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EFFECT OF NANOTECHNOLOGY FERTILIZATION ON GROWTH AND FRUITING OF ZAGHLOUL DATE PALMS

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ABSTRACT

This study was carried out during 2014 and 2015 seasons to examine the effect of nano NPK fertilizers against conventional NPK ones on growth and fruiting of Zaghloul date palms grown under Minia region conditions. N, P and K as nano and conventional were added at 500& 1000, 250&500 and 250&500 g / palm/ yr., respectively.

The data reveal that, N at 500 & 1000 g / palm / yr. with both P and K at 250 & 500 g/ palm/ yr. either single or combined via nanotechnology material was superior in enhancing growth, yield and fruit quality than using these nutrients as conventional fertilizers. Increasing levels of N from 500 to 1000 g / palm/ yr. as well as both P and K from 250 to 500 g/ palm/ yr. had meaningless promotion on the aforementioned characteristics under nano system, The vice versa was noticed with NPK applied as conventional form.

The best treatments in improving growth, yield and fruit quality of Zaghloul date palms when added NPK as nanotechnology system as compared with conventional form.

Generally, from these results the data presented that nano NPK fertilizers each at 500, 250 and 250 g. /palm /yr., respectively is a better than application of conventional NPK at 1000 , 500 and 500 g./ palm/yr., respectively to enhance growth, yield and fruit quality of Zaghloul date palms grown under Minia region conditions.

Keywords: Nanotechnology, conventional method, NPK, growth, yield, fruit quality and Zaghloul date palms.

INTRODUCTION

Because of the limitation in arable lands and water resources, the development of agriculture sector is only possible by increasing of resources use efficiency with the minimum damage to production bed through effective use of modern technologies. Among these nanotechnology has the potential to revolutionize the agricultural systems.

Nanotechnology is the manipulation of self assembly of individual atoms molecules or molecular clusters into structures to create materials and devices with new or vastly different properties. The potential of nanotechnology to revolutionize the healthcare, textile, materials, information and communication technology and energy sectors has been well- publicised.Coming nanotecnologies in the agricultural field seem quiet promising. Such system is designed to deliver nutrients in a regulated pattern in correspondence with the crop demand thereby nutrients use efficiency can be improved without associated effects . Nano-fertilizer which was produced to improve slow releasing ability of fertilizer is a suitable alternative to conventional fertilizer to enhance the nutrient use efficiency (Liu *et al.,* 2006). According to Heller and Atkinson, (2007) and Subramanian and Sharma,(2009) nano- sizing makes fertilizers nutrients more available to nano scale plant and therefore result in greater nutrient use efficiency.

The results of Fernandez *et al.*,(2009);Baruah and Dutta,(2009);Remya *et al.*,(2010);Sheykhbaylou *et al.*,(2010); Mousavi and Rezaei(2011);Bazary (2012); Ekinchi *et al.*,(2014); Sabir *et al.*,(2014) and Refaai (2014) confirmed the beneficial effects of using nano-fertilizers on growth and fruiting of crops against conventional NPK fertilizers

The beneficial effects of nutrients applied in conventional or nano forms on enhancing cell division as well as the biosynthesis of all organic foods were reviewed by Nijjar (1985).

Previous studies showed that using N P K Zn Fe Mn fertilizers via traditional sources was very effective in improving yield and fruit quality of fruit crops El-Sayed- Esraa,(2010); Hassan- Huda,(2014)and Ahmed *et al.*,(2014). Similar trend was observed by Abd – Allah, (2006).

The main effect of this study was finding out the suitability of nano- NPK fertilizers to replace NPK conventional for choose the best treatment that responsible for enhancing Zaghloul date palm production and fruit quality.

MATERIALS AND METHODS

This study was initiated during 2014 and 2015 seasons in a private orchard located at Matay district, Minia Governorate on 48 uniform in vigor 12- years' old Zaghloul date palms to study the effect of nanotechnology fertilization on growth and fruiting of Zaghloul date palms.

The palms are planted at 8x8 meters apart. Table (1) shows the analysis of the tested soil according to Wilde *et al.,* (1985). All the selected palms received the same horticultural practices that already applied in the orchard especially hand pollination by using pollen grains from a certain source (five male strands/ female spathe) at two days after spathe cracking (Saad, 2008). Number of bunches per palm was adjusted to ten bunches.

Table (1): Analysis of the tested soil

Characters	Values
Sand %	20.0
Silt %	30.0
Clay %	50.0
Texture	Clay loam
pH (1: 2.5 extract)	7.82
E.C. (1: 2.5 extract) (ppm)	410
Organic matter %	2.22
Total CaCO3 %	1.92
Total N %	0.08
Available K (ppm)	350
Available P (ppm)	3.1

This experiment included the following sixteen treatments:

1- Using N as conventional form at 500 g. / palm/ yr. (1.492 kg ammonium nitrate 33.5%N/palm/yr.).
2- Using N as conventional form at 1000 g. / palm/ yr. (2.985 kg ammonium nitrate/palm/yr.).
3- Using N as nano form at 500 g. / palm/ yr. (1 kg pot crystal fertilizer 50% N/palm/yr.).
4- Using N as nano form at 1000 g. / palm/ yr. (2 kg pot crystal fertilizer 50% N/palm/yr.).
5- Using P as conventional form at 250 g. / palm/ yr. (1.612 kg superphosphate 15.5% P_2o_5 /palm/yr.).
6- Using P as conventional form at 500 g. / palm/ yr. (3.225 kg superphosphate15.5% P_2o_5/palm/yr.).
7- Using P via nano form at 250 g. / palm/ yr. (0.625 kg phosphor- one fertilizer 40% P_2o_5/palm/yr.).
8- Using P as nano form at 500 g. /palm/ yr. (1.250 kg phosphor-one fertilizer 40% P_2o_5/palm/yr.).
9- Using K as conventional form at 250 g. / palm/ yr. (0.520 kg potassium sulphate 48% K_2o/palm/yr.).
10- Using K as conventional form at 500 g. /palm/ yr. (1.040 kg potassium sulphate 48% K_2o/palm/yr.).
11- Using K as nano form at 250 g. / palm/ yr. (0.455 kg strona fertilizer 55% K_2o/palm/yr.).
12- Using K as nano form at 500 g. / palm/ yr.(0.909 kg stronafertilizer 55% K_2o/palm/yr.).
13- Using NPK as conventional form at 500, 250 and 250 g/ palm/ yr. (1.492kg , 1.612 kg and 0.520 kg from the aforementioned fertilizers, respectively).
14- Using NPK as conventional form at 1000,500 and 500 g/ palm/ yr. (2.985kg , 3.225 kg and 1.040 kg from the aforementioned fertilizers, respectively).
15- Using NPK as nano form at 500, 250 and 250g/palm/yr. (10kg, 0.625 kg and 0.455 kg from the aforementioned fertilizers, respectively).
16- Using NPK as nano form at 1000,500 and 500 g/palm/yr. (20kg, 1.250 kg and 0.909 kg from the aforementioned fertilizers, respectively).

Each treatment was replicated three times, (one palm per each replicate). Nitrogen, phosphorus and potassium fertilizers either nano or conventional form were added at three equal doses at growth start (1st week of March), just after fruit setting (last week of April) and at one month later (last week of May) every season. After all treatments,palms were directly irrigated. Nano fertilizers produced by Bionano tecnology company .

Randomized complete block design (RCBD) was followed for carrying out statistical analysis of the obtained data.

During both seasons, the following parameters were measured:

1- Leaf area of full grown leaf (m^2)according to Shabana and Rntoun,(1980).

Total leaf area = leaflet length × maximum leaflet width × 0.84×number of leaflets per leaf

2- Leaf pigments namely chlorophylls a, b, total chlorophylls and total carotenoids (mg/ 100 g F.W.) Von-Wettstein, (1957).
3- Percentages of N, P and K on dry weight basis Summer, (1985) and Wilde *et al.*, (1985).
4- Yield/ palm (kg.) and bunch weight (kg.)
5- Physical and chemical characteristics of the fruits namely fruit weight (g.), pulp %, , T.S.S. %, total sugars %, total acidity% (as g malic acid/ 100 g pulp), fibers % and total soluble tannins % A.O.A.C., (2000). Nitrate and nitrite in the pulp (as ppm) according to Ridnour- Lisa *et al.*, (2000).

Statistical analysis was done using the procedure of Mead *et al.*, (1993) and the treatment means were compared using new L.S.D. at 5%.

RESULTS AND DISCUSSION

1- Leaf area and its chemical composition:

It is clear from the data in Tables (2 & 3) that nano technology application of N at 500&1000 g /palm/yr., as well as P and K each at 250&500 g/ palm/yr. significantly enhanced the leaf area and its content of chlorophylls a, b, total chlorophylls, total carotenoids, N, P and K rather than using NPK via conventional form. Using all nutrients together either in nano or conventional formulation significantly was superior than using each nutrient alone. Using N, P and K either in nano or conventional form, significantly increased the leaf area and its content of pigments and nutrients. Increasing levels of N, P and K applied by conventional formulation from 500 to 1000 g, 250 to 500 g and 250 to 500 g / palm/ yr., respectively had significant promotion on the leaf area and its content of pigments. The leaf content of N, P and K tended to reduce or increase depending on the nutrient applied. Meaningless effect was attributed due to increasing levels of N from 500 to 1000 as well as both P and K each from 250 to 500 g/ palm/ yr. on the leaf area and its content of pigments and nutrients when they applied via nano formulation. The maximum values were recorded on the palms that received NPK via nano technology at 1000, 500 and 500 g / palm / yr., respectively. These results were true for both seasons.

Table (2): Effect of conventional and nano forms of N, P and K fertilizers on the leaf area and its content of chlorophylls a & b , total chlorophylls and total carotenoids of Zaghloul date palms during 2014 & 2015 seasons.

Conventional and nano forms of N, P and K fertilizers treatments	Leaf area (m2)		Chlorophyll (a) (mg./ 100 g. F.W.)		Chlorophyll (b) (mg./ 100 g. F.W.)		Total chlorophylls (mg./ 100 g. F.W.)		Total carotenoids (mg./ 100 g. F.W.)	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
Conv. N at 500 g / palm	0.95	0.91	7.1	6.9	3.5	3.4	10.6	10.3	3.0	2.9
Conv. N at 1000 g / palm	1.03	0.99	7.7	7.5	3.9	3.8	11.6	11.3	3.4	3.3
Nano- N at 500 g / palm	1.11	1.07	8.3	8.1	4.2	4.1	12.5	12.2	3.7	3.6
Nano- N at 1000 g / palm	1.12	1.08	8.4	8.2	4.3	4.2	12.7	12.5	3.8	3.7
Conv. P at 250 g / palm	0.78	0.74	5.8	5.6	2.9	2.9	8.7	8.5	2.4	2.4
Conv. P at 500 g / palm	0.86	0.83	6.3	6.1	3.2	3.2	9.5	9.3	2.7	2.8
Nano- P at 250 g / palm	0.95	0.90	7.0	6.8	3.5	3.6	10.5	10.4	3.0	3.1
Nano- P at 500 g / palm	0.96	0.91	7.1	6.9	3.6	3.7	10.7	10.6	3.1	3.2
Conv. K at 250 g / palm	0.62	0.58	4.1	3.9	2.1	2.1	6.2	6.0	1.6	1.6
Conv. K at 500 g / palm	0.70	0.67	4.6	4.5	2.4	2.4	7.0	6.9	2.0	2.0
Nano- K at 250 g / palm	0.79	0.75	5.2	5.0	2.6	2.6	7.8	7.6	2.3	2.3
Nano- K at 500 g / palm	0.80	0.76	5.3	5.1	2.7	2.7	8.0	7.8	2.4	2.4
Conv. NPK at 500: 250: 250	1.03	0.99	9.0	8.8	4.5	4.6	13.5	13.4	4.0	4.1
Conv. NPK at 1000: 500: 500	1.11	1.09	9.5	9.5	4.8	4.9	14.3	14.4	4.4	4.5
Nano . NPK at 500: 250: 250	1.21	1.22	10.0	10.0	5.2	5.4	15.2	15.4	4.8	5.0
Nano. NPK at 1000: 500: 500	1.22	1.23	10.2	10.1	5.3	5.5	15.5	15.6	4.9	5.1
New L.S.D. at 5%	0.08	0.07	0.05	0.06	0.3	0.3	0.7	0.7	0.3	0.3

Conv. = Conventional

Table (3): Effect of conventional and nano forms of N , P and K fertilizers on the percentages of N, P and K in the leaves , yield / palm and bunch weight of Zaghloul date palms during 2014 & 2015 seasons.

Conventional and nano forms of N, P and K fertilizers treatments	Leaf N %		Leaf P %		Leaf K %		Yield/ palm (kg.)		Av. Bunch weight(kg)	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
Conv. N at 500 g / palm	1.61	1.70	0.11	0.13	1.11	1.20	151.0	143.0	14.8	14.0
Conv. N at 1000 g / palm	1.71	1.80	0.09	0.11	1.16	1.25	161.0	157.0	15.8	15.4
Nano- N at 500 g / palm	1.81	1.90	0.13	0.15	1.22	1.31	170.0	166.0	16.8	16.4
Nano- N at 1000 g / palm	1.82	1.91	0.12	0.14	1.21	1.30	171.0	167.0	16.9	16.5
Conv. P at 250 g / palm	1.22	1.31	0.20	0.22	1.11	1.20	119.0	115.0	11.8	11.4
Conv. P at 500 g / palm	1.21	1.30	0.26	0.27	1.16	1.25	129.0	125.0	12.8	12.6
Nano- P at 250 g / palm	1.25	1.34	0.31	0.32	1.22	1.31	143.0	139.0	14.4	14.0
Nano- P at 500 g / palm	1.24	1.33	0.32	0.33	1.21	1.30	144.0	139.0	14.5	14.0
Conv. K at 250 g / palm	1.22	1.31	0 .11	0.11	1. 41	1. 50	118.0	114.0	11.7	11.3
Conv. K at 500 g / palm	1. 21	1.29	0 .09	0.09	1 .50	1.60	128.0	124.0	12.7	12.4
Nano- K at 250 g / palm	1.25	1.34	0.13	0.14	1.60	1.69	143.0	138.0	14.4	13.9
Nano- K at 500 g / palm	1 .24	1.33	0.11	0.11	1.61	1.70	144.0	139.0	14.5	14.0
Conv. NPK at 500: 250: 250	1.61	1.71	0.20	0.20	1.41	1. 50	162.0	160.0	16.3	16.1
Conv. NPK at 1000: 500: 500	1.71	1.81	0.26	0.27	1.50	1.59	174.0	170.0	17.5	17.1
Nano . NPK at 500: 250: 250	1.81	1.91	0.31	0.31	1.60	1.70	184.0	186.0	18.6	18.8
Nano. NPK at 1000: 500: 500	1.82	1.92	0.32	0.32	1.61	1.71	185.0	187.0	18.7	18.9
New L.S.D. at 5%	0.06	0.06	0.02	0.02	0.04	0.04	2.1	2.2	1.0	1.1

Conv. = Conventional

2- Yield/ palm and bunch weight

Data in Table (3) show clearly that fertilizing the palms with N at 500 & 1000 g/ palm/ yr., both P and K each at 250 &500 g / palm/ yr. via nano technology system significantly improved the yield and bunch weight relative to using the conventional form of NPK. The best nutrient applied via nano technology was N followed by P. Potassium ranked the last position in this respect. Nano technology application of all nutrients together at 1000 g N, 500 g P and 500 g K / palm/ yr. gave the maximum values of yield/palm and bunch weight, but because the negligible effect detected among the higher two levels of each nutrient applied via nano on yield and bunch weight it is suggested from the economical point of view to use N, P and K via nano technology at 500 g N, 250 g P and 250 g K. Under such promised treatment (Nano.NPK at 500:250:250) the yield per palm reached 184 & 186 kg for both seasons, respectively. The palms received the same treatment via conventional form produced yield/ palm reached 162.0 & 160.0 kg during 2014 and 2015 seasons, respectively. The percentage of increment on the yield per palm due to using nano technology versus conventional methods reached 13.60 & 16.25 % for both seasons, respectively.

3- Quality of the fruits:

It is clear from Tables (4 & 5) that supplying Zaghloul date palms with N at 500 & 1000 g , P at 250 & 500 g and K at 250 & 500 g / palm/ yr. via nano technology either alone or in combination significantly effective in improving quality of the fruits in terms of increasing fruit weight, pulp % , T.S.S% and total sugars % and decreasing total acidity, fibers %, total soluble tannins %., nitrate and nitrite as compared with the palms which received NPK via conventional form at the same levels. Increasing levels of nano N from 500 to 1000 g as well as nano P and K from 250 to 500 g / palm/ yr. failed to show significant promotion on all quality parameters. Under conventional method of N, P and K application, varying levels of these nutrients had significant effect on fruit quality. The best treatment in this respect was the application of N, P and K via nano technology at 500, 250 and 250 g / palm/ yr, respectively from economical point of view, since no significant differences were observed among the two levels of each nutrient applied via nano technology. Using N via conventional method at 1000g/palm/yr. gave unfavorable effects on fruit quality attributes except fruit weight and pulp %. These results were true for both seasons.

Table (4): Effect of conventional and nano forms of N, P and K fertilizers on some physical and chemical characteristics of the fruits of Zaghloul date palms during 2014 & 2015 seasons.

Conventional and nano forms of N, P and K fertilizers treatments	Av. fruit weight (g.)		Pulp %		T.S.S. %		Total sugars %	
	2014	2015	2014	2015	2014	2015	2014	2015
Conv. N at 500 g / palm	27.2	27.5	83.3	82.9	26.0	26.1	19.0	19.1
Conv. N at 1000 g / palm	28.0	28.3	84.4	84.0	25.5	25.5	18.5	18.6
Nano- N at 500 g / palm	29.0	29.2	85.6	85.2	26.9	27.0	19.6	19.7
Nano- N at 1000 g / palm	29.1	29.3	85.7	85.3	26.4	26.5	19.0	19.1
Conv. P at 250 g / palm	25.2	25.5	80.0	79.6	27.0	27.0	20.5	20.6
Conv. P at 500 g / palm	25.7	25.8	81.0	80.6	27.6	27.7	21.0	21.0
Nano- P at 250 g / palm	26.3	26.4	82.0	81.6	27.9	28.0	21.9	22.0
Nano- P at 500 g / palm	26.3	26.5	82.2	81.8	28.0	28.0	22.0	22.1
Conv. K at 250 g / palm	25.1	25. 2	78.0	77.6	29.9	29.0	22.6	22.7
Conv. K at 500 g / palm	25.7	25.9	78.6	78.2	30.5	30.6	23.0	23.0
Nano- K at 250 g / palm	26.2	26.4	79.4	79.0	31.1	31.0	23.9	24.0
Nano- K at 500 g / palm	26.2	26.5	79.5	79.1	31.6	31.6	24.0	24.0
Conv. NPK at 500: 250: 250	30.1	30.6	87.0	86.6	32.9	33.0	24.9	25.0
Conv. NPK at 1000: 500: 500	30.6	30.3	87.5	87.1	33.6	33.1	25.4	25.5
Nano . NPK at 500: 250: 250	31.0	31.4	88.9	88.4	33.9	34.0	26.0	26.1
Nano. NPK at 1000: 500: 500	31.1	31.5	89.0	88.6	34.0	34.1	26.1	26.2
New L.S.D. at 5%	0.4	0.4	0.5	0.5	0.4	0.4	0.3	0.3

Conv. = Conventional

Table (5): Effect of conventional and nano forms of N , P and K fertilizers on some chemical characteristics of the fruits of Zaghloul date palms during 2014 & 2015 seasons.

Conventional and nano forms of N, P and K fertilizers treatments	Total acidity %		Fibres %		Soluble tannins %		Nitrate (ppm)		Nitrite (ppm)	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
Conv. N at 500 g / palm	0.300	0.309	1.02	1.04	0.94	0.99	2.97	3.00	1.11	1.12
Conv. N at 1000 g / palm	0.330	0.339	1.06	1.08	0.99	1.04	3.04	3.07	1.15	1.16
Nano- N at 500 g / palm	0.270	0.279	0.94	0.96	0.90	0.95	2.60	2.63	1.0 1	1.00
Nano- N at 1000 g / palm	0.288	0.297	0.93	0.95	0.88	0.93	2.59	2.62	0.99	0.99
Conv. P at 250 g / palm	0.269	0.278	0.87	0.89	0.80	0.84	2.40	2.42	0.80	0.81
Conv. P at 500 g / palm	0.258	0.267	0.81	0.81	0.74	0.79	2.32	2.34	0.71	0.70
Nano- P at 250 g / palm	0.231	0.240	0.78	0.80	0.69	0.74	2.21	2.23	0.55	0.56
Nano- P at 500 g / palm	0.229	0.238	0.77	0.77	0.68	0.73	2.18	2.20	0.54	0.55
Conv. K at 250 g / palm	0.210	0.219	0.74	0.74	0.60	0.66	1.80	1.82	0.40	0.41
Conv. K at 500 g / palm	0.190	0.200	0.71	0.71	0.55	0.60	1.78	1.80	0.36	0.37
Nano- K at 250 g / palm	0.170	0.179	0.66	0.66	0.50	0.55	1.40	1.42	0.30	0.30
Nano- K at 500 g / palm	0.169	0.179	0.65	0.65	0.48	0.53	1.39	1.41	0.29	0.30
Conv. NPK at 500: 250: 250	0.158	0.167	0.60	0.60	0.40	0.45	1.11	1.13	0.24	0.24
Conv. NPK at 1000: 500: 500	0.137	0.146	0.56	0.57	0.36	0.41	1.05	1.07	0.19	0.19
Nano . NPK at 500: 250: 250	0.110	0.119	0.50	0.50	0.30	0.36	0.90	0.91	0.15	0.15
Nano. NPK at 1000: 500: 500	0.108	0.117	0.49	0.48	0.29	0.34	0.80	0.81	0.14	0.13
New L.S.D. at 5%	0.018	0.017	0.03	0.03	0.03	0.03	0.05	0.05	0.04	0.04

Conv. = Conventional

Discussion :

From this study, fertilizers particularly synthetic fertilizers, have a major potential to pollute soil, water and air, in recent years, many efforts were done to minimize these problems by agricultural practices and the design of the new improved fertilizers. The appearances of nanotechnology open up potential novel applications in different fields of agriculture and biotechnology. Nanostructured formulation through mechanisms such as targeted delivery or slow controlled release mechanisms, conditional release, could release their active ingredients in responding to environmental triggers and biological demands more precisely. There is the possibility of using these mechanisms to design and construction of nano fertilizers. The use of these nano fertilizers causes an increase in their efficiency, reduces soil toxicity, minimizes the potential negative effects associated with over dosage and reduces the frequency of the application. Nano fertilizers mainly delays the release of the nutrients and extends the fertilizer effect period. Obviously, there is an opportunity for nanotechnology to have a significant influence on energy, the economy and the environment, by improving fertilizers (Ditta, 2012). Hence, nanotechnology has a high potential or achieving sustainable agriculture, especially in developing countries. (Baruah and Dutta, 2009). These results are in harmony with those obtained by Fernandez *et al.,* (2009); Baruah and Dutta, (2009); Remya *et al.,* (2010), Sheykhbaylou *et al.,* (2010); Mousavi and Rezaei, (2011); Bazary, (2012); Ekinchi *et al.,* (2014); Sabir *et al.,* (2014) and Refaai (2014) who worked on nanotechnology fertilizers and El- Sayed- Esraa, 2010; Hassan- Huda, 2014 and Ahmed *et al.,* 2014) who worked on traditional fertilizers.

CONCLUSION

Results of this study revealed that nano NPK fertilizers each at 500, 250 and 250 g. /palm /yr., respectively is a better than application of conventional NPK at 1000 , 500 and 500 g./ palm/yr., respectively to enhance growth, yield and fruit quality of Zaghloul date palms grown under Minia region conditions.

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تأثير التسميد بنظام النانوتكنولوجى على النمو والاثمار فى نخيل البلح الزغلول

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أجريت هذه الدراسة خلال موسمى ٢٠١٤ ، ٢٠١٥ لاختبار تأثير الاسمدة النتروجينية والفوسفاتية والبوتاسية بنظام النانو تكنولوجى فى مواجهة نفس الاسمدة التى تستخدم بالصورة التقليدية على النمو و الاثمار فى نخيل البلح الزغلول النامى تحت ظروف منطقة المنيا . وقد تم اضافة الاسمدة النتروجينية والفوسفانية والبوتاسية المستخدمة بنظام النانو تكنولوجى وبالطرق التقليدية بمعدلات ٥٠٠ ، ١٠٠٠جم / نخلة/سنة و٢٥٠، ٥٠٠ جم / نخلة/سنة و٢٥٠، ٥٠٠ جم / نخلة/سنة على التوالى وكانت النتائج كالتالي:

تفوق استخدام النتروجين بمعدل ٥٠٠، ١٠٠٠جم /نخلة/سنة والفوسفور بمعدل ٢٥٠، ٥٠٠جم/ نخلة /سنة والبوتاسيوم بمعدل ٢٥٠، ٥٠٠جم/ نخلة/ سنة سواء منفردين أو مجتمعين عند استخدامهم بنظام النانوتكنولوجى على استخدامهم بالصورة التقليدية فى تحسين النمو وكمية المحصول وخصائص الجودة للثمار .

زيادة المعدل المستخدم من ٥٠٠ الى ١٠٠٠ جم نيتروجين/نخلة/سنة وكلا من الفوسفور والبوتاسيوم بمعدل من ٢٥٠ الى ٥٠٠ جم/ نخلة/سنة تحت نظام النانوتكنولوجى لم يكن له تاثير يذكر على جميع الصفات تحت الدراسة، وقد لوحظ عكس ذلك عند استخدام هذه العناصر فى الصورة التقليدية.

كانت أفضل المعاملات- فى تحسين النمو وكمية المحصول وجودة الثمار لنخيل البلح الزغلول النامى تحت ظروف منطقة المنيا هى استخدام النتروجين والفوسفور والبوتاسيوم معا بمعدل ٥٠٠ ، ٢٥٠ ، ٢٥٠ جم/ نخلة/ سنةعلى التوالى خلال نظام النانوتكنولوجى بالمقارنة باستخدام هذه العناصر بالصورة التقليدية بمعدلات ١٠٠٠ , ٥٠٠ , ٥٠٠ جم /نخلة/ سنة.

الكلمات الدالة :النانوتكنولوجى- الطرق التقليدية- النيتروجين- البوتاسيوم- الفوسفور- نخيل البلح الزغلول- كمية المحصول- خصائص الجودة .