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The Use of Ethrel in the Colouring of 'Ajami' Apple Fruits

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ABSTRACT

Eight, six year-old, 'Ajami' apple (*Pyrus malus* L.) trees were treated with ethrel at 0, 250, 500 and 1000 ppm, two weeks before harvest. Ethrel significantly promoted the abscission of fruits and the development of red colour. However, ethrel at a concentration of 250 and 500 ppm induced higher percentage of coloured fruits than the higher concentration. The percentage dry weight and firmness of fruits were not affected by ethrel treatments.

INTRODUCTION

Due to unsufficient amount of chilling temperature, the commercially known apple cultivars are not successfully grown in Tripoli (Jamahiriya). However, a low chilling requiring cultivar 'Ajami' imported from Iraq, has been growing and producing successfully. The fruits attain a good marketable size, but they stay green in colour even when they mature.

Along with the promotion of abscission for mechanical harvesting of apple fruits, attention has been recently directed to the use of preharvest chemicals that induce ethylene production to enhance ripening of fruits without retarding abscission. The 2-chloroethyl-phosphonic acid, known as ethrel (2) has been intensively used for this purpose.

Ethrel was first tested by Luckwill (9) in 1967, on trees of a cider apple variety, Brown Snout. The application of ethrel at a concentration of 500, 2000 and 5000 ppm induced, within 6–9 days, 90–97% fruit drop. Some defoliation resulted from the highest rate, but it did not increase fruit ripening. Unsprayed trees shaken to the same extent dropped their crop gradually over a period of 36 days (9,10). Edgerton (3,4) reported that foliar application of ethrel at the rate of 200 to 2000 ppm, one to two weeks prior to harvest, promoted and accelerated fruit abscission on apple varieties such as Rome Beauty, Twenty Ounce, Ben Davis, Melba, Gravenstein, Milton, and Early McIntosh. In addition to fruits loosening, ethrel hastens maturity, colour development, and accumulation of soluble solids. The effect of ethrel on ripening, colour development, and quality of apple fruits were also reported by other workers (6,7,11). Pollard (11), and Green *et al.* (6,7) found that preharvest treatment of 'McIntosh' apples with ethrel, had significantly increased the development of red colour in fruits but the fruits were

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less firm and their respiratory climateric was advanced 6 to 10 days. The application of 2, 2-dimethyl hydrazide (SADH), prior to ethrel, was found necessary to maintain firmness of fruits (11). Ethrel was not found injurious to the apical meristems of shoots of apples even at a concentration that retarded growth and elongation of shoots (5). The response of plants to ethrel varies according to the rate of ethrel decomposition and release of ethylene. This depends on the pH of plant sap. The release of ethylene at a pH lower than 3 was found to be very slow, while at pH ranges from 4.9 to 7, the decomposition of ethrel to ethylene occurred rapidly (5).

The abscission promoting effect of ethrel was prevented, when NAA (10 ppm) and alar (2000 ppm) were added to it. However, they did not prevent ethrel's stimulatory effect on fruit ripening (4,10).

This experiment was initiated to investigate the possibility of using ethrel to stimulate the development of the desired colour of apple, variety 'Ajami'.

MATERIALS AND METHODS

Eight, six year-old apple (*Pyrus malus* L.) trees of the cultivar 'Ajami' were sprayed with 0, 250, 500, and 1000 ppm ethrel in a completely randomized design. Trees were sprayed with ethrel on June 8, 1976 (approximately two weeks before harvest). Hand thinning was intended at the time of treatment, to remove inferior, and cull fruits. Trees were closely observed, for any side effects of the chemical, and data were collected one and two weeks after treatment as following:

Fruit drop

The fruit drop, expressed in percentage, was determined on weight basis. Dropped fruits, were collected one and two weeks after spraying. All fruits were harvested two weeks after spraying. The coloured and non-coloured fruits were sorted and weighed.

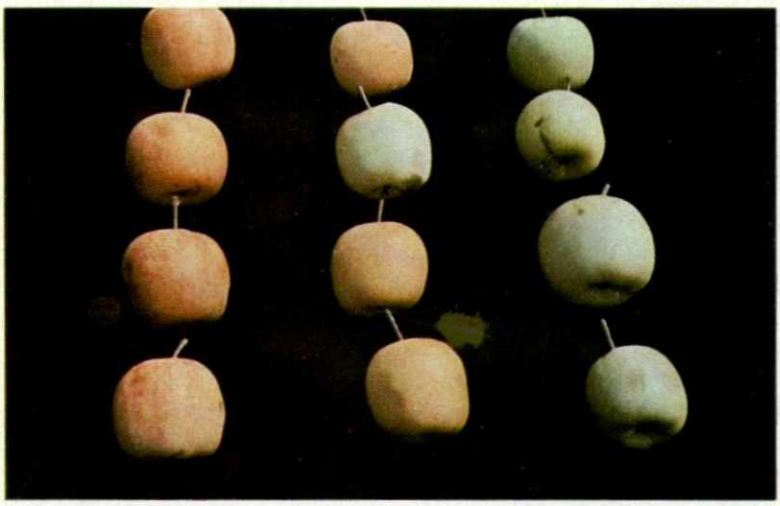

Fig. 1. The coloured vs. non-coloured 'Ajami' apple fruits. Slightly coloured fruits (middle row) were considered non-coloured.

Fruit colour

The colour of fruits was visually evaluated (Fig. 1). The percentage of coloured fruits was determined by weight, after one week for the dropped fruits, and then after two weeks for the whole crop (including fruits dropped in the second week).

Firmness of fruits

At each of the two sampling dates, ten coloured and ten non-coloured fruits, picked at random, were used for this test. Using Ballau's, magnus Taylor pressure tester, with plunger 0.79 cm, the firmness at both sides of each fruit was determined in Kg/cm^2. The average of both sides of each fruit was used in the statistical analysis.

Dry weight

Three random apple fruits from each treatment, and from the coloured and non-coloured fruits were cut into thin slices, leaving the seeds and core of fruits. The percentage of dry weight was evaluated according to the AOAC (1).

RESULTS AND DISCUSSION

Fruit drop

The quickest and first apparent influence of ethrel on 'Ajami' apples was the promotion of fruit abscission. In all treatments, fruits began to drop after three days of application, and continued till the fruits were harvested after two weeks. The percentages of total fruit drop were 74.05, 82.06, and 82.98% for the treatments 250, 500, and 1000 ppm ethrel, respectively, while the control dropped only 18.13% of its crop. No significant differences were found among treated trees. However, treated trees had higher fruit drop than the control (Table 1). The fruit drop, two weeks after ethrel application was significantly higher than after one week (Table 2). So, ethrel at all concentrations promoted the abscission of fruits, but it should be applied at least two weeks prior to harvest, if the fruits were to be mechanically harvested.

Table 1 Effect of ethrel on the percentages of fruit drop, colouring, and dry weight; and on the firmness of 'Ajami' apple fruits.

Ethrel conc. (ppm)	Fruit drop %	Colouring in total crop %	Colouring in dropped fruits %	Dry weight %	Firmness (kg/cm^2)
0	18.13 a	2.00 a	10.58 a	12.39	13.43
250	74.05 b	43.05 c	61.69 c	12.36	11.68
500	82.06 b	46.58 c	54.69 bc	12.51	12.67
1000	82.98 b	29.05 b	33.56 ab	12.41	12.06
LSD (0.01)	25.95	9.26	23.43	N.S.	N.S.

Means in a column, followed by the same letter, are not significantly different.

Table 2 The percentages of dropping, colouring and dry weight; and the firmness of 'Ajami' apple fruits, one and two weeks after treatment with ethrel.

Date	Dropping %	Colouring %	Dry weight %	Firmness kg/cm²
One week	25.65 a	43.53	12.20 a	10.12 a
Two weeks	38.65 b	36.63	12.66 b	15.14 b
LSD (0.01)	8.84	N.S.	0.393	1.59

Means in a column, followed by the same letter, are not significantly different.

Fruit colouring

The colour development in 'Ajami' apple fruits was significantly promoted by the use of ethrel, at all concentrations. However, ethrel at a concentration of 250 ppm and 500 ppm induced higher percentages of fruit colouring (Table 1). The percentages of coloured fruits, were found higher in dropped fruits than in total crop, in all treated and untreated plants (Table 1). Apparently the development of colour enhances the formation of abscission promoting substances in fruits.

Comparison of the percentage colouring in fruits, one and two weeks after treatment showed no significant differences between the two dates (Table 2). So, ethrel could be effectively used to improve the colouring of 'Ajami' apple fruits, if applied one or two weeks before harvest, at a concentration of 250 ppm.

Dry weight

Ethrel treatments had no effect on the percentage of dry weight of 'Ajami' apple fruits (Table 1). However, the percentage dry weight two weeks after treatment was significantly higher than after one week (Table 2). This is natural, since the total solids are increased as fruits advance towards maturity (8). No significant differences were found in the percentage dry weight of coloured and non-coloured fruits (Table 3).

Firmness of fruits

Ethrel did not have any effect on the firmness of 'Ajami' apple fruits (Table 1). However, the firmness of fruits over the two dates of sampling and the firmness of coloured and non-coloured fruits were significantly different (Table 2 and 3). The firmness of fruits after one and two weeks of ethrel application was 10.12 and 15.14

Table 3 The effect of fruit colouring on the percentage dry weight and the firmness of 'Ajami' apple fruits treated with ethrel.

Fruit colouring	Dry weight %	Firmness (kg/cm²)
Coloured	12.43	9.25 a
Non-coloured	12.41	14.34 b
LSD (0.01)	N.S.	1.26

Means in a column, followed by the same letter, are not significantly different.

kg/cm², respectively. The greater fruit firmness after two weeks could be due to the fact, that fruits of the first week were dropped fruits; so they were more mature than the fruits remaining on the tree. The coloured fruits, were found significantly softer than the non-coloured fruits (Table 3). This could be due to an increased rate of respiration in the coloured fruits (6,7). No side effects for the chemical were observed during the season of treatment or the following season.

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مستخلـــص

استعمال مادة الأثريل فى تلوين ثمار التفاح صنف « عجمـــى »

د٠ حسين أحمـــد ومحمد شلـــدان

تمت معاملة ثمانية أشجار من التفاح ، صنف عجمى ، ذات عمر ٦ سنـــوات قبل جمع المحصول بأسبوعين ، بمادة الأثريل بتركيزات قدرها صفر ، ٢٥٠ ، ٥٠٠ ، ١٠٠٠ جزء فى المليون ٠ وقد تسببت مادة الاثريل فى تساقط الثمار وزيادة النسبـــة المئوية للثمار الملونة ، الا أن المعاملتين ٢٥٠ ، ٥٠٠ جزء فى المليون قد اعطيتا نسبـــة أعلى من الثمار الملونة عن المعاملة الأخرى ٠ ولم تتأثر النسبة المئوية للوزن الجـــاف أو صلابة الثمار بالمعاملات المختلفة بمادة الاثريل ٠