

Effect of Some Growth Regulators on Yield and Fruit Quality of Manzanillo Olive Trees

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Abstract: The present work is an attempt to elucidate the effect of some growth regulators on fruit drop, yield and quality of olive cv. Manzanillo. Thirteen years old olive trees were foliar sprayed with both GA₃ and NAA individually and additively at 50 and 75 ppm. Maximum fruit drop % was recorded by using NAA at 75 ppm. Spraying trees with 75 ppm of GA₃ and NAA at either 50 or 75 ppm decreased fruit drop% in comparison to those sprayed with NAA only. Spraying trees with GA₃ at 75 ppm caused maximum fruit yield/ tree in comparison to those of other treatments including control. Maximum fruit weight, volume, length, diameter as well as fruit shape index were obtained when trees were treated with GA₃ at 75 ppm. GA₃ and NAA either individually or additively increased TSS % as well as TSS/Acid ratio of fruit juice and decreased total acidity than control. Maximum oil content (% of dr. wt.) was recorded when trees were sprayed with 75 ppm of GA₃ in comparison with other treatments including control. Accordingly, it is preferable to spray Manzanillo olive trees with GA₃ and NAA individually or additively 10 days after fruit set to improve tree yield and fruit quality.

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1. Introduction

Olive tree (*Olea europaea*, L.) is an evergreen tree belongs to Oleaceae family has a high economic value to Egypt and to many countries in Mediterranean sea region since they use it for pickling, oil extraction or for both purposes (Payvandi *et al.*, 2001). Olive is successfully cultivated in the irrigated semi arid areas in Egypt. Recently, olive growers complained the low productivity of olive especially in the new reclaimed areas such as Sinai region, on both sides of the desert roads and also in the northwestern coast. The low fruit productivity of the olive trees may be due to that olive has a very marked alternate bearing phenomenon in all production regions through the world. Also, fruit quality of Manzanillo olive cultivar decreased linearly with an increase in yield (Krueger *et al.*, 2004).

Major losses in profit are occurred in "On" season since the fruit being too small for table olive usage (Lavee, 2006), while in an "Off" season, the increase in fruit size dose not make up for the loss in yield. Spraying olive trees with GA₃ increased the annual vegetative growth of long and short fruit bearing branches thus it increased fruit yield of the following year and appeared to stabilize fruit production over two years period and reduce the degree of alternate bearing compared with control (Boulouha *et al.*, 1993). Rotundo and Gioffre (1984) reported that GA₃ treatments increased the weight, length, width of olive fruits and flesh weight in comparison to control. Also, fruit thinning using thinning materials such as NAA at different

concentrations improved fruit quality and reduced alternate bearing in various crops (Link, 2000). Fruit thinning approximately two weeks after full bloom (FB) increased vegetative growth, flower bud differentiation, fruit size and cumulative yield of consecutive years in various table and oil olive cultivars (Dag *et al.*, 2009). Application of plant growth regulators such as Gibberellic acid and Naphthalene acetic acid individually or in combinations on olive trees may improve cropping potential and fruit quality. Therefore, this study aimed to explore the effect of application GA₃ and NAA on controlling fruit drop and improving yield and fruit quality of Manzanillo olive trees under semi arid conditions in Egypt.

2. Materials and Methods

Olive tree (*Olea europaea*, L. CV. Manzanillo) trees of similar vigor, age (13 years old) and size were selected for foliar spray treatments during the two successive seasons of 2010 and 2011 at a private farm in Wadi El-Faregh, Behira Governorate, Egypt. Trees were grown in sandy soil, 5x6 m apart and irrigated through drip irrigation system. The orchard received normal cultural practices according to the farm plan.

1. The treatments:

GA₃ and NAA were applied individually or in combinations, 10 days after fruit set as foliar spray on the trees as follows:

- 1.1 T1= Control
- 1.2 T2= GA₃ at 50 ppm
- 1.3 T3 = GA₃ at 75 ppm

1.4 T4 = GA₃ at 75 ppm+NAA at 50 ppm

1.5 T5 = GA₃ at 75 ppm+NAA at 75 ppm

1.6 T6 = NAA at 75 ppm.

Each treatment had five replicates with one tree per a replicate. A complete randomized block design was adopted in this experiment. Each tree was received 10 L of the applied solution plus 5cm per liter of tween 20 to avoid the surface tension. The trees of control treatment were sprayed with tap water.

2. The measurements:

2.1. Fruit drop percentage:

Four main branches in each replicate were tagged and the number of fruits per 1m length of fruiting shoots was recorded twice, 10 days after fruit set and at harvest date. Consequently, the fruit drop % was recorded according to the following equation:

$$\text{Fruit drop\%} = \frac{\text{No. of fruits at fruit set} - \text{No. of retained fruits at harvest}}{\text{No. of fruits at fruit set}} \times 100$$

2.2. The yield: At harvesting time (last week of October) of each season, yield of each tree was recorded in Kg/tree (Sibbett *et al.*, 1986). A random sample of 30 fruits was collected from each replicate at harvest to determine the following characteristics:

2.3. Fruit physical characteristics: Fruit weight (g), Fruit volume (cm³), Fruit length (cm), Fruit diameter (cm), and Fruit shape index (L/D ratio) were recorded.

2.4. Fruit chemical characteristics: Fruit samples were taken (30 fruits per a replicate at harvest to determine the chemical characteristics such as TSS %, Total acidity % and Fruit oil content (% dry weight).

Oil determination: Oil extraction and determination (% dr.wt) was determined according to A.O.A.C (2000).

Statistical analysis: The obtained data were subjected to analysis of variance (ANOVA) according to Snedecor and Cochran (1968) using Mstat program. Least significant differences (L.S.D) were used to compare between means of treatments according to Waller and Duncan (1969) at probability of 5%.

3. Results and Discussion

3. Effect of growth regulators on Manzanillo olive trees:

3.1. Fruit drop percentage:

Fig.(1) indicated that spraying Manzanillo olive trees with GA₃ generally reduced fruit drop % in the two seasons in comparison with other treatments including control. The results showed that fruit drop percentage was reduced by increasing GA₃

concentration since the fruits attained the lowest drop percentage when the trees treated with GA₃ at 75 ppm as foliar spray. The present result is in agreement with that obtained by Daood (2002) who cleared that spraying Picual olive trees with 25, 50 or 100 ppm of GA₃, 10 days after fruit set significantly increased the retained fruit percentage and reduced the total fruit drop percentage in comparison with the control. The results also are in agreement with those of Abdrabboh (2009) who cleared that fruit drop % of Picual olive trees was decreased by spraying the trees with GA₃ at 30 or 60 ppm in comparison to that of control. Gibberellins are still used commercially on various fruit tree species to reduce fruit drop% especially in fruit species which their harvest agree to be during May and June (Crous, 2012). The results in Fig.(1) also indicated that spraying Manzanillo olive trees with NAA either at 50 or 75 ppm, 10 days after fruit set showed a significant increase in fruit drop percentage in comparison with other treatments and control. The maximum value of drop percentage was achieved at 75 ppm of NAA. The last result is in harmony with those of Crous, (2012) working on Manzanillo olive trees who found that fruit drop percentage of olive was increased by increasing NAA concentration. Therefore, NAA is applied for fruit thinning in many fruit species especially olive trees during the "On" year to regulate annual bearing of trees and to improve fruit quality (Lavee, 2006 and Dag *et al.*, 2009). The results in Fig. (1) Indicated also that the additive treatment combined GA₃ at 75 ppm plus NAA either at 50 or 75 ppm decreased drop percentage of Manzanillo cultivar when compared with individually applied NAA. However, the additive treatment which contained NAA at 50 ppm slightly decreased the fruit drop percentage compared with that which contained NAA at 75 ppm only in the first season. El-Shewy (1999) supported the present results since he reported that adding GA₃ at 75 mg / L plus 50 mg/L of NAA reduced fruit shedding of Guava either during June or at pre-harvest drop. It can be concluded that spraying olive trees with GA₃ at 50 or 75 ppm caused a significant decrease in fruit drop percentage in comparison to control. On the other hand, spraying trees with NAA 50 or 75 ppm either additively or in combinations with GA₃, increased fruit drop percentage in the two seasons in comparison with other treatments including control.

3.2. Effect of growth regulators on the yield (kg/tree):

Results in Fig. (2) showed that yield of Manzanillo olive trees significantly increased by increasing GA₃ concentration from 50 ppm to be 75 ppm. The increase in yield was significant in comparison with that of control. The maximum increase in yield per tree was obtained by spraying

GA₃ solution at 75 ppm. The results are in agreement with that obtained by **Ramezani and Shekafandeh (2009)** working on Shengeh olive cultivar who found that spraying olive trees with GA₃ at different concentrations 10 days after fruit set significantly increased yield of trees. They also reported that this increase in yield may be attributed to the ability of GA₃ in reducing fruit drop and consequently increasing fruit yield / tree. **Ramezani and Shekafandeh (2009)** also reported that increasing yield of olive due to GA₃ sprays may be attributed to its effect on increasing levels of IAA. The results in Fig.(2) elucidated also that spraying the trees of Manzanillo olive cultivar with 75 ppm of NAA individually exhibited insignificantly decrease in the yield (kg/ tree) in the two seasons in comparison with control. These results may be acceptable with regard to the thinning effect of NAA especially at high concentration. The results are in harmony with that obtained by **Crous (2012)** working on Manzanillo

olive trees as he reported that spraying trees with NAA at high concentrations decreased tree yield in comparison to control due to its thinning effect on trees. Data of the present results also showed that treating Manzanillo olive trees with a combination of GA₃ at 75 ppm and NAA at either 50 or 75 ppm caused slight increase in fruit yield / tree in comparison with NAA alone in first season while insignificant increase was noticed in the second one. Slight insignificant difference was recorded between NAA at 50 ppm and 75 ppm combined with 75 ppm of GA₃. These results are in a harmony with those of **El-Shewy (1999)** who reported that spraying guava trees with combination of NAA and GA₃ led to an increase in fruit yield/ tree in comparison with control. Spraying the Manzanillo olive trees with 75 ppm NAA individually results in significant decreases of olive yield/ tree.

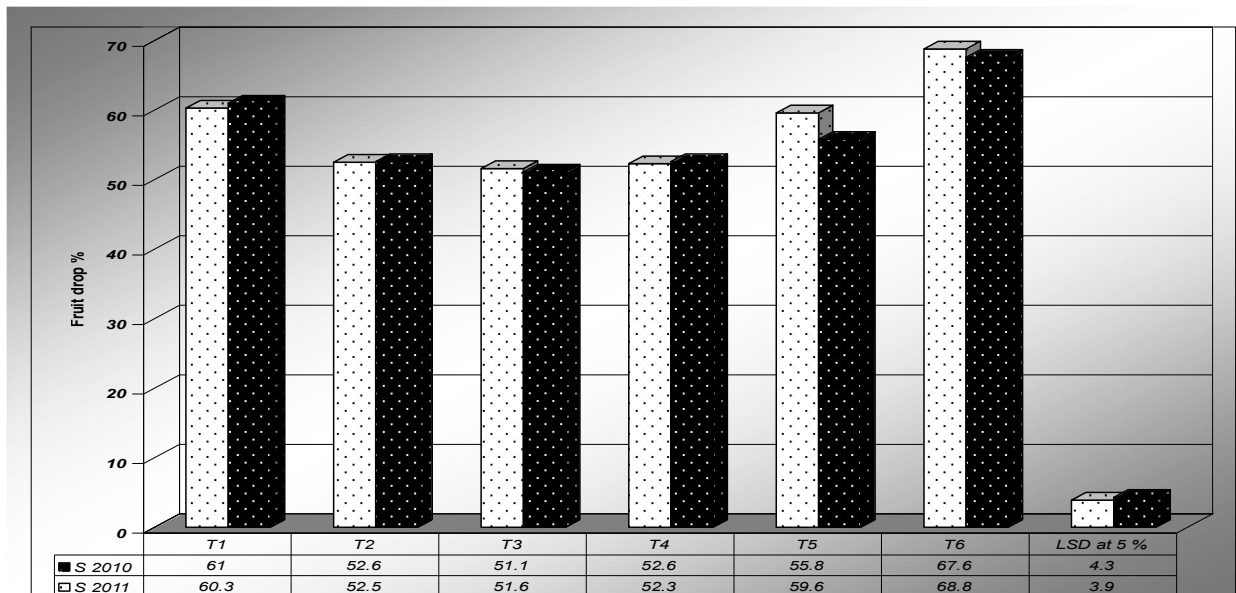


Fig.(1): Effect of GA₃ and NAA (ppm) on fruit drop % of Manzanillo olive trees in 2010 and 2011 seasons.

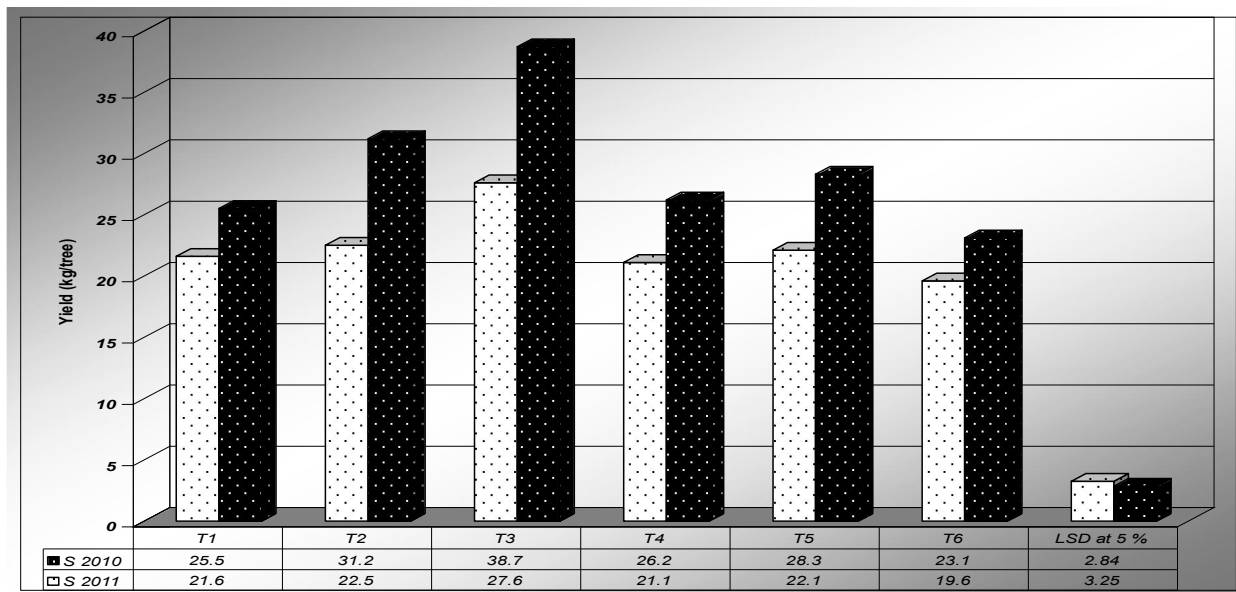


Fig.(2): Effect of GA₃ and NAA (ppm) on yield (kg/tree) of Manzanillo olive trees in 2010 and 2011 seasons.

3.3.Effect of growth regulators on fruit quality

3.3.1.Fruit physical properties:

Fruit weight, volume, length and diameter.

Figs. (3, 4, 5, 6 and 7) clearly showed that spraying Manzanillo olive trees with GA₃, 10 days after fruit set at 50 or 75 ppm significantly increased fruit weight, fruit volume, fruit length and fruit diameter in comparison to those of control treatment. The results also cleared that GA₃ at the two tested concentrations gave insignificant increase in fruit shape index (length/ diameter ratio) and produced nearly round fruit due to higher growth rate of diameter than that of the control treatment especially in the second season. The results are in agreement with that of (Abdrabboh, 2009) working on Picual olive cultivar and with those of (Ramezani and Shekafandeh, 2009) working on Shengeh olive cultivar who reported that spraying olive trees with GA₃ ranged from 25 to 100 ppm increased the physical fruit parameters than control. The present results may be attributed to stimulative influence of this bioregulator on cell extension and/or cell division. This result had been also supported by Eman *et al.* (2007) who reported that the role of GA₃ in improving fruit quality such as fruit weight and

fruit size may be due to its role in increasing cell elongation. Fruit size increase in response to exogenously applied GA₃ according to the view of others can be associated with an increase in cell size of the mesocarp (Zhang *et al.*, 2007). The role of GA₃ in increasing the fruit mesocarp could be interpreted through its action on sink demand by enhancement of phloem unloading or/and the metabolism of carbon assimilates in fruit (Ramezani and Shekafandeh, 2009). The results in Figs. (3, 4, 5, 6 and 7) also cleared that spraying Manzanillo olive trees 10 days after fruit set with NAA either individually or in combination with GA₃ slightly increased fruit weight, fruit volume, fruit length and fruit diameter than those of control treatment. These results are in harmony with that obtained by Lavee (2006) and Crous (2012) who reported that NAA positively influenced fruit quality, i. e., fruit size, flesh/pit ratio and oil content and improved return bloom. As a matter of fact, NAA induces thinning out of the fruits such that the retained fruits at harvest should be little in number. The share of each fruit as a sink from the assimilates should be greater than control and the fruits becomes bigger.

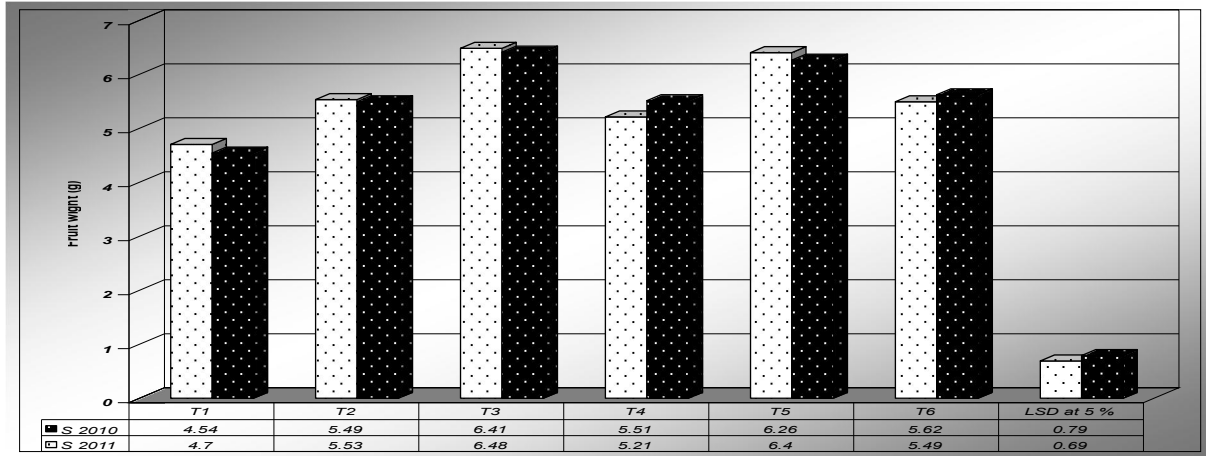


Fig.(3): Effect of GA₃ and NAA (ppm) on fruit weight (g) of Manzanillo olive trees in 2010 and 2011 seasons.

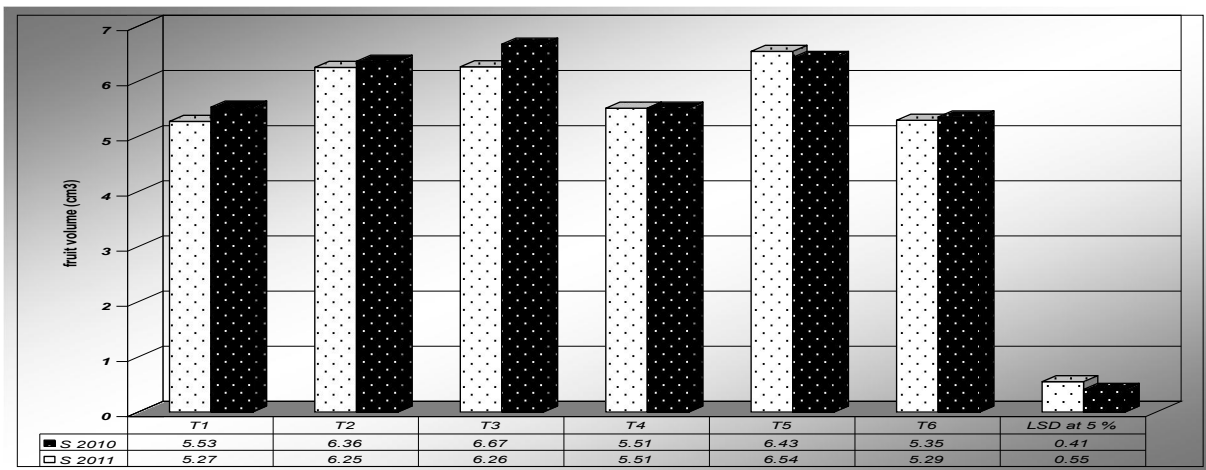


Fig.(4): Effect of GA₃ and NAA (ppm) on fruit volume (cm³) of Manzanillo olive trees in 2010 and 2011 seasons.

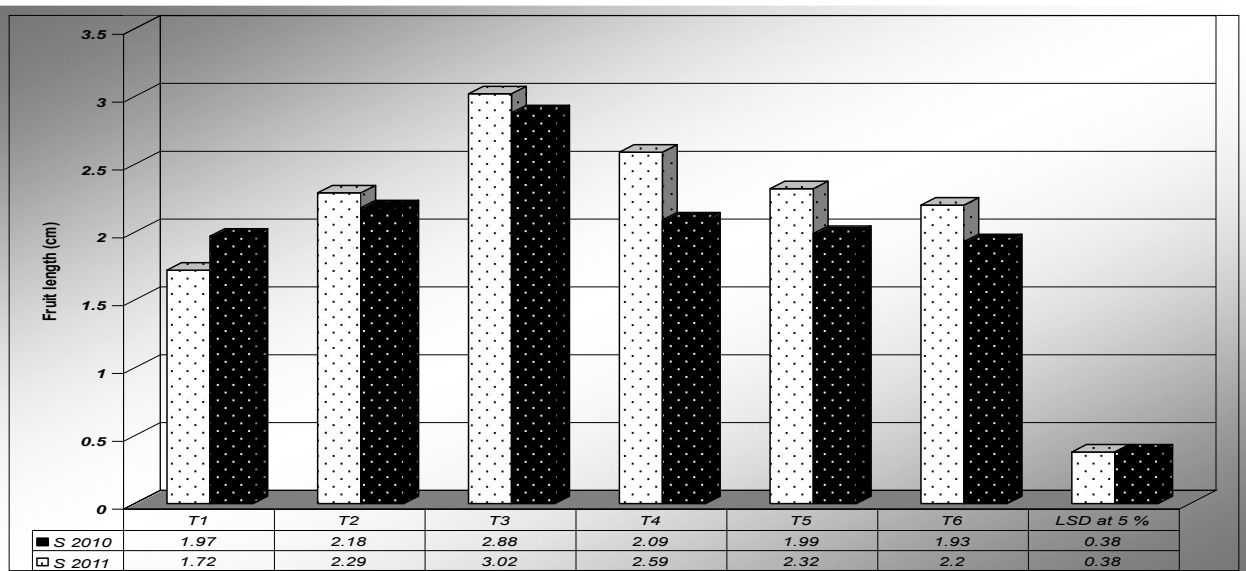


Fig.(5): Effect of GA₃ and NAA (ppm) on fruit length (cm) of Manzanillo olive trees in 2010 and 2011 seasons.

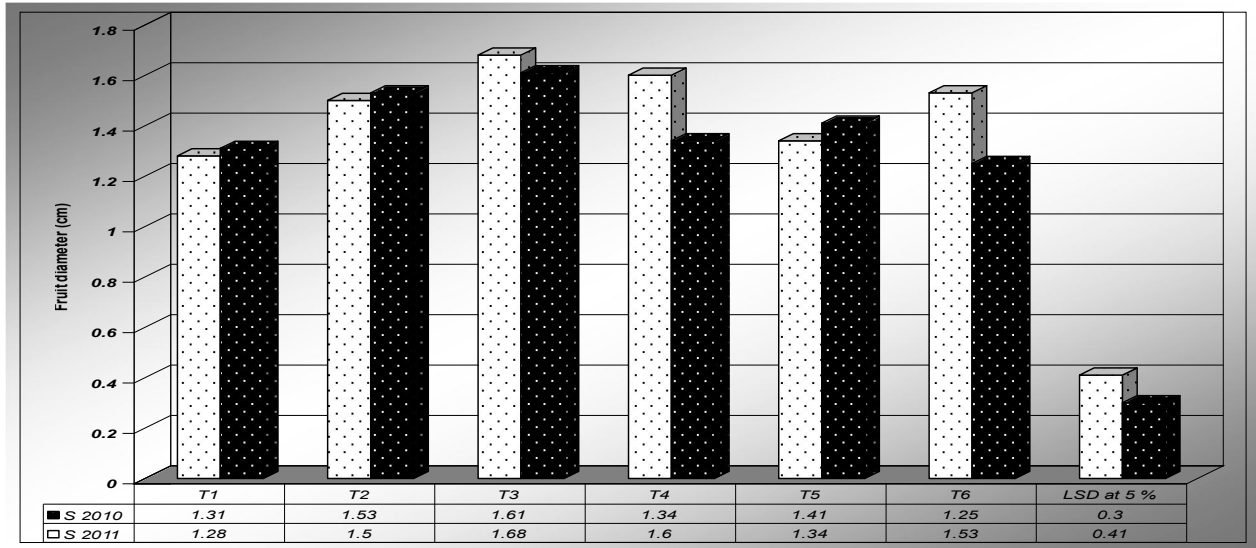


Fig.(6): Effect of GA₃ and NAA (ppm) on fruit diameter (cm) of Manzanillo olive trees in 2010 and 2011 seasons

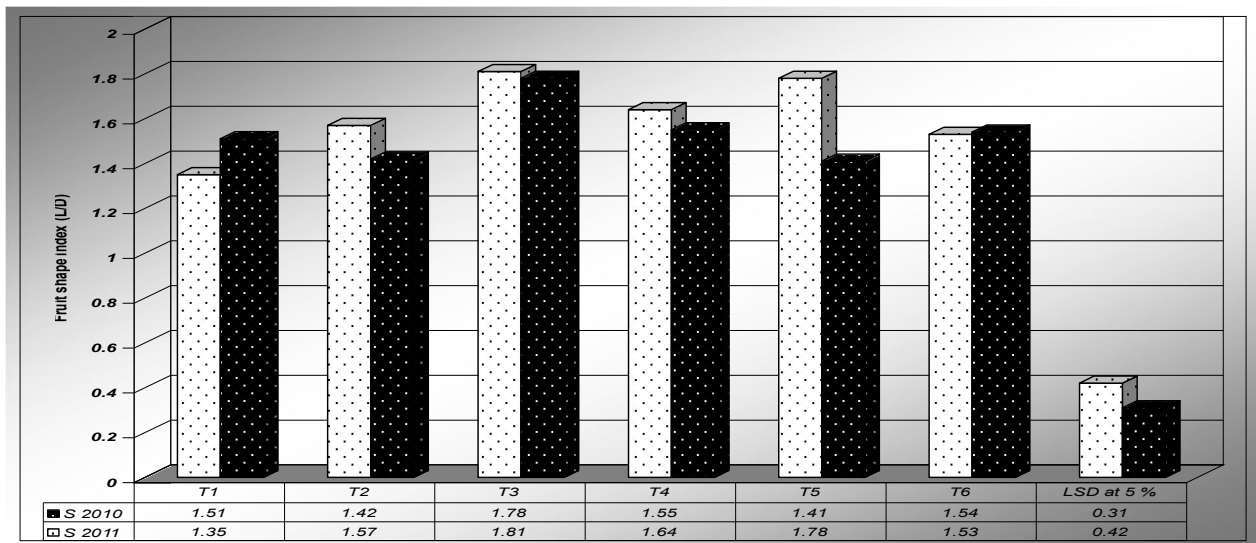


Fig.(7): Effect of GA₃ and NAA (ppm) on fruit shape index (L/D) of Manzanillo olive trees in 2010 and 2011 seasons.

3.3.2. Fruit chemical properties:

TSS %:

Data in Fig.(8) showed that TSS percentage of Manzanillo olive cultivar significantly increased by increasing GA₃ in the two seasons in comparison with control treatment. Maximum value of TSS percentage was obtained by spraying the olive tree with GA₃ at 75 ppm. The data in Fig. (8) also cleared that using NAA individually at 75 ppm led to a significant increase in TSS compared with control. The additive treatment with GA₃ at 75 ppm plus NAA either at 50 or 75 ppm resulted a significant

increase in TSS% in comparison with control. Insignificant difference in TSS % was noticed between these additive treatments and GA₃ treatments. These results are in agreement with those of **Abdrabboh, (2009)** working on olive who reported that TSS% of olive fruits was increased by spraying the trees with some growth regulators. **Hifny et al.,(2009)** reported that the increase in TSS% of fruit at harvest might be attributed to the intensive photosynthesis in trees previously treated with growth regulators.

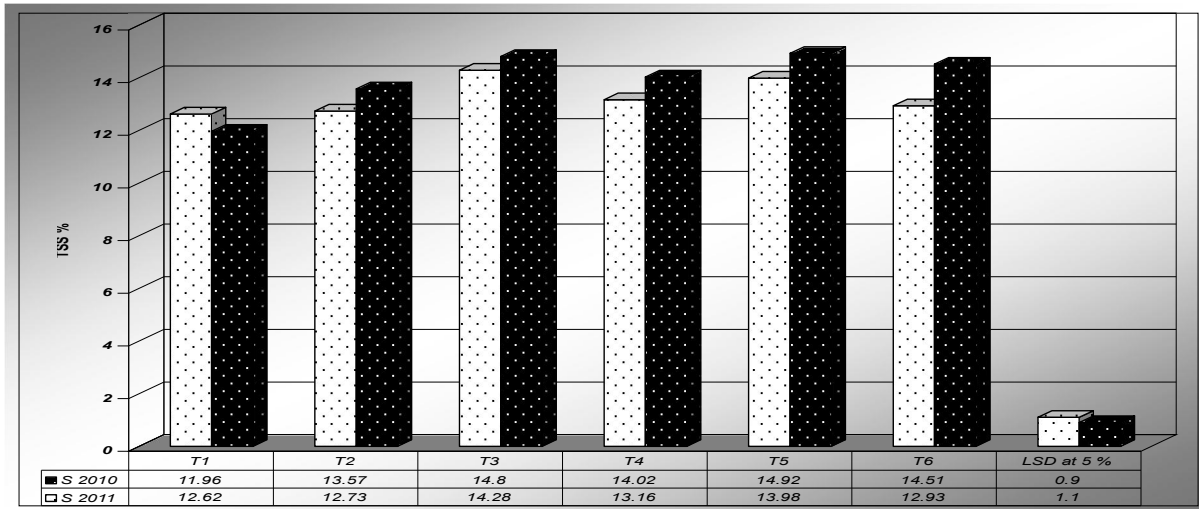


Fig.(8): Effect of GA₃ and NAA (ppm) on fruit TSS % of Manzanillo olive trees in 2010 and 2011 seasons.

Total acidity%:

Regarding the total acidity of fruit juice, data in Fig. (9) showed an opposite trend of that of TSS percentage in all treatments when compared with that of control in the two seasons. Spraying Manzanillo olive trees 10 days after fruit set with GA₃ and/or NAA either individually or in combinations at all tested concentrations resulted a decrease in total acidity% in comparison with control. In this regard,

the combination of NAA at 50 ppm supplemented with 75 ppm of GA₃ treatment recorded the least total acidity % in olive fruits in comparison with control and other treatments. The significant decrease in total fruit acidity could be attributed to the promotion occurred in fruit maturity, whereas the fruit ripened earlier than those of control trees. (Hifny *et al.*, 2009).

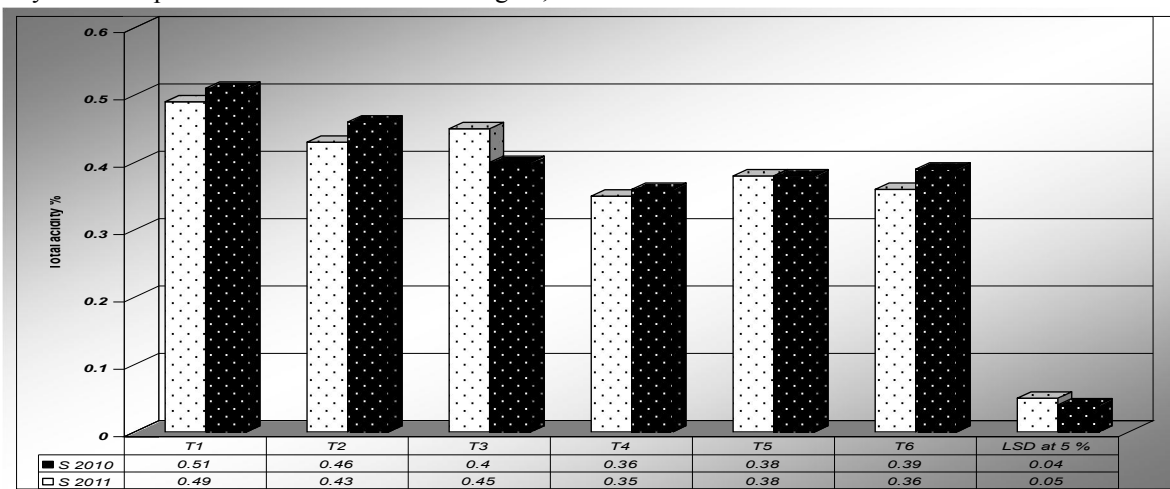


Fig.(9): Effect of GA₃ and NAA (ppm) on fruit total acidity % of Manzanillo olive trees in 2010 and 2011 seasons.

TSS/ acid ratio:

Data in Fig. (10) showed that TSS/ acid ratio significantly increased by increasing GA₃ concentrations in the two seasons in comparison with control treatment. Maximum values of TSS/Acid ratio were achieved after spraying the olive trees with 75 ppm of GA₃. Regarding NAA, data in Fig. (10) also cleared that spraying olive trees with NAA at 75 ppm caused a significant increase in TSS/Acid ratio compared with control. The data also indicated that

adding GA₃ at 75 ppm to NAA either at 50 or 75 ppm led to a significant increase in TSS/Acid ratio in comparison with control. Insignificant difference in TSS/Acid ratio was noticed between these treatments and GA₃ treatments. These results are in agreement with that of Brahmachari *et al* (1996) on Guava and with Hifny *et al.*, (2009) on olive who reported that TSS/ Acid ratio of fruits were increased while fruit total acidity were decreased by spraying the trees with some growth regulators.

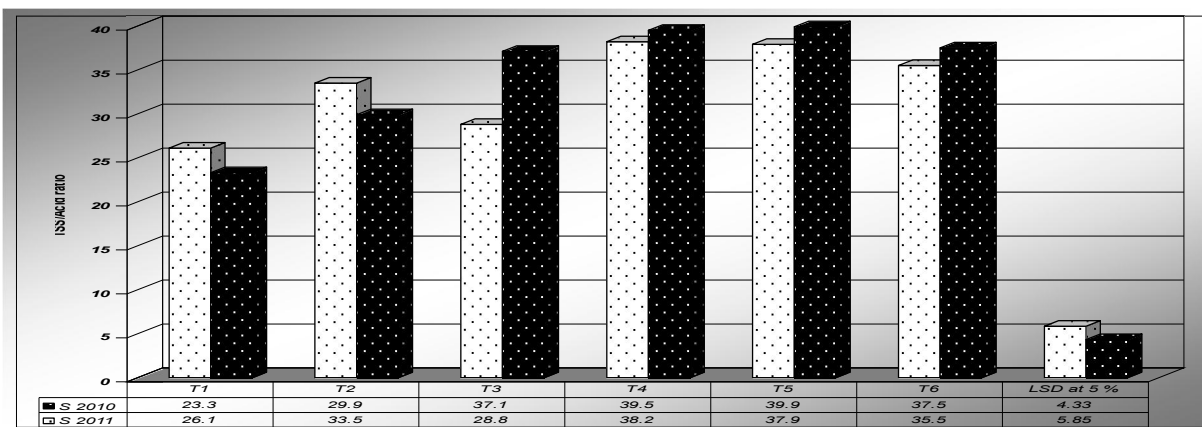


Fig.(10): Effect of GA₃ and NAA (ppm) on fruit TSS/Acid rati of Manzanillo olive trees in 2010 and 2011 seasons.

Effect of growth regulators on oil content (% of dr. wt):

The results in Fig. (11) also showed similar trend to that of TSS percentage of fruit juice in the two seasons. The data showed that oil content of Manzanillo olive trees (% of dr. wt) increased by increasing GA₃. GA₃ at concentration 75 ppm had increased the fruit oil content more than those were produced under the effect of 50 ppm ppm GA₃ or those under control in both seasons. The results are in agreement with that obtained by **Abd El-Naby *et al.* (2012)** working on olive trees, who reported that GA₃ greatly increased fruit oil percentage compared with control. Data presented in Fig. (11) also cleared that

oil content of Manzanillo olive trees significantly increased by spraying the trees with NAA either alone or in combination with 75 ppm of GA₃ compared with control. Similar results were obtained regarding NAA where **Eris and Barut (1993)** working on olive trees reported that NAA treatments greatly increased fruit oil %. The improvement in fruit quality could be attributed to the effect of NAA as a thinner whereas it decrease the number of retained fruits, so decrease the degree of competition between fruits in obtaining more photosynthesis product. **Martin *et al.* (1980)** and **Lavee (2006)** reported that NAA positively influenced fruit quality i.e., fruit size, flesh/pit ratio and oil content.

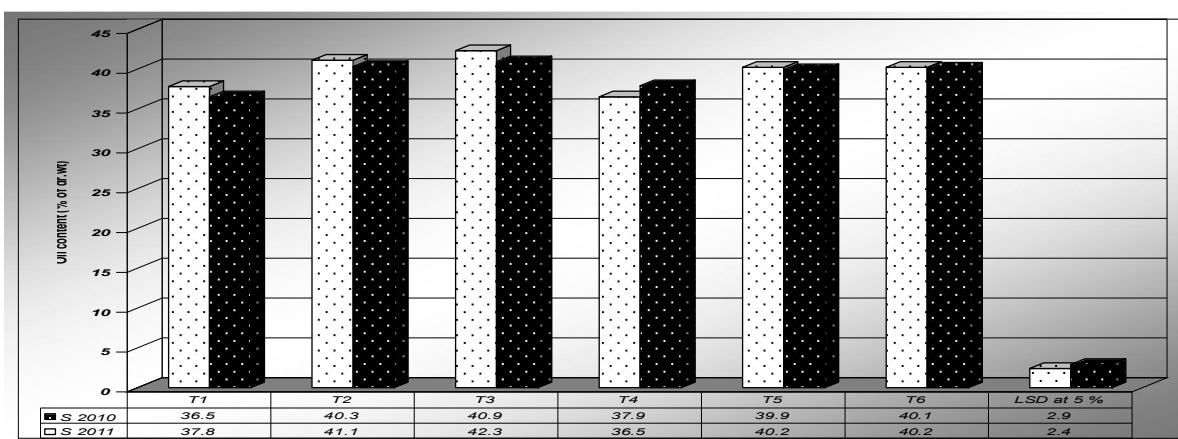


Fig.(11): Effect of GA₃ and NAA (ppm) on fruit oil content(% of dr.wt.) of Manzanillo olive trees in 2010 and 2011 seasons.

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