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Research Article

The Effects of Chemical Thinning Applications on Yield and Quality Characteristics in Different Olive Varieties

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Abstract

Olive is a very important and useful fruit species that is cultivated economically in the Mediterranean regions. Yield and quality effects of olive oil and olive fruits are increased by many methods, one of them is fruit thinning. Fruit thinning is an application to control periodicity as well as increasing fruit yield and quality in olive cultivation. In addition to olives, it is currently applied in apricots, peaches, apples and pears. In recent years, potassium salt of naphthalene acetic acid (K-NAA) started to be used intensively in thinning of various fruit crops. In this study, the effects of chemical fruit thinning by using naphthalene acetic acid as potassium salt (K-NAA) on fruit yield and quality of the table olive varieties Domat, Gemlik and Memecik was determined. NAA was applied at 120, 160 and 200 ppm at 12, 16 and 20 days after full bloom, respectively, and at 100, 120 and 150 ppm at 3 - 5 mm fruit length. It was determined that 160 ppm at post-bloom and 120 ppm at fruitlet stage gave the highest increase in yield. The highest yield was obtained from Memecik and the lowest yield from Gemlik. In terms of quality parameters such as fruit weight (g), flesh/pip ratio (%), yield per unit trunk sectional area, fruit width (mm), and fruit length (mm), 160 ppm at post-bloom and 120 ppm at fruitlet stage gave the best results. This research is very important as it is a method to reduce alternate bearing and to increase yield and quality in olive.

Keywords: Olive; Thinning; NAA; Yield; Quality

Introduction

In Turkey, olive cultivation is increasing day by day with modern technic. Olive cultivation of Turkey reached about 846.061 hectares in 2017/2018 years [1]. According to the International Olive and Olive Oil Council, it is predicted that olive production is 1 million 515 thousand tons and olive oil production is 225 thousand tons in 2019 [2]. In Turkey, common olive varieties are Memecik, Ayvalık, Domat, Erkence and Gemlik varieties and also in the Aegean region [3]. Manisa/Ahmetli province where the study is conducted is a region that has a high olive cultivation potential in The Aegean Region. Manisa/Ahmetli region has Mediterranean climate where is range of min 3°C, max 34.3°C in the temperature and Gemlik and Ayvalık varieties are cultivated in this region. Olive orchards is intensively irrigated and fertilized in this region. Olive intends to alternate bearing by genetical, environmental factors (such as temperature or water and nutrient availability). Alternate bearing affects vegetative growth and the performance of reproductive processes (induction, evocation, differentiation, bloom, fruit set, and fruit growth and ripening), endogenous determinants such as the balances of carbohydrate, mineral nutrients, and hormones [4,5].

Chemical thinning is the most useful practice to control the fruit yield and quality and alleviate the alternate bearing in olive tree both on and off years [6-9]. This phenomenon gives rise to an economically fluctuating fruit production in olive tree. For example,

this causes severe labour, marketing and also economic problems can affect the entire sector [7,8]. Chemical thinning such as NAA (naphthaleneacetic acid) application, increases the fruit size and yield/tree (kg) in especially olive table cultivars and also oil olive cultivars. In addition to chemical thinning affects positively the flower bud differentiation and full bloom [10]. Chemical thinning is the most useful practice to control the fruit yield and quality and alleviate the alternate bearing in olive tree both on and off years [6-9]. This phenomenon gives rise to an economically fluctuating fruit production in olive tree. For example, this causes severe labour, marketing and also economic problems can affect the entire sector [7,8]. Chemical thinning such as NAA (naphthaleneacetic acid) application, increases the fruit size and yield/tree (kg) in especially olive table cultivars and also oil olive cultivars. In addition to chemical thinning affects positively the flower bud differentiation and full bloom [10].

Materials and Methods

"Gemlik, Memecik and Domat" varieties are the most important table varieties in Turkey. Therefore these 3 olive varieties were used as plant material in this study. Research were conducted on a total of 63 trees (including control plots) in order to reveal the effects of different NAA application on fruit yield and quality in Gemlik, Domat and Memecik varieties in Manisa/Ahmetli.

Experimental site

Experimental site carried out in Manisa/Ahmetli region. Trees took place same orchard which were 10 years old and planted at 6 x 6 meters. Selected trees were applied to appropriate agricultural practices such as fertilization, irrigation, pruning and pest-diseases control. Trees subjected chemical thinning were grown in experimental plots of Manisa/Ahmetli region. Fruit thinnings were conducted in two consecutive years (off-year 2015 and on-year 2016).

NAA application

Two methods were used to accurately time NAA applications. In May 2015, 12, 16, 20 days later after full bloom (AFB) (Full bloom in 2015: 16 May; in 2016: 26 April), thinning applications were done as dilute sprays of NAA (1-Naphtalene Acetic Acid, Potassium Salt, Amvac, USA) as 120 ppm, 160 ppm, 200 ppm respectively (10 ppm per each day was calculated for final concentration) when the tree appears to be white, with shoots containing 80 to 90 percent open, fresh flowers, with bright yellow anthers exposed, accepted as full bloom [6,8]. In second year (on-year), full bloom was opened 20 days earlier following the phenology of olive trees (Table 1).

Post-Bloom		Small Fruit size (3 to 5 mm)	
NAA	**Application Date***	**NAA**	**Application Date***
120 ppm	01.06.2015	100 ppm	01.07.2015
160 ppm	05.06.2015	120 ppm	01.07.2015
200 ppm	10.06.2015	150 ppm	01.07.2015

Table 1: Phenology periods and doses of NAA application in Gemlik, Domat and Memecik varieties (off- year).
*16 May 2015 full blossom began.

Another NAA application was sprayed as respectively 100 ppm, 120 ppm, 150 ppm at same time in which average fruit size is between 3 to 5 mm in diameter (in 2015: 1 July; in 2016: 26 June). In second year (on year), NAA application was sprayed in average fruit size at 5 days earlier following the phenology of olive trees (Table 2).

Post-Bloom		Small Fruit size (3 to 5 mm)	
NAA	**Application Date***	**NAA**	**Application Date***
120 ppm	08.05.2016	100 ppm	26.06.2016
160 ppm	12.05.2016	120 ppm	26.06.2016
200 ppm	16.05.2016	150 ppm	26.06.2016

Table 2: Phenology periods and doses of NAA application in Gemlik, Domat and Memecik varieties (on- year).
*26 April 2016 full blossom began.

Measurements

The fruit harvested in November, each treatment in accordance with the appropriate average maturity level (3 - 4), determined according to the international standard index for olive ripeness (IOOCC, 1984). In first (none-year) and second year (on-year) of experiments, on the basis of fruit maturity index, Domat and Memecik trees were harvested on 17 November, Gemlik was harvested on 21 November in 2015 (none-year). Domat and Memecik were harvested on 9 November, Gemlik was harvested on 18 November in 2016 (on-year).

Determination of effects of NAA treatments on fruit yield and quality; fruit weight (g), flesh/pip ratio (%), yield per unit trunk section area, fruit width (mm), and length (mm) were determined (Hermoso., *et al.* 1991).

Experimental design and statistical analyses

The design of the experiments was completely randomized block design with tree factors (variety*doses*year) of a tree. Data were analyzed by least significant difference (L.S.D) test as significance level of 0.05 and all calculations were performed using by SPSS software.

Results

The effect of different olive varieties, NAA doses, years (on-off) on yield/tree (kg), fruit weight (g), yield per unit trunk section area (g) in different phenology period

Data obtained in first season (2015-none year) and second season (2016-on year), showed that tree yield (kg) was significantly higher 160 ppm among olive varieties in post-bloom (Table 3). In post-bloom, Domat variety was 7.28 kg in control while Domat variety was highest (9.27) with 160 ppm in none year (2015). However, Domat variety was 10.28 kg in control while Domat variety was highest (12.45 kg) with 160 ppm in on year (2016). In post-bloom, Gemlik and Memecik varieties were respectively 9.05 kg and 8.86 kg in control (untreated), but highest yield (kg) were obtained respectively with 160 ppm (12.30 kg and 12.25 kg) in none year (2015).

In second season (on year -2016), yield (kg) of Domat, Memecik and Gemlik olive varieties were highest (respectively 10.28 kg, 9.80 kg, 10.05 kg) in 160 ppm than yield of olive varieties in 2015 (none year). Also, 160 ppm NAA doses were significantly important and highest in all olive varieties in post-bloom (Table 3). In small fruit period, Domat variety was 7.64 kg in control while Domat variety was highest (8.80 kg) with 120 ppm in none year (2015). However, Domat variety was 10.34 kg in control (untreated) while Domat variety was highest (12.51 kg) with 120 ppm in on year (2016). Also, Gemlik and Memecik varieties were respectively 9.05 kg and 9.11 kg in control, but highest yield (kg) were obtained respectively with 120 ppm (11.11 kg and 12.33 kg) in none year (2015). In on year (2016), Yield (kg) of Domat, Memecik and Gemlik olive varieties were highest (respectively 12.51 kg, 12.33 kg, 12.53 kg) in 120 ppm than yield of olive varieties in 2015 (none year). Also, 120 ppm NAA doses were significantly important and highest in all olive varieties in small fruit period (Table 3).

The effect of NAA application doses ($p < 0.005$) and Domat, Memecik, Gemlik olive varieties were found to be statistically significant in post-bloom period. In terms of fruit weight (g), the highest fruit weight (g) was obtained with 160 ppm doses in after full bloom period (Table 4). The effect of different application doses on fruit weight (g) was found to be statistically significant in 120 ppm during the small fruit period ($p < 0.005$). In 2015 (none year), Domat variety increased (8.12g) compared to the control (8.01 kg)

Olive Varieties	Yield/Tree (kg)					
	2015	2016	2015	2016	2015	2016
Post- Bloom	**Domat**		**Gemlik**		**Memecik**	
Control	7.28 cd	10.28 c	9.05 d	9.80 d	8.86 d	10.05 c
120 ppm	8.23 b	11.34 b	10.42 c	10.35 c	10.76 b	11.78 b
160 ppm	9.27 a	12.45 a	12.30 a	12.27 a	12.25 a	12.49 a
200 ppm	7.76 c	12.30 ab	11.53 b	11.48 b	9.06 c	10.14 c
Mean	8.14 b	11.59 ab	10.83 c	10.95 c	10,23 b	11.12 b
Small Fruit Period	**Domat**		**Gemlik**		**Memecik**	
Kontrol	7.64 c	10.34 d	9.05 c	9.11 d	9.11 d	10.11 c
100 ppm	8.41 b	11.42 c	10.51 b	10.41 c	10.41 c	11.81 b
120 ppm	8.80 a	12.51 a	11.11 a	12.33 a	12.33 a	12.53 a
150 ppm	8.10 b	12.32 b	9.31 c	11.52 b	11.52 b	10.23 c
Mean	8.24 b	11.65 c	10.00 b	10.84 c	10.84 c	11.17 b

Table 3: The effect of different olive varieties, NAA doses and years (on-off) on yield/tree ın different phenology period.
LSD value at 0.05: Cultivar (C): 0.0240, Doses (D): 0.038, C&D: 0.045, Year (Y): 0.004, Y&C: 0.000,
Treatments (T): 0.027, C&T: 0.016, D&T: 0.009, C&D&T: 0.012, Different Period (DP): 0.015, DP&C: 0.000.

in 160 ppm NAA dose, Gemlik and Memecik varieties were found 3.53g and 11.03g in control (untreated) while Gemlik and Memecik varieties increased respectively 3.24g and 11.23g in 160 ppm NAA doses in 16 days after full bloom (Table 4). According to the results of the statistical analysis in 2016 (on year), it was determined that the application dose of 160 ppm NAA of Domat variety increased (8.41g) compared to the control (8.04g). Gemlik and Memecik varieties were found 4.54g and 10.97g in control while fruit weight (g) of Gemlik and Memecik varieties increased respectively 4.95g and 11.98g in 160 ppm NAA doses in after full bloom (Table 4). The effect of NAA application doses ($p < 0.005$) and Domat, Memecik, Gemlik olive varieties were found to be statistically significant in small fruit period. In 2015 (none year), Fruit weight (g) of Domat variety increased (7.43g) compared to the control (7.23 kg) in 120 ppm NAA dose, Gemlik and Memecik varieties were found 3.54g and 10.96g in control (untreated) while fruit weight (g) of Gemlik and Memecik varieties increased respectively 3.87g and 11.12g in 120 ppm NAA doses in small fruit period (Table 4).

According to the results of the statistical analysis in 2016 (on year), it was determined that the application dose of 120 ppm NAA of Domat variety increased (8.13g) compared to the control (8.19g). Gemlik and Memecik varieties were found 4.56g and 11.06g in control while Gemlik and Memecik varieties increased respectively 4.97 g and 11.45 g in 120 ppm NAA doses in small fruit period (Table 4).

The effect of NAA application doses ($p < 0.005$) and Domat, Memecik, Gemlik olive varieties were found to be statistically significant in post-bloom period (Table 5). In terms of yield per unit trunk section area (g), the highest yield per unit trunk section (g) was obtained with 160 ppm doses in 16 days after full bloom period (Table 5). The effect of different application doses on yield per unit trunk section (g) was found to be statistically significant in 120 ppm during the small fruit period ($p < 0.005$). In 2015 (none year), Domat, Gemlik and Memecik varieties increased respectively 251g, 300g, 350g compared to the control (untreated) 206g, 265g, 259g in 160 ppm NAA dose in after full bloom (Table 5). According to the results of the statistical analysis in 2016 (on year), it was determined that the application dose of 160 ppm NAA of Domat, Gemlik and Memecik varieties increased respectively 343g, 330g, 354g compared to the control (291g, 264g, 294g) in 16 days after full bloom period (Table 5). The effect of NAA application doses ($p < 0.005$) and Domat, Memecik, Gemlik olive varieties were found to be statistically significant in small fruit period. In 2015 (none year), yield per unit trunk section area (g) of Domat, Gemlik and Memecik varieties respectively increased (265g, 273g, 291g) compared to the control (240g, 264g, 255g) in 120 ppm NAA dose in small fruit period (Table 5). According to the results of the statistical analysis in 2016 (on year), it was determined that 120 ppm NAA doses of Domat, Gemlik and Memecik varieties respectively increased (344g, 318g, 355g) compared to the control (291g, 285g, 295g) in 120 ppm NAA doses in small fruit period (Table 5).

Olive Varieties	Fruit Weight (g)					
	2015	2016	2015	2016	2015	2016
Post- Bloom	**Domat**		**Gemlik**		**Memecik**	
Control	8.01 c	8.04 c	3.53 c	4.54 c	11.03 c	10.97 c
120 ppm	8.03 c	8.20 b	3.77 b	4.87 b	11.02 c	11.74 b
160 ppm	8.12 a	8.41 a	3.84 a	4.95 a	11.23 a	11.98 a
200 ppm	8.08 b	8.23 b	3.80 b	4.82 b	11.07 b	11.79 b
Mean	8.06 a	8.22 b	3.74 b	4.80 b	11.09 b	11.62 b
Small Fruit Period	**Domat**		**Gemlik**		**Memecik**	
Control	7.23 c	8.13 c	3.54 c	4.56 c	10.96 c	11.06 c
100 ppm	7.27 c	8.15 b	3.74 b	4.88 b	10.98 c	11.08 c
120 ppm	7.43 a	8.19 a	3.87 a	4.97 a	11.12 a	11.45 a
150 ppm	7.32 b	8.14 b	3.75 b	4.86 b	11.08 b	11.23 b
Mean	7.31 b	8.15 b	3.73 b	4.82 b	11.04 b	11.21 b

Table 4: The effect of different olive varieties, naa doses and years (Off-On) on fruit weight (g) ın different phenology period.
LSD value at 0.05: Cultivar (C): 0.015, Doses (D): 0.008, C&D: 0.005, Year (Y): 0.004, Y&C: 0.000
Treatments (T): 0.000, C&T: 0.004, D&T: 0.005, C&D&T: 0.000, Different Period (DP): 0.015, DP&C: 0.000.

Olive Varieties	Yield per unit trunk section area (g)					
	2015	2016	2015	2016	2015	2016
Post-Bloom	**Domat**		**Gemlik**		**Memecik**	
Control	206 c	291 c	265 d	264 d	259 d	294 b
120 ppm	240 b	331 b	294 c	296 b	324 b	355 a
160 ppm	251 a	343 a	330 a	330 a	350 a	354 a
200 ppm	210 c	331 b	322 b	317 c	265 c	297 b
Mean	227 b	324 b	303 c	302 b	300 b	325 b
Small Fruit Period	**Domat**		**Gemlik**		**Memecik**	
Control	240 b	291 c	264 c	285 c	255 c	295 c
100 ppm	244 b	332 b	272 b	296 c	274 b	312 b
120 ppm	265 a	344 a	298 a	331 a	291 a	355 a
150 ppm	242 b	331 b	273 b	318 b	270 b	318 b
Mean	248 b	325 b	277 b	308 b	273 b	320 b

Table 5: The effect of different olive varieties, NAA doses and years (on-off) on yield per unit trunk section area (g) in different phenology period.
LSD value at 0.05: Cultivar (C): 0.002, Doses (D): 0.008, C&D: 0.012, Year (Y): 0.004, Y&C: 0.000 Treatments (T): 0.030, C&T: 0.004, D&T: 0.005, C&D&T: 0.000, Different Period (DP): 0.010, DP&C: 0.000.

The effect of different olive varieties, NAA Doses, years (on-off year) on fruit width (cm), fruit length (cm), flesh/pip ratio (%) in post-bloom and small fruit period

The effect of NAA application doses ($p < 0.005$) and Domat, Memecik, Gemlik olive varieties were found to be statistically significant in post-bloom period (Table 6). In terms of fruit width (cm), fruit length (cm), flesh/pip ratio (%), the highest fruit width (cm), fruit length (cm), flesh/pip ratio (%) was obtained with 160 ppm doses in 16 days after full bloom period (Table 6).

In 2015 (off- year), Domat, Gemlik and Memecik varieties increased respectively 2.07g, 1.77g, 2.20 g compared to the control 1,95g, 1,72g, 2.04g on fruit width (cm) in 160 ppm NAA dose in after full bloom (Table 6). Also, Domat, Gemlik and Memecik varieties increased respectively 2.94g, 2.26g, 3.32g compared to the control (untreated) 2.74g, 2.09g, 3.12g on fruit length (cm) in 160 ppm NAA dose in 16 days after full bloom (Table 6). In addition to Domat, Gemlik and Memecik varieties increased respectively 4.78 g, 3.87 g, 4.46 g compared to the control 4.45g, 3.12g, 4.05g on fruit length (cm) in 160 ppm NAA dose in post-bloom (Table 6). The effect of NAA application doses ($p < 0.005$) and Domat, Memecik, Gemlik olive varieties were found to be statistically significant in post-bloom period (Table 6). In terms of fruit width (cm), fruit length (cm), flesh/pip ratio (%), the highest of fruit width (cm), fruit length (cm), flesh/pip ratio (%) was obtained with 160 ppm doses in post-bloom (Table 6). In 2016 (on year), Domat, Gemlik and Memecik varieties increased respectively 2.15g, 1.76g, 2.23g compared to the control 1,97g, 1,68g, 2.06g on fruit width (cm) in 160 ppm NAA dose in post- bloom (Table 6). Domat, Gemlik and Memecik varieties increased respectively 2.74g, 2.11g, 2.93g compared to the control 2.05g, 2.01g, 2.65g on fruit length (cm) in 160 ppm NAA dose in 16 days after full bloom (Table 6). In addition to Domat, Gemlik and Memecik varieties increased respectively 4.46g, 3.81g, 4.43g compared to the control 4.22g, 3.01g, 4.08g on flesh/pip ratio (cm) in 160 ppm NAA dose in 16 days after full bloom (Table 6).

Olive Varieties	NAA concentration (ppm)	2015			2016		
		Fruit Width (cm)	Fruit Lenght (cm)	Flesh/pip ratio (%)	Fruit Width (cm)	Fruit Lenght (cm)	Flesh/pip ratio (%)
Post-Bloom							
Domat	Control	1.95 d	2.74 d	4.45 d	1.97 d	2.05 d	4.22 c
	120 ppm	2.04 b	2.90 b	4.69 b	2.13 b	2.80 b	4.35 b
	160 ppm	2.07 a	2.94 a	4.78 a	2.15 a	2.74 a	4.46 a
	200 ppm	2.01 c	2.80 c	4.51 c	2.10 c	2.70 c	4.30 b
	Mean	2.02 c	2.85 c	4.61 b	2.09 c	2.57 c	4.33 b
Gemlik	Control	1.72 b	2.09 c	3.12 d	1.68 d	2.01 d	3.01 d
	120 ppm	1.76 ab	2.16 b	3.69 b	1.74ab	2.05 c	3.74 b
	160 ppm	1.77 a	2.26 a	3.87 a	1.76 a	2.11 a	3.81 a
	200 ppm	1.73 b	2.13 b	3.39 c	1.80 c	2.08 b	3.55 c
	Mean	1.75 ab	2.16 b	3.52 b	1.76ab	2.06 b	3.53 c
Memecik	Control	2.04 c	3.12 c	4.05 d	2.06 d	2.65 d	4.08 d
	120 ppm	2.16 b	3.24 b	4.22 c	2.19 b	2.82 b	4.21 c
	160 ppm	2.20 a	3.32 a	4.46 a	2.23 a	2.93 a	4.43 a
	200 ppm	2.13 b	3.26 b	4.36 b	2.12 c	2.74 c	4.32 b
	Mean	2.13 b	3.24 b	4.27 c	2.15 c	2.79 c	4.26 b

Table 6: The effect of different NAA application period and different olive varieties ın post-bloom period.
LSD value at 0.05: Cultivar (C): 0.000, Doses (D): 0.0080 C&D: 0.009, Year (Y): 0.003, Y&C: 0.000
Treatments (T): 0.000, C&T: 0.002, D&T: 0.000, C&D&T: 0.012, Different Period (DP): 0.000, DP&C: 0.000.

The effect of NAA application doses ($p < 0.005$) and Domat, Memecik, Gemlik olive varieties were found to be statistically significant in small fruit period (Table 7). In terms of fruit width (cm), fruit length (cm), flesh/pip ratio (%), the highest fruit width (cm), fruit length (cm), flesh/pip ratio (%) was obtained with 120 ppm doses in small fruit period (Table 7). In 2015 (none year), Domat, Gemlik and Memecik varieties increased respectively 2.21g, 1.67g, 2.24g compared to the control 2.11g, 1.54g, 2.12g on fruit width (cm) in 120 ppm NAA dose in small fruit period (Table 7). Also, Domat, Gemlik and Memecik varieties increased respectively 2.84g, 2.14g, 3.19g compared to the control (untreated) 2.75g, 2.03g, 3.11g on fruit length (cm) in 120 ppm NAA dose in small fruit period (Table 7). In addition to Domat, Gemlik and Memecik varieties increased respectively 4.47g, 3.37g, 4.46g compared to the control 4.31g, 3.14g, 4.17g on flesh/pip ratio (cm) in 120 ppm NAA dose in small fruit period (Table 7). According to 2016 (on year), Domat, Gemlik and Memecik varieties increased respectively 2.15g, 1.84g, 2.18g compared to the control (2.10g, 1,71g, 2.12g) on fruit width (cm) in 120 ppm NAA dose in small fruit period (Table 7). Domat, Gemlik and Memecik varieties increased respectively 2.93 g, 2.15 g, 2.92 g compared to the control (2.74g, 2.11g, 2.79g) on fruit length (cm) in 120 ppm NAA dose in small fruit period (Table 7). In addition to Domat, Gemlik and Memecik varieties increased respectively 2.21g, 1.64g, 2.24g compared to the control 2.11g, 1.54g, 2.12g on flesh/pip ratio (cm) in 120 ppm NAA dose in small fruit period (Table 7).

Discussion

NAA application increases the fruit size and yield/tree (kg) in olive table varieties and positively affects the flower bud differentiation and bloom [10]. In result of present study is in parallel with Crous [11], Lavee and Spiegel [12], Martin., *et al.* [13], Çigdem [14] who found that increase to yield/tree (kg), fruit weight (kg) and reduce to alternate bearing. El Kassas [15] found that spray-

Olive Varieties	NAA concentration (ppm)	2015			2016		
		Fruit Width (cm)	Fruit Lenght (cm)	Flesh/pip ratio (%)	Fruit Width (cm)	Fruit Lenght (cm)	Flesh/pip ratio (%)
Small Fruit Period							
Domat	Control	2.11 c	2.75 b	4.31 c	2.10 d	2.74 c	2.11 c
	100 ppm	2.16 b	2.77 b	4.36 b	2.12 c	2.82 b	2.16 b
	120 ppm	2.21 a	2.84 a	4.47 a	2.15 a	2.93 a	2.21 a
	150 ppm	2.15 b	2.76 b	4.35 b	2.14 b	2.76 c	2.15 b
	Mean	2.16 b	2.78	4.37 b	2.13 b	2.81 b	2.16 b
Gemlik	Control	1.54 c	2.03 c	3.14 c	1.71 b	2.11 c	1.54 c
	100 ppm	1.62 b	2.13 ab	3.28 b	1.75 b	2.14 ab	1.64 b
	120 ppm	1.67 a	2.14 a	3.37 a	1.84 a	2.15 a	1.67 a
	150 ppm	1.63 b	2.11 b	3.27 b	1.67 c	2.13 b	1.63 b
	Mean	1.62 b	2.10 b	3.27 b	1.74 b	2.13 b	1.62 b
Memecik	Control	2.12 d	3.11 a	4.17 c	2.12 c	2.79 c	2.12 c
	100 ppm	2.14 c	3.14 b	4.38 b	2.17 b	2.81 b	2.14 c
	120 ppm	2.24 a	3.19 a	4.46 a	2.18 a	2.92 a	2.24 a
	150 ppm	2.22 b	3.14 b	4.39 b	2.14 b	2.81 b	2.22 b
	Mean	2.18 c	3.15 b	4.35 b	2.15 b	2.83 b	2.18 b

Table 7: The effect of different olive varieties, NAA doses and years (on-off year) ın small fruit period. LSD value at 0.05: Cultivar (C):0.000, Doses (D):0.008, C&D:0.002, , Year (Y): 0.000, Y&C: 0.000, Treatments (T): 0.005, C&T: 0.000, D&T: 0.000, C&D&T: 0.000.

ing GA3 at 100 ppm, 150 ppm, 200 ppm, sprayed on Chemlali olive cv., 15 days after full bloom, increase oil content compared to control (untreated). According to result of present study, different NAA doses found statistically significant on yield/tree (kg), fruit weight (g), yield per unit section area (g).

In present study on Domat, Gemlik and Memecik olive table varieties, 160 ppm of NAA dose effected on yield/tree (kg), fruit weight (g), yield per unit section area (g) in 16 days after full bloom period. According to result of analyze, 160 ppm NAA was highest effect on fruit width (cm), fruit length (cm), flesh/pip ratio (%), yield /tree (kg) both off and on years in 16 days after full bloom. In another study conducted in South Africa, 200 mg/L dose of NAA was found suitable 10 - 15 days after full bloom in 'Mission' and 'Manzanillo' varieties while it has been observed that 400 mg/L of NAA prevents vegetative growth in 'Mission' variety and reduces olive fruit formation [11]. In a research related to Gemlik olive trees, according to results of 180 ppm NAA dose treated gave the highest yield in both (on-off) years. Also, 180 ppm NAA dose obtained with two fold enhance in yield (kg) compared to control (untreated) in off year while 180 ppm NAA dose obtained with three fold increase in yield/tree (kg) compared to control (untreated) in on year [14]. In another research about NAA application, according to results, some olive varieties which have intermediate and high tendency to alternate bearing, increase in yield/tree in off years 6 - 12 days after full bloom by using NAA applications [8,16]. Barouni, Mission and Manzanillo olive varieties increased by using 400 ppm NAA dose in the rate of fruits [11]. In a research about fruit thinning using NAA shows potential for reducing biennial bearing of "Barnea" and 'Picual' oil olive trees. According to results, NAA application (100 mg/L, 10 days after full bloom) diminished to alternate bearing in two oil olive varieties and also showed the possibility of using NAA post-bloom spraying to balance biennial bearing in Barnea and Picual oil olive trees [17].

In present study on Domat, Gemlik and Memecik olive table varieties, 120 ppm of NAA dose effected on yield/tree (kg), fruit weight (g), yield per unit section area (g) in small fruit period. According to result of analyze, 120 ppm NAA was highest effect on fruit width (cm), fruit length (cm), flesh/pip ratio (%), yield /tree (kg) both none and on years in small fruit period. Chemical thinning such as NAA (naphthaleneacetic acid) application, increases the fruit size and yield/tree (kg) in especially olive table cultivars and also oil olive cultivars. In addition to chemical thinning affects positively the flower bud differentiation and full bloom [10]. Consequently, this study is parallel as other studies [18].

Conclusion

The following conclusions can be drawn from the study:

- Post bloom and small fruit period is commercially increased fruit weight and reduced to alternate bearing in table olive varieties.
- Provide to balance for biennial bearing.
- Using NAA are effective for increasing olive quality especially for table olive varieties.
- The different phenological periods are important to sprayed NAA doses.
- It is applicable to spray 160 ppm NAA dose at 16 days later after full bloom or spray 120 ppm NAA dose in 3 to 5 mm small fruit on table olive varieties such as Gemlik, Domat and Memecik olive varieties.

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