسبوع الثانى من يونيو) .

وقد أظهرت النتائج ما يلى :

- سبب خف الثمار نقصاً جوهرياً فى عدد الثمار والمحصول / شجرة خلال موسم الحمل الغزير (on-year) مقارنة بالأشجار التى لم تخف ثمارها . بينما حدث العكس خلال موسم الحمل الخفيف (off-year) أو متوسط سنتى الدراسة – حيث أدى الخف إلى زيادة جوهرية فى المحصول / شجرة .

- كانت معاملة الخف بإزالة 40% من الثمار هى أكثر المعاملات تأثيراً على زيادة المحصول وتقليل معامل تبادل الحمل وبالتالى تنظيم الحمل السنوى للأشجار .

- سبب خف الثمار زيادة جوهرية فى وزن الثمرة وأبعادها فى سنة الحمل الغزير أو متوسط سنتى الدراسة بينما حدث العكس فى سنة الحمل الخفيف مقارنة بالأشجار التى لم تخف ثمارها.

- أدت جميع معاملات خف الثمار إلى تحسين الصفات الكيميائية لعصير الثمار من حيث زيادة نسبة المواد الصلبة الذائبة والسكريات ومحتواها من فيتامين (ج) مع قلة الحموضة الكلية.

- سجلت معاملتى الخف بإزالة 40 أو 50% من الثمار/شجرة أعلى درجات التقييم العام للمعاملات وهى 99.8 ، 93.7 درجة على التوالى .

من نتائج هذه الدراسة يمكن التوصية بضرورة إجراء خف الثمار يدوياً بنسبة 40% عندما يكون قطرها حوالى 25–30 مم حيث يؤدى ذلك إلى تقليل تبادل الحمل وبالتالى تنظيم المحصول وتحسين خصائص الثمار .