EFFECT OF SITOFEX (CPPU) ON FRUIT SET, FRUIT QUALITY OF ANNA APLLE TREES

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ABSTRACT

Efficiency of the synthetic cytokinin (CPPU) (N- (2-chloro-4-pytidyle-N-phenylurea) was studied on Anna apple trees at full bloom, 14 days after full bloom and two time spraying (at full bloom and 14 days after full bloom). CPPU tended significantly to increase the percentage of fruit set, yield and fruiting, while it decreased fruit drop of all treatments. The best results were obtained by 20 ppm CPPU at full bloom and 10 ppm CPPU two time spraying in the first season. While, the 15 pm CPPU at full bloom was the best during the second season.

Highest fruit weight, fruit size and fruit dimensions were obtained by 15 ppm concentrations at 14 days after full bloom in the two seasons. Concerning fruit shape index (L/D), an increase in fruit diameter than its length due to all conducted CPPU treatments in both seasons. As well as, acidity and TSS/acid ratio were significantly improved as a result of all studied treatments when compared to the control.

It could be concluded that, most of studied treatments resulted in a positive and significant effect on most studied characteristics, since (CPPU at 15 ppm at full bloom and 20 ppm at 14 days after full bloom were the most effective treatments for increasing fruit set and yield as well as improving the most fruit properties.

Key words: Cytokinin (CPPU), Anna apple trees, Fruit set and Fruit drop

INTRODUCTION

Apple is considered one of the major and the most important deciduous fruit trees in Egypt. Many investigators reported that, yield and quality of Anna apple fruits depended upon several factors, one of the most vital factor which affects and plays an important role in this concern is spraying with some growth regulators which enhance fruit set, reduce fruit drop, consequently increase productivity. Moreover, both concentration and date of application are very important factors which in true reflect in increasing and improving fruit yield and fruit characteristics.

Several investigations mentioned that, spraying deciduous fruit trees with Sitofex (CPPU) different concentrations enhanced cell division, increased cell size, increased fruit weight, size and fruit yield. Furthermore, application of the abovementioned growth regulators improved the most fruit properties. **Nickell (1986), Rizk (1998), Feng *et al.*, (1999), Al-Ashkar (2000) Ranpise *et al.*, (2000) and Marwad (2001)** on grapes; **El-Barkooky (1985)**, **Greene (1989) and Khurshid *et al.*, (1997)**, on apple; **Biasl *et al.*, (1991) and Lowes and Woolley (1992)** on kiwi; **Jindal and Sharma (1986)** on plum; **Kabeel (1999)** on persimmon; **Kabeel and Fawaaz (2005)** on pear.

Due to the little information currently available about the effect of CPPU on apple fruit, this study was carried out to explore the effect of concentration and application time of CPPU on apple, fruit set, drop and quality.

MATERIAL AND METHODS

The current investigation was under taken in the experimental farm at El-Kanater, Horticultural Research Station, Kalyubia, Governorate, Egypt. This study has been extended for the two consecutive seasons of 2007 and 2008 on 10- year-old-apple trees. Anna apple trees were budded on Malling Maritton 106 rootstock, planted at 2.5 meters apart and grown in clay loamy soils. Selected trees were healthy, nearly uniform as possible in their vigour and subjected to the similar fertilization, irrigation, pruning and pest control programs usually done at this region.

Different foliar sprays with Sitofex (CPPU) treatments used in this study were as follows:

1- CPPU at 5 ppm.
2- CPPU at 10 ppm
3- CPPU at 15 ppm
4- CPPU at 20 ppm
5- Control

These treatments were sprayed at: a) Full bloom stage, b) At full bloom and two weeks after full bloom and c) Two weeks after full bloom.

Forty five trees were devoted and complete randomized design was used, since each treatment was replicated by a two trees. Four main branches well distributed around the periphery of tree (one branch on each direction) were tagged and the following measurements were determined:

1- Fruiting measurements:

1-a. Percentages of fruit set and fruit drop:

Both number of flowers and set fruitlets on the tagged branches were counted and recorded for all treatments, then percentage of fruit set was calculated by the following equation according to **Westwood (1978)**

$$(\%)\ \text{Fruit set} = \frac{\text{Number of set fruitlets}}{\text{No. of opened flowers}} \times 100$$

Furthermore, number of dropped fruits were recorded till harvest time, then estimated as percentage on the basis of initial number of fruitlets according to this equation:

$$(\%)\ \text{Fruit drop} = \frac{\text{Number of dropped fruits}}{\text{Number of set fruitlets}} \times 100$$

1-b. Yield and percentage of yield increment than control:

The average of tree yield in kgs for each treatment was determined at harvest time (at maturity stage). Furthermore, the yield increment percentage for each treatment as compared to the control was estimated according to the following equation:

$$(\%)\text{Yield incr.} = \frac{\text{Yield / treatment} - \text{yield /control}}{\text{Yield / control}} \times 100$$

At picking date, number of fruits/tree were used to calculate yield monetary value = Fruit yield (kg)/tree x farm – gate price (L.E.1.5).

2- Fruit quality:

At the time of harvest (at maturity stage), ten fruits from each replicate were randomly sampled and the following fruit characteristics were determined including average fruit weight (gm.), fruit firmness (Ib/inch2) using a **Magness and Tayler** pressure tester with 7/18 inch plunger. Furthermore, fruit chemical

properties were also determined including the average fruit juice TSS percentage using handy refactometer, fruit juice acidity percentage as malic acid (mgs/100 gms fruit juice) according to **A.O.A.C. (1985)** and **Vogel (1968)**, TSS/acid ratio was calculated.

All the obtained data were statistically analyzed of variance method according to **Snedecor and Cochran (1990)** using L.S.D. values at 0.5 % level. However, means were compared according to Duncan`s multiple range test (**Duncan, 1955**).

RESULTS AND DISCUSSION

1. Fruiting measurements:

1-a. Percentages of fruit set and fruit drop:

Data in Table (1) displayed clearly that, all treatment sprays resulted in a significant increase in fruit set % as compared to the control. Moreover, trees sprayed with 20 ppm concentration of CPPU were statistically the superior as exhibited significantly the highest value fruit set (18.59 %). Meanwhile, the opposite trend was observed with the control which was statistically the inferior as exhibited the least value of fruit set (11.58 %). On the other hand, the best time to treat spraying was at full bloom and after two weeks (15.72 % and 20.71) this result was detected during both 2007 and 2008 seasons. In additions, the best interaction in this respect was obtained by 20 ppm concentration of CPPU with the two time applications during 2007 and 2008 seasons, respectively (22.5 and 26.87 %).

With regard to the percentage of fruit drop, data in the same Table showed obvious trend where all treatment concentrations under study decreased significantly percentage of fruit drop as compared to the control in the two experimental seasons. Data pointed out that, the highest percentage of fruit drop was always concomitant to the control (85.5 and 80.83 %) whereas either CPPU at 5 ppm in the first season (65.22 %) and CPPU at 10 ppm in the second season (68.53 %) were the most effective treatments regarding reducing fruit drop. Since they resulted in statistically the lowest values in this concern.

On the other hand, the application time after two weeks of full bloom had the least value of fruit drop (70.19 and 68.15 %) during the two seasons. Whereas either CPPU at 20 ppm or at 10 ppm application after two weeks of full bloom or the two application (at full bloom and after two weeks) were the most effective treatments regarding reducing of fruit drop. The obtained results are in conformity with those previously reported by **Nickell (1986) and Feng *et al*., (1999)** on grapes, **El-Barkouky (1985) and Khurshid *et al*., (1997)** on apple; **Kabeel (1999)** on persimmon, **Guirguis *et al*., (2003) and Kabeel and Fawaaz (2005)** on pear trees.

Table (1): Effect of Sitofex spray at different concentrations (A) and at different dates (B) on percentage of fruit set and fruit drop.

2007 season								
Date	**Fruit set (%)**				**Fruit drop (%)**			
Treat	A*	B	C	**Ave.(A)**	A	B	C	**Ave. (A)**
5 ppm	13.33d-f	13.37ef	11.83ef	**12.84D**	54.50f	67.83de	73.33cd	**65.22CD**
10 ppm	16.67c	15.07c-e	13.00d-f	**14.91C**	74.23cd	76.27bc	66.70e	**72.48B**
15 ppm	12.87d-f	16.93bc	20.00b	**16.60B**	78.23bc	79.23bc	68.90de	**75.46B**
20 ppm	17.20bc	22.50a	16.07cd	**18.59A**	81.63ab	73.67cd	55.03f	**70.11C**
Control	12.67ef	10.73f	11.33f	**11.58E**	82.23ab	87.33a	86.97a	**85.50A**
Ave. (B)	**14.55B**	**15.72A**	**14.45B**		**74.17B**	**76.87A**	**70.19C**	
2008 season								
5 ppm	20.70b	22.43b	15.87c	**19.67A**	77.20bc	71.83cd	72.33cd	**73.79B**
10 ppm	14.57ed	21.00b	10.63e	**15.40C**	76.20c	63.80e	65.60e	**68.53C**
15 ppm	15.13ed	21.70b	20.33b	**19.05B**	77.33bc	72.67cd	67.83de	**72.61B**
20 ppm	20.50b	26.87a	15.17cd	**20.84A**	71.60cd	82.53ab	62.33e	**72.15B**
Control	12.60de	11.53e	10.53e	**11.55D**	84.83a	85.00a	72.67cd	**80.83A**
Ave. (B)	**16.70B**	**20.71A**	**14.51C**		**77.43A**	**75.17A**	**68.15B**	

L.S.D. at 5 %:

A =	**1.315**	**1.125**	**2.600**	**2.520**
B =	**1.697**	**1.453**	**3.357**	**3.258**
A x B =	**2.94**	**2.517**	**5.814**	**5.649**

* A: Spray at full bloom.
B: Spray at full bloom and two weeks after full bloom.
C: Spray at two weeks after full bloom.

1-b. Yield and yield increment % in relation to the control:

Data tabulated in Tables (2 & 3) clear that, both number of fruits/tree, yield/tree, yield/feddan and yield increment percentage were responded significantly to all used concentrations as compared to the control during the two studied seasons. Furthermore, the greatest statistically values of yield parameters were resulted from Anna apple trees being sprayed with CPPU at 20 ppm (450 fruits/tree, 59.27 kg fruits/tree, 15.53 ton fruits/feddan and 2.7% increment) followed by 15 ppm, 10 ppm and 5 ppm treatments as compared to the control, which reflected significantly the lowest value of yield parameters (170.6 fruits/tree, 16.01 kg/fruits/tree, 4.29 ton fruits/feddan and 0.0% increment). On the other hand, the best results in this respect were obtained by two application time (at full bloom and after two weeks) during the two seasons. While, the lowest value were obtained by sprayed with CPPU after two weeks from full bloom. Moreover, the interaction 20 ppm CPPU sprayed at full bloom and after two weeks was better than the other treatments.

These results are completely agreed with those being mentioned by many investigators **Greene (1989)** on apple, **Kabeel (1999) Kabeel and Fawaaz (2005)** on pear, **Feng *et al*., (1999), Al-Ashkar (2000), Marwad (2001)** on grapes.

Table 2

It is also noticeable that, yield monetary value (**Table 2**) was parallel to the increase of CPPU concentration from 0.0 ppm (LE 24.0), to 5 ppm (LE 32.0) to 10 ppm (LE 35.6) to 15 ppm (LE 37.1) and to 20 ppm (LE 88.9). this trend was clear throughout the two studied seasons and statistically confirmed. We can also say that CPPU sprays have better return when sprayed at full bloom and next after two weeks (LE 49.9 and 55.5) than the other treatments. However, the best interaction was 20 ppm at full bloom and after two weeks (LE 95.4 and 82.4).

Table (3): Effect of Sitofex spray at different concentrations (A) and at different dates (B) on percentage of yield increment than control and fruit yield/feddan.

2007 season								
Date	**Yield increment than control**				**Yield/feddan (ton)**			
Treat	A*	B	C	**Ave. (A)**	A	B	C	**Ave. (A)**
5 ppm	0.317de	0.400de	0.307de	**0.341C**	5.083h	5.817f-h	5.670gh	**5.52D**
10 ppm	0.583d	0.613d	0.313de	**0.503C**	6.373fg	6.573f	5.690gh	**6.21C**
15 ppm	1.363c	1.487c	1.333c	**1.394B**	9.543e	10.310d	10.050de	**9.97B**
20 ppm	2.777ab	3.033a	2.370b	**2.727A**	15.350b	16.650a	14.570c	**15.53A**
Control	0.000e	0.000e	0.000e	**0.00D**	4.223i	4.327i	4.323i	**4.29E**
Ave. (B)	**1.008AB**	**1.107A**	**0.865B**		**8.11B**	**8.74A**	**8.06B**	
2008 season								
5 ppm	0.237de	0.423d	0.197de	**0.286C**	5.333fg	6.830e	5.250fg	**5.81D**
10 ppm	0.483d	0.533d	0.310de	**0.442C**	6.573e	8.760d	5.770ef	**7.03C**
15 ppm	1.317c	1.907ab	1.363c	**1.529B**	9.770cd	13.700a	10.410c	**11.29B**
20 ppm	1.917ab	2.017a	1.636bc	**1.854A**	12.210b	14.340a	11.580b	**12.71A**
Control	0.000e	0.000e	0.000e	**0.00D**	4.330g	4.760fg	4.400g	**4.50E**
Ave. (B)	**0.791B**	**0.976A**	**0.700B**		**7.64B**	**9.68A**	**7.48B**	

L.S.D. at 5 %:

A =	**0.209**	**0.148**	**0.324**	**0.497**
B =	**0.270**	**0.191**	**0.419**	**0.642**
A x B =	**0.467**	**0.330**	**0.725**	**1.112**

* A: Spray at full bloom.
B: Spray at full bloom and two weeks after full bloom.
C: Spray at two weeks after full bloom.

2. Fruit characteristics:

2-1. Fruit physical characteristics:

2-1-a. Fruit weight, size and firmness:

As shown in Table (4), fruit weight was increased by CPPU applications after two weeks of full bloom (117.4 and 116.4 g) as compared with the other treatments (113.2, 113.3, 109.6 and 114.0 g.) through 2007 and 2008 seasons, respectively.

It is also noticeable that, fruit weight gradually and significantly increased with increasing CPPU concentration from 5 ppm (104.0g.) to 10 ppm (110.2g.) to 15 ppm (125.3g.) to 20 ppm (129.4g.) comparing to control (97.8g.).

It is clear from the same Table that, foliar applications of the deferent treatments of CPPU, resulted in significant increases in fruit size. The highest value was obtained by CPPU at 20 ppm (138.1 cm^3) followed by 15 (125.0 cm^3), 10 (123.3 cm^3) 5 ppm (105.2 cm^3) compared to the control (86.0 cm^3). The present data are in accordance with those mentioned by **El-Barkouky (1985); Jindal and Sharma (1986); Biasl *et al*., (1991); Lowes and Woolley (1992); Rizk (1998); Kabeel (1999) and Guirguis *et al*., (2003)** on some fruit deciduous trees.

Data of fruit flesh firmness in the two seasons as shown in the same Table obviously indicate that, it was significantly increased by increasing CPPU concentrations. The results also indicated that, all the after full bloom application gave higher values than the other treatments and showed a positive relation as the values increased by increasing CPPU concentrations. These results are in agreement with the fact that, at maturity, firmer fruits easily tolerate post harvest treatments. Moreover, previous reports of **Khurshid *et al*., (1997); Kabeel (1999) and Guirguis *et al*., (2003)** on apple, persimmon and pear trees have supported this trend.

2-1-b. Fruit dimensions:

It is clear in Table (5) that, fruit length and diameter gradually increased as CPPU concentration increased from 0.0 ppm (4.76 and 4.90 cm.) to 5 ppm (4.86 and 5.06 cm.) to 10 ppm (5.5 and 5.22 cm.) to 15 ppm (5.87 and 5.60 cm.) to 20 ppm (5.97 and 5.81 cm.).

Meanwhile, CPPU spray was more effective when sprayed at full bloom and after two weeks (5.57 and 5.46 cm.) than the other treatments. Moreover, 20 ppm CPPU spray at full bloom and after two weeks show better interaction in this respect.

The results of the two seasons indicated that, all the CPPU treated fruits resulted in an increase in length than in diameter as all obtained shape index values were less than the control and the increase in length values has positively linked with a parallel increase in CPPU concentration. Obtained results concerning the response of fruit dimensions and fruit shape index were generally supported by finding of **Nickell (1986), Biasl *et al*., (1991), Lowes and Woolley (1992) Kabeel (1999) and Guirguis *et al*., (2003)** on kiwi, grapes and pear fruits.

2-2. Fruit chemical properties:

2-2-a. Fruit juice TSS %:

Regarding the response of fruit juice TSS % of tested treatments, data in Table (6), indicates that TSS responded significantly to the most of treatments. Moreover, the richest fruits in their content of TSS % was achieved by trees sprayed with 5 ppm CPPU treatments (13.39 and 11.78%). Meanwhile, juice TSS was better when CPPU sprayed after two weeks from full bloom. Meanwhile, the lowest significant values of fruit juice TSS was the interaction 10, 15 ppm CPPU applied twice (at full bloom and after two weeks).

On the other hand, total soluble solids (T.S.S.) percentage results of the first season showed that, the most CPPU treatments increased values than the control either applied after two weeks from full bloom are applied twice (at full bloom and after two weeks).

Table 4

Table 5

Table 6

2-2-b. Fruit juice total acidity %:

Obtained results in Table (6) show clearly that, CPPU treatments decreased values than the control specially 5 ppm (0.361 and 0.351 % during the two studied seasons, respectively. Moreover, CPPU spray at full bloom resulted in lower acidity (0.386 and 0.376 % in 2007 and 2008 seasons, respectively) than the other treatments. However, 10 ppm CPPU spray at full bloom consider better interaction in this respect (0.307 and 0.297 %, respectively). Meanwhile, TSS/acidity ratio did not show clear trend.

CONCLUSION

The present results of 5, 10, 15 and 20 ppm CPPU sprays at: A) full bloom, B) full bloom and after two weeks, and C) after two weeks of full bloom showed a positive effect than control. However, 20 ppm concentration was superior where it increased percentage of fruit set, number of fruits/tree, fruit yield per tree and per feddan, yield increment than control and subsequently yield monetary value. Also 20 ppm has a benefit effect (than the other treatments) on fruit characteristics (fruit weight, size, dimensions, fruit shape index and juice TSS). Moreover, CPPU spray at full bloom and after two weeks has better effect on the former fruit and yield attributes. So, we can recommended apple (Anna cv.) growers to spray 20 ppm CPPU at full bloom and next after two weeks to increase the yield, fruit quality and yield monetary value.

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تأثير السيتوفكس CPPU على عقد ومحصول وجودة ثمار التفاح صنف آنا

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تم دراسة تأثير رش مادة السيتوفكس (CPPU) على أشجار التفاح صنف آنا فى ثلاث مواعيد: ١) عند تمام التزهير. ٢) عند تمام التزهير وبعد ١٤ يوم من تمام التزهير، ٣) بعد ١٤ يوم من تمام التزهير. وذلك خلال الموسمين ٢٠٠٧، ٢٠٠٨. وأوضحت الدراسة أن رش اشجار التفاح بمركب السيتوفكس أدى إلى زيادة نسبة العقد والإثمار وتقليل النسبة المئوية لتساقط الثمار وزيادة المحصول والعائد النقدى مقارنة بالكنترول وكانت أفضل النتائج عند استخدام التركيز ٢٠ جزء فى المليون عند الرش عند تمام التزهير و ١٥ جزء فى المليون عند الرش بعد ١٤ يوم من تمام التزهير وذلك خلال الموسم الأول بينما كانت أفضل النتائج فى الموسم الثانى عند الرش بتركيز ١٥ جزء فى المليون عند تمام التزهير.

كما أوضحت الدراسة إلى أن كل من الصفات الطبيعية للثمار مثل (وزن – حجم – أبعاد – معامل الشكل – الصلابة) وكذلك الصفات الكيماوية للثمار مثل (النسبة المئوية للمواد الصلبة الذائبة الكلية – نسبة الحموضة – النسبة بين المواد الصلبة الذائبة / الحموضة) قد تحسنت معنوياً نتيجة رش معظم تلك المعاملات تحت الدراسة بمادة السيتوفكس مقارنة بالأشجار الغير معاملة (الكنترول) فى كل من موسمى الدراسة.

ونتيجة لذلك فإنه يمكن الإشارة إلى أن رش أشجار التفاح بالسيتوفكس قد أدت إلى تأثير إيجابى ومعنوى لمعظم الصفات المدروسة وكانت المعاملة (السيتوفكس ٢٠ جزء فى المليون عند الرش عند تمام التزهير)، السيتوفكس ١٥ جزء فى المليون عند الرش بعد ١٤ يوم من تمام التزهير هى أفضل المعاملات فاعلية فى زيادة عقد الثمار والمحصول وكذلك تحسين معظم صفات الثمار الطبيعية والكيماوية.