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Sunscald Reduction, Increasing Yield and Fruit Quality of Murcott Mandarin Fruits Using Different Compounds as Nano Form

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ABSTRACT: The current study was carried out on six-year-old Murcott Mandarin trees (a naturally occurring mandarin hybrid from tangerine to sweet orange) budded on 'Volkamer' lemon rootstock grown in sandy soil under drip irrigation system in a private orchard located at El-Nubaria, Beheira governorate, Egypt, during the two successful seasons of 2018 and 2019. It was intended to look into employing several substances in nano form (such as calcium carbonate and kaolin clay) to protect murcott mandarin fruit plants from sunburn and to increase fruit output and quality. Four replicates of a randomized full block design experiment were used. Findings showed that overall, all treatments greatly reduced fruit juice acidity and sun scales while increasing the number of murcott mandarin fruits per tree, fruit weight, yield (kg/tree), yield (ton/feddan), total soluble solids and decreasing sugars by % in comparison to the control over the 2018 and 2019 research seasons. Trees treated with 3% kaolin showed a higher, considerably increased yield over both seasons.

***Keywords**: 'Murcott' Mandarin, nano-synthesized compounds, Calcium carbonate, kaolin clay, sun scalds, yield and fruit quality*

INTRODUCTION

In terms of fruit production worldwide, citrus was placed third behind grapes and apples. In general, it is one of the most lucrative crops, particularly in Egypt. After Spain and Italy, Egypt produces 15% of all the citrus in the Mediterranean Basin, placing it third overall according to **Youseif *et al.* (2014)**. The several mandarin cultivars are among the most prominent citrus fruits in Egypt, with a high market value. A variety of thin-skinned, easily peeled fruits known as mandarins include well-known citrus fruits including tangerines, satsumas, and clementines. Egypt's citrus production has grown during the past few decades.

Citrus attained a fruiting area of 429778.6 fed., yielding 4388325 tons on average per fed at a rate of 10.21 tons. The Murcott mandarin, one of the most significant citrus types for the export market, with a total fruiting area of 109609.5 fed. According to **FAO statistics (2018)**, output was 1038753 tons with an average of 9.48 tons per fed, accounting for 25.5% of the world's citrus crop.

The ability of kaolin-based particle films to alter the micro environment of the plant canopy because of the reflective properties of the particles allows them to reduce insect, heat, and ultraviolet stress in horticultural crops. **Glenn (2012).** According to **Schrader *et al*. (2008)**, this kind of sunburn is mostly caused by fruit being directly exposed to visual radiation; infrared and UV rays are not necessary. Crystalline limestone or high-grade calcium carbonate is the principal active component. These chemicals are promoted as a liquid that may be sprayed onto agricultural foliage and fruit to create a light-reflecting thin crystalline coating. According to **Ahmed *et al.* (2011)**, CaCO3 increased photosynthesis, the production of plant pigments, favor, and the quality of fruits, all of which boosted plant metabolism. The same has also been reported by **Glenn *et al*. (2002) and Morsy *et al*. (2008).**

The objective of this investigation was to evaluate the impact of calcium carbonate and kaolin clay, two nano-synthesized substances, on the production and fruit quality of murcott mandarin fruit trees.

MATERIALS AND METHODS

The current research was done on six-year-old Murcott Mandarin (tangerine and sweet orange) trees budded on 'Volkamer' lemon rootstock planted at 44 meters apart (262 tree/feddan), received standard horticultural practices, and grown in sandy soil with drip irrigation in a private orchard located at El-Nubaria, Beheira governorate, Egypt, during the two successful seasons (2018 and 2019). It was intended to investigate how (Murcott) mandarin fruit trees' fruit productivity and quality were affected by nano-synthesized chemicals. In the beginning of this study, samples of soil were gathered to evaluate the physical and chemical parameters **(Table 1)** according to **Chapman and Partt (1978).**

Table (1): Soil physical and chemical properties of the experimental site

Parameter	Soil depth, cm	
	0 - 30	30 - 60
Mechanical analysis %		
Sand	91.6	90.0
Silt	6.1	7.0
Clay	2.3	3.0
Textural class	Sandy	Sandy
$Caco_3$ %	5.4	4.2
Organic matter , %	0.35	0.20
PH	8.25	8.28
EC (ds/m)	0.801	0823
Available Nutrients , mg/kg		
N	117.5	117.5
P	18.4	18.0
K	405	190
Soluble cations, mg/L		
Ca^{++}	2.30	2.15
Mg^{++}	1.70	1.30
Na^{+}	3.78	3.54
K^{+}	0.45	0.40
Soluble Anions, mg/L		
HCO_3^-	3.22	3.02
CL^-	4.80	4.35
SO_4--	5.20	4.63

Fifty-two uniform trees were selected for this study and all of them were subjected to the same cultural practices during both successive seasons.

The foliar application of 13 treatments were as follows:

T1:	Tap water (control).
T2:	Calcium Carbonate ($CaCO_3$) at 1.5 %.
T3:	Calcium Carbonate ($CaCO_3$) at 3 %.
T4:	Calcium Carbonate ($CaCO_3$) at 4.5 %.
T5:	Nano-Calcium Carbonate at 1.5 %.
T6:	Nano Calcium Carbonate at 3 %.
T7:	Nano Calcium Carbonate at 4.5 %.
T8:	Kaolin clay at 1.5 %.
T9:	Kaolin clay at 3 %.
T10:	Kaolin clay at 4.5 %.
T11:	Nano-kaolin clay at 1.5 %.
T12:	Nano kaolin clay at 3 %.
T13:	Nano kaolin clay at 4.5 %.

Treatments were provided three times; the first application took place in the middle of June, the second 15 days later, and the third 15 days later. A Randomized Full Block Design was used to apply and organize the treatments (RCBD). Four duplicates of each treatment were used, with one tree for each replication. By assessing their impact on the following metrics, these therapies' effects were examined:

1. Fruit sun scalds (%)

For this experiment, 40 uniform trees were chosen and placed across the orchard. Four branches from each tree were selected and tagged in the spring. According to **Westwood (1978)**, fruit sun scalds were counted as a percentage, and the following formulae were used to get the percentages:

$$(\%)\ \text{Fruit sun scalds} = \frac{\text{Number of sun scald fruits}}{\text{Total number of fruits on the tree}} \times 100$$

2. Juice percentage.

Fruit pulps were recorded (grams/fruit) and then homogenized in a blender and filtrated to collect juice weight (grams/fruit).

$$\text{The juice percentage} = \frac{\text{juice weight}}{\text{total weight (juice + pulp)}} \times 100$$

3. Yield

The fruit production on each replication tree as a result of the applied treatments was expressed as the number of fruits per tree and the weight of fruits as kg per tree, which was obtained at harvest stage. Also, the weight of the fruits per tree was multiplied by the quantity of trees per feddan to indicate the yield generated as ton/feddan.

3.1 Average fruit weight (g/fruit)

Fruit samples were weighted and the average fruit weight for each replicate was calculated and expressed as (g).

3. 2 Weight of fruits/tree

At harvest time, yield of each treatment was recorded as yield weight/tree by the multiplying number of fruits × average weight of fruit.

Also, yield produced as ton/feddan was expressed by multiply the weight of fruits/tree × number of trees/feddan.

4. Fruit quality

For determining the chemical fruit attributes, samples of 10 fruits per tree from each replicate were randomly taken on March 21 in the first season and February 21 in the second season.

Fruit chemical characteristics:

The fruit samples listed above were used to establish the following factors: **Chen and Mellenthin (1981)** used a hand refractometer to measure total soluble solids (TSS%). Citric acid was used to calculate the total acidity (%) in fruit juice, which was then represented as a percentage, in accordance with **AOAC's 1985** methodology. By titrating the juice with 2, 6-dichlorophenol-indo-phenol (**AOAC, 1985**), the amount of vitamin C (measured as mg/100 ml juice) was found in the juice.

Using a spectrophotometer, carotene concentration was assessed in accordance with **Winterman and Mats (1965).** Fresh fruit samples were analyzed for total and reducing sugars in accordance with **Malik and Singh's (1980)** methodology. Non-reducing sugars were computed using the difference between total and decreasing sugars.

Data of the measured parameters were subjected to computerized statistical analysis using COSTAT package for analysis of variance (ANOVA) and means of treatments were compared using LSD at 0.05 level of possibility according to **Sendecor and Cochran (1980)**.

RESULTS AND DISCUSSION

Data in Tables (2-5) show how Murcott Mandarin trees responded to foliar applications of calcium carbonate and kaolin clay in terms of sun scalds, yield, and fruit quality.

1. Sun scaled

The results showed that T11, T12, and T13 treatments were less sensitive to the sun during both study seasons than other research treatments. There was no noticeable change in the first study season between T1 and T2 treatments on sunscalds, nor was there any difference between T1, T2, T3, or T4 treatments. The results of the kaolin treatments previously described were in line with those of **Schupp *et al.* (2002) and Mohamed *et al.* (2019)**. On the other hand, **Tsai *et al.* (2013), Hegazi *et al*. (2014), and Rodriguez *et al*. (2015)** revealed the similar tendencies of these outcomes of calcium carbonate treatments.

2- Juice percentage

Data in **Table (2**) revealed that, on average, across the two trial seasons, Kaolin 4.5% (57.69 and 64.61%), Nano-Kaolin 3% (54.65 and 61.21%), Kaolin 3.5% (51.92 and 58.15%), and Nano-$CaCO_3$ 1.5% (53.28 and 51.73%) all contributed to the biggest increase in juice percentage (60.72 and 65.76%). In both seasons, there were not sufficient differences between other treatments and control to be statistically significant. These findings of **Kotb and Abd-Eladl (2017); El-Kholy *et al.* (2018); El-Tanany *et al*. (2019), and Farid and Mohamed (2021)** agreed with the outcomes of the kaolin treatments stated above. On the other hand, **Wünsche *et al.* (2004), Alvareza *et al.* (2015), Narayan Lal and Nisha Sahu (2017)** noticed the identical tendencies of these calcium carbonate treatment results.

3- Total soluble solids (%):

Results from both experimental seasons showed that, except for Ca Co_3, Nano Ca Co_3, and Kaolin, all treatments significantly increased total soluble solids as compared to the control. In the first season, trees treated with Nano-Kaolin 4.5% application treatment (11.92%), followed by Kaolin 4.5% (11.33%) as compared to the control (8.51%), showed a gradual rise in total soluble solids. In the second season, trees treated with Nano-Kaolin 4.5% (13.35%), followed by Kaolin 4.5% (12.69%) comparing to the control (8.88%), showed a gradual increase **(Table 2).** These finding results of the kaolin treatments are similar with those attained by **Mohamed *et al*. (2019).** The identical patterns of these calcium carbonate treatment findings, however, were reported by **Tsai et al. (2013), Hegazi et al. (2014), and Rodriguez *et al.* (2019).**

Table (2): Juice percentage, sun scaled (%) and TSS (%) of Murcott mandarin trees as affected by different compounds as nano form in 2018 and 2019 seasons

Treatments	Sun scaled (%)		Juice percentage		TSS (%)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season
Control	13.59 a	13.9 a	48.01 g	51.45 g	8.51 gh	8.88 g
CaCO3 1.5%	12.80 a	13.7 a	51.12 efg	51.05 g	8.32 h	9.54 fg
CaCO3 3%	11.65 b	13.15 ab	55.69 bc	51.17 g	9.47 def	10.80 de
CaCO3 4.5%	11.23 b	12.42 ab	50.76 efg	56.86 cde	9.97 cde	11.16 cde
Nano-CaCO3 1.5%	10.61 c	11.87 bc	53.28 cde	51.73 g	9.00 fgh	10.27 ef
Nano-CaCO3 3%	10.76 bc	11.95 bc	53.09 cde	53.86 efg	10.19 cd	11.32 cde
Nano-CaCO3 4.5%	8.98 d	10.05 de	53.43 cde	59.84 bc	10.49 c	11.75 bcd
Kaolin 1.5%	9.54 d	10.67 cd	51.73def	52.33 fg	9.18 efg	10.28 ef
Kaolin 3%	8.78 de	9.85 de	51.92 def	58.15 bcd	10.2 cd	11.42 cde
Kaolin 4.5%	8.08 ef	9.05 ef	57.69 ab	64.61 a	11.33 ab	12.69 ab
Nano-Kaolin 1.5%	8.59 e	9.625 def	49.18 fg	55.09 def	9.66 def	10.82 de
Nano-Kaolin 3%	7.91 ef	8.85 ef	54.65 bcd	61.21 b	10.73 bc	12.22 bc
Nano-Kaolin 4.5%	7.27 f	8.15 f	60.72 a	65.76 a	11.92 a	13.35 a

Means with the same letter(s) in the same column are not statistically different at the 0.05 level of probability.

4. Yield components:

4.1 Number of fruits per tree:

Results showing how the aforementioned treatments affected the number of murcott mandarin fruits produced per tree are provided in **Table (3).** All treatments considerably raised the number of murcott mandarin fruits per tree compared to the control, according to the data. No significant difference was found between $CaCO_3$ 1.5%, nano $CaCO_3$ 1.5% and $CaCO_3$ 3% treatments during the first season (2018). These results of kaolin treatments are in harmony with those obtained by **Schupp *et al.* (2002) and Mohamed *et al.* (2019).** On the other hand, the same trends of these results of calcium carbonate treatments were found by **Tsai *et al*. (2013); Hegazi *et al.* (2014) and Rodriguez *et al.* (2019).**

4.2 Fruit weight (g)

The findings in **Table 3** showed that, in comparison to the control, all treatments significantly increased fruit weight. During the first season, there was no discernible difference between the CaCO3 1.5%, nano $CaCO_3$ 1.5%, and $CaCO_3$ 3% treatments. The results of the kaolin treatments previously described agreed with those of **Schupp *et al.* (2002) and Mohamed *et al.* (2019).** On the other hand, the same trends of these results of calcium carbonate treatments were found by **Tsai *et al*. (2013); Hegazi *et al.* (2014) and Rodriguez *et al.* (2019).**

4.3 Yield (kg/tree):

In **Table 3,** the findings about the impact of the investigated nano-synthesized chemicals (Calcium carbonate and kaolin clay) on the yield (kg/tree) of murcott mandarin fruits during the 2018 and 2019 seasons. The mean values of both experimental seasons indicated that, all treatments, significantly ($P \leq 0.05$) increased yield (kg/tree) as compared with the control. No significant difference were found between $CaCO_3$ 1.5%, nano $CaCO_3$ 1.5% and $CaCO_3$ 3% treatments during the first season (2018). The results of kaolin treatments agreed with the findings of **Kotb and Abd-Eladl (2017); El Kholy *et al.* (2018); El-Tanany *et al.* (2019) and Farid and Mohamed (2021).** On the other hand, the same trends of these results of calcium carbonate treatments were found by **Wünsche *et al.* (2004); Alvareza *et al.* (2015) and Narayan and Sahu (2017).**

4.4 Total yield (ton/feddan):

Regarding the gross yield (ton/feddan) of murcott mandarin fruits as influenced by various applied treatments for the 2018 and 2019 growing seasons, **Table 3's** findings showed that there were significant variations in the yield (ton/feddan) except for the CaCO3 1.5%, nano CaCO3 1.5%, and CaCO3 3% treatments for the first season (2018). These findings of kaolin treatments agreed with those obtained by **Ahmed *et al.* (2013)** on 'Hindy Bisinnara' mango trees, **El-Khawaga and Mansour (2014)** on Washington Navel orange trees grown under Bany Suef region conditions,they all found that kaolin treatments significantly increased total yield (ton/feddan) as compared with the control. On the other hand, the same trends of these results of calcium carbonate treatments were found by **Glenn *et al.* (2002); Lin *et al.* (2004); Melgarejo *et al.*, (2004); Wünsche *et al.* (2004); Morsy *et al.* (2008) and Ahmed *et al.* (2011).**

Table (3). Reproductive growth parameters of murcott mandarin trees as affected by different compounds as nano form during 2018 and 2019 seasons.

Treatments		Fruit weight (g) (g)		Number of fruits per tree		Yield kg \ tree		Yield (ton/ fed)	
		1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
T 1	Control	161.35 h	163.23 g	176.32 h	178.23 g	28.45 h	29.09 g	9.95 h	10.18 g
T 2	$caco_3$ 1.5%	176.35 g	176.52 f	191.35 g	191.52 f	33.75 g	33.82 f	11.81 g	11.83 f
T 3	$caco_3$ 3%	175.41 g	179.51 ef	190.41 g	194.51 ef	33.41 g	34.92 ef	11.69 g	12.22 ef
T 4	$caco_3$ 4.5%	183.49 ef	184.71 cde	198.49 ef	199.71 cde	36.45 ef	36.89 cde	12.75 ef	12.91 cde
T 5	nano-$caco_3$ 1.5%	180.51f g	183.97 cde	195.51 fg	198.97 cde	35.31 fg	36.62 cde	12.36 fg	12.81 cde
T 6	nano-$caco_3$ 3%	185.29 def	185.52 cd	200.29 def	200.52 cd	37.12 def	37.20 cd	12.99 def	13.02 cd
T 7	nano-$caco_3$ 4.5%	184.21 def	183.16 de	199.21 def	198.16 de	36.70 def	36.33 de	12.84 def	12.71 de
t 8	kaolin 1.5%	186.08 cdef	188.31 bcd	201.08 cdef	203.31 bcd	37.45 cdef	38.30 bcd	13.11 cdef	13.40 bcd
t 9	kaolin 3%	192.04 abc	188.27 bcd	207.04 abc	203.27 bcd	39.76 abc	38.29 bcd	13.91 abc	13.40 bcd
t 10	kaolin 4.5%	189.77abcd	188.54 bcd	204.77 abcd	203.54 bcd	38.86 abcd	38.38 bcd	13.60 abcd	13.4 bcd
t 11	nano-kaolin 1.5%	188.64 bcde	189.28 bc	203.64 bcde	204.28 bc	38.42 bcde	38.67 bc	13.44 bcde	13.53 bc
t12	nano-kaolin 3%	195.44 a	195.59 a	210.44 a	210.59 a	41.13 a	41.19 a	14.39 a	14.41 a
t13	nano-kaolin 4.5%	194.1 ab	191.49 ab	209.1 ab	206.49 ab	40.59b	39.54b	14.20b	13.84 b

- Means with the same letter(s) in the same column are not statistically different at the 0.05 level of probability.

5- Vitamin C (mg/100 ml juice):

As compared to the control during both study seasons, the treatments of nano-Kaolin 3%, nano-Kaolin 4.5%, nano-CaCO3 4.5%, and CaCO3 1.5% significantly (at 0.05) boosted the vitamin C content of fruit juice. While no discernible variations were seen between the other treatments **(Table 4)**. These results of kaolin treatments agreed with the findings of **Kotb and Abd-Eladl (2017); El Kholy *et al.* (2018); El-Tanany *et al.* (2019) and Farid and Mohamed (2021).** On the other hand, the same trends of these results of calcium carbonate treatments were found by **Wünsche *et al.* (2004); Alvareza *et al.* (2015) and Narayan and Sahu (2017).**

6. Acidity (%):

Regarding the results of fruit juice acidity (%) in response to various applied treatments, the results in Table (4) revealed that, all treatments, significantly ($P \leq 0.05$) decreased fruit juice acidity (%) as compared with the control. A gradual decrease was observed with trees treated with Nano Kaolin 4.5% (0.63) and (0.71) followed by Nano-CaCO3 4.5% (0.71 %) and (0.80 %) as compared with the control (1.75 %) and (1.13 %) respectively. The above-revealed results of kaolin agreed with the findings of **Schupp *et al.* (2002) and Mohamed *et al.* (2019).** On the other hand, the same line of these results of calcium carbonate treatments were cleared by **Tsai *et al.* (2013); Hegazi, *et al.* (2014) and Rodriguez *et al.* (2019).**

7. Carotene (mg/100g fw)

Table 4 comprises the findings of the impact of treatments with calcium carbonate and kaolin clay, two nano-synthesized chemicals, on the carotene content of murcott mandarin fruits during the 2018 and 2019 growing seasons (4). The findings of both experimental seasons showed that, during the 2018 and 2019 growing seasons, application of Kaolin 3%, Kaolin 4.5%, Nano-Kaolin 1.5%, Nano-Kaolin 3%, Nano-Kaolin 4.5%, Nano-CaCO3 4.5%, and CaCO3 4.5% significantly increased carotene compared to the control. These results of kaolin treatments come to an agreement with the findings of **Kotb and Abd-Eladl (2017); El Kholy *et al.* (2018); El-Tanany *et al.* (2019) and Farid and Mohamed (2021).** On the other wise, the same line of these results of calcium carbonate application were stated by **Wünsche *et al.* (2004); Alvareza *et al.* (2015) and Narayan and Sahu (2017).**

Table (4): V. C (mg/100 ml juice), acidty (%) and carotene (mg/100g) of murcott mandarin trees as affected by different compounds as nano form during 2018 and 2019 seasons.

Treatments	V .C (mg/100 ml juice)		Acidty (%)		Carotene (mg/100g)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season
Control	30.72 ef	34.19 ef	1.75 a	1.13 a	0.153 e	0.162 g
CaCO3 1.5%	33.99 bc	30.02 h	0.95 b	1.07 b	0.156 e	0.159 g
CaCO3 3%	31.55 de	31.42 gh	0.86 c	0.96 c	0.1582 e	0.177 ef
CaCO3 4.5%	31.17 def	34.91 de	0.77 d	0.86 d	0.1757 cd	0.19 bcd
Nano-CaCO3 1.5%	32.17 cde	31.15 gh	0.88 c	0.99 c	0.157e	0.168 fg
Nano-CaCO3 3%	31.16 def	33.50 ef	0.80 d	0.89 d	0.1667 de	0.186 de
Nano-CaCO3 4.5%	33.23 cd	37.22 c	0.71 e	0.80 e	0.1852 bc	0.207 ab
Kaolin 1.5%	29.06 f	32.55 fg	0.85 c	0.95 c	0.167 de	0.187 de
Kaolin 3%	32.54 cde	36.45 cd	0.77 d	0.86 d	0.1862 bc	0.2085 a
Kaolin 4.5%	35.88 ab	40.19 b	0.69 e	0.77 e	0.202 a	0.200 abc
Nano-Kaolin 1.5%	30.59 ef	33.51 ef	0.78 d	0.87 d	0.176 cd	0.197 abcd
Nano-Kaolin 3%	33.99 bc	39.32 b	0.70 e	0.78 e	0.196ab	0.192 cd
Nano-Kaolin 4.5%	37.77 a	42.80 a	0.63 f	0.71 f	0.19 ab	0.20 abc

- Means with the same letter(s) in the same column are not statistically different at the 0.05 level of probability.

8. Total sugars (%):

The data shown in **Table (5)** show how the various treatments affected the total sugar content (%) of murcott mandarin fruits over the two research seasons. In comparison to the control throughout the 2018 and 2019 research seasons, the average values of the two experimental seasons showed that Nano-$CaCO_3$ 4.5%, Kaolin 3%, Kaolin 4.5%, Nano-Kaolin 3%, and Nano-Kaolin 4.5% significantly increased total sugars percent. While there was no discernible difference between the other treatments. These findings of kaolin treatments agreed with those obtained by **Ahmed *et al.* (2013)** on 'Hindy Bisinnara' mango trees**, El-Khawaga and Mansour (2014)** on Washington Navel orange trees grown under Bany Suef region conditions, they indicated that kaolin treatments significantly improved total sugars (%) as compared with the control. On the other hand, the same way of these results of calcium carbonate treatments were found by **Glenn *et al.* (2002); Lin *et al.* (2004); Melgarejo *et al.*, (2004); Wünsche et al. (2004) and Morsy *et al*, (2008) and Ahmed *et al*, (2011).**

9. Reducing sugars (%):

Table 5 illustrates the results of the aforementioned treatments' impact on sugar reduction throughout the 2018 and 2019 growing seasons. All treatments significantly improved the proportion of reducing sugars throughout the first season of the research compared to the control, according to the acquired data. When compared to the control during the second season, Nano-$CaCO_3$, $CaCO_3$, Kaolin 3, Kaolin 4, Nano-Kaolin 1, Nano-Kaolin 3%, and Nano-Kaolin 4.5% considerably enhanced reducing sugars percent. These results are in harmony with those obtained by **Schupp *et al.* (2002) and Mohamed *et al* (2019).** On the other hand, the same way of these results of calcium carbonate treatments were found by **Tsai *et al*. (2013); Hegazi, *et al.* (2014) and Rodriguez *et al.* (2019).**

10. Non-reducing sugars (%):

The results in Table (5) for the non-reducing sugars percent in response to treatments with calcium carbonate and kaolin clay throughout the 2018 and 2019 growing seasons showed that the Nano-Kaolin 4.5% treatment substantially (P0.05) boosted non-reducing sugars percent in comparison to the control. Amongst the other treatments, there was no discernible difference between the seasons of 2018 and 2019.These findings reach agreement with those obtained by **Ahmed *et al.* (2013)** on 'Hindy Bisinnara' mango trees, **El-Khawaga and Mansour (2014)** on Washington Navel orange trees grown under Bany Suef region conditions,they all found that kaolin treatments significantly increased total sugars (%) as compared with the control. On the other hand, the same trends of these results of calcium carbonate treatments were found by **Glenn *et al* (2002); Lin *et al.* (2004); Melgarejo *et al*, (2004); Wünsche et al. (2004); Morsy *et al.* (2008) and Ahmed *et al.* (2011).**

Table (5): Total sugars (%), reducing sugars (%) and non-reducing sugars (%) of murcott mandarin trees as affected by different compounds as nano form during 2018 and 2019 seasons.

Treatments	Total sugars (%)		Reducing sugars (%)		Non reducing sugars (%)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season
Control	5.491 hi	6.132 g	2.365 m	3.15 hi	3.126 bc	2.98 fg
CaCO3 1.5%	5.517 hi	6.617 defg	2.63 l	3.447 efgh	2.887 cdef	3.172 defg
CaCO3 3%	5.327 i	6.245 fg	2.922 j	3.272 ghi	2.405 g	2.972 fg
CaCO3 4.5%	6.19 ef	6.94 cdef	3.245 f	3.635 cdef	2.95 cdef	3.305 cdef
Nano-CaCO3 1.5%	5.422 hi	6.17 g	2.767 k	3.097 i	2.655 fg	2.82 g
Nano-CaCO3 3%	5.872 g	6.327 fg	3.077 h	3.447 efgh	2.795 def	3.132 defg
Nano-CaCO3 4.5%	6.522 cd	7.307 bcd	3.417 d	3.827 bcd	3.105 bcd	3.477 bcd
Kaolin 1.5%	5.705 gh	6.39 efg	2.99 i	3.35 fghi	2.715 efg	3.042 efg
Kaolin 3%	6.335 de	7.095 cde	3.32 e	3.72 cde	3.015 cde	3.375 cde
Kaolin 4.5%	7.04 b	7.885 ab	3.69 b	4.135 ab	3.35 ab	3.752 ab
Nano-Kaolin 1.5%	6.002 fg	6.72 cdefg	3.145 g	3.525 defg	2.857 cdef	3.2 cdef
Nano-Kaolin 3%	6.667 c	7.467 bc	3.49 c	3.912 bc	3.175 bc	3.555 bc
Nano-Kaolin 4.5%	7.41 a	8.29 a	3.88 a	4.347 a	3.52 4 a	3.95 a

Means not sharing the same letter(s) with each column are significantly different at 0.05 level of probability.

LITERATURE CITED

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الملخص العربى

إستخدام مركبات مختلفه مجهزة بتكنولجيا النانو لتقليل لسعة الشمس وزيادة محصول وجودة ثمار اليوسفى "ميركوت"

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أجريت هذه الدراسة خلال موسمى 2018 و2019 على أشجار اليوسفى صنف 'ميركوت ' مطعومة على أصل الفولكا ماريانا عمرها 6 سنوات منزرعة فى تربة رملية تروى بنظام الرى بالتنقيط وذلك بمزرعة خاصة فى منطقة النوبارية بمحافظة البحيرة – مصر بهدف دراسة إستخدام مركبات مختلفه مجهزة بتكنولوجيا النانو لتقليل لسعة الشمس وزيادة محصول وجودة ثمار اليوسفى "ميركوت". وكان التصميم الإحصائى المستخدم هو القطاعات العشوائية الكاملة ويمكن تلخيص أهم النتائج المتحصل عليها فيما يلي:

بصفة عامة كل المعاملات أدت إلى تقليل لسعة الشمس وحموضة الثمار بينما أعطت زيادة معنوية في عدد الثمار لكل شجرة, وزن الثمار, المحصول بالكيلو جرام لكل شجرة, المحصول بالطن للفدان, نسبة المواد الصلبة الذائبة الكلية وكذلك النسبة المئوية للسكريات المختزلة مقارنة بالكنترول خلال موسمي الدراسة. وأفضل معاملة كانت الرش بالكاؤلين (سيليكات الألومنيوم) بتركيز 3% أعطت زيادة معنوية فى المحصول مقارنة بالكنترول خلال موسمي الدراسة.