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Effect of Several Nano-Fertilization Forms on Cotton Productivity and Quality of Two Cotton Cultivars

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Abstract: The study investigated the influence of traditional nitrogen, phosphorus and potassium (NPK) mineral fertilizers and nano-fertilizers on yield, and its attributes, and fiber characters of two Egyptian cotton varieties Giza 94 and Giza 96. The design of the experiment was a split- plot with four replicates. Results indicated that Giza 94 cultivar surpassed Giza 96 in agronomic characteristics, although Giza 96 exhibited the highest fiber reading. Nano-chitosan (NPK)-fertilization significantly improved the mean value of boll weight, seed yield, lint yield, lint percentage, upper half mean (UHM), fiber uniformity index, fiber tenacity, and Micronaire value in both seasons. Conversely, the most minimal values for the aforementioned characteristics were recorded with the control NPK fertilizer over the two seasons.

1 Introduction

Nitrogen, phosphorus and potassium (NPK) fertilization methods are the key factors of yield increase in cotton cultivars. The nutrients assume a fundamental part in cotton creation. Nutrition manner is considered one of the main factors influencing cotton development. Moreover, N structures are the leading plant supplements restricting, plant advancement and thus yield. Many traits are usually assigned to determine the optimum N fertilization levels for commercial varieties through cotton agronomy programs. Nanotechnology opens an enormous extent in normative technique areas in agricultural science, because nanoparticles have extraordinary physical and synthetic characteristics, high superficial regions, and increased interaction (Siddiqui et al 2015). It was observed that an increment in N levels prompted an improvement in lint percentage, boll weight, and yield of cottonseed kentar per feddan. Panayotova et al (2016) demonstrated that potassium is essential for crop development and advancement. Potassium is important for keeping up with the cell osmotic strain balance enhancing stomatal movement, assuring enzyme function, maximizing photosynthetic performance, stimulating assimilate transport, and further developing plant protection from resident to various stressors (Zahoor et al 2017, Hafeez et al 2018, Shahzad et al 2019). While, Hu et al (2017) showed that potassium could likewise expand nitrogen manure use, help the development of cotton plant roots, stems, leaves, and conceptive organs. The study aimed to investigate the impact of some nano compounds and mineral treatment on fiber quality characters and productivity of two cotton cultivars.

2 Materials and Methods

This study was conducted at The Agricultural Research Station, Sakha, Kafr El-Sheik Governorate, Cotton Research Institute. During the two growing seasons, 2019 and 2020, we assessed the impact of some nano compounds and mineral fertilization on yield, yield attributes, and fiber technological characteristics of two cultivars, Giza 94 and Giza 96.

The seeds of the two Egyptian cotton varieties, Giza 94 and Giza 96, were sown on April 10, 2019, and April 7, 2020, Seeds were drilled in hills 70 cm distance and 25 cm apart and there were two plants in the hill.

The mechanical and chemical characteristics of the trial soil were estimated according Jackson (1973). **Table 1,** illustrates the obtained values of physical and chemical soil for both seasons.
Fertilizer treatments involved,
normal mineral fertilizer NPK as control,
nano-neem NPK,
nano-geranium NPK and
nano-chitosan NPK

Table 1. Physical and synthetic investigation of the exploratory soil in the two seasons 2019 and 2020

		2019	2020
Mechanical analysis	Clay %	44.6	42.2
	Silt %	32.5	37.1
	Sand %	22.9	20.7
Chemical analysis	PH	8.0	7.8
	EC	3.4	3.3
	SP %	70	70
Available macronutrients (mg)	N	93.4	91.6
	P	0.01	2.0
	K	153.6	138.2
Solution ions (mg)	Fe	2.0	3.8
	Mn	0.8	0.9
	Zn	0.1	0.1
	Cu	5.1	0.2

The recommended fertilization rate of cotton (62 kg N/feddan, 22.5 kg P_2O_5/feddan, and 50 kg K_2O/feddan) was applied as a control. Nitrogen, phosphorus and potassium fertilizers were added as ammonium nitrate (33.5%N), calcium superphosphate (15 % P_2O_5), and potassium sulfate (48% K_2O) respectively.

The experimental treatments were arranged in a split-plot design with four replicates, where cultivars occupied the main plots and fertilizers allocated the sub-plots. The plot size was 15.12 m2 (6 ridges, 3.6 m long and 0.7 m wide). Nano-chitosan fertilizer was prepared at Lezar Institute, Cairo University (Corradini et al 2010) used a modified approach to expose nano-fertilizers to high-power laser rays. According to Celsia and Mala (2014), plant protection institute, Agriculture Research center nano -neem and nano-geranium fertilizers were created.

According to the treatments, control fertilizers were separated into three rates at the following intervals: first rate before the second irrigation is about 41 days after sowing, the second rate before the third irrigation is about 56 days after sowing, and the third rate before the fourth irrigation is about 71 days after sowing.

Nano-chitosan fertilizers, Chitosan is extracted from the shells or exoskeletons of some crustaceans and converted to nanoscale in form of polymer to coat the fertilizer elements on it using concentrations were 310 mg /L for nitrogen, 60 mg /L for phosphorous, and 120 mg /L for potassium. Nano-neem and nano-geranium fertilizers, it is prepared using both neem oil extracted from neem trees as well as geranium oil extracted from geranium plant and converted to emulation with nano-size by ultra-sonication to coat the fertilizer elements on it using concentrations were 100 mg /L for nitrogen, 50 mg /L for phosphorous, and 50 mg /L for potassium. Fertilizer treatments were, divided into three rates and sprayed according to the treatments on the following intervals: first rate before the second irrigation is about 41 days after sowing, the second rate before the third irrigation is about 56 days after sowing, and the third rate before the fourth irrigation is about 71 days after sowing.

Harvest dates were on September 25, 2019, and September 27, 2020. Ten plants were haphazardly gathered from the inward ridges to determine the following attributes.

2.1 Yield and yield components

Boll weight (g) determined as average boll weight in gram of 50 bolls picked at random from each plot.

Yield of cotton seed (kentar/feddan) estimated as the weight of yield of cotton seed in Kentar / faddan equals 157.5 kg on plot basis.

Yield of cotton lint (kentar/feddan) estimated as weight of yield of cotton lint in Kentar / faddan equals 50 kg

Lint percentage (%) ratio of lint to seed cotton sample expressed as percentage using the formula

$$\text{Lint percentage} = \frac{\text{Weight of lint cotton (kg)}}{\text{weight of seed cotton (kg)}} \times 100$$

2.2 Fiber properties

In the fiber department, several fiber technological traits, i.e. upper half mean UHM (mm), uniformity index (UI), fiber strength (g/tex), and Micronaire value (MIC) were measured using constant RH (±2) and 20°C. Additionally, the fibers' properties were measured using the HVI instrument system (ASTM 1993).

2.3 Statistical analysis

All obtained data for each season were subjected to analysis of variance as described by Senedecor and Cochran (1980). The most significant variances, Fisher's least significant difference, were determined at a significance score of 0.05 for the inter treatment examination. The data were analyzed using Statistical Package for Social Sciences v.15.

3 Results and Discussions

3.1 Productivity and yield compounds

3.1.1 Impact of cultivars

Table 2 shows that the Giza 94 cultivar was distinguished and gave the best values in “lint percentage (35.64% and 35.46%), boll weight (3.13 and 3.16 g), yield of cottonseed per feddan. (10.82 and 10.85 kentar), and yield of cotton lint/feddan (12.14 and 12.11 kentar) "in the two seasons. These outcomes agreed with those of (Siddiqui et al 2015). They found that distinctions might be caused by the hereditary contrasts between two cultivars. The prevalence of G. 94 cultivar in seed and lint of cotton yield per feddan of over the G. 96 cultivar may be due to the increment in yield components.

3.1.2 Impact of nano treatments

The information in **Table 2** showed that the effect of using treatment on the yield and yield components in the 2019 and 2020 seasons. Results uncovered that nano-chitosan (NPK) was the best treatment and recorded the most important qualities for “lint percentage (36.33% and 36.85 %), boll weight (3.20 and 3.22 g), the yield of cottonseed (10.80 and 12.35 kentar), and yield of cotton lint (12.35 and 12.47 kentar) "during the first and second seasons, respectively. In 2019, the yield of the cottonseed enhanced by 12.00%, 7.77% and 1.3% when using nano-chitosan (NPK), nano-neem (NPK), and nano-geranium (NPK), separately, over the control treatment (control mineral NPK applied) Comparable outcomes were seen in the 2020 season, the cottonseed yield improved with approximately 13.52%, 6.44%, and 3.95.%. The increment in yield and its parameters under the application of nano-chitosan, nanoneem, and nano-geranium treatments in 2020 may be due to the synergetic role of microelements in improving directly or indirectly photosynthesis, vital processes in plant at a similar resolution (Siddiqui et al 2015, Hafeez et al 2018).

3.1.3 Effect of the combination between the two factors

Table 2 shows the impact of combining cultivars and mix among nano-preparation and mineral treatment acquired for yield and yield parts during the 2019 and 2020 seasons. For example, establishing of G. 94 but nano-chitosan (NPK) treatment essentially recorded the most elevated upsides of the yield of cottonseed (11.33 and 11.17 kentar), yield of cotton lint (12.65 and 12.56 kentar), boll weight (3.78 and 3.37 g), and lint percentage (35.47% and 35.70%) in the two seasons, separately. The Giza 96 NPK application showed a minimal, cottonseed yield (8.50 and 8.57 kentar) boll weight was not significant in 2019 but significant in the 2020 season (2.91 g). Cotton lint yield was significant in 2019 (9.97 kentar) but not significant in the 2020 season and lint percentage% (37.37 %). (Eichert et al 2008) also uncovered comparable outcomes.

3.2 Fiber characteristics

3.2.1 Impact of cultivars

In **Table 3** significant differences can be seen in these two types of Egyptian cotton on most fiber characters during the 2019 and 2020 seasons. Most observable are the benefits of the UHM (35.65 and 35.62 mm), fiber strength (46.35 and 46.32 g/tex), UI (87.62% and 87.80 %), and the best perusing in Micronaire (3.82 and 4.01) in 2019 and 2020 seasons, individually were recorded for G. 96. These outcomes can be credited to the great genetic design of G. 96 cotton, characterized by its extra -long stability. Additionally, few scientists concurred with comparative discoveries, (Sawan 2006, 2014).

Table 2. Effect of nano-fertilizers on yield of cotton lint (kentar/feddan), yield of cottonseed (kentar/feddan), lint percentage (%), and boll weight (g),) of cotton during 2019 and 2020

Treatment	Trait	Boll weight (g)		Lint percentage (%)		Seed cotton yield (kentar/feddan)		Lint cotton yield (kentar/feddan)	
	Season	2019	2020	2019	2020	2019	2020	2019	2020
Cotton cultivars									
Giza 94		3.13	3.16	35.64	35.46	10.82	10.85	12.14	12.11
Giza 96		2.94	2.95	33.89	33.85	9.42	9.5	10.05	10.12
L.S.D at 5%		**N.S**	**0.07**	**0.93**	**0.74**	**0.33**	**0.22**	**0.74**	**0.09**
Nano compounds									
Control		2.90	2.95	36.14	35.53	9.23	10.50	10.50	10.44
Nano -neem (NPK)		3.03	3.05	35.18	34.62	9.78	10.83	10.83	10.81
Nano -geranium (NPK)		3.03	3.05	35.43	35.62	9.88	11.02	11.02	11.13
Nano -chitosan (NPK)		3.20	3.22	36.33	36.85	10.80	12.35	12.35	12.47
L.S.D at 5%		**0.09**	**0.08**	**0.59**	**0.46**	**0.50**	**0.30**	**0.95**	**0.18**
Cotton cultivars× × Nano compounds									
Giza 94	Control	3.06	3.1	33.20	33.70	9.97	10.1	10.42	10.72
	Nano -neem (NPK)	3.74	3.2	34.47	34.10	10.47	10.53	11.36	11.31
	Nano -geranium (NPK)	3.60	3.17	34.83	34.60	10.63	10.63	11.66	11.31
	Nano -chitosan (NPK)	3.78	3.37	35.47	35.70	11.33	11.17	12.65	12.56
Giza 96	Control	2.81	2.8	37.20	37.37	8.50	8.57	9.97	10.08
	Nano -neem (NPK)	3.07	2.9	35.90	35.13	9.10	9.3	10.29	10.29
	Nano -geranium (NPK)	2.94	2.93	37.43	37.1	9.13	9.2	10.76	10.75
	Nano -chitosan (NPK)	3.11	3.07	34.40	34.27	10.27	10.33	11.12	11.15
L.S.D at 5%		**N.S**	**0.11**	**N.S**	**0.90**	**0.22**	**0.24**	**1.10**	**N.S**

3.2.2 Impact of nano treatments

Table 3 reveals the distinctions between the concentrated on four preparation application (100%) mineral preparation NPK (control), nano-neem NPK, nano -geranium NPK, and nano-chitosan in fiber characters of cotton in 2019 and 2020 seasons were critical. These outcomes found that using combined nano-chitosan (NPK) treatment gave the highest upsides of upper half mean UHM length (35.03 and 35.38 mm), UI (88.07% and 87.83 %), fiber strength (45.55 and 46.02), and MIC value (4.23 and 4.40) in the two seasons, respectively. The use of nano-fertilization directly or indirectly improved photosynthesis, plant vital processes, protein synthesis, reproductive stage, biochemical and physiological activities which contributed to improving the properties of cotton fibers. Numerous agents emerged with comparative outcomes (Wu and Liu 2008, Corradini et al 2010, Zakzok et al 2017).

3.2.3 Effect of the combination between the two factors

The information outlined in **Table 3** uncovered that a few fiber characters, for example, UHM, UI, fiber strength, and MIC. Values were essentially impacted by the combination of Egyptian cotton cultivars and among nano-preparation and mineral preparations during the 2019 and 2020 seasons. The most noteworthy UHM length (35.90 and 35.97 mm), UI (88.10% and 88.37 %), fiber strength (46.87 and 46.90), and MIC (4.37 and 4.57) in 2019 and 2020 seasons, individually was registration from establishing of nano-chitosan (NPK) with G. 96. Comparative outcomes were likewise revealed by (Corradini et al 2010, Gebaly 2011).

Table 3. Effects of nano-fertilizers on UHM (mm), UI (%), fiber strength (g/tex), and mic. value of cotton during 2019 and 2020 seasons

Treatment	**Trait**	**Upper half mean**		**Length uniformity index**		**Fiber strength**		**Micronaire value**	
	Season	**2019**	**2020**	**2019**	**2020**	**2019**	**2020**	**2019**	**2020**
Cotton cultivars									
Giza 94		33.73	34.08	86.32	86.09	43.42	43.93	4.17	4.20
Giza 96		35.65	35.62	87.62	87.80	46.35	46.32	3.82	4.01
L.S.D at 5%		**0.13**	**0.37**	**0.38**	**0.39**	**0.3**	**0.33**	**0.11**	**0.11**
Nano compounds									
Control		34.63	34.58	86.02	86.20	44.20	44.52	3.91	3.92
Nano-neem (NPK)		34.88	34.92	87.48	86.83	45.08	45.23	4.12	4.03
Nano -geranium (NPK)		34.63	34.80	86.02	86.40	44.35	44.47	4.00	4.08
Nano-chitosan (NPK)		35.03	35.38	88.07	87.83	45.55	46.02	4.23	4.40
L.S.D at 5%		**0.14**	**0.35**	**0.32**	**0.33**	**0.17**	**0.3**	**0.14**	**0.13**
Cotton cultivars × Nano compounds									
Giza 94	Control	33.67	33.97	85.47	86.27	42.53	43.23	3.80	3.73
	Nano-neem (NPK)	33.90	34.10	86.80	86.60	43.83	43.93	4.03	4.07
	Nano -geranium (NPK)	33.73	33.97	85.60	86.23	42.63	43.23	3.96	3.90
	Nano -chitosan (NPK)	34.17	34.80	88.03	87.97	44.23	45.13	4.10	4.23
Giza 96	Control	35.00	35.23	86.57	86.27	45.87	45.80	4.03	4.10
	Nano-neem (NPK)	35.87	35.73	88.17	86.13	46.33	46.53	4.20	4.00
	Nano -geranium (NPK)	35.53	35.63	86.43	87.07	46.07	45.70	4.03	4.17
	Nano -chitosan (NPK)	35.90	35.97	88.10	88.37	46.87	46.90	4.37	4.57
L.S.D at 5%		**0.2**	**0.25**	**0.45**	**0.48**	**0.24**	**0.42**	**0.24**	**0.23**

4 Conclusion

The results show that the treatment of nano-chitosan fertilization led to the highest yield of cotton lint and yield of cottonseed and its superiority in the technological qualities of two Egyptian cotton cultivars Giza 94 and Giza 96, during the 2019 and 2020 growing seasons, under the conditions of Kafr El-Sheikh.

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