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Effect of Kaolin and Calcium Carbonate on Vegetative Growth, Leaf Pigments and Mineral Content of Kalamata and Manzanillo Olive Trees

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ABSTRACT

This study was carried out during two successive seasons, (2015and 2016) in a private orchard located at Ismailia governorate, Egypt. The study was conducted on 15 years old olive trees of Kalamata and Manzanillo cv., planted at 5 X 5 m apart grown in sandy soil, under drip irrigation, system and uniform in shape and received the common horticultural practices. The experiment was to study the effect of sprayed kaolin and calcium carbonate at (3, 5 and 7%) in three different dates (mid October, November and December) compared with trees untreated on vegetative growth, leaf pigments and mineral content of Kalamata and Manzanillo olive trees. Results proved that spraying Kalamata and Manzanillocvs with Calcium Carbonate 7% on mid December was the promising treatment for improve vegetative growth, leaf pigments and mineral content compared with other treatment and control.

Keywords: Olive (*Olea europaea*), Kalamata, Manzanillo, Kaolin, Calcium Carbonate, Vegetative growth, Leaf pigments, Mineral content.

Introduction

Climate change is undoubtedly the most imminent environmental issue the world is facing today. The rise in climate temperature will have certain major effects on ecosystems, wildlife, food chains and eventually human life (Appels *et al.,* 2011). Climate change alters both average and extreme temperatures and precipitation patterns which in turn influence crop yields, pest and weed ranges and introduction and the length of the growing season (Anon., 2008). Olive trees are tougher than vines and can thrive on many different terrains and under various climate conditions.

Temperatures are often higher than optimal in ornamental production systems. This situation may stress plants, causing a reduction of quality and/or yield of ornamental crops (Restrepo-Díaz *et al.,* 2010). The high solar radiation and temperatures cause high rates of plant water loss and plants regularly show symptoms of burn or withering in leaves or fruits (Callejón-Ferre *et al.,* 2009). In Colombia, it is common find high tem-peratures (above 35°C) in greenhouses during dry season (period of time without rains) or the Niño phenomenon (Asocolflores, 1997). High temperatures may reduce flower quality be-cause of excessive plant transpiration and respiration (Fernandez *et al.,* 1994). On the other hand, low leaf water content causes negative effect on leaf area, CO_2 assimilation rate, stomatal conductance and yield in rose plants (Raviv and Blom, 2001).

Olive (*Olea europaea* L.) is an evergreen tree belongs to family Oleaceae, one of the oldest cultivated trees in the history of the world about 8000 years ago. It is a widely distributed tree grown in many arid zones of the world, native to all the countries around the Mediterranean region. The olive species includes many cultivars which are used for oil extraction, or table olives and double purpose. Olive cultivation plays an important role in the economy of many countries, comparatively it resists drought and salinity conditions to a great extent. In addition, it increases the land values where the soil is unsuitable for other crops (Hegazi *et al.,* 2007).

In Egypt, table olive cultivars play an important role in economics of the growers and countries where most of the olive production is consumed as pickling products. Thereby, poor fruit set, high fruit shedding and consequently poor yields are considered critical factors for growing table cultivars. Kalamata is a pickling olive cultivar, where high fruit set and consequently the number of fruits per tree with good quality is essential factor to gain high income.

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Reflective materials can be applied as a leaf or fruit particle film coating to reduce solar heat stress, especially in areas with hot or sunny weather for a substantial part of the year. Such coatings can reduce heat stress, the extent of solar-injured fruit and water stress, and are involved in pest control and the suppression of disease incidence (Glenn and Puterka, 2005). Some of the reflective materials that may be used as leaf coating material include kaolin and calcium carbonate.

Kaolin has been tested in different horticultural crops and its response has been heterogeneous (Rosati *et al.* 2006). Kaolin showed a reduction on leaf temperature in apple trees (Wunsche *et al.,* 2004), and improved light-saturated CO_2 assimilation rate (Amax) and stomatal conductance (gs) in citrus at midday (Jifon and Syvertsen 2003). However, kaolin has no effect on gas exchange pa- rameters in pepper (Russo and Diaz-Perez 2005) and did not suffice to mitigate the adverse effects of heat and water stress on photo- synthesis in almond and walnut (Rosati *et al.* 2006), and enhanced water loss from fruit in tomato (Nakano and Uehara, 1996).

Calcium carbonate (CaCO3) is a white, nontoxic, odorless solid. It is one of the most common and widely dispersed minerals occurring in eggshells, limestone, marble, seashells and other biominerals (McGregor, 1963). Because of its harmlessness and low cost, calcium carbonate has been used for a variety of purposes such as a neutralizing agent, filler, flux and in cement (McGregor, 1963; Sheikholeslami and Ong, 2003). Researchers have studied the effects of these reflective clay particle films on plant physiology processes.

The objectives of this experiment were to study the light transmission of two coating calcium carbonate and kaolin clays on vegetative growth, leaf pigments and mineral content of Kalamata and Manzanillo olive trees.

Materials and Methods

This study was carried out during two successive seasons, (2015and 2016) in a private orchard located at Ismailia governorate, Egypt. The study was conducted on 15 years old olive trees of Kalamata and Manzanillo cvs., planted at 5 X 5 m apart grown in sandy soil, under drip irrigation, system and uniform in shape and received the common horticultural practices. The orchard soil analysis are given in (Table 1) and water irrigation analysis are given in (Table 2) according to procedures which are outlined by Wild *et al.* (1985).

Experimental design

The treatments will be arranged in a randomized complete block design (RCBD), the experiment contains seven treatments, each containing three replicates and the replicate represented by one tree. The normal horticulture practices that used in the farm were applied to all Kalamata and Manzanillo olive trees.

Experimental material

Calcium carbonate is a chemical compound with the formula CaCO3. It is a common substance found in rocks as the minerals calcite and aragonite (most notably as limestone, which is a type of sedimentary rock build mainly of calcite). Calcium carbonate is the active ingredient in agricultural lime

Kaolin is a clay mineral, part of the group of industrial minerals, with the chemical composition $Al_2Si_2O_5(OH)_4$. It is a layered silicate mineral, with one tetrahedral sheet of silica (SiO_4) linked through oxygen atoms to one octahedral sheet of alumina (AlO_6) octahedra. Rocks that are rich in kaolinite are known as kaolin or china clay.

Treatments: the study is divided into two separated experiments as follows:

T1- Control (water spray).
T2- Calcium carbonate 3% **T5**- Kaolin 3%.
T3- Calcium carbonate 5% **T6**- Kaolin 5%.
T4- Calcium carbonate 7%. **T7**- Kaolin 7%.

All treatments were applied on three different dates. The first October, November, December.

Table 1: Some physical and chemical analysis of the orchard soil

Parameters	Depth of simple (cm)		
	Surface sample	30 cm depth	60 cm depth
pH	8.02	8.70	8.11
EC(dSm-1)	3.80	0.80	1.70
	Soluble cations (meq\l)		
Ca^{++}	6.00	2.50	3.00
Mg^{++}	4.00	1.50	1.50
Na^{+}	28.60	4.40	12.90
K^{+}	0.12	0.14	0.78
	Soluble anions (meq\l)		
$CO3^{-}$	-	-	-
$HCO3^{-}$	4.40	2.40	2.00
Cl^{-}	27.20	5.00	13.00
$SO4^{=}$	7.12	1.14	3.18

Table 2: Chemical characteristics of water weal used for the present study.

Parameters	Values
pH	7.49
EC(dSm^{-1})	4.40
Soluble cations (meq\l)	
Ca^{++}	7.50
Mg^{++}	5.00
Na^{+}	33.1
K^{+}	0.16
Soluble anions (meq\l)	
$CO3^{=}$	-
$HCO3^{-}$	1.60
Cl^{-}	40.00
$SO4^{=}$	4.16

Measurements

On early January of each season, twenty healthy one year old shoots, well distributed around periphery of each tree were randomly selected and labeled (5 shoots toward each direction) for caring out the following measurements.

a. Vegetative growth

At the end of each growing season during first week of September the following characteristics were measured.

1. Shoot length (cm)
2. Shoot diameter (mm).
3. Leaf area (cm^2) according to (Ahmed and Morsy, 1999) using the following equilibration: Leaf area = 0.53 (length x width) + 1.66.

b. Leaf mineral content and pigments

Leaves needed were randomly sampled from the previously labeled shoots per each tree / replicate on the second week of September. Whereas, 2 - 3 leaves from every shoot (4th and 5th leaves) were picked then mixed together as a composite for carrying out the following chemical analysis:

Leaf mineral content

Leaves sample from each tree / replicate was separately oven dried at 70 º C till constant weight, and then grounded for determination the following nutrient elements (Percentage as dry weight):

N- Using the modified micro - kjeldahl method as lined by Pregl, (1945).

P- Was estimated as described by Chapman and Pratt, (1961).

K- Flamephotometerically determined according to Brown and Lilleland, (1946).

Fe, Zn and Mn as ppm was spectrophotometerically determined using atomic absorption (Model, spectronic 21 D) as described by Jackson. (1973).

Total chlorophyll content

Total chlorophyll content was estimated in intact flag leaves using a portable chlorophyll meter (CCM-200, Opti-Sciences, England).

Statistical analysis

All obtained data during both 2015 and 2016 experimental seasons were subjected to analysis of variances (ANOVA) according to Snedecor and Cochran, (1980) using MSTAT program. Least significant ranges (LSR) were used to compare between means of treatments according to Duncan, (1955) at probability of 5 %.

Results and Discussion

This trial was carried out to study the effect of kaolin and calcium carbonate on vegetative growth, leaf chemical composition, flowering, fruit set, yield and fruit physical and chemical properties.

Effect of kaolin and calcium carbonate on vegetative growth characteristics of Kalamata and Manzanillo olives:

Shoot length (cm)

Data in Table (3) show shoot length of Kalamata and Manzanillo as affected by different tested spraying kaolin and calcium carbonate in 2015 and 2016 seasons. Average shoot length of the two cultivars was varied significantly among the used kaolin and calcium carbonate. Trees sprayed with kaolin and calcium carbonate produced the highest shoot length, while untreated trees produced significant lowest shoot length in both seasons. On the other hand, among the three date, first date produced the highest shoot length compared with the other dates in both seasons. The interaction between treatments and application dates was significant. The variation ranged in Kalamata and Manzanillo from 19.67 to 26.00 & 23.46 to 30.58 cm in the first season and between 23.33 to 24.66 & 23.49 to 26.92 cm in the second season respectively.

Table 3: Effect of Kaolin and Calcium Carbonate spraying on shoot length (cm) of Kalamata and Manzanillo olive trees in 2015 and 2016 seasons

Treat.	Season 2015				Season 2016			
	Oct.	Nov.	Dec.	Mean	Oct.	Nov.	Dec.	Mean
				Kalamata				
Control		21.76 d-g		**21.76 D**		23.46 a		**23.46 B**
$Al_2Si_2O_5(OH)_4$3%	22.25 def	24.50 abc	23.92abd	**21.94 CD**	23.91 a	24.16 a	23.83 a	**23.97 AB**
$Al_2Si_2O_5(OH)_4$5%	19.67 g	24.67 ab	23.42bcd	**22.97 BC**	24.24 a	24.41 a	23.41 a	**24.02 AB**
$Al_2Si_2O_5(OH)_4$7%	20.83 fg	24.50 abc	23.83abc	**24.28 A**	23.33 a	23.50 a	23.66 a	**23.50 B**
$CaCo_3$ 3%	22.33c-f	26.00 a	23.42bcd	**23.92 AB**	24.50 a	23.83 a	24.16 a	**24.16 AB**
$CaCo_3$5%	23.17bcd	23.33bcd	25.75 a	**24.08 AB**	24.16 a	23.58 a	24.08 a	**23.94 AB**
$CaCo_3$7%	25.25 ab	25.75 a	21.33 efg	**24.11 AB**	24.00 a	24.41 a	24.66 a	**24.36 A**
Mean	**23.42 A'**	**24.00 A'**	**22.47 B'**		**23.94 A'**	**23.91 A'**	**23.90 A'**	
				Manzanillo				
Control		23.46 j		**23.46 D**		23.49 d		**23.49 B**
$Al_2Si_2O_5(OH)_4$3%	29.33 a-d	26.17 f-i	27.75cd-g	**27.75ABC**	26.83 a	24.42 bcd	23.92 cd	**25.83 A**
$Al_2Si_2O_5(OH)_4$5%	28.58a-d	26.33 e-i	25.25 hij	**26.72 C**	25.83 a-d	24.75 a-d	25.00 a-d	**25.06 A**
$Al_2Si_2O_5(OH)_4$7%	29.92 abc	25.75 g-j	25.42 g-j	**27.03 BC**	26.08 abc	23.75 cd	24.17 bcd	**25.19 A**
$CaCo_3$ 3%	27.67c-g	28.25b-f	24.50 ij	**26.81 BC**	26.33 ab	23.92 cd	24.17 bcd	**24.67 A**
$CaCo_3$5%	30.58 b	27.58d-h	25.27 hij	**27.97 AB**	26.92 a	23.75 cd	25.00 a-d	**24.81 A**
$CaCo_3$7%	30.33 ab	27.42d-h	27.42d-h	**28.39 A**	25.83 a-d	24.33 bcd	24.42 bcd	**25.22 A**
Mean	**28.55 A'**	**26.422 B'**	**25.65 C'**		**25.90 A'**	**24.31 B'**	**24.06 '**	

Shoot diameter

Kalamata Cultivar

Comparison between the treatments means for the shoot diameter (Table 4) indicated that sprayingAl$_2$Si$_2$O$_5$(OH)$_4$7% and CaCo$_3$ at 7% concentration treatment gave the highest shoot diameter (5.96 and 5.94 mm) & (6.74 and 6.74 mm) in both season, respectively with insignificant differences between fourth and seventh treatments across all studied application dates. On the other hand, the application of treatments in the third date gave the maximum number of shoot diameter (5.70 and 6.49 mm) in both seasons, respectively. The interaction between treatments and application dates was significant. The variation ranged from 4.19 to 5.02 mm in the first season and between 4.67 to 5.56 mm in the second season respectively.

Table 4: Effect of Kaolin and Calcium Carbonate spraying on shoot diameter (mm) of Kalamata and Manzanillo olive trees in 2015 and 2016 seasons

Treat.	Season 2015				Season 2016			
	Oct.	Nov.	Dec.	Mean	Oct.	Nov.	Dec.	Mean
				Kalamata				
Control		4.15g		**4.15D**		4.95h		**4.95D**
Al$_2$Si$_2$O$_5$(OH)$_4$3%	5.23ef	5.34de	5.69c	**5.42C**	6.03fg	6.14fg	6.49cde	**6.22C**
Al$_2$Si$_2$O$_5$(OH)$_4$5%	5.45d	5.70c	5.92b	**5.69B**	6.25ef	6.50cde	6.72a-d	**6.49B**
Al$_2$Si$_2$O$_5$(OH)$_4$7%	5.68c	5.95b	6.25a	**5.96 A**	6.48de	6.75abc	6.99a	**6.74 A**
CaCo$_3$ 3%	5.16f	5.44d	5.74c	**5.45C**	5.96g	6.24ef	6.54bcd	**6.25C**
CaCo$_3$5%	5.40d	5.73c	5.98b	**5.70B**	6.20fg	6.53bcd	6.78ab	**6.50B**
CaCo$_3$7%	5.69c	5.96b	6.18a	**5.94 A**	6.49cde	6.76abc	6.98a	**6.74 A**
Mean	**5.25 C'**	**5.47 B'**	**5.70 A'**		**6.05 C'**	**6.27 B'**	**6.49 A'**	
				Manzanillo				
Control		4.64 a-d		**4.64 AB**		4.83 d-g		**4.83 C**
Al$_2$Si$_2$O$_5$(OH)$_4$3%	4.61 a-d	4.43 bcd	5.02 a	**4.69 A**	5.01 b-e	5.53 a	5.13 b	**5.22 A**
Al$_2$Si$_2$O$_5$(OH)$_4$5%	4.24 cd	4.30 bcd	4.60 a-d	**4.38 BCD**	4.67 g	5.05 bcd	5.08 bc	**4.93 BC**
Al$_2$Si$_2$O$_5$(OH)$_4$7%	4.75 abc	4.19 d	4.80 ab	**4.58 ABC**	4.91 b-f	5.12 b	5.00 b-f	**5.01 B**
CaCo$_3$ 3%	4.26 cd	4.25 cd	4.51 bcd	**4.34 CD**	5.08 b	4.85 c-g	5.08 b	**5.00 B**
CaCo$_3$5%	4.26 cd	4.25 cd	4.20 d	**4.24 D**	5.08 bc	4.78 efg	5.09 b	**4.98 BC**
CaCo$_3$7%	4.31 bcd	4.44 bcd	4.51 bcd	**4.42 BCD**	4.81 efg	4.78 efg	5.56 a	**5.05 B**
Mean	**4.64 A'**	**4.36 B'**	**4.61 A'**		**4.91 B'**	**4.99 B'**	**5.11 A'**	

Manzanillo Cultivar

Comparison between the treatments means for the shoot diameter (Table 4) indicated that spraying Al$_2$Si$_2$O$_5$(OH)$_4$3% concentration treatment gave the highest shoot diameter (4.69 and 5.22 mm) in both season, respectively. On the other hand, the application of treatments in the third date gave the maximum shoot diameter. The interaction between treatments and application dates was significant. The variation ranged from 4.19 to 5.02 mm in the first season and between 4.67 to 5.56 mm in the second season respectively.

These results were in agreement with those obtained by Saour, (2005), Bedrech and Farag (2015), El-Said, (2015) and Omran (2013) they demonstrated that foliar applications with kaolin and CaCo$_3$ significantly increased vegetative growth characteristics. In addition, (Saour, and Makee, 2004) found that Kaolin-sprayed olive trees significantly outperformed their unsprayed counterparts in terms of dry matter percentage.

On contrary, Sugar *et al*., (2005) revealed that no significant differences in trunk area were observed among Kaolin treatment. No significant differences in shoot growth were observed of Doyenne du Comice (‘Comice’) pear.

The pronounced promotional effect of the foliar application of kaolin on vegetative growth characteristics may be related to the direct effects of kaolin on plant resistance to both biotic and abiotic stress including drought (Glenn *et al*., 2002). In addition, kaolin foliar application was reported to improve CO_2 assimilation under high temperature (Glenn *et al*., 2002). Such gains can explain the enhancement of plant growth in associated with higher plant water content.

Leaf area

Kalamata Cultivar

As shown in Table (5) leaf area was statistically affected by different treatments in two seasons. Trees sprayed with kaolin and calcium carbonate produced the largest leaf area, while untreated trees produced significant the smallest leaf area in both seasons. On the other hand, the application of treatments in the third date gave the largest leaf area (4.70 and 5.19 cm^2) in the first and second season respectively without any significant difference as compared with those resulted from other treatments. The interaction between treatments and application dates was significant.$CaCo_3$ 3% in Dec. treatment resulted in the largest leaf area during two season of studied (4.96 and 5.64 cm^2), respectively.

Table 5: Effect of Kaolin and Calcium Carbonate spraying on leaf area (cm²) of Kalamata and Manzanillo olive trees in 2015 and 2016 seasons.

Treat.	Season 2015				Season 2016			
	Oct.	Nov.	Dec.	Mean	Oct.	Nov.	Dec.	Mean
				Kalamata				
Control		3.83d		**3.83B**		4.50d		**4.50C**
$Al_2Si_2O_5(OH)_4$3%	4.92ab	4.37c	4.77ab	**4.68 A**	5.42a	4.87c	5.27ab	**5.18B**
$Al_2Si_2O_5(OH)_4$5%	4.78ab	4.81ab	4.69ab	**4.76 A**	5.28ab	5.31ab	5.19ab	**5.26AB**
$Al_2Si_2O_5(OH)_4$7%	4.73ab	4.82ab	4.88ab	**4.81 A**	5.23ab	5.32ab	5.25ab	**5.27AB**
$CaCo_3$ 3%	4.63bc	4.75ab	4.96a	**4.78 A**	5.13bc	5.25ab	5.46a	**5.28AB**
$CaCo_3$5%	4.73ab	4.91ab	4.90ab	**4.85 A**	5.29ab	5.41a	5.40ab	**5.36 A**
$CaCo_3$7%	4.75ab	4.83ab	4.87ab	**4.81 A**	5.25ab	5.33ab	5.23ab	**5.27AB**
Mean	**4.63 A'**	**4.62 A'**	**4.70 A'**		**5.16 A'**	**5.14 A'**	**5.19 A'**	
				Manzanillo				
Control		4.11g		**4.11 E**		4.73 c-f		**4.73 C**
$Al_2Si_2O_5(OH)_4$3%	4.64 b	5.03 a	4.63 b	**4.77 A**	5.03 b	5.43 a	5.03 b	**5.16 A**
$Al_2Si_2O_5(OH)_4$5%	4.13 fg	4.55 bcd	4.59 bc	**4.43 D**	4.57 f	4.95 bcd	4.98 bc	**4.83 BC**
$Al_2Si_2O_5(OH)_4$7%	4.40 cde	4.62 b	4.69 b	**4.57 B**	4.81b-e	5.02 b	4.90b-e	**4.91 B**
$CaCo_3$ 3%	4.31 ef	4.35 e	4.64 b	**4.43 CD**	5.03 b	4.75 c-f	4.98 bc	**4.92 B**
$CaCo_3$5%	4.58 bc	4.36 de	4.59 bc	**4.51 BCD**	4.98 bc	4.68 ef	4.99 bc	**4.88 BC**
$CaCo_3$7%	4.31 ef	4.24 efg	5.06 a	**4.54 BC**	4.71 def	4.68 ef	5.46 a	**4.95 B**
Mean	**4.35 C '**	**4.47 B'**	**4.62 A'**		**4.83 B'**	**4.89 B'**	**5.01 A'**	

Manzanillo Cultivar

As shown in Table (5) leaf area was statistically affected by different treatments in two seasons. Trees sprayed with kaolin and calcium carbonate produced the largest leaf area, while untreated trees produced significant the smallest leaf area in both seasons. On the other hand, the application of treatments in the third date gave the largest leaf area (4.62 and 5.01 cm^2) in the first and second season respectively. The interaction between treatments and application dates was significant.$CaCo_3$ 7% in Dec. treatment resulted in the largest leaf area during two season of studied (5.06 and 5.46 cm^2), respectively.

Such results are in harmony with the findings of Saour, (2005), Bedrech and Farag (2015), EL-Said, (2015) and Omran (2013) they found that leaf area increased statistically by kaolin and calcium carbonate treatments., while untreated trees produced significant the smallest leaf area.

Effect of kaolin and calcium carbonate on total chlorophyll of Kalamata and Manzanillo olives:

Kalamata Cultivar

Data in Table (6) showed that, there was no clear trend concerning different treatments on total chlorophyll. The highest total chlorophyll content (SPAD units) was found under $CaCo_3$ 7% for mid Nov. treatment in the first season. Meanwhile in the second $CaCo_3$ 7% for mid Des. recorded the highest values. on the contrary, the lowest values were recorded with $CaCo_3$ 3% for mid December in the first seasons. Meanwhile in the second season $Al_2Si_2O_5(OH)_4$ 5% for mid Des.

Manzanillo Cultivar

Data in Table (6) showed that, there was no clear trend concerning different treatments on total chlorophyll content. The highest total chlorophyll content (SPAD units) was found under $Al_2Si_2O_5(OH)_4$ 7% for mid Des. treatment in the first season. Meanwhile in the second season $Al_2Si_2O_5(OH)_4$ 7% for mid Nov. recorded the highest values. On the contrary, the lowest values were recorded with $Al_2Si_2O_5(OH)_4$ 5% for mid Oct. and $Al_2Si_2O_5(OH)_4$ 3% for mid Des. in both seasons, respectively.

These results are not in agreement with those obtained by Persefoni and Nanos (2015) they postulated that Leaf chlorophyll content slightly decreased during the summer until early September In late September, chlorophyll content increased significantly in kaolin-treated leaves, while in control leaves this increase was not significant. In addition, kaolin-treated olive leaves had slightly or significantly higher chlorophyll content than control leaves.

Moreover, Lombardini *et al*., (2005), Khaleghi *et al.,* (2015) and El-Said, (2015) found that kaolin-treated leaves had higher chlorophyll content than control leaves.

Table 6: Effect of Kaolin and Calcium Carbonate spraying on leaf content of total chlorophyll (SPAD units) of Kalamata and Manzanillo olive trees in 2015 and 2016 seasons.

Treat.	Season 2015				Season 2016			
	Oct.	Nov.	Dec.	Mean	Oct.	Nov.	Dec.	Mean
				Kalamata				
Control		85.30 def		**85.30C**		88.56 efg		**88.56C**
$Al_2Si_2O_5(OH)_4$3%	93.30 abc	86.10 def	74.77g	**84.72C**	92.83bcd	91.97cde	91.87cde	**92.22B**
$Al_2Si_2O_5(OH)_4$5%	88.30b-e	83.17ef	85.13 def	**85.53C**	97.90ab	95.00abc	84.17g	**92.36B**
$Al_2Si_2O_5(OH)_4$7%	94.77 ab	97.17a	83.07ef	**91.67B**	99.73a	96.93abc	92.50bcd	**96.39 A**
$CaCo_3$ 3%	90.63a-d	80.37fg	92.30abc	**87.77BC**	98.23a	90.20def	91.47cde	**93.30AB**
$CaCo_3$5%	93.47 ab	85.17 def	90.77a-d	**89.80B**	91.57cde	98.97a	95.37abc	**95.30AB**
$CaCo_3$7%	96.13 a	97.93a	94.83 ab	**96.30 A**	85.13fg	98.87a	99.00a	**94.33AB**
Mean	**91.70 A'**	**87.89 B'**	**86.60 B'**		**93.42AB'**	**94.36 A'**	**91.85 B'**	
				Manzanillo				
Control		86.10 cde		**86.10C**		87.73e		**87.73C**
$Al_2Si_2O_5(OH)_4$3%	83.53de	90.13bcd	98.67a	**90.78ABC**	94.67bcd	92.07d	86.93e	**91.22B**
$Al_2Si_2O_5(OH)_4$5%	71.03f	94.37abc	98.20a	**87.87BC**	96.23ab	94.23bcd	96.37ab	**95.61A**
$Al_2Si_2O_5(OH)_4$7%	97.73ab	88.40cde	99.23a	**95.12A**	95.87abc	97.17ab	96.70ab	**96.58A**
$CaCo_3$ 3%	81.67e	95.87abc	97.80ab	**91.78AB**	95.67abc	95.13abc	95.67abc	**95.49A**
$CaCo_3$5%	96.80ab	92.57bcd	98.93a	**96.10A**	95.03bcd	98.73a	94.50bcd	**96.09A**
$CaCo_3$7%	92.67bcd	97.03ab	98.90a	**96.20A**	96.03ab	92.47cd	95.13abc	**94.54A**
Mean	**87.08 C'**	**92.07 B'**	**96.83 A'**		**94.46 A'**	**93.93 A'**	**93.29 A'**	

Effect of kaolin and calcium carbonate on leaf mineral content of Kalamata and Manzanillo olives:

Leaf content of N

Kalamata Cultivar

Data in Table (7) showed that, there was no clear trend concerning different treatments on N content. The highest N (%) was found under $CaCo_3$ 3% for mid Dec. and $Al_2Si_2O_5(OH)_4$ 3% for mid Nov. treatments in the first season. Meanwhile in the second season $Al_2Si_2O_5(OH)_4$ 3% for mid Oct. and $Al_2Si_2O_5(OH)_4$ 3% for mid Nov. recorded the highest values. On the contrary, the lowest values were recorded with $CaCo_3$ 3% for mid Oct. in both seasons.

Manzanillo Cultivar

Data in Table (7) showed that, there was no clear trend concerning different treatments on N content. The highest N (%) was found under $CaCo_3$ 3% for mid Dec. treatment in the first season. Meanwhile in the second season $CaCo_3$ 5% for mid Dec.recorded the highest values. On the contrary, the lowest values were recorded with $Al_2Si_2O_5(OH)_4$ 5% for mid Nov. in both seasons.

Table 7: Effect of Kaolin and Calcium Carbonate spraying on leaf content of N (%) of Kalamata and Manzanillo olive trees in 2015 and 2016 seasons.

Treat.	Season 2015				Season 2016			
	Oct.	Nov.	Dec.	Mean	Oct.	Nov.	Dec.	Mean
				Kalamata				
Control		2.04de		**2.04B**		2.62abc		**2.62AB**
$Al_2Si_2O_5(OH)_4$3%	2.46a	2.45a	2.18cd	**2.36 A**	1.66d	2.74a	2.49c	**2.29C**
$Al_2Si_2O_5(OH)_4$5%	2.46a	2.42ab	1.92ef	**2.27 A**	2.75a	2.66ab	2.55bc	**2.65 A**
$Al_2Si_2O_5(OH)_4$7%	1.94ef	2.36ab	1.84f	**2.05B**	2.55bc	2.50c	2.55bc	**2.53B**
$CaCo_3$ 3%	1.36i	1.57gh	2.47a	**1.80C**	1.13f	1.56d	1.52d	**1.41D**
$CaCo_3$5%	1.63g	1.96ef	1.42hi	**1.67D**	1.52d	1.34e	1.53d	**1.46D**
$CaCo_3$7%	1.60gh	1.26i	2.26bc	**1.71CD**	1.55d	1.55d	1.36e	**1.49D**
Mean	**1.93 B'**	**2.01 A'**	**2.02 A'**		**1.97 B'**	**2.14 A'**	**2.09 A'**	**1.93B**
				Manzanillo				
Control		1.39 d		**1.39 CD**		1.42 h		**1.43 C**
$Al_2Si_2O_5(OH)_4$3%	1.39 d	1.57 b	1.41 d	**1.46 AB**	1.76 abc	1.79 abc	1.59 ef	**1.71 AB**
$Al_2Si_2O_5(OH)_4$5%	1.54 bc	1.38 d	1.55 bc	**1.49 A**	1.79 abc	1.70 cd	1.65 de	**1.71 AB**
$Al_2Si_2O_5(OH)_4$7%	1.45 cd	1.13 e	1.71 a	**1.43 BC**	1.73 bcd	1.54 fg	1.82 ab	**1.69 B**
$CaCo_3$ 3%	1.35 d	1.43 d	1.18 e	**1.32 E**	1.73 bcd	1.70 cd	1.65 de	**1.69 B**
$CaCo_3$5%	1.42 d	1.21 e	1.36 d	**1.33 DE**	1.76 abc	1.59 ef	1.84 a	**1.73 AB**
$CaCo_3$7%	1.35 d	0.88 f	1.54 bc	**1.26 F**	1.76 abc	1.76 abc	1.79 abc	**1.77 A**
Mean	**1.41 A'**	**1.28 B'**	**1.45 A'**		**1.71 A'**	**1.64 B'**	**1.68 AB'**	

Leaf content of P

Kalamata Cultivar

Data in Table (8) showed that, there was no clear trend concerning different treatments on P content. The variation ranged from 0.08 to 0.22% in the first season and between 0.22 to 0.27% in the second season respectively.

Manzanillo Cultivar

Data in Table (8) showed that, there was no clear trend concerning different treatments on P content. The variation ranged from 0.68 to 1.16% in the first season and between 0.74 to 1.41% in the second season respectively.

Table 8: Effect of Kaolin and Calcium Carbonate spraying on leaf content of P (%) of Kalamata and Manzanillo olive trees in 2015 and 2016 seasons.

Treat.	Season 2015				Season 2016			
	Oct.	Nov.	Dec.	Mean	Oct.	Nov.	Dec.	Mean
				Kalamata				
Control		0.08 i		**0.08 D**		0.27 a		**0.27 A**
$Al_2Si_2O_5(OH)_4$3%	0.11 gh	0.16 d	0.19 bc	**0.15 AB**	0.25 bc	0.25 bc	0.25 bc	**0.25 B**
$Al_2Si_2O_5(OH)_4$5%	0.16 d	0.14 ef	0.11 gh	**0.13 C**	0.25 bc	0.26 b	0.23 cde	**0.24 BC**
$Al_2Si_2O_5(OH)_4$7%	0.16 d	0.18 bc	0.12 fg	**0.15 AB**	0.26 b	0.25 bc	0.23 cde	**0.24 BC**
$CaCo_3$ 3%	0.10 h	0.21 a	0.11 gh	**0.14 BC**	0.24 bcd	0.24 bcd	0.23 cde	**0.24 C**
$CaCo_3$5%	0.11 gh	0.22 a	0.14 ef	**0.16 A**	0.25 bc	0.22 efg	0.23 cde	**0.24 C**
$CaCo_3$7%	0.12 fg	0.21 a	0.14 ef	**0.16 A**	0.25 bc	0.23 cde	0.25 bc	**0.24 BC**
Mean	**0.12 B'**	**0.17 A'**	**0.13 B'**		**0.25 A'**	**0.24 B'**	**0.24 B'**	
				Manzanillo				
Control		0.98 def		**0.98 B**		0.86 e		**0.86 D**
$Al_2Si_2O_5(OH)_4$3%	1.05 bc	0.93 fgh	0.87 ijk	**0.95 BC**	1.29 bc	1.36 ab	1.08 d	**1.24 A**
$Al_2Si_2O_5(OH)_4$5%	0.74 m	0.82 i	0.68 n	**0.75 D**	1.30 bc	1.21 c	1.24 c	**1.25 A**
$Al_2Si_2O_5(OH)_4$7%	1.06 bc	1.00 de	0.83 jkl	**0.96 B**	1.30 bc	1.02 d	1.09 d	**1.14 B**
$CaCo_3$ 3%	1.08 b	0.89 hij	0.95 efg	**0.97 B**	0.74 f	1.25 c	1.11 d	**1.03 C**
$CaCo_3$5%	1.02 cd	0.83 kl	0.92 ghi	**0.92 C**	0.81 ef	1.06 d	1.41 a	**1.09 BC**
$CaCo_3$7%	1.08 b	0.94 fg	1.16 a	**1.06 A**	0.90 e	1.26 c	1.29 bc	**1.15 B**
Mean	**1.00 A'**	**0.91 B'**	**0.91 B'**		**1.03 B'**	**1.15 A'**	**1.15 A'**	

Leaf content of K

Kalamata Cultivar

Data in Table (9) showed that, there was no clear trend concerning different treatments on K content. The variation ranged from 0.08 to 0.22% in the first season and between 0.22 to 0.27% in the second season respectively.

Manzanillo Cultivar

Data in Table (9) showed that, there was no clear trend concerning different treatments on K content. The variation ranged from 0.82 to 1.37% in the first season and between 0.74 to 1.16% in the second season respectively.

Table 9: Effect of Kaolin and Calcium Carbonate spraying on leaf content of K (%) of Kalamata and Manzanillo olive trees in 2015 and 2016 seasons.

Treat.	Season 2015				Season 2016			
	Oct.	Nov.	Dec.	Mean	Oct.	Nov.	Dec.	Mean
				Kalamata				
Control		1.09 fgh		**1.09 C**		1.22 bc		**1.22 A**
$Al_2Si_2O_5(OH)_4$3%	1.20 cde	1.22 cd	1.23 bc	**1.22 AB**	1.32 a	1.32 a	1.07 gh	**1.23 A**
$Al_2Si_2O_5(OH)_4$5%	1.18 de	1.23 bc	1.22 cd	**1.21 B**	1.16 de	1.06 gh	0.93 i	**1.05 C**
$Al_2Si_2O_5(OH)_4$7%	1.30 a	1.16 de	1.27 ab	**1.24 A**	1.24 b	0.97 i	1.02 h	**1.08 BC**
$CaCo_3$ 3%	0.93 j	1.09 fgh	0.93 j	**0.98 E**	0.98 i	1.05 gh	1.20 bcd	**1.08 BC**
$CaCo_3$5%	0.94 j	1.10 fg	1.11 e	**1.05 D**	1.03 h	1.06 gh	1.19 cd	**1.09 B**
$CaCo_3$7%	1.06 gh	1.05 h	1.01 i	**1.04 D**	1.06 gh	1.13 ef	1.09 fg	**1.09 B**
Mean	**1.10 B'**	**1.13 A'**	**1.12 A'**		**1.14 A'**	**1.11 B'**	**1.10 B'**	
				Manzanillo				
Control		1.08 ef		**1.08 CD**		1.11 f		**1.11 D**
$Al_2Si_2O_5(OH)_4$3%	0.98 g	1.08 ef	1.09 ef	**1.05 D**	1.32 ab	1.21 de	1.31 ab	**1.28 AB**
$Al_2Si_2O_5(OH)_4$5%	1.17 cde	1.05 fg	1.27 ab	**1.17 AB**	1.37 ab	1.21 de	1.37 ab	**1.32 A**
$Al_2Si_2O_5(OH)_4$7%	1.08 ef	1.08 ef	1.15 cde	**1.10 CD**	1.38 a	0.98 g	1.23 d	**1.20 C**
$CaCo_3$ 3%	1.08 ef	1.37 a	1.17 cd	**1.20 A**	1.13 f	1.31 bc	1.21 de	**1.22 C**
$CaCo_3$5%	1.20 bc	1.36 a	0.82 h	**1.13 BC**	1.24 cd	1.31 ab	1.34 ab	**1.29 A**
$CaCo_3$7%	1.14 c-f	1.08 ef	1.14 c-f	**1.12 BC**	1.14 ef	1.35 ab	1.21 de	**1.24 BC**
Mean	**1.00 A'**	**0.91 B'**	**0.91 B'**		**1.03 B'**	**1.15 A '**	**1.15 A'**	

Leaf content of Ca

Kalamata Cultivar

Data in Table (10) showed that, there was no clear trend concerning different treatments on Ca content. The variation ranged from 1.04 to 1.22% in the first season and between 1.03 to 1.34% in the second season respectively.

Manzanillo Cultivar

Data in Table (10) showed that, there was no clear trend concerning different treatments on Ca content. The variation ranged from 0.82 to 1.37% in the first season and between 0.98 to 1.38% in the second season respectively.

Leaf content of Fe

Kalamata Cultivar

Data in Table (11) showed that, there was no clear trend concerning different treatments on Fe content. The variation ranged from 142.30 to 272.37 ppm in the first season and between 103.53 to 234.53 ppm in the second season respectively.

Manzanillo Cultivar

Data in Table (11) showed that, there was no clear trend concerning different treatments on Fe content. The variation ranged from 153.57 to 291.77 ppm in the first season and between 102.67 to 241.73 ppm in the second season respectively.

Table 10: Effect of Kaolin and Calcium Carbonate spraying on leaf content of Ca% of Kalamata and Manzanillo olive trees in 2015 and 2016 seasons.

Treat.	Season 2015				Season 2016			
	Oct.	Nov.	Dec.	Mean	Oct.	Nov.	Dec.	Mean
				Kalamata				
Control		1.14 b		**1.14 A**		1.26 bc		**1.26 A**
$Al_2Si_2O_5(OH)_4$3%	1.01 ij	1.01 ij	1.07 efg	**1.03 E**	1.34 a	1.13 d	1.28 b	**1.25 A**
$Al_2Si_2O_5(OH)_4$5%	1.10 cde	1.06 fgh	1.14 b	**1.10 BC**	1.26 b	1.26 b	1.26 b	**1.26 A**
$Al_2Si_2O_5(OH)_4$7%	1.13 bc	1.09 def	1.12 bcd	**1.11 B**	1.25 b	1.22 c	1.25 b	**1.24 A**
$CaCo_3$ 3%	1.10 cde	1.04 hi	1.04 hi	**1.06 D**	1.11 d	1.11 d	1.11 d	**1.11 C**
$CaCo_3$5%	1.22 a	1.05 fgh	1.08 def	**1.12 B**	1.07 e	1.28 b	1.26 b	**1.20 B**
$CaCo_3$7%	1.10 cde	1.04 hi	1.12 bcd	**1.09 C**	1.03 f	1.34 a	1.26 b	**1.21 B**
Mean	**1.11 A'**	**1.06 B'**	**1.10 A'**		**1.19 B'**	**1.23 A'**	**1.24 A'**	
				Manzanillo				
Control		1.08 ef		**1.08 CD**		1.11 f		**1.11 D**
$Al_2Si_2O_5(OH)_4$3%	0.98 g	1.08 ef	1.09 ef	**1.05 D**	1.32 ab	1.21 de	1.31 ab	**1.28 Ab**
$Al_2Si_2O_5(OH)_4$5%	1.17 cde	1.05 fg	1.27 ab	**1.17 AB**	1.37 ab	1.21 de	1.37 ab	**1.32 A**
$Al_2Si_2O_5(OH)_4$7%	1.08 ef	1.08 ef	1.15 cde	**1.10 CD**	1.38 a	0.98 g	1.23 d	**1.20 C**
$CaCo_3$ 3%	1.08 ef	1.37 a	1.17 cd	**1.20 A**	1.13 f	1.31 bc	1.21 de	**1.22 C**
$CaCo_3$5%	1.20 bc	1.36 a	0.82 h	**1.13 BC**	1.24 cd	1.31 ab	1.34 ab	**1.29 A**
$CaCo_3$7%	1.14 c-f	1.08 ef	1.14 c-f	**1.12 BC**	1.14 ef	1.35 ab	1.21 de	**1.24 Bc**
Mean	**1.10 B'**	**1.15 A'**	**1.10 B'**		**1.24 AB'**	**1.21 B'**	**1.25 A'**	

Table 11: Effect of Kaolin and Calcium Carbonate spraying on leaf content of Fe (ppm) of Kalamata and Manzanillo olive trees in 2015 and 2016 seasons.

Treat.	Season 2015				Season 2016			
	Oct.	Nov.	Dec.	Mean	Oct.	Nov.	Dec.	Mean
				Kalamata				
Control		272.37 a		**272.37 A**		103.53 g		**103.53 D**
$Al_2Si_2O_5(OH)_4$3%	223.33cd	210.53 fg	250.27 b	**228.04 B**	151.60de	205.53 d	158.80cd	**171.98 B**
$Al_2Si_2O_5(OH)_4$5%	209.00 fg	175.13 i	204.87 g	**196.33 C**	177.20 c	149.47df	131.00 f	**152.56 C**
$Al_2Si_2O_5(OH)_4$7%	191.03 h	186.07 h	218.73de	**198.61 C**	172.73 c	162.27cd	136.93 ef	**157.31 C**
$CaCo_3$ 3%	212.27 ef	228.60 c	155.30 j	**198.72 C**	171.80 c	172.00 c	225.67 a	**189.82 A**
$CaCo_3$5%	249.17 b	158.33 j	176.90 i	**194.80 C**	176.60 c	234.53 a	171.00 c	**194.04 A**
$CaCo_3$7%	191.00 h	142.30 k	218.33de	**183.88 D**	218.87ab	166.27cd	164.07cd	**183.07AB**
Mean	**221.17 A'**	**196.19 C'**	**213.82 B'**		**167.48 A'**	**170.51 A'**	**155.86 B'**	
				Manzanillo				
Control		237.73 e		**237.73 C**		120.60 fg		**120.60 C**
$Al_2Si_2O_5(OH)_4$3%	291.77 a	210.40 h	244.20 d	**248.79 A**	186.93e	226.07ab	184.73e	**199.24 A**
$Al_2Si_2O_5(OH)_4$5%	186.80 j	185.97 j	207.80 h	**193.52 G**	208.93ab	185.00e	163.47cd	**185.80ab**
$Al_2Si_2O_5(OH)_4$7%	225.97 f	248.67 d	208.00 h	**227.54 D**	167.27cd	139.07ef	173.53bc	**159.96 B**
$CaCo_3$ 3%	285.77 b	259.10 c	183.47 j	**242.78 B**	163.07cd	216.53ab	208.07ab	**195.89AB**
$CaCo_3$5%	260.07 c	218.13 g	153.57 k	**210.59 E**	228.93ab	155.60de	152.93de	**179.16AB**
$CaCo_3$7%	199.93 i	207.40 h	196.67 i	**201.33 F**	241.73 a	203.67ab	102.67 g	**182.69AB**
Mean	**241.15 A'**	**223.91 B'**	**204.49 C'**		**188.21 A'**	**178.08AB'**	**158.00 B'**	

Leaf content of Zn

Kalamata Cultivar

Data in Table (12) showed that, there was no clear trend concerning different treatments on Zn content. The variation ranged from 23.17 to 26.13 ppm in the first season and between 7.80 to 27.40 ppm in the second season respectively.

Manzanillo Cultivar

Data in Table (12) showed that, there was no clear trend concerning different treatments on Zn content. The variation ranged from 23.33 to 45.20 ppm in the first season and between 12.60 to 30.20 in the second season respectively.

Table 12: Effect of Kaolin and Calcium Carbonate spraying on leaf content of Zn (ppm) of Kalamata and Manzanillo olive trees in 2015 and 2016 seasons.

Treat.	Season 2015				Season 2016			
	Oct.	Nov.	Dec.	Mean	Oct.	Nov.	Dec.	Mean
Kalamata								
Control	23.60 fg			**23.60 D**	7.80 h			**7.80 C**
$Al_2Si_2O_5(OH)_4$3%	23.63 fg	24.43 d	26.13 a	**24.73 A**	17.60 g	27.47 a	22.47 d	**22.51 B**
$Al_2Si_2O_5(OH)_4$5%	23.93 ef	23.43 g	20.80 h	**22.72 E**	25.13 bc	19.27 ef	24.80 bc	**23.07 B**
$Al_2Si_2O_5(OH)_4$7%	25.40 bc	23.20 g	24.23 de	**24.28 BC**	27.13 a	26.20 ab	19.93 ef	**24.42 A**
$CaCo_3$ 3%	23.40 g	23.17 g	25.70abc	**24.09 C**	26.33 ab	23.73 cd	23.80 cd	**24.62 A**
$CaCo_3$5%	25.23 bc	24.03 de	24.40 de	**24.56 AB**	25.93 ab	23.93 cd	18.40 fg	**22.76 B**
$CaCo_3$7%	25.83 eb	25.37 cd	22.70 h	**24.63 A**	20.53 e	27.40 a	26.00 ab	**24.64 A**
Mean	**24.43 A'**	**23.89 B'**	**23.94 B'**		**21.50 A'**	**22.26 A'**	**20.46 B'**	
Manzanillo								
Control	25.33 j			**25.33 E**	12.60 i			**12.60 F**
$Al_2Si_2O_5(OH)_4$3%	32.17 d	29.23 f	34.23 c	**31.88 B**	16.40 h	13.00 i	18.33 g	**15.91 E**
$Al_2Si_2O_5(OH)_4$5%	30.20 e	23.33 k	34.40 c	**29.31 C**	19.00 g	17.00 h	18.93 g	**18.31 D**
$Al_2Si_2O_5(OH)_4$7%	30.83 e	28.27 g	28.83 fg	**29.31 C**	12.60 i	17.00 h	18.93 g	**16.18 E**
$CaCo_3$ 3%	26.40 i	45.20 a	27.10 h	**32.90 A**	28.80 bc	26.80 d	26.67 d	**27.42 A**
$CaCo_3$5%	29.10 f	31.77 d	22.20 b	**27.69 D**	26.87 d	30.20 a	20.47 f	**25.84 C**
$CaCo_3$7%	28.37 g	35.27 b	35.83 b	**33.16 A**	22.53 e	28.20 c	29.33 ab	**26.69 B**
Mean	**28.91 C'**	**31.20 A'**	**29.70 B'**		**19.83 B'**	**20.69 A'**	**20.75 A'**	

Leaf content of Mn

Kalamata Cultivar

Data in Table (13) showed that, there was no clear trend concerning different treatments on Mn content. The variation ranged from 21.20 to 30.27 ppm in the first season and between 19.87 to 26.07 in the second season respectively.

Table 13: Effect of Kaolin and Calcium Carbonate spraying on leaf content of Mn (ppm) of Kalamata and Manzanillo olive trees in 2015 and 2016 seasons.

Treat.	Season 2015				Season 2016			
	Oct.	Nov.	Dec.	Mean	Oct.	Nov.	Dec.	Mean
Kalamata								
Control		25.17 e		**25.17 A**		26.07 a		**26.07 A**
$Al_2Si_2O_5(OH)_4$3%	25.47 e	21.47 i	22.13 h	**23.02 E**	20.73 def	21.47bcd	22.20 bc	**21.47 B**
$Al_2Si_2O_5(OH)_4$5%	22.37 gh	21.20 i	28.40 b	**23.99 D**	21.80bcd	21.40bcd	22.20 bc	**21.80 B**
$Al_2Si_2O_5(OH)_4$7%	22.30 gh	21.53 i	30.27 a	**24.70 B**	20.66 def	21.40bcd	22.06 bc	**21.37 B**
$CaCo_3$ 3%	24.60 f	27.67 c	21.37 i	**24.54 BC**	22.40 b	21.60bcd	21.13cde	**21.71 B**
$CaCo_3$5%	24.47 f	22.70 g	21.50 i	**22.89 E**	21.73bcd	21.93 bc	19.87 f	**21.18 B**
$CaCo_3$7%	26.40 d	22.50 gh	24.27 f	**24.39 C**	21.73bcd	22.00 bc	20.80 def	**21.51 B**
Mean	**24.40 B'**	**23.18 C'**	**24.73 A'**		**22.16 A'**	**22.27 A'**	**22.05 A'**	
Manzanillo								
Control		30.43 a		**30.43 A**		29.00 g		**29.00 D**
$Al_2Si_2O_5(OH)_4$3%	25.57 d	22.63 g	24.57 e	**24.26 C**	34.53 b	34.93 b	29.20 g	**32.89 A**
$Al_2Si_2O_5(OH)_4$5%	25.43 d	22.53 g	25.60 d	**24.52 C**	32.67 cd	26.60 i	32.20 de	**30.49 C**
$Al_2Si_2O_5(OH)_4$7%	27.33 c	28.37 b	25.57 d	**27.09 B**	31.27 f	20.67 j	27.07 i	**26.33 E**
$CaCo_3$ 3%	24.57 e	24.40 e	24.43 e	**24.47 C**	27.93 h	36.73 a	32.13 de	**32.27 B**
$CaCo_3$5%	24.33 e	22.33 g	23.43 f	**23.37 E**	28.20 h	32.20 de	31.60 ef	**30.67 C**
$CaCo_3$7%	24.53 e	22.30 g	24.43 e	**23.76 D**	28.53 gh	33.00 c	29.27 g	**30.27 C**
Mean	**26.03 A'**	**24.71 C'**	**25.50 B'**		**30.30 AB'**	**30.45 A'**	**30.07 B'**	

Manzanillo Cultivar

Data in Table (13) showed that, there was no clear trend concerning different treatments on Mn content. The variation ranged from 22.30 to 30.43 ppm in the first season and between 20.67 to 36.73 ppm in the second season respectively.

The obtained results are not in agreement with those obtained by Aly *et al.* (2010) he confirmed that particle reflective films (RF) show high positive 'Anna' apple leaf and fruit contents of N, Ca and Mg response to RF than trees no RF and reduced with increasing the concentrations of RF.

Moreover, EL-Gioushy *et al.* (2017) found that foliar treatments of CaCO3 affected the K, Mg and N concentrations in fruit. While, eight time foliar Ca sprays decreased the K concentration and K/Ca ratio of fruit skin. Six- or twelve-time Ca sprays decreased the N/Ca, K/Ca, (K+Mg)/Ca ratios in Keitt mango fruits.

On conversely, El-Said, (2015) postulated that calcium carbonate, magnesium carbonate and kaolin on chemical composition of eggplant foliage, foliar application of different used sources of antitranspirants significantly enhanced N, P, K and Fe contents as compared with the untreated plants

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