Egypt. J. Hort., **Vol. 40**, No, **1**. pp. 133-142 (2013)

Effect of Different Concentrations of Foliar Applications of Urea, NAA and Ethrel on Fruit Thinning of 'Dolce' Olive cv.

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THIS EXPERIMENT was executed in an olive private farm in Cairo Alexandria desert road (64 kilometer) to study the effect of spraying with Urea at 2% and 4%, NAA at 100 mg.L^{-1} and 150 mg.L^{-1} and Ethrel at 150 mg.l^{-1} and 300 mg.l^{-1} on 'Dolce' olive cv. trees (7 years-old) were planted 6 x 4m and irrigated with drip irrigation. The farm received the recommended managements of Horticulture Research Institute publication (2011). As for thinning NAA with at 150 mg.l^{-1} concentration gave the might percentage of thinning, however the foliar application of urea 2 % concentration and Ethrel at 150 mg. l^{-1} gave the least ratios and the rest of the treatments showed the middle values between them. The remaining fruits per meter before harvesting were less when sprayed with NAA with at 150 mg.l^{-1}concentration, also the highest thinning ratios was before harvesting (resulted from thinning + June dropping + dropping before harvesting) in both seasons. It is obvious that spraying NAA with at 150 mg. l^{-1}concentration leads to the increasing significantly of the length, diameter and weight in addition to the fruit volume and yield during the two growing seasons. Although those treatments didn't gave any significant difference in the fruit moisture percentage, spraying with NAA gave the highest significant difference in oil percentage as dry weight. Depending on these results we can recommend the spraying of NAA with at 150 mg. l^{-1} concentration to improve the production and quality of "Dolce" olive fruits through thinning.

Keywords: Urea, Naphthaline acetic acid, Ethrel, Olive 'Dolce' cv., Oil percentage and Yield.

Fruit thinning has been used for many years. Heavy crop load can result in fruits with small size and poor quality, breakage of limbs, exhaustion of tree reserves and reduced cold hardiness (Dennis, 2000). Fruit trees are often affected by spring frost. So, fruit thinning must to be done on time after fruit blooming (Bolat and Karlidağ, 1999) and as reported earlier (Surányi, 1982), best results gained when fruit thinning was applied after the danger of spring frost was averted. The discovery of plant hormones and their ability to regulate all aspects of growth and development were defining moments in horticulture (Greene, 2010).

Urea induced fruitlet abscission in apricot trees and its effect was the same as NAA. Urea significantly reduced fruit set in peaches and nectarines (Zilkah *et al.*, 1988), and pistachio (Rahemi and Ramezanian, 2007). Estembridge and Gambrell (1971) found that for peach cultivars, application of Ethrel at 100 to 150 mg l^{-1} in endosperm cytokines is stage resulted in sufficient thinning.

Certain endogenous hormones are involved in there gulation of fruit setting in many fruits. Plant growth regulating chemicals like naphthalene acetic acid (NAA) may be used to increase fruit set of certain fruit crops like apples, dates, and citrus and olive. Plant growth regulating hormones like naphthalene acetic acid alone and/or combined with other managerial operations may be playing an important role in fruit production and quality of olive (Khalil *et al.*, 2012). Thomas (1982) said that to have successful thinning NAA must be sprayed 12-18 days after full blooming. Spraying NAA affected percentage of thinning and fruit quality (Bolat and Karlidag, 1999). Ethrel is a follow up thinner when prior chemical thinning agents have unsuccessful to thinning successfully (Byers, 2003).

The purpose of this study was to investigate the preferable effect of urea, NAA or Ethrel on thinning of "Dolce" cv. to improve fruit quality.

To increase the fruit size normally the farmers practice hand thinning of fruit. But recently naphthalene acetic acid (NAA) has been reported to be useful for thinning of fruits (Agusti *et al.*, 2000). It plays important roles in fruit formation and abscission, cell elongation, apical dominance, photoperiod and geotropism (Haidry *et al.*, 1997).

Material and Methods

The present study was carried out during 2011 and 2012 growing seasons on 'Dolce' olive trees (7 years old), planted in a private farm at kilometer 64 from Cairo (Cairo Alexandria desert road). These trees were uniform in shape and size as possible and planted 6 x 4 meters apart and grown in sandy loam soil and irrigated with drip irrigation from well (underground water). Trees received the normal of organic and chemical fertilizers in winter at the beginning of November and the chemical fertilization program during the growing season. Also irrigation and pest control program were executed according to the recommendation in olive and semiarid Dept. in Horticulture Research Institute, ARC (Elsayed and Abou-Shanab, 2011).

The research study included the effect of foliar applications of urea (at 46% concentration) 2% and 4%, Naphthalin acetic acid (NAA) 100 and 150 mg. l^{-1}, Ethrel at 150 and 300 mg.l^{-1} on thinning of "Dolce" olive cv. Spraying was executed 15 days after full bloom. The complete randomized design with three replicates per treatment (one tree of replicate) was adapted in this study. The following treatments were included:

1- Control
2- Urea at 2%
3-Urea at 4%
4- NAA at 100 mg. l^{-1}.
5- NAA at 150 mg. l^{-1}.
6- Ethrel at 150 mg. l^{-1}.
7- Ethrel at 300 mg. l^{-1}.

Measurements

Growth parameters: At the beginning of the growing season (during first week of May) the Shoot length (cm) was measured to relate the number of fruits.

Fruiting: Number of fruit set before spraying at the beginning of May, and number of fruits after spraying in mid June and before harvesting at the beginning of September were measured per meter.

Fruit quality: Thirty fruits per tree were randomly selected for carrying out the fruit quality measurements:

Fruit length (cm), fruit diameter (cm) and volume, fruit weight (g), flesh weight (g.), seed length (cm), seed diameter (cm), seed weight (g).

Yield: average yield per tree was calculated from each treatment (Kg/tree).
Oil percentage as dry weight. By means of soxhalt extraction apparatus using petroleum ether as described by A.O.A.C. (1975).

Statistical analysis

The experiment included in this study followed a complete randomized design in factorial experiment. The obtained data was subjected to analysis of variance (ANOVA) according to Snedecor and Cochran (1980). Differences between treatments were compared by Duncan's multiple range test described in the SAS (SAS, 1986).

Results and Discussion

Number of fruits/m and fruit drop percentage

Concerning the effect of foliar application (15 days after full bloom) of urea at 2% and 4%, NAA at 100 and 150 mg. l^{-1}, Ethrel at 150 and 300 mg. l^{-1} on "Dolce" cv. shoot length, number of fruit before spraying and after June drop and before harvesting during 2011 and 2012 seasons, data presents in Tables 1 and 2. As for number of fruits after spraying, control, urea at 2% gave the highest significant differences in 2011 season, meanwhile Ethrel at 150 mg. l^{-1} performed the highest significant difference after spraying, after June drop and before harvesting compared to other treatments in both seasons. Whereas, percent of fruit thinning after spraying, after June drop and before harvesting showed the superior values as affected by NAA at 150 ppm during 2011 and 2012 seasons. These results consistent with (Zilkah *et al.*, 1988) who found that, thinning of peaches and nectarines with different concentrations of urea. These results go also in line with those of

Taghipour and Rahemi,(2009 and 2010), Taghipour *et al*. (2011) and Bonghi, *et al*. (2002).

TABLE 1. The effect of foliar applications of different concentrations of urea, Naphthaline acetic acid and Ethrel on number of fruits/m and fruit drop percentage "Dolce" olive cv. during 2011 growing season.

Treatments	2011 season						
	Number of fruits/m before spraying	Number of fruits/m after spraying	% of fruit drop after spraying	Number of fruits/mafter June drop	% of fruit drop after June drop	Number of fruits/m before harvesting	% of fruit drop before harvesting
Control	59.44	55.70a	6.08d	48.60ab	18.18d	47.33ab	20.39d
Urea 2%	56.74	51.23a	8.99d	45.11b	19.90d	43.96b	22.06d
Urea 4%	55.11	46.13b	16.30d	34.24c	37.83c	34.46c	37.07c
NAA 100 mg.L^{-1}	67.37	37.94c	43.85b	35.49c	47.41b	34.69c	48.61b
NAA 150 mg.L^{-1}	58.94	23.98d	58.45a	21.00d	63.89a	20.44d	64.88a
Ethrel 150 mg.L^{-1}	59.17	54.48a	7.81d	49.98a	16.05d	49.27a	17.26d
Ethrel 300 mg.L^{-1}	56.89	41.79bc	27.09c	37.68c	34.09c	38.64c	37.57c
L.S.D at 5 %		4.434	10.05	3.813	6.587	4.294	6.678

*Means followed by the same higher case letter within the same column are not significantly different, p = 0.05.

TABLE 2. The effect of foliar applications of different concentrations of urea, Naphthaline acetic acid and Ethrel on number of fruits/m and fruit drop percentage on "Dolce" olive cv. during 2012 growing season.

Treatments	2012 season						
	Number of fruits/m before spraying	Number of fruits/m after spraying	% of drop fruits	Number of fruits/m after June drop	% of drop fruits	Number of fruits/m before harvesting	% of drop fruits
Control	54.22	44.81b	17.25b	43.76b	19.24d	43.58b	19.53d
Urea 2%	48.40	41.17b	14.91b	38.70c	20.04cd	38.42c	20.62cd
Urea 4%	51.85	43.54b	16.10b	40.44bc	21.59cd	40.36bc	22.16cd
NAA 100 mg.L^{-1}	35.03	29.27c	17.04b	23.27d	33.85b	23.13d	34.19b
NAA 150 mg.L^{-1}	23.76	17.32d	27.68a	14.42f	39.68a	14.42e	39.68a
Ethrel 150 mg.L^{-1}	65.26	53.87a	17.42b	50.53a	22.54c	50.41a	22.74c
Ethrel 300 mg.L^{-1}	28.81	22.01d	24.33a	19.70e	32.50b	19.41d	33.34b
L.S.D at 5 %		4.896	5.968	3.424	2.928	4.131	2.613

*Means followed by the same higher case letter within the same column are not significantly different , p = 0.05.

Fruit and seed dimensions

Data in Tables 3 and 4 presents fruit dimensions (fruit length and diameter, fruit weight, seed weight, seed length and diameter) of Dolce olive cv. during 2011 and 2012 seasons. It is obvious that NAA at 150 mg. l^{-1} increased

significantly fruit and seed length, diameter and weight compared to the control and other treatments in both seasons. Whereas, Ethrel at 150 mg. l^{-1} increased significantly the seed length, control and urea at 2 % increased significantly seed diameter in the first season. Meantime, NAA at 100 mg. l^{-1} gave the same effect on seed and fruit weight during 2011 season.

TABLE 3. The effect of foliar applications of different concentrations of urea, Naphthaline acetic acid and Ethrel on fruit and seed dimensions of "Dolce" olive cv. during 2011 growing season.

Treatments	2011 season					
	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (g)	Seed length (cm)	Seed diameter (cm)	Seed Weight (g)
Control	3.28b	1.53cd	3.94b	2.07b	0.700a	0.543cd
Urea 2%	3.14c	1.63b	3.78b	2.06b	0.703a	0.497d
Urea 4%	3.09c	1.50d	3.24c	2.07b	0.663c	0.487d
NAA 100 mg.L^{-1}	3.13c	1.61bc	4.63a	2.10b	0.687ab	0.727a
NAA 150 mg.L^{-1}	3.41a	1.76a	4.84a	2.26a	0.703a	0.747a
Ethrel 150 mg.L^{-1}	2.81d	1.51d	2.79d	2.30a	0.693ab	0.653b
Ethrel 300 mg.L^{-1}	2.82d	1.48d	2.79d	2.11b	0.680bc	0.557c
L.S.D at 5 %	0.126	0.080	0.264	0.149	0.018	0.056

*Means followed by the same higher case letter within the same column are not significantly different, p = 0.05.

TABLE 4. The effect of foliar applications of different concentrations of urea, Naphthaline acetic acid and Ethrel on fruit and seed dimensions of "Dolce" olive cv. during 2012 growing season.

Treatment	2012 season					
	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (g)	Seed length (cm)	Seed diameter (cm)	Seed Weight (g)
Control	3.28b	1.53cd	3.94b	2.60a	0.743b	0.837a
Urea 2%	3.14c	1.63b	3.78b	2.33b	0.747b	0.710bc
Urea 4%	3.09c	1.50d	3.24c	2.28b	0.697cd	0.640c
NAA 100 mg.L^{-1}	3.13c	1.61bc	4.63a	2.43ab	0.730b	0.773ab
NAA 150 mg.L^{-1}	3.41a	1.76a	4.84a	2.57a	0.813a	0.803a
Ethrel 150 mg.L^{-1}	2.81d	1.51d	2.79d	2.03c	0.707c	0.493d
Ethrel 300 mg.L^{-1}	2.82d	1.48d	2.79d	2.01c	0.680d	0.510d
L.S.D at 5 %	0.126	0.080	0.264	0.169	0.019	0.080

*Means followed by the same higher case letter within the same column are not significantly different, p = 0.05.

Meanwhile, NAA (mg. l^{-1}) increased significantly fruit weight; in addition the control increased significantly seed length and weight during 2011 and 2012 seasons. Noor *et al*. (1995), Mistra & Datta, (2001) and Levin & Lavee, (2005) reported that NAA improved number of inflorescence flower number fruit setting and fruit size.

Fruit moisture, flesh weight and volume, oil % and yield

As regard to, fruit flesh weight (g) and volume, moisture %, oil % and yield (kg/tree) were presented in Tables 5 and 6 in 2011 and 2012 seasons. It is obvious that NAA at 150 mg. l^{-1} increased significantly fruit volume, flesh weight (g.) and yield (kg/tree) in comparison with the control and other treatments in both seasons, as oil % as fresh weight (g.) didn't show any significant differences in the first season but only oil % as dry weight (g) in the second season, Ethrel at (mg. l^{-1}) performed the least significant differences of moisture content (%) and oil % as dry weight (g) in the first season and yield in both seasons.

TABLE 5. The effect of foliar applications of different concentrations of urea, Naphthaline acetic acid and Ethrel on fruit volume, flesh weight (g.), moisture content (%), oil (%) and yield (kg/tree) of "Dolce" olive cv during 2011 growing season.

Treatments	2011 season					
	Fruit volume	Flesh weight (g)	Moisture content %	Oil % as fresh weight	Oil % as dry weight	Yield(kg)/ee
Control	**3.70c**	**2.68d**	**65.66a**	**16.11a**	**46.92a**	**50.00c**
Urea 2%	3.47c	2.48de	65.66a	16.12a	46.94a	47.67c
Urea 4%	3.60c	2.40e	65.84a	16.13a	47.23a	52.67b
NAA 100 mg.L^{-1}	4.73b	3.65b	65.71a	16.31a	47.56a	55.00ab
NAA 150 mg.L^{-1}	5.20a	4.20a	65.73a	16.23a	47.38a	56.00a
Ethrel 150 mg.L^{-1}	4.40b	3.26c	62.70b	16.24a	43.89b	35.00d
Ethrel 300 mg.L^{-1}	3.57c	2.65de	65.39a	16.44a	47.42a	52.67b
L.S.D at 5 %	0.351	0.264	1.051	N.S.	1.565	2.409

*Means followed by the same higher case letter within the same column are not significantly different, p = 0.05.

TABLE 6. The effect of foliar applications of different concentrations of urea, Naphthaline acetic acid and Ethrel on fruit volume, flesh weight (g.), Moisture content (%), oil (%) and yield (kg/tree) of "Dolce" olive cv during 2012 growing season.

Treatments	2012 season					
	Fruit volume	Flesh weight (g)	Moisture content %	Oil % as fresh weight	Oil % as dry weight	Yield (kg)/tree
Control	4.43b	3.10b	65.55a	16.00a	46.44bc	51.00c
Urea 2%	4.13bc	3.07b	66.05a	15.86a	46.72bc	54.00b
Urea 4%	3.77c	2.60c	66.42a	16.10a	47.95ab	56.00ab
NAA 100 mg.L^{-1}	5.00a	3.86a	65.37a	15.97a	46.11c	54.33b
NAA 150 mg.L^{-1}	5.23a	4.04a	66.45a	16.24a	49.12a	58.00a
Ethrel 150 mg.L^{-1}	3.10d	2.30c	65.93a	16.09a	47.22bc	45.33d
Ethrel 300 mg.L^{-1}	3.80c	2.28c	66.21a	15.81a	46.79bc	50.33c
L.S.D at 5 %	0.386	0.308	N.S.	N.S.	1.634	2.387

*Means followed by the same higher case letter within the same column are not significantly different, p = 0.05.

Although, moisture content (%) and oil % as fresh weight (g) didn't show any significant differences, NAA at (150 mg. l^{-1}) gave the highest and significant value of oil % as dry weight during 2012 season.

Conclusion and Discussion

These results are coincide with those of Ryan *et al*. (2002), Bianchi (2003) and Khalil *et al*. (2012), Variable response of plant growth regulators (PGRs) might be due to fact that PGRs role depends upon the time of application, concentration and absorbed quantity (Rajput and Haribabu, 1985). Moreover, NAA effects might be due to that to an improve of the internal hormonal and carbohydrate level of the canopy which is responsible for improving number of inflorescence (Levin and Lavee, 2005), flower number (Noor *et al.,* 1995) fruit setting and fruit size in Kalamata olive cv. (Proietti & Tombesi, 1990 and Petrisou and Voyiatzis, 1994). Similarly, Mistra and Datta (2001). Ethrel effectively induced fruit abscission. As Ethrel is absorbed by the tissue, its hydrolysis occurs and released Ethylene induces abscission by elevating respiration rate and production of enzymes which hydrolyze cellulose in the abscission layer (Wolpert and Ferguson, 1990).

Conclusively, spraying NAA at 150 mg. l^{-1} may improve the fruit production and quality of "Dolce" cv. through fruit thinning.

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(*Received* 28/3/2013;
accepted 26/5/2013)

تأثير الرش بتركيزات مختلفة من اليوريا ونفثالين حامض الخليك والإثيريل على خف ثمار الزيتون صنف الدولسى

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هذا البحث تم تنفيذه فى مزرعة خاصة بالطريق الصحراوى مصر ـ إسكندرية (كيلو ٦٤) وذلك لدراسة تأثير الرش بتركيزات مختلفة من (يوريا ٢٪ و ٤٪)، والنفثالين حمض الخليك (١٠٠ و١٥٠ جزء فى المليون) والإثريل (١٥٠ و ٣٠٠ جزء فى المليون) بعد قمة التزهير باسبوعين على خف ثمار الزيتون صنف الدولسى عمر ٧ سنوات والاشجار منزرعة على مسافات ٦ x ٤ م تحت نظام الرى بالتنقيط وكان يطبق عليها توصيات معهد بحوث البساتين فى خدمة أشجار الزيتون. وكانت النتائج كالأتى:

- تم الحصول على أعلى نسبة مئوية للخف بالنفثالين حمض الخليك بتركيز ١٥٠ جزء فى المليون وكانت أقل نسبة عند الرش باليوريا بتركيز ٢٪ والأيثريل بتركيز ١٥٠ جزء فى المليون وباقى القيم واسطاً بين الحدين.

- كانت نسبة الثمار المتبقية فى المتر الطولى قبل الجمع أقل عند الرش بالنفثالين حمض الخليك بتركيز ١٥٠ جزء فى المليون وأيضاً أعلى نسبة تساقط قبل الجمع (ناتجة عن الخف + تساقط يونيه + تساقط قبل الجمع) وذلك فى كلا الموسمين.

- ومن الواضح أن رش النفثالين حمض الخليك ١٥٠ جزء فى المليون أدى إلى زيادة معنوية فى طول وقطر الثمار ووزن الثمار وكذلك حجم الثمار والمحصول أثناء موسمى الدراسة.

- على الرغم أن هذه المعاملات لم تعطى أى فرق معنوى بالنسبة لنسبة الرطوبة فى الثمار إلا أن الرش بنفثالين حمض الخليك ١٥٠ جزء فى المليون أعطى أعلى قيمة معنوية من النسبة المئوية للزيت على أساس الوزن الجاف.

وبناءً على هذه النتائج فإنه يمكن أن نوصى بالرش بنفثالين حمض الخليك بتركيز ١٥٠ جزء فى المليون لتحسين إنتاج وجودة ثمار الزيتون صنف الدولسى من خلال خف الثمار.