

Preharvest Ethephon spray on fruit quality and increasing the rate of ripening of date palm fruit (*Phoenix dactylifera* L.) cv. Helali

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Summary. This study was conducted at the Dirab, to study the effect of fruits date (bisir stage) spray by ethephon solution on fruit physical and chemical properties. Results showed that spraying ethephon significantly affected by different treatments for Helali cultivar in both seasons of study. It was clearly noticed that there is a positive relationship between ethephon concentrations and fruit physical and chemical properties. Meanwhile, found there is a direct correlation between the concentrations of ethephon and increase the proportion of rutab date. Ethephon treated fruits at 1500 ppm resulted in decreased fruit dimension, flesh weight, fruit weight, fruit volume, total acidity percentage and moisture content. In addition, increased of total soluble solids, reducing and total sugars percentage at rutab stage during in both seasons of study compared to the control at harvest. It is concluded that spray by ethephon on bisir stage of Helali date fruit for increasing the proportion of ripening and rutab date moreover early harvest.

Key words: *Phoenix dactylifera* L., Ethephon, preharvest, ripening, fruit quality

Introduction

Botes and Zaid (1) they recorded the hot arid desert regions, date palm crop is the most successful and important subsistence and is one of the important fruit crops has been grown in Kingdom of Saudi Arabia. Date palm productivity negatively affected the quality of characteristics especially weight and size fruit under hot desert conditions. Awad and Al-Qurashi (2). Helali is one of the best soft type date palm cultivars found be acceptable for Saudi consumer. Helali cultivar of the late maturing cultivar in Saudi Arabia and the Gulf region. It harvested after collecting the fruits of most cultivars. After harvested Hilali date can be divided at three stages from mature, Bisir, Rutab and Tamer stages. Some of the changes occurring in the

fruit where you start green, increase in weight and size then turn to yellow and then turn to the color brown or black and becomes soft and this is the fruit considered physiologically mature. Hilali fruits of the late maturing cultivars and high tannin and acidity in the fruit and the fruit to mature it is important to remove these tannins and acidity, Awad (3). Greene (4) found that the regulate development in horticulture and growth are by physiological changes of plant growth regulators. Davies (5) recorded that the ethylene and gibberellins that lead almost the same role in effect on physiological processes such as plant hormone that affect by very small concentrations. Ethylene and Gibberellic acid affect the fruit maturing and accelerate the ripening, Rizk-Alla and Meshrake (6) and Eliving et al. (7). Al-Khafaji et.al. (8) found that the ethrel in-

duced hastened color in date fruits and early ripening. Mawloud, (9) and Ibrahim & Mawloud (10) found tht the fruit ripening of Khadrawi date by dipping Rutab stage in ethephone of different concentration for 5-10 minutes led to fruit ripening, accelerated maturity and improved fruit quality. Spraying ethyphon increase ethylene content in the fruit and early the harvest date because of quicken fruit maturing, ripening processes, Kassem et al. (11). In addition, ethephon also affects numerous cellular, developmental and stress-response operation related to photosynthesis, Balota et al. (12). Kassem et al. (13) found that the ethyphon advanced fruit ripening date. Becatti et al. (14) found tht the respond fruits to exogenous ethylene preharvest treatments and date fruit are classified as non-climacteric fruit. Glasner et al. (15) recorded tht the harvesting depends on climatic conditions and market demand, cultivar properties and soluble tannins levels. Successful orchard management practices include suitable spraying ethephon which gives the stagnant fruits a better chance to develop better quality. Some investigators have studied the different effects of ethephon and influence of etherel on physical and chemical characteristics, El-Hammady et al. (16), Serrano et al. (17), Musa (18), Al-Juburi et al. (19), Klee and Clark (20), Pesis (21). Dal Ri et al. (22) reported that the evidence is compelling that ethylene plays a role in grapevine berry ripening and some of the related. Marzouk and Kassem (23) they found tht the ethephon application on fruits used direct consumption, early harvest date and shortest shelf life. Therefore, the goal was sprayed on fruits ethephon in bisir stage for the occurrence of rutab stage (ripening) and increase the percentage rutab fruits in addition the early harvest.

Materials and Methods

This study was conducted at the Dirab, Riyadh, Saudi Arabia on Helali date palm cultivar. Twelve date palm trees of each cultivar were selected according to their similarity in age (15 year old) and vigorous. The same number of leaves and Eight bunches were left on each single experimental tree All cultural practices were applied as normal schedule in orchard. The twelve palms

were divided into four treatments (three ethephon combinations and control) in three replicates (each one tree) and arranged in a randomized complete block design as the following:

- A- Spraying ethephon application at 500 ppm.
- B- Spraying ethephon application at 1000 ppm.
- C- Spraying ethephon application at 1500 ppm.
- D- Spraying distilled water (Control).

Uses the same male pollinated in bunches in all treatments in both seasons. Spathe pollination by hand pollination was done by 5 male strands inserted in the middle of female inflorescence in all treatments. After that fruits left the grow natural growth until beser stage. When mention the time, sprays of ethephon solution were thoroughly applied by small hand sprayer (two liter capacity) on bunche. While, control treatment splashed by distilled water. Each spathe on each palm splashed by ethephon. After two weeks from fruit color change all treatments were applied. bunches were individually covered by white canvas bags. So that it applied to all treatments on a single Palm. Thereafter, the bags were removed out after two weeks. The fruits were harvested during the second week of October in both seasons and following characters were determined:

Fruit physical properties

Samples were taken from three replicates, 20 fruits were taken randomly from each bunch (replicate) to determine dimensions (in cm), fruit size (in cm), seed weight (in grams), fruit flesh weight and fruit weight. After harvest the number of rutab fruit was recorded and expressed as a percentage per hundred fruit in all treatments. Awad (2007) found thate the when softening fruit for about 25% considered fruit ripe (Rutab). The results were statistically as a complete randomized design with each treatment replicated three times.

Fruit chemical properties (fresh fruits)

Chemical properties of fruits fruit acidity, total soluble solid, moisture content and sugar content (total sugar, reducing and non-reducing and) were determined according to A.O.A.C. (24). The titrable acidity was calculated as citric acid, Mawlood (25).

Statistical analysis:

Observations recorded were processed using Microsoft Excel (Microsoft, 2000). All statistical analysis and the simple correlation, as well as stepwise multiple regression analysis were carried out using the statistica program (StatSoft, Inc., 1995) (38).

Results*Fruit physical properties*

Data in Tables 1, indicated that fruit dimension, fruit volume, flesh weight and fruit weight was significantly affected by different treatments for Helali date palm cultivar in both seasons of study. It was clearly noticed that there is a positive relationship between ethephon concentrations and physical properties. Control treatment gave the highest fruit dimension, fruit volume, flesh weight and fruit weight during in both seasons of study compared to other treatment. Meanwhile, found there is a direct correlation between the concentrations of ethephon and increase the proportion of rutab date. Ethephon treated fruits

resulted in decreased fruit dimension, fruit volume, flesh weight, fruit weight at harvest in both seasons when compared with the control. Spraying ethephon application at 1500 ppm gave the lowest values of fruit length and fruit diameter, fruit volume, flesh weight and fruit weight followed by spraying ethephon application at 1000 ppm and spraying ethephon application at 500 ppm during in both seasons of study. Where less fruit length and diameter, fruit weight, flesh weight and fruit volume, the greater the ethephon concentration. Accordingly, the values 11.7&12.1- 11.6&11.9 - 10.9&11.1- 12.6&12.8, 11.1&11.6 - 11.0&11.3 - 10.3&10.5 - 12.0&12.2, 11.3&12.3 - 11.2&11.9 - 10.7&11.2 - 12.7&13.2, 3.3&3.5- 3.3&3.4 - 3.2&3.3 - 3.4&3.5, 2.6&2.6- 2.5&2.4 - 2.4&2.5 and 2.6&2.7 at 500, 1000, 1500 ppm and control as first and second seasons, respectively. Data of fruit softening (rutab) of Helali date in both seasons showed that ripening were increased significantly by increasing ethephon concentrations. Spraying ethephon at 1500 followed by 1000 ppm gave the height ratio rutab of date as compared with spraying ethephon at 500 ppm and control (Table 2).

Table 1. Effect of ethephon treatments on fruit physical properties.

Treatments	Fruit weight weight (g)	Flesh weight (g)	Seed weight (g)	Fruit volume (cm)	Fruit Length (cm)	Fruit diameter (cm)
2013-2014 seasons						
Spraying ethephon application at 500 ppm.	11.7	11.1	0.55	11.3	3.3	2.6
Spraying ethephon application at 1000 ppm.	11.6	11.1	0.48	11.2	3.3	2.5
Spraying ethephon application at 1500 ppm.	10.9	10.3	0.56	10.7	3.2	2.4
Control, Spraying distilled water.	12.6	12.0	0.63	12.7	3.4	2.6
LSD at 0.05	1.6	1.57	0.11	1.8	0.2	0.1
2014-2015 seasons						
Spraying ethephon application at 500 ppm.	12.1	11.6	0.48	12.3	3.5	2.6
Spraying ethephon application at 1000 ppm.	11.9	11.3	0.56	11.9	3.4	2.4
Spraying ethephon application at 1500 ppm.	11.1	10.5	0.56	11.2	3.3	2.5
Control, Spraying distilled water.	12.8	12.2	0.64	13.2	3.5	2.7
LSD at 0.05	1.6	1.6	0.11	1.9	0.1	0.06

Table 2. Effect of ethephon treatments on ripening of bisir Helali date.

Treatments	Rutab fruit (%)	
	2013-2014 seasons	2014-2015 seasons
Spraying ethephon application at 500 ppm.	62	57
Spraying ethephon application at 1000 ppm.	66	61
Spraying ethephon application at 1500 ppm.	80	83
Control, Spraying distilled water.	45	38
LSD at 0.05	2.3	5.9

Table 3. Effect of ethephon treatments on fruit physical properties.

Treatments	Acidity	TSS	Reducing	Non-R.	Total	Moisture
	%	%	sugars	sugars	sugars	content %
2013-2014 seasons						
Spraying ethephon application at 500 ppm.	0.181	64.8	30.6	32.9	63.5	37.9
Spraying ethephon application at 1000 ppm.	0.162	69.2	31.2	33.4	64.6	20.3
Spraying ethephon application at 1500 ppm.	0.155	73.2	34.9	31.2	66.1	17.6
Control, Spraying distilled water.	0.154	47.4	11.2	22.7	33.9	52.8
LSD at 0.05	0.45	10.2	3.4	10	9.9	0.011
2014-2015 seasons						
Spraying ethephon application at 500 ppm.	0.192	66.9	28.7	31.1	59.8	37.1
Spraying ethephon application at 1000 ppm.	0.168	67.9	29.5	34.8	64.3	19.9
Spraying ethephon application at 1500 ppm.	0.165	76.4	32.7	35.5	68.2	18.7
Control, Spraying distilled water.	0.148	45.3	12.3	23.2	35.4	54.3
LSD at 0.05	0.11	5.8	2.7	6.6	6.0	4.8

Fruit chemical properties

The effect of the various spray treatments on fruit chemical characteristics of Helali date at rutab stage are presented in Tables 3. The data obtained showed that at the rutab stage, fruit acidity was significantly increased by spraying ethephon at 500 then decreased with 1000 and 1500 ppm as compared with the control in two seasons. In addition, data of both seasons indicated an increase in fruit total soluble solids percentage

by all sprayed ethephon application as compared with the control at rutab stage. At the rutab stage, spraying ethephon by 1500 ppm resulted gave the highest total soluble solid value followed by 1000 and 500 ppm than those the control treatment in two seasons. Moreover, the fruit total and reducing sugars percentage at rutab stage was increased by all treatments as compared with the control during two seasons. The results showed that the, spraying ethephon treatment 1500

followed by 1000 and 500 ppm gave the highest values fruit total and reducing sugar percentage than those the control at rutab stage in two seasons. In addition, the fruit non-reducing sugars were increased with all treatments as compared to the control. The fruit non-reducing sugars content at rutab stage gave the highest values with spraying ethephon treatment 1000 followed by 500 and 1500 ppm and 1500 followed by 1000 and 500 ppm in the first and second seasons, respectively. Data presented showed that Helali dates had the highest values of moisture with control than those other spraying ethephon application treatments at rutab stage in both seasons. Increase the concentration of ethephon followed by an increase in rutab date and lack of moisture. Spraying ethephon application by 1500 followed by 1000 and 500 ppm gave lowest moisture in both seasons.

Discussion

Fruit physical properties

The data of this present study showed that the preharvest application of ethephon had positive effect in increasing rutab date with increasing concentration. This is in agreement with those of Awad (3) in Helali date palm found that the preharvest ethrel implementation considerably increment rutab fruit yield per bunch. Kassem et al. (11) found that the speed up fruit maturing, ripening processes, early harvest of fruits and emission increase Ethylene production in the fruit is obtained when spraying ethyphon on fruits in timely physiology. Kassem et al (13) found that the ethyphon uses in fruits (preharvest treatments) led to advanced fruit ripening date. Kamal (26) he studied the effect of spraying by ethyphon concentration (500, 1000 and 1500 ppm) on Zaghoul and Samani cultivars, found that the higher fruit ripening thought out one Month. Ethylene responsible for the ripening process in date fruits. Date are climacteric fruit and suggesting that early ripen of date fruit a little climax in ethylene manufacture was after that a climax in respiration rate, Serrano et al. (17). Serrano et al. (17) and Glasner et al. (15) they found that the soften of date fruit is especially effected by cellulose enzymes, beta-galactosidase and polygalacturonase and it follows

that the lack of tannin and acidity. These results do not agree with those of Al-Juburi et al. (19) and El-Hammady et al. (16) who recorded the in dry and hot regions shortage of competence of ethyphon on date fruits. Martin-Cabrejas et al. (27) found tht the degradation of soluble pectin by high activity of endopolygalacturonase in fruits cause softening of fruits. Ethephon had no effect on fruit dimension at harvest in two seasons. Ethephon had no effect on flesh and fruit weight and reduce fruit firmness, stone weight and fruit size, Karim et al. (28). Chen et al.(29) reported that the change in the installation of cell wall pectin's and lipo protein diaphragm the cells cause alter in fruit hardness. Martin-Cabrejas et al. (30) found tht the pectin polysaccharides, cortical tissues and parenchyma cell walls were answerable for decrease fruit hardness during ripening. Ning et al. (30) found that the change cellulose action through fruit ripening in pear reduce in flesh hardness. Similarly, Patharnakh pear fruit the hardness decreased through ripening at 20°C after chilling the fruit at 0-1°C, Dhillon et al. (31). Ethyphon significantly improved fruit ripening of Helali date palm cultivar in both seasons, Table (3). Agree with that Awad (3).

Fruit chemical properties

Results indicated that the increasing of total and reducing sugars percentage and total soluble solids percentage with increasing concentration ethyphon application. On the contrary whenever more than concentration ethyphon less total acidity percentage and moisture content. Date palm fruit response to exogenous etherl preharvest treatments in spite of categorized as non-climacteric fruit, Becatti et al. (14). Kassem et al (13) found that the spraying ethyphon on fruits lead to quicken fruit maturing and ripening operation this is due to the increase ethylene content. Serrano et al. (17) and Glasner et al.(15) they found that the increment in total solids, total & reducing sugars and concentrations, the tannins under speed in an unsolvable form and the fruit loses astringency. Ethephon applied on fruit increased the rate of ripening at the shortly period. This may be in part due to release of ethylene from the treated fruits and this depends on the type of fruit. This is in agreement with those of Ibrahim, and Mawloud (10), where they found that the fruits treating to ethylene gas makes

them mature quickly. Moreover, increase total soluble solids and total sugars in treated fruits with ethephone. This may be due to the quick effect of ethephone on the rate of ripening. These results agree with those of El-Hammady et al. (32), Ibrahim and Mawloud (10) and Mawloud (9) who reported that the sprinkle of date fruit by solution ethephone contained higher quantity of total soluble solids (TSS) and total sugars. Maier and Metzler (33) they found that the enzymatic action led to ripening of fruits. Kassem et al. (11) recorded that the quicken fruit maturing and ripening operation and early the harvest and this is the result ethyphon would add to ethylene content in the fruit. There are no significant differences in rutab yield / bunch either way injection of ethrel into the bunch peduncle or sprays during harvesting season. Postharvest dipping of fruit at the bisir stage in ethrel significantly improved ripening, Awad (3). Solution treatments of ethephon, chemical components of the fruit, fruit firmness, colour development and fruit ripening of the fruit was better at 1000 ppm, Dhillon and Mahajan (34). Sinha et al. (35), Lelievre et al. (36) who found that the higher in sugars and soluble solids during ripening could be due to analysis of organic compounds and starch. Ethephon-treated fruits resulted in increased reducing and total sugars, total soluble solids, total soluble solids/ acidity ratio, while in decreased chlorophyll a and acidity. Ethephon treatment had no effect on chlorophyll b, Karim et al. (28). These results disagree with those of Khorshidi and Davarynejad (38) who reported that the one week before commercial harvest, Fruits from ethephon-sprayed trees had lessen firmness, anthocyanin content, antioxidant activity and soluble solids concentration. The ethephon spray did not affect total phenolic content, titratable acidity, pH and total soluble solids/titratable acidity ratio. Generally it could be concluded that ethephone applied at bisir stage of date fruits can increasing the proportion of ripening and rutab date moreover, early harvest with retain the quality of rutab.

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