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EFFECT OF MANUAL FRUIT THINNING ON YIELD AND FRUIT QUALITY OF CLEMENTINE MANDARIN (*Citrus clementine* Hort. ex Tanaka) UNDER NORTH SINAI CONDITIONS

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ABSTRACT

The effect of fruit thinning time and thinning rate on flowering, fruit yield and fruit quality of clementine trees (*Citrus clementine* Hort. ex Tanaka) was investigated during three successive seasons 2017/2018, 2018/2019 and 2019/2020. Data recorded only during 2018/2019 and 2019/2020 seasons. Thinning applied at three different times on 1st June, 15th June and 30th June. Fruit thinning rate were performed when the fruit diameter reached about 25-30 mm, as hand thinning by removing 0, 25 or 50% of fruit number/shoot per tree. Clementine trees grafted on sour orange were studied in an 8-years-old orchard in Al-Sheikh Zuwaid destrict, North Sinai, Egypt. The experimental treatments were arranged in a complete randomized block design. The results obtained showed that thinning clementine trees on 1st June exhibited the greatest value for each of No. inflorescences/ one year shoot, flowers number/ one year shoot, fruit set (%), No. remaining fruits, fruit yield (kg/tree) and fruit weight (g), fruit volume (cm^3), fruit length (cm), fruit width(cm) in both seasons while 15th June time thinning gave the highest T.S.S.(%) and segments number, on the contrary 15th June time thinning gave the highest juice acidity(%). Hand thinning at 50% increased all fruit yield and quality parameters except the juice acidity (%) that induced with non- thinning tree (control). Finally, on 1st June, removing 50% of fruit number/shoot per tree caused a significantly increase in flower number, fruit set (%), fruit number, fruit weight, yield/tree and improved the commercial classification of mandarin fruits compared to unthinned ones.

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INTRODUCTION

The genus Citrus belongs to the family Rutaceae. It is the most widespread fruit crops throughout the world, being their global production around 122 million tonne per year **(FAO, 2020)**. It is considered the first economic fruit crop in Egypt which produces four million tonne rate and about 3.27% of the total global production. The acreage valued about 518.7 thousand feddan according to **Yearly of Statistic and Agricultural Economic Dept. (2020)**.

Clementine (*Citrus clementine*) is a hybrid between a Mediterranean *Citrus deliciosa* and sweet orange. Similarly, to tangerines, they tend to be easy to peel **(Ziegler, 2007)**. It is among the citrus cultivars which tend to produce a heavy crop with many small fruits under North Sinai conditions **(Mostafa and Abdel-Aal, 2009)**. Fruit size has become as an important quality criterion in citrus marketing that increase their consumption and improve the prices received by farmers **(Guardiola and Garcia-Luis, 2000)**. What matters to the consumer is that the fruit be large, and the price is good? and what matters the farmer

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to get a profitable return? Thus, the income from the smaller clementine fruit does not bring economic return.

From this point, increase in fruit size it has become an important marketing and economic necessity for clementine fruits **(Guardiola and Garcia-Luis, 2000)**. One of the cultural practices which may be helping to increase clementine fruit size is fruit thinning such as hand, chemical and mechanical thinning **(Zaragoza *et al.*, 1992; Nartvaranant, 2016)**. Fruit thinning is defined as the removal of certain flowers or clusters of flowers or individual fruitlets after fruit set and natural dropping have occurred to reduce fruit load **(Ouma, 2012)**. Although remove some fruits from clementine trees will cause a significant reduction in total yield in the same year but that increase fruit size, fruit yield and quality on the following year **(Monselise *et al.*, 1981; Byers *et al.*, 2003)**. This practice offset the economic benefit obtained from the high yield of fruitlets under normal conditions **(Guardiola and Garcia-Luis, 2000)**.

This work aimed to investigate the effect of the thinning time and the thinning rate treatments on flowers parameters, fruit yields and fruit quality of clementine trees.

MATERIALS AND METHODS

This study was carried out during the three consecutive seasons of 2017/2018 an expected "On" season, 2018/2019 an expected "Off" seasons and 2019/2020 an expected "On" seasons. In each season, the experiment was started during the early winter on December end at the private citrus farm supervised by North Sinai Desert Research Station at Hajj Jihad Saqr village in Al-Sheikh Zuwaid destrict, North Sinai Governorate, Egypt. The plant material devoted for this study was 8-years-old clementine trees (*Citrus clementine* Hort. ex Tanaka) growing on sour orange rootstock (*C. aurantium* L.) planted at 5 × 5m apart in sandy soil under drip irrigation system. Eighty-one trees have been selected for this study were similarity in growth, vigor, productivity, and uniform were in an "On-year" according to number of fruits per tree after fruit set. All experiment treatments were applied on selected trees during 2017/2018 season without recorded any growth and yield measurements. But experiment treatments were applied, and data recorded during 2018/2019 and 2019/2020 seasons. The main objective of this work was to study the effect of hand thinning time and rate treatments on some flower parameters, fruit yield and fruit quality of clementine trees.

Experiment Treatments

Thinning time

The hand thinning treatments were applied on 1st June, 15th June and 30th June in the three studied seasons "after the end of the natural fruit drop period in May. Which, the fruit diameter reached about 25-30 mm".

Thinning density:

The selected trees were received thinning treatments on each previous date as hand thinning of (fruits number/shoot) at 25%, 50% and without thinning (Control).

Measurements

Tree flowering

No. inflorescences/ one year shoot

On early-March of both seasons four branches nearly uniform in diameter at different tree directions were labeled. Then the total number of inflorescences per shoot on each labeled branch were counted during full bloom stage (late March).

No. flowers/ one year shoot

On late-March of both seasons, the number of flowers per shoot on each labeled branch were counted at full bloom stage.

Tree fruiting

Fruit set percentage (%)

Number of set fruitlets was also counted after fruit set (April 15th and 19th in 2018 and 2019 seasons, respectively). Fruit set percentages were calculated based on initial number of flowers at full bloom according to **Ferguson *et al.* (1994)** as follows:

$$\text{Fruit set (\%)} = \frac{No.of\ developing\ fruitlets}{Total\ initial\ no.of\ flowers\ at\ fullbloom} \times 100$$

Number of fruit retention

Fruit retention was estimated by counting the number of harvested fruits per each labeled branch and divided by number of setting fruitlets × 100 as follows:

$$\text{Fruit retention} = \frac{No.harvested\ fruits}{No.setting\ fruitlets} \times 100$$

Tree yield (kg/tree)

On December 3rd and 4th in 2018 and 2019 seasons, respectively, fruits of treated trees were harvested as soon as the fruits attained the maturity indices. Number of fruits of each tree was weighed (kg) per tree. Adequate number of fruits taken at random and transferred to the laboratory for fruit quality measurements.

Fruit quality

Fruit length and diameter (cm)

It was measured by using the Vernier Caliper

Fruit volume (cm^3)

It was determined from the volume of water-displaced method.

Fruit weight (g)

It was determined by weighing the sample using a sensitive scale.

Segment number

It was done by counting the number of segments in each fruit.

Chemical Characteristics

Titratable acidity

It was determined in fruit juice by using 0.1 NaOH in the presence of phenolphthalein until pH 8.0 and expressed as citric acid percent. It was calculated by using the following Eq.:

$$\%TA = \frac{(ml\ NaOH\ used)\ (Normality\ of\ NaOH)\ (Equivalent\ wt.of\ citric\ acid)}{(wt.of\ sample)\ (vol.of\ aliquot\ taken)}$$

according to (**AOAC, 2006**).

Total soluble solids (TSS)

TSS were measured in fruit juice by using a Carl Zeiss hand refractometer at 20°C and expressed as percent.

Statistical Analysis

Data were statistically analyzed with a randomized complete block design (RCBD) by using Co-STAT software, V.6.13 (CoHort software, Berkeley, CA 94701) with three replicates and each replicate was represented by two trees. Mean values of treatments were differentiated by using least significant range (Duncan's multiple range tests) at 0.05 level probability **(Duncan, 1955).**

RESULTS AND DISCUSSION

Regarding, the specific effect of the thinning time treatments, Table 1 clears that, no significant difference found between thinning time treatments on No. inflorescences/ one year shoot. On the otherwise, thinning clementine trees on 1st June proved to be the most effective treatment on flower number/ one year shoot (90.41 and 102.61) and fruit set (32.51% and 36.44%) in 1st and 2nd seasons, ordery, but the least value of flower number/ one year shoot obtained when thinning clementine trees on 30th June (86.09 and 98.12) and fruit set (30.89% and 34.94%) in 1st and 2nd seasons, ordery, respectively.

Table 1. Effect of the fruit thinning time and rate on number of inflorescences/ one year shoot, flower number/ one year shoot and fruit set (%) of the clementine trees during 2018/2019 and 2019/2020 seasons

Treatment	No. inflorescences/ one year shoot				Flower number/ one year shoot				Fruit set (%)			
	01-June	15-June	30-June	Effect of thinning rate	01-June	15-June	30-June	Effect of thinning rate	01-June	15-June	30-June	Effect of thinning rate
2018/2019 Season												
Control	9.51 g	9.33 h	9.02 i	9.29 C	80.48 g	75.22 i	76.42 h	77.38 C	27.99 g	23.14 i	27.24 h	26.13 C
Thinning 25%	10.73 d	10.44 e	9.65 f	10.27 B	89.49 d	88.18 e	86.81 f	89.10 B	33.89 d	32.84 e	31.30 f	32.74 B
Thinning 50%	11.68 a	11.60 b	11.14 c	11.47 A	101.24 a	91.58 c	95.05 b	95.02 A	35.64 a	35.06 b	34.12 c	34.88 A
Effect of thinning time	10.64 *a*	10.46 *a*	9.94 *a*		90.41 *a*	85.00 *b*	86.09 *b*		32.51 *a*	30.35 *b*	30.89 *b*	
2019/2020 Season												
Control	12.55 g	11.97 h	11.57 i	12.37 C	88.63 f	83.96 g	81.79 h	84.79 B	31.00 g	30.96 h	29.70 i	30.56 C
Thinning 25%	14.17 e	14.93 d	13.94 f	14.57 B	106.87 d	106.87 d	103.70e	105.8A	37.81 d	36.88 e	36.18 f	35.96 B
Thinning 50%	15.65 a	15.34 b	15.18 c	15.95 A	112.31 a	109.89 b	108.86c	110.3A	40.50 a	39.65 b	38.94 c	39.70 A
Effect of thinning time	14.46 *a*	14.64 *a*	13.79 *a*		102.61 *a*	100.2*ab*	98.12 *b*		36.44 *a*	35.83 *a*	34.94 *b*	

* Different superscript capital letters (A, B, C) indicate significance ($p < 0.05$) between thinning rate treatments.

* Different superscript small italic letters (*a*, *b*, *c*) indicate significance ($p < 0.05$) between thinning time treatments.

* Different superscript small letters (a, b, c) indicate significance ($p < 0.05$) between interaction effect of the thinning rate and thinning time treatments.

This pattern is similar to that reported by **Iwahori *et al.* (1973)** on "ponkan" mandarin cultivar determined the effect of thinning fruit on 11th May (5 days after full bloom), 26th May, 10 June or 23 June thinned the fruit and they found that the number of flowers increased at the following spring especially when thinning applied on 26 May and 10 June.

Moreover, the hand thinning of 50% of the clementine fruits caused significant increase in No. inflorescences/one year shoot (11.47 and 15.95), flower number/ one year shoot (95.02 and 110.30) and fruit set (34.88% and 39.70%) in 1st and 2nd seasons, respectively. On the other hand, the non-thinning trees (control) gave the lowest values in this respect. These results tend to agree with those reported by **Suzuki and Hirose, (1977), Guardiola and Garcia-Luis, (2000)** and **Stander and Cronje, (2016)** who concluded that thinning citrus fruit treatment increased the number of flowers produced in the following year.

Concerning, the interaction effect between the thinning time and the thinning rate treatments, results in the same table reveals that the significant increase in number of inflorescences/one year shoot (11.68 and 15.65), flower number/one year shoot (101.24 and 112.31) and fruit set (35.64% and 40.50%) in 1st and 2nd seasons, respectively came from the interaction of thinning 50% of the clementine fruits on 1st June. The least number of inflorescences/ one year shoot (9.02 and 11.57), flower number/ one year shoot (75.22 and 83.96) and fruit set (27.24% and 29.70%) in 1st and 2nd seasons, respectively were recorded by the non-thinning trees (control) on 30th June. The other treatments revealed in between.

The concerned results from Table 2 indicated that remaining fruits number, fruit yield (kg/tree) and fruit weight (g) were increased when thinning clementine trees on 1st June compared with thinning clementine trees on 15th June or 30th June in both seasons. The highest values of no. remaining fruits were observed on 1st June thinning date treatment (8.49 and 9.94), fruit yield (kg/tree) (86.87 and 91.54 kg) and fruit weight (112.70 and 113.06 g) in 1st and 2nd seasons, respectively. Similar observations were reported by **Stander and Cronje, (2016)** who found that the hand thinning of 'Nadorcott' mandarin fruit smaller than 20 mm in diameter in late January resulted in significantly larger fruit at harvest without a significant loss of yield or a noticeable negative effect on fruit quality.

In the same Table, results show that 50% hand thinning of the clementine fruits gave the highest values of number of remaining fruits (10.20 and 12.11), fruit yield (96.91 and 100.50 kg/tree) and fruit weight (121.60 and 124.36 g) during 2018/2019 and 2019/2020 seasons. While the non-thinning trees (control) gave the least values in this respect. The other treatments came in between effect. These results go in line with those reported by **Mostafa and Abdel-Aal, (2009)** who found that removing 40% of fruits number/tree caused a significant increase in fruits number, fruit weight, dimension, yield/tree, and relative yield compared to un-thinned ones. Similar observations were reported by **Sartori *et al.*, (2007)** they found that hand thinning of 66% of mandarin fruits increased fruit mass. Also, **Ouma (2012)** on mandarin, reported that 50% fruit thinning was done to improve fruit retention.

The interaction effect between the thinning time and the thinning rate, (Table 2) reveal that in both seasons, thinning 50% of the clementine fruits on 1st June significant increased number of remaining fruits (10.65 and 12.56), fruit yield (102.50 and 107.86 kg/tree) and fruit weight (128.31 and 131.00 g) during 2018/2019 and 2019/2020 seasons. On the other hand, the non-thinning trees (control) on 30th June gave the least values. Concerning, the specific effect of the thinning time, Table 3 shows that in 2018/ 2019 and 2019/2020 seasons the thinning clementine trees on 1st June gave the highest

Table 2. Effect of the fruit thinning time and rate on number of remaining fruits, fruit yield (kg/tree) and fruit weight (g) of the clementine trees during 2018/2019 and 2019/2020 seasons

Treatment	No. remaining fruits				Fruit yield (kg/tree)				Fruit weight (g)			
	01-June	15-June	30-June	Effect of thinning rate	01-June	15-June	30-June	Effect of thinning rate	01-June	15-June	30-June	Effect of thinning rate
2018/2019 Season												
Control	5.46 g	5.36 h	5.08 i	5.30 C	63.62 g	62.17 h	59.74 i	61.85 C	90.48 g	85.70 h	82.25 i	86.15 C
Thinning 25%	9.34 d	8.94 e	8.37 f	8.88 B	94.48 c	92.94 d	84.89 f	90.77 B	119.28c	117.32 d	108.52 f	115.04B
Thinning 50%	10.65 a	10.24 b	9.71 c	10.20 A	102.50 a	100.04 b	88.18 e	96.91 A	128.31a	125.16 b	111.45e	121.6A
Effect of thinning time	8.49 *a*	8.18 *ab*	7.72 *b*		86.87 *a*	85.06 *a*	77.60 *b*		112.70a	109.39 b	100.74c	
2019/2020 Season												
Control	6.27 g	6.04 h	5.51 i	5.90 C	67.33 g	65.08 h	63.31 i	65.24 C	87.01 h	87.49 g	81.87 i	85.46 C
Thinning 25%	11.10 d	10.49 e	10.41 f	9.67 B	99.43 c	96.64 d	89.03 f	95.03 B	121.18c	119.54 d	110.68 f	117.14B
Thinning 50%	12.56 a	12.07 b	11.68 c	12.11 A	107.86 a	101.41 b	92.32 e	100.5A	131.0 a	128.47 b	113.61e	124.36A
Effect of thinning time	9.94 *a*	9.54 *ab*	9.21 *b*		91.54 *a*	87.71 *b*	81.56 *c*		113.06*a*	111.83 *a*	102.05*b*	

*** Different superscript capital letters (A, B, C) indicate significance ($p < 0.05$) between thinning rate treatments.**
*** Different superscript small italic letters (*a*, *b*, *c*) indicate significance ($p < 0.05$) between thinning time treatments.**
*** Different superscript small letters (a, b, c) indicate significance ($p < 0.05$) between interaction effect of the thinning rate and thinning time treatments.**

increase in fruit length (5.98 and 6.13 cm), fruit width (6.59 and 6.64 cm) and fruit volume (116.29 and 117.90 cm^3). While, the non-thinning trees (control) achieved the lowest fruit length (5.32 and 5.46 cm), fruit diameter (6.00 and 6.07 cm) and fruit volume (103.08 and 106.78 cm^3). On the other hand, hand thinning 50% of the clementine caused significant increase in fruit length (6.36 and 6.46 cm), fruit width (7.08 and 7.08 cm) and fruit volume (125.43 and 128.08 cm^3) in 1st and 2nd seasons, respectively. But the other treatments gave the lowest value.

Results in Table 3 also referring that, the highest value for each of fruit length (7.13 and 7.18 cm), fruit width (7.67 and 7.66 cm) and fruit volume (133.51 and 136.10 cm^3) came when thinning 50% of the clementine fruits on 1st June. While the least values in both seasons was record by non-thinning trees (control) on 15th June or 30th June. The other treatments came in between with significant difference among them in this sphere. According to **Sartori *et al.* (2007)** who found that hand thinning of 66% of mandarin fruits increased fruit quality than control. Meanwhile, **Ouma (2012)** on mandarin, reported that 50% fruit thinning was done to improve fruit quality.

Results presented in Table 4 clearly indicate that significant differences found between thinning time treatments regarding juice acidity and total soluble solids (TSS). Thinning clementine trees on 1st June gave the highest value of juice acidity (1.10% and 1.07%), while thining on 15th June recorded the highest total soluble solids (10.05 and 10.23%) in 1st and 2nd seasons, respectively, but the lowest value was recorded with 30th June thinning time treatment. Otherwise, no significant difference found between thinning time treatments on segments number in 2018/2019 and 2019/ 2020 seasons.

The results also showed that, hand thinning decrease the juice acidity. Control treatment recorded the highest juice acidity (1.21% and 1.19%). On the other hand, hand thinning at 25% of the clementine fruits significantly increases total soluble solids (10.32% and 10.53%) as compared with control treatment (without thinning) and hand thinning at 25% in 1st and 2nd seasons, respectively. On the contrary, no significant difference found between thinning rate treatments on segment number in 2018/2019 and 2019/2020 seasons.

These results agree with **Sawale *et al.* (2001)** and **Mostafa and Abdel-Aal (2009)** who indicated that all fruit thinning rates significantly increased fruit juice content of soluble solids, sugars, and vitam.C and decreased total acidity. Also, thinning intensities of 33% and 66% improved the commercial classification of mandarin fruits **(Rosa *et al.*, 2012)**.

With respect to, the interaction effect between the thinning time and the thinning rate treatments, Results in Table 4 reveals that the highest juice acidity (1.21% and 1.20%) in 1st and 2nd seasons, respectively obtained from the interaction of non-thinning tree (control) on 30th June. While results indicated that the highest total soluble solids (10.91% and 11.04%) in 1st and 2nd seasons obtained when thinning 25% of the clementine fruits was applied on 15th June. On the other hand, the highest segments number (8.84 and 8.51) in 1st and 2nd seasons was obtained when thinning 50% of the clementine fruits on 15th June.

Generally, results quite evident that general evaluation of the studied fruit thinning time and rate of two studied seasons, according to yield/tree and fruit quality that removing 50% of fruits number per trees gained the highest values. This explains that fruit thinning caused reduction in number of fruits per tree which increased the leaf to fruit ratio, thus resulting into increased availability of photosynthates and carbohydrates availability for remaining fruitlets resulting in improving the fruit weight and size gradually as relationship

Table 3. Effect of the fruit thinning time and rate on the fruit volume (cm^3), fruit length (cm) and fruit diameter (cm) of the clementine trees during 2018/2019 and 2019/2020 seasons

Treatment	Fruit volume (cm^3)				Fruit length (cm)				Fruit diameter (cm)			
	01-June	15-June	30-June	Effect of thinning rate	01-June	15-June	30-June	Effect of thinning rate	01-June	15-June	30-June	Effect of thinning rate
2018/2019 Season												
Control	93.89 g	86.29 h	84.44 i	88.21 C	5.07 h	4.81 i	5.09 g	4.99 C	5.73 g	5.53 i	5.68 h	5.65 C
Thinning 25%	121.48 c	119.9 d	110.55 f	117.3 B	5.72 c	5.67 d	5.43 e	5.61 B	6.38 c	6.35 d	6.07 f	6.27 B
Thinning 50%	133.51 a	128.5 b	114.25 e	125.4 A	7.13 a	6.53 b	5.43 f	6.36 A	7.67 a	7.31 b	6.25 e	7.08 A
Effect of thinning time	116.29 *a*	111.6*b*	103.08 *c*		5.98 *a*	5.67 *b*	5.32 *c*		6.59 *a*	6.40 *b*	6.00 *c*	
2019/2020 Season												
Control	93.51 g	89.07 h	88.33 i	90.30 C	5.34 g	5.12 i	5.24 h	5.24 C	5.81 i	5.82 g	5.82 h	5.82 C
Thinning 25%	124.07 c	121.8 d	114.07 f	119.9 B	5.86 c	5.85 d	5.47 f	5.73 B	6.46 d	6.47 c	6.05 f	6.32 B
Thinning 50%	136.10 a	130.1 b	117.96 e	128.0 A	7.18 a	6.51 b	5.67 e	6.46 A	7.66 a	7.23 b	6.33 e	7.08 A
Effect of thinning time	117.90 *a*	113.7*b*	106.78 *c*		6.13 *a*	5.83 *b*	5.46 *c*		6.64 *a*	6.51 *a*	6.07 *b*	

*** Different superscript capital letters (A, B, C) indicate significance ($p < 0.05$) between thinning rate treatments.**
*** Different superscript small italic letters (*a*, *b*, *c*) indicate significance ($p < 0.05$) between thinning time treatments.**
*** Different superscript small letters (a, b, c) indicate significance ($p < 0.05$) between interaction effect of the thinning rate and thinning time treatments.**

Table 4. Effect of the fruit thinning time and rate on the segments number, juice acidity (%) and TSS (%) of the clementine trees during 2018/2019 and 2019/2020 seasons

Treatment	Segment number				Juice acidity (%)				TSS (%)			
	01-June	15-June	30-June	Effect of thinning rate	01-June	15-June	30-June	Effect of thinning rate	01-June	15-June	30-June	Effect of thinning rate
2018/2019 Season												
Control	7.70 h	7.96 f	7.81 g	8.93 A	1.20 c	1.20 b	1.21 a	1.21 A	9.26 g	9.22 h	9.20 i	9.23 C
Thinning 25%	8.25 d	8.25 d	8.36 c	8.29 A	1.02 g	0.88 i	1.07 e	0.99 C	10.10 c	10.91 a	9.94 e	10.32 A
Thinning 50%	8.59 b	8.84 a	7.99 e	8.37 A	1.08 d	1.04 f	0.92 h	1.02 B	9.77 f	9.99 d	10.69 b	10.15 B
Effect of thinning time	9.25 *a*	8.28 *a*	8.06 *a*		1.10 *a*	1.04 *b*	1.07 *ab*		9.71 *c*	10.05 *a*	9.94 *b*	
2019/2020 Season												
Control	8.18 c	7.88 g	7.96 e	8.08 A	1.19 c	1.19 b	1.20 a	1.19 A	9.37 g	9.34 h	9.31 i	9.34 C
Thinning 25%	8.18 c	7.96 e	8.00 d	8.04 A	0.97 g	0.84 i	1.04 e	0.95 B	10.32 c	11.14 a	10.13 e	10.53 A
Thinning 50%	8.51 b	8.51 a	7.92 f	8.24 A	1.05 d	1.01 f	0.88 h	0.98 B	9.97 f	10.20 d	10.93 b	10.37 B
Effect of thinning time	8.39 *a*	8.04 *a*	7.93 *a*		1.07 *a*	1.02 *b*	1.04 *ab*		9.89 *c*	10.23 *a*	10.12 *b*	

*** Different superscript capital letters (A, B, C) indicate significance ($p < 0.05$) between thinning rate treatments.**
*** Different superscript small italic letters (*a*, *b*, *c*) indicate significance ($p < 0.05$) between thinning time treatments.**
*** Different superscript small letters (a, b, c) indicate significance ($p < 0.05$) between interaction effect of the thinning rate and thinning time treatments.**

with thinning rates **(Ruiz *et al.*, 2001; Blanusa *et al.*, 2006; Iglesias *et al.*, 2006; Meitei *et al.*, 2013)**. Also, the increase in fruit yield might be owing to increase in fruit set **(Lavee *et al.*, 1983)** and due to increase in fruit size and fruit weight **(Valentine and Arroyo, 2002)**. Moreover, 50% fruit thinning had no effect on fruit quality and fruit dry weight in fruits **(Nartvaranant, 2016)**.

Conclusion

It is concluded that removing 50% on 1st June of clementine fruits number/shoot caused a significantly increased in flower number, fruit set (%), fruit number, fruit weight, yield/tree and improved the commercial classification of mandarin fruits compared to unthinned ones.

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الملخص العربي

تأثير الخف اليدوي على المحصول وخصائص ثمار اليوسفي كلمنتين تحت ظروف شمال سيناء

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تحمل أشجار الكلمنتين عادةً محصولًا غزيرًا من الفاكهة الصغيرة ومنخفضة الجودة، ولذلك تمت دراسة تأثير توقيت خف الثمار ومعدل الخف على التزهير ومحصول الثمار وجودته لأشجار الكلمنتين خلال ثلاثة مواسم متتالية 2018/2017 و2019/2018 و2020/2019. تم تسجيل البيانات فقط خلال موسمي 2019/2018 و2020/2019. تم تطبيق معاملات الخف في ثلاث أوقات مختلفة في 1 يونيو و15 يونيو و30 يونيو. كما تم إجراء معدل خف الثمار عندما بلغ قطر الثمرة حوالي 25-30 مم، وأجريت عملية الخف يدويًا عن طريق إزالة صفر% أو 25% أو 50% من عدد الثمار/الفرع لكل شجرة من أشجار الكلمنتين المطعمة على النارنج في بستان عمره 8 سنوات في مركز الشيخ زويد، شمال سيناء، مصر، وتم ترتيب المعاملات التجريبية وفق تصميم القطاعات العشوائية الكاملة. أظهرت نتائج الدراسة أن خف الثمار لأشجار الكلمنتين في الأول من يونيو أعطى أكبر نسبة للنورات/الفرع عمر عام، وعدد الأزهار/الفرع عمر عام، وعقد الثمار (%)، وعدد الثمار المتبقية، ومحصول الثمار (كجم/شجرة)، ووزن الثمرة(جم)، وحجم الثمرة (سم^3)، وطول الثمرة (سم)، وعرض الثمرة (سم) في كلا الموسمين بينما أعطى الخف في 15 يونيو أعلى نسبة من المواد الصلبة الذائبة (%) وعدد الفصوص. وعلى العكس من ذلك فقد أعطى خف الثمار في 15 يونيو أعلى نسبة حموضة للعصير (%). كما أدى الخف اليدوي بنسبة 50% للثمار إلى زيادة محصول الثمار وخصائص جودة الثمار ما عدا حموضة العصير (%) التي كانت نسبتها مرتفعة في الثمار مع معاملة المقارنة. وأخيرًا، إزالة 50% من عدد الثمار/الفرع لكل شجرة في الأول من شهر يونيو أدت إلى زيادة معنوية في عدد الأزهار، وعقد الثمار (%)، وعدد الثمار، ووزن الثمار، والمحصول/الشجرة، وتحسين الخصائص التجارية لثمار اليوسفي مقارنة بثمار الأشجار التي لم يجرى لها عملية خف للثمار.

الكلمات الاسترشادية: أشجار الكلمنتين، الخف، كمية وجودة الثمار.

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