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Article

Fruit Quality of Al-Saidy Date Palm cv. in Relation to Traditional and Nano NPK Fertilization

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Abstract: This present study focused on the response of Al-Saidy date palm fruit quality under New Valley governorate – Egypt in relation to replacement of the traditional NPK mineral fertilizers by using nano NPK fertilizers, individually or in combination. Field experiment included fourteen treatments from traditional and nano fertilizers were achieved on fifty-six female palms of Al-Saidy date palm *cv.* grown in sandy soil, during 2018 and 2019 seasons. The present investigation shows that using the nano NPK fertilizers shows superior to using the traditional NPK fertilizers. However, all nano NPK combinations present significant effect than using each element individually. The best fruit physical and chemical parameters were obtained whine the palms received the three elements in combination in form of nano fertilizers. These results were true during both seasons.

Key words: Al-Saidy date palm, NPK, nano fertilizers, physical and chemical parameters, fruit quality.

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INTRODUCTION

The Date palm (*phoenix dactylifera* L.) considered as one of the oldest fruit trees in the world. It is a classified as tropical and subtropical zone fruits. it has a high resistance to water stress, tolerates climate variability climate change, and high levels of salinity **(Wrigley, 1995; Zaid & Wet 2002; Hodel & Johnson 2007; and Eshmawy, 2015).** However, Egypt consider as one of the major date palm producing in the world. Al-Saidy cultivar (also called Sewy cultivar) conceded as one of the main Egyptian semi-dray *cvs.*, since the total cultivated area with this cultivar is 65313 fed. Produce 413551 tons fruits. it is oriented in middle Egypt region and New Valley regions **(Gebreel, 2015 and Omar, 2015).**

Some challenges in fruit trees cultivation including the problem of trees nutrition, due to the many soil problems such as contamination with chemical fertilizer residues and unviability of some mineral nutrients unbalanced of the requirements macro and micro nutrients in soil. These problems may be led to low growth and production of fruit trees **(Al-Hchami and Alrawi 2020)**. Using the fertilizers in form of

nano-fertilizers may be achieving many advantages due to their use with lower chemicals and the speed of absorption by the plant root (**Chopra *et al.*, 2022)**. The development of agriculture sector can possible increasing the resources use efficiency with the minimum damage to production, through the effective uses of modern agriculture technologies methods. Among of these technologies, nano-fertilizers 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; Alalaf *et al.*, 2020 and Chopra *et al.*, 2022)**.

The aim of the present investigation is studying the effect of replacement of traditional mineral NPK fertilization by nano NPK fertilizers on fruit quality of "Al-saidy" date palm, grown in sandy soil under New valley Governorate conditions – Egypt.

MATERIALS AND METHODS

This was carried out during 2018 and 2019 seasons on fifteen-six produced through conventional propagation by offshoots, it characterized by regular bearing and uniform in vigor female palms of Al-Saidy date palm cultivar. The chosen palms were grown in private orchard located at Mochia village, El-Dakhla district New Valley Governorate – Egypt, where the soil texture is sandy, since water table depth is not less than two meters. These palms were planted at 7 X 7 meters apart and irrigated through groundwater using well water (EC = 650 ppm). 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 by using Al-Saidey male palms, during 2-3 days after female spathe cracking.

Soil characters

A composite sample of soil was collected and subjected to physical and chemical analysis according to **Chapman and Partt (1961) and Wilde *et al.*, (1985)**. Then, 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 traditional N fertilizer was add in form of ammonium nitrate 3kg/palm in three equal doses, traditional P was added in form of super phosphate at 3 kg/palm yearly. In addition, 1kg of K_2SO_4 was added to each palm yearly, as a source of traditional mineral K 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).

Physical and chemical characteristics of fruits: samples of fifty date fruits from all bunches per palm were picked randomly for estimation the following physical and chemical characteristics of fruit:

1. Measurement of fruits physical properties:

- Average fruit weight and seed weight (g) was estimated by using balance of 0.01g sensitivity.
- Average fruit dimensions (length and diameter (cm) were measured by using vernier caliper.
- Pulp and seed weight were estimated by using balance of 0.01g sensitivity.
- Edible (pulp weight) to non-edible portions (seed weight) ratio was calculated (flesh weight/seed weight).

2. Determination of fruits chemical properties:

100 grams of fruit pulp was mixed with 100 ml distilled water and stand two hours, then the samples minced will with electric blender for determination of the following chemical parameters:

The percentage of total soluble solids (TSS %) was determined by using hand refractometer according to **Rangana (1977)**.

Percentage of reducing sugar and total sugars were determined by using Lane and Eynone volumetric method according to **Rangana (1977)**.

Percentage of total acidity (expressed as grams malic acid per 100 grams of flesh) by using the titration with 0.1 NaOH in the presence of phenolphthalein as indicator according to **A.O.A.C. (2000**).

Statistical analysis of data

The present investigation was arranged in complete randomized design (CRBD). Then, the data were tabulated and subjected to proper statistical analysis. Comparisons between means were made by least significant differences (LSD) at p= 0.05 **(Snedecore and Cochran, 1977)**.

Results and Discussion

Fruit physical properties

Fruit weight and fruit dimensions

The results pertaining to the effect of replacement of traditional NPK fertilizers by NPK nano fertilizers in individually or combined application on fruit weight (g), fruit height (cm) and fruit diameter (cm) of "Al-Saidy" date palm during the two experimental seasons are presented in Table (2). The perusal of data reveals that, all nano fertilizers treatments of these three main elements (NPK) exerted a significant effect on the fruit weight and fruit dimensions compared to using the traditional NPK fertilizers, in both experimental seasons.

It is clear from the data illustrated in this Table that treated Al-Saidy date palm with the mixture of the three nano fertilizers (N, P and K) in combination have an announced and significant effect on fruit weight, fruit longitudinal and fruit equatorial compared to the other treatments. Furthermore, the palms received the combined application N, P and K in form of nano-fertilizers present the higher values in all studied fruit physical properties (14.0 & 14.9 g for fruit weight, 6.6 & 7.3 cm in fruit height, 3.8 & 4.0 cm in fruit diameter) than those received any individual one of them in form of nano. In any case, any two combined applications of the three nano fertilizers was superior than using any one singly. While on the opposite side, the palms received individual K in conventional form present the lowest fruit weight (9.5 & 9.4 g), fruit height (3.1 & 3.0 cm) and fruit diameter (2.0 & 2.1 cm) during the two experimental seasons respectively.

These positive effect of using nano fertilizers on the physical properties of Al-Saidy date palm fruits were previously reported by **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 Barhy cultivar. It is worth to mention that, the important role of nano fertilizers on enhancing mineral elements efficacy and uptake as well as stimulating some important biological functions in plant cells was able to explain its favorable effect on fruit physical properties, which found in this work. Similar findings were observed by **Idris *et al.* (2012); Gebreel (2015); Ahmed *et al.* (2015); El-Sayed *et al.*, (2019); Abd EL-Rahman *et al.* (2022) and Chopra *et al.*, (2022)**.

Table (2). Effect of conventional and nano NPK fertilizers on fruit weight (g) and fruit dimensions (cm) of Al-Saidy date palm, during 2018 and 2019

Treatments	Fruit weight (g)		Fruit height (cm)		Fruit diameter (cm)	
	2018	2019	2018	2019	2018	2019
Traditional NPK	11.6	12.0	4.8	5.0	3.2	3.0
Traditional N	10.5	10.7	3.8	4.0	2.3	2.5
Traditional P	9.8	9.9	3.3	3.3	2.1	2.2
Traditional K	9.5	9.4	3.1	3.0	2.0	2.1
Traditional P+K	10.2	10.3	3.5	3.7	2.2	2.3
Traditional N+K	10.7	11.2	4.1	4.3	2.4	2.6
Traditional N+P	11.2	11.6	4.4	4.6	2.6	2.8
Nano N	11.9	13.7	5.7	6.3	2.8	3.5
Nano P	12.2	12.9	5.2	5.6	3.0	3.2
Nano K	11.9	12.4	5.0	5.3	2.9	3.1
Nano P+N	12.6	13.3	5.3	6.0	3.1	3.3
Nano N+K	13.2	14.0	5.9	6.6	3.4	3.6
Nano N+P	13.6	14.4	6.2	6.9	3.6	3.8
Nano N+P+K	14.0	14.9	6.6	7.3	3.8	4.0
New LSD 5%	0.3	0.4	0.2	0.3	0.1	0.1

Table (3). Effect of conventional and nano NPK fertilizers on fruit pulp weight (g), seed weight (g) and edible/non edible portion of Al-Saidy date palm, during 2018 and 2019

Treatments	Pulp weight (g)		seed weight (g)		Edible / non-edible ratio	
	2018	2019	2018	2019	2018	2019
Traditional NPK	8.2	8.7	3.6	3.3	2.3	2.6
Traditional N	7.1	7.5	3.4	3.2	2.1	2.3
Traditional P	6.3	6.7	3.5	3.2	1.9	2.1
Traditional K	6.2	6.3	3.3	3.1	1.8	2.0
Traditional P+K	6.8	7.1	3.4	3.2	2.0	2.2
Traditional N+K	7.2	7.9	3.5	3.3	2.1	2.4
Traditional N+P	7.6	8.2	3.6	3.3	2.1	2.5
Nano N	8.6	10.6	3.3	3.2	2.6	3.3
Nano P	8.8	9.7	3.4	3.2	2.6	3.0
Nano K	8.5	9.2	3.4	3.1	2.5	2.9
Nano P+N	9.3	10.2	3.3	3.1	2.8	3.3
Nano N+K	9.8	10.8	3.4	3.2	2.9	3.4
Nano N+P	10.1	11.1	3.5	3.3	2.9	3.4
Nano N+P+K	10.7	11.7	3.3	3.2	3.2	3.7
New LSD 5%	0.5	0.6	NS	NS	0.5	0.4

Pulp weight, seed weight and edible to non-edible portion

Data obtained during the two experimental seasons as shown in Table (3) displayed that, regardless the source of NPK fertilizers, all treatments with conventional or nano fertilizers failed to varying the weight of seed of Al-Saidy date palm significant neither in the first season nor in the second season. On the other hand, replacement the traditional NPK by nano NPK fertilizers, each one individually or in combination significantly increased fruit pulp weight (g) and the ratio of edible / non-edible portion, during the two experimental seasons. It is clear from the obtained data that treating Al-Saidy date palm with the N, P or K nano fertilizers significantly was followed by stimulating the fruit pulp weight and edible portion ratio, rather than using the traditional N, P and K fertilizers. This stimulation was highly when the palms received the three cations (NPK) in form of nano fertilizers in combination. Contrary, the palms received only the potassium fertilizer in form of traditional mineral fertilizer produced the lowest values of fruit pulp weight (7.1 g & 7.5 g) and edible/non edible portion ratio (1.8 & 2.0), These results were true in both experimental seasons.

Fruit chemical properties

TSS% total acidity% and TSS/acidity ratio

Data concerning the effect of nano NPK fertilizers verses traditional NPK fertilizers on total soluble solids, total acidity, TSS/acidity, reducing sugars, total sugars, total soluble tannin of Al-Saidy date palm during 2018 and 2019 seasons are illustrated in Tables (4 and 5). Data present in Table (4) shows that, regarding the treatment of palms with N, P and K in form of nano fertilizers caused a significant promotion in fruit TSS% and TSS/acidity ratio rather than using the NPK conventional fertilizers, during the two experimental seasons. Contrary, all nano fertilizers treatment caused a significant decrease in fruit total acidity compared to using the conventional fertilizers. It is worth to mention that, all combined treatments of N, P and K in form of nano-fertilizers present higher and significant TSS% and TSS/acidity ratio, and lowest significant total acidity % rather than the individual treatment of each element.

However, the palms received the three elements fertilizers in form of nano-fertilizers in combination present highest TSS% (76.6% &76.3%) and TSS / acidity ratio (331.8 & 302.8), during the two seasons respectively. While, the same treatment produced the lowest total acidity% in fruit pulp (0.231% & 0.252%), compared to the other treatments, this data were true in both experimental seasons.

On the other hand, the lowest TSS% of fruit pulp and lowest TSS/acidity were obtained when the palms received only the traditional phosphorus fertilizer (66.4 & 66.9% for TSS% value and 165.8 % 165.0 for TSS/acidity ratio), it is worth to mention that the same treatment produced the highest total acidity percentage in fruit pulp (0.383% and 0.390%), during the two experimental seasons respectively.

Reducing sugars%, total sugars% and total tannins%

The obtained data during the two experimental seasons (2018 and 2019) illustrated in Table (5) displayed that, treated Al-Saidy date palm with N, P and K in from of nano fertilizers forms significantly enhancing reducing sugars and total sugars rather than using the NPK in traditional fertilizers. These increments were relatively correlated with the source of NPK fertilizers. In this concern, treated Al-Saidy palms with nano N fertilizer were superior to treat it with P or K nano fertilizers, during the two experimental seasons. Further, treated the palms with N+P nano fertilizers present higher and significant effect on increasing reducing and total sugars, rather than those of N+K or P+K. Furthermore, the treatment included the three nano fertilizers (N, P and K) in combination present the highest percentage of reducing sugars (74.2 & 75.3%) and total sugars (33.7 & 32.9%), and lowest total soluble tannins (0.30 & 0.41%), during the two experimental seasons respectively. Other words, individual treatment with nano nitrogen fertilizer showed more effective in decreasing the total soluble tannins in fruit pulp rather than the individual treatments with nano P or nano K. Considering that, all nano fertilizers treatments were super than conventional counterpart, these data were true in both experimental seasons.

The role of nano fertilizers in enhancing Al-Saidy date palm fruit chemical properties are in agreement with those obtained by **(Monreal *et al.*, 2016; Idris *et al.* (2012); Gebreel (2015); Ahmed *et al.* (2015); Hussein & Abd-Elall 2018; El-Sayed *et al.*, (2019); Alalaf *et al.*, 2020; Abd EL-Rahman *et al.* (2022) and Chopra *et al.*, 2022**).

Nitrogen and phosphorus are participant the structural of plant cell. It is participated the structure of amino acids and other compounds such as compounds rich in energy (ADP and ATP). While, it did not record any essential role for potassium in plant structure. Even if the potassium dose not participation the structure of plant cell, may it plays some important regulator roles in plant cell, such as; it activates more than 60 enzymes **(Marschner, 2012; Prajapati & Modi, 2012; Mengel, 2007 and Moustafa & Abdelzaher, 2018)**, it can neutralize a different organic anion **(Prajapati & Modi, 2012)**, it regulates the process of opening and closing of stomata. So, potassium regulate the water balanced in plant **(Mengel, 2007 and Marschner, 2012)** K regulate the photosynthesis processes in plant (Mengel, 2007 and Paliwal, 2018), it play an important role in carbohydrates transportation through phloem to the other parts of plant **(Van-Brunt & Sultenfuss, 1988 and Mengel, 2007)**; K also play an important role in mineral nutrient transport **(Marschner, 1995 and Paliwal, 2018)**, it activate the protein synthesis **(Patil, 2011 and Prajapati & Modi, 2012)**, the role of K in improvement the quality of fruit well studied and curtained by **(Mengel, 2007; Khalil & Aly 2013 and Ibrahim *et al.*, 2019)**.

It is well known that, the photosynthetic translocation is related to mineral nutrients availability. Nitrogen significantly enhances the fruit physical parameters. Split application of nitrogen, at different growth stages of date palm, improve fruit weight and dimensions. In date palm Phosphorus contributes to root and shoot systems and fruit development. However, due to its important role of enhancing large number of enzymes, potassium plays a very important role in green leaves number, flowers, and fruit growth and physic-chemical properties **(Mengel 1985; Mengel 2007; Marschner, 2012 and Paliwal, 2018)**. N, P and K which are the most important macro-nutrients in agricultural production, might be given only very few parts to plant and soil need. Although, it has been reported that the using the nano fertilizers in very small particles is more effective than this rates **(Marschner, 2012 and De-Rosa *et al.*, 2010)**. To enhance nutrient use efficiency and overcome the chronic problem of eutrophication, nano-fertilizer might be a best alternative. However, some of the reports and patented products strongly suggest that there is a vast scope for the formulation of nano-fertilizers. An enhanced production has been observed by soil application of nano particles as nano fertilizers **(De-Rosa *et al.*, 2010; Paliwal, 2018 and Al-Hchami & Alrawi 2020)**. Many trials have attempted to create nano fertilizers to increase the fertilizers utilization efficiency by plants **(Gouma *et al.*, 2012; Hu *et al.*, 2013; Xiaoyu *et al.*, 2013 and Paliwal, 2018)**.

Table (5). Effect of conventional and nano NPK fertilizers on fruit chemical properties (TSS%, total acidity% and TSS/acidity ratio) of Al-Saidy date palm, during 2018 and 2019

Treatments	TSS %		Total acidity %		TSS/Total acidity ratio	
	2018	2019	2018	2019	2018	2019
Traditional NPK	70.7	71.0	0.320	0.336	220.9	211.3
Traditional N	68.1	68.6	0.357	0.369	190.8	186.0
Traditional P	66.4	66.9	0.383	0.390	165.8	165.0
Traditional K	65.5	66.0	0.395	0.400	173.4	171.5
Traditional P+K	67.2	67.7	0.370	0.379	181.6	178.6
Traditional N+K	69.0	69.4	0.345	0.358	200.0	193.9
Traditional N+P	69.8	70.2	0.332	0.348	210.0	201.7
Nano N	74.0	74.1	0.270	0.288	274.1	257.3
Nano P	72.4	72.6	0.294	0.313	246.1	231.9
Nano K	71.5	71.8	0.308	0.325	232.1	220.9
Nano P+N	73.2	73.4	0.283	0.300	258.2	244.7
Nano N+K	74.8	74.8	0.257	0.277	291.1	270.0
Nano N+P	75.7	75.5	0.244	0.265	310.2	284.9
Nano N+P+K	76.6	76.3	0.231	0.252	331.6	302.8
New LSD 5%	0.8	0.7	0.012	0.10	7.0	6.0

Table (6). Effect of conventional and nano NPK fertilizers on fruit chemical properties (total sugars %, reducing sugars % and total soluble tannins %) of Al-Saidy date palm, during 2018 and 2019

Treatments	Total sugars %		Reducing sugars %		Total S. tannins %	
	2018	2019	2018	2019	2018	2019
Traditionnel NPK	66.5	67.6	29.0	28.9	0.67	0.73
Traditionnel N	63.3	64.4	27.0	26.9	0.85	0.88
Ttraditional P	61.2	62.2	25.6	25.7	0.95	0.98
Traditional K	60.1	61.0	25.0	25.2	1.01	1.02
Traditional P+K	62.2	63.3	26.3	26.3	0.90	1.39
Traditional N+K	64.3	65.4	27.6	27.5	0.79	0.83
Traditional N+P	65.4	66.5	28.3	28.2	0.73	0.78
Nano N	70.8	71.9	31.6	31.2	0.46	0.55
Nano P	68.5	69.7	30.3	30.0	0.56	0.64
Nano K	67.5	68.7	29.6	29.4	0.62	0.69
Nano P+N	69.6	70.8	30.9	30.5	0.51	0.59
Nano N+K	71.9	73.1	32.2	31.8	0.41	0.51
Nano N+P	73.0	74.2	32.9	32.3	0.36	0.46
Nano N+P+K	74.2	75.3	33.7	32.9	0.30	0.41
New LSD 5%	1.1	1.2	0.6	0.5	0.05	0.04

Conclusion

In order to study the effect of nano NPK fertilizers verses traditional mineral NPK fertilizers on fruit physical and chemical properties of "Al-Saidy" date palms grown under the experimental region conditions (New Valley, Governorate, which the soil texture is sandy) and resembling conditions. The present investigation shows that using the nano NPK fertilizers shows superior to using the traditional NPK fertilizers. However, all nano NPK combinations present significant effect than using each element individually. The best fruit physical and chemical parameters were obtained whine the palms received the three elements in combination in form of nano fertilizers.

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