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Effects of Ethephon treatments on Ripening and Uniformity of Fig Fruit (Ficus carica. L)

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ABSTRACT

The current experiment was carried out to determine the effect of the application of ethephon on the maturation of "Peter" figs. Fig fruits were treated with three aqueous concentrations of ethephon (500, 1000, and 1500 ppm) during the developmental stage. The physic-chemical characteristics, such as fruit weight, fruit length, fruit diameter, total soluble solids (TSS), and fruit acidity were recorded and analysed. The results showed that ethephon application during the developmental period of the fig fruits significantly accelerated fruit ripening and enhanced the fruits' uniformity. Fig fruits treated with ethephon showed increased TSS compared to untreated fruits, and the acidity of the treated fruit decreased compared to that of untreated fruits. Additionally, TSS/ acidity ratio was significantly higher in 1500 ppm treatment in comparison with other treatments. On the basis of our data, we conclude that the application of ethephon to fig fruit increases ripening and uniformity of the fruit.

تأثير المعاملة بالاثيفون علي نضج وتجانس ثمار التين (Ficus carica. L)

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الكلمات المفتاحية:
ثمار التين
الاثيفون
المواد الصلبة
حموضة الثمار

الملخص

الدراسة الحالية تم تنفيذها لمعرفة تأثير أستخدام الاثيفون علي أنضاج ثمار التين نوع بيتر. تم معاملة الثمار بثلاث تركيزات من الاثيفون خلال طور النمو. الخواص الفيزوكيمائية للثمار مثل وزن الثمرة و طول الثمرة و قطر الثمرة و مجموع المواد الذائبة و حموضة الثمرة تم تسجيلها و تحليلها. النتائج أظهرت ان معاملة بالاثيفون خلال مرحلة النمو كانت معنوية علي سرعة الأنضاج و التماثل. أيضا أظهرت النتائج أن مجموع المواد الصلبة الذائبة (TSS) في الثمار المعاملة بالاثيفون كانت أعلي من الشاهد وأيضا كانت حموضة الثمار أقل من الشاهد بغض النظر عن مستوى التركيز المستخدم. بالاضافة الى ذلك، نسبة الحموضة في المواد الصلبة كانت أحصائيا أعلي في المعاملة 1500 ppm مقارنة بباقي المعاملات. البيانات المتحصل عليها خلصت الى أن رش ثمار التين بالاثيفون أسرعت من النضج والتجانس.

1. Introduction

Figs (*Ficus carica* L.) are an important fruit crop grown in Libya, especially in the eastern part; their popularity is due to figs' tolerance to salinity, drought, and lack of sufficient water for irrigation [1]. Libya was ranked fifth among other Arabian fig-producing countries; where its fig production is estimated at around 35 metric tons per year [2]. The fig tree belongs to the botanical family *Ficus Moraceae*, it produces two distinct crops: the main crop and a secondary, or Berba crop, with the latter mostly discarded, and the former preserved for human consumption.

Fig fruits are nutritious and are consumed fresh or dried, depending on the consumer's choice. Fresh fruits contain roughly

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23% water, 4.3% proteins, and 69.1% carbohydrates, in addition to vitamins such as A, B, B3, and C, and minerals such as Ca, P, Fe, Na, and K [4]. Due to their high nutritious value, figs are often used to relieve constipation. Boiled fig leaves are also utilized to cure external wounds and skin diseases.

Ethephon, or 2-chloroethyl phosphonic acid, is a well-known commercial ethylene-releasing product that stimulates fruit ripening and uniformity in climacteric fruits. Ethephon, *in vivo,* decomposes to ethylene and phosphate groups. Ethylene is an indispensable systematic plant growth regulator (PGR) hormone that regulates and governs pivotal physiological plant processes such as fruit ripening, leaf abscission, plant growth, development, and plant senescence [5, 6]. The first report on ethylene impacts on fruit ripening dates to 1960 [7], when Looney et al. [8] found that peach fruits treated with ethephon resulted in increasing endogenous ethylene levels that accelerated fruit ripening. Similarly, ethylene levels in paw fruits increased significantly during the ripening stage, with an incremental rise in fruit respiration [9]. Since then, this phytohormone has received great attention from both plant physiologists and the food industry. It is well known that fig fruit ripening is irregular, and as result, fruit harvesting is quite cumbersome in terms of time and increased labor cost. Thus, this current study aims to evaluate the effect of the application of ethephon in accelerating fig fruit ripening and uniformity as well as reductions in harvesting costs.

2. Materials and methods

2.1 Experiment site description

The experiment was conducted at the Benghazi University farm (31°45 N 20°14 E). The experiment began in 2006 during the development stage of fig trees planted in salty clay and lasted for one month. Eleven-year-old Peter's Honey cultivars were subjected to investigation to determine the effect of ethephon application on fruit ripening and uniformity. The fig trees were fertigated (fertilized and irrigated) three times a week with a general 19-19-19 NPK fertilizer.

2.2. Experimental setup and measurements

A completely randomized block design with three replications was used for each treatment, and each replication consisted of ten fruits.

Four treatments were used in the experiment, including three levels of ethephon (500, 1000, and 1500 ppm) and an untreated as control. The ethephon was sprayed on the fig trees until trees runoff. Two weeks post- treatment, the following fruit parameters were measured and recorded, including:

1. Fruit weight (gm)
2. Fruit length (cm)
3. Fruit diameter (cm)
4. Total soluble solids (TSS), determined after extracting fruit juice by mortar (without adding water). A drop of the extract was obtained after filtration and was put on a cell surface of the refractometer to determine the fruits' TSS.
5. Fruit acidity was determined by titration via sodium hydroxide (NaOH), and calculated using the formula below:

$$Acidity\ (\%) = \frac{(0.007) \times (NaOH\ valume \times titration)}{\text{sample weight (cm)}} \times 100$$

2.3 Statistical analysis

The data were analyzed using SAS software (SAS institute, Cary, NC) where the GLM procedure was applied using a two-way ANOVA, and the means were compared using Duncan's test ($P<0.05$).

3. Results and discussion

As shown in Table 1, there were no significant differences among the treatments with regard to the effect of ethephon application on the fig properties. Contrary to this finding, Çelikel et al. [10] had reported that treating fig fruits with ethephon greatly enhanced fruit diameters and caused much faster ripening than was the case with non-treated fruits. It can be postulated that preharvest application of ethephon did not have noticeable effects on the figs' physical development due to the time of application (i.e., being applied too late) [11].

Table 1. Effect of ethephon treatments on fruit properties

Ethephon concentration	Mean of fruit weight (g)	Mean of fruit diameter (cm)	Mean of fruit length (cm)
0	73.4 a	5.75 a	4.86 a
500 (ppm)	70.81 a	5.46 a	4.58 a
1000 (ppm)	77.62 a	5.96 a	4.85 a
1500 (ppm)	80.25 a	5.8 a	4.73 a

Means followed by the same letters in each column are not significantly different.

In contrast to the data presented in the table 1, significant differences were found among treatments in table 2 in response to ethephon application on fruit chemical properties. Fruits treated with 1500 ppm had a significantly higher amount of TSS in comparison with other treatments. Fruit acidity was significantly higher in control fruits compared to the other treatments. In addition to that, all treated fruits with ethephon application, irrespective of their concentration, were decreased in fruit acidity. TSS/ acidity ratio was significantly higher when ethephon concentration was 1500 ppm compared to other treatments.

Table 1. Effect of ethephon treatments on fruit chemical properties

Ethephon concentration	TSS (%)	Acidity (%)	TSS/ acidity ratio
0	10 c	0.16 a	62.53 c
500 (ppm)	10.3 c	0.11 c	94.06 b
1000 (ppm)	12 b	5.96 a	85.66 b
1500 (ppm)	16 a	5.8 a	145.95 a

Means followed by the same letters in each column are not significantly different.

The results indicated that the 1500 ppm treatment significantly increased the TSS/acidity ratio compared to the other ethephon treatments. Therefore, we find that this treatment may achieve fruit ripening much faster. Our results were in agreement with Ohara et al. [12], who found that after two weeks, the application of 500 ppm ethephon, kiwi fruit flavor and amount of TSS were increased and fruit acidity was decreased. Likewise, mango fruits treated with ethephon solution ranging from 250-2000 ppm experienced an increase in both TSS and the ratio of TSS/fruit acidity, while fruit acidity declined [13]. McGarry et al. [14] reported that exogenous ethephon application on Saskatoon (*Amelanchier alnifolia* Nutt.) fruits accelerated fruit ripening without affecting fruit quality. However, no ethephon effect was observed on the fruit yield. Fig fruit leaves that were exposed to ethephon treatments resulted in substantial decreases in the levels of plant pigments such as chlorophyll-a, b, b-carotene, lutein, violaxanthin, and neoxanthin [15]. Green tomatoes (*Solanum Lycopersicum* L.) fruits (*cv.* Hybrid-1001), treated with ethephon, ripened much faster than untreated ones

[16]. However, in the same study, fruit marketability significantly decreased in treated fruits because fruit rotting increased.

4. Conclusion

Our study clearly illustrated that ethephon application to fig fruits during the developmental period stimulates much faster fruit ripening and more uniform fruits. No ethephon effect was observed on other fruit parameters, including fruit diameter and fruit weight. Further research should be directed to answering such questions as whether or not ethephon treatments can prolong post-harvest fruits' shelf life in storage.

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