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THE EFFECT OF GIRDLING AND SOME GROWTH REGULATORS ON FRUIT DROP OF PERSIMMON

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Abstract

This study identified the effect of girdling and different concentrations of growth regulators on fruit drop, of trees persimmon (*Diospyros kaki L*). GA_3 at 20p.p.m. plus girdling at full bloom decreased fruit drop and consequently increased the yield. The girdling treatment only during full bloom significantly increased final yield, while, treatment of growth regulators spraying plus girdling gave the best yield compared with the yield of control trees. The treatment of GA_3 plus girdling tended to give larger leaf area and leaf dry weight, while girdling treatment gave small leaf area.

Girdling treatment at full bloom increased leaf and shoot total carbohydrate compared with control.

Girdling significantly improved fruit weight and size while, total soluble solids (T.S.S) level was slightly affected by girdling for applied treatment. There was insignificant effect on acidity and fruit colour of persimmon.

INTRODUCTION

Persimmon tree has been introduced to Egypt in 1911 by Ministry of Agriculture (Baghdady and Mineasy, 1964). Recently, cultivation of Oriental persimmon (*Diospyros kaki L*) are extended in Egypt especially Costata cultivar.

Persimmon can bear three types of flowers: pistillate, staminate and perfect on a single tree. Hodgson, 1939 classified Oriental persimmon to five groups with reference to sex condition. Gould 1940 mentioned that Costata cultivar followed pistillate constants group, so it's fruit setting is true parthenocarpically. Young parthenocarpic fruits tend to be more easily casued to drop than young fruits from pollinated flowers (Bailey, 1933 and Chandler 1957). Hodgson, 1939 postulated that girdling the unpollinated persimmon reduces fruit drop during the current season and the following season. Chandler, 1957 stated that girdling trunks and branches tends to reduce the amount of fruit drop.

Thompson and Taylor (1967) showed that girdling just after blooming prevented some fruit drop and resulted in significantly greater harvested yields of fruit. Blumenfeld, 1986 studied improving productivity of Triumph persimmon. He found that spraying at full bloom with 30 p.p.m. GA_3 increased yields by de-

creasing fruitlet abscission, Yield also were increased by girdling 60% Combining the two treatments the two treatments gave the best yields, and caused no residual effects in the following year.

Monselise *et al.*, 1972 indicated that girdling at the beginning of bloom increases yield of orange trees by increasing fruit number but not fruit size. They have shown that girdling increases gibberellin activity in the aerial parts, the dual effect of gibberellin on flower formation and fruit setting may explain these influences of girdling.

Bargioni, *et al.*, 1979 postulated that drop of persimmon fruit cultivar Lycopersicun was negligible but drop of seedless fruit was very marked and occurred in all times, when fruit growth rate was low. He noticed that seedless fruit contained less auxin and cytokinin than normal fruit, and no GA_3. Zhang., 1983 suggested that the tendency of the fruit to drop during June is related to the balance between growth promoters produced in the seed and inhibitors produced in the leaves.

Evaluation of natural drop of flowers and fruits from persimmon trees (Diospyros kaki L). were studied by Elizabeth, 1991. She stated that there were two maximum of effective drop : 55 and 77 days after flowering, 1991. She stated that there were two maximums of effective drops : 55 and 77 days after flowering, which occurred at 2.6 cm. and 4.5 cm fruit diameter, coincided with the period of maximum fruit growth velocity. Roan *et al.*, 1994 demonstrated that the highest fruit set in two persimmon cultivars (Niour Sin and Shyr), was generally obtained with 100 p.p.m. GA_3.

It has been investigated that NAA application prevents fruit drop of apples (Hegazi, 1980), of pears (Martin and Griggs, 1970), of apricot (Srivastava *et al.*, 1971) and of plum (Jankovic and Parunovic, 1973). On the other hand, NAA increased fruit drop when it was sprayed before 30 days from persinmon full bloom (Yamamurs, *et al*, 1976) or applied 20 day after persimmon flowering (Yamamurs and Natto, 1980). Similar results were found by Cranko and *et al*, 1983), when applied NAA 2-3 weeks after full bloom.

Ping and Rabe, 1996 stated that girdling applied 2-4 weeks after the physiological fruit drop in satsumas, significantly improved fruit colour, total soluble solid levels and T.S.S/TA (titratable acidity) ratio in the first season. Consecutive girdling did not improve the above indices significantly in the second season, TA and juice percentage were not influenced by girdling at differenct times and during successive years.

Rabe and VanRensbung, 1996 documented that girdling treatment during full bloom significantly increased final yield in citrus., The blossom GA_3 sprays increasd yield only slight, while the postbloom GA_3 sprays did not affect final yield at all.

The effect of girdling on yield, fruit size and quality have been widely studied on all fruit crops. Plant growth regulators were used also to increase fruit set and success of crosses between various two hardy breeding line (Allen, 1967 and Dubois and Vries, 1986).

In Egypt the high drop of fruits before maturity is the major problem for persimmon production, so the final yield is very low. Our objective was initially to increase yield of Costata cultivar by spraying treatments with GA_3 or GA_3 plus NAA or by a mechanical treatment (girdling). This study reports the effects of spraying growth regulators and girdling on final yield, leaf area, dry weight of leaves, total carbolydrate in leaves and shoots and mature fruit characters.

MATERIALS AND METHODS

Costata culttivar of persimmon trees (*Diospyros kaki* L.) were used for this study. Visibly uniform trees in growth were located in a newly reclained, sandy soil (sixety five km. apart from Cairo), planted in 1990, at of 6 m.x4m apart. Trees were irrigated by drip irrigation and all normal agricultural practices were applied. Ten treatments were tested in a complete randomized block design, each treatment consisted of three replicates and each replicate consisted of three trees. All treatments were carried out at the same day on trees which reached full bloom during the two successive seasons 1996 and 1997.

Girdling procedures: Girdling was carried out using a girdling knife by making complete ring cut of two mm. effective width around the main branches, and no wood layer was injured. It was applied at full bloom stage.

Treatments were:

1. Trees were sprayed with 10 p.p.m. GA_3.
2. Trees were sprayed with 10 p.p.m. GA_3 plus girdling.
3. Trees were sprayed with 10 p.p.m. GA_3 plus 5 p.p.m. NAA.
4. Trees were sprayed with 10 p.p.m. GA_3 plus 5 p.p.m. NAA plus girdling.
5. Trees were sprayed with 20 p.p.m. GA_3.
6. Trees were sprayed with 20 p.p.m. GA_3 plus girdling.
7. Trees were sprayed with 20 p.p.m. GA_3 plus 10 p.p.m. NAA.
8. Trees were sprayed with 20 p.p.m. GA_3 plus 10 p.p.m. NAA plus girdling.

9. Trees were girdled only.
10. Trees were left without spraying or girdling (control).

Fruit set, fruit drop and yield: For each tree, 10 shoots were tagged, and the fruit drop percentage was recorded for all the the ten treatments every 15 days after the end of fruit set, until the end of September. Fruits were harvested at maturity for each tree of various replicates and yield was determined.

Measurement of carbohydrats: One Handred leaves and 100 gm of shoots were collected per tree at the end of growth season and their carbohydrate contents were determined. After taking fresh weight, the tissues were dried at 60^{o}C to a constant weight.

The carboydrate determination procedures were as follows: A dried sample of 0.1 gm. was subjected to acid hydrolysis for six hours in boilling water bath using H2SO4. Total carbohydrates were asayed using the phenol sulfuric acid method (Smith *et al.*, 1956) and calculated as 1 gm. glucose per 100 gms of the dry matter.

Fruit quality measurement: Fruits were picked at maturity stage (September). Fruit weight, size diameter and height were determined. The percentage of total soluble soilds (T.S.S.) and acidity were measured, in addition, skin colour was estimated by matching with colour chart (Robert, 1938).

All data of the present investigation were analyzed statistically according to Snedecor and Cochran (1990).

RESULTS AND DISCUSSION

Effect of spraying or girdling on fruit drop: In both seasons, all treatments applied during the full bloom period delayed fruit drop compared to the control (Tables 1 & 2 and Fig. 1) Statistical evaluation of the data showed that girdled trees significantly dropped less fruit than those not girdled in all treatments. Sprayed trees with GA3, or GA3 plus NAA (different concentrations) significantly dropped less fruit than untreated trees also. All fruits remaining on the trees on June 6. 1996 or June 13. 1997 were harvested in September in both seasons. Tables 1 and 2 showed that the highest percentage of remain fruits was for trees sprayed with 20 p.p.m. GA3 plus girdled (68.54 and 82.15% for two seasons respectively). Applied with 10 p.p.m. GA_3 plus girdling (59.50 and 75.49% respectively). It was mentioned that girdled trees gave the higher percentage of remain fruits (55.68%) insignificantly with than those for trees sprayed with 10 p.p.m. GA3 plus 5 p.p.m. NAA plus girdling and trees applied with 20 p.p.m. GA3 plus 10

Table 1. The percentage of remained fruits for different treatments at different intervals from the end of fruit set in 1996.

Treatment	May 7	May 22	Jun. 6	Jun. 21
10 ppm GA_3	62.98	32.81	24.20	24.20
10 ppm GA_3 + girdling	94.45	63.78	60.04	59.50
10 ppm GA_3 + 5 ppm NAA	61.81	50.80	34.86	34.86
10 ppm GA_3 + 5 ppm NAA + girdling	87.34	68.86	54.49	54.39
20 ppm GA_3	67.80	43.72	34.79	34.79
20 ppm GA_3 + girdling	97.67	85.00	68.75	68.54
20 ppm GA_3 + 10 ppm NAA	31.49	24.74	18.47	18.47
20 ppm GA_3 + 10 ppm NAA + girdling	87.11	68.80	53.71	53.71
Girdling	83.00	59.49	55.90	55.68
Control	57.51	21.04	14.18	14.18
L.S.D at 5%	1.16	1.90	3.33	3.33

Table 2. The percentage of remained fruits for different treatments at different intervals from the end of fruit set in 1997.

Treatment	May 14	May 29	Jun. 13	Jun. 28
10 ppm GA_3	97.89	5.61	5.6	5.6
10 ppm GA_3 + girdling	94.35	77.65	75.65	75.49
10 ppm GA_3 + 5 ppm NAA	90.83	10.54	7.61	7.6
10 ppm GA_3 + 5 ppm NAA + girdling	99.99	79.50	73.98	73.93
20 ppm GA_3	96.45	14.41	8.89	8.8
20 ppm GA_3 + girdling	99.48	83.38	82.78	82.15
20 ppm GA_3 + 10 ppm NAA	88.99	24.24	3.78	3.69
20 ppm GA_3 + 10 ppm NAA + girdling	94.84	51.65	46.50	46.50
Girdling	99.97	71.48	66.93	66.43
Control	98.44	4.82	2.93	2.93
L.S.D at 5%	0.98	1.48	1.87	1.87

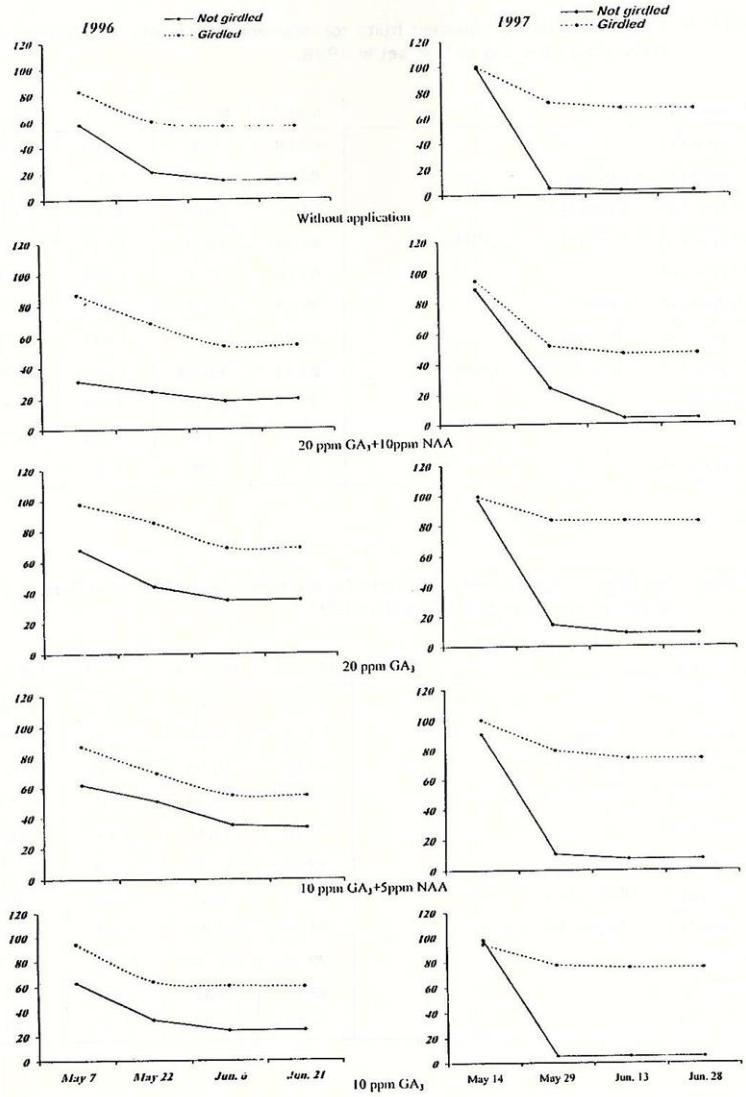

Fig. 1. The effect of GA3 or GA3 plus NAA at different concentrations and girdling on remained fruits percentage at different intervales in two seasons 1996 and 1997.

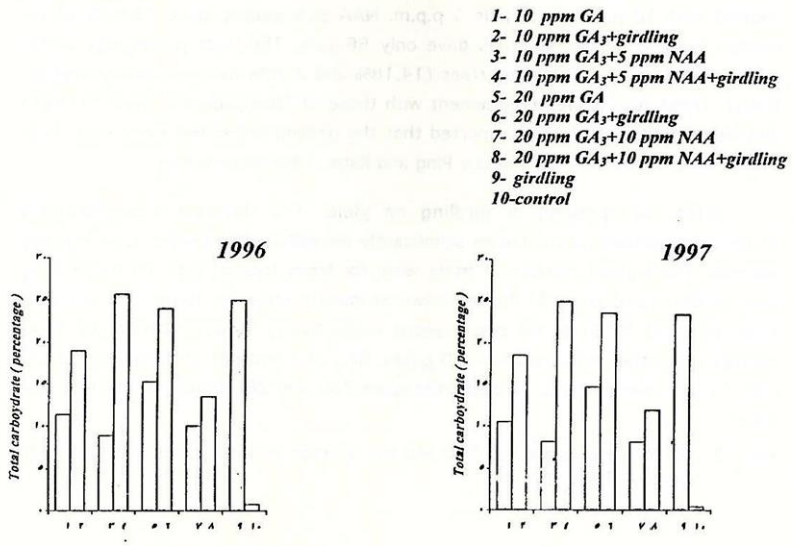

Fig. 2. The effect of different treatments on total carbohydrate in percentage for leaves.

p.p.m. NAA plus girdling (53.71), in the first season. In the second season trees treated with 10 p.p.m. GA3 plus 5 p.p.m. NAA plus girdling gave 73.93% of remained fruits while girdled trees gave only 66.43%. The least percentage of remained fruits was for untreated trees (14.18% and 2.93% for two seasons respectively). These results are in agreement with those of Thompson and Tayler, (1967) and Blumenfeld, (1986), who reported that the girdling prevented some fruit drop. About similar trend was obtained by Ping and Rabe, 1996 in satsumas.

Effect of spraying or girdling on yield: The different concentrations of GA3 plus girdling at full bloom significantly increased yield (Table 3) in the two seasons. The highest number of fruits were for trees treated with 20 p.p.m. GA_3 plus girdling (342 and 331 fruits in two seasons), while the lowest for untreatd trees (71 and 15 fruits for two seasons respectively). It was followed by trees treated with other concentration (10 p.p.m. GA_3 plus girdling) which gave 300 and 302 fruits in two seasons. Girdled trees gave 288 and 265 fruits for the two seasons.

Table 3. The average number of fruit and the average of yield per tree for all treatments in 1996 and 1997.

Treatment	No. of fruit per tree		Yield (kg.) per tree	
	1996	1997	1996	1997
10 ppm GA_3	125	26	9.87	1.67
10 ppm GA_3 + girdling	300	302	25.19	35.86
10 ppm GA_3 + 5 ppm NAA	170	38	10.64	2.22
10 ppm GA_3 + 5 ppm NAA + girdling	276	311	22.65	30.52
20 ppm GA_3	162	35	12.34	2.62
20 ppm GA_3 + girdling	342	331	28.77	36.03
20 ppm GA_3 + 10 ppm NAA	102	15	6.73	0.89
20 ppm GA_3 + 10 ppm NAA + girdling	279	192	23.10	15.68
Girdling	288	265	22.51	24.15
Control	71	15	4.55	1.16
L.S.D at 5%	18.55	13.45	1.80	0.84

In the first season,trees treated with 20 p.p.m.GA_3 plus girdling gave highest yield (28.77 kg),followed by trees treated with 10 p.p.m.GA_3 plus girdling (25.19 kg).

In the second season, these two treatments gave insignificantly differences (36.03 and 35.86 respectively). The girdled trees gave higher yield in two seasons (22.51 and 24.15 kg respectively), while the lowest yield was from untreated trees (4.55 and 1.16 kg, respectively).

Our results indicate that girdling or spraying with 20 p.p.m. GA_3 plus girdling at full bloom increased yield by decreasing the percentages of drop fruit these finding match with those of Rabe and VanRensburg (1996) in citrus who mentioned that girdling treatment increased final yield.

Effect of spraying or girdling on vegetative growth and carbohydrate contents: The analyses of variance showed that trees treated with different concentration of GA_3 plus girdling had a significant effect on leaf area compared with girdling trees only (Table 4). The leaf area ranged between 88.40 cm2. to 76.92 cm2 for sprayed trees with 10 p.p.m. GA_3 plus girdling, while trees which were girdled only gave smalles Leaf area, ranging between 46.69 cm2 to 46.14 cm2 for the two successive seasons.

Leaves of trees treated with 20 p.p.m. GA_3 plus girdling had highest dry weight in the two seasons (13.20 and 12.53 gm), wheras the leaves from untreated trees gave least dry weight (7.00 and 5.72 in two seasons respectively). Compared with shoot dry weight, the same results were obtained, the highest dry weight for trees treated with 20 p.p.m. GA_3 plus girdling was (22.07 and 21.23 gm), the least for shoots of untreated trees (12.63 and 12.27 gm) in the two seasons, respectively.

Total carbohydrate in leaves and shoots: Girdling trees markedly increased the carbohydrate in leaves and shoots for all treatments, (Table 4). Furthermore the trees girdled only, gave the same results. The total carbohydrate in leaves of trees treated with 10 p.p.m. GA_3 + 5 p.p.m. NAA + girdling showed highest values (25.65% and 25.0% for the two successive seasons). In the first season, the same value was unsignificant for the leaves of trees girdled only (25.0%) followed by the value for leaves of trees, treated with 20 p.p.m. GA_3 + girdling (24.0%) In the second season, the leaves of trees treated with 20. p.p.m. p.p.m. GA_3 plus girdling gave the percetage of total carbohydrate (23.61%), the same value differes insignificant for the leaves of trees girdled only (23.5%). In contrat, the leaves of untreated trees markedly reduced the value of total carboydrate in the two seasons (0.75% and 0.46% respectively).

Figurs 2 and 3 showed that shoots whether treated or not gave higher values

Table 4. Average leaf area, leaf dry weight, shoot dry weight, total carbohydrate of leaves and shoots for all treatments in 1996 and 1997.

Treatments	Leaf area $(cm)^2$		Leaf dry weight (gm)		Shoot dry weight (gm)		Total carbohydrate leaves %		Total carbohydrate shoot %	
	1996	1997	1996	1997	1996	1997	1996	1997	1996	1997
10 ppm GA_3	64.40	48.14	9.53	8.73	17.5	16.13	11.32	10.53	24.2	23.73
10 ppm GA_3 + girdling	88.40	76.92	10.73	10.33	18.1	17.23	19.00	18.52	36.4	35.30
10 ppm GA_3 + 5 ppm NAA	52.33	53.37	9.73	9.33	14.27	17.47	8.95	8.22	29.2	27.89
10 ppm GA_3 + 5 ppm NAA + girdling	59.19	67.87	9.90	9.53	16.40	18.23	25.65	25.0	33.0	35.18
20 ppm GA_3	65.80	57.84	10.77	9.33	20.1	17.20	15.3	14.7	33.2	31.37
20 ppm GA_3 + girdling	81.34	78.69	13.20	12.53	22.07	21.23	24.0	23.61	36.2	35.07
20 ppm GA_3 + 10 ppm NAA	51.33	49.80	7.67	5.70	14.47	10.43	10.04	8.22	22.1	19.79
20 ppm GA_3 + 10 ppm NAA + girdling	56.14	51.54	10.10	8.73	16.7	14.57	13.5	11.92	36.2	34.05
Girdling	46.69	46.14	9.2	7.83	15.37	19.07	25.0	23.5	32.0	35.07
Control	50.07	50.19	7.0	5.73	12.63	12.27	0.75	0.46	12.2	11.92
L.S.D at 5%	1.38	1.50	0.34	0.39	0.57	0.45	0.89	0.84	0.61	0.31

than leaves. Shoots of girdled trees had markedly high values of total carbohydrate in all treatments. In the first season the highest value of carbohydrate was for shoots of trees treated with 10 p.p.m. GA_3 plus girdling (36.4%). Shoots of trees treated with 20 p.p.m. GA_3 plus girdling or treated with 20 p.p.m. GA_3 + 10 p.p.m. NAA + girdling gave insignificant value and same percetage of total carbohydrates (36.2%). The lowest value was for untreated shoots (12.2%) while the shoots of girdled trees gave 32.0% of total carbohydrate. In the second season, shoots of all girdled treatments gave almost equal values about 35.30%, untreated shoots gave 11.92% percentage.

All girdling treatments at full bloom, significantly (at 5%) increased leaf and shoot total carbohydrates, compared to control. A similar effect was found in Triumph persimmon for improving productivity (Blumenfeld, 1986), and in "Mihowase" satsumas (Ping and Rabe, 1996).

The effect of spraying and girdling on fruit characters: Concerning fruit characters, data in Table 5 and plate 1 indicates that there were significant differences in fruit quality between the treatment under study. In general, fruits resulted from any treatment with girdling were biggest in weight and size, while smallest was for control in the two seasons. Statistical analysis revealed that other fruit characrters were slightly different.

It was found that fruit weight and size were correlated with leaf area. Yamanure *et al.*, 1989 found only an occasional positive correlation between fruit weight and size, and leaf number per fruit.

It can be concluded that girdling at full bloom reduced fruit drop and resulted in significantly higher harvested yields. Additional effect of girdling was that total carbohydrates in early October was increased in leaves and shoots, which affect fruit weight and size. These results are in harmony with those of Monselise *et al.*, (1972). They reported, at girdling enhances endogenous gibberellin contents and its activity. It may act in a dual way, causing both abortion of late flowers which are in the first stages of differetiation and increasing setting of ovaries of earlier flowers. Other effect of girdling is on fruit characters.

Table 5. Mature fruit characters for all treatments in 1996 and 1997.

Treatments	Weight (g)		Size (cm³)		Diameter (cm)		Length (cm)		T.s.s (%)		Acidity (%)		Skin color	
	1996	1997	1996	1997	1996	1997	1996	1997	1996	1997	1996	1997	1996	1997
10 ppm GA_3	77.40	64.24	76.43	58.49	5.2	5.1	5.3	4.6	24.9	22.3	0.347	0.304	Apricot 609 page 70 I	Apricot 609 page 70 I
10 ppm GA_3 + girdling	83.97	118.88	79.60	118.17	5.5	6.3	5.2	5.8	28.4	26.1	0.400	0.515	Apricot 609/1 page 70 I	Apricot 609/1 page 70 I
10 ppm GA_3 + 5 ppm NAA	62.67	73.28	62.00	68.36	4.9	6.2	5.3	4.8	25.0	24.9	0.387	0.464	Apricot 609 page 70 I	Apricot 609 page 70 I
10 ppm GA_3 + 5 ppm NAA + girdling	81.97	98.19	80.60	90.93	5.5	6.0	5.4	5.4	27.3	24.9	0.416	0.498	Apricot 609 page 70 I	Apricot 609 page 70 I
20 ppm GA_3	76.03	78.83	75.17	66.50	5.3	5.3	5.2	4.8	24.4	25.2	0.405	0.440	Apricot 609 page 70 I	Apricot 609 page 70 I
20 ppm GA_3 + gird'ling	84.20	109.18	88.77	100.66	5.5	6.6	5.9	6.8	27.8	26.9	0.419	0.504	Apricot 609/1 page 70 I	Apricot 609/1 page 70 I
20 ppm GA_3 + 10 ppm NAA	66.67	59.83	64.30	54.56	5.0	4.9	5.4	4.4	26.0	24.2	0.371	0.418	Apricot 609/1 page 70 I	Apricot 609/1 page 70 I
20 ppm GA_3 + 10 ppm NAA + girdling	84.80	80.54	78.17	76.00	5.3	5.8	5.3	6.5	28.8	27.3	0.396	0.448	Cadmium Orange page 8 I	Cadmium Orange page 8 I
Girdling	78.23	91.90	78.77	86.19	5.3	5.8	5.1	5.5	23.3	22.3	0.457	0.375	Apricot 609 page 70 I	Apricot 609 page 70 I
Control	64.67	88.83	62.67	79.00	5.0	5.4	5.6	5.3	23.9	26.1	0.390	0.289	Maize yellow 607/1 page 69I	Maize yellow 607/1 page 69I
L.S.D at 5%	5.69	2.08	6.24	2.35	0.28	0.29	0.25	0.28	1.65	1.64	0.03	0.03		

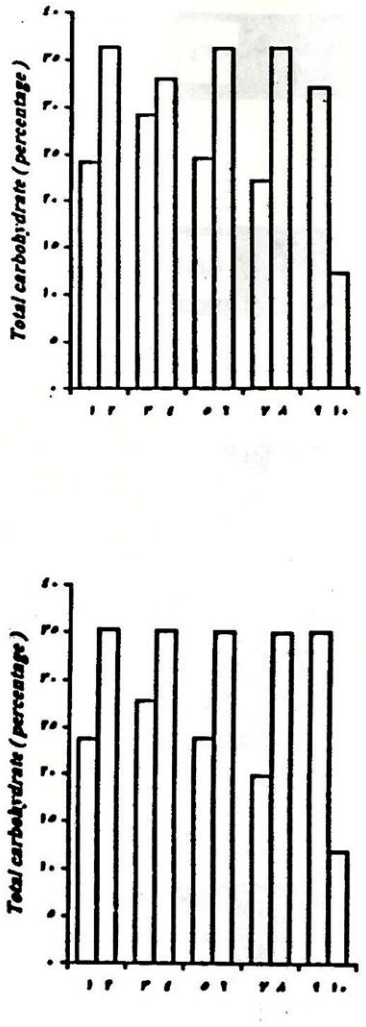

Fig. 3. The effect of different treatments on total carbohydrate in percentage for shoots.

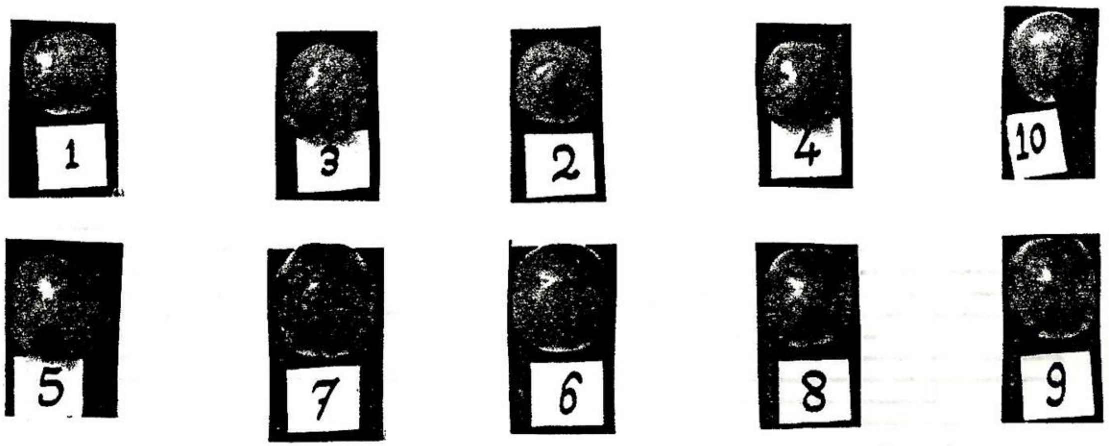

Plate1: Treated Costata persimmon fruits .

1- 10 ppm GA
5-10 ppm GA_3-girdling

3- 10 ppm GA_3-5 ppm NAA
7-10 ppm GA_3+5 ppm NAA+ girdling

2- 20 ppm GA
6- 20 ppm GA_3+girdling

4-20 ppm GA_3+10 ppm NAA
8- 20 ppm GA_3+10 ppm NAA+ girdling

10- Control
9- girdling

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تأثير التحليق وبعض منظمات النمو علي تساقط ثمار الكاكي

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أجري هذا البحث في خلال موسمي ١٩٩٦ ، ١٩٩٧ علي أشجار كاكي عمرها ست سنوات – منزرعة في ارض رملية مستصلحة علي بعد ٦٠ كيلو متر – من القاهرة.

أدت المعاملة بحمض الجبرلين تركيز ٢٠ جزء في الميلون والتحليق علي الفروع الرئيسية في قمة التزهير الي زيادة المحصول عن طريق تقليل نسبة تساقط الثمار، وقد اثبتت المعاملة بالتحليق فقط وقت الزهير زيادة معنوية في المحصول.

اعطت المعاملة بالرش بمنظمات النمو والتحليق معا افضل محصول واعطت ايضا اكبر مساحة ورقة واكبر وزن جاف – بينما كان اقل مساحة للأوراق في حالة المعاملة بالتحليق فقط.

أعطت كل المعاملات التي استخدمت التحليق الفروع الرئيسية في وقت قمة النزهير نسب كبيرة للكربوهيدرات الكلية في الأوراق والفروع.

حسن التحليق من وزن وحجم الثمرة – بينما كان التأثير بسيط علي المواد الصلبة الكلية والحموضة وكذلك اللون.