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STUDY ON USING SOME COMPOSITES TO REDUCE THE ADVERSE EFFECTS OF SOIL SALINITY ON SAKKOTI DATE PALMS UNDER UPPER EGYPT CONDITIONS

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ABSTRACT: Three commercial nano-composite's, Active humic acid, Hypertonic, and Root fast, each at 2.5, 5, and 10 g/palm tree, were tested during the 2020 and 2021 growing seasons for their ability to mitigate the adverse effects of soil and irrigation water salinity on the fruiting of Sakkoti date palms grown in sandy soil. The salinities of soil and irrigation water were 2400 and 2800 ppm, respectively. In comparison to the control, all treatments significantly increased the leaf content of total chlorophylls, nitrogen (N), phosphorus (P), and potassium (K) as well as the leaf area. In addition, these treatments increased the bunch weight, yield/palm tree, and fruit quality attributes. The increasing of the parameters under investigation was related to the concentration increase. In descending order, Active humic acid, Hypertonic, and Root fast were the best nanocomposites. Each nanocomposite's soil additive dose was increased from 5 to 10. However, this did not result in any discernible improvement. The most striking effect on mitigating the salinity-induced adverse effects on fruiting and promoting yield and fruit attributes of Sakkoti date palm is the soil addition of Root fast at 5 g. / palm tree/ year.

Key words: Sakkoti date palms, Nano soil- conditions – nano –Active humic acid, Hypertonic, Root fast, leaf area, yield, fruit characteristics.

INTRODUCTION

Researchers have taken many actions recently to reduce the agricultural problems associated with using fertilizers. Fertilizers, particularly synthetic ones, might damage soil, water, and air. We can make this possible by adopting advanced agricultural methods and designing new, improved fertilizers. Nanotechnology creates opportunities for innovative applications in various areas of agriculture and biotechnology. The introduction of such technology facilitated the targeting of fertilizer and modification of their release and bioavailability. The nanostructured formulations offer slow/controlled release, or conditional release mechanisms, that could more accurately release active ingredients in response to biological needs and environmental cues. It is possible to create and build Nano-fertilizers using these methods.

Nanotechnology has the potential to impact energy, economics, and the environment significantly via enhancing fertilizers' effects. Nano fertilizers are used mainly to postpone the release of nutrients and prolong the fertilizer effect period. These Nano fertilizers have the advantages of increasing efficiency combined with reducing levels of toxic residues in the soil. Being equipped with proper release mechanisms and improved bioavailability minimizes the dosage-associated potential adverse effects on the plant and the environment and reduces the need for frequent application. As a result, nanotechnology offers great promise for attaining sustainable agriculture, notably in underdeveloped nations (**Sultan *et al.*, 2009; Prasad *et al.*, 2014; Mukhopudhyay, 2014 and Mahjunatha *et al.*, 2016**).

Controlling soil salinity brought on by irrigation water requires careful consideration of the soil environment .To improve the drawbacks of current normal soil conditions, the notion of using soil conditioners with nanotechnology emerged to solve the problems faced by plants growing in saline soils (**Guo *et al.*, 2005**). The excess of salinity in root zone result in increased uptake of the toxic ions (Na and Cl) by the roots. These toxic ions inhibit the minerals uptake, which ultimately reduced growth and yield of plants (**Ahmad *et al.*, 2019**). Application of mineral nutrients alleviates salinity stress on plants (**Etesamia and Jeong, 2020)**. Nano-composites are more effective for regulation of ionic balance by inhibiting Na and Cl in root zone, which is important for alleviation of harmful effects of salinity in fruit trees. In the cell walls of plant roots there are so-called aquaporins, which are effective membrane proteins that improve water flow in the roots (**Ahmad and Anjum, 2020)**, in the same time reduce the toxic effects of Na and Cl. The addition of Nano-composites in the root zone stimulates the formation of aquaporins in the roots and thus limits the harmful effects of salinity on plants (**Muhammad *et al.*, 2022**).

Treating different fruit crop species with Nano-fertilizers and Nano-soil conditioners enhances plant growth, and nutritional status, in addition to increasing the yield and improving fruit quality (**Stewart *et al.*, 2005; Lui *et al.*, 2006; Ahmed, 2018, Ahmed, *et al.*, 2019, Dabdoub-Basma, 2021, Akl, *et al.*, 2020 and Zakier, 2022)**.

This study aimed to determine whether adopting some Nano -soil conditions may mitigate the negative impacts of salt on Sakkoti date palm tree growth, leaf mineral contents, yield, and fruit quality attributes under sandy soil conditions.

MATERIALS AND METHODS

This research was started on Sakkoti date palms that were thirty-nine years old during the 2020 and 2021 growing seasons .They are grown in a private orchard in West Kom Ombo, Kom Ombo district, Aswan Governorate, Egypt, and are distinguished by uniform vigour. The chosen palms are grown at a distance of 7x7 m. (85 palms / fedd.) and are developed using classic offshoot techniques. After two days of female cracking, hand pollination was accomplished by introducing five male threads into each female spathe. Before using in-hand pollination, pollen grains underwent inspection.

The chosen palms were given the usual horticultural and agricultural techniques currently used in the orchard .Ten bunches per palm were the new adjusted quantity of bunches. Sand-like dirt makes up the terrain .Salinity levels of the irrigation water and soil for the palms that were treated to drip irrigation with well water were 2400 and 2800 ppm, respectively. According to a soil analysis done by **Cottenie *et al.*, (1982)** (Table 1).

Table (1). Analysis of the tested soil

Parameters	Values
Sand %	76.3
Silt %	6.7
Clay %	17
Texture	Sandy
Organic matter %	0.21
E.C. (1: 2.5 extract) (ppm)	2400
pH (1: 2.5 extract)	7.95
$CaCO_3$ %	3.11
Total N %	0.005
Available P (Olsen, ppm)	2.2
Available K (ppm, ammonium acetate)	81.2

This experiment comprised of ten soil addition treatments arranged as follows:

1- Control.

2- Nano-Active humic acid at 2.5 g / palm.

3- Nano-Active humic acid at 5.0 g / palm.

4- Nano-Active humic acid at 10.0 g / palm.

5- Nano Hypertonic acid at 2.5 g / palm.

6- Nano Hypertonic acid at 5.0 g / palm.

7- Nano Hypertonic acid at 10.0 g / palm.

8- Nano Roots fast at 2.5 g / palm.

9- Nano Roots fast at 5.0 g / palm.

10- Nano Roots fast at 10.0 g / palm.

Three times, one palm from each treatment was repeated. Each palm had the three nano soil conditions added once at the beginning of growth (first week of March), around 25 cm away from the palm trunk. 10% humic acid, 5% amino acids, 2% algae extract, 1% vitamins and 6% K_2O, make up active humic acid. Hyper tonic consisted of 10% Ca, 10% algae extract, 5% biosak, 15% carboxylic acid, and Root fast contains 3.5 % amino acids, 5% vitamins, 10% algae extract 10% biosak, 1% tricarboxylic acid, 0.2 % root promoter, 0.5% boron to 0.5% Zn. Randomized complete block design (RCBD) was followed.

During both seasons, the forming measurements were recorded:

1- Leaf area (cm^2) (**Ahmed and Morsy, 1999**).

2- Total chlorophylls (mg/ g. F.W.) (**Hiscox and Isralstam, 1979**).

3- Percentage of N, P and K in the middle pinae of the leaves (**Chapman and Pratt, 1965, Peach and Tracey, 1965), Summer, 1985 and Wilde *et al.*, 1985)**.

4- Yield/ palm (kg.) and bunch weight (kg.)

5- Fruit characteristics namely weight (g.), height and diameter (cm.) fruit, pulp/seed, T.S.S.%, Total and reducing sugars %, total acidity (as g malic acid/ 100 g pulp) and total soluble tannins % (**Lane and Eynon, 1965) and A.O.A.C., 2000**).

Statistical analysis was done and treatment means were compared using Tukey test at 5% (**Steel and Torrie, 1980 Mead *et al.*, 1993**).

RESULTS AND DISCUSSION

1- Leaf area

Data in Fig. (1) exhibit that soil addition of the three nanocomposites namely nano-Active humic acid, Hypertonic, and Root fast each at 2.5 to 10 g/palm tree / year significantly stimulated the leaf area compared with the control (salinized soil and without treatment). There was a progressive promotion of the leaf area with rising levels of any of the three nanocomposites. Significant differences in the leaf area were detected among all rates except among the higher two levels, namely 5 and 10 g / palm tree/ year. Using Active humic acid, Hypertonic, and Root fast via nanotechnology, in ascending order, significantly stimulated the leaf area. These results clearly show that the superior values of leaf area (2.47 & 2.49 cm^2) were registered on palms subjected to Root fast at 5.0 g / palm tree/ year. Untreated palms exhibited the least values a comparable direction was noticed through both seasons.

2- Leaf chemical components

Data in Fig. (2) display the concentrations of total chlorophylls in the leaves of Sakkoti date palms, as well as their content of N, P and K (in Fig. 3 and 4) were significantly enhanced due to treating the palms with any one of the three nano-composites namely Active humic acid, Hypertonic, and Root fast each at 2.5 to 10.0 g applied via nanotechnology over the control. Increasing levels of each nanocomposite from 2.5 to 10 g / palm tree caused a gradual promotion of these leaf chemical components. Increasing levels from each nanocomposite from 5 to 10 g had no significant promotion on these chemical traits. The best results were obtained with the application of Root fast, followed by Hypertonic, and Active humic acid. Treating the soil with Root fast at 10 g/ palm tree/ year achieved the highest values of these leaf chemical constituents, while the untreated palms showed the lowest concentrations. These results were reproduced during both seasons.

3- Bunch weight and yield per palm

It is evident from the data in Fig. (5 & 6) that supplying the palms with any one of the three nanocomposites (Active humic acid, Hypertonic, and Root fast) each at 2.5 to 10 g/ palm tree/ years caused a significant increase in the bunch weight and total yield per palm when compared with the control untreated palms. Such positive effects on yield progressively increased with increasing levels of nano- soil conditions from 2.5 to 10.0 g / palm tree/ year. Indeed, palms treated with nano–Active humic acid, nano Hyper tonic, and nano Root showed the highest values, in ascending order. A slight promotion in the yield was observed among the higher two levels, namely 5 and 10 g/palm tree/year. Therefore, from an economic point of view, the best treatment was the application of Root fast at 5.0 g / palm tree/ year. On the contrary, the untreated palms registered the lowest values. Yield/ palm in the palms received Root fast at 5.0 g / plant reached (135 and 137 kg), and the untreated palms produced the minimum values (89 & 90 kg). The increment in the yield caused by such promising treatment above the control reached 51.7 and 52.2 % during both seasons, respectively. A similar trend was noticed during both seasons.

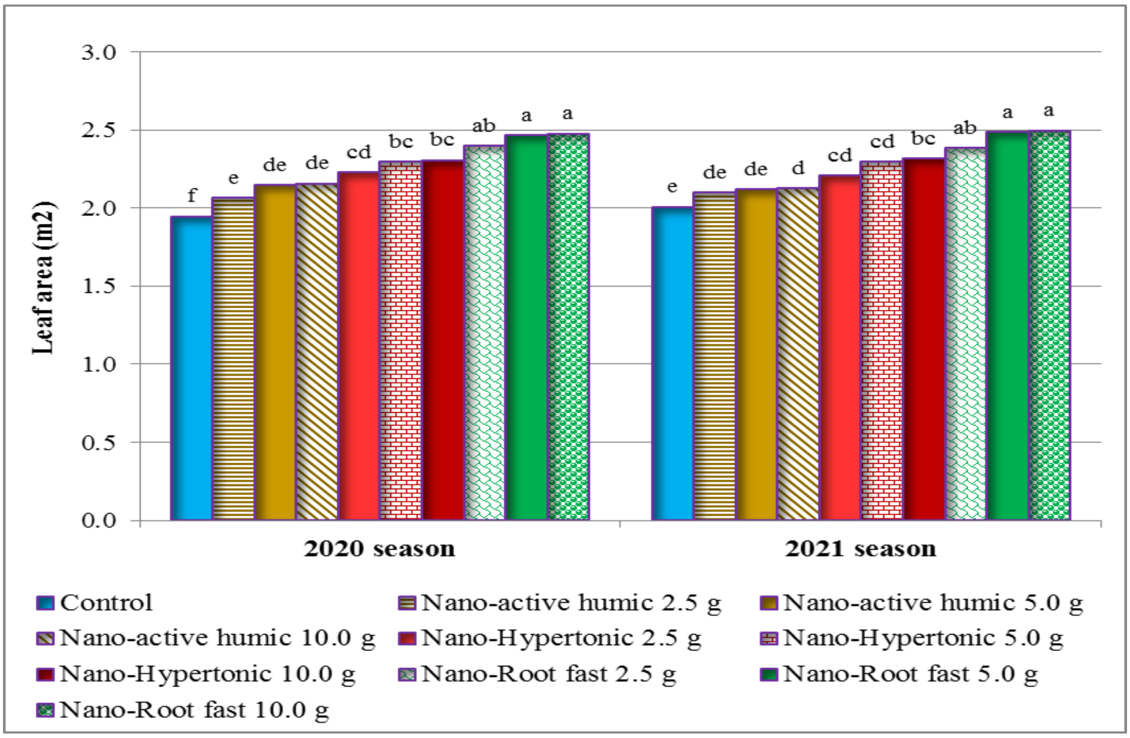

Fig. (1): Effect of some nano soil composites on leaf area and total chlorophylls, in the leaves, of Sakkoti date palms during 2020 and 2021 seasons.

Means containing similar letters are not statistically different at the 0.05 level according to Tukey's test.

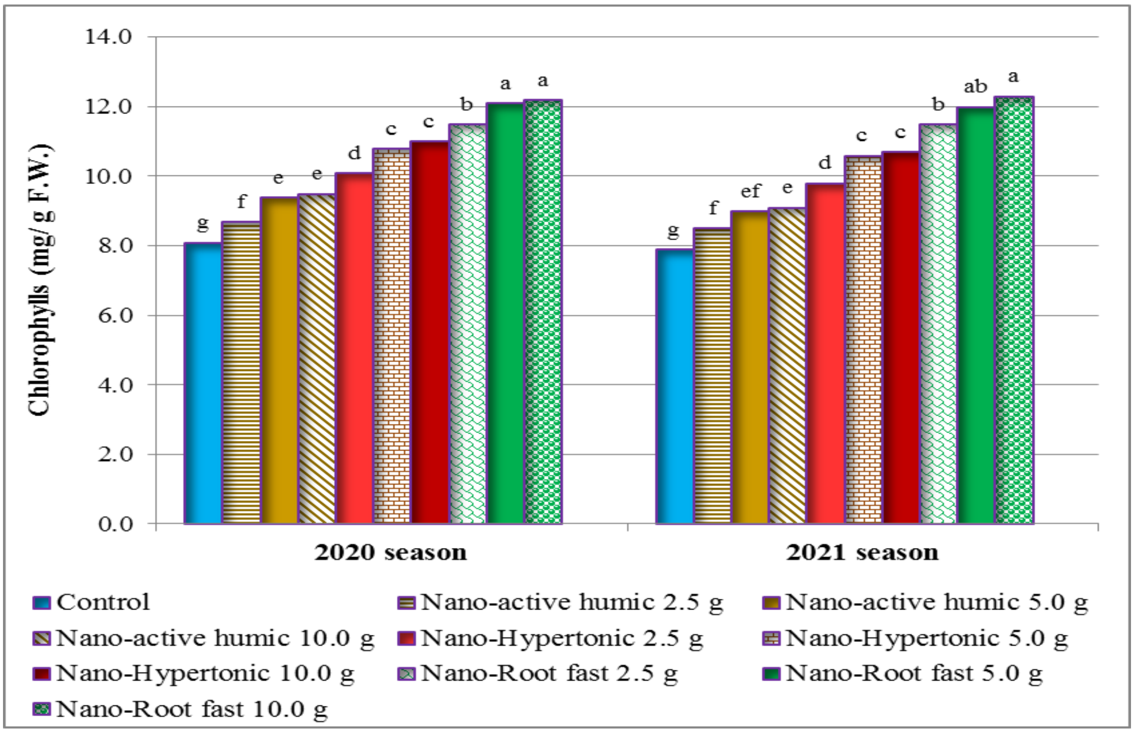

Fig. (2): Effect of some nano soil composites on total chlorophylls, in the leaves, of Sakkoti date palms during 2020 and 2021 seasons.

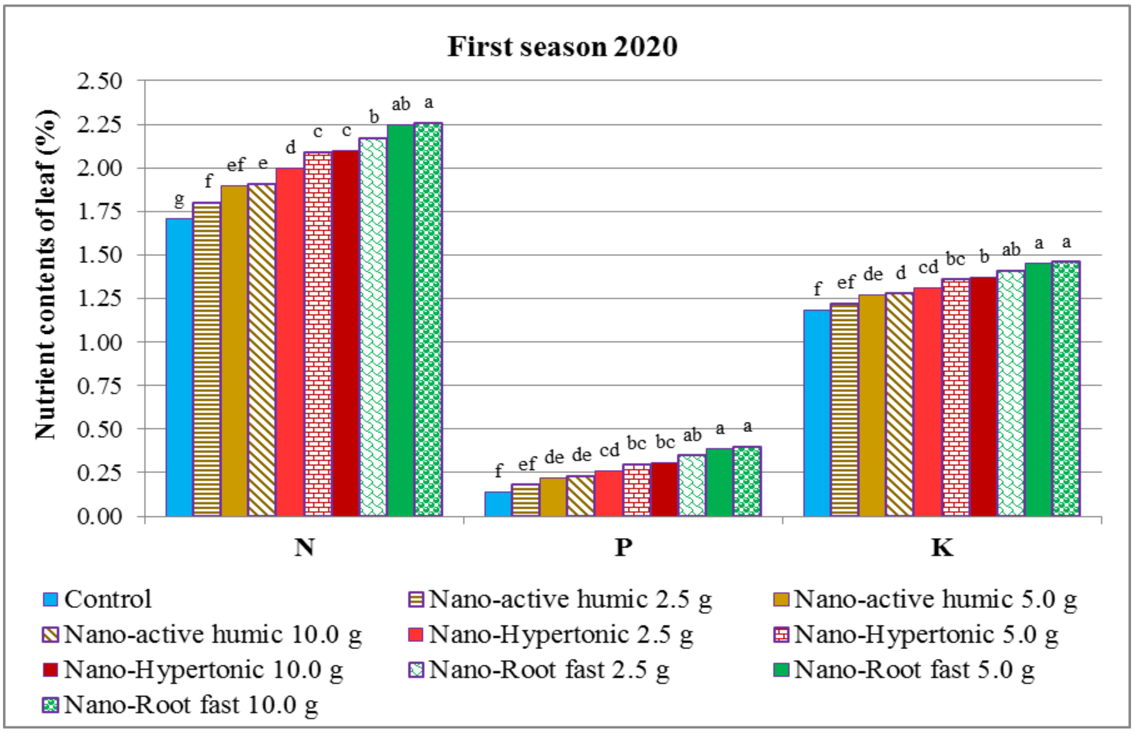

Fig (3): Effect of some nano soil composites on, percentage of N, P and K in the leaves of Sakkoti date palms during 2020 season.

Means containing similar letters are not statistically different at the 0.05 level according to Tukey's test.

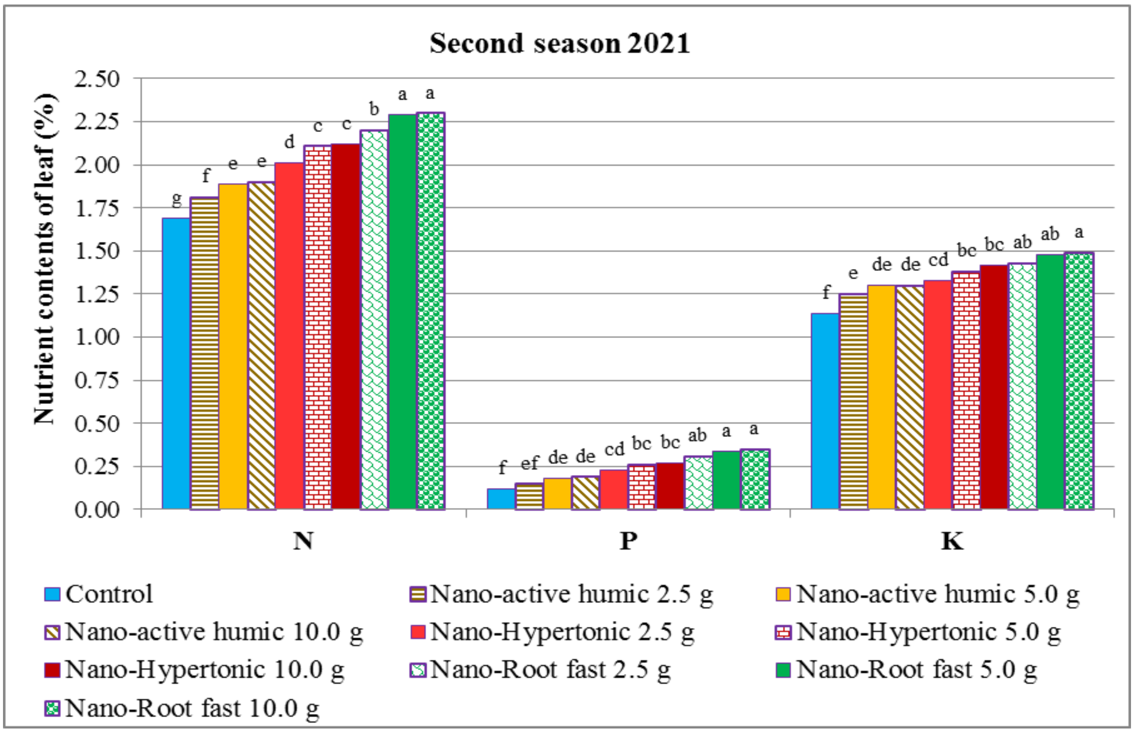

Fig (4): Effect of some nano soil composites on, percentage of N, P and K in the leaves of Sakkoti date palms during 2021 season.

Means containing similar letters are not statistically different at the 0.05 level according to Tukey's test.

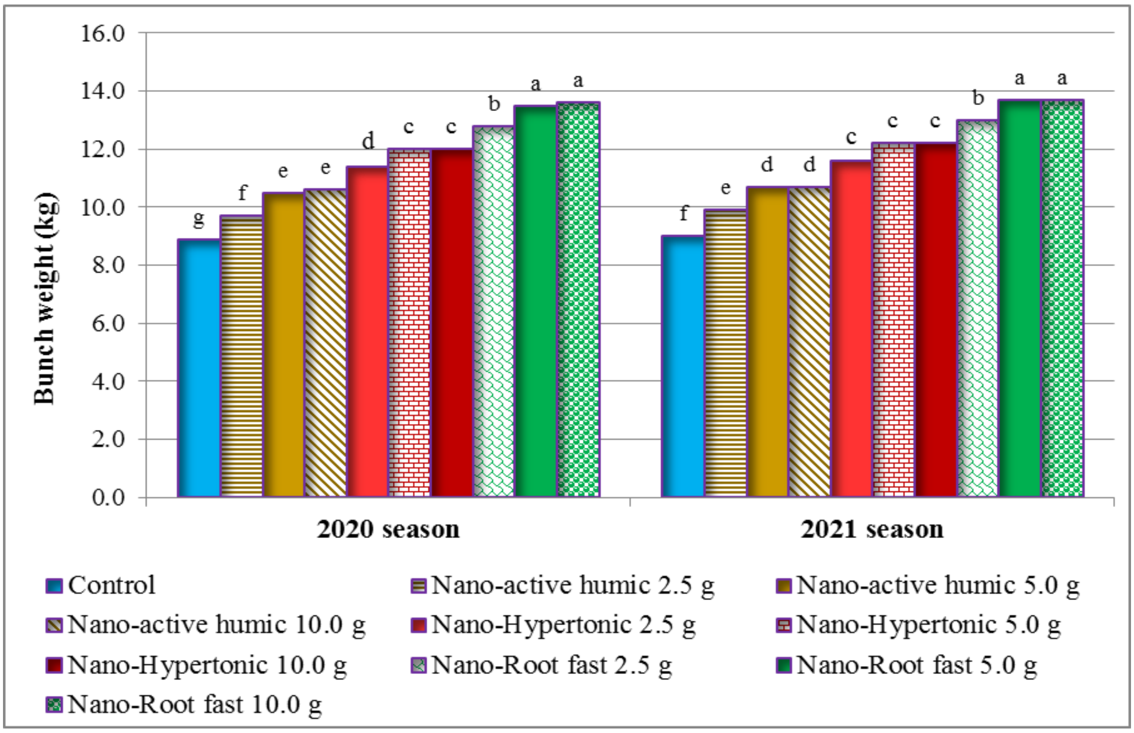

Fig. (5): Effect of some nano soil composites on bunch weight of Sakkoti date palms during 2020 and 2021 seasons.

Means containing similar letters are not statistically different at the 0.05 level according to Tukey's test.

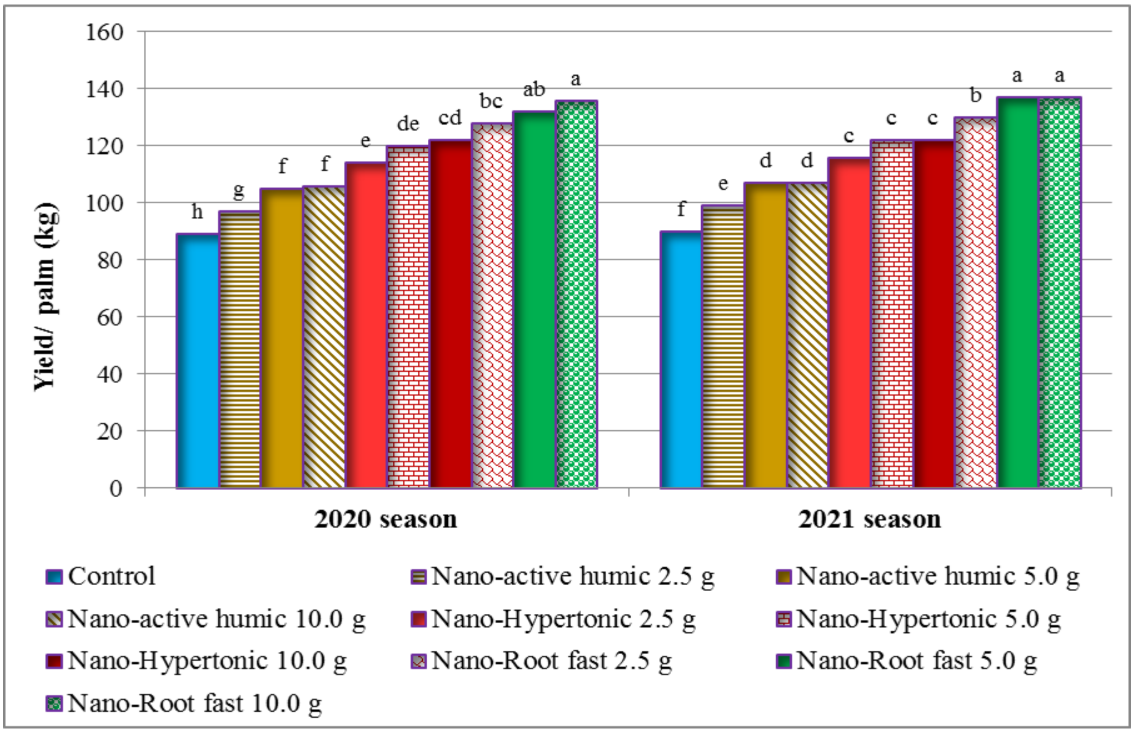

Fig. (6): Effect of some nano soil composites on yield of Sakkoti date palms during 2020 and 2021 seasons.

Means containing similar letters are not statistically different at the 0.05 level according to Tukey's test.

4- Fruit characteristics

According to the findings in Tables (2, 3 & 4) that subjecting Sakkoti date palms to any of the three nano- composites (Active humic acid, Hyper tonic, or Root fast) each at 2.5 to 10 g / palm tree/ year significantly improved the fruit quality. This improvement was manifested as increased fruit weight, dimensions, and enhanced flesh-to-seed ratio. Chemically, these treatments increased the percentages of T.S.S., total, reducing and non–reducing sugars, while decreasing the total acidity%, total crude fiber %, and total soluble tannins compared with the control treatment. The promotion of fruit characteristics was significantly associated with using nano-Active humic acid, nano Hyper tonic, and Root fast, in ascending order. Increasing levels of the three nano-composites from 2.5 to 10.0 g / palm tree/ year followed the progressive promotion of the quality of the fruits. Significant differences in quality parameters were observed among levels of nano-composites except among the higher two levels, namely 5 and 10 g / palm tree/ year. Treatment of the palms with Root fast at 5 g/ palm tree/ year resulted in the highest fruit quality aspects. Unfavorable effects on both physical and chemical characteristics were obtained on untreated palms. These results were accurate during both seasons.

Table (2). Effect of some nano soil composites on some fruit characteristics of Sakkoti date palms during 2020 and 2021 seasons.

Treatments (per palm)	Fruit weight (g)		Fruit height (cm)		Fruit diameter (cm)		Flesh/ seed	
	2020	2021	2020	2021	2020	2021	2020	2021
Control	9.11 f	9.14 f	4.11 f	4.14 f	2.00 f	2.06 f	10.8 f	11.0 f
Nano-active humic acid at 2.5 g	9.20 e	9.23 e	4.16 ef	4.20 ef	2.05 f	2.11 ef	11.3 f	11.5 f
Nano-active humic acid at 5.0 g	9.27 e	9.30 e	4.20 de	4.25 de	2.11 e	2.16 de	11.8 e	12.1 e
Nano-active humic acid at 10 g	9.28de	9.30 e	4.21 de	4.26 de	2.12 e	2.17 d	11.9 e	12.2de
Nano-Hypertonic acid at 2.5 g	9.36 d	9.40 d	4.26 cd	4.32 cd	2.2 d	2.31 c	12.5d	12.7cd
Nano-Hypertonic acid at 5.0 g	9.50 c	9.55 c	4.30 bc	4.38 bc	2.27 c	2.35 c	13.0 c	13.1bc
Nano-Hypertonic acid at 10.0 g	9.51 c	9.55 c	4.31 bc	4.39 bc	2.28bc	2.36 bc	13.1 c	13.1cbc
Nano-Root fast at 2.5 g	9.69 b	9.74 b	4.36 ab	4.44 ab	2.33ab	2.41 ab	13.6b	13.6 ab
Nano-Root fast at 5.0 g	9.80 a	9.85 a	4.41 a	4.51 a	2.37 a	2.45 a	14.2 a	14.1 a
Nano-Root fast at 10.0 g	9.81 a	9.86 a	4.41 a	4.52 a	2.38 a	2.46 a	14.3 a	14.1 a

Means followed in same column by similar letters are not statistically different at 0.05 level according to Tukey test.

Table (3). Effect of some nano soil conditions on percentage of TSS and sugars of the fruits of Sakkoti date palms during 2020 and 2021 seasons

Treatments (per palm)	TSS %		Total sugars %		Reducing sugars %		Non- reducing sugars %	
	2020	2021	2020	2021	2020	2021	2020	2021
Control	68.0 g	67.8g	62.0 g	61.9 h	12.1 g	12.0 g	49.9 e	49.9 f
Nano-active humic acid at 2.5 g	68.6 f	69.0 f	63.0 f	62.9 g	12.6 f	12.7 f	50.4 de	50.2 f
Nano-active humic acid at 5.0 g	69.4 e	69.9 e	64.0 e	63.8 f	13.2 e	13.3 e	50.8 d	50.2 f
Nano-active humic acid at 10.0 g	69.5 e	70.0 e	64.1 e	64.2 f	13.3 e	13.4 e	50.8 d	50.8 e
Nano-hypertonic acid at 2.5 g	70.4 d	71.0d	66.0 d	65.8 e	14.0 d	13.9 d	52.0 c	51.9d
Nano-hypertonic acid at 5.0 g	71.0 c	72.0 c	68.0 c	68.0 d	14.5 c	14.6 c	53.5 b	53.4 c
Nano-hypertonic acid at 10.0 g	71.1 c	72.2 c	68.2 c	68.3 d	14.6 c	14.7 c	53.6 b	53.6 c
Nano-root fast at 2.5 g	71.9 b	73.0b	69.9 b	71.0 c	15.2 b	15.5 b	54.7 a	55.5b
Nano-root fast at 5.0 g	73.0 a	74.0 a	71.0 a	71.9 b	16.0 a	16.5 a	55.0 a	55.4b
Nano-root fast at 10.0 g	73.1 a	74.1 a	71.2 a	72.9 a	16.1 a	16.6 a	55.1 a	56.3 a

Means followed in same column by similar letters are not statistically different at 0.05 level according to Tukey test.

Table (4). Effect of some nano soil conditions on percentage of acidity, fiber and tannins of the fruits of Sakkoti date palms during 2020 and 2021 seasons

Treatments (per palm)	Total acidity %		Total crude fiber %		Total soluble tannins %	
	2020	2021	2020	2021	2020	2021
Control	0.399 a	0.400 a	1.51 a	1.41 a	0.66 a	0.67 a
Nano-active humic acid at 2.5 g	0.390 ab	0.391 ab	1.46 a	1.37 a	0.62 ab	0.63 ab
Nano-active humic acid at 5.0 g	0.377 bc	0.378 bc	1.40 b	1.30 b	0.57 bc	0.58 b
Nano-active humic acid at 10.0 g	0.375 bc	0.347 cd	1.39 b	1.29 b	0.56 c	0.58 b
Nano-hypertonic acid at 2.5 g	0.360 c	0.359 bc	1.35 bc	1.25 bc	0.52 cd	0.50 c
Nano-hypertonic acid at 5.0 g	0.341 d	0.341 de	1.30 cd	1.20 cd	0.48 d	0.46 c
Nano-hypertonic acid at 10.0 g	0.340 d	0.339 de	1.29 d	1.19 d	0.47 d	0.45 cd
Nano-root fast at 2.5 g	0.320 e	0.319 ef	1.20 e	1.16 de	0.41 e	0.40 de
Nano-root fast at 5.0 g	0.3.15 e	0.311 f	1.15 ef	1.12 e	0.37 e	0.35 ef
Nano-root fast at 10.0 g	0.313 e	0.310 f	1.14 f	1.11 e	0.36 e	0.34 f

Means followed in same column by similar letters are not statistically different at 0.05 level according to Tukey test.

DISCUSSION

The results obtained from this study showed that soil addition of any of the nanocomposites (Active humic acid, Hypertonic, and Root fast) increased the date palm leaf area and its content of chlorophyll and nutrients (N, P, K) compared to the untreated palm. These nanocomposites also increased the bunch weight, palm yield and improved the physical (weight, height, diameter and Flesh/seed) and chemical (T.S.S and sugars) properties of the fruits. Nano-Root fast was the best of these nano compounds, as it gave the highest values in yield and desirable fruit traits, while it gave the lowest values in undesirable fruit traits. On the contrary, these nanocomposites led to a decrease in the acidity, crude fiber and soluble tannins content of the fruits.

The superiority of nanocomposites treatments in vegetative characteristics (Leaf area and Total chlorophylls) under saline conditions may be attributed to the excess of salinity in root zone result in increased uptake of the toxic ions (Na and Cl) by the roots. These toxic ions inhibit the minerals uptake which ultimately reduced growth and yield of plants (**Ahmad *et al.*, 2019**). Application of mineral nutrients alleviates salinity stress on plants (**Etesamia and Jeong, 2020)**. Nano-composites are more effective for regulation of ionic balance by inhibiting Na and Cl in root zone which is important for alleviation of harmful effects of salinity in fruit trees. In the cell walls of plant roots there are so-called aquaporins, which are effective membrane proteins that improve water flow in the roots (**Ahmad and Anjum, 2020)**, in the same time reduce the toxic effects of Na and Cl. The addition of nano-composites in the root zone stimulates the formation of aquaporins in the roots and thus limits the harmful effects of salinity on plants (**Muhammad *et al.*, 2022**).

Increasing nutrient content in palm leaves treated with nanocomposites may explain that these composites are small in size, with a larger adsorption surface area, and higher stability, which makes them more effective in crossing cell and plasma membranes to regulate the effective uptake that further improves the supply of plants with nutrients (**Monica and Cremonini 2009; Shang *et al.*, 2019**). Nanoparticles are effective in enhancing stress tolerance in fruit trees growing in saline conditions, as the application of nanoparticles to leaves or roots significantly reduce the harmful effects of salinity (**Zhang *et al.*, 2017**). It is known that root size plays a major role in the absorption of nutrients; salinity conditions in the root zone decrease the root size of fruit crops (**Elsheery *et al.*, 2020; Wanderley *et al.*, 2020**). The use of nano-fertilizers improved root growth by mitigating the harmful effects of salinity. Moreover, these nanoparticles improved secondary and lateral root growth of trees (**El-Dengawy *et al.*, 2021**). These mitigations of the harmful effects of salt stress increases essential nutrients uptake within plant cells and tissues via roots, which improves the production and quality of fruit crops. This explains the increase in yield and fruit quality of palm treated with nanocomposites.

The superiority of nanocomposites treatments in fruit content of TSS and sugars may be attributed to application of these nanocomposites under saline conditions led to increase in plant growth by improving plant photosynthesis and concentration of photosynthetic pigments (**Yassen *et al.*, 2017; Boutchuen *et al.*, 2019; Siddiqui *et al.*, 2020**). This leads to an increase in the production of photosynthesis products and an increase in their transport and storage in the fruit. Consequently, TSS and sugars content of fruits increases.

Generally, the advantageous effects of nano–soil conditioners on the Sakkoti date palms' growth and fruiting attributes are associated with their improving effects on the solubility of fertilizers. Moreover, these nano-soil conditioners can hold the salts while slowing their release in the soil, thus increasing their efficiency, and reducing soil toxicity instead of overdosing with regular chemicals. These nano formations extended the fertilizer effect period (**Sultan *et al.*, 2009, Prasad *et al.*, 2014 and Mahjunathia *et al.*, 2016**). These results are in harmony with those obtained by **Steward *et al.*, (2005), Liu *et al.*, (2006), Ahmed (2018), Ahmed *et al.*, (2019), Dabdoub- Basma (2021); Akl *et al.*, (2020) and Zakier (2022).**

CONCLUSION

For overcoming problems of salinity and promise yield and fruit quality of Sakkoti date palms it is subjected to Root fast at 5 g %.

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RESEARCH ARTICLE

Study on using some composites to reduce the adverse effects of soil salinity on Sakkoti date palms under Upper Egypt conditions

Authors' contributions

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