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Growth and Productivity of Al-Saidy Date Palm Cv. in Relation to Traditional and Nano NPK Fertilization

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Abstract: In order to study the effect of replacement the traditional mineral NPK fertilizers by using NPK nano fertilizers, whether individual or in combination on vegetative growth, nutritional status and productivity of fifteen years old "Al-Saidy" date palm (also called Sewy *cv.*) grown under New Valley conditions. Field experiment was achieved during 2018 and 2019. The obtained data shows that all nano fertilizers treatments present higher and significant effect on vegetative growth (i.e. number of green leaves/palm, number of leaflets/leaf, leaflet area and leaf area), leaf main pigments (i.e. chlorophyll a, chlorophyll b, total chlorophyll and total carotenoids), nutritional statues (i.e. N, P and K leaf contents) and productivity (i.e. bunch weight (kg) and yield (kg/palm)) than using the same analogous traditional fertilizers treatments. All combined nano fertilizers treatments caused significant increases in all study parameters than using each one individually, these results were true in both experimental seasons. Furthermore, treated Al-Saidy date palm with the three nano fertilizers in combination (N+P+K) present the best results.

Key words: Al-Saidy" date palm, Sewy, NPK, nano fertilizers, productivity, growth, nutritional status.

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INTRODUCTION

Date palm (*phoenix dactylifera* L.) belongs to Family *Palmaceae.* The genus *Phoenix* includes all known date palm varieties. Date palm considered as one of the oldest fruit trees in the world. **(Hodel & Johnson 2007; Eshmawy, 2010 and Eshmawy, 2015)**. Egypt is considered as one of the major date palm producer in the world, it grown successfully under Egyptian climate conditions. Al-Saidy (also called Sewy cultivar) date palm is one of the famous semi-dry Egyptian cultivars, it is oriented in middle Egypt region **(Gebreel, 2015 and Omar, 2015)**. The total cultivated area is 65313 fed., Produce 413551 tons fruits. So, this cultivar transfers to New Valley Governorate and successfully adapted in this region. Then, it locally called Al-Saidy date palm in New valley region **(Eshmawy, 2010; Gebreel, 2015 and Omar, 2015)**.

Using the fertilizers in form of nano-particles may be achieving many advantages; it uses in lower chemicals quantity, speed of

absorption by plant roots. it has the potential to revolutionize the agricultural systems, biomedicine, environmental engineering, safety and security, water resources, energy conversion, and numerous other areas **(Hussein & Abd-Elall 2018 and Alalaf *et al.*, 2020)**. The use of nano-fertilizers technique can be causes an increase in nutrients use efficiency, reduces soil toxicity, minimizes the potential negative effects associated with over dosage and reduces the frequency of the application **(Prasad *et al.*, 2014)**.

The present study aimed to investigate compared between using N, P and K in form of nano-fertilizers verses the traditional mineral form of theses fertilizers, included the vegetative growth and fruiting of "Al-saidy" date palm, grown under New Valley Governorate conditions.

MARTIALS AND METHODS

The present study was carried out during two successive seasons 2018 and 2019 on fifty-six semi-dry "Al-Saidy" date palm *cv.* (also called Sewy cultivar) uniform in vigor. The chosen palms were fifteen years old and grown in private orchard located at Mochia village, El-Dakhla district New Valley Governorate, where the soil texture is sandy, since water table depth is not less than two meters. The chosen palms were produced through conventional propagation by offshoots, it characterized by regular bearing. These palms irrigated through groundwater using well water (EC = 650 ppm). The palms were planted at 7 X 7 meters apart. Pruning was performed adjusted to maintain leaf / bunch ratio at 8:1. However, the number of female spathes/palm was adjusted to 10 spathes. Hand pollination of the selected palms was achieved, using Al-Saidey male palms, during 2-3 days after female spathe cracking. (according to Al-Tahir and Asif 1983). The selected palms were subjected to regular common horticulture practices that common applied in date palm orchards: including fertilization, irrigation, and hoeing and pest management.

Soil characters

The experimental orchard located at Mochia Village, El-Dakhla district - New Valley Governorate. A composite soil sample was collected and subjected to physical and chemical analysis according to **Chapman and Partt (1961)** and **Wilde *et al.* (1985)**. The obtained data illustrated in Table (1).

Table (1). Physical and chemical analysis of orchard soils

Constituents	Values
Sand %	79.0
Silt %	12.2
Clay %	8.8
Texture	Sandy
EC (1 : 2.5 extract) mmhos /1cm / 25 TC	0.95
Organic matter %	1.02
pH (1 : 2.5 extract)	8.8
Total CaCO3 %	19.2
N %	0.05
Available P (Olsen, ppm)	35
Exch. K^+ (mg/100g)	91.2
Exch. Ca^{++} (mg/100g)	69.9

Experimental work

In order to study the effect of using N, P and K nano fertilization versus traditional mineral N, P and K fertilization on "Al-Saidy" date palm. Whereas, the conventional nitrogen fertilizer was adding in form of ammonium nitrate 3 kg/palm in three equal doses, conventional phosphorus was added in form of super phosphate at 3 kg/palm yearly. In addition, 1kg of potassium sulphate was added to each palm yearly, as a source of conventional potassium fertilizer. While, nano-fertilizers; 250 g N /palm, 150 g P /and 125 g K / palm were added in one dose yearly during the second week of Aril.

Then, the present study included the following fourteen treatments from conventional and nano N, P and K fertilizers, as follows:

1-Fertilization with N, P and K in form of traditional fertilizers.

2-Fertilization with traditional N fertilizer.

3-Fertilization with traditional P fertilizer.

4-Fertilization with traditional K fertilizer.

5-Fertilization with traditional N and P fertilizers.

6-Fertilization with traditional N and K fertilizers.

7-Fertilization with traditional P and K fertilizers.

8-Fertilization with nano N fertilizer.

9-Fertilization with nano P fertilizer.

10- Fertilization with nano K fertilizer.

11- Fertilization with nano N and P fertilizers.

12- Fertilization with nano N and K fertilizers.

13- Fertilization with nano P and K fertilizers.

14- Fertilization with nano N, P and K fertilizers

Each treatment was replicated four times, one palm per each replicate. The treatments were arranged in a complete randomized block design (CRBD).

Different measurements and determinations: The following vegetative growth parameters, leaves main pigments, leaves mineral concentration, bunch weight and yield/palm of Al-Saidey were determined.

1- Leaf morphology measurements: Morphology measurements of adult leaves have been achieved. The morphological measurements included the number of green leaves per palm, number of leaflets per adult leaves, leaflet area (cm^2), leaf area (m^2). The leaflet area (cm^2) and leaf area (m^2) has been measured by using adult leaves. The leaflet area (cm^2) was determined by using **Ahmed and Morsy (1999)** equation (biased on leaflet the maximum width and length of leaflet). Then, leaf area (m^2) has been calculated by multiplying the number of leaflets/leaf by the area of leaflet.

2- Measurements of main pigments: Samples of six adult and fresh leaflets located at the middle part of adult leaf (six month old leaves) were taken during 2^{ed} week of August in both experimental seasons. The leaflets were cut a small pieces, then 0.2 g from each sample was taken, homogenized and extracted by 85% acetone in the presence of little amounts of Na_2CO_3, then, it the mixture was filtrated. The residue party washed several times with acetone until the filtrate became colorless. Then the extract completed to 20 ml with acetone 85%. Little portion was taken for determination of chlorophylls a, b, total chlorophyll and total carotenoids were calorimetrically determined at wave lengths of 662, 664 and 640 nm for chlorophylls a, chlorophyll b and total carotenoids respectively. (according to **Ward and Johnston, 1962 and Hiscox and Isralstan 1979)**.

Chl. a = (9.784 x E 662) – (0.99 x E 662) = mg / 100 g F.W.

Chl. b = (21.426 x E 644) – (4.65 x E 644) = mg /100 g F.W.

Total Carotenoids = (4.695 × E 440) – 0.268 (E 662 + E 644) = mg/100g F.W.

Where E = optical density at a given wavelength. Total chlorophyll was estimated by summation of chlorophyll a plus chlorophyll b (mg/ 100 g. F.W).

While the total chlorophylls were estimated (mg/100g FW) by summation of chlorophyll a and b concentrations **(Ibrahim 2010)**.

3- Determination of NPK in leaves: Sixteen pinnae were selected from the middle area of adult leaves for each palm (according to Martin-Préval *et al.*, 1984 and Ibrahim 2010) to achieved NPK contents. The leaflet samples were picked and washed several times with tap water and rinsed with distilled water. The leaflets were air-dried in oven at 70 °C for 48 hours. Then it grounded and stored in small pockets prior analysis. Then, accurate sample (0.5 g) was digested using sulfuric acid and hydrogen peroxide until clear solution was obtained as recommended by **Jones *et al.* (1991)**.

- Nitrogen% was determined by modified micro kjeldahl method as described by **(Martin-Préval *et al.*, 1984)**.
- Phosphorus was determined by using colorimetric method, described by **Jones *et al.* (1991)**, by measuring the optical density of phosphor-molibdo-vanadate complex by Spectro-photometrically at wave length 430 nm.
- Potassium was flam-photometrically determined by using the method outlined by **Martin-Préval *et al.* (1984)**.

4- Bunch weight and Yield (kg/palm): harvesting took place after rutab stage (**Fageria *et al.*, 2000**), for Al-Saidy date palm under New Valley conditions on the last week of September during the two experimental seasons. Average bunch weight (kg) was recorded. The yield of each palm (kg/palm) was estimated by multiplying the number total of bunches per palm by average bunch weight (kg).

RESULTS AND DISCUSSION

Vegetative growth of Al-Saidy date palm

Data concerning the effect of replacement the traditional mineral NPK fertilizers by nano NPK fertilizers, individually or in combination, on green leaves number, number of leaflets/leaf, leaflet area (cm^2) and leaf area (m^2) of Al-Saidy date palm during 2017 and 2018 seasons are illustrated in Table (3).

Green leaves number / palm and number of leaflets per leaf

Concerning the average number of green leaves/palm and the average number of leaflets/leaf, the obtained data shown in table (2) declare that, all nano fertilizers treatments present higher and significant number of green leaves per palm and number of leaflets per leaf than the same analogous conventional fertilizers treatments. The data also shows that both studied characters (number of green leaf/palm and number of leaflet/leaf) were remarkable varied according to the type of treatment (individually or in combination). However, all combined nano fertilizers treatments caused significant increases in green leaves number and number of leaflets pear leaf rather than using the individual treatment. Furthermore, treated Al-Saidy date palm with the three nano fertilizers in combination present the highest number of green leaves / palm and highest number of leaflets/leaf, during the two experimental seasons (Table 2).

Leaflet area (cm^2) and leaf area (m^2)

Data present in Table (2) shows that, the effect of traditional and nano NPK fertilizers on leaflet area (cm^2) and leaf area (m^2) of Al-Saidy date palm during 2018 and 2019. This Table shows that, replacing the conventional fertilizers by nano fertilizers was accompanied with significant increase in leaflet area (cm2) and leaf area (m^2). Furthermore, any combined treatment of nano fertilizers was superior to the single using of each element. This increment reached a maximum when replaced the three mineral fertilizers (N, P and K fertilizers) by using the three nano fertilizers. These results were similar during the two experimental seasons.

This positive effect on green leaves number/palm, leaflets number/leaf, leaflet area (cm^2) and leaf area (m^2) which is observed in the present study, can be explained by the essential role of nitrogen and phosphorus in amino and fatty acids syntheses as well as the essential role of potassium in enzymes activation. Using the fertilizers in form of nano-technology considered as one of the most important recent methods in fertilization in fruit orchards. It plays an important role in improving its growth and mineral status of fruit trees, which lade to improving fruit trees flowering and fruiting as well as fruit quality **(Peng *et al.*, 2016; Elamin *et al.*, 2017; Hussein & Abd-Elall 2018; Abobatta 2019 and Alalaf *et al.*, 2020)**.

Table (2). Effect of traditional and nano NPK fertilizers on green leaves number/palm, Number of leaflet/leaf, leaflet area (cm^2) and leaf area (m^2) of Al-Saidy date palm, during 2018 and 2019

Treatments	Green leaves per palm		No. of leaflet Per leaf		Leaflet area (cm^2)		Leaf area (m^2)	
	2018	2019	2018	2019	2018	2019	2018	2019
Traditional NPK	25.6	26.3	189.5	189.0	154.5	155.0	2.89	2.93
Traditional N	22.3	22.9	182.0	182.4	144.8	145.3	2.61	2.63
Traditional P	20.1	20.6	177.1	178.1	138.3	138.6	2.42	2.45
Traditional K	19.0	19.5	175.0	176.1	135.1	135.5	2.33	2.35
Traditional P+K	21.1	21.7	179.6	180.3	141.5	141.9	2.52	2.54
Traditional N+K	23.3	24.1	184.5	184.4	147.9	148.8	2.70	2.73
Traditional N+P	24.5	25.2	187.0	186.5	151.2	151.8	2.79	2.82
Nano N	30.0	31.0	199.5	199.1	168.0	168.1	3.27	3.30
Nano P	27.7	28.5	194.2	194.0	161.5	161.3	3.08	3.12
Nano K	26.6	27.4	192.1	191.7	157.9	158.1	2.98	3.02
Nano P+K	28.9	29.7	197.0	196.5	164.5	164.8	3.17	3.21
Nano N+K	31.2	32.3	201.7	201.7	171.3	171.4	3.36	3.40
Nano N+P	32.3	33.4	204.0	204.1	175.0	175.1	3.44	3.51
Nano N+P+K	33.5	35.6	206.6	206.7	178.2	178.7	3.55	3.65
New LSD 5%	1.0	1.1	2.1	2.0	3.0	3.1	0.08	0.09

Leaves min pigments

The observations related to leaflet chlorophyll a, chlorophyll b, total chlorophyll as well as total carotenoids (mg/100g F.W.) of Al-Saidy date palm as influenced by replacement of traditional NPK fertilizers by nano NPK fertilizers during 2018 and 2019 seasons are presented in Table (3). The perusal of data in this Table reveals that replaced the NPK traditional mineral fertilizers treatments, ether individual or in possible combinations, had a significant effect on these main leaves pigments, during both the seasons. Data presented in Table (3) also showed that, replaced the three main cations conventional mineral fertilizers (NPK) by using nano NPK fertilizers present the best contents of all main pigments (11.4 & 11.1 mg/100g for chlorophyll a, 7.1 & 7.3 mg/100g for chlorophyll b, 18.5 & 18.3 mg/100g for total chlorophyll and 7.0 & 6.7 mg/100g for total carotenoids). Contrary, using the conventional potassium fertilizer alone present the lowest values of the main pigments (6.0 & 6.1 mg/100g for chlorophyll a, 2.0 & 2.1 mg/100g for chlorophyll b, 8.0 & 8.2 g/100g for total chlorophyll and 1.9 & 2.0 g/100g for total carotenoids).

The role of NPK as an essential elements in date palm nutrition and its effect on stimulating the main pigments such as chlorophylls and carotenoids in leaves was reported in different date palm cultivars by certain authors such as: **Gebreel (2015), Ahmed *et al.* (2015)** on Al-Saidy cultivar; **Elamin *et al.*, 2017** on Khenazi date palm ; **El-Sayed *et al.* (2017)** on Khenazi date palm, **El-Salhy *et al.* (2021) and Abd EL-Rahman *et al.* (2022)** on Zaghloul cultivar; **El-Merghany *et al.* (2019)** on Ferehy cultivar and **El-Sayed *et al.*, 2019; Idris *et al.* (2012)** on some dray cultivars and **Handal (2021)** on Barhi cultivar. Furthermore, using NPK in form of nano fertilizers can improve the fertilizers efficiency and minimization the fertilizers loses through draining for declining nutrient use efficiency and increasing the surface area which can offer opportunity for better and effective interaction of nanoparticles to target sites as well as nano-fertilizers hold potential to plant nutrition requirements along with imparting, this technique well led to improving the main pigments in fruit trees leaves **(Elamin *et al.*, 2007; Ahmed *et al.*, 2012; Abobatta, 2019; Al-Hchami and Alrawi 2020; Kumar *et al.*, 2021 ; and Chopra *et al.* (2022)**.

Table (3). Effect of conventional and nano NPK fertilizers on chlorophyll a, chlorophyll b, total chorophyll and total carotenoids (mg/100g F.W.) of Al-Saidy date palm, during 2018 and 2019

Treatments	Chlorophyll a (mg/100g F.W.)		Chlorophyll b (mg/100g F.W.)		Total Chlorophyll (mg/100g F.W.)		Total carotenoids (mg/100g F.W.)	
	2018	2018	2018	2019	2018	2019	2018	2019
Traditional NPK	8.2	8.2	4.0	4.3	12.2	12.7	4.0	4.1
Traditional N	7.0	7.0	3.0	3.3	10.0	10.5	2.9	3.0
Traditional P	6.3	6.3	2.3	2.4	8.6	8.9	2.2	2.3
Traditional K	6.0	6.0	2.0	2.1	8.0	8.2	1.9	2.0
Traditional P+K	6.7	6.7	2.5	2.9	9.2	9.7	2.6	2.7
Traditional N+K	7.3	7.3	3.3	3.7	10.6	11.2	3.3	3.4
Traditional N+P	7.7	7.7	3.5	4.0	11.2	11.9	3.6	3.7
Nano N	9.8	9.8	5.3	5.7	15.1	15.5	5.6	5.5
Nano P	8.9	8.9	4.5	5.0	13.4	13.7	4.7	4.8
Nano K	8.6	8.6	4.3	4.6	12.9	14.0	4.3	4.4
Nano P+N	9.3	9.3	5.0	5.3	14.3	15.4	5.2	5.2
Nano N+K	10.3	10.3	5.8	6.0	16.1	16.6	6.0	5.7
Nano N+P	10.8	10.8	6.4	6.5	17.2	17.1	6.5	6.2
Nano N+P+K	11.4	11.4	7.1	7.2	18.5	13.3	7.0	6.7
New LSD 5%	0.3	0.3	0.2	0.3	0.5	0.7	0.3	0.3

Leaves NPK contents

Data in Table (4) shows the effect of traditional NPK fertilizers and nano NPK fertilizers on leaf mineral content (N, P and K %) of Al-Saidy date palm cultivar, during 2018 and 2019 seasons. Change in leaves NPK contents (on percentages) of Al-Saidy date palm during 2018 and 2019 seasons as a response of replacing conventional NPK fertilizers by nano NPK fertilizers are shown in Table (4). It's clear from these Table and figures that, replaced the three cations in traditional fertilizers by nano fertilizers were very effective in enhancing the percentages of N, P and K in leaves, these results were true in both experimental seasons. it is worth to mentioned that treated the Al-Saidy date palm with the three elements in combination (N+P+K) in form of nano fertilizers present the highest leavel of the three element in adult leaves, during the two experimental seasons. Furthermore, treated the palms with K individually in form of traditional mineral fertilizer present the lowest percentages of N, P and K in adult leaves.

Table (4). Effect of conventional and nano NPK fertilizers on leaf area N, P and K contents (%) of Al-Saidy date palm, during 2018 and 2019

Treatments	Leaf N (%)		Leaf P (%)		Leaf K (%)	
	2018	2019	2018	2019	2018	2019
Traditional NPK	1.76	1.73	0.32	0.30	1.33	1.34
Traditional N	1.57	1.57	0.24	0.22	1.25	1.26
Traditional P	1.45	1.47	0.19	0.17	1.19	1.21
Traditional K	1.40	1.43	0.17	0.15	1.16	1.18
Traditional P+K	1.51	1.52	0.22	0.20	1.22	1.23
Traditional N+K	1.63	1.61	0.27	0.25	1.27	1.28
Traditional N+P	1.70	1.67	0.29	0.27	1.30	1.31
Nano N	1.99	1.92	0.42	0.38	1.44	1.44
Nano P	1.87	1.82	0.35	0.32	1.39	1.38
Nano K	1.82	1.78	0.33	0.30	1.36	1.36
Nano P+N	1.98	1.87	0.38	0.28	1.41	1.41
Nano N+K	2.05	1.98	0.44	0.35	1.46	1.47
Nano N+P	2.11	2.03	0.46	0.43	1.49	1.50
Nano N+P+K	2.16	2.09	0.49	0.46	1.52	1.54
New LSD 5%	0.05	0.04	0.02	0.02	0.02	0.02

The using of NPK fertilizers in form of nanotechnology has helped to regulate the release of mineral elements nutrients from fertilizers, that may be lead to release of nitrogenous and phosphate and K fertilizers absorption from soil, therefore, it can decrease in nutrient doses. The absorption method of these nutrients through the roots is the usual increase the fertilizers effeminacy **(Taha *et al.*, 2016; Elamin *et al.*, 2017 and Jubeir & Ahmed, 2019)**.

Bunch weight and yield (kg)

The observations related to Bunch weight (kg) and yield (kg/palm) of Al-Saidy date palm as influenced by replacement of traditional NPK fertilizers by using nano NPK fertilizers, during 2018 and 2019 seasons are presented in Tables (5). The perusal of data in Table (5) reveals that, all treatments concerning the replacement of traditional NPK fertilizers by nano fertilizers had a significant effect on the productivity of Al-Saidy palms i.e. bunch weight (kg) and yield (kg/palm), during the two experimental seasons. Data obtained during the two experimental seasons as shown in Table (5) displayed that, regardless the element which replaced from traditional mineral fertilizer by nano NPK fertilizer, all NPK treatments were capable to increase the bunch weight and yield/palm significant. Regarding the bunch weight (kg) and yield kg / palm, among the individual replacement of the three examined conventional fertilizers, using nano nitrogen fertilizer in place of traditional nitrogen fertilizer was superior to those of phosphorus or potassium nano fertilizers (Table 5). It is worth to noting that, all combined replacement treatments of the three main cations was more effectiveness on bunch weight and yield (kg/palm) comparison to replace each cation individually. While, the palms received the two main cations (N+P) in form of nano-fertilizers present higher and significant bunch weight and yield than those received the N+K or P+K in form of nano fertilizers. Furthermore, replaced the three cations (N. P and K) in form of nano fertilizers present the highest bunch weight (13.8 and 12.8 kg) and yield/palm (138.0 and 128 kg) during the two experimental seasons respectively.

The role of NPK as an essential element in date palm nutrition and its effect on bunch weight and palm yield was reported in different date palm trees by certain authors such as: **Gebreel (2015), Ahmed *et al.* (2015)** on Al-Saidy cultivar; **El-Sayed *et al.* (2017), El-Salhy *et al.* (2021)** and **Abd EL-Rahman *et al.* (2022)** on Zaghloul cultivar; **El-Merghany *et al.* (2019)** on Ferehy cultivar and **El-Sayed *et al.*, 2019; Idris *et al.* (2012)** on some dray cultivars and **Handal (2021)** on Barhi cultivar.

Table (5). Effect of traditional and nano NPK fertilizers on bunch weight (kg) and yield (kg/palm) of Al-Saidy date palm, during 2018 and 2019

Treatments	Bunch weight (kg)		Yield (kg)	
	2018	2019	2018	2019
Traditional NPK	9.9	9.5	99.0	95.0
Traditional N	8.1	7.9	81.0	79.0
Traditional P	6.8	6.9	68.0	69.0
Traditional K	6.3	6.5	63.0	65.0
Traditional P+K	7.5	7.4	75.0	74.0
Traditional N+K	8.6	8.4	86.0	84.0
Traditional N+P	9.3	9.0	93.0	90.0
Nano N	12.1	11.2	121.0	112.0
Nano P	11.0	10.3	110.0	103.0
Nano K	10.4	9.9	104.0	99.0
Nano P+N	11.5	10.8	115.0	108.0
Nano N+K	12.7	11.7	127.0	117.0
Nano N+P	13.2	12.2	132.0	122.0
Nano N+P+K	13.8	12.8	138.0	128.0
New LSD 5%	0.5	0.4	5.1	4.3

Conclusion

In order to improving the vegetative growth, mineral status of palms, Bunch weigh and yield of "Al-Saidy" date palms grown under the experimental region conditions (New Valley, Governorate, which the soil texture is sandy) and resembling conditions. It is strongly recommended to using the three main elements (N, P and K) in form of nano fertilizers, add as soil application.

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