IMPACT OF MINERAL AND NANO PHOSPHORUS FERTILIZER FORMS SOME WITH HUMIC ACID APPLICATION ON QUALITY AND QUANTITY OF GIZA 95 COTTON CULTIVARS AS WELL AS SOIL PROPERTIES AND FERTELTITY

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ABSTRACT

Two field experiments were performed in Agricultural Farm of Sids Agricultural Research Station , ARC ,Beni-Suef Governorate , Egypt (lat .29^0 04N, Long .31^0 ob E and 30-40 m above the mean sea level) To investigate the possibility of using nano- natural rock P instead of chemical superphsphate along humic acid on productivity of cotton as well as soil properties and fertility . The design of the experiment was split plot design , where humic acid treatments (without , 10kg/fed humic acid as soil application and 2 % foliar spraying twice of humic acid solution) were located in main plot , and phosphorus treatments (without , 15.5 kg P_2O_5 /fed , 31.0 kg P_2O_5 /fed and 2% foliar spraying twice of nano rock P solution) were developed in subplots.

The results indicated that soil properties and fertility did not affected by phosphorus treatments, except phosphorus availability ,which positively increased due to 15.5 or 31.0 kg P_2O_5 /fed as superphosphate .) On the other hand add in 10 kg/fed humic acid improved soil pH, OM,bulk density and soil available water as well as soil available N,P and K after cotton harvest in Foliar spraying of 2% nano rock P had equal effect of additions 31.0 kgP_2O_5 /fed , where it increased plant height, number of fermiting branches, searlinss % , number of open balls /plot , boll weight , seed indx , seed cotton yield as well as leaf cotton content of N,P,K and chlorophyll A and B. Humic acid application improved the above mentioned growth parameter yields and yield components and life cotton content , except earliness % , where 10 kg/fed humic acid as soil application surpassed added humic acid as foliar spraying. On the other hand lint% and fiber properties did not responded to humic acid or phosphorus application . The result of the interaction showed that the best treatment for Gisaas cotton antiwar production is 2% foliar spraying of nano rock P solution or 31kg/fed P_2O_5 + 10 kg /fed humic acid as soil application.

KEY WORDS, humic acid , nano fertilizes , phosphorus fertilizers , cotton , yield , yield component . soil properties .

INTRODUCTION

It is evident that about third of crop production is damaged every year , due to many stress condition ,e.g., pest infestigation microbial disease, reduce in soil fertility,…(Baker *et el* .,2017). To overcome this limitation, many technological strategies are made up , such as nanotechnology which deals with nanoparticles that its a molecular size ranged between 1_100 nm . The use of nanofertilizer is a new technology in crop production play an important role in plant growth and development to high quality and innocuous foods, and less environment and good health. Nanofertilizer is more stable and high efficient than conventional fertilizer

(Lopez- Valdez and Fernandez – Luqueno 2018) . Nanoparticles have various advantages comparing with a conventional fertilizer, such as a smaller size of nano fertilizer means agreater specific area ,increasing the activity of particle surface as well as it's mobility and transportation (Leon - silva et el 2016) . Another advantage is its shape, where nanoparticles come in several rod shaped and spherical which had a good prtecting for avoiding aggregation of the product.

Many auothers indicated the beneficial effects of nano phosphorus on cotton plant such as is Hassien *et el* (2015).

Phosphorus is one of the most important nutrients for plant growth, where its functions cannot be performed by any other or micronutrients . It is vital for plant growth and development. It is functions including photosynthesis, energy transfer sugars and starches transformation as well as nutrient movement within plants and genetic characteristics transfer from one generation to the next .Brady(2002) reported that p has Beneficial effects on photosynthesis root development nitrogen fixation flowers and seed formation and fruit development . Many workers reported that phosphorus application enhance the quality and quantity of cotton plant grown in P-defect deficient soil , such as Mai *et el* (2018) , Emara *et el* (2018) and Iqbal *et el* (20200 .

Humic acids consisted of humic materials which used in agriculture practices as soil conditioners soil supplemants and fertilizer amendments Drobek *et el* (2019) and Jindo *et el* (2020)).All humic acids are formed from chemically complex , nano - bio chemical organic materials . Its major properties is largely hydrophilic, amorphous, dark in color, in liquid or powder phase and has high resistance to degradation by chemical and biological processes(Mackowiak et el 2001 and Adani *et el* 2006) . the mechanisms of the positive effect of humic acid on plant growth are refer to assimilation of nutrients , enzyme activation , membrane permeability , protein synthesis , consequently activation of biomass production. More over it enhanced seed germination, oxygen uptake, respiration(especially in roots, photosynthesis phosphorus and nutrient absorption as well is root cell elongation) Mauromical *et el,* (2011) and Bezuglove *et el* (2017) . Several investigators reported the positive response of cotton productivity to humic acid application such as, Seadth *et el* (2012) , and Rady *et el* (2016) .

Humic acid can break the bonds between phosphate and other metals, such is iron and calcium in sodic soils. Also, it enhanced the macro and micronutrients (Eyhearaguibel *et el* 2008) , improve soil fertility and modifying soil properoties (Natesan *et el* ,2007) . Moreover , Verlinden *et el* (2009 stated humic acid increased the solubility of several neutrients by building complex forms or chelating with nutrient cations.

Objective of this study was to investigate the improvement of soil properties and fertility as well as cotton productivity as responded to mineral and nano phosphorus fertilizers under humic acid application .

MATERIALS AND METHODS

To field experiments were conducted in two successive seasons of 2018 and 2009 at the experimental farm of Sids Agriculture Research Station, ARC, Beni - Suef Government, Egypt this aims to investigate the possibility of reducing

chemical phosphorus fertilizer by using nano - natural rock phosphate under humic acid application and its (Gossypium babadense) effect on cotton product ivy as well as soil properties and fertility . The soil of the two season is clay in texture , with 8.1 and 8.0 p H , 1.12 and 1.16 (dSm^{-1}) salinity 1.81 and 1.75 % , organic matter, as well as 24 and 26, 11 and 10 ,and 165 and 176 ug g-1 soil available N, P and K , respectively (according to A.O.A.C , 1990) . The design of the experiment was splite splite plot design in four replication, where humic acid treatment (without , 10 kg humic acid/ fed as soil application and foliar spraying of 2% humic acid solution twice) were located in the main plot , while , the phosphorus treatments (0.0 , foliar spraying or 2% nano – rock phosphate solution twice , soil application of 15.5 k g $P_2 O_5$/fed as superphosphate , and soil application of 31.0 kg P_2O_5/fed as superphosphate were applied in subplot . The nano – natural rock phosphate was prepared by Faculty of Postgraduate Studies For Advanced Sciences , Beni – Suef – Unive , Egypt . The nano – rock P had average partical size less than 30nm and specific surface more than 30 m^2/g .

Cotton seeds, variety Giza 95 were sown on 10 and 15 April in both seasons , respectively . The plot area was $12m^2$ (4x3m) including five ridges , each ridge wsa 4.0m long ; o.60m width with the hills of 0.20m apart . The cowing was done in one side of the ridge , where the hills were thinned after three weeks from sowing to two plants . All plants fertilized with 75kg N /fed as ammonium nitrate (33.5%N) in two equal doses , the first after thinning and the second after 15 day later , Also , potassium fertilizer was added before planting as potassium sulphate (48%k_2O) at rate of 24 kg k_2O /fed . Other cultural practices were done as recommended for cotton cultivation in district . At 15 days after full flowering stage , index leave samples were randomly taken from each plot from the top fourth node to determine N,P and K concentration (according to Chapman and Pratt, 1961) as well as chlorophyll A and B (according to Arnon, 1949) . At harvest representative plants from the three inner ridges of each plot were randomly taken to determine the following traits: plant height (cm) , number of fruiting branches / plant , number of open bolls /plant , boll weight (g) , seed index (g) , lint (%) , earliness (%) and seed cotton yield (karat/fed) Also , some fiber properties ,e.g., pressely index , micronarie reading , fiber length and uniformity index were measured by using High Volume instrument according to A.S.T.M, 1986.

The obtained data were subjected to the statistical analysis according to Sander and Cochran (1980) . The significant difference between treatments were compared using L.S.D. at 0.05 level of probability .

RESULTS AND DISCUSSION

The data in Table (1) represent the effect of mineral and nano – phosphorus fertilization and method of humic acid application and their interaction on some soil properties after cotton harvest . The data clearly reveal that mineral or nano – rock phosphate were not significant affected the studied soil properties , namely , pH , EC ,OM, bulk density and soil available water after cotton harvest . These findings are the same with Ahmed (2017) and El – Sheref *et el* 2019) .

As for the effect of humic acid , the obtained data show that added humic acid as soil application improved all studied soil properties , except salinity value

comparing with no humic acid or added humic acid as foliar spraying (Brady and Weily 2008) mentioned that the positive effect of humic acid on soil bulk density and available water is mostly due to addition of humic acid increase soil aggregation , water retention as well as water holding capacity . Furtheremore , (Quilty and Cattle 2011) reported that humic acid improve soil aggregation which in turn promotes , high infiltration rates and increased cation exchange capacity . The reduction in soil pH could be due to various acids or acids formining during growth season resulted in decrease soil pH (Abdel-Fattah,2012). The results are in line with those obtained by El – Shereif *et el* (2013) and Ahmed and Ismail (2016).

With regard to the interaction between treatments , the data show that soil properties did not significantly responded to the interaction between phosphorus and humic acid application . In general, the best values of pH,M.O, bulk density and available water were recorded from the treatment of added 10kg/fed humic acid as soil application under any phosphorus treatments.

Table (1): effect of mineral and nano- phosphorus fertilization under humic acid application on soil properties after cotton harvest.

Humic acid (A)	P-Fertilization (B)ؠ	pH		EC (dSm^{-1})		O.M (%)		Bulk density ($g\ cm^{-3}$)		Soil water available %	
		2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
0.0 control	P1	7.95	8.00	1.22	1.34	1.82	1.74	1.26	1.24	22.19	22.02
	P2	7.96	8.01	1.23	1.33	1.82	1.74	1.26	1.23	22.20	22.03
	P3	7.95	7.99	1.22	1.34	1.81	1.75	1.25	1.24	22.26	22.00
	P4	7.94	8.00	1.23	1.33	1.83	1.75	1.26	1.24	22.23	22.01
mean		7.95	8.0	1.23	1.34	1.82	1.75	1.26	1.24	22.22	22.02
10kg/fed as soil application	P1	7.85	7.92	1.21	1.33	1.92	1.86	1.22	1.20	24.01	23.89
	P2	7.86	7.93	1.22	1.34	1.93	1.85	1.21	1.21	24.07	23.83
	P3	7.83	7.93	1.22	1.33	1.93	1.87	1.21	1.21	24.01	23.90
	P4	7.86	7.92	1.21	1.34	1.94	1.86	1.22	1.22	24.05	23.85
mean		7.85	7.93	1.22	1.34	1.93	1.86	1.22	1.21	24.04	23.87
2% foliar spraying	P1	7.94	7.99	1.22	1.34	1.83	1.75	1.25	1.24	22.25	22.03
	P2	7.96	8.00	1.23	1.33	1.82	1.74	1.25	1.24	22.16	22.01
	P3	7.95	7.99	1.23	1.34	1.81	1.76	1.26	1.23	22.13	22.00
	P4	7.94	8.01	1.22	1.33	1.81	1.75	1.25	1.23	22.27	22.03
mean		7.95	8.00	1.23	1.34	1.82	1.75	1.25	1.24	22.20	22.02
mean of P levels	P1	7.91	7.97	1.22	1.34	1.86	1.78	1.24	1.23	22.82	22.65
	P2	7.93	7.98	1.23	1.33	1.86	1.78	1.24	1.23	22.81	22.62
	P3	7.91	7.97	1.22	1.34	1.85	1.79	1.24	1.23	22.80	22.63
	P4	7.91	7.98	1.22	1.33	1.86	1.79	1.24	1.23	22.85	22.63
L.S.D at 0.05 A		0.03	0.03	NS	NS	0.08	0.07	0.03	0.02	0.95	0.93
B		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
AB		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

P1= without superphosphate

P2 = 15.5 kg P_2O_5 /fed as superphosphate

P3 = 31.0 kg P_2O_5 /fed as superphosphate

P4 = foliar spraying of 2% Nano –P solution twice

Soil fertility:

The data in Table (2) clearly show that only soil available phosphorus after cotton harvest was significantly responded to soil phosphorus application as super phosphate in comparison with no phosphorus application treatment . Added 31.0kgP_2O_5 /fed achieved with highest values of available phosphorus which exceeded the of 15.5kg P_2O_5/fed and zero phosphorus by about 19.5 and 66.9 % in the first season , and 21.3 and 75.6 % in the second season , respectively . It is obvious to notice that foliar spraying of nano – rock phosphate did not affect soil available P after cotton harvest . The increment in soil available P due to added superphosphate fertilizer may be due to the release of phosphorus during the growth season and protect from losing in the clay soil by fixation (Gowda et el 2011) . Similar results obtained by Cavusoglu et el(2017) and El- Sheref *et el* (2019).

As for humic acid, the data indicate that added 10kg/fed humic acid increased soil available N,P and K after cotton harvest . where as N, P and K availability did not respond to added humic acid as foliar spray which produced N, P, and K content in soil statistically equal to without humic acid . In this concern , Osman and Rady (2012) mentioned that humic acid as soil application improved soil fertility by enhanced soil microorganisms ,which increased nutrient cycling and reduce soil pH , hence resulted in increase nutrient availability to plant roots ..

Regarding the interaction effect ,the data clearly indicated that N ,P and K availability did not affect by the interaction between phosphorus and humic acid treatments . This means that the treatment of 10 kg/fed under any phosphorus treatments led to highest values of soil available N, P and K after cotton harvest . On the other hand the treatment of no or humic as foliar spraying under any phosphorus treatments yielded the lowest nutrient availability after harvest .

Growth parameters and earliness percentage:

The data in Table (3) show the response of growth parameters (plant height and number of fruiting branches / plant) and earliness percentage to humic acid as phosphorus treatments . Concerning phosphorus fertilization , the data indicate that added phosphorus as soil application or foliar spraying of nano – rock phosphate increased growth parameters of cotton add earliness (%) comparing with, without phosphorus application . It is worthy to notice that added phosphorus as nano- rock P gave growth parameter and earliness(%) in bar to those under added 31.0kg P_2O_5 / fed . Increasing phosphorus levels 15.5 to 31.0 kgP_2O_5/fed or foliar spraying of 2% nano- rock P twice resulted in increasing of plant height and no of fruiting branches /plant and earliness (%) by about 3.1 and 4.8 % and 8.4 over without phosphorus application in the first season , respectively . Similar trends were obtained in the second season . The increament in cotton growth due to phosphorus application may be due to phosphorus is very important to nuclic acids formulation and cell layers and basic for metabolic processes , therefore sufficient phosphorus in soil improve photosynthesis , which led to enhance plant growth (Ah**medand Hasanuzzaman ,2020) . As for the positive effect of nano –** phosphorus , Soliman *et el* (2016) explained that to the high reactivity of nano – particle due to more specific surface area , more density of reative areas increased reactivity of these area on the particle surfaces . Respecting earliness percentage (Widowati *et el* ,2012) indicated that

phosphorus application induce proper and balanced nutrients which promoted the fertility of the soil . These balanced nutritional for cotton led to increased first picking to total seed cotton yield . Similar results were obtained by Abou – El- Nour *et el* (2001) and Abd El- Gayed and Abd El Hafeez (2014) for the effect of mineral phosphorus on growth parameters and earliness percentage , and Hussien *et el* (2015) and Eed *et el* (2018) for nano- phosphorus fertilizers. With regard to the effect of humic acid , the obtained data reveal that added humic acid as soil application or as foliar spraying were significantly enhanced plant height than without humic acid application . Whereas no of fruiting branches /plant was affected only by 10kg humic acid /fed as soil application in both seasons. The relative increasing in cotton plant height due to soil application of humic acid and foliar spraying reached to 3.7 and 1.5 % over control the first season . Similar trends were obtained in the second season . However , the increment in number of branches /plant caused by 10kg/fed humic acid were 5.5 and 6.5 % when compared with no humic acid treatments in both seasons , respectively .

Table (2) : Effect of mineral and nano – phosphorus fertilization under humic acid application on soil fertility after cotton harvest .

Humic acid (A)	P- Fertilization (B)	N (ug g^{-1})		P (ug g^{-1})		K (ug g^{-1})	
		2018	2019	2018	2019	2018	2019
0.0 control	P1	21.4	17.9	11.6	11.1	181.2	180.4
	P2	21.5	18.0	15.6	15.3	183.7	181.3
	P3	21.3	17.3	19.0	18.7	186.1	181.7
	P4	21.6	17.4	11.8	11.5	185.6	182.1
mean		21.5	17.7	14.5	14.2	184.2	181.4
10 kg/fed as soil application	P1	27.2	23.9	12.9	12.2	195.3	190.6
	P2	27.7	24.0	19.4	18.9	195.0	190.7
	P3	28.0	23.8	22.5	22.0	196.1	192.2
	P4	27.3	23.9	13.0	12.4	194.8	193.5
mean		27.6	23.9	17.0	16.4	195.3	191.8
2%foliar spraying	P1	21.5	17.8	11.8	11.0	183.4	180.2
	P2	21.4	17.8	15.6	15.1	184.0	181.3
	P3	21.7	17.4	19.2	18.9	186.3	182.5
	P4	21.3	17.5	11.8	11.3	185.7	182.95
Mean of P levels	mean	21.5	17.6	14.6	14.0	184.9	181.7
	P1	23.4	19.9	12.1	11.4	186.6	183.7
	P2	23.5	19.9	16.9	16.4	187.6	184.4
	P3	23.7	19.5	20.2	19.9	189.5	185.5
	P4	23.4	19.6	12.2	11.7	188.7	186.1
L.S.D at 0.05 A		1.59	1.31	0.97	0.91	4.37	4.25
B		NS	NS	1.07	1.03	NS	NS
AB		NS	NS	NS	NS	NS	NS

Table (3): Effect of mineral and nano phosphorus fertilization under humic acid application on growth parameter and earliness % .

Humic acid (A)	P- Fertilization (B)	Plant height		No of fruiting branches / plant		Earliness (%)	
		2018	2019	2018	2019	2018	2019
0.0 control	P1	118.2	119.2	14.1	15.0	75.7	75.5
	P2	120.6	121.6	14.6	15.4	79.1	79.0
	P3	121.7	122.4	14.9	15.7	82.1	82.0
	P4	121.8	122.3	14.9	15.87	82.1	81.9
mean		120.6	121.4	14.6	15.5	79.8	79.6
10 kg/fed as soil application	P1	122.7	123.7	14.9	15.8	75.9	75.6
	P2	124.3	125.8	15.4	16.4	79.1	79.0
	P3	126.8	127.1	15.7	16.8	82.3	82.1
	P4	126.7	125.9	15.7	16.8	82.3	82.0
mean		125.1	123.5	15.4	16.5	79.9	79.7
2% asFoliar spraying	P1	120.0	121.1	14.4	15.3	75.8	75.5
	P2	122.5	123.6	14.8	15.7	79.0	79.0
	P3	123.6	124.5	15.0	16.0	82.2	82.0
	P4	123.5	124.6	15.0	16.1	82.1	82.0
mean		122.4	123.5	14.7	15.8	79.8	79.6
Mean of P levels	P1	120.3	121.3	14.5	15.4	75.8	75.5
	P2	122.5	123.7	14.9	15.8	79.1	79.0
	P3	124.0	124.7	15.2	16.2	82.2	82.0
	P4	124.0	124.6	15.2	16.2	82.1	82.0
L.S.D at 0.05 A B AB		1.20 0.95 NS	1.11 0.97 NS	0.62 0.20 NS	0.67 0.20 NS	NS 0.68 NS	NS 0.66 NS

On the other hand neither soil application of humic acid nor foliar spraying did not affect earliness percentage of seed cotton . The promotive effect of humic acid assoil application may be due to its effect on activation the oxidation – reduction state of ions at the root level that resulted in increase in absorption of nutrients , which in turn improved plant growth (Osman and Rady , 2012) , On the other hand , the effect of foliar spraying of humic acid may be due to its effect on metabolic processes , nucleic acid synthesis and ion uptake as well as RNA production (Ouni *et el* 2013) . These results are in accordance with those obtained by Rady et el (2016) for added humic acid as soil application **,** Ahmed *et el* (2013) for foliar spraying and Seadh *et el* (2012) for both cotton growth .

As for the interaction , the data cleary show that cotton growth parameters and earliness percentage were not respond to the interaction between phosphorus and humic treatments . In general the highest values of plant height was achieved with 31kgP_2O_5/fed or nano phosphorus in combined with 10kg/fed humic acid . Whereas, highest values of no of fruiting branches/plant were recorded to treatments include 31.0 kg P_2O_5 or nano – rock P . Meanwhile , earliness (%) did not affected by phosphorus or humic acid treatments or its interaction .

Yield and yield components :

The effects of phosphorus fertilizer form and humic acid application and their interaction on yield and yield components of cotton were presented in Table (4) . The data show that the yield and its components were significantly responded to phosphorus treatments , except lint percentage , which did not affect . It could be arranged the effect of phosphorus treatments of cotton yield and its components of the descending order as follow 31.0kgP_2O_5/fed = foliar spraying 2 % nano – rock P > 15.5kg P_2O_5/fed > without phosphorus application (control) . The data reveal that the effect of 31.0kg P_2O_5/fed on these parameters was statistically equal to the effect of nano – rock P treatment . Comparing with control the increment of No of open bolls/plant , boll weight , seed index and seed cotton yield due to 31.0 kg P_2O_5/fed or nano - rock P were 18.0 and 17.7 , 4.0 and 4.0 , 4.0 , 5.5 and 5.3 and 38.2 and 38.2 % , respectively in the first season . Similar trends were obtained in the second season . The increase in the reproductive organs , hence cotton yield , consed by higher application of phosphorus may be due to higher P application resulted in enhanced N and P effect and photo synthesis translocation towards the reproductive organs rather

Table (4) Effect of mineral and nano phosphorus fertilization under humic acid application on yield and yield components

Humic acid (A)	P-fertilization (B)	No of open bolls/plant		Boll weight (g)		Seed index (g)		Lint (%)		Seed cotton Yield	
		2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
0.0 control	P1	11.1	11.9	2.67	2.62	9.42	9.45	40.13	40.15	7.12	7.10
	P2	13.5	14.1	2.76	2.73	9.75	9.61	40.15	40.16	9.65	9.42
	P3	14.1	14.8	2.80	2.77	9.97	9.85	40.16	40.15	10.21	9.95
	P4	14.1	14.7	2.79	2.75	9.96	9.86	40.16	40.14	10.21	9.96
	mean	13.2	13.9	2.76	2.72	9.78	9.72	40.15	40.15	9.30	9.11
10kg/fed as soil application											
	P1	14.2	15.0	2.76	2.70	10.0	9.92	40.15	40.16	8.16	8.18
	P2	15.4	16.1	2.83	2.80	10.13	10.03	40.15	40.15	10.43	10.92
	P3	16.1	17.0	2.86	2.83	10.52	10.38	40.16	40.15	10.85	11.35
	P4	16.1	17.1	2.86	2.83	10.53	10.37	40.15	40.16	10.86	11.34
mean		15.5	16.3	2.83	2.79	10.30	10.18	40.15	40.16	10.08	10.45
2%foliar spraying	P1	13.8	14.4	2.73	2.64	9.73	9.56	40.15	40.17	7.75	8.03
	P2	15.1	16.0	2.80	2.77	10.01	9.87	40.16	40.16	10.17	10.66
	P3	15.9	16.7	2.83	2.81	10.25	10.3	40.17	40.16	10.76	11.17
	P4	15.8	16.8	2.83	2.80	10.24	10.4	40.15	40.17	10.75	11.16
mean		15.2	16.0	2.80	2.76	10.10	9.88	40.16	40.17	9.86	10.26
mean of P levels											
	P1	13.0	13.8	2.27	2.65	9.72	9.65	40.14	40.16	7.62	7.77
	P2	14.7	15.4	2.80	2.77	9.96	9.84	40.15	40.16	10.08	10.33
	P3	15.4	16.2	2.83	2.80	10.25	10.09	40.16	40.15	10.61	10.82
	P4	16.2	16.2	2.83	2.79	10.24	10.09	40.15	40.16	10.61	10.82
L.S.D at o.o5											
A		0.17	0.17	0.02	0.02	0.05	0.06	NS	NS	0.15	0.17
B		0.31	0.33	0.06	0.05	0.08	0.07	NS	NS	0.13	0.34
AB		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

vegetative growth. Also , Singh et el (2014) mentioned that in case of higher P , the accumulation of dry matter was augmented higher in case better photosynthesis , in turn better supply ofphotosynthesis and assimilation in fruits . The positive effect of nano – rock P on yield and yield components may be due to nano - particle fertilizers have high reactivity due to higher specific area , which enhanced the absorption of phosphorus. In addition to, Urrota(2010) mentioned that nano fertilizers stimulate the root growth, consequently improved water and nutrient absorption towards the areas of metabolic activity. These results are in a good agreement with those obtained by Meena et el (2017) and Eed *et el* (2018) and Hussien et el (2015) for nano- phosphorus fertilizer **.**

As for the humic acid effect , the data clearly show that either soil application or foliar sprayingof humic acid were significantly augmented yield and yield components of cotton , except lint percentage . The effect of humic acid as soil application is more pronounced on these characters than the effect of foliar spraying . Over control , the increment in seed cotton yield due to 10kg/fed humic acid and foliar spraying of 2% humic acid solution reached to 8.4 and 6.0 % in the first season and 14.7 and 12.6 % in the second one , respectively . Regardless , the method of humic acid application , the beneficial effect of humic acid on yield and yield component may be due to their effect on increasing vegetative growth parameters (Table , 3) , photosynthetic pigments and leaf N,P and K content (Table , 6) ,which increased plant productivity . Similar results were obtained by Ahmed et el (2013).

Concerning the interaction between phosphorus and humic acid treatments , the obtained data clearly show that all studied yield and yield component parameters did not respond to the interaction between the two factors . which means that each factors may be acting independently on these parameters . On general , the treatment of 31kgP_2O_5/fed + 10kg/fed humic acid as soil application produced the highest yield and yield component of cotton plant (except lint %) .On the other hand the treatment of without phosphorus fertilization + without humic acid application yielded the lowest ones .

Fiber properties:

Data in Table (5) show the effect of phosphorus fertilization and humic acid application and their interactions on fiber properties , i.e. fiber length (Pressely index) , fiber fineness (Micronair reading) , Fiber length (mm) and uniformity index) . The obtained data indicate that , phosphorus fertilization , whether mineral or nano aswell as humic acid as soil or foliar application and their interactions did not exhibited any effect on the abovementioned fiber properties . This may be due to these characters were less affected by the environmental factors , beside these properties had genetical and varietal affect (Emaraet el , 2018) . these results agree with those obtained by Hamoudaet el (2014) and Emara and Abd el –Aal (2017) .

Table (5) Effect of mineral and nano phosphorus fertilization under humic acid application on fiber properties

Humic acid (A)	P-fertilization (B)	Fiber strength pressley index		Fiber fineness (Micr nair reading)		Fiber length (mm)		Uniformity ratio %	
		2018	2019	2018	2019	2018	2019	2018	2019
0.0 Control	P1	9.2	9.2	4.5	4.4	31.1	31.3	81.6	81.5
	P2	9.4	9.3	4.4	4.5	31.2	31.5	81.5	81.4
	P3	9.3	9.2	4.5	4.5	31.1	31.3	81.6	81.5
	P4	9.3	9.2	4.5	4.4	31.0	31.3	81.6	81.6
	mean	9.30	9.23	4.45	4.45	31.1	31.35	81.58	81.5
10 kg/fed as soil application	P1	9.3	9.1	4.5	4.4	31.0	31.5	81.7	81.8
	P2	9.4	9.0	4.5	4.5	31.2	31.4	81.5	81.7
	P3	9.3	9.1	4.5	4.4	31.1	31.3	81.6	82.0
	P4	9.4	9.2	4.4	4.4	31.4	31.4	82.1	81.6
	mean	9.35	9.1	4.48	4.43	31.18	31.4	81.73	81.78
2% Foliar spraying	P1	9.4	9.1	4.4	4.5	31.2	31.4	81.1	82.0
	P2	9.3	9.1	4.5	4.3	31.2	31.5	81.3	81.8
	P3	9.3	9.0	4.5	4.4	31.1	31.4	81.6	82.1
	P4	9.4	9.2	4.4	4.4	31.3	31.4	81.6	81.7
mean		9.35	9.1	4.54	4.40	31.20	31.4	81.9	81.9
Mean of P levels	P1	9.30	9.10	4.47	4.43	31.1	31.4	81.8	81.77
	P2	9.37	9.13	4.47	4.43	31.2	31.5	81.8	81.63
	P3	9.30	9.10	4.50	4.43	31.1	31.3	81.6	81.87
	P4	9.37	9.20	4.43	4.40	31.23	31.4	81.8	81.63
L.S.D. at 0.05									
A		NS	NS	NS	NS	NS	NS	NS	NS
B		NS	NS	NS	NS	NS	NS	NS	NS
AB		NS	NS	NS	NS	NS	NS	NS	NS

Leaf cotton contents of nutrients and chbrophy :

The effects of phosphorus and humic acid treatments and their interactions are shown in Table (6). As for phosphorus , the results indicate that leaf cotton content , i.e, N,P and K (%) as well as chlorophyll A and B were significantly affected by phosphorus fertilization . The maximum values for leaf cotton content were obtained from added 31kg $P2O_5$/fed , while without phosphorus fertilization exhibited the lowest ones . Compared with control , spraying cotton plant with 2% solution of nano – rock P increased these contents by about 20.1,54.5, 16.7, 5.7 and 18.7 % , respectively in the first season . Similar trends were obtained in the second season and for the treatment of 31kg P_2O_5/fed . These increment may be due to phosphorus application led to increase available P in soil resulted in well- established transport of water and nutrients towards cotton leaf (Iqbal et el ,2020) . Also , Abou El- Nour et el (2010) and Favi et el (2015) reported that nano- particles having larger surface area than bulk fertilizers led to more contact with and reactive responses from leaf plant surface , consequently enhanced to more water and nutrient absorption as mentioned before . As for chlorophyll A and B , Wahdan et el (2000) mentioned that

P plays an important role in many enzymatic reaction , which effect phosphorylation , in turn increase the pigments content in plant leaves . These results are in line with those obtained by Abd El – Gayed and Abd El – Hafeez (2014) for chemical P and Hussien et el (2015) for nano – phosphorus fertilizer . With regard to humic acid , the data show that leaf cotton content were significantly affected by humic acid application . It could be arranged the effect of humic acid treatments on leaf cotton content in the descending order as : follow without humic acid > foliar spraying of humic acid > soil application of humic acid . The relative increasing in N,P,K , chlorophyll A and B due to 10kg /fed humic acid and foliar spraying of humic acid were 17.5 and 10.2 ,8.5 and 6.0 , 9.3 and 5.2 , 27.2 and 25.3 , and 16.2 and 12.5 % in comparison with control , respectively in first season . Similar trends were obtained in the second season . The beneficial effect of humic acid on leaf cotton content could be explained by its effect in improving nutrients availability in root zone leading to more nutrient uptake which resulted in corresponding increase in chlorophyll fluorescence Raddy et el (2016) .

Table (6) Effect of mineral and nano phosphorus fertilization under humic acid application on leaf chemical contents

Humic acid (A)	P-Fertilization (B)	N(%)		P(%)		K (%)		Chlorophyl A (mg/g ,dw)		Chlorophyl B (mg/g dw)	
		2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
0.0 control	P1	1.68	1.83	0.16	0.14	2.22	2.25	2.17	3.19	2.16	2.01
	P2	1.92	1.90	0.19	0.17	2.41	2.46	2.23	3 .30	2.29	2.08
	P3	2.23	2.21	0.22	0.20	2.64	2.67	2.34	3.35	3.33	2.22
	P4	2.22	2.21	0.22	0.20	2.65	2.67	2.33	3.34	3.32	2.21
Mean		2.06	2.04	0.20	0.18	2.48	2.51	3.27	3.29	2.78	2.13
10kg/fed as soil application	P1	2.12	2.10	0.28	0.25	2.44	2.46	3.16	3.19	2.21	2.16
	P2	2.46	2.14	0.37	0.33	2.76	2.80	3.28	3.30	2.32	2.30
	P3	2.55	2.52	0.42	0.40	2.83	2.86	3.32	3.35	2.75	2.72
	P4	2.56	2.53	0.41	0.40	2.82	2.86	3.31	3.34	2.74	2.72
mean		2.24	2.35	0.37	0.35	2.71	2.74	3.27	3.30	2.51	2.48
2% as foliar spraing	P1	2.00	1.90	0.21	0.19	2.35	2.38	3.10	3.12	2.16	2.11
	P2	2.27	2.22	0.30	0.28	2.64	2.68	3.21	3.24	2.29	2.25
	P3	2.40	2.37	0.39	0.36	2.71	2.75	3.28	3.32	2.63	2.60
	P4	2.40	2.37	0.39	0.37	2.72	2.76	3.28	3.31	2.62	2.60
mean		2.27	2.22	0.32	0.30	2.61	2.64	3.22	3.25	2.43	2.39
Mean of P levels	P1	1.99	1.94	0.22	0.19	2.34	2.36	2.81	2.83	2.14	2.09
	P2	2.22	2.18	0.29	0.26	2.60	2.65	2.91	2.94	2.24	2.21
	P3	2.39	2.37	0.34	0.32	2.37	2.76	2.98	3.01	2.54	2.51
	P4	2.39	2.37	0.34	0.32	2.37	2.76	2.97	3.00	2.54	2.51
L.S.D at o.o5											
A		0.08	0.06	0.02	0.02	0.07	0.08	0.07	0.08	0.07	0.07
B		0.06	0.05	0.02	0.03	0.06	0.06	0.07	0.07	0.06	0.05
AB		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

These results are in line with those obtained by Asik *et el* (2009) , Denre et el (2014) for the effect of soil application of humic acid on wheat , Garlic and cotton plants , respectively and Ahmed et el (2013) , Osman et el (2013) and Bezuglova et el (2017) for the effect of foliar spraying of humic acid on cotton , rice and wheat plants , respectively. The data of the interaction revel that chemical content in cotton leaves did not affected by the interaction between phosphorus and humic acid treatment . In general , leaf cotton plants treated with 31.0kgP_2O_5/fed or nano rock P along with 10kg/fed humic acid contain maximum N,P,K and chlorophyll A and B . On the other had the lowest values of these constituents were recorded for the plants without both phosphorus and humic acid application.

CONCLUSION

From the results of this investigation , it could be recommended supplement the high price chemical phosphorus fertilizer by using the nano – particle technology for natural rock P in combined with humic acid to improve cotton productivity , beside improve soil properties and fertility .

REFERANCES

Abd El – Gayed , S.SH. and A.M.Abd El – Hafeez (2014) . Fertilizing cotton with calcium superphosphate combined with rock phosphate and its effect on cotton productivity and soil fertility .Egypt . J. Agric .Res., 92 (1) : 197 – 210 .

Abdel – Fattah , M.K.(2012) . Role of gypsum and compost in reclaining saline – sodic soils . J . Agric . Veterinary Sci ., 1: 30 – 38 .

Abou El – Nour , K.M.M.; A.Al – Warthan and R.A.R. Ammar (2010) . Synthesis and application of silver nanoparticles . Arab J . Chem ., 3: 135-140 .

Abou-El- Nour , M.Sh.; O.M.M. Wassed and S. A. Ismail (2001). Response of Giza 80 cotton cultivate to some cultural properties to control excessive vegetative growth . Egypt .J. Agric . Res., 79(1) : 191 – 204 .

Adani , F. ; M. Spagnol and K.G.J. Nierop (2006) . Biochemical origin and refractory properties of humic acid extracted from maize plants . The contribution of lignin . Biogeochem. DOI 10 . 1007/5 10533-006-905-4.

Ahmed , sh. and M. Husanuzzaman (2020) . cotton production and uses . Agronomy ,Crop Production and Postharves Technologies . Springer Nature Songapore Pte LtD , pp : 87 .

Ahmed , H .M . R.M. and F.S.H.Ismail (2016) . Effectiveness of humic acid application on improving saline soil properties and fodder beet production . J.Soil Sci and Agric . Eng., Mansoura Univ ., 7(9) : 623 - 634.

Ahmed , T.A.M. (2017) . Studies on phosphorus fertilization for wheat plants . M.Sc Thesis . Fac . of Agric , Benha Univ . Egypt .

Ahmed ,A.H.; E.Darwish ; S.A.F.Hamoda and M.G . Alobaidy (2013) . Effect of putrescine and humic acid on growth , yield and chemical composition

of cotton plant grown under saline soil conditions , American – Eurasin J. Agric and Environ . Sci , 13 (4) : 479 – 497 .

Arnon , D.I. (1949) . Copper enzeme is isolated chloroplasts . Plant Physiol., 24 (1) : 1-5 .

A.O.A.C . (1990) . Official Methods of Analysis (15th ed) . The Association of Official Analytical Chemists .Inc.U.S.A.

Asik , B.B.; M.A. Turan ; H.Celik and A.V. Katkat (2009) . Effects of humic substance on plant growth and mineral nutrients uptake of wheat (Triticum durum c.v. Salihli) under conditions of salinity . Asian J. Grop Sci ., 1: 87-95 .

A.S.T.M. (1986). American Society for testing and Materials . D- 4605 , 7 (1) , Easton , MD, USA.

Baker , O.K. ; L.L.Volva ; S.V.Prudnikova and S. Prasad (2017) . Nanogagro particle trends and future prospect in modern agriculture system . Environ . Toxical pharmacc . .

Bezuglova , O.S . ; E.A. Policnko ; A.V. Gorovtsov ; V.A. Lyhman and P.D. Pavlov. (2017) . Annals of Agrarian Science , 15: 239-242.

Brady , N.C. and R.R. Weil (2008) . The Nature of Properties of Soils Pearson Prentice Hail , Upper Saddle River , NJ.

Brady , N.C. (2002) . Phosphorus and potassium . In : The nature and properties of soils . Prentice – Hall of India , Delhi : PP 352 .

Cavusoglu , M.N.; N. Turkoglu and F.A. Ozdemir (2017). The effects of phosphorus and humic acid on some soil properties flowers quality of Gladiolus . Journal of Nutrition and International Medicine ,19 (1-5) : 150-155.

Chapman , H.D. and F. Pratt (1961). Method of Analysis of Soil , Plants and Water , Univ. Calf .

Denre , M., S. Ghanti and Sh . Sarker (2014) . Effect of humic acid application on accumulation of mineral nutrition and pungency in garlic (Allium sativum L.) . Int. J. Biotechnol . Mol . Biol . Res . , 5 (2) : 7-12 .

Drobek , M.; M. Frac ; J. Cybulska (2019). Plant biostimulants : importance of the quality and yield of horticultural crops and improved of plant tolerance to a biotic stress – a review . Agronomy , 9:335 . doi : 10 – 3390 / agronomy 9060335 .

Eed, S.; A.A. Nbdall ; A.M.Anany ; Hossain and R.A. Houda (2018). Evaluation of nitrogen , phosphorus and potassium nano – fertilizers on yield , yield component and fiber properties of Egyption cotton (Gossypiun barbadense L.) . Journal of Plant Science and Crop production , 1(3) : 302- 311 .

El- Sherief , A.A. ; M. F. Tantawy and Kh. A. Shaban (2013) . Improving newly reclaimed sandy saline soil properties and its productivity of Suden grass by organic , bio and mineral N fertilization . On Environmental Studies and Research (Natural Resources and Future Challenges). Environmental Studies and Research Institute (ESRI) . University of Sadat City , Egypt , 25 – 27 February , PP – 249 – 266 .

El – Sheref , Gh.F.H.; H.A.Awadalla and G.A. Mohamed (2019) . Use of gypsum and sulphur for improving rock P efficiency and their effect on wheat productivity and soil properties . Alex .J . Soil and Water Sci (Fac . Agric Saba Basha) , 3 (2) : 50 – 67.

Emara , M.M.A. ; S.A.F.Hamouda and M.M.A.Hamada (2018) . Effect of potassium silicate and NPK fertilization levels on cotton growth and productivity under different sowing dates . Egypt . J. Agron ., The 1sth Int .Conf . Crop Sience , pp . 115-123 .

Emara , M.A. and A.S.A. Abde – Aal (2017) . Effect of nano – fertilizer on productivity of cotton under stress conditions . Egypt . J. Sci. , 32(12B) :445-458.

Eyheraguibel , B. ; J. Silvestre and Morard (2008) . Effects of humic substance derived from organic waste enhancenment on the growth and mineral nutrition of maize. Bioresource Technology, 99: 4206-4212.

Favi , P.M.; M.M. Valencia and P.R. Elliott (2015). Shape and surface chemistry effects on the cyto- mtoxicity and cellular uptake of metallic nanorods and namospheres. J. Biomed matter Res ., Alo3 : 3940 – 3955 .

Gowda , A.M. ; A.A. El- Taweel and K.B .Eassa (2011) . Studies on reducing the harmful effect of saline water irrigation on picual olive . Minufiya J.Agric .Res ,36 (3)623-645**.**

Hamoda , S.A.F. ; M.A. Ibrahim and M.A.Emara (2014). Effect of irrigation intervals and NPK fertilization on growth , yield and quality for new hybrid cotton [Giza75 x 5844] x Giza 80 . The 1st International cotton Conference . Challenges to sustainable Cotton Production and Quality ^{n} . Egypt . J .Agric . Res . (Special Issue) 92 (1) : 111-123 .

Hussian ,M.M. ; S.M.El Ashry ; W.M.Haggag and D.M.Mobark (2015) . Response of mineral status to nano-fertilize and Moiture stress during different growth stage of cotton plants . International of chem. Tech Research , 8 (12) : 643-650 .

Iqbal , B.; F. Kong ; I. ullah ; S. Ali ; H. Li ; J.Wang ; W.A. Khattak and Z. Zhon (2020) . Phosphorus application improves the cotton yield by enhancing reproductive organ biomass and nutrients accumulation in two cotton cultivars with different phosphorus sensitivity . Journal of Agronomy , 10 (2) : 153—162 .

Jindo , K . ; F.L. Olivares ; D.J.P. Malcher ; M.A.S. Monedere ; C. Kempenaar and L.P. Canellas (2020) . From Lab to Field : Role of Humic substance Under Open – Field and Greenhouse Conditions Biostimulant and Biocontrol Agent . Front . Plant Sci ., doi –Org / 10.3389 fpls .

Lopez –Valdez , F. and F. Fernandez –Luqueno (2018**) .** Agricultural Nanobiotechnology . Modern Agriculture for a Swtainable Future . Springer Nature SwitzelandA.G.

Kazemi , M. (2014) . Effect of foliar application of humic acid and calcium chloride on tomato growth . Bulletin of Environment , Pharmcology and Life Sciences , 3 (3) : 41-46 . **Mackowiak , C.L. ; P.R. Grossel and**

B.G. Bugbee (2001) .Benificial affects of humic acid on micronutrient availability to wheat . Soil Soc . Am .J. , 65 : 1744 – 1750 .

Mai , W., X.Xue ; F.Gu ; Y.Rong and C. Tim (2018) . Can application of phosphorus input lead to high productivity and high phosphorus use efficiency of cotton through maximization of root / mycorrhizal efficiency in phosphorus acquisition ? . Field Crop Res ., 216 : 100 – 108.

Meena , D.S.; C.Gautam ; Q.Patidar ; H. Meena and G. Prakasha (2017) . Nano fertilizers is a new way to increase nutrient use efficiency in crop production . International Journal of Agriculture Sciences , 9 : 3831- 3.

Mouromicale , G. ; M.G.L.Angela and A.L. Momaco (2011) . The effect of organic supplementation of salarized soil on the quality of tomato . Sientin Hort ., 29 (7) : 189—196.1

Natesan , R. ; S. Kandasamy ; S. Thiyageshwari and P.M. Boopathy (2007). Influence of lignite humic acid on the micronutrient availability and yield of blackgran in an alfisol . Sci . World J., 7 : 1198 – 1206 .

Osman , A. Sh. and M. M. Rady (2012) . Ameliorative effects of sulphur and humic acid on the growth , antioxidant levels and yield of Pea (Pasium sativum L.) plants grow in reclaimed saline soil . J. Hortic . Sci . Biotechnol . , 87 : 226 – 232 . **Osman , E.A.M. ; A.A. El- Masry and K.A. Khatab (2013) .** Effect of nitrogen fertilizer source and foliar spray of humic and / or fulvic acids on yield and quantity of rice plants . Adv . Appl . Sci . Res ., 4 (4) : 174 – 183 .

Ouni, Y.; T. Ghnaya ; F. Monternurro ; Ch. Abdelly and A. Lakhdar (2013) . The role of humic acid substances in mitigation the harmful effects of soil salinity and improve plant productivity . International . J . of Plant Production , 8 (3) : 353 – 374 .

Quilty , J. and S.Cattle (2012) . Use and Understanding of Amendments in Australian : A Review Soil Research ,4(1) :1-26.

Rady , M.M.; T.A. Abd El- Mageed ; H.A Abdurrahman and A.H. Mahdi (2016). Humic acid application improves field performance of cotton (Gossypium barbadence L.) under saline conditions . The Journal of Plant Sciences , 28 (2) : 487-493 .

Seadh , S.E. ; M.H.El-Hendi ; H.A. Abd El-Aal and S.S.El-Sayed (2012). Effect of NPK rates and humic acid application on growth of Egyption .J.Flant Production , Mansoura Univ., 3(8) : 2287-2299.

Singh, S.K ; V.R. Reddy ; D.H. Fleisher and D.J. Timlin (2014) . Growth nutrient dynamics and efficiency reponses to carbon dioxide and phosphorus nutrition in soyben .J.Plant interact ., 9: 838-849.

Soliman , A.SH .; M.Hassan ; F.Abou-Elella ; A.H.H.Ahmed and S.A.El- Feky (2016) . Effect of nano and molecular Phosphorus fertilizers on growth and chemical composition of boobab Adansonia digitata L.) . Journal of Plant Science , 11(4) : 52-60 .

Uarrola , V.G. (2010) . Response of cowpea (Vigna unguiculata L. Wolp) to water stress and phosphorus fertilization . J.Agron., 9: 87 -91.

Seudec, G.W. and Cochran W. G. (1980). Statistical Methods ^{H} 7th ed Iowa State Universty Press, Iaw, V. S. A.

Widowati,I.; W.Utomo ; B.Guritno and L.Soehmo (2012) . The effect of biocher on the growth and N fertilizer requirement of maize (Zea mays L) in greenhouse experiment . J. Agric . Sci ., 4 : 255 – 262.

Wohdan , G.A.; U.A. Saeed and H.H. Ghourab (2000) . Role of phosphorus as foliar application flowering stage on naturation of cotton plants : Chemical composition , yield components and seed quality . Minufiya J. Agric . Res ., 25 (4) : 891-905.

تأثير بعض صور أسمدة الفسفور مع استخدام حامض الهيوميك على أنتاجية القطن صنف جيزة ٩٥ وخواص التربة وخصوبتها

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أجريت تجربتان حقليتان بمزرعة البحوث الزراعية بسدس – محافظة بنى سويف - مصر فى موسمى النمو ٢٠١٨،٢٠١٩ لدراسة امكانية الاستفادة من تكنولوجيا النانو بأستخدام رش محلول صخر الفوسفات النانو بدلا من سماد السوبر فوسفات مع استخدام حامض الهيوميك على انتاجية القطن وصفات التربة وخصوبتها بعد الحصاد . وقد أستخدم نظام القطع المنشقة للتجربة ، وكانت معاملات الفسفور كما يلى بدون تسميد فوسفاتى ، ١٥,٥ كجم ، ٣١كجم من فو٢أه / فدان من سماد السوبر فوسفات كأضافة أرضية ، رش محلول صخر الفوسفات النانو بمعدل ٢% مرتان بينما كانت معاملات حامض الهيومك كما يلى : بدون هيومك ، أضافة ١٠كجم /فدان هيومك كأضافة أرضية ، رش محلول حامض الهيومك بمعدل ٢% مرتان . ويمكن تلخيص أهم النتائج كما يلى :-

- لم تتأثر خواص التربة وخصوبتها بمعاملات التسميد الفوسفاتى ، ما عدا الفسفور الميسر فى التربة بعد الحصاد ا لذى أزداد بأضافة سماد السوبر فوسفات أرضى .
- أدى أضافة ١٠كجم / فدان حامض هيومك الى تحسين كلا من حموضة التربة ، المادة العضوية بالتربة ، الكثافة الظاهرية والماء الميسر للتربة بعد حصاد القطن .
- أدى التسميد الفوسفاتى وحامض الهيومك الى زيادة كلا من أرتفاع النبات وعدد الافرع الثمرية للنبات وعدد اللوز المتفتح للنبات ووزن اللوزه ومحصول القطع الزهر ومحتوى أوراق القطن من النيتروجين والفوسفور والبوتاسيوم والكلوروفيل أ والكلوروفيل ب ، بينما تأثرت نسبة التبكير بالتسميد الفوسفاتى فقد ،حيث أزداد التبكير بالتسميد الفوسفاتى ، وكان تأثير رش الفوسفور النانو مساويا أحصائيا لتأثير أضافة حامض الهيومك أرضى على أضافته رشاً .
- لم تتأثر صفات الالياف بمعاملات أضافة الفوسفور وحامض الهيومك .
- أظهرت نتائج التداخل أن أفضل المعاملات هى رش ٢% من صخر الفوسفات النانو أو أضافة ٣١كجم /فدان سوبر فوسفات + أضافة ١٠كم / فدان حامض الهيومك .
- ويمكن التوجيه برش نبات القطن بمحلول صخر الفوسفات النانو بمعدل ٢% مرتان مع أضافة حامض هيومك أرضى بمعدل ١٠كم / فدان لتعظيم أنتاجية القطن وتحسين خواص التربة .