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Response of Zaghloul Date Palm Productivity, Ripening and Quality to Different Polyethylene Bagging Treatments

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Abstract: A field study was carried out during 2009 and 2010 seasons on adult Zaghloul date palm trees growing in sandy soil at a private orchard in Edko region, El- Behaira Governorate near Alexandria, Egypt in order to study the effect of polyethylene bagging on fruit ripening, improve productivity and postharvest fruit quality of palm date. Spathes bagging were carried out at pollination time using transparent and blue polyethylene bags at a thickness of 30 ìm. Bags were removed at three phenological fruit growth stages; stage one (S1= kimri stage, 1.1-1.3 cm fruit diameter), stage two (S2 = mature stage, fruits were green) and stage three (S3 = partially-ripe, 50 – 60% fruits coloring). In general, polyethylene bagging with removing at later growth stages caused a significant early fruit ripping date; increased fruit weight, length, diameter and yield, as well as decreased the percentage of tip cracked fruits at harvest time comparing with no bagging control. Also, harvest spread was shorter with bagging treatments and when covers were removed at later stages (S2 and S3). However, fruit showed an increase in the percentage of rutab, decay, unfit for marketing by bagging treatments and removal at later growth stage compared with the non covered control.

Key words: Ripening · Polyethylene · Bagging · Quality · Productivity · Shelf life · Date palm

INTRODUCTION

Date palm *Phoenix dactylifera*, L., is one of the ancient domestic fruit tree in the Middle East countries and their fruits play an important role in the nutritious pattern of many people. According to FAO [1], Egypt is considered the first country of the top ten date producers (11 30000 tones). In Egypt many cultivars are grown in different regions according to the diversity of their climatic necessity, particularly average temperature and relative humidity that affect fruit growth and development. Zaghloul, Samany, Halaway and Hayany varieties are the earliest ripening varieties of soft date grown in Egypt. Zaghloul date is the most important commercial cultivar in Egypt and highly demanded in the Arab markets. Zaghloul date farmers face the problem of early winter rain fall which causes fruit tip cracking and other fruit physiological disorders that occurs very suddenly and rapidly at khalal stage. Dowson [2] reported that high air humidity during date maturation shows several cuts or breaks with an edge-blackening (Blacknose) on the fruit skin and the soft fruits fall to the ground and consequently lose their commercial value. Periods of high humidity immediately before the khalal stage, when fruits are just beginning to fade a little in transition but still green, often cause minute superficial breaks, or checks in the skin which vary according to different date varieties [3]. Zaghloul checking occurs mainly near the fruit tip and is one of the most important factors that have decreased fruit quality at harvest and during cold storage or marking [3] Zaghloul date export season to Arab countries starts early in Mid-September, thus, practice methods to enhance ripening date would be very useful to overcome fruit disorder problems as well as obtaining early exporting season of high quality dates. Many researchers investigated the effect of bunch bagging on ripening date [3, 4] as well as fruit quality [5]. Accordingly, the present study aimed to evaluate the effect of different bagging treatments on fruit development and ripening rate of Zaghloul dates growing in Edko region in Al Behaira governorate.

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MATERIALS AND METHODS

Plant Material, Design and Treatments: The present study was performed during 2009 and 2010 seasons on twenty year old Zaghloul palm cv., grown in sandy soil at a private orchard in Edko region, El- Behaira governorate near Alexandria, Egypt. Twenty one palm trees were uniformly selected and were subjected to the same usual horticultural practices and pollinated from the same male palm trees. Number of spathes per palm was adjusted to 10 nearly equal size and strands number per spate was reduced to 60 by thinning- out from the spathes center. Spathes were bagged with transparent and blue Polyethylene bags of 30µm thickness. The polyethylene covers were placed like sleeves over the spathes soon after pollination and were tied at the top. The spathes were kept under bagging until fruits reached three different phonological fruit growth stages. Stage one (S1) the kimri stage (fruit diameter ranged 1.1-1.3 cm), stage two (S2) mature stage (fruits had green color) and stage three (S3) partially-ripe (fruit coloring reached 50 – 60%). For this study, Twenty- seven palm trees were chosen as uniform as possible. The treatments were arranged in a randomized complete design (RCD) with three bagging types,no bagging, bagging with transparent polyethylene and bagging with blue polyethylene and bagging removal at three phonological stages; S1, S2 and S3. Each treatment consists of three replicates and one palm tree /replicate (3x3x3= 27 palm tree). In order to determine the effect of the different treatments on fruit physical and chemical characteristics, a sample of 10 strands were randomly collected from each bunch/ replicate during both seasons when the fruits for each treatment reached full maturity and red color (commercial harvest date). To study the effect of the different treatments on fruit storagablity and marketability, a second fruit sample of 25 strands was randomly collected from each replicate when every treatment reached full maturity and red color and harvest date for each treatment in both seasons was recorded. Strands were kept at 0°C and 85 -90% relative humidity for 15 days and the incidence percentages of fruit rutab, decay, unfit for marketing and weight loss were determined after the end of cold storage period (15 days) to determinate the fruit storage life.

Yield Components: The percentage of fruit set was determined as previously mentioned by El-Makhtoum [6]. Fruit drop percent was calculated as the number of fruit dropped during two months period after fruit set in relation to the total number of setting fruits. In addition, the average yield weight of kg/bunch and kg/palm were recorded at initial and final harvest date, then the percentage of yield at initial and final harvest was calculated.

Fruits Physical Properties: The following fruit physical properties were determined at commercial harvest time:

The average percentage of fruit tip cracking (calculated as percentage of total fruits on each bunch), fruit and pulp weight (gm), fruit diameter and length (cm), shape index (fruit length/ diameter) and seed weight. Also, the ground red fruit color was assessed visually and recorded on a scale from 0 (no red color) to 10 (complete red color).

Fruits Chemical Properties: The following fruit chemical properties were determined at commercial harvest time: The percentage of fruit total soluble solids was measured by a hand refractometer, fruit acidity percent was determined by titration according to AOAC [7]. Five grams were taken from the whole fruit (peel + pulp) and extracted in 95% ethyl alcohol and total and reducing sugars were determined as percentage of fresh weight according to AOAC [7]. Ten fruit samples from each replicate was taken and washed with tap water, rinsed twice in distilled water and were cut into small pieces with a clean knife, then an amount of the fresh sample was weighed (fresh weight) and dried to a constant weight (g) in air drying oven at 70°C, then weighed (dry weight). Fruit moisture and dry matter contents were calculated as follows:

Fruit moisture (%) = [(average fresh weight – average dry weight)/average fresh weight] x 100

Fruit dry matter (%) = (average dry weight/ average fresh weight) x 100

Statistical Analysis: The obtained data were tested for bagging and stage effects on analyzed parameters by the two-way analysis of variance (ANOVA). Main effect of bagging (first factor) and stage (second factor) and their interactions were separated and compared using the LSD test at 0.05 level of significance. Calculations were carried out using the software package Statistica™ for Windows version 6.1 [8, 9].

RESULTS AND DISCUSSION

Yield Components: Data presented in Table 1 showed that both bagging types caused an increase in the percentage of fruit set, fruit drop, bunch weight and yield as compared to the no bagging treatment during both seasons. Blue polyethylene bagging had greater influence on fruit set, bunch weight and yield than the transparent polyethylene bagging but the differences were not significant. Removing the bags at any of the fruit growth stages did not differ from each other on influencing fruit set. Whereas, fruit drop, bunch weight and yield were significantly higher when bags were removed at S2 and S3 than removing at S1. In addition, no significant differences were obtained between bags removal at the both later stages. Ruther and Crawford [10] reported that low temperature in the first half of pollination period significantly decreased fruit set. Accumulation of higher heat unites by polyethylene bagging; especially blue polyethylene was also reported by Awad [4]. Increasing the temperature degree and the relative humidity keep stigmas under bags fresh and crisp much longer than those on exposed flowers and prolong the period of receptivity [11, 12]. Similarly, Kassem *et al*. [3] found that bunch bagging treatments increased fruit set and yield of different date varieties. Also, Weerasinghe and Ruwanpathirana [13] found that the bunch covering increased bunch weight by 32%. Also, Anon [14] reported that the bunch weight could be increased 18- 23% with promoting the appearance of the fruit. In this respect, the increase in fruit set and yield obtained in the present study might be related to the increase in temperature of bagged bunches, as well as the reduction of pollens loss by the wind or the rain during the pollination period. In addition, the increase in fruit drop percent by bags removal at the later fruit growth stages might had a thinning influence which accordingly increased bunch weight and palm yield. The bunch weight was increased by 18-23% with promoting the appearance of the fruit [14]. Samson [15] observed that the bagging increased the bunch weight.

Fruit Tip Cracking: Data in Table 2 indicated that in both seasons, the percentage of fruit tip cracking was decreased by transparent and blue polyethylene bagging in comparison with the no bagging treatment. The percentage of fruit tip cracking was highest when bags were removed at the first stage (Kimri) and lowest when removing at the third stage (partially ripe). Similarly, Izadi [16] reported a decrease in dates physiological disorder up to 70% by bunch bagging and he stated that climatically factors affected dates fruit disorder by the following effectiveness sequence: weather relative humidity > wind speed and streamline > weather temperature.

Table 1: Effect of bagging and growth stage on fruit set and drop percentages, bunch weight and yield during 2009 and 2010 years

		2009				2010			
Treatments		Fruit set (%)	Fruit drop (%)	Bunch weight (kg)	Yield (kg/palm)	Fruit set (%)	Fruit drop (%)	Bunch weight (kg)	Yield (kg/palm)
Polyethylene	Without	63	14.0	18.3	185	54	15.7	15.0	161
	Transparent	72	21.4	23.4	220	69	23.3	20.2	197
	Blue	80	19.6	25.5	225	79	22.7	22.1	202
L.S.D	0.05	6	3.3	2.7	16	8	5.2	3.6	21
Stage	S1	71	15.1	20.0	194	64	15.7	16.0	168
	S2	72	18.7	23.0	217	69	21.1	20.8	195
	S3	72	21.2	24.2	219	69	25.0	20.5	197
L.S.D	0.05	NS	3.3	2.7	16.0	NS	5.2	3.6	21

Table 2: Effect of bagging and growth stage on fruit tip cracking, weight, length and diameter during 2009 and 2010

		2009	2010						
Treatments		Fruit tip cracking (%)	Fruit weight (g)	Fruit length (cm)	Fruit diameter (cm)	Fruit tip cracking (%)	Fruit weight (g)	Fruit length (cm)	Fruit diameter (cm)
Polyethylene	Without	37.7	22.5	4.53	2.40	39.8	24.6	5.04	2.24
	Transparent	22.1	26.5	6.70	2.95	20.0	28.2	6.85	2.98
	Blue	20.5	28.2	6.67	2.97	19.4	30.0	7.02	3.43
L.S.D	0.05	4.3	2.2	1.1	0.34	2.8	1.8	1.4	0.52
Stage	S1	32.5	24.5	4.78	2.20	33.1	26.2	5.17	2.50
	S2	26.8	25.5	6.18	3.04	25.0	27.2	6.75	3.04
	S3	21.1	27.2	6.39	3.08	21.1	29.3	6.99	3.11
L.S.D	0.05	4.3	2.2	1.1	0.34	2.8	1.8	1.4	0.52

Fruit Physical Properties: Data in Table 2 showed that fruit weight, length and diameter were significantly increased by bagging treatments when compared with the no bagging one. However, both bagging types did not significantly differ from each other. Additionally, the results obtained in Table 3 showed that bagging with blue polyethylene resulted in higher seed weight than no bagging (in the first season) and no bagging or bagging with transparent polyethylene (in the second season). Moreover a significant improvement in fruit ground coloring with bagging treatments as compared to the no bagging one (Table 3).

In addition, data of both seasons showed that bags removal when fruit reached mature (S2) or partially ripe (S3) resulted in significantly higher fruit weight, length and diameter in comparison with bags removal at the kimri stage (S1). Also, bags removal at the latest stage of fruit growth (S3) resulted in higher seed weight than removing at the earlier fruit growth stage (S1). Furthermore, bags removal at either stages S2 or S3 increased significantly fruit ground color in comparison with removing at stage one (S1).

These results are in line with those obtained by Kassem *et al*. [3] and Al-Baker [11]. They obtained similar increase in fruit weight, length and improvement of fruit shape by date bagging. Microclimate of bunch could favorably be changed by bunch covering [5] Samson [15] observed a temperature rise of 1.1-1.6°C surrounding banana bunch and an increase in bunch weight by 1 kg. Similarly, Awad [4] reported that date bunch bagging treatments, especially with black and blue polyethylene bags, accumulated high heat units. Consequently, in the present study removing bags later in the season might give the chance for more heat accumulation and thus, better fruit growth rates and coloring.

Fruit Chemical Properties: The effect of the different treatments on fruit chemical characters is presented in Tables 3 and 4. Fruit acidity was higher with bagging treatments than no bagging in the first season only. Blue polyethylene bagging significantly decreased fruit total soluble solids, dry matter, reducing and total sugars and increased fruit moisture contents compared to the no bagging treatment. Generally, no significant differences were found between bagging with transparent polyethylene and no bagging in fruit TSS, dry matter, moisture, reducing s and total sugars contents. Bags removal at the three growth stages had no influence on fruit acidity. Fruit TSS, dry matter, reducing and total sugars contents decreased with removing bags in the latest stage of fruit growth (S3) compared with the earlier one (S1). On the contrary, fruit moisture content was highest when bags were removed at the later stage of fruit growth (S3).

Table 3: Effect of bagging and growth stage on fruit seed weight, ground color and acidity and TSS contents during 2009 and 2010

		2009				2010			
Treatments		Seed weight (g)	Ground fruit color	Acidity (%)	TSS (%)	Seed weight (g)	Ground fruit color	Acidity (%)	TSS (%)
Polyethylene	Without	2.12	8.2	0.11	27.4	2.26	9.0	0.15	28.8
	Transparent	2.25	9.8	0.19	26.7	2.36	9.9	0.16	28.8
	Blue	2.31	9.6	0.19	25.5	2.53	9.6	0.14	26.0
L.S.D	0.05	0.11	1.0	0.06	1.6	0.15	0.5	NS	2.2
Stage	S1	2.12	8.5	0.18	27.8	2.30	9.0	0.16	29.9
	S2	2.26	9.6	0.15	26.3	2.38	9.8	0.14	28.2
	S3	2.31	9.5	0.16	25.5	2.47	9.7	0.16	25.5
L.S.D	0.05	0.11	1.0	NS	1.6	0.15	0.5	NS	2.2

Table 4: Effect of bagging and growth stage on fruit dry matter, moisture, reducing and total sugars contents during 2009 and 2010

		2009				2010			
Treatments		Fruit dry matter (%)	Fruit moisture (%)	Reducing sugars (%)	Total sugars (%)	Fruit dry matter (%)	Fruit moisture (%)	Reducing sugars (%)	Total sugars (%)
Polyethylene	Without	79.3	20.7	18.7	23.1	80.0	18.6	19.4	23.7
	Transparent	77.0	23.0	17.9	23.3	78.8	22.6	19.3	24.6
	Blue	71.0	29.0	16.6	20.3	73.6	26.4	16.6	20.8
L.S.D	0.05	2.7	3.1	1.7	2.0	4.7	3.3	2.4	1.9
Stage	S1	80.2	19.8	19.0	23.2	82.6	17.9	20.1	24.6
	S2	74.9	25.1	17.7	21.9	77.1	22.4	18.4	22.1
	S3	72.2	27.8	16.5	21.6	72.7	27.3	16.8	22.4
L.S.D	0.05	2.7	3.1	1.7	2.0	4.7	3.3	2.4	1.9

These results are in agreement with those obtained by Awad [4], who reported that, a significant decrease in fruit TSS content by using blue polyethylene bagging. Who also added that white polyethylene bags decreased date fruit acidity. The increase in fruit ground coloring previously mentioned in this study might be related to the increase in fruit moisture content obtained by the same treatments. The bunch bagging improvement the appearance fruit quality [14]. Wade *et al*. [17] attributed to the protection of bunches from UV radiation, which on the other side caused necrotic scorching of the fruit peel.

Harvesting Date: In both seasons, the initial harvest date was about 20-25 days earlier with bagging treatments than the no bagging one (Table 5). In addition, the percentage of the initial palm yield increased and final yield percent decreased by bunch covering. Yield spread period was shorter by bagging treatment in comparison with no bagging treatment. Bags removal at either mature stage (S2) or partially ripe stage (S3) enhanced initial harvest date by about 20-25 days and increased the percentage of initial yield compared with earlier removal at the kimri stage. However, final percent of palm yield decreased significantly by the late bags removal (S2 and S3). Accordingly, shorter harvest spread was obtained by later bags removal with the shortest spread obtained in both seasons by removing bags at the third growth stage (partially ripe).

The present results showed that the ripening date of the covered bunches were earlier than the uncovered control. Data also showed that the blue or transparent polyethylene bags shortened harvest spread. Awad [4] stated that bunch bagging, especially with black and blue polyethylene bags induced higher respiration rates and the CO_2 accumulation within bags might lead to more acetaldehyde production and removal of astringency then hasten fruit filling and caused early fruit ripening. In addition, Chillet and Jannoyer [5] and Perumal and Adam [18] reported that the bagging raised the temperature around bunches and reduced the shooting until harvesting time under temperate conditions. Also, Daniells and Lindsay [19] found that the temperature under covering can be 2-6°C warmer during cool times of the year, this can increase fruit length and hasten fruit filling (harvest 4-14 days earlier).

Storagablity: In both seasons data presented in Table 6 indicated that the bagging treatments either with transparent or blue polyethylene caused a significant increase in the percentage of rutab fruits as well as fruit decay, fruit weight loss and unfit for marketing after 15 days cold storage compared with the uncovered bunches (control).Similarly, bags removal at the later growth stages (S2and S3) resulted in higher percentages of rutab fruits, weight loss, decay and the percent of fruits unfit for marketing.

Table 5: Effect of bagging and growth stage on harvest dates, yield percent and harvest spread during 2009 and 2010

		2009				2010			
Treatments		Initial harvest date	Yield at initial harvest date (%)	Yield at final harvest date (%)	Harvest spread (days)	Initial harvest date	Yield at initial harvest date (%)	Yield at final harvest date (%)	Harvest spread (days)
Polyethylene	Without	15/10	20	48	38	19/10	17	40	42
	Transparent	20/9	60	23	15	24/9	64	16	20
	Blue	25/9	50	28	18	30/9	56	21	23
L.S.D	0.05	--	16	18	8	--	21	7	14
Stage	S1	3/10	33	51	33	7/10	26	38	39
	S2	22/9	45	27	20	25/9	51	26	24
	S3	20/9	52	21	18	22/9	60	13	22
L.S.D	0.05	--	16	18	8	--	21	7	14

Table 6: Effect of bagging and growth stage on fruit weight loss, rutab, decay and unfit for marketing percentages after 15 day from cold storage during 2009 and 2010

		2009				2010			
Treatments		Weight loss	Rutab	Decay	Unfit for marketing	Weight loss	Rutab	Decay	Unfit for marketing
Polyethylene	Without	3.7	13.8	13.8	29.9	4.4	14.9	11.3	30.8
	Transparent	4.8	16.9	14.8	33.7	5.9	19.8	15.9	33.1
	Blue	6.8	20.8	16.9	37.9	7.5	30.8	17.2	41.9
L.S.D	0.05	1.3	4.9	1.5	3.1	1.6	6.3	1.7	2.9
Stage	S1	4.1	14.0	13.1	31.0	3.9	16.3	11.3	28.3
	S2	5.5	16.8	16.4	35.8	6.9	20.9	17.0	38.9
	S3	5.8	20.7	16.0	34.7	7.0	29.3	16.1	38.6
L.S.D	0.05	1.3	4.9	1.5	3.1	1.6	6.3	1.7	2.9

CONCLUSION

From the above results it might be concluded that covering date bunches directly after pollination with blue or transparent polyethylene bags and removing at later growth stage of fruit might enhance the early ripening of Zaghloul dates and shorten its harvest spread but may not improve its storage life.

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