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Strand thinning of Khadrawi date palm cultivar in relation to yield and fruit quality

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Abstract

Background: This experiment was carried out during 2015 and 2016 seasons to investigate the effect of strand thinning treatments by removing 15 and 30% of the total number of strands from the bunch center after 8 weeks from pollination (kimri stage) on productivity and fruit quality of Khadrawi date palm cultivar compared to the control (without thinning).

Results: The present results indicated that strand thinning by removing 30% of the total number of strands gave the lowest bunch weight and yield per palm compared to thinning 15% and control treatments during the two seasons of study. Also, removing 30% of the total number of strands improved some physical properties, i.e., fruit weight, flesh weight, fruit length, and fruit diameter than control in both seasons. All strand thinning treatments improved some chemical properties such as TSS %, total sugars %, and reducing sugars % than control (without thinning). However, both 15 and 30% strand thinning treatments had no significant effect on nonreducing sugars %, total acidity %, and tannins content in the two studied seasons.

Conclusion: From the obtained results, it was revealed that application of thinning treatment by removing 15 or 30% of the total number of strands from bunch center improved some physical and chemical properties of Khadrawi date palm fruits although there are no significant differences found between strand thinning at 15% and control during the second season.

Keywords: Date palm, Khadrawi, Strand thinning, Yield, Fruit quality

Background

Date palm (*Phoenix dactylifera* L.) belongs to the family Arecaceae, and it is considered the tree of life in the desert, because it tolerates high temperatures, drought, and salinity more than many other fruit crops (Lunde 1978). Date palm is the most successful and commercially important crop in Egypt. Numbers of date palm trees in Egypt are about 12,827,235 trees producing about 1,465,030 tons/year (Ministry of Agriculture and Land Reclamation, Egypt 2015). Khadrawi date palm is one of the commercial cultivars that have greenish amber fruits on ripening, slightly tolerant to humid conditions than many other varieties. As well as, fruits are consumed at rutab stage (Hussein 2011). In additions, Khadrawi cv. is characterized by short strands in length and as a consequence here is often considerable crowding of fruits on the strands within bunch, which results in large variations between them in most properties and adversely affect the marketing process.

Fruit thinning is one of the most important practices which give the remaining fruits a better chance to develop larger size and reduce compactness among fruits within the bunch. Consequently, fruit thinning enhances fruit quality of dates (Moustafa et al. 1984, Khalifa et al., 1987 and Mahmoud et al., 2003). The fruits may be thinned either by reducing the number of fruits per strand or by reducing the number of bunches per palm depending on the variety and other considerations (Nixon and Carpenter 1978).

Nirmaljit et al. (2006) revealed that bunch thinning treatments of Khadrawi date palm cv. by removing 10, 20, 30, and 40% of total number of strands from the bunch center after pollination improved fruit quality over control. Also thinning treatment at the rate of 40% was the best treatment in this regard. Also, Soliman and Harhash (2012) found that removing 30% of the total

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number of strands 4 weeks after pollination of Succary date palm cultivar improved most physical and chemical properties of fruits.

The main objective of the present study is to investigate the effect of thinning treatments by removing 15 or 30% of the total number of strands from the bunch center after 8 weeks from pollination on yield and fruit quality of "Khadrawi" date cultivar.

Materials and methods

This study was carried out during two successive seasons 2015 and 2016 at the Agricultural Research Center Experimental Station, El-Kanater El-Khairia, Kalubia Governorate, Egypt, on "Khadrawi" date palm cultivar. Nine female palm trees about 40 years old grown in a clay soil at 4 × 6 m under flood irrigation system were selected uniformly of nearly equal size and growth vigor and were subjected to the same horticultural practices. Hand pollination was used (3 to 5 days after spathe cracking) by inserting five fresh male strands into the center of female spathe using the same source of pollens in the two seasons to avoid the effect of metaxenia. The inflorescences were wrapped with bags to prevent natural contamination and then removed out after 3 weeks. The leaf/bunch ratio was maintained at 7:1 for all treatments. The number of bunches per palm was adjusted at seven bunches by removing earliest, latest, and smallest inflorescence for each palm at the end of pollination period.

The three treatments were as follows:

1. Without thinning (control)
2. Thinning by removing 15% from the total number of strands/bunch
3. Thinning by removing 30% from the total number of strands/bunch

The thinning was carried out by removing 15 or 30% of the total number of strands from the center of each bunch after 8 weeks from pollination until fruit set was insured.

The following determinations were carried out:

Yield: bunches of each palm were harvested at ripening (rutab stage), 170 days from pollination (mid-September), and weighed to determine the yield Kg/palm.

Fruit quality

Fruit physical characteristics

Samples of 10 fruits were taken randomly from each bunch (70 fruits/palm) to determine fruit physical properties, i.e., fruit weight (g), flesh weight (g), seed weight (g) and flesh %, fruit volume (cm^3), fruit dimensions (fruit length and diameter in cm), and then fruit shape index (length/diameter).

Fruit chemical characteristics

Sample of 100 g fresh pulp was placed in a blender plus 200 ml of distilled water. The mixture was carefully blended for 2 minutes to insure complete extraction and homogenization. Sample of pulp, 10 ml of the juice, was taken in 250 ml beaker to determine fruit chemical properties as follows:

Total soluble solids (TSS %): total soluble solids of date fruit juice were measured using a hand refractometer according to (A.O.A.C. 1995).

Sugars content: total sugars and reducing sugars were determined as fresh weight according to the method of Lane and Eynon as described in the A.O.A.C., 1995. Then nonreducing sugars were calculated by the difference between total and reducing sugars.

Total acidity, crude fibers, and moisture (%) were determined according to A.O.A.C., 1995.

Tannins content (μg/g) was determined according to (Hagerman and Butler 1978).

Statistical analysis

The experiment was designed as a randomized complete block design where each treatment was replicated three times with one palm per replicate. The obtained data were subjected to analysis of variance (ANOVA) according to Snedecor and Cochran (1980). The least significant ranges (LSR) were used to compare between means of treatments according to Duncan (1955) at the probability of 5%.

Results

Bunch weight and yield per palm

Results in Table 1 show the effect of strand thinning treatments on average bunch weight (kg) and yield/palm (kg) of Khadrawi date palm cultivar during 2015 and 2016 seasons.

Thinning treatments decreased significantly average bunch weight and yield per palm than that of the control in the first season. Comparing treatments of thinning degrees, results indicate that removing 15% of the total number of strands of the bunch center after 8 weeks from pollination increased significantly bunch weight and yield per palm than strand thinning treatment at 30% in the two seasons, although there are no significant differences found between strand thinning at 15% and control during the second season.

Fruit quality

Fruit physical characteristics

Fruit weight Results in Table 2 indicated that the two thinning treatments increased significantly fruit weight (rutab) at harvest date than control in the two seasons of study. Thinning treatment by removing 30% of the total

Table 1 Effect of strand thinning treatments on average bunch weight (kg) and yield/palm (kg) of Khadrawi date palm cultivar at rutab stage during 2015 and 2016 seasons

Treatments	Bunch weight (kg)		Yield/palm (kg)	
	2015 season	2016 season	2015 season	2016 season
Without thinning (control)	15.92 a	17.43 a	111.44 a	122.01 a
Strand thinning 15%	14.85 b	16.63 a	103.95 b	116.41 a
Strand thinning 30%	13.90 c	15.27 b	97.30 c	106.89 b

Means in each column with similar letter(s) are not significantly different at 5% level

number of strands of the bunch center gave the highest fruit weight (14.46 and 12.63 g) followed by thinning treatment at 15% (13.53 and 12.35 g), while control treatment (without thinning) recorded the lowest value (12.30 and 10.74 g) in the first and second seasons, respectively. Meanwhile, there were no differences between thinning 30 and 15% in the second season.

Flesh weight Results in Table 2 showed that thinning treatments by removing 15 and 30% of the total number of strands from the bunch center led to an increase in flesh weight compared to control in the two seasons. In another words, thinning treatment by removing 30% of the total number of strands of the bunch center gave the highest flesh weight (13.19 and 11.42 g) followed by thinning treatment at 15% (12.25 and 11.09 g), while control treatment (without thinning) recorded the lowest value (11 and 9.62 g) in the two studied seasons, respectively. Meanwhile, there were no differences between thinning 30 and 15% in the two seasons.

Seed weight Results in Table 2 indicated that there are no significant differences between all thinning treatments and control on seed weight at rutab stage in the first season, while thinning treatments increased significantly seed weight than control in the second season, where thinning treatment in the second season by removing 15% of the total number of strands of the bunch center gave the highest seed weight (1.26 g) followed by thinning treatment at 30% (1.21 g), while control treatment (without thinning) recorded the lowest value (1.12 g). Meanwhile, there were no differences between thinning 30 and 15% in this season.

Flesh percentage Results in Table 2 indicated that thinning treatment by removing 30% of the total number of strands of the bunch center after 8 weeks from pollination gave the highest flesh % (91.22 and 90.42%) followed by thinning treatment at 15% (90.54 and 89.80%), while control treatment (without thinning) recorded the lowest value (89.50 and 89.57%) in the two studied seasons, respectively. Meanwhile, there were no differences between thinning 15% and control in the second season.

Fruit volume Results in Table 3 revealed that thinning treatment by removing 30% of the total number of strands of the bunch center after 8 weeks from pollination increased significantly final fruit volume than other treatments in the first season although the two thinning treatments increased significantly final fruit volume than control in the second season. Strand thinning treatment by removing 30% of the total number of strands recorded 12.7 and 11.30 cm^3, followed by thinning treatment at 15% (11.43 and 10.87 cm^3) and then control treatment (without thinning) which recorded the lowest value (10.80 and 9.60 cm^3) in the first and second seasons, respectively. Meanwhile, there were no differences between thinning 30 and 15% in the second season.

Table 2 Effect of strand thinning treatments on fruit weight, flesh weight, seed weight, and flesh % of Khadrawi date palm cultivar at rutab stage during 2015 and 2016 seasons

Treatments	2015 season			
	Fruit weight (g)	Flesh weight (g)	Seed weight (g)	Flesh %
Without thinning (control)	12.30 c	11.00 b	1.30 a	89.50 c
Strand thinning 15%	13.53 b	12.25 ab	1.28 a	90.54 b
Strand thinning 30%	14.46 a	13.19 a	1.27 a	91.22 a
Treatments	2016 season			
Without thinning (Control)	10.74 b	9.62 b	1.12 b	89.57 b
Strand thinning 15%	12.35 a	11.09 a	1.26 a	89.80 b
Strand thinning 30%	12.63 a	11.42 a	1.21 ab	90.42 a

Means in each column with similar letter(s) are not significantly different at 5% level

Table 3 Effect of strand thinning treatments on fruit volume, fruit length, fruit diameter and fruit shape index of Khadrawi date palm cultivar at rutab stage during 2015 and 2016 seasons

Treatments	2015 season			
	Fruit volume (cm3)	Fruit length "L" (cm)	Fruit diameter "D" (cm)	Fruit shape index (L/d)
Without thinning (Control)	10.80 b	3.49 b	2.30 b	1.52 a
Strand thinning 15%	11.43 b	3.59 b	2.34 ab	1.53 a
Strand thinning 30%	12.70 a	3.83 a	2.44 a	1.57 a
Treatments	2016 season			
Without thinning (Control)	9.60 b	3.53 b	2.29 b	1.54 a
Strand thinning 15%	10.87 a	3.73 a	2.38 a	1.57 a
Strand thinning 30%	11.30 a	3.77 a	2.38 a	1.58 a

Means in each column with similar letter(s) are not significantly different at 5% level

Fruit length The effect of strand thinning treatments on fruit length is presented in Table 3 for "Khadrawi" date palm cultivar. Results revealed that all thinning treatments increased significantly fruit length at rutab stage than control (without thinning) in the two studied seasons. Strand thinning treatment by removing 30% of the total number of strands from the bunch center recorded the highest value (3.83 and 3.77 cm) and then thinning treatment by removing 15% of the total number of strands (3.59 and 3.73 cm), while the control treatment (without thinning) recorded the lowest value (3.49 and 3.53 cm) in the first and second seasons, respectively. Meanwhile, there were no differences between thinning 30 and 15% in the second season.

Fruit diameter Regarding final fruit diameter at (rutab stage), results indicated that thinning treatments increased final fruit diameter than control (without thinning) in the two studied seasons. Strand thinning treatment by removing 30% of the total number of strands from the bunch center recorded the highest value 2.44 cm followed by thinning treatment by removing 15% of the total number of strands which recorded 2.34 cm, while the control treatment (without thinning) recorded the lowest value 2.30 cm in the first season. In addition, strand thinning treatment by removing 30% of the total number of strands and strand thinning treatment by removing 15% of the total number of strand increased significantly final fruit diameter with the same value (2.38 cm) than control which recorded the lowest value (2.29 cm) in the second season.

Fruit shape index: Results in (Table 3) show the effect of strand thinning treatments on fruit shape index at Rutab stage of "Khadrawi" date palm cv. during 2015 and 2016 seasons. Results indicated that, there are no significant differences between all strand thinning treatments and control (without thinning) in the two studied seasons.

Fruit chemical characteristics:

Total Soluble Solids percentage (TSS %): Concerning TSS % at rutab stage, results in (Table 4) indicated that both thinning treatments significantly increased TSS % compared to control, although, there are no significant differences between two thinning treatments in the two studied seasons. Meanwhile, strand thinning treatment by removing 30% of total number of strands gave the highest TSS% (40.50 and 45.53 %) as well as, strand

Table 4 Effect of strand thinning treatments on fruit TSS%, total sugars%, reducing sugars % and nonreducing sugars % of Khadrawi date palm cultivar at rutab stage during 2015 and 2016 seasons

Treatments	2015 season			
	TSS (%)	Total sugars%	Reducing sugars%	Nonreducing sugars%
Without thinning (Control)	35.27 b	34.56 b	31.99 b	2.57 a
Strand thinning 15%	39.73 a	36.83 a	33.96 ab	2.87 a
Strand thinning 30%	40.50 a	38.48 a	35.87 a	2.61 a
Treatments	2016 season			
Without thinning (Control)	41.70 b	35.42 b	32.58 c	2.84 a
Strand thinning 15%	43.95 a	37.02 ab	34.01 b	3.01 a
Strand thinning 30%	45.53 a	38.06 a	35.15 a	2.91 a

Means in each column with similar letter(s) are not significantly different at 5% level

thinning treatment by removing 15 % of total number of strands gave (39.73 and 43.95 %) compared to control (35.27 and 41.70 %) in the first and second seasons, respectively.

Total sugars percentage: Results in (Table 4) show the effect of strand thinning treatments on total sugars % of Khadrawi date palm cv. at rutab stage during 2015 and 2016 seasons.

As for the total sugars % at rutab stage, results revealed that all strand thinning treatments increased total sugars % compared to control (no thinning) in the two seasons. Meanwhile, the highest value (38.48 and 38.06 %) was obtained with thinning treatment by removing 30 % of total number of strands, followed by thinning treatment by removing 15 % of total number of strands (36.83 and 37.02 %) as compared to control which gave the lowest total sugars % (34.56 and 35.42 %) in the two seasons, respectively. In this regard, we conclude that total sugars % increased gradually towards the ripening (rutab stage) and this increase was high in this stage.

Reducing sugars percentage: Regarding reducing sugars percentage at rutab stage, results in (Table 4) indicated that strand thinning treatments increased reducing sugars% compared to control (without thinning) in both seasons. In another meaning, strand thinning treatment by removing 30 % of total number of strands gave the highest value (35.87 and 35.15 %), followed by strand thinning treatment by removing 15 % of total number of strands (33.96 and 34.01 %), while the least value was obtained by control (31.99 and 32.58 %) in the first and second seasons, respectively.

Nonreducing sugars percentage: Concerning nonreducing sugars % at rutab stage, results in (Table 4) showed that there are no significant differences between strand thinning treatments and control (no thinning) during the two seasons.

Total acidity percentage: Results in (Table 5) show the effect of strands thinning treatments on total acidity % of Khadrawi date palm cultivar at rutab stages during 2015 and 2016 seasons.

Results showed that there are no significant differences between all thinning treatments and control on rutab stage in the two seasons.

Tannins content: Results in (Table 5) show the effect of strand thinning treatments on tannins content of Khadrawi date palm cv. at rutab stages during 2015 and 2016 seasons.

Results indicated that there are no significant differences between all strands thinning treatments and control on rutab stage (170 days after pollination) in the two seasons. Also we noticed from results that tannins content recorded the lowest level in this stage.

Fibers percentage: Regarding fiber % at rutab stage, results in (Table 5) revealed that, there are no significant differences between all strand thinning treatments and control in the first season. While, strand thinning treatments by removing 30 and 15 % of total number of strands decreased significantly fiber % (1.32 and 1.41 %, respectively) than control which recorded the highest value (1.53 %) in the second season.

Moisture percentage: Results in (Table 5) show the effect of strand thinning treatments on moisture% of Khadrawi date palm cultivar during 2015 and 2016 seasons. Concerning the moisture % at rutab stage (170 days after pollination), results indicated that there are no significant differences between all strand thinning treatments and control (without thinning) on moisture % in the first season.

Meanwhile, strand thinning treatment by removing 30% of the total number of strands decreased significantly moisture % (42.57 %) as compared to strand thinning by removing 15 % of the total number of strand and control (no thinning) which gave the highest

Table 5 Effect of strand thinning treatments on total acidity%, tannins (μg/g), fibers % and moisture % of Khadrawi date palm fruit at rutab stage during 2015 & 2016 seasons

Treatments	2015 season			
	Total acidity%	Tannins(μg/g)	Fibers%	Moisture%
Without thinning (Control)	0.061 a	0.028 a	1.68 a	50.59 a
Strand thinning 15%	0.061 a	0.022 a	1.79 a	47.12 a
Strand thinning 30%	0.072 a	0.019 a	1.79 a	46.81 a
Treatments	2016 season			
Without thinning (Control)	0.071 a	0.029 a	1.53 a	46.15 a
Strand thinning 15%	0.074 a	0.019 a	1.41 b	46.23 a
Strand thinning 30%	0.055 a	0. 018 a	1.32 b	42.57 b

Means in each column with similar letter(s) are not significantly different at 5% level

moisture % (46.23 and 46.15 %, respectively) in the second season.

Discussion

Thinning treatments by different degrees and methods of many date palm cvs. decreased the average of bunch weight and yield/palm as reported by Al-Obeed et al. (2005), Soliman et al. (2011), Soliman and Harhash (2012) and Bashir et al. (2014). On the other hand, when Marashi and Mousavi (2007) studied the effects of different thinning methods and degrees at 6 weeks after pollination on yield of Barhee date palm cultivar, they found that no significant effect on fruit yield between removal of one third or one fourth of the strand length and the control. In addition, all thinning treatments generally improved fruit physical properties such as fruit weight, flesh weight, fruit volume, fruit length and fruit diameter. Those results had appeared due to the reduction of fruit compactness within the bunch which gave more space for the fruit to grow (Al-Saikhan 2008 and Moustafa 1993).

Concerning fruit chemical characteristics, all thinning treatments had improved TSS (%), total sugars and reducing sugars compared to control. This is maybe due to the change in source to sink ratio (leaf/fruit ratio) and the increase of fruits exposed to the light. In addition, fruit contain malic acid which is produced during the krebs cycle and its decrease in the date show an increase in sugars content. Also, the relation among sugars and acidity may be related to cultivars properties and the stage of fruit date growth. Also, the decision for harvesting depends on cv. properties especially soluble tannins levels.

These results are in harmony with those obtained by Mahmoud, et al. (2003) on "Zaghluol", Al-Obeed et al. (2005) on "Succary", Nirmaljit et al. (2006) on Khadrawy, Soliman, et al. (2011) on "Khalas" and Soliman and Harhash (2012) on Succary Bashir et al. (2014) on "Kur" and Soliman et al. (2015) on "Segae" date palm.

Conclusion

Such thinning is considered the best horticultural treatment in regular bearing which lead to suitable number of inflorescence and reduced compactness within bunch, so, improve the light, air and competition of nutrients among the bunches, so, improve fruit properties (quality).

Thinning by removing 30 % of the total number of strands from the bunch center after 8 weeks from pollination increased fruit weight, flesh weight, fruit volume, fruit length, fruit diameter, TSS%, total sugar % and reducing sugar % in both seasons, while, thinning by removing 15 % of the total number of strands from bunch center did not reduce the yield in the second season although it has improved some physical and chemical properties of Kadrawi date palm cultivar.

Abbreviations

TSS: Total soluble solids

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Authors' contributions

Abdel-Hamid N., Abd El-Hamid A., El-Sonbaty M. R. and Abd El-Naby S. K. M. have contributed significantly to the conception and design of the study. Moustafa A. R. has conducted the experiment and collected data. All authors drafted, revised and approved the final manuscript.

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Availability of data and materials

The datasets generated and/or analyzed during the current study areincluded in this published study.

Ethics approval and consent to participate

Not applicable

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Competing interests

The authors declare that they have no competing interests.

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