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# Effect of Ethrel and Temperature on the Storability of Zahdi Date Fruit

## Abstract

The objective of this study is to determine the effect of ethrel at 1000 ppm on the storability of matured Zahdi date fruit at +3°C, 0°C, and -3°C and 80% R.H. Treated and untreated fruits were left attached to the strands and stored for six months. Results have indicated that; ethrel enhanced significantly fruits ripening percentage, whilst untreated fruits showed slow rate of change in both physical and chemical characteristics until the fourth month of storage. Regardless of ethrel treatment, storing fruit at 0°C or -3°C preserved their quality only for two months period. These results could facilitate Rutab marketing schedule, especially off season production. Subsequently, uniform maturity and high quality of Rutab can be obtained with relatively low cost.

## Introduction

Zahdi variety is one of the most important Date palm cultivars in Iraq; it's grown in central part. It comprises 78% of the total date production in the country (Al-Baya., 1988). Date fruit passes through five stages of development, i.e. Hababuk, Kimri, Khalal, Rutab and Tamar. Zahdi fruits are usually harvested at the Tamer stage (Dawson, and Aten. 1962). A new technique has been developed in Iraq to store Zahdi date fruits attached to their strands at the Rutab stage. Zahdi fruit has strong attachment force by their strands (Mawloud et.al., 1989). It also has been concluded that the ripening of date palm fruits is climacteric where sudden increases in ethylene production occur when the fruit changes from Khalal to Tamar stages stored at -3°C and 75-85% relative humidity (Abdalatif, 1989).

Under such storage conditions, fruits maintain their high quality and they become available at times out of their normal ripening season.

Many researchers have indicated that per harvest application of ethrel or ethephone (2-chloro ethyl phosphonic acid) induced early ripening and hastened color development of date fruit (Al-Khafaji et.al., 1988). Post harvest application by dipping Khadrawi date fruits at Rutab stage in ethephone at 1000, 2000 and 4000 ppm for 5-10 minutes enhanced the fruit ripening. Furthermore, it was pointed out, that applications of ethrel treatment had accelerated maturity and improved fruit quality (Mawlou, 2002 and Ibrahim & Mawlou, 1889)

Yektankhodaie et.al, (2006) found promising results by using high temperature combined with some chemicals to ripen Khuneizi date fruit in Iran.

The present study was undertaken:

- 1- To investigate the effect of ethrel and temperature on ripening, uniformity, and quality of Zahdi date fruit at Rutab stage.
- 2- To regulate marketing time of Rutab fruits out of their season.

## Materials and Methods

This study was carried out at a private processing plant at Baghdad, Iraq by cooperation with General State Board of Date palm (GBDP) during 2010 and 2011. Mature date fruits cv. Zahdi, at the late Khalal or at the beginning of Rubtab stage, were obtained from Kerbala governorate- Central Iraq (Mawlou et.al., 1989). Selected fruits that are uniform in shape and appearance and are free of infection were left attached to their strands. Fruits samples were divided into two groups: the first one was dipped for

two minutes in ethrel at 1000 ppm, whereas the second group was dipped in tap water as control treatment. Both groups were dried by air blower and packed in 2 Kg. capacity carton boxes. All boxes were pre-cooled at 8-10°C. Thirty boxes from each group were stored at the following three different temperatures; +3°C, 0°C, and -3°C where the relative humidity was maintained at 85%. The experiment was set in a Complete Randomized Block Design and the final data at the end of each treatment were analyzed as factorial (Snedecore. 1965).

The following physical and chemical characteristics were monitored weekly and monthly from the first of October, 2010 until the end of storage period on the first week of the next April, 2011.

- 1- Ripening percentage measured when soft spots appeared on the fruits.
- 2- The attachment force and shrinkage percentage were determined by counting the numbers of abscessed and/ or shrinkage fruits for each treatment and the percentage were calculated.
- 3- Total soluble solids measured by Abbe refract meter.
- 4- Total sugars were determined on fresh weight basis according to Berlin method (A.O.A.C. 1985).
- 5- Water content %: Ten grams of fruits were dried in a vacuum oven at 65-75°C for 48 hrs and the percentage was calculated.
- 6- Sensory evaluation of each sample was conducted to evaluate appearance, color, taste, odor, and fruit deterioration.

## Results

The physical and chemical

characteristics changes of treated and untreated Zahdi date at -3°C,

0°C and +3°C were studied from the beginning to the end of the course as follows:

### 1- Ripening %

Dipping date fruit in ethrel at 1000 ppm had increased the ripening percentage during the first three months of storage at the three temperatures, +3°C, 0°C, and -3°C. While the untreated fruits reached to similar percentage after the fourth month of storage at the three temperatures of study (Fig 1).

### 2- Attachment force %

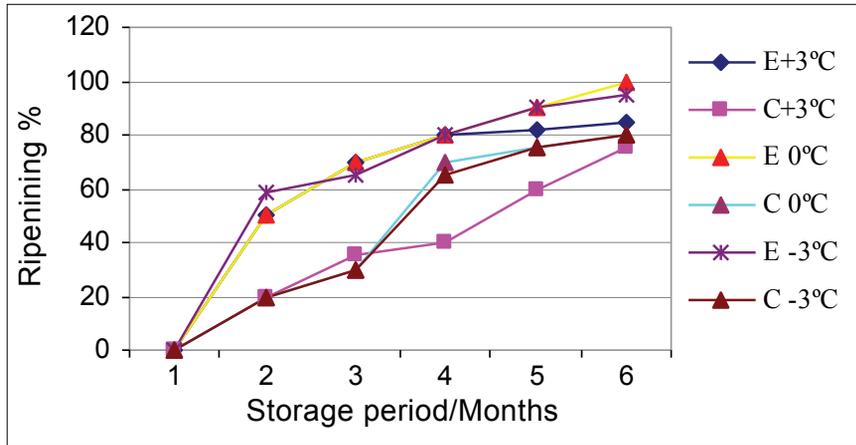
The attachment force is considered as a favorable character in selecting date cultivars for Rutab cold storage. Zahdi date fruit is characterized by having strong attachment force. The untreated fruit stored at 0°C or -3°C showed a tendency to maintain this force to the end of study. However, ethrel treatments reduced the attachment force percentage after three months at +3°C or after 5 months at 0°C and -3°C. (Fig 2)

### 3-Shrinkage %

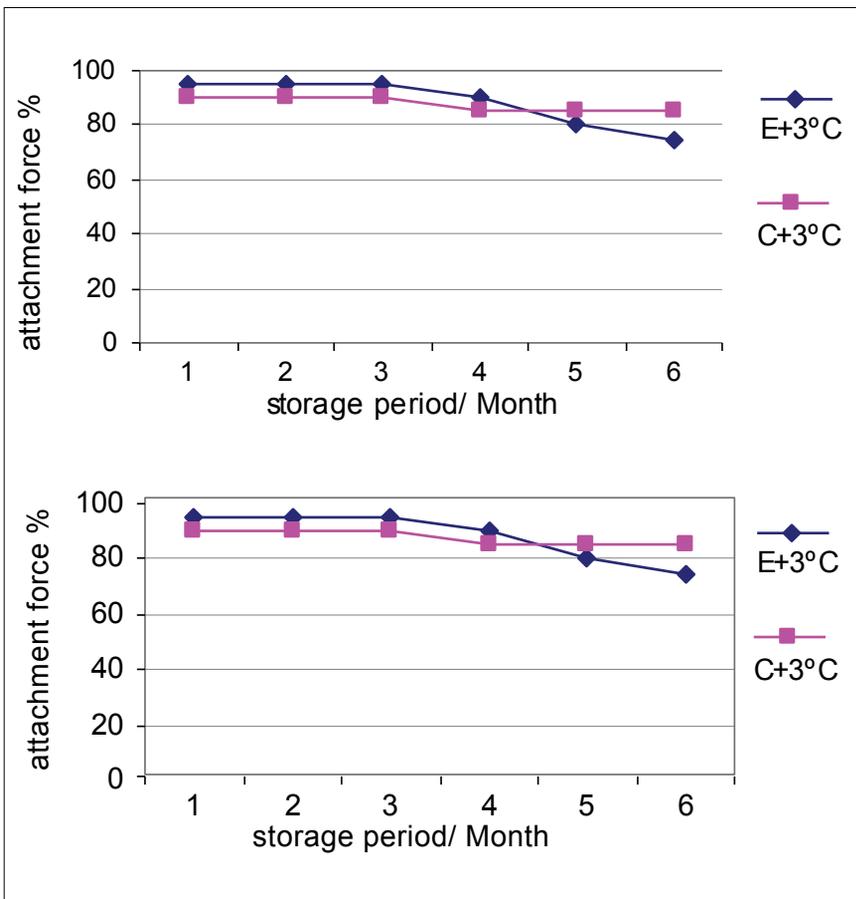
Shrinkage was delayed when fruits were stored at 0°C or at -3°C. However, storage at +3°C accelerated this percentage after two months. Furthermore, ethrel treatment continued to increase shrinkage % at +3°C gradually throughout the storage period as compared with the other treatments (Fig 3)

### 4- Total soluble solids % and total sugars %

Ethrel tended to increase sharply the total soluble solids % after two months as compared with the untreated fruits. Generally, the total soluble solids % increased steadily of treated and



Where: E is ethrel at 1000 ppm, and C is control  
 Fig 1: Effect of different treatments on the ripening % of Zahdi date fruits



Where: E is ethrel at 1000 ppm, and C is control  
 Fig 2: The effect of ethrel and temperature on the attachment force% of Zahdi fruits.

untreated fruits until the termination of experiments. (Fig 4)

The total sugars % of untreated fruits at +3°C and 0°C were increased gradually during the whole storage period. Ethrel treatment had increased appreciably the total sugars percentage after two months from storage time at all studied temperatures. Moreover, storage at -3°C increased the total sugars % after the third month of storage for the untreated fruits (Fig 5).

### 5-Water contents %

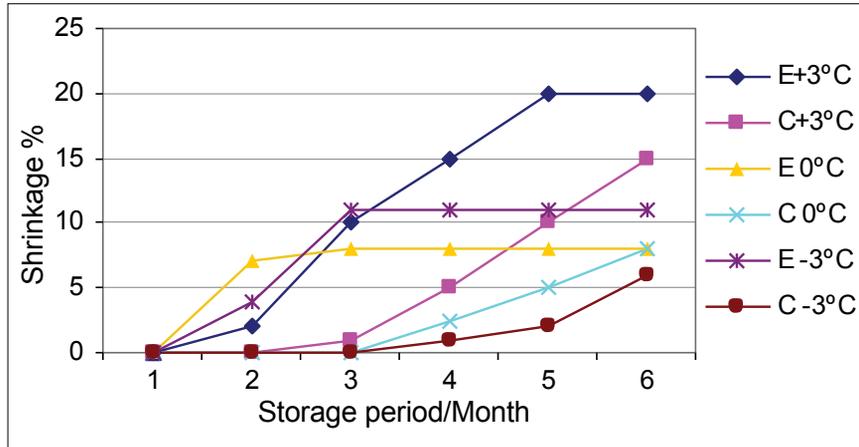
The water contents of treated and untreated fruits decreased through the storage period, but the rate of decrement was related to the storage factors; temperature and ethrel at 1000 ppm. In this regard, the untreated fruits lost high percentage of water content at +3°C, while date fruits stored at 0°C and -3°C lost water content less than other testaments. However, the loss of water content was very high when the fruits were treated with ethrel at 1000 ppm and the temperature storage was +3°C. (Fig 6)

### Analysis of date fruit attributes at the end of storage period

The statistical analysis of the two factors; ethrel and temperature as well as their interaction was carried out at the end of storage period of each treatment as shown in table 1.

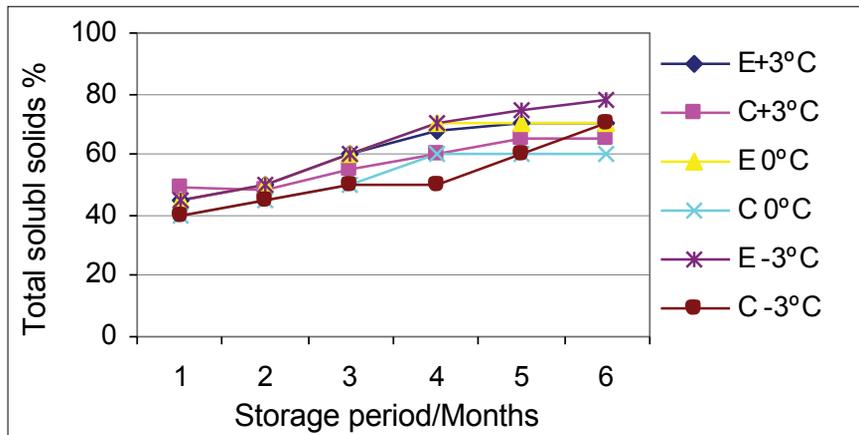
### 1-Ripening%

The study of ripening % of treated and untreated fruits with ethrel at 1000 ppm found significant differences at 5 % level with least significant differences (LSD) at the end of storage period in hastening date fruits. However, the three temperatures under study; +3°C, 0°C,



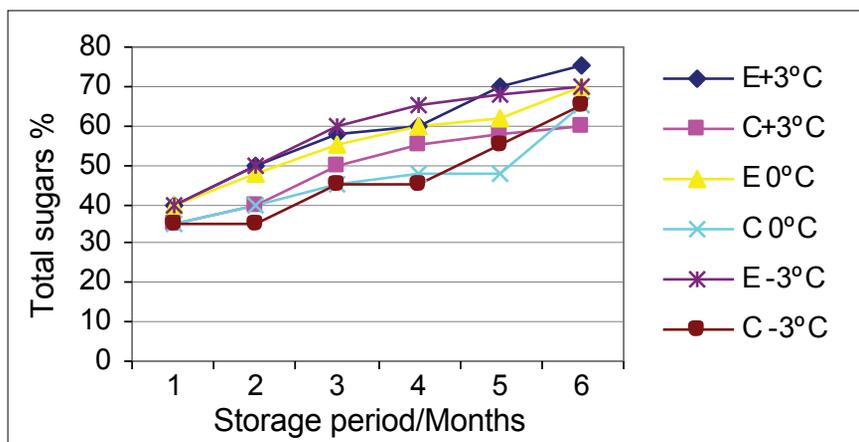
Where: E is ethrel at 1000 ppm, and C is control

Fig 3: The effect of ethrel and temperature on shrinkage % of Zahdi fruits.



Where: E is ethrel at 1000 ppm, and C is control

Fig 4: The effect of ethrel and temperature on TSS% and total sugars% of Zahdi fruits.



Where: E is ethrel at 1000 ppm, and C is control

Fig 5: The effect of ethrel and temperature on the total sugars% of Zahdi fruits.

and -3°C and their interactions with ethrel treatment gave insignificant differences.

## 2-Attachment force%

Even though Zahdi CV. is known to have a high attachment force, ethrel treatment increased the abscission of fruits significantly at 5% level (L.S.D). Moreover, the statistical analysis at the same level indicated that storage of date fruits at +3°C also increased the abscission of date fruits significantly. At the same time the temperatures -3°C and 0°C retain the attachment force of date fruit. The interaction at -3°C and 0°C with ethrel subsequently maintain the fruits attachment to their strands significantly. (Fig8)

## 3-Shrinkage%:

The statistical analysis at 5% level of L.S.D showed that the two factors; ethrel and temperature at +3°C increased significantly the percentage of shrinkage. On the other hand, the other two temperatures; -3°C, and 0°C and their interactions with ethrel treatment at 1000ppm decreased shrinkage percentage significantly at the same level of statistical analysis (Fig 9).

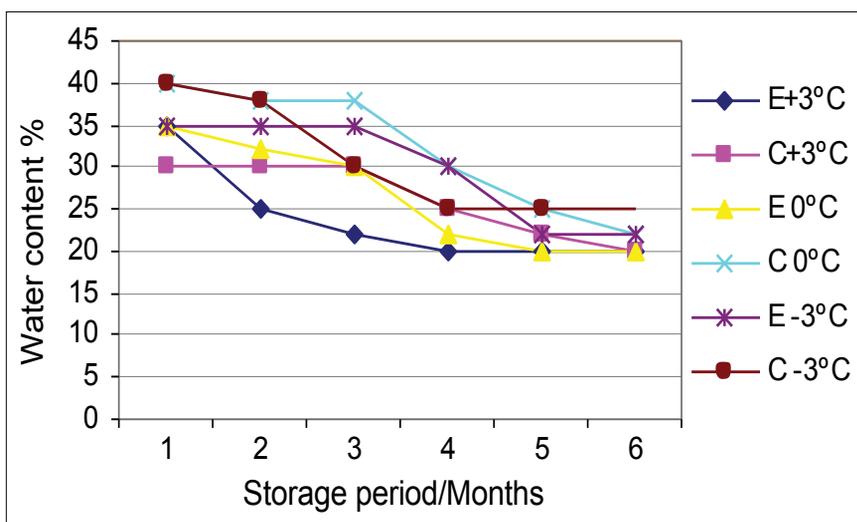
## 4- TSS%, total sugars%, and water content%

The studied attributes; total soluble solids %, total sugars %, and water content % of treated and untreated fruits with ethrel at 1000 ppm and +3°C of storage gave insignificant different at 5% level with least significant differences (LSD) at the end of storage period. Also, the statistical analysis showed no significant differences for the three studying temperatures; +3°C, 0°C, and -3°C and their interactions with ethrel treatment at 1000 ppm. (Table 2)

## 5- Sensory

Table 1: Treatments, storage period, and Analysis time

Treatments	Storage period	Analysis time
Ethrel+3°C	October to January	January
Ethrel 0°C	October to February	February
Ethrel-3°C	October to February	February
Control+3°C	December to February	February
Control 0°C	December to March	March
Control-3°C	December to March	March



Where: E is ethrel at 1000 ppm, and C is control

Fig 6: The effect of ethrel and temperature on water content % of Zahdi fruits.

## characteristics

Other characteristics such as appearance, color, taste, odor, and deterioration are considered as quality attributes for consumer attraction. Treatment with ethrel at 3°C maintained the desired fruit quality for first three months of storage. However, such treated fruit stored at 0°C or -3°C retained their bright yellow color, normal taste, and odor until the fifth month of storage. Deterioration of ethrel treated fruits

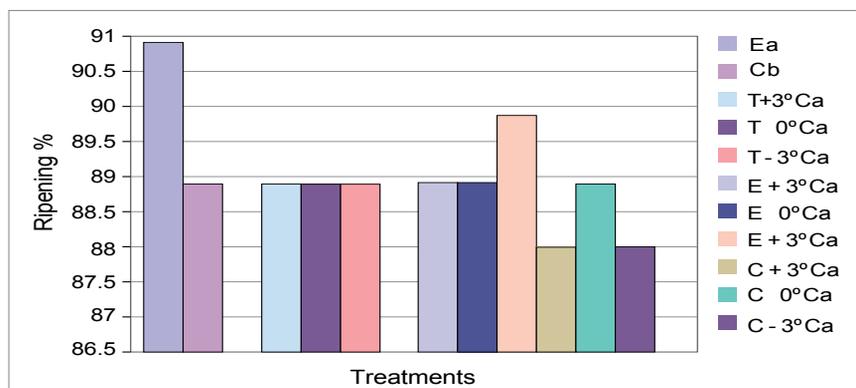
varied from high at -3°C to medium at 0°C during the last month. On the other hand, untreated fruits kept their quality at 3°C until the end of storage period. Generally Rutab stored at 0°C, and -3°C had a higher degree of edibility and palatability until the fifth month (Table 3)

## Discussion and Conclusion

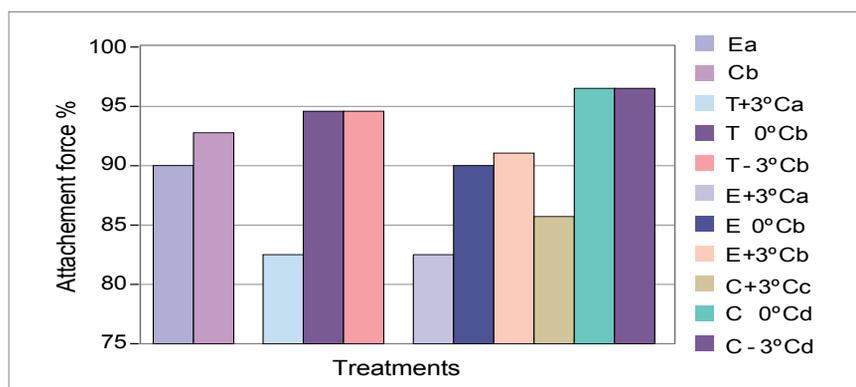
Ethrel application enhanced the rate of ripening at the early period of

storage. This might be in part due to release of ethylene from the treated fruits. This is in agreement with those of (Ibrahim, and Mawlou1989), where they found that dipped fruit in ethrel has a tendency to ripe more rapidly. Moreover, treated fruits with ethrel had higher TSS and total sugars. This may be due to the accelerating effect of ethrel on the rate of ripening. These results agree with those of (Mawlou., 2002, Ibrahim and Mawlou, 1989 and El-Hammady et.al., 1982), who reported that date fruit treated with ethephone contained higher amount of TSS and total sugars. However, since ripening is a result of enzymatic action (Maier. and Metzler, 1962), its rate should be lower at temperature (0° and 3°C) than at +3°C. Generally, low temperature delayed ripening; this delay might be due to the enzymatic action which is known to be retarded at low temperature (Maier. and Metzler, 1961).

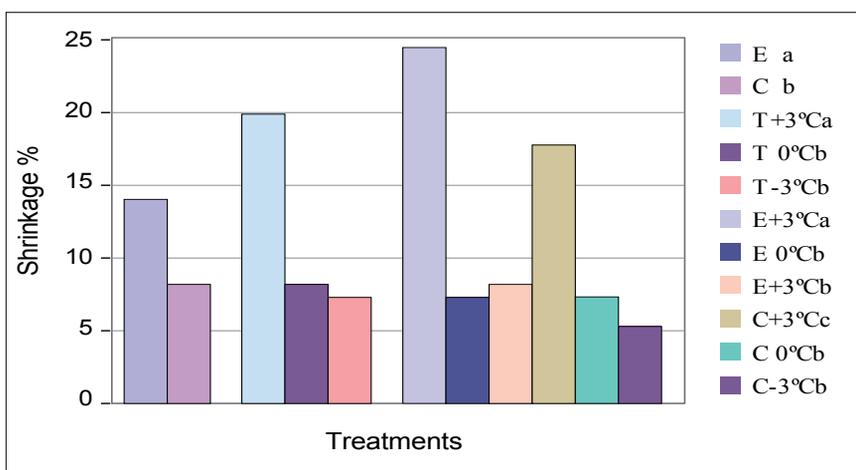
Ethrel treatment increased the percentage of abscised fruits. Once again ethylene gas might cause an increase in the endogenous ABA which is responsible of fruit abscission. However, the abscission phenomenon was not noticeable at low temperature. The onset of shrinkage occurred after two months in fruits stored at +3°C as compared with 0°C or -3°C. This might be the result of the excessive moisture loss. Since low temperature induced ability of the fruit to maintain higher water content, therefore, storing date fruits at Rutab stage would increase their weight which will have possible economic effect. Generally it could be concluded that applying ethrel at khalal stage can regulate the uniformity of ripening and retain the quality of Rutab at temperatures between 0°C and -3°C. Storing Rutab at 0°C is more feasible than at -3°C and from the cost point of view, storage at 0° C can be recommended for Zahdi



Where: C is control. Values with same letter not significant differences  
 Fig 7: The effect of ethrel at 1000 ppm (E), temperature (T), and their interaction on the ripening% of Zahdi fruits.



Where: C is control. Values with same letter not significant differences  
 Fig 8: The effect of ethrel at 1000 ppm (E), temperature (T), and their interaction on the attachment force% of Zahdi fruits.



Where: C is control. Values with same letter not significant differences  
 Fig 9: The effect of ethrel at 1000 ppm (E), temperature (T), and their interaction on the shrinkage% of Zahdi fruits.

Rutab. Which summarizes the possible schedules for the utilization of the Zahdi fruits (Rutab stage) stored at different temperatures and ethrel treatment. The histogram shows the period through which the stored fruit maintain their desired quality. Thus it will allow the selection of treatments that are economical and desirable. For example, the following treatment could be selected: ethrel at +3°C, ethrel at 0°C, untreated fruits at +3°C, and at 0°C. From preceding results, we can suggest that future research should emphasize on economic feasibility of the different methods which have been developed to regulate Rutab storage project.

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Where: C is C control. Values with same letter not significant differences

Table 2: The effect of ethrel at 1000 ppm (E), and temperatures (T) on TSS%, total sugars%, and water content %

Treatments	TSS %	Total sugars %	Water content %
E	76a	74a	22a
C	75a	73a	23a
T+3°C	74a	72a	23a
T 0°C	75a	73a	22a
T-3°C	74a	73a	22a
E+3°C	74a	72a	23a
E 0°C	75a	73a	22a
E+3°C	74a	73a	22a
C+3°C	73a	72a	22a
C 0°C	73a	72a	22a
C-3°C	74a	73a	22a

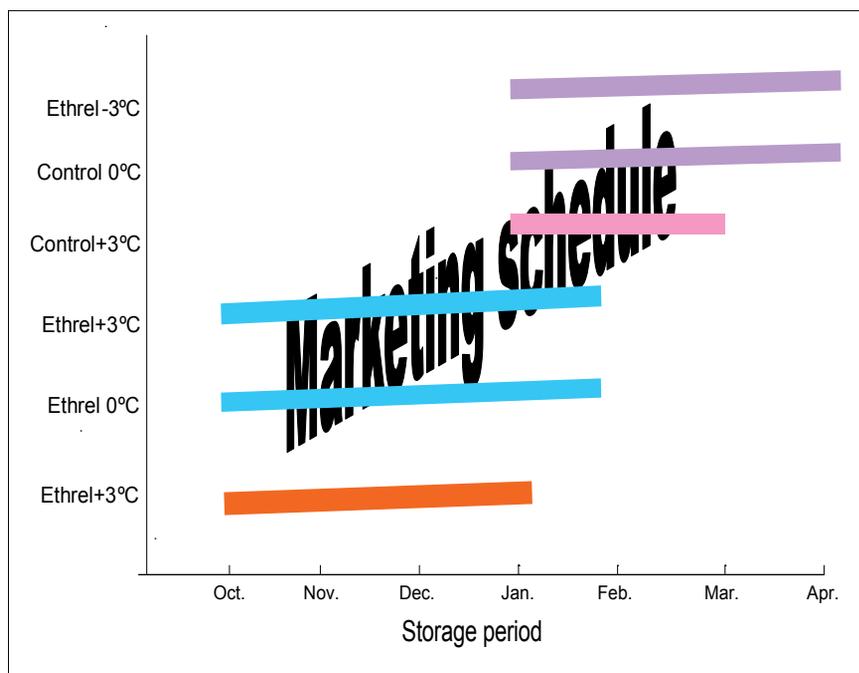


Fig 10 : The Effect of Different Storage Period and Ethrel at 1000ppmm on Rutab Schedule

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Table 3: Effect of Ethrel at 1000 ppm and temperature on some date fruit characteristics during storage period

Storage period (month)	Temperature °C	Appearance	color	Taste	Odor	Deterioration
1 <sup>st</sup>	Eth +3°C	Excellent	Normal	Normal	Normal	Non
	Control +3°C	Excellent	Normal	Normal	Normal	Non
	Eth 0°C	Excellent	Normal	Normal	Normal	Non
	Control 0°C	Excellent	Normal	Normal	Normal	Non
	Eth -3°C	Excellent	Normal	Normal	Normal	Non
	Control -3°C	Excellent	Normal	Normal	Normal	Non
2 <sup>nd</sup>	Eth +3°C	Very good	Y.B	Normal	Normal	Non
	Control +3°C	Excellent	Normal	Normal	Normal	Non
	Eth 0°C	Excellent	Y.B	Normal	Normal	Non
	Control 0°C	Excellent	Normal	Normal	Normal	Non
	Eth -3°C	Excellent	Y.B	Normal	Normal	Non
	Control -3°C	Excellent	Normal	Normal	Normal	Non
3 <sup>rd</sup>	Eth +3°C	Very good	Y.B	Normal	Normal	Light
	Control +3°C	Excellent	Normal	Normal	Normal	Non
	Eth 0°C	Excellent	Y.B	Normal	Normal	Non
	Control 0°C	Excellent	Normal	Normal	Normal	Non
	Eth -3°C	Excellent	Y.B	Normal	Normal	Non
	Control -3°C	Excellent	Normal	Normal	Normal	Non
4 <sup>th</sup>	Eth +3 °C	Good	Y.B	Fermented	Abnormal	Light
	Control +3°C	Excellent	Normal	Normal	Normal	Non
	Eth 0°C	Very good	Y.B	Normal	Normal	Non
	Control 0°C	Excellent	Normal	Normal	Normal	Non
	Eth -3°C	Very good	Y.B	Normal	Normal	Non
	Control -3°C	Excellent	Normal	Normal	Normal	Non
5 <sup>th</sup>	Eth +3°C	Good	D.B	Fermented	Abnormal	Light
	Control +3°C	Very good	Y.B	Normal	Normal	Light
	Eth 0°C	Very good	Y.B	Normal	Normal	Light
	Control 0°C	Excellent	Normal	Normal	Normal	Non
	Eth -3°C	Very good	Y.B	Normal	Normal	Non
	Control -3°C	Excellent	Normal	Normal	Normal	Non
6 <sup>th</sup>	Eth +3°C	Good	D.B	Fermented	Abnormal	Sever
	Control +3°C	Very good	Y.B	Normal	Normal	Medium
	Eth 0°C	Very good	D.B	Fermented	Abnormal	Medium
	Control 0°C	Excellent	Normal	Normal	Normal	Light
	Eth -3°C	Very good	D.B	Fermented	Abnormal	Light
	Control -3°C	Excellent	Normal	Normal	Normal	Light

Where; Y.B Yellow brown and D.B Dull brown