

Effect of Nano-N fertilizer on growth, fruiting and the fruits nutritive value of zaghoul date palm

Abd EL-Rahman, M.M.A.^{1*} and Naglaa A.A. Abd-Elkarim ²

¹ Horticulture Department, Faculty of Agriculture, South Valley University, Qena, Egypt.

² Food Science Department, Faculty of Agriculture, South Valley University, Qena, Egypt.

Abstract

An experiment was conducted during two growing seasons 2017 and 2018 seasons to study the impact using of nano N fertilizer compare to conventional form on the growth, yield and nutritive value of the fruits of Zaghoul date palm grown under Qena, Egypt condition. Nano N fertilizer was added at 20, 40, 60 and 80% of recommended dose. Two methods of application, soil surface and foliar spray were used to applied nano fertilizer form. It is evident from the obtained results that using nanotechnology N fertilizer was very effective in improving growth and yield as well as fruits quality compare to using conventional form. Supplying of Zaghoul date palm by 20 % of recommended N dose in form nano fertilizer led to significant decreased in all studied traits. Raising the dose of N nano to 40% of recommended dose failed to show significant differences compared to control. While, raising the dose from nano N to 60% led to significant increasing in all studied traits. However, increasing the dose from 60 to 80 % of recommended dose led to non-significant increase in all studied characteristics. On the other hand, spraying method surpass adding via soil in traits of vegetative growth, while these no significant differences between different methods of application in the other studied traits. From the economic point of view, this study recommends to use N fertilizer in nano-form by rate of 60 % of recommended dose via soil surface in fertilization of Zaghoul date palms.

Keywords: growth; fertilization; fruit quality; nanotechnology; Zaghoul date palms.

1. Introduction

Date palm (*Phoenix dactylifera* L.) considered is one of the oldest cultivated fruit trees in all over the world, specially of Middle East and its fruits play an important role in the feed a lot of many people (Harhash and Abd el-Nasser, 2010). In Egypt Zaghoul date palm is considered one of the most important soft types which are consumed at the Khalal (Bisr) stage. Dates are a rich source of sugars and mineral salts and vitamins that are essentially required to support

life and good health (El-Salhy *et al.*, 2017). There are many studies on the impact of fertilization on the productivity and quality of date palm fruits (Atalla *et al.*, 1999; Shawky *et al.*, 1999; Diab, 2006; Al-Wasfy and El-Khawaga, 2008; Al-Wasfy and Abd El-Raman, 2014). The most important aim in all agricultural systems to increase the yield and to decrease the cost is efficient use of fertilizers (Dong *et al.*, 2005). Nitrogen is considered one of the important basic nutrients are needed by palms which the gets through fertilization and its plays an important roles in physiological processes in plant and its development. Nitrogen forms, levels and soil physical and chemical properties are factors associated with it's used by plants and can have a major impact on growth and productivity of plant. So the main goal to


*Corresponding author: Montaser M.A. Abd EL-Rahman

Email: montoali@yahoo.com

Received: January 12, 2022; Accepted: February 9, 2022;

Published online: March 2, 2022.

©Published by South Valley University.

This is an open access article licensed under 

maximize nutrient uptake by the palms from fertilizers for best growth, productivity and fruit quality (Al-Kharusi *et al.*, 2009; Tung *et al.*, 2009; Harhash and Abdel-Nasser, 2010; Marzouk- Hend, 2011). The nanotechnology has made progress in many sectors such as information and communication technology, healthcare and energy this allowed this technology to invade the agricultural sector as well as became promising in it which can help increasing of resources use efficiency especially fertilizers. Using nano fertilizers makes nutrients greater available to plant through led to regulate the release of nutrients from fertilizers and therefore result in enhance nutrient use efficiency and reduce in nutrient doses (Xiu-Mei *et al.*, 2006; Heller and Atkinson, 2007; Subramanian and Sharma, 2009; De Rosa *et al.*, 2010; Mustafa and Zaied-Nagwa, 2019; El-Salhy *et al.*, 2021). Thought to be nanotechnology will be an effective tool to reduce gap between food production and increasing world demand on food. In addition to a wide range of advantages related to human health, economic and environment. (Ali *et al.*, 2014).

The useful impacts of using nano-fertilizers on growth and productivity of crops against conventional fertilizers confirmed by the results of (Baruah and Dutta, 2009; Remya, *et al.*, 2010; Sheykhbaylou, *et al.*, 2010; Mousavi and Rezaei 2011; Bozorgi 2012; Sabir, *et al.*, 2014; Refaai 2014 and Jubeir & Ahmed 2019).

Therefore, this study focused on the beneficial effect of using nano N fertilizer as an alternative to conventional fertilizers to reduce fertilizer doses and choose the best dose and method of adding to improve growth, production and dates quality of Zaghoul date palms.

2. Materials and methods

The present study was conducted during two growing seasons 2017 and 2018 on twenty-seven 20-years old Zaghoul date palms grown at the empirical orchard of Faculty of Agri. Qena,

South Valley Univ, Egypt. The palms were selected as possible similar in growth and health. The palms were growing in sandy loam soil at 10 m. The soil was analyzed according to (Wild, *et al* 1985). And data were illustrated in table (1). The selected palms were pollinated manually from the same pollen source through two days from female spathes cracking according to (Omar, 2007 and Saad, 2008). The number of bunch has been modified to ten bunches/ tree to maintain leaf / bunch ratio at 8:1 according to (Sayed, 2002 and Diab, 2006). All the date palm trees that have been selected received the same agriculture practices that applied in farm except the nitrogen fertilization. The source of nitrogen fertilizers used is ammonium nitrate (33.5% N) and nano- N fertilizer (50% N) was produced by Nano Lab, Faculty of Science, South Valley University, Egypt.

2.1. This study included the nine treatments as follow:

T1- (Control) applying 100 % of recommended N dose at (1000 g. /palm) as conventional form (3 kg ammonium nitrate 33.5% N) via soil application.

T2- Applying 20 % of recommended N dose as nano at (400 g. /palm) via soil application.

T3- Applying 40 % of recommended N dose as nano at (800 g. / palm) via soil application.

T4- Applying 60 % of recommended N dose as nano at (1200 g. /palm) via soil application.

T5- Applying 80 % of recommended N dose as nano at (1600 g. /palm) via soil application.

T6- Applying 20 % of recommended N dose as nano at (400 g. /palm) via foliar spray.

T7- Applying 40 % of recommended N dose as nano at (800 g. /palm) via foliar spray.

T8- Applying 60 % of recommended N dose as nano at (1200 g. /palm) via foliar spray.

T9- Applying 80 % of recommended N dose as nano at (1600 g. /palm) via foliar spray.

The treatments were arrangement in randomized completely block design (RCBD) with three replicates, one palm per replicate.

Soil surface application of nitrogen fertilizer either nano or conventional were added at three equal doses at growth start (March 1st), after fruit set (May^{1st}) and after month (June^{1st}) every season .

Foliar spraying of nano nitrogen fertilizer was application at four equal doses at growth start (March1st), after fruit set (first week of May, June and July) every season.

2.2. The following traits were measured during the two study seasons

2.2.1. Growth measurements

1- Leaf area

The area of the leaf was calculated by using the equation:

Total leaf area (m²) = leaflet length × maximum leaflet width × 0.84×number of leaflets per leaf according to (Shabana and Antoun, 1980).

2- Leaf mineral content from NPK were estimated according to (Wilde *et al.*, 1985)

2.2.2. Yield and its components

1- Initial fruit set and fruit retention %:

Initial fruit setting was calculated in three bunches labeled just after fruit set by using equation of following

$$\text{Initial fruit setting (\%)} = \frac{\text{number of setting fruits}}{\text{total number of flowers}} \times 100$$

Fruit retention % was determined in bunches labeled one week before harvesting, sample from five strands were taking from each bunch. Then calculated fruit retained % by using the following equation:

$$\text{Fruit retention(\%)} = \frac{\text{Number of retained fruits}}{\text{Total No. of flowers}} \times 100$$

2- Weight of bunch and yield/palm:

Bunches was harvested when fruits reached the Khalal stage in mid-August in two seasons. Then, average weight of bunch (kg) and yield per palm (kg) has been recorded.

2.2.3. Fruits quality

Physical and chemical characters of the fruits (fruit weight, fruit length, fruit diameter, flesh weight, T.S.S. %, reducing sugars, total sugars and total acidity were determined according to (A.O.A.C., 2005).

2.2.4. Fruits nutritional value

1- Moisture content of the fruits

The moisture content of date fruit was determined after drying in a vacuum oven at 70°C for 48 h to reach constant Waite .Crude fiber, ash, crude fat and crude protein were determined according to AOAC (2005) methods.

2- Total phenols content (TPC)

Total phenols content was determined by using Folin–Ciocalteu reagent and external calibration with gallic acid (GAE) (Małyszko and Karbarz 2009).

3- Antioxidant activity:

The antioxidant activity was investigated using the stable free radical DPPH assay, according to the method described by (Brand-Williams *et al.*, 1995) with modifications.

Then, collected all the obtained data during the two seasons of study and analyzed statistically according to (Mead, *et al.*1993). The differences between treatments were compared by new L.S.D. at 5%

Physical and chemical properties of fruit were determined as outlined in A.O.A.C. (2005).

Table 1. soil analyses.

Characters	values	Characters	Values
Sand %	75.3	Ca CO ₃ %	5.46
Silt %	18.2	O.M %	0.94
Clay %	6.5	Total N%	0.21
Texture	Sandy loam	Available P (ppm)	2.8
pH (1:2.5)	7.95	Available K (ppm)	7.4

3. Results and discussion

3.1. Leaf area and its chemical composition

Results in Table (2) clearly indicated that N fertilization as nano form significantly affected the vegetative growth of Zaghoul date palm i.e. Leaf area and leaf N and K contents in both seasons. Increasing the N -fertilization dose of nano formulation from 20 to 80% of recommended dose increased the leaf area and leaf content of N and K. while, did not affect the leaf phosphorous content. The same trend obtained for both methods of N application.

The results also, indicated that the difference between the application methods of N -

fertilization were significant, where the spraying method surpass fertilization via soil on its effect of leaf traits. Increasing dose of N -fertilization of nano formulation from 60 to 80% of recommended dose was not significant increased the leaf area and leaf mineral content of N, P and K in both seasons, respectively. The same trend obtained in both and methods of N application.

The maximum values of the leaf area and leaf mineral content of N, P and K were observed in the palms that fertilized by N via nano technology at 80% from recommended dose as foliar spraying. These results were true during the two seasons of study.

Table 2. Effect of nano N fertilizer on leaf area and leaf N, P and K content of Zaghoul date palm during 2017&2018 seasons.

Treatments	Leaf area (m ²)		Leaf N%		Leaf P%		Leaf K%	
	2017	2018	2017	2018	2017	2018	2017	2018
T1- 100% mineral	1.85	1.82	1.69	1.66	0.24	0.23	1.64	1.61
T2- 20 % via soil	1.72	1.70	1.54	1.48	0.23	0.23	1.66	1.67
T3- 40% via soil	1.88	1.85	1.75	1.69	0.24	0.23	1.68	1.65
T4 - 60% via soil	2.12	2.08	1.88	1.85	0.25	0.24	1.70	1.69
T5- 80% via soil	2.18	2.13	1.91	1.89	0.24	0.25	1.68	1.67
T6 - 20% foliar spray	1.83	1.80	1.58	1.54	0.23	0.24	1.68	1.65
T7- 40% foliar spray	1.97	1.95	1.84	1.73	0.24	0.25	1.72	1.70
T8 - 60% foliar spray	2.26	2.25	1.98	1.95	0.23	0.24	1.73	1.74
T9- 80% foliar spray	2.31	2.29	2.02	1.97	0.24	0.25	1.76	1.75
New LSD at 0.05	0.12	0.10	0.07	0.06	N.S	N.S	0.06	0.05

3.2. Yield and its components

Data the illustrated in Table (3) clearly the influence of levels and application methods of N nano fertilization on initial fruit set%, fruit retained% , weight of bunch and yield per palm of Zaghoul date palms during 2017 & 2018 seasons.

The initial fruit set (%), fruit retained %, weight of bunch and yield/palm tended to be increase with increasing the rate of N -fertilization from 20 to 80 % of recommended dose as nano fertilization, either methods application soil or spraying. Fertilization the date palm by 20 % of recommended dose as nano fertilization led to significant decrease in these traits, while there don't significant differences were show on these

traits when fertilization date palm by 40 % from recommended dose compared to the control. Also, there don't significant differences were noted on these traits when increasing dose fertilization from 60 to 80% of recommended dose as well as, between different application methods foliar spray or soil application.

The maximum values of initial fruit set (%), fruit retained%, and weight of bunch and yield/palm were recorded on the palms received nitrogen fertilizer via nano form at 80% of recommended N dose. Fertilization with N via nano technology at 20% of recommended dose produced the minimum values of these traits. These results took the same trend during two study seasons.

Table 3. Effect of nano N fertilizer on the initial fruit set%, fruit retained%, bunch weight and yield/palm of Zaghoul date palm during 2017&2018 seasons.

treatments	Initial fruit set %		Fruit retained %		Bunch weight (kg)		Yield per palm (kg)	
	2017	2018	2017	2018	2017	2018	2017	2018
T1- 100% mineral	62.1	60.8	47.3	45.6	15.9	16.6	143.1	149.4
T2- 20 % via soil	55.8	55.1	38.6	37.8	14.2	14.6	127.8	131.4
T3- 40% via soil	62.7	61.2	47.5	45.9	16.3	17.0	146.7	153.0
T4- 60% via soil	66.9	66.8	54.8	52.8	18.4	18.9	165.6	170.1
T5- 80% via soil	68.1	67.4	55.4	54.2	18.9	19.2	170.1	172.8
T6- 20% foliar spray	57.6	55.9	39.5	38.0	14.5	14.8	130.5	133.2
T7- 40% foliar spray	65.8	62.1	47.9	47.1	16.5	16.9	148.5	152.1
T8- 60% foliar spray	69.7	68.6	55.5	54.2	18.5	19.2	166.5	172.8
T9- 80% foliar spray	70.8	69.2	57.4	56.1	19.1	19.5	171.9	175.5
New LSD at 0.05	3.2	2.9	2.7	2.4	1.2	1.3	4.9	5.3

3.3. Physical and chemical properties of the fruits

It is obvious from data in Table (4 and 5) that physical and chemical properties of Zaghoul dates were differed greatly by different levels and application methods of nano N fertilizer during 2017 and 2018 seasons. Supplying palms with N at 40, 60 and 80% of recommended N dose as nano form via soil or spraying was greatly effective on improving quality properties of the fruits represented in the increasing of fruit weight, fruit dimensions, flesh %, T.S.S%, sugars contents and reduction of total acidity percentage compared to fertilize of palms with

100% of recommended N dose as fertilizers traditional.

fertilized of Zaghoul date palm by 20 % of recommended dose led to significant decreased in this traits as compared with the palms which received N at 100% via conventional fertilization, While there no significant differences were observed on this traits when fertilization the date palm by 40 % of recommended dose as nano compared to fertilization the palms with 100 % N mineral form. Increasing levels of N nano fertilization from 60 to 80% of recommended dose failed to show significant enhancing on all quality properties of the fruits. No significant differences were found between the different application methods.

Table 4. Effect of nano N fertilizer on some physical characters of Zaghoul dates during 2017&2018 seasons.

Treatments	Fruit weight (g)		Fruit length (cm)		Fruit diameter (cm)		Flesh %	
	2017	2018	2017	2018	2017	2018	2017	2018
T1- 100% mineral	15.9	16.3	4.62	4.66	2.25	2.27	84.1	84.9
T2- 20 % via soil	14.5	15.1	4.12	4.21	2.11	2.15	82.9	83.5
T3- 40% via soil	16.1	16.3	4.61	4.69	2.24	2.29	84.4	84.8
T4- 60% via soil	17.5	18.0	4.70	4.75	2.28	2.36	86.1	86.7
T5 - 80% via soil	17.9	18.1	4.73	4.77	2.30	2.40	86.5	87.1
T6- 20% foliar spray	14.8	15.3	4.25	4.32	2.14	2.17	83.4	83.9
T7- 40% foliar spray	16.5	17.1	4.66	4.70	2.28	2.32	85.0	85.2
T8- 60% foliar spray	18.1	18.3	4.73	4.77	2.32	2.38	86.8	86.9
T9- 80% foliar spray	18.2	18.5	4.75	4.80	2.33	2.41	87.1	87.2
New LSD at 0.05	0.57	0.53	0.31	0.34	0.07	0.08	1.8	1.7

Table 5. Effect of nano N fertilizer on some chemical characters of Zaghoul dates during 2017&2018 seasons.

treatments	T.S.S %		Total sugars %		Reducing sugars %		Total acidity %	
	2017	2018	2017	2018	2017	2018	2017	2018
T1- 100% mineral	33.1	32.6	25.9	25.5	15.8	15.4	0.236	0.245
T2- 20 % via soil	31.9	31.5	24.6	24.4	14.7	14.4	0.198	0.219
T3- 40% via soil	33.2	33.1	25.9	25.7	15.5	14.9	0.195	0.216
T4- 60% via soil	34.5	34.6	28.5	28.1	16.9	16.7	0.191	0.203
T5- 80% via soil	34.9	34.8	28.8	28.3	17.8	17.6	0.185	0.197
T6- 20% foliar spray	32.9	32.6	24.8	24.5	15.1	14.5	0.218	0.223
T7- 40% foliar spray	33.5	33.1	26.1	25.8	15.7	15.3	0.213	0.218
T8- 60% foliar spray	34.8	34.4	28.4	28.3	17.2	16.8	0.199	0.204
T9- 80% foliar spray	35.1	34.6	28.9	28.6	17.3	17.1	0.191	0.200
New LSD at 0.05	0.71	0.68	0.63	0.65	0.54	0.51	0.012	0.014

The highest values of fruit weight and dimensions, flesh percentage, T.S.S%, and sugar contents were observed in palms that fertilized by nano N form with dose 80 % of recommended dose through spraying followed by via soil application. On the other hand results indicated that the acidity percentage in all treatments fertilization were significantly decreased compared to check treatment in the two studied seasons. It is clear from the obtained data that results took same trend in the two seasons.

3.4. Nutritive value of the fruits

Analyzing the results in Table (6) showed the crude fiber of Zaghoul dates during 2017&2018 seasons. It is clear from the obtained data that using 20% of recommended N dose via nanotechnology as soil application (T2) registered the maximum value in the two seasons, followed by the check treatment (T1) with no significant detected in crude fiber value compared to control (T1). While using 80% of recommended N dose via nano as spraying (T9) recorded the lowest value in the two studied seasons. Also, Results in table (6) reveals that percentages of moisture in date flesh fruits the high moisture content dates recorded due to use 80% from recommended N dose via nanotechnology either foliar spray or via soil application in treatment (T9 and T5) , respectively.

But didn't differed significantly effect when increased level fertilization from 60 to 80% of recommended N dose through nanotechnology) in the two study seasons. While the lowest percentages of moisture in fruit were found due to use 20% of recommended N dose as soil application (T2) it was recorder 12.45 and 12.85 in the two studied seasons, respectively.

The higher ash content obtained in this work was 2.80 and 2.74% recorded due to use (soil application 80% of recommended N dose via nanotechnology (T5) in the two seasons, respectively. While the lowest value obtained 2.21 and 2.18% registered due to foliar application 20% of recommended N dose via nanotechnology (T6) in the two studied seasons respectively.

Our results found that the best fats content in Zaghoul dates when fertilization by using nano N fertilizer at 80% of recommended N dose via soil application (T5) in the two studied seasons 2017 and 2018 , which reached the highest content of fat (2.81 and 2.73 %) , respectively. While using nano N fertilizer at 20% of recommended N dose via foliar spray (T6) recorded the lowest value (2.00 and 1.94%).The results in the same table indicated that the levels and the methods of addition nano N fertilizer had a positive significant effect on the dates flesh content of fats compared to the control (T1) excepted (T2 and T6) fertilization by rate 20% from recommended N dose through

nanotechnology via soil and foliar application, respectively in the two seasons.

Table 6. Effect of of nano N fertilizer on some nutritive value of Zaghloul dates during 2017&2018 seasons.

Treatments	Crude Fibers %		Fruit moisture %		ash %		Fat %	
	2017	2018	2017	2018	2017	2018	2017	2018
T1- 100% mineral	4.66	4.44	13.15	13.61	2.45	2.41	2.15	2.26
T2- 20 % via soil	4.69	4.58	12.45	12.85	2.26	2.23	2.10	2.08
T3- 40% via soil	4.51	4.10	13.21	13.46	2.58	2.51	2.31	2.29
T4- 60% via soil	3.30	3.27	13.88	13.95	2.76	2.69	2.70	2.65
T5- 80% via soil	3.12	3.08	14.03	14.20	2.80	2.74	2.81	2.73
T6- 20% foliar spray	4.65	4.49	13.10	13.45	2.21	2.18	2.00	1.94
T7- 40% foliar spray	3.51	3.47	13.75	13.91	2.45	2.42	2.27	2.31
T8- 60% foliar spray	3.07	2.89	14.56	14.69	2.69	2.61	2.45	2.33
T9 -80%foliar spray	2.90	2.76	15.08	15.25	2.76	2.70	2.51	2.43
New LSD at 0.05	0.52	0.49	0.63	0.68	0.18	0.21	0.12	0.14

Moreover, the results of protein analysis are presented in Table (7). The protein content ranged from 2.39 to 3.01% and 2.48 to 3.09 % dry matter in the T2 and T9 in both seasons, respectively. Add Nano N fertilization lead to increase of protein in date flesh, no significant difference in protein content was observed between treatments (T3, T7) and control (T1) in seasons 2017and 2018 . While T9 recorded the highest value of protein (3.01 and 3.09 %) compared with other treatment in the two studied seasons, respectively.

Antioxidant activity of date flesh DPPH radical scavenging recorded activities are presented in Table (7), where lower IC50 values indicate higher activity. The date flesh under investigation exhibited antioxidant activity IC50 28.12 and 29.68 in due to use nano N fertilization by rate 20% of recommended N dose via soil application (T5).

The total phenol content of date flesh from different treatments ranged from 3.39 to 4.11 and 3.41 to 4.19 mg GAE/g being in T6 and T9 in seasons 2017 and 2018, respectively. There

were significant variations between all treatments and control treatment except T3 and T8.

The results indicate that the fertilization using Nano fertilizer has significant effects on the total phenol content in the flesh dates under study, then can be considered the date fruits with higher content of total phenol and antioxidant activity as a food additive and complementary food.

Also, Data in table (7) clear that nitrate significantly decreased due to use nano fertilizer compared to the applied traditional fertilizer except supplying nano N at 80% of the recommended dose via spraying in the two seasons.

On the other hand application of fertilization via soil application better than foliar application in improving nutritive value of the fruits. In our data above we can concluded that nano-fertilization play a significant role in chemical composition of the fruits and improving production.

Table 7. Effect of nano N fertilizer on protein, antioxidant activity, total phenols and nitrate of Zaghoul dates during 2017&2018 seasons.

Treatments	protein mg /g d.w.		Antioxidant activity IC50		Total Phenols mg /g d.w.		Nitrate (ppm)	
	2017	2018	2017	2018	2017	2018	2017	2018
T1- 100% mineral	2.55	2.66	44.68	45.55	3.71	3.93	27.18	26.25
T2- 20 % via soil	2.39	2.48	49.70	51.65	3.55	3.62	15.17	12.25
T3- 40% via soil	2.61	2.73	41.51	42.26	3.79	3.85	19.61	17.50
T4- 60% via soil	2.79	2.94	31.60	33.10	4.01	4.15	22.40	21.75
T5- 80% via soil	2.85	3.04	28.12	29.68	4.16	4.29	25.68	24.15
T6- 20% foliar spray	2.41	2.54	50.25	51.90	3.39	3.41	18.20	16.70
T7- 40% foliar spray	2.65	2.81	42.67	43.53	3.77	3.81	23.60	20.00
T8- 60% foliar spray	2.89	2.98	34.98	36.17	3.96	4.03	27.15	25.75
T9- 80% foliar spray	3.01	3.09	31.91	33.10	4.11	4.19	33.20	31.95
New LSD at 0.05	0.14	0.16	4.12	4.26	0.16	0.19	3.65	3.61

4. Discussion

Conventional fertilizers cause soil, water and air pollution, in the last years much effort has been done to reduce this problem through produced the new fertilizers improved forms. Nowadays, nanotechnology its opens a wide range of opportunities in the field of agriculture and other fields.

Nanotechnology is new installation of material in new forms with particles measuring a dimension of one-millionth of a millimeter associated with superior and effective properties i.e. chemical, physical, biological, mechanical, magnetic, optical and electrical...etc. Nano-fertilizers aimed to enhancing the nutrient use efficiencies by to benefit from unique properties of nano-particles (Yogesh *et al.*, 2015).

Nano-fertilizers are known to release nutrients slowly and steadily in a regulated pattern in correspondence with the crop requirements as well as extend the fertilizer effect period which may assist in improving and development the nutrient use efficiency. It is clear that there is a wide range of opportunity for nanotechnology to play an important role in improving fertilizers (Ditta, 2012).as the nano-fertilizers are worked to release nutrients slowly over a long period of time, which leads to less the loss of nutrients and reducing environmental contamination (Heller and Atkinson, 2007; Subramanian and Sharma,

2009; Subramanian *et al.*, 2015; Roshdy and Refaai, 2016; Mustafa and Zaied- Nagwa, 2019; El-Salhy *et al.*, 2021).

using nanotechnology in the fertilizers can be to improved the nutritive value of the fruits i.e (fats%, antioxidants activity, ash%, proten% and total phenols), due to biological processes associated with fruit maturity which leads to increasing nutritive value of the fruits and which is considered as a food additive and complementary food. This difference is due to the different varieties and degree of maturity. (Biglari *et al.*, 2008; Sadeghi, *et al.*, 2015; Alghamdi *et al.*, 2018; Jubeir and Ahmed, 2019; Kuras *et al.*, 2020). Dates contain a higher percentage of protein (2.3–5.6%) compared to other types of fruits i,e apples, bananas and oranges , where the protein content does not to exceed 1%. (Al-Shahib and Marshall, 2003; Sulieman *et al.*, 2012).

The positive effect of nanotechnology fertilizers in improving growth and fruiting, thereby increasing productivity and fruit quality for different horticultural crops and achieving sustainable agriculture were emphasized by (Baruah and Dutta, 2009; Remya *et al.*, 2010; Sheykhbaylou *et al.*, 2010; Mousavi and Rezaei, 2011; Bozorgi, 2012; Refaai, 2014; Roshdy and Refaai, 2016; Jubeir and Ahmed, 2019; Zahedi *et al.*, 2020; El-Salhy *et al.*, 2021).

5. Conclusion

On the light of this study results it could be concluded that, from the economic point of view, recommend that fertilizing Zaghoul date palm with 60 % of recommended N dose as nano fertilizers via soil application to improve growth, yield and get the best nutritive value of the fruits.

Authors' Contributions

All authors are contributed in this research.

Funding

There is no fund in this research.

Institutional Review Board Statement

All Institutional Review Board Statement are confirmed and approved.

Data Availability Statement

Data presented in this study are available on fair request from the respective author.

Ethics Approval and Consent to Participate

This work carried out at Horticulture and food Science departments and followed all the departments instructions.

Consent for Publication

Not applicable.

Conflicts of Interest

The authors declare no conflict of interest.

6. References

Alghamdi, A.A., Awadelkarem, M. A., Sharif Hossain¹, A.B.M., Ibrahim, N.A., Fawzi, M., Ashraf, S.A. (2018). 'Nutritional assessment of different date fruits (*Phoenix dactylifera* L.) varieties cultivated in Hail province, Saudi Arabia', *Biosci. Biotech. Res. Comm.*, 11(2), pp. 263-269.

Ali, M.A., Rehman, I., Iqbal, A., Din, S., Rao, A.Q., Latif, A., Samiullah, T.R., Azam, S., Husnain, T. (2014). 'Nanotechnology, a new frontier in Agriculture', *Adv. Life Sci.*, 1(3), pp. 129-138.

Al-Kharusi, L.M., Elmardi, M.O., Ali, A., Al-Julanda, F., Al-Said, L., Abdelbasit, K., Al-Rawahy, S. (2009). 'Effect of mineral and organic fertilizers on the chemical characteristics and quality of date fruit.', *Int. J. Agric. Biol.*, 11(3), pp. 290-296.

Al-Shahib, W., Marshall, R.J. (2002). 'Dietary fibre content of 13 varieties of datepalm (*Phoenix dactylifera*L.)', *J. Food Sci., Tech.*, 37(6), pp. 719-721.

Al-Shahib, W., Marshall R.J. (2003). 'The fruit of the date palm: its possible use as the best food for the future', *Int J. Food SciNutr.*, 54, pp. 247-259.

Al-Wasfy, M.M., Abd El- Rahman, M.M.A. (2014). 'Reducing Inorganic N Fertilizer Partially In Hayany Date Palm Orchards By Using Animal And Chicken Manures.', *World Rural Observations.* 6 (1), pp. 94-98.

Al-Wasfy, M.M., El-Khawaga, A.S. (2008). 'Effect of organic fertilization on Growth, yield and fruit quality of Zaghoul date palm grown in sandy Soil', *Assiut J. of Agric. Sci.*, 39 (1), pp. 121-133.

A.O.A.C. (2005). 'Official Method of analysis of the Association of official Analytical Chemist', Published by the Association of Official Analytical Chemists Inc. Arlington, Virginia, 22209 U.S.A

Atalla, A.M., Attia, M.M., Aly, H.S. (1999). 'Effect of NPK fertilization trials on yield and fruit characteristics of 'Zaghoul' date palm cultivar grown in Egypt', International Conf. Date Palm.Assiut University, 9-11 November.

Baruah, S., Dutta, I. (2009). 'Nanotechnology applications in pollution sensing and degradation in agriculture. A Review', *Environ Chem. Lett.*, 7(3), pp. 191-204.

Biglari, F., Al Karkhi, A.F.M., Easa, A.M. (2008). 'Antioxidant activity and phenolic content of various date palm (*Phoenix dactylifera*) fruits from Iran.', *Food Chem.*, 107(4), pp.1636-1641.

Bozorgi, H.R. (2012). 'Study effect of nitrogen fertilizer management under Nano iron chelate foliar spraying on yield and yield components of Egyptplant (*Solanum*

- melangera* L.)', *ARPN J. of Agric. and Biology. Sci.*, 7(5), pp. 357-362.
- Brand-Williams, W., Cuvelier, M.E., Berset, C. (1995). 'Use of a free radical method to evaluate antioxidant activity.', *Food sci. and tech.*, 28(1), pp. 25-30
- DeRosa, M.R., Monreal, C., Schnitzer, M., Walsh, R., Sultan, Y. (2010). 'Nanotechnology in fertilizers', *Nat. Nanotechnology. J.*, 5(2), pp. 91-96.
- Diab, Y.M. (2006). 'Effect of some cultural practices on yield and fruit quality of *Phoenix dactylifera* L. cv *Sewy* under New Valley conditions', M. Sc. Thesis Fac. of Agric. Assiut Univ. Egypt.
- Ditta, A. (2012). 'How Helpful is nanotechnology in Agricultural Ad.', *Nat. Sci. Nano sci. Nanotechnology.* 303302. (10pp).
- Dong, S, Cheng, L., Scagel, C.F., Fuchigami, L.H. (2005). 'Timing of urea application affects leaf and root N uptake in young Fuji / M9 apple trees', *J. Hort. Sci. Biotech.*, 80(1), pp. 116-120
- El-Salhy, A.M., Eman A.A. Abou-Zaid; Y.M.S; Diab, Y.M and Heba A.M. Mohamed (2017). 'Effect of Antioxidants, Growth Regulators and Yeast Spraying on Fruiting of *Seewy* Date Palms.', *Assiut J. Agric. Sci.*, 48 (5), pp. 178-186.
- El-Salhy A.M., Al-Wasfy, M.M., Badawy, E.F.M., Gouda, F.M., Shamroukh, A.A. (2021). 'Effect of nano-potassium fertilization on fruiting of Zaghoul date palm.', *SVU- International journal of Agricultural Science.* 3 (1), pp. 1-9.
- Harhash, M.M., Abdel-Nasser, G. (2010). 'Improving of fruit set, yield and fruit quality of "Khalas" tissue culture derived date palm through bunches spraying with potassium and/or boron', *Australian Journal of Basic and Applied Sciences*, 4(9), pp. 4164-4172.
- Heller, H., Atkinson, B. (2007). 'Agricultural Nanotechnology *Nanotech. InterventionS in Agricultural science and their technical implications*, 260 pp *Knut*', H. Heller and Bill Atkins on Dominant (Eds) pp- 10-20.
- Jubeir, S.M., Ahmed, W.A. (2019). 'Effect of nano fertilizers and application methods to yield characteristics of date palm', *Iraqi Journal of Agricultural Sciences*, 50(1), pp. 267- 274
- Kuras, M.J., Zielinska--Pisklak, M.Z., Duszyn'ska, J., Jablon'ska, J. (2020). 'Determination of the elemental composition and antioxidant properties of dates (*Phoenix dactylifera*) originated from different regions', *J. Food Sci Tech.*, 57(8), pp. 2828–2839.
- Małyszko, J., Karbarz, M. (2009). 'Spektrofotometryczne i elektrochemiczne metody oznaczania aktywności antyoksydacyjnej.', *Wiad Chem*, 63(1–2), pp. 30–31.
- Marzouk- Hend A. (2011). 'Soil Fertilization Study on Zaghoul Date Palm Grown in Calcareous Soil and Irrigated with Drainage Water', *American-Eurasian J. Agric. & Environ. Sci.*, 10 (5), pp. 728-736.
- Mead, R., Gurnow, R.N., Harted, A.M. (1993). 'Statistical Methods in Agriculture and Experimental Biology (2nd ed.)', Chapman and Hall, London, pp. 10-44.
- Mousavi, S.R., Rezaei, M. (2011). 'Review article Nano technology in agriculture and Food production.', *J. Appl. Environ. Biol. Sci.*, 1(10), pp. 414-419.
- Mustafa and Zaied- Nagwa S. (2019). 'Nano-technology applications in fruit trees orchards.', *Journal of Innovations in Pharmaceutical and Biological Sciences*, 6(3), pp. 36-45.
- Omar, M.G. (2007). 'Effect of some pollination treatments on yield and fruit quality of *Sewy* date palms grown under El- Farafra Oasis

- conditions', M.Sc. Thesis Fac. of Agric. Minia Univ. Egypt.
- Refaai, M.H. (2014). 'Response of Zaghloul date palms grown under Minia region conditions to spraying wheat seed sprout extract and nano – boron.', *Stem Cell*, 5(4), pp. 22-28
- Remya, N., Saino, H.V., Baiyu, G., Maekawa, T., Yashida, Y., Sakthi, K.I. (2010). 'Nano particular material delivery to plants.', *Plant Sci.*, 179(3), pp. 154-163.
- Roshdy, Kh.H., Refaai, M.M. (2016). 'Effect of nanotechnology fertilization on growth and fruiting of zaghloul date palms.', *J. Plant Production. Mansoura Univ.*, 7(1), pp. 93-98.
- Saad, H.H.A. (2008). 'Evaluation of some different date palm pollinators and its effects on fruit physical and chemical characteristics of Zaghloul and Samany date palm cultivars.', 3rd Inter. Conf. on date Palm, El- Arish Egypt, 25- 27 April pp. 12.
- Sadeghi, Z., Valizadeh, J., Shermeh, O.A., shermeh, O.Z. (2015). 'Antioxidant activity and total phenolic content of some date varieties from Sarvana Region, Baluchestan, Iran.', *journal of medicinal*, 9(4), pp. 78-83.
- Sayed, E.F.A. (2002). 'The productive capacity of Sewy date palms grown under New Valley conditions in response to leaves /bunch ratio.', M. Sc. Thesis Fac. of Agric. Minia Univ. Egypt.
- Shabana, H.R., Antoun, N.S. (1980). 'The determination of leaf area in date palm', *BeitroyazurLand Wirtschaft und VeterinarMedizin*, 18(4), 345349. (C.F. Hort.Abst. 51: 9012).
- Shawky, I., Yousif, M., El-Gazzar, A. (1999). 'Effect of nitrogen fertilization on 'Sewy' date palm. Inter.', Conf. Date Palm. Assuit University. 9-11 November
- Sheykhbaylou, R., Sedyhi, M., Tajbakhsh, S., Sharifi, S. (2010). 'Effects of nano- Iron oxide particles on Agronomies traits of Soybean', *Not Sci. Bio.*, 2(2), pp. 112-113.
- Subramanian, K.S., Sharma, R.E. (2009). 'Nano-fertilizer formulations for balanced fertilization of crops paper presented at the platinum Jubilee celebrations of Iss', New Delhi, pp 2-25
- Subramanian, K.S., Manikandan, A., Thirunavukkarasu, M., Rahale, C.S. (2015). 'Nano-fertilizers for balanced crop nutrition.', *Nanotechnologies in food and agriculture, Springer*, pp. 69-80 .
- Suliaman, A.M.E, Itimad, A.A.E., Abdelrahim, A.M. (2012). 'Comparative study on five Sudanese date (*Phoenix dactylifera* L.) fruit cultivars.', *Food Nutr.Sci.*, 3(9), pp. 1245–1251.
- Tung, P.G.A., Yusoff, M.K., Majid, N.M., Joo, G.K., Huang, G.H. (2009). 'Effect of N and K fertilizers on nutrient leaching and ground water quality under mature oil palm in Sabah during themonsoon period.', *American Journal of Applied Sciences*, 6(10), pp. 1788-1799.
- Wilde, S.A., Corey, R.B., Lyer, J.G., Voiget, G.K. (1985). 'Soil and Plant Analysis for Tree Culture.', Oxford and IBH publishing Co., New Delhi, pp. 96 – 106.
- Xiu-mei, L., Zhao-bin, F., Fu-dao, Z., Shu-qing, Z., Xu-sheng, H. (2006). 'Preparation and testing of cementing and coating nano- slow release fertilizer.', *Agric. Sci. China.*, 5(9), pp. 700-706.
- Yogesh, B., Gangadhara, K., Rabinal, C., Chaudhari, G., Ugale, P., (2015). 'Nanotechnology in Agriculture: A Review.', *Journal of Pure and Applied Microbiology*, 9(1), pp. 1-11.
- Zahedi, S.M., Karimi, M., da Silva, J.A. (2020). 'The use of nanotechnology to increase quality and yield of fruit crops.', *J. Sci. Food Agric.*, 100(1), pp. 25–31