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**EFFECT OF GA₃ FOLIAR SPRAY ON FRUIT GROWTH
DEVELOPMENT, YIELD AND FRUIT QUALITY OF "PICUAL"
OLIVE TREES**

BY

Abou Rawash, M.*; El-Wakeel, H.M.F.*; Malaka A. Saleh
and Elham Zinhom****

* Hort Dept., Fac. of Agric., Ain Shams Univ., Shoubra El-Kheima, Cairo, Egypt.

** National Research Center, Dokki, Egypt.

ABSTRACT

The effect of spraying "Picual" olive trees with GA₃ at 0, 25, 50 and 100 ppm was evaluated during 1996-1997, 1997-1998, 1998-1999 seasons on fruit development, fruit dropping, yield and fruit quality. Fruit diameter increase gradually in three different successive periods from 30-40, 90-105 and 120-135 days after fruit set. GA₃ spray at 50 or 100 ppm reduced fruit drop % than the control by 14.6%, 32.5% and 40% in 1st, 2nd and 3rd seasons, respectively. The higher GA₃ levels (50 and 100 ppm) proved to be more effective in increasing fruit weight, fruit volume, fruit length, fruit diameter and fruit pulp % and significantly increased fruit oil % than the control. All GA₃ treatments reduced total carbohydrates, total nitrogen and phenols than the control.

Key words: GA₃, olives, fruit growth, yield, fruit oil %, fruit properties.

INTRODUCTION

Olive trees characterized by alternate bearing and their fruits classified botanically as drop fruits, such as various stone fruits, which show a double sigmoid growth curve with a distinct stationary stage for pit hardening. The effect of GA₃ on yield was investigated by Antognozzi and Catalano (1985), Bini and Giannone (1995), Boulouha (1990) and Eris and Borut (1993) on olive trees. They reported that application of GA₃ greatly increased fruit set and yield. While, decreased fruit dropping as recommended by Bini and Giannone (1995) on olive trees. More beneficial effects of GA₃ on fruit characteristics were also demonstrated by Southwick and Yeager (1991) and Southwick *et al.* (1995) on apricot, Gur *et al.* (1993) and Lemus and Monct (1998) on peach trees. They found an increase in fruit size.

Additionally, application of GA₃ to olive trees greatly increased fruit oil content Proietti and Tombesi (1996) and Lazovic *et al.* (1998).

Therefore, this study was carried out to evaluate the effect of GA₃ on fruit development, yield and fruit quality of Picual olive trees.

MATERIALS AND METHODS

The present study was conducted in a private farm at Kafr Dawood district, Monofeya Governorate, through three successive seasons (1996/1997,

1997/1998 and 1998/1999) on "Picual" olive cv. Trees of 8-year-old grown in a sandy soil to study the effect of GA₃ on fruit development, yield and fruit quality

Trees chosen for the experimental treatments had uniform as far as possible in their growth vigour and in the "on" year season in both the first and third year of study. Planting distance was 6 x 6 m and trees received the regular fertilization and pest control programs as adopted in the farm. Irrigation system was the drip irrigation.

This experiment included spraying trees after 15 days of fruit set with one of the four GA₃ (Gibberellic acid) concentration treatments i.e. 0, 25, 50 and 100 ppm where each treatments replicated four times with one tree per replicate. Moreover, ten litres of GA₃ solution were prepared and sprayed on each tree (replicate) by using a compression sprayer.

The following measurements and determinations were carried out on the trees:

1- Fruit development (Growth curve):

Ten fruits from each replicate were labeled after fruit setting and the fruit diameter was measured using a vernier caliper beginning 15 days after fruit set and continue after 15 days intervals until harvest time. The successive increase in fruit diameter was illustrated in a curve.

2- Fruit dropping percentage:

The number of fruits born per 1 m length of fruiting shoots was recorded periodically (15 day interval) beginning after fruit set until harvesting date. Consequently, fruit dropping % in each intervals was estimated and expressed in curves.

3- Yield (kg/tree):

Yield / tree was determined in kilograms, at harvest time in mid November as the fruit attained full colouration (deep purplish). The means of the three seasons were calculated.

4- Fruit physical characteristics:

At harvest time, samples of 30 fruits per each replicate were taken and fruit weight (gm), fruit volume (cm³), fruit length (cm); fruit diameter (cm), fruit shape (length / diameter) and fruit pulp% parameters were determine.

5- Fruit oil content (gm/100 gm fresh weight):

It was determined by extracting the oil from the dried fruit samples by "Soxhlet" fat extraction apparatus using petroleum ether of 80°C boiling point as described by A.O.A.C. (1970). The percentages of oil content were expressed as gm/100gm fresh weight.

Shoot chemical composition:

Total nitrogen content was determined by conventional miro-Kjeldahl method reported by Yemm and Folkes (1953).

Total carbohydrates were estimated using the colorimetric method described by Herbert *et al.* (1971).

Total indoles were calorimetrically determined at 530 mu wave length by using the P-dimethyl aminobenzaldehyde test (Larsen *et al.*, 1962).

Total soluble phenols were calorimetrically determined at 730 mu wave length by using Folin and Denis. Colorimetric method (A.O.A.C., 1970) and the concentration was calculated as mg pyrogallol per 100 g dry weight.

Statistical analysis:

The statistical analysis described by Snedecor and Cochran (1968). Means were compared by using the L.S.R. at 0.05 test given by Waller and Duncan (1969), where the complete randomize blocks was adopted.

RESULTS AND DISCUSSION

Effect on fruit growth and development (fruit diameter):

As it is shown in Tables (1, 2, 3) and Fig. (1) GA₃ spray greatly increased fruit diameter of Picual olives during 1997, 1998 and 1999 seasons specifically at level of GA₃ 100 ppm which induced the highest fruit diameter. Data also showed that fruit diameter was increased with the advance in days after application. Interaction between the two studied factors was significant in most cases. Where the highest fruit diameter (2.51, 2.21 and 2.81 cm) were obtained with 100 ppm GA₃ after 210 days of application in the 1st, 2nd and 3rd season, respectively. The opposite was true for the untreated trees, 15 days after fruit set (0.61, 0.51 and 0.71 cm, respectively).

It is obvious in the first season, that control fruits did not show a distinct period of growth cessation whereas, fruit of 25, 50, 100 ppm GA₃ showed an insignificant increase in fruit diameter through (135-165), (30-60) and (180-210) respectively after fruit set.

With regard to the results of the second season, fruit diameter gradually increased with the progress in sampling date, but the increment was insignificant in two distinct intervals i.e. 15-30 and 75-90 days after fruit set.

As for the results of the third season is concerned data revealed that GA₃ spray at (25 ppm) significantly reduced fruit diameter than the control, regardless of sampling date.

Results indicated also that fruits of control trees showed three different periods of insignificant increase in diameter i.e., 15-60, 105-135 and 150-180 days after fruit.

Therefore, one can say that fruits of untreated trees did not show a steady (pit hardening period) in their growth in 1997 and 1998 seasons, whereas, they exhibited two distinct periods of growth cessation in 1999 season i.e. 105-135 and 150-180 days after fruit set. So the first period, may be the steady stage for the pit hardening of Picual olive fruit trees under such conditions.

Table (1): Effect of different concentrations of GA₃ foliar spray (15 days after fruit set) in relation to days after application on fruit development (fruit diameter in cm) of Picual olive trees in 1997 season.

Sampling date	Days after fruit set													Mean	
	15	30	45	60	75	90	105	120	135	150	165	180	195		210
Control	0.61 v	0.71uv	0.82r-u	0.87q-t	0.93p-r	1.36no	1.41m-o	1.51k-n	1.53k-m	1.56j-m	1.61i-l	1.71h-j	1.81gh	1.94fg	1.31C
GA ₃ at 25 ppm	0.75s-v	0.82r-u	0.83r-u	1.04p-q	1.34 o	1.46l-o	1.51k-n	1.63i-k	1.71h-j	1.74hi	1.81gh	1.91fg	2.01ef	2.11de	1.48B
GA ₃ at 50 ppm	0.73t-v	0.89p-s	0.92p-r	1.03p-q	1.31o	1.43m-o	1.55k-m	1.65i-k	1.73hi	1.81gh	1.91fg	1.93fg	2.11de	2.21cd	1.51B
GA ₃ at 100 ppm	0.82r-u	0.86q-u	0.91p-r	1.01p-q	1.21o	1.53k-m	1.61el	1.81gh	1.91fg	2.21cd	2.31bc	2.41ab	2.45ab	2.51a	1.68A
Mean	0.73 k	0.82 j	0.87 j	0.98 i	1.19 h	1.44 g	1.52 g	1.65 f	1.72 f	1.83 e	1.91 d	1.99 c	2.09 b	2.19 a	

Means having the same letter(s) are not significant at 5%.

Table (2): Effect of different concentration of GA₃ foliar spray (15 days after fruit set) in relation to days after application on fruit development (fruit diameter in cm) of Picual olive trees in 1998 season.

Sampling date	Days after fruit set														Mean
	15	30	45	60	75	90	105	120	135	150	165	180	195	210	
Control	0.51 s	0.55 s	0.75qr	0.78p-r	0.81o-q	0.85o-q	0.91n-p	1.0l-n	1.21jk	1.31ij	1.41hi	1.51gh	1.63fg	1.71ef	1.07 D
GA ₃ at 25 ppm	0.64rs	0.73qr	0.81o-q	0.91n-p	1.01l-n	1.11kl	1.21jk	1.31ij	1.41hi	1.54gh	1.61fg	1.71ef	1.81de	1.91cd	1.26 C
GA ₃ at 50 ppm	0.65rs	0.75qr	0.85o-q	0.95m-o	1.11kl	1.21jk	1.31ij	1.41hi	1.51gh	1.59fg	1.71ef	1.81de	1.91cd	2.11ab	1.35 B
GA ₃ at 100 ppm	0.75qr	0.81o-q	0.83o-q	0.93m-o	1.03l-n	1.08k-m	1.41hi	1.51gh	1.61fg	1.81de	1.91cd	1.96cd	2.01bc	2.21a	1.42 A
Mean	0.64 l	0.71 l	0.81 k	0.89 j	0.99 l	1.06 l	1.21 h	1.31 g	1.43 f	1.56 e	1.66 d	1.75 e	1.84 b	1.98a	

Means having the same letter(s) are not significant at 5%.

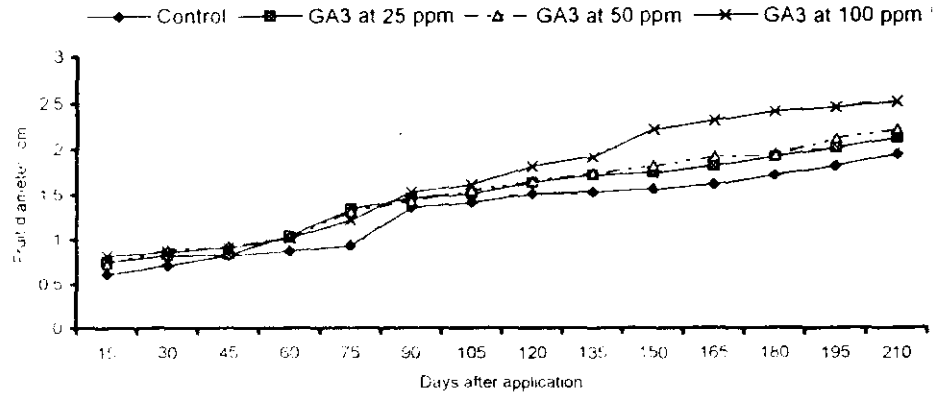
Table (3): Effect of different concentrations of GA₃ foliar spray (15 days after fruit set) in relation to days after application on fruit development (fruit diameter in cm) of Picual olive trees in 1999 season.

Sampling date	Days after fruit set														Mean
	15	30	45	60	75	90	105	120	135	150	165	180	195	210	
Control	0.71 s	0.75 s	0.81rs	0.85rs	0.91qr	1.41qr	1.61j-l	1.71ij	1.75ij	1.85hi	1.91gh	1.95gh	2.01fg	2.11ef	1.45 C
GA ₃ at 25 ppm	0.75 s	0.81 s	0.86q-s	0.91qr	0.95qr	1.01pq	1.11op	1.21no	1.41m	1.61j-l	1.81hi	1.91gh	2.31e	2.41d	1.36D
GA ₃ at 50 ppm	0.81rs	0.84rs	1.01pq	1.41mn	1.51k-m	1.61j-l	1.65jk	1.75ij	1.81hi	1.95gh	2.21 e	2.41d	2.61bc	2.71ab	1.73A
GA ₃ at 100 ppm	0.91qr	1.01pq	1.21no	1.36mn	1.43m	1.46lm	1.51k-m	1.61j-l	1.71ij	1.81hi	1.95gh	2.01fg	2.51cd	2.81a	1.66B
Mean	0.791	0.851	0.97 k	1.13 j	1.21 j	1.37 l	1.47 h	1.57 g	1.67 f	1.81 e	1.97 d	2.07 c	2.36 b	2.51a	

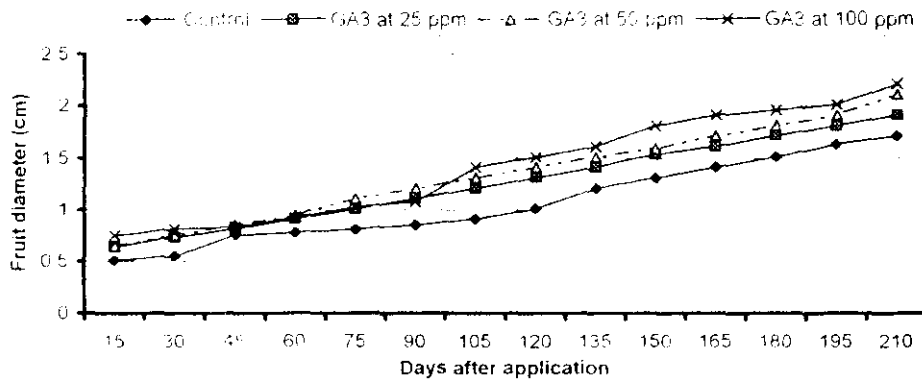
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Effect Of GA₃ Foliar Spray On Fruit Growth Development... 1757

1997 season



1998 season



1998 season

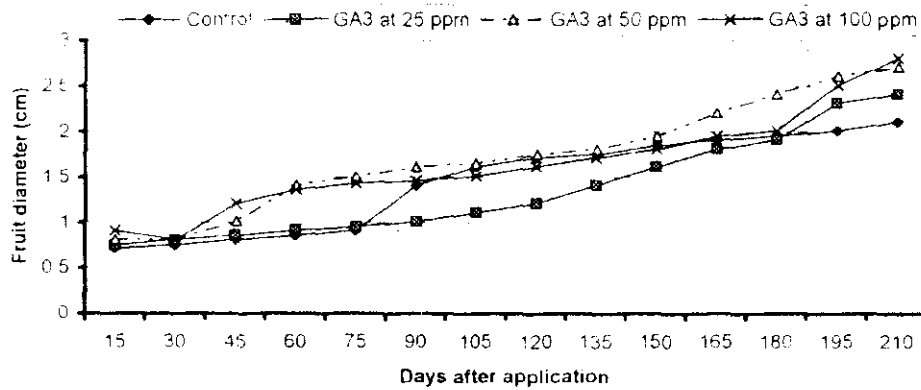


Fig. (1): Effect of different concentrations of GA₃ foliar treatments on fruit development (fruit diameter in cm) in relation to days after application of Picual cv. olives at 1997, 1998 and 1999 seasons.

The use of GA₃ as a foliar spray 15 days after fruit set altered the growth curve of such fruits. The effect of such growth substance differs according to the used level as well as the days after application. Meanwhile, 25 ppm GA₃ resulted in a steady stage after (135-165 days) in the 1st season, whereas, 50 ppm GA₃ showed such stage after 90-120 days in the 3rd season. GA₃ at 100 ppm however, exhibited a growth cessation after 60-90 days from fruit set in both the 2nd and 3rd seasons of investigation. These results are in line with those of Sharma *et al.* (1998) on apricot.

Effect on percentage of fruit dropping:

Data presented in Table (4) and Fig. (2) obviously indicated that GA₃ spray generally reduced fruit dropping % of Picual olives in the three studied seasons. The higher levels 50 and 100 ppm were more effective than the lower one (25 ppm).

Therefore it is concluded that GA₃ spray at 50 or 100 ppm 15 days after fruit set considerably reduced fruit dropping % than control by 14.6%, 32.5% and 40% in 1st, 2nd and 3rd seasons, respectively. Commercially the gibberellins are widely used specially in May and June to reduce fruit dropping of various fruit trees.

The obtained results go in line with the findings of Southwick and Yeager (1991) on Patterson apricot, Boyhan *et al.* (1992) on plum, Eris and Barut (1993) on olive, Gur *et al.* (1993) on peach and Southwick *et al.* (1997) on apricot. They stated that GA₃ spray reduced fruit dropping%.

Effect on tree yield:

Results of Table (5) indicated that GA₃ spray on Picual olive trees, 15 days after fruit set increased tree yield (in kg) in the three successive seasons. The increase in tree yield was parallel to the increase in GA₃ concentrations.

If the means of two successive seasons (on year, off year) were considered in comparison, one can notice that in the mean of 97/98, control trees produced 28.51 kg/tree while GA₃ treatments at 25, 50 and 100 ppm increased such yield by 4.38%, 14.91% and 27.36%, respectively.

With regard to the mean of 98/99, it is obvious that control trees had 29.26 kg / tree where as GA₃ at the three concentrations increased the yield by 5.13%, 16.46% and 28.37% respectively.

These results go in line with the findings of Eris and Barut (1993) on olive, Gur *et al.* (1993) on peach and Southwick *et al.* (1997) on apricot.

Effect on some fruit physical properties:

Including average fruit weight; fruit volume; fruit length; fruit diameter; fruit shape; and fruit pulp % Table (6) showed a great with different concentration of GA₃ spray 15 days after fruit set during the three considered seasons.

In general, the higher levels of GA₃ (100 ppm) proved to be more effective in increasing the aforementioned parameters than the lower one. This is true in all the considered seasons of investigation. GA₃ at 25 ppm markedly lowered fruit length / diameter ratio in all seasons and consequently produced nearly fruits due to greater growth rate of diameter than the length of the control fruits. The increase in fruit pulp

% with GA₃ spray may be due to the role of gibberellic acid in stimulating cell enlargement of pulp tissues much more than growth of seed.

These results are in agreement with the findings of Lavee and Haskal (1993) on olive.

Effect of fruit oil content:

From the obtained data in Table (7) it is clear that GA₃ foliar application specially at 50 ppm, 10 days after fruit set increased fruit oil% of Picual olives than the control, and reached the maximum values after 210 days after fruit set in the three considered seasons irrespective to GA₃ level. Such results are in agreement with the findings of Antognozzi and Catalano (1985) and El-Khawaga (2001) on olives trees. They reported that GA₃ greatly increased fruit oil percentage. On the other hand our results deviated from the results obtained by Proietti and Tombesi (1996) and Lazovic *et al.* (1998) on olives trees. They stated that GA₃ greatly decreased fruit oil content.

Effect on total nitrogen content:

As shown in data of Table (8) it could be easily noticed that all GA₃ treatments reduced total nitrogen content in shoots than the control. The reduction in shoot total content with GA₃ treatments could be explained by the role of GA₃ in increasing vegetative growth and consequently lowering the concentration of nutrients in different plant organs than the untreated trees. Interaction between GA₃ concentrations and sampling date was significant in the third season only (1999), where the least total nitrogen % was recorded by the treatment of 100 ppm GA₃ after 30 days of treatments (0.96%), whereas the highest total nitrogen % was found in the untreated trees after 7 months of treatments (1.35%).

The obtained results are in harmony with the findings of Gao *et al.* (1999) on peaches and Sherin (2002) on olive.

On the contrary, the present data are in contrast with Mehouchi *et al.* (1996) on orange. They reported that GA₃ increased total nitrogen content.

Effect on total carbohydrates content:

As it shown in Table (9), all GA₃ levels reduced shoot total carbohydrates content than the control with significant differences between them. In all the studied seasons, the least total carbohydrates content were recorded by 25 ppm level.

An evident increase in total carbohydrates were noticed with advancing in sampling date with significant differences between successive different sampling dates in most cases. Interaction between sampling date and GA₃ levels were significant during all the experimental periods in both the first and second seasons of investigation while opposite to the third one. The obtained results are in agreement with those of Gao *et al.* (1999) on peaches.

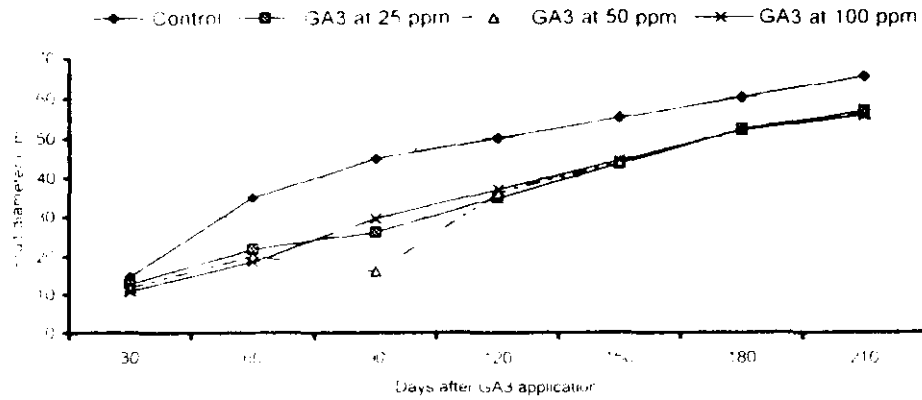
Table (4): Effect of different concentrations of GA₃ foliar spray (15 days after fruit set) in relation to days after application on percentage of fruit drop of Picual cv. olives during 1997, 1998 and 1999 seasons.

Treatments	No. of fruits per 1m shoot length at treatment	No. of fruits after 30 days from fruit set time	% of fruits drop after 30 days from fruit set time	No. of fruits after 60 days from fruit set time	% of fruits drop after 60 days from fruit set time	No. of fruits after 90 days from fruit set time	% of fruits drop after 90 days from fruit set time	No. of fruits after 120 days from fruit set time	% of fruits drop after 120 days from fruit set time	No. of fruits after 150 days from fruit set time	% of fruits drop after 150 days from fruit set time	No. of fruits after 180 days from fruit set time	% of fruits drop after 180 days from fruit set time	No. of fruits after 210 days from fruit set time	% of fruits drop after 210 days from fruit set time
1997 season															
Control	20	17	15.00A	13	35.00A	11	45.00A	10	50.00A	9	55.00A	8	60.00A	7	65.00A
GA ₃ at 25 ppm	23	20	13.04B	18	21.74B	17	26.09C	15	34.78C	13	43.48B	11	52.17B	10	56.52B
GA ₃ at 50 ppm	25	22	12.00B	21	20.00C	18	16.00D	16	36.00BC	14	44.00B	12	52.00B	11	56.00B
GA ₃ at 100ppm	27	24	11.11B	22	18.52C	19	29.62B	17	37.04B	15	44.44B	13	51.85B	12	55.50B
1998 season															
Control	22	19	13.63BC	15	31.82A	12	45.45A	9	59.09A	7	68.18A	6	72.72A	5	77.27A
GA ₃ at 25 ppm	21	18	14.28B	16	23.81BC	15	28.57C	13	38.09C	12	42.86C	10	52.38C	9	57.14BC
GA ₃ at 50 ppm	23	20	13.04C	18	21.74C	16	30.43BC	15	34.78D	14	39.13D	12	47.83D	11	52.17C
GA ₃ at 100ppm	25	21	16.00A	19	24.00B	17	32.00B	14	44.00B	13	48.00B	11	56.00B	10	60.00B
1999 season															
Control	24	21	12.56C	18	25.00A	15	37.50A	13	45.83A	11	54.17A	9	62.50A	8	66.67A
GA ₃ at 25 ppm	26	23	11.54C	20	23.08B	19	26.92B	16	38.46B	15	42.31B	14	46.15B	12	52.00B
GA ₃ at 50 ppm	28	24	14.28A	22	21.43C	20	28.57B	18	35.71C	17	39.28C	16	42.86C	15	46.42C
GA ₃ at 100ppm	3017	26	13.33B	25	16.67D	23	23.33C	22	26.67D	20	33.33D	19	36.67D	18	40.00D

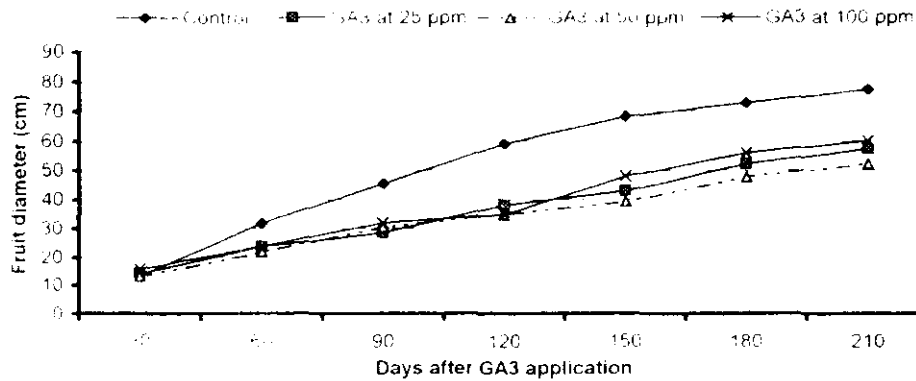
Means having the same letter(s) in each column are statistically insignificant at a level of 5%.

Effect Of GA₃ Foliar Spray On Fruit Growth Development... 1761

1997 season



1998 season



1998 season

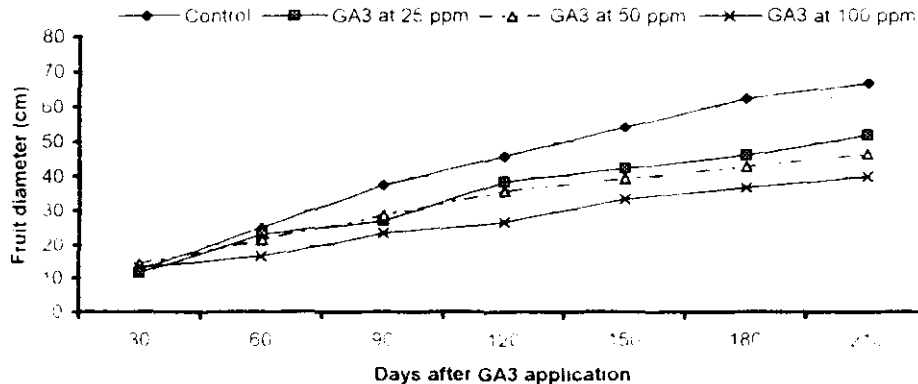


Fig. (2): Effect of different concentrations of GA₃ foliar spray (15 days after fruit set) in relation to days after application on percentage of fruit drop of Picual cv. olives at 1997, 1998 and 1999 seasons.

Effect on total indoles, phenols content:

It is clear from Table (10) and (11) that all the GA₃ concentrations decreased total indoles and phenols content than the control. Interaction between GA₃ levels and sampling dates were significant in most cases. Such results are in agreement with the findings of Rodrigue *et al.* (1999) on olive.

Table (5): Effect of different concentrations of GA₃ spray after different applications times on tree yield (kg) of Picual cv. olive during 1997, 1998 and 1999 seasons.

Treatments	Seasons								
	1997 (On year)	1998 (Off year)	1999 (On year)	Mean of 1997/1998	Percentage of increase	Mean of 1998/1999	Percentage of increase	Mean of 1997/98/99	Percentage of increase
Control	33.51 D	26.51 D	32.01 D	28.51	0.00	29.26	0.00	29.68	0.00
GA ₃ at 25 ppm	32.51 C	27.01 C	34.51 C	29.76	4.38	30.76	5.13	31.34	5.59
GA ₃ at 50 ppm	35.01 B	30.51 B	37.75 B	32.76	14.91	34.13	16.64	34.42	15.97
GA ₃ at 100 ppm	40.01 A	32.61 A	42.51 A	36.31	27.36	37.56	28.37	38.37	29.28
Mean	34.51	29.16	36.69	31.83		32.92		33.45	

Means having the same letter(s) are not significant at 5%.

Table (6): Effect of different concentrations of GA₃ foliar spray (15 days after fruit set) in relation to days after application on some fruit physical properties of Picual cv. Olive trees during 1997, 1998 and 1999 seasons.

Treatments	Average fruit weight (gm)	Average fruit volume (cm)	Average fruit length (cm)	Average fruit diameter (cm)	Length / diameter ratio	Fruit pulp %
1997 season						
Control	3.51 A	4.11 D	2.32 B	1.94 B	1.19	45.01 C
GA ₃ at 25ppm	3.91 BC	4.62 C	2.34 B	2.11 B	1.11	48.85 B
GA ₃ at 50ppm	4.51 A	5.42 B	2.72 A	2.21 AB	1.23	53.44 A
GA ₃ at 100ppm	3.93 B	5.51 A	2.92 A	2.51 A	1.16	49.62 B
1998 season						
Control	2.51 C	3.91 C	1.92 C	1.71 B	1.12	48.21 D
GA ₃ at 25 ppm	3.01 B	4.41 B	2.01 BC	1.91 AB	1.05	50.17 C
GA ₃ at 50 ppm	3.54 A	4.71 B	2.51 AB	2.11 AB	1.19	54.24 B
GA ₃ at 100ppm	3.16 A	5.01 A	2.61 A	2.21 A	1.19	62.02 A
1999 season						
Control	3.21 C	3.71 C	2.42 B	2.11 C	1.15	51.40 C
GA ₃ at 25 ppm	4.54 B	4.91 B	2.52 B	2.41 BC	1.04	59.03 B
GA ₃ at 50 ppm	4.91 A	5.31 A	3.00 A	2.71 AB	1.11	59.27 B
GA ₃ at 100ppm	4.61 AB	5.49 A	3.23 B	2.81 A	1.15	61.34 A

Means having the same letter(s) in each column are statistically insignificant at a level of 5%.

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Table (7): Effect of different concentrations of GA₃ foliar spray (15 days after fruit set) in relation to days after application on the changes in fruit oil percentage (gm/100gm fresh wt.) of Picual cv. olive trees during 1997, 1998 and 1999 seasons.

Sampling date Treatments	Days after fruit set							Mean
	30	60	90	120	150	180	210	
1997 season								
Control	2.76 l	3.66 x	6.05 t	8.62 o	10.90 k	12.66 g	14.05 d	8.38 D
GA ₃ at 25 ppm	2.99 f	4.39 w	6.94 r	8.88 n	11.37 j	13.01 f	14.54 b	8.87 B
GA ₃ at 50 ppm	3.55 y	5.13 u	7.38 q	9.42 m	11.96 l	13.45 e	15.01 a	9.41 A
GA ₃ at 100ppm	3.13 z	4.57 y	6.78 s	8.15 p	10.17 i	12.18 h	14.25 c	8.46 C
Mean	3.11 G	4.44 F	6.79 E	8.77 D	11.10 C	12.82 B	14.46 A	
1998 season								
Control	2.18 l	4.18 x	6.49 t	8.14 p	10.61 i	12.08 h	13.26 d	8.13 D
GA ₃ at 25 ppm	2.61 f	4.54 w	7.05 s	8.62 o	11.05 k	12.54 g	13.82 b	8.60 C
GA ₃ at 50 ppm	3.78 y	6.14 u	8.09 q	10.18 m	12.06 l	12.86 e	14.49 a	9.66 A
GA ₃ at 100ppm	2.77 z	5.30 v	7.80 r	9.84 n	11.21 j	12.66 f	13.81 c	8.99 B
Mean	2.83 G	5.04 F	7.36 E	9.09 D	11.23 C	12.53 B	13.84 A	
1999 season								
Control	2.97 l	4.38 w	6.57 t	8.21 q	10.37 i	12.25 h	14.49 d	8.46 D
GA ₃ at 25 ppm	3.82 y	6.14 u	8.72 p	10.14 m	12.09 l	13.46 e	15.01 b	9.84 B
GA ₃ at 50 ppm	4.14 x	6.58 s	8.67 o	10.61 k	12.50 g	14.54 c	15.45 a	10.35 A
GA ₃ at 100ppm	3.78 z	5.46 v	7.81 r	9.45 n	11.86 j	13.03 f	15.74 c	9.59 C
Mean	3.68 G	5.64 F	7.82 E	9.60 D	11.70 C	13.32 B	15.17 A	

Means having the same letter(s) are not significant at a level of 5%.

Table (8): Effect of different concentrations of GA₃ foliar spray (15 days after fruit set) in relation to days after application on the changes in shoot* total nitrogen content (gm/100gm dry wt.) of Picual cv. olive trees during 1997, 1998 and 1999 seasons.

Sampling date Treatments	Days after application							Mean
	30	60	90	120	150	180	210	
1997 season								
Control	1.05 g-i	1.15 d-g	1.17 c-f	1.21 b-e	1.24 a-e	1.27 ab	1.32 a	1.20 A
GA ₃ at 25 ppm	0.98 i	1.10 f-h	1.15 d-g	1.16 c-f	1.17 c-f	1.20 b-f	1.23 a-e	1.14 C
GA ₃ at 50 ppm	0.97 i	1.04 g-l	1.18 b-f	1.19 b-f	1.23 a-e	1.25 a-d	1.28 ab	1.16 B
GA ₃ at 100ppm	0.95 i	1.02 hi	1.14 e-g	1.17 c-f	1.19 b-f	1.23 a-e	1.25 a-d	1.13 C
Mean	0.99 F	1.08 E	1.16 D	1.18 CD	1.21 BC	1.23 AB	1.27 A	
1998 season								
Control	0.98 j-m	1.02 i-l	1.10 f-h	1.14 c-f	1.21 a-d	1.26 ab	1.29 a	1.14 A
GA ₃ at 25 ppm	0.90 m	0.95 l-m	1.02 i-l	1.03 i-l	1.12 e-h	1.21 a-d	1.22 a-c	1.06 D
GA ₃ at 50 ppm	0.95 l-m	0.97 km	0.98 j-m	1.06 g-j	1.16 c-f	1.25 ab	1.26 ab	1.08 B
GA ₃ at 100ppm	0.92 m	0.98 j-m	1.05 h-k	1.13 d-h	1.15 c-f	1.19 b-f	1.21 a-d	1.10 B
Mean	0.94 E	0.98 E	1.04 D	1.09 C	1.16 B	1.23 A	1.25 A	
1999 season								
Control	1.12 r	1.15 p	1.18 m	1.21 j	1.25 g	1.30 c	1.35 a	1.22 A
GA ₃ at 25 ppm	0.95 v	0.98 t	1.14 q	1.16 o	1.19 l	1.24 h	1.27 f	1.13 C
GA ₃ at 50 ppm	1.10 s	1.14 q	1.17 n	1.20 k	1.26 g	1.29 d	1.32 b	1.21 B
GA ₃ at 100ppm	0.96 u	0.97 t	1.10 s	1.15 p	1.23 l	1.26 f	1.29 d	1.14 C
Mean	1.03 G	1.07 F	1.14 E	1.18 D	1.23 C	1.27 B	1.31 A	

* Samples were taken from the middle portion of bearing shoots.

Means having the same letter(s) are not significant at a level of 5%.

Table (9): Effect of different concentrations of GA₃ foliar spray (15 days after fruit set) in relation to days after application on the changes in shoot* total carbohydrates content (gm/100gm dry wt.) of Picual cv. olive trees during 1997, 1998 and 1999 seasons.

Sampling date Treatments	Days after application							Mean
	30	60	90	120	150	180	210	
1997 season								
Control	30.05 a	30.10 a	30.24 a	30.34 a	30.38 a	30.42 a	30.45 a	30.28 A
GA ₃ at 25 ppm	22.23 h	22.25 h	22.28 h	23.14 g-h	23.40 fg	23.63 e-g	23.80 e-g	22.96 C
GA ₃ at 50 ppm	26.93 c	27.13 bc	27.34 bc	27.83 bc	27.95 b	27.98 b	28.23 b	27.63 B
GA ₃ at 100ppm	23.45 fg	23.53 fg	23.80 e-g	24.20 ef	24.34 d-f	24.56 de	25.34 d	24.17 C
Mean	25.67 D	25.75 CD	25.92 B-D	26.36 AC	26.52 AB	26.65 A	26.95 A	
1998 season								
Control	27.50 c	27.73 bc	27.94 bc	28.35 bc	28.43 bc	28.65 b	29.20 a	28.26 A
GA ₃ at 25 ppm	20.40 n	20.63 mn	20.90 l-n	21.10 k-n	21.35 j-n	21.65 l-l	21.90 l-l	21.13 D
GA ₃ at 50 ppm	24.75 f	24.95 ef	25.43 d-f	25.95 de	26.43 cd	27.45 c	27.92 bc	26.13 B
GA ₃ at 100ppm	21.63 j-m	21.94 l-k	22.30 h-j	22.64 g-i	22.94 gh	23.15 gh	23.45 g	22.58 C
Mean	23.57 E	23.81 DE	24.14 CD	24.51 B-D	24.79 BC	25.23 AB	25.62 A	
1999 season								
Control	30.64 cd	30.92 cd	31.20 b-d	31.57 a-c	31.94 ab	32.34 a	32.56 a	31.60 A
GA ₃ at 25 ppm	23.56 o	23.86 no	24.23 m-o	24.73 k-n	25.13 k-m	25.31 kl	25.73 k	24.65 D
GA ₃ at 50 ppm	27.94 hi	28.20 g-l	28.63 fh	28.94 e-h	29.12 e-g	29.32 ef	29.56 de	28.82 B
GA ₃ at 100ppm	24.53 l-o	24.93 k-m	25.20 k-m	25.63 k	26.53 j	27.20 j	27.45 j	25.92 C
Mean	26.67 E	26.98 DE	27.32 CD	27.72 BC	28.18 AB	28.54 A	28.82 A	

* Samples were taken from the middle portion of bearing shoots.
Means having the same letter(s) are not significant at a level of 5%.

Table (10): Effect of different concentrations of GA₃ foliar spray (15 days after fruit set) in relation to days after application on the changes in shoot* total indoles content (gm/100gm dry wt.) of Picual cv. olive trees during 1997, 1998 and 1999 seasons.

Sampling date Treatments	Days after application							Mean
	30	60	90	120	150	180	210	
1997 season								
Control	0.37 c-h	0.39 b-f	0.42 a-d	0.45 a-c	0.46 a-c	0.48 ab	0.51 a	0.44 A
GA ₃ at 25 ppm	0.23 k	0.25 jk	0.27 h-k	0.29 f-k	0.32 e-k	0.34 d-j	0.36 c-l	0.29 C
GA ₃ at 50 ppm	0.34 d-j	0.36 c-l	0.38 b-g	0.41 a-e	0.43 a-d	0.45 a-c	0.46 a-c	0.41 B
GA ₃ at 100ppm	0.24 jk	0.26 i-k	0.28 g-k	0.32 e-k	0.34 d-j	0.36 c-l	0.38 b-g	0.31 D
Mean	0.29 G	0.31 F	0.33 E	0.36 D	0.38 C	0.40 B	0.42 A	
1998 season								
Control	0.34 b-f	0.36 a-e	0.38 a-d	0.41 a-c	0.42 ab	0.43 ab	0.45 a	0.41 A
GA ₃ at 25 ppm	0.17 j	0.19 j	0.21 ij	0.22 h-j	0.24 g-j	0.26 f-j	0.28 e-l	0.22 C
GA ₃ at 50 ppm	0.26 j	0.28 e-i	0.31 d-h	0.32 c-g	0.34 b-f	0.35 b-f	0.38 a-d	0.32 B
GA ₃ at 100ppm	0.24 g-j	0.26 f-j	0.28 e-i	0.31 d-h	0.32 c-g	0.34 b-f	0.36 a-e	0.31 B
Mean	0.25 G	0.27 F	0.29 E	0.31 D	0.33 C	0.34 B	0.36 A	
1999 season								
Control	0.45 e-k	0.47 d-i	0.49 c-g	0.52 b-e	0.56 a-c	0.59 ab	0.62 a	0.53 A
GA ₃ at 25 ppm	0.33 o	0.35 mo	0.37 k-o	0.39 i-o	0.41 g-o	0.43 f-m	0.46 e-j	0.39 D
GA ₃ at 50 ppm	0.44 e-l	0.46 e-j	0.47 d-i	0.50 c-f	0.52 b-e	0.54 a-d	0.56 a-c	0.50 B
GA ₃ at 100ppm	0.34 no	0.36 l-o	0.38 j-o	0.40 h-o	0.42 f-n	0.46 e-j	0.48 c-h	0.41 C
Mean	0.39 G	0.41 F	0.43 E	0.45 D	0.48 C	0.50 B	0.53 A	

* Samples were taken from the middle portion of bearing shoots.
Means having the same letter(s) are not significant at a level of 5%.

Table (11): Effect of different concentrations of GA₃ foliar spray (15 days after fruit set) in relation to days after application on the changes in shoot* total phenols content (gm/100gm dry wt.) of Picual cv. olive trees during 1997, 1998 and 1999 seasons.

Sampling date	Days after application							Mean
	Treatments	30	60	90	120	150	180	
1997 season								
Control	1.90 d-f	1.93 c-e	1.95 cd	1.97 c	2.15 b	2.45 a	2.52 a	2.12 A
GA ₃ at 25 ppm	1.62 l	1.67 kl	1.72 i-l	1.75 h-k	1.84 e-h	1.86 d-g	1.92 d-f	1.77 C
GA ₃ at 50 ppm	1.78 g-j	1.82 f-i	1.86 d-g	1.92 d-f	1.95 cd	2.04 c	2.20 b	1.94 B
GA ₃ at 100ppm	1.65 kl	1.69 j-l	1.72 l-l	1.75 h-k	1.80 f-l	1.85 d-h	1.87 d-f	1.76 C
Mean	1.74 F	1.77 E	1.81 E	1.85 D	1.93 C	2.05 B	2.13 A	
1998 season								
Control	1.68 f-j	1.71 e-i	1.74 d-g	1.78 c-f	1.81 c-e	1.85 bc	1.98 a	1.79 A
GA ₃ at 25 ppm	1.56 k-n	1.58 j-m	1.61 i-l	1.62 i-l	1.64 g-k	1.65 g-k	1.67 g-j	1.62 B
GA ₃ at 50 ppm	1.67 g-j	1.69 f-i	1.73 d-h	1.75 c-g	1.78 c-f	1.83 b-d	1.92 ab	1.77 A
GA ₃ at 100ppm	1.47 n	1.49 mn	1.53 l-a	1.56 k-n	1.63 h-l	1.64 g-k	1.69 f-i	1.57 B
Mean	1.58D	1.62 CD	1.65 BD	1.69 BC	1.72 AB	1.78 A	1.81 BD	
1999 season								
Control	1.97 d	1.98 d	2.23 c	2.46 ab	2.48 ab	2.50 ab	2.56 a	2.31 A
GA ₃ at 25 ppm	1.78 h-k	1.79 g-k	1.82 f-j	1.85 e-l	1.87 e-h	1.89 d-g	1.92 d-f	1.85 B
GA ₃ at 50 ppm	1.89 d-g	1.92 d-f	1.95 de	1.97 d	2.23 c	2.43 b	2.53 ab	2.13 A
GA ₃ at 100ppm	1.69 k	1.72 j-k	1.75 l-k	1.78 h-k	1.83 f-i	1.92 d-f	1.95 de	1.81 B
Mean	1.83 F	1.85 F	1.94 E	2.01 D	2.10 C	2.18 B	2.24 A	

* Samples were taken from the middle portion of bearing shoots.
Means having the same letter(s) are not significant at a level of 5%.

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تأثير الرش بالجبرلين على تطور نمو الثمرة والمحصول وجودة ثمار الزيتون البكوال

محمد. أبو رواش^{*}، حسن محمد فاضل الوكيل^{*}، ملكة عبد الفتاح صالح^{**}،

إلهام زينهم

- * قسم البساتين - كلية الزراعة - جامعة عين شمس - شبرا الخيمة - القاهرة - مصر.
- ** قسم الفاكهة - المركز القومي للبحوث - الدقى - الجيزة - مصر.

أجريت هذه الدراسة فى مزرعة خاصة بكفر داوود بمحافظة المنوفية على أشجار الزيتون 'بكوال' وذلك خلال ثلاث سنوات متتالية هى ٩٧/٩٦ ، ٩٨/٩٧ ، ٩٩/٩٨ على أشجار عمرها ٨ سنوات ومنزوعة فى أرض رملية على مسافة ٦ × ٦ وكان الهدف من الدراسة هو الرش بالجبرلين بتركيزات صفر ، ٢٥ ، ٥٠ ، ١٠٠ جزء فى المليون ودراسة تأثيراتها على نمو الثمرة والتساقط والمحصول الكلى للأشجار وبعض الصفات الطبيعية والكيمائية وتم اختيار الأشجار لإجراء المعاملات فى سن الحمل الغزير خلال موسم الدراسة الأول والثالث وبعد ١٠ أيام من التزهير الكامل وتتلخص النتائج فى الآتى:

- زاد قطر الثمرة تدريجياً مع تقدم عمر الثمرة وكانت زيادة غير معنوية فى الفترات الثلاثة من ٣٠-٤٥ ، ٩٠-١٠٥ ، ١٢٠-١٣٥ يوم بعد عقد الثمار وفشلت ثمار أشجار المقارنة وثمار الأشجار التى رشت بالجبرلين بتركيزات ٥٠ ، ١٠٠ جزء فى المليون فى إظهار أى توقف عن النمو ولوحظ نقص ملحوظ فى نسبة تساقط الثمار التى رشت بتركيز ٥٠ ، ١٠٠ جزء فى المليون من أشجار المقارنة بنسبة ١٤,٦% ، ٣٢,٥% ، ٤٠% فى الموسم الأول والثانى والثالث.
- زاد نسبة متوسط محصول سنوات الدراسة الثلاثة عن أشجار المقارنة وأظهرت المستويات المرتفعة من الجبرلين ٥٠ ، ١٠٠ جزء فى المليون زيادة فى وزن الثمار وحجم الثمار وقطر الثمرة وطول الثمار والنسبة المئوية لللب عن التركيز المنخفض وعلى العكس بالنسبة لطول الثمرة إلى قطرها أدى الرش بـ ٥٠ جزء فى المليون إلى انخفاض هذه النسبة وبالتالي أصبحت الثمرة تميل إلى الاستدارة.
- أظهرت نتائج الرش بتركيزات الجبرلين المختلفة إلى زيادة نسبة الزيت بالثمار بصورة معنوية عن الكنترول ، أما عن محتوى الأفرع من النيتروجين الكلى والكاربوهيدرات الكلية والإندولات والفينولات التى رشت كانت منخفضة مقارنة بالأشجار الغير معاملة.