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Effect of Different Sources of Phosphorus and Boron on Chemical Composition and Water Relations in Leaves, Growth, Productivity and Quality of Egyptian Cotton.

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ABSTRACT

Two field experiments were carried out on clay soil in El-Gemmeiza Agric. Res. St., ARC, El-Gharbiya Governorate, Egypt during 2015 and 2016 seasons to study the effect of four phosphorus and boron fertilizers sources on leaves chemical composition, photosynthetic pigments and water relations, growth, seed cotton yield/fed and its components and fiber quality of Egyptian cotton cultivar Giza 86. A split-plot design with four replicates was used, where the main plots included treatments of phosphorus namely; A-Soil application of 22.5 kg P_2O_5/fed. as superphosphate (Control), B- Phosphate rock + Phosphorein (400g/30kg seed), C- Foliar application of 2 ml phosphoric acid/liter water, and D- Phosphorein (400g/30kg seed)., and the sub plots involved the sources of boron namely; 1- Control (without application), 2- Foliar spray with boric acid, 3- Foliar spray with B-Nano, and 4- Foliar spray with B-EDTA. The obtained important could be summarized as follows: 1-The phosphorus sources gave significant effect on leaves N, P, K, photosynthetic pigments, total sugars, total carbohydrates and proline contents, leaves water content, water deficit, relative water content and osmotic pressure in 2016 season, No. of open bolls/plant, boll weight, seed cotton yield/plant, seed cotton yield/fed, lint percentage and seed index in both seasons, in favor of soil application with 22.5 kg P_2O_5/fed, final plant height and No. of sympodia/plant, in favor of foliar application with phosphoric acid.2- Foliar application with boron treatments fertilization significantly affected leaves N, P, K, photosynthetic pigments, total sugars, total carbohydrates and proline contents, leaves water content, water deficit, relative water content, osmotic pressure and transpiration rate in 2016 season, plant height at harvest, No. of sympodia/plant, No. of open bolls/plant, boll weight, seed cotton yield/plant, seed cotton yield/fed., lint percentage and seed index in both seasons, where the superiority was found in favor of foliar spray with B-Nano 5 g/liter water. 3-The interaction between phosphorus and boron fertilizers sources gave a significant effect on leaves N, P, K, photosynthetic pigments, total sugars, total carbohydrates and proline contents, leaves water content, water deficit, relative water content and osmotic pressure in 2016 season, boll weight, lint % and seed index in 2015 season and No. of open bolls/plant, seed cotton yield/plant, seed cotton yield/fed., in 2015 and 2016 seasons, in favor of soil application with 22.5 kg P_2O_5/fed and foliar spraying with B-Nano 5 g/liter water.4- Upper half mean length, uniformity index, micronaire reading and fiber strength did not affect by the different phosphorus and boron sources and their interaction in both seasons.

Keywords: Cotton, Phosphorus, Boron, Growth, Yield, Photosynthetic and Fiber.

INTRODUCTION

Yield and growth are affected by environmental factors and agricultural practices interacting with the genetically determined physiological and biochemical systems of the plant. Agricultural production strategy must be based on optimizing plant function in relation to environment to give high productivity with long-term stability. Cotton growers face major problem of increase in production cost. There is a constant increase in prices of many inputs; raising production costs and wiping out profit margins. Fertilizer is one of many inputs, which raises production cost (Bickersteth and Walker 1988).

Cotton crop in general showed tremendous response to fertilizers in all soil types, but its response to phosphorus fertilizer was erratic and variable in most areas (Malik *et al.,* 1996). However many soils throughout the world are phosphorus deficient because the free phosphorus concentration even in fertile soils is generally not higher than where it is most soluble (Arnou, 1953). Consequently, to achieve optimum crop yields, soluble phosphate fertilizers have to be applied at high rates which cause unmanageable excess of phosphate application and environmental and economic problems (Brady, 1990). However, there are cases where cotton response to phosphorus has been positive and economical (Gill *et al.,* 2000). Several factors including soil type affect cotton response to phosphorus. The critical level of phosphorus is a function of actual concentration of the labile pool that in turn determines the available phosphorus at a given time during the growth of cotton (Crozier *et al.,* 2004). Reiter and Kreig (2000) reported some positive and notable phosphorus effects on lint fiber quality factors. Although both lint yield and lint quality were driven more by moisture availability than by phosphorus. Foliar spraying has been recommended by many workers to increase most of cotton yield characters (Wahdan *et al.*, 2000; Muhammed *et al.,* 2001; Singh, 2003; Kefyalew *et al.*, 2007; Sawan *et al.*, 2008 and Saleem *et al.*, 2010). Information available on phosphorus requirements for cotton plants showed better response to moderate dose of phosphorus application namely; 15.5-31 kg P_2O_5/fed. (Koreish *et al.,* 1998 and Abou-Zaid *et al.,* 2009 and 2013).

Micronutrients deficiencies occur under low organic matter and high pH of Egyptian soils, (Hamissa and Abdel-Salam, 1999). Micronutrients play many complex roles in plant development, production and stress tolerance, (El-Fouly, 2006 and Wazir and Shahbaz, 2013). Foliar application with micronutrients reduce boll shedding and increase the yield (Radhika *el al.,* 2013).

Boron has been universally recognized as the most important micronutrient for cotton production, and cotton plant requires boron in relatively large amounts as compared with other plants (Roberts *et al.*, 2000). Boron regulates the percentage of water in the plant, where it controls in the speed of plant absorption or its various parts absorption to water. In addition, major function of boron is in sugar transport to meristem regions of roots and tops, resulting in increased growth (Niaz *et al.*, 2002). Boron helps in the biosynthesis of cell walls, and thereby cell division and elongation, in the rapidly growing, conductive and storage tissues; and also aids in sugars and nutrients translocation, resulting in promoting growth of vegetative growing tissues and developing storage sinks (Blevins and Lukaszewski, 1998). Boron deficiency during flowering and fruiting significantly reduced boll retention, resulting in lower yields (Gupta, 1993). Rosolem and Costa (1999) and Zhao and

Oosterhuis (2003) showed that boron deficiency in cotton decreased leaf photosynthesis and carbohydrate transport from leaves to developing fruit, depressed total dry matter production, plant height, number of reproductive structures, plant growth resulting in increased fruit abscission. Carvalho *et al.* (1996) and Howard *et al.* (1998) reported that foliar sprays of boron at early growth stages significantly increased yield and fiber length. Many recent studies have demonstrated positive effects of foliar application of boron on cotton growth, fruit retention, yield and yield components of cotton Saeed (2000); El-Shazly *et al.* (2005); Kassem *et al.* (2009); Halepyati *et al.* (2012), El-Gabiery (2014) and Attia *et al.* (2016). These contrasting results may be associated with soil texture, soil pH, soil fertility, and soil boron level because all these factors influence boron uptake by plants and crop yield response to supplemental boron application (Gupta, 1993).

Our objective was to determine the influence of different phosphorus and boron fertilizers sources fertilizers on leaves chemical composition, photosynthetic pigments, water relations, growth, seed cotton yield, yield components and fiber quality of cotton Giza 86 cultivar in El-Gemmeiza location.

MATERIALS AND METHODS

Two field experiments were conducted during the two successive seasons 2015 and 2016 on a clay soil in El-Gemmeiza Agric. Res. St., El-Gharbiya Governorate, Egypt, to study the effect of different phosphorus and boron fertilizers sources on chemical composition, photosynthetic pigments and water relations in leaves, growth, seed cotton yield, yield components and fiber properties of Egyptian cotton cultivar Giza 86. A split-plot design with four replicates was used.

The main plots involved the four treatments of phosphorus sources namely;

A- Soil application of 22.5 kg P_2O_5/fed, as calcium superphosphate during land preparation.

B- Phosphate Rock + Seed inoculation with Phosphorein 400 g/30 kg seeds.

C- Foliar application with phosphoric acid at the rate of $2cm^3$/Liter water.

D- Seed inoculation with Phosphorein 400g/30kg seeds.

Phosphorein is a commercial multi-strains bio-fertilizer produced by the General Organization for Agricultural Equalization Fund in Egypt (GOAEF), Ministry of Agriculture. Seeds inoculated with Phosphorein were not dressed by either fungicide or pesticides. The inoculation was performed by coating seeds at the rate of 400 g/30Kg seeds, using a sticking substance (Arabic gum 5%) just before sowing. Seeds were sown in dry soil and then immediately irrigated.

The sub plots involved the four treatments of boron fertilizer sources were:

1) Without application (Control).

2) Foliar spray with boric acid 2 g/L water.

3) Foliar spray with B-Nano 5 g/L water.

4) Foliar spray with B-Edta 2 g/L water.

The foliar spraying treatments under study was done two times at the flowering initiation then after 15 days.

Before sowing representative samples of soil were taken in the two seasons from the experimental soil sites and prepared for analysis according to Page *et al.* (1982) and results of the soil analysis are shown in Table 1.

Table 1. Some properties of the experimental soil

Season	pH	EC (mmhos/cm)	Available element (ppm)				Organic matter (%)	Texture class
			N	P	K	B		
2015	7.8	0.26	21.3	10.7	312	0.27	1.29	Clay
2016	8.0	0.54	28.7	11.1	306	0.34	1.42	Clay

The size of each plot was 14 m2 included five ridges70 cm wide and 4 m long with hills 25 cm apart. Sowing date was on 8th April in both seasons. The preceding crop was Egyptian clover (Trifolium alexandrinum L.). The plants were thinned to two plants/hill before the first irrigation.

Nitrogen fertilizer was added as ammonium nitrate (33.5% N) at the rate of 45 Kg N/fed in two equal portions, the 1st portion was applied after thinning and the 2nd portion was added at the following irrigation. Potassium was added as Potassin-P three times. The other cultural practices were carried out as recommended for the conventional cotton planting.

Leaves water relations; after 110 days from planting leaves total water content (TWC %), free and bound water (Gosev, 1960 and Kreeb, 1990), relative water content (RWC %) (Barrs and Weatherley, 1962), leaf water deficit (LWD), osmotic pressure (Gosev, 1960) and transpiration rate (Kreeb, 1990) were determined in the second season.

Leaves chemical composition; After 110 days from planting a leaf sample of 10 leaves (blade + petiole) was taken from the youngest fully matured leaves (4th leaf from the apex of the main stem) from each plot. After samples preparation for analysis photosynthetic pigments; Chlorophyll a, chlorophyll b, total chlorophyll, the ratio of chlorophyll b to a and carotenoids wettestein's formula in (A.O.A.C., 2005), Determination of total carbohydrates using the phenol sulfuric acid method as described by A.O.A.C. (2005). Proline concentration was measured according the method of Bates et al., (1973). Determination of mineral composition; Nitrogen, phosphorus and potassium (%) in leaves were determined, respectively as a described by A.O.A.C. (2005) in the second season, only (2016).

In both seasons, ten representative plants were from the 2nd ridge within each plot to determine the following traits: Growth characters; final plant height at harvest from the cotyledonary node to the apix of the main stem (cm) and number of sympodia/plant. Yield and yield components; number of open bolls/plant, boll weight (g), seed cotton yield/plant (g), lint % and seed index (g). The yield of seed cotton in kentars/fed was estimated from the three inner ridges of each plot.

Fiber quality; Fiber length and uniformity index, fiber fineness and fiber strength were determined on digital

Fibrograph instrument 630, Micronaire instrument 675 and Pressley instrument, respectively, according to A.S.T.M. (2012) at the C.R.I. laboratories.

Statistical analysis was done according to the procedures outlined by Snedecor and Cochran (1980) using M Stat-C microcomputer program for a split plot. The treatments means were compared using L.S.D. values at 5% level of probability.

RESULTS AND DISCUSSION

The results of water relations, chemical composition and photosynthetic pigments in leaves, growth, seed cotton yield and its components and fiber quality as affected by phosphorus and boron treatments fertilization and their interaction on cotton Giza 86 during 2015 and 2016 seasons are shown in Tables 2 to 7.

A-Water relations:

There was a remarkable gradual increase in TWC, free water and RWC, meanwhile a significant decrease in bound water, LWD and osmotic pressure in leaves of cotton plants with all treatments nutrition of phosphorus or boron and their interaction (Table 2).

1- Effect of phosphorus sources:

The data listed in Table 2 indicated that, TWC, free water, RWC, bound water, LWD and osmotic pressure were significantly affected by the different treatments of phosphorus. Where the highest increase in TWC, free water, bound water and RWC was recorded from superphosphate application, meanwhile, the highest decrease in LWD (8.89%) and osmotic pressure (4.86 bar) was recorded at the same application at 110 days from sowing as compared with the control.

2- Effect of boron treatments:

Data presented in Table 2 showed that, the application with the different boron sources had a significant effect on water relations measurements in leaves of cotton plants. TWC, free water, bound water, RWC and transpiration rate were increased, meanwhile, LWD and osmotic pressure were decreased in leaves of cotton plants treated with the different sources of boron nutrition. The maximum increase was observed at foliar application treatment of B-Nano with regard to TWC (87.56%), free water (13.40%), bound water (74.16%) and RWC (78.93%), meanwhile, the highest decrease in LWD (9.21%) and osmotic pressure (4.92 bar) was observed at foliar spray with B-Nano 5 g/L water at the flowering initiation then after 15 days.

Table 2. Water relations in cotton leaves as affected by the different phosphorus and boron fertilizers sources and their interaction during 2016 season.

Treatments Phosphorus sources (A)	Characters Boron sources (B)	Water content (%) Total	 Free	 Bound	Leaf water deficit (%)	Relative water content (%)	Osmotic pressure (bar)	Transpiration rate (mg/gfw/h)
Superphosphate	Without B	85.18	13.04	72.14	9.08	76.66	5.75	0.27
	Boric acid	87.30	13.36	73.94	8.97	77.35	4.84	0.28
	B-Nano	89.48	13.70	75.78	8.59	84.63	4.32	0.29
	B-Edta	88.11	13.49	74.62	8.91	81.44	4.53	0.28
Mean		87.52	13.40	74.12	8.89	80.02	4.86	0.28
Phosphate Rock + Phosphorein	Without B	84.80	12.98	71.82	9.13	75.83	5.93	0.27
	Boric acid	85.83	13.14	72.69	9.07	76.13	5.45	0.27
	B-Nano	88.79	13.59	75.20	8.79	79.15	5.10	0.28
	B-Edta	86.93	13.30	73.63	8.94	77.42	5.21	0.27
Mean		86.59	13.25	73.34	8.98	77.13	5.42	0.27
Phosphoric Acid	Without B	84.23	12.89	71.34	11.87	75.66	5.36	0.26
	Boric acid	85.27	13.05	72.22	11.65	76.66	5.17	0.26
	B-Nano	87.77	13.43	74.34	9.61	77.68	4. 54	0.28
	B-Edta	86.32	13.21	73.11	10.56	77.06	4.79	0.27
Mean		85.90	13.15	72.75	10.92	76.77	5.11	0.27
Phosphorein	Without B	81.43	12.46	68.97	11.34	67.53	6.88	0.27
	Boric acid	81.90	12.53	69.37	10.11	71.29	6.60	0.27
	B-Nano	84.20	12.89	71.31	9.83	74.24	5.34	0.28
	B-Edta	82.43	12.62	69.81	10.05	73.61	5.98	0.28
Mean		82.49	12.63	69.87	10.33	71.67	6.20	0.28
Boron sources Mean	Without B	83.91	12.84	71.07	10.36	73.92	5.98	0.27
	Boric acid	85.08	13.02	72.06	9.95	75.36	5.52	0.27
	B-Nano	87.56	13.40	74.16	9.21	78.93	4.92	0.28
	B-Edta	85.95	13.16	72.79	9.73	77.38	5.13	0.28
LSD at 0.05 for	A	0.01	0.01	0.05	0.03	0.10	0.02	NS
	B	0.01	0.01	0.03	0.04	0.06	0.02	NS
	A X B	0.03	0.02	0.09	0.07	0.14	0.04	N.S

Similar findings have been demonstrated by Sharama and Ramchandra (1990) who also reported that, boron deficient plants had low water potential, stomatal pore opening and transpiration. Thus, the adequate quantities of boron supply to the needs of cotton plants improve water relations.

3- Effect of the interaction:

As shown from the obtained data and the analysis of variance, the interaction between phosphorus sources fertilizer treatments and foliar application boron sources treatments fertilization remarkable a significant effect on water relation measurements in leaves of treated cotton plants. The maximum values of TWC (89.48%), free water (13.70%), bound water (75.78%) and RWC (84.63%), meanwhile, the highest decrease in LWD (8.59%) and osmotic pressure (4.32 bar) were illustrated at soil application with superphosphate with foliar spray with B-Nano 5 g/L water. The minimum values of TWC (81.43%), free water (12.46%), bound water (68.97%) and RWC (67.53%) were obtained from seed inoculation with Phosphorein 400g/30kg seeds without foliar application of boron, meanwhile, the highest increase in LWD (11.34%) and osmotic pressure (6.88 bar) was recorded at the same interaction treatment.

The phosphorus (macroelemnt) and boron (microelemnt) are very important in the biological processes within the plant cell, such as the effect on enzyme activity and cycles of biosynthesis as they are entering in the composition of amino acids, fatty acids, nuclear acids and another different process. Therefore, it affects the formation of chlorophyll a and b and carotenoids leading it to influence on photosynthesis process and output of them from the simple and complex sugars. It follows that the effect on the osmotic pressure and water content of the plant cell, also leads to influence on absorption of mineral elements and the content of vacuole of this element.

Leaves chemical composition:

Averages of leaves N, P, K, total carbohydrates and total sugars contents at 110 days from planting as affected by phosphorus and boron sources as well as their interaction in 2016 season are shown in Table 3.

1- Effect of phosphorus sources:

The differences among phosphorus sources treatments in leaves N, P, K, total carbohydrates and total sugars contents were significant. The greatest values of these traits in consideration were produced from soil application with superphosphate during land preparation (control) and the least values resulted from seed inoculation with phosphorein 400g/30kg seeds.

Table 3. Cotton leaves chemical analysis as affected by the different phosphorus and boron fertilizers sources and their interaction in 2016 season.

Treatments / Characters: Phosphorus sources (A)	Boron sources (B)	N (%)	P (%)	K (%)	Total carbohydrates (mg/g dwt)	Total sugars (mg/g dwt)	Proline (µg/g fwt)
Superphosphate	Without B	3.45	0.49	3.57	0.927	0.021	219.97
	Boric acid	3.46	0.49	3.60	0.932	0.021	217.31
	B-Nano	3.49	0.55	3.69	0.954	0.022	208.10
	B-Edta	3.43	0.54	3.62	0.937	0.021	215.85
Mean		3.46	0.52	3.62	0.938	0.021	215.31
Phosphate Rock + Phosphorein	Without B	3.37	0.44	3.57	0.911	0.019	221.18
	Boric acid	3.38	0.48	3.58	0.917	0.019	219.73
	B-Nano	3.47	0.43	3.66	0.937	0.021	212.94
	B-Edta	3.42	0.44	3.60	0.929	0.021	216.58
Mean		3.41	0.45	3.60	0.924	0.020	217.61
Phosphoric Acid	Without B	3.31	0.44	3.51	0.896	0.021	284.95
	Boric acid	3.36	0.48	3.55	0.912	0.021	274.72
	B-Nano	3.40	0.50	3.66	0.933	0.020	238.13
	B-Edta	3.37	0.48	3.62	0.922	0.019	256.37
Mean		3.36	0.48	3.59	0.916	0.020	263.55
Phosphorein	Without B	3.24	0.42	3.54	0.889	0.019	287.56
	Boric acid	3.33	0.41	3.52	0.896	0.019	285.23
	B-Nano	3.42	0.43	3.64	0.924	0.019	249.82
	B-Edta	3.41	0.43	3.61	0.925	0.020	242.81
Mean		3.35	0.42	3.58	0.909	0.019	266.36
Boron sources Mean	Without B	3.34	0.45	3.55	0.906	0.020	253.42
	Boric acid	3.38	0.47	3.56	0.914	0.020	249.25
	B-Nano	3.44	0.48	3.67	0.937	0.020	227.25
	B-Edta	3.42	0.47	3.63	0.928	0.020	232.90
LSD at 0.05 for	A	0.09	0.06	0.03	0.017	0.001	2.34
	B	0.07	0.06	0.03	0.021	0.001	1.65
	A X B	0.11	0.09	0.06	0.029	0.001	2.80

In this respect, Wahdan *et al*., (2000) concluded that phosphorus plays a fundamental role in large number of enzymatic reactions that depends on phosphorylation. In general, phosphorus application is likely to increase considerably respiration and the reproductive growth, where there was tricking accumulation of total carbohydrates associated with phosphorus application and this may be due to a moderate activation of photosynthesis.

The inverse was true in leaves proline content, where it decreased form (266.36 ug/g fwt) by seed inoculation with phosphorein 400g/30kg seeds to (215.31 ug/g fwt) by the soil application of 22.5 kg P2O5/fed., as superphosphate during land preparation (control), which indicates favorable plant conditions. Phosphorus fertilizer effects on cotton biochemical composition is the increase in non-phosphorylated sugars and starches, and the corresponding increase in sugar phosphates (Ergle and Eaton, 1957).

2- Effect of boron treatments:

Foliar application with boron fertilizers sources gave a significant effect on leaves nitrogen, phosphorus, potassium and total carbohydrates (Table 3), in favor of foliar spray with B-Nano 5 g/L water at the flowering initiation and 15 days later. While, the inverse was true in leaves proline content which induced favorable plant conditions. Similar results were obtained by cotton El-Shazly *et al*., (2005); Kassem *et al*., (2009); El-Gabiery, (2014) and Attia *et al*., (2016).

3- Effect of the interaction:

The interaction between phosphorus fertilizer sources treatments and spraying with boron sources treatments fertilization gave a significant effect on nitrogen, phosphorus, potassium, total sugars, total carbohydrates and proline contents in leaves in 2016 season. The highest values of these traits were produced from soil application with 22.5 kg P2O5/fed., as superphosphate during land preparation (control) with foliar spray with B-Nano 5 g/L water at the flowering initiation and 15 days later stages. While, the inverse was true in leaf proline content.

Leaves photosynthetic pigments:

Averages of leaves chlorophyll a, b, total chlorophyll, the ratio of chlorophyll b to a and carotenoids concentrations at 110 days from planting as affected by phosphorus, boron and their interaction in 2016 season are shown in Table 4.

1- Effect of phosphorus sources:

The differences among phosphorus sources treatments in leaves photosynthetic pigments were significant, where the greatest values of leaves chlorophyll a, chlorophyll b, total chlorophyll and carotenoids contents and the ratio of chlorophyll b to a produced from soil application of 22.5 kg P2O5/fed., as superphosphate during land preparation (control) and the least values resulted from from seed inoculation with phosphorein 400g/30kg seeds.

Table 4. Photosynthetic pigments as affected by the different phosphorus and boron fertilizers sources and their interaction in 2016 season.

Treatments Phosphorus sources (A)	Characters Boron sources (B)	Chlorophyll a. (mg/g dwt)	Chlorophyll b. (mg/g dwt)	Total Chlorophyll. (mg/g dwt)	Chl. b. / Chl. a. (%)	Carotenoids (mg/g dwt)
Superphosphate	Without B	3.60	1.52	5.12	29.69	1.70
	Boric acid	3.62	1.53	5.15	29.71	1.72
	B-Nano	3.66	1.55	5.21	29.96	1.77
	B-Edta	3.60	1.54	5.14	29.75	1.72
Mean		3.62	1.53	5.15	29.71	1.73
Phosphate Rock + Phosphorein	Without B	3.48	1.23	4.71	26.11	1.31
	Boric acid	3.50	1.33	4.83	27.54	1.42
	B-Nano	3.60	1.50	5.10	29.41	1.64
	B-Edta	3.56	1.48	5.04	29.37	1.61
Mean		3.54	1.38	4.92	28.05	1.50
Phosphoric Acid	Without B	3.49	1.33	4.82	27.59	1.49
	Boric acid	3.55	1.38	4.93	27.99	1.52
	B-Nano	3.43	1.55	4.98	31.12	1.70
	B-Edta	3.41	1.48	4.89	30.27	1.67
Mean		3.47	1.43	4.90	29.18	1.60
Phosphorein	Without B	3.31	1.20	4.51	26.61	1.35
	Boric acid	3.41	1.34	4.75	28.21	1.41
	B-Nano	3.50	1.36	4.86	27.98	1.48
	B-Edta	3.55	1.35	4.90	27.55	1.47
Mean		3.44	1.31	4.75	27.58	1.43
Boron sources Mean	Without B	3.47	1.32	4.79	27.56	1.46
	Boric acid	3.52	1.39	4.91	28.31	1.51
	B-Nano	3.55	1.49	5.04	29.56	1.65
	B-Edta	3.53	1.46	4.99	29.26	1.61
LSD at 0.05 for	A	0.02	0.02	0.06	0.05	0.02
	B	0.01	0.01	0.04	0.03	0.01
	A X B	0.02	0.02	0.10	0.08	0.02

The significant increase in leaves photosynthetic pigments is mainly due to that this treatment significantly increased leaves N, P and K contents, where P is necessary for chlorophyll biosynthesis as pyridoxal which must be present for its biosynthesis. Phosphorus plays an important role in CO_2 conversion to sugar (Uchida, 2000), N is an essential constitute of chlorophyll Tucker (1999). Assimilate accumulation may result from direct effects on photochemical capacity, enzyme driven reactions affecting carbon partitioning, protein and chlorophyll per unit area are not much affected by phosphorus fertilizer (Rao and Terry, 1989).

2- Effect of boron treatments:

Spraying with boron fertilizer sources had a significant effect on leaves photosynthetic pigments, where the greatest values of leaves chlorophyll a, chlorophyll b, total chlorophyll and carotenoids contents and the ratio of chlorophyll b to a produced from foliar spray with B-Nano 5 g/L water at the flowering initiation then after 15 days (Table 4).

The increase in leaves photosynthetic pigments contents due to the foliar spray with B-Nano is mainly attributed with the high percentages of N, P and K in leaves due to this treatment (Table 3), where chlorophyll synthesis is related to nitrogen Tucker (1999). Similar results were obtained by cotton Kassem *et al.,* (2009); Halepyati *et al.*, (2012), El-Gabiery, (2014) and Attia *et al.,* (2016).

3- Effect of the interaction:

The interaction between phosphorus sources fertilizer treatments and foliar application with boron sources treatments fertilization gave a significant effect on leaves photosynthetic pigments, where the greatest values of leaves chlorophyll a, chlorophyll b, total chlorophyll and carotenoids contents and the ratio of chlorophyll b to a produced from soil application of 22.5 kg P_2O_5/fed as superphosphate during land preparation (control) with foliar spray with B-Nano 5 g/L water at the flowering initiation then after 15 days, while the lowest values were produced from seed inoculation with phosphorein 400g/30kg seeds without foliar application of boron (Table 4).

Growth traits:

1- Effect of phosphorus sources:

Phosphorus sources treatments had a significant effect on plant height at harvest and no. of sympodia/plant in 2015 and 2016 seasons (Table 5). The tallest plants and the highest no. of sympodia/plant were produced from spraying of 2 cm^3 phosphoric acid/liter water, while the shortest plants and the lowest no. of sympodia/plant were produced from seed inoculation with phosphorein 400g/30kg seeds in both seasons. In this respect, Wahdan *et al.,* (2000), showed that foliar application of phosphorus tended to reduce the excessive vegetative growth of cotton plant, it decreased significantly plant height. This might be due to the role of phosphorus to divert the plant toward the reproductive phase, because phosphorus has vital role in cell division, cell elongation and stimulate early flowering (Singh, 2003). Increased in growth under phosphorus fertilizer extend to tissues such as plant height. Similar results were obtained by Kefyalew *et al*., (2007), Saleem *et al*., (2010) and Abou-Zaid *et al.,* (2013).

Table 5. Averages of plant height and number of sympodia/plant at harvest as affected by the different phosphorus and boron sources and their interaction during 2015 and 2016 seasons.

Characters / Seasons / Treatments		Plant height at harvest (cm)		No. of sympodia/Plant	
Phosphorus sources (A)	Boron sources (B)	2015	2016	2015	2016
Superphosphate	Without B	163.20	163.90	13.56	14.26
	Boric acid	163.46	164.26	14.06	14.86
	B-Nano	166.16	167.66	14.40	15.90
	B-Edta	164.10	166.03	14.13	15.73
Mean		164.23	165.46	14.04	15.19
Phosphate Rock + Phosphorein	Without B	163.76	164.26	14.20	14.70
	Boric acid	164.30	164.86	14.36	14.96
	B-Nano	167.53	168.83	14.90	15.90
	B-Edta	164.80	166.20	14.50	15.90
Mean		165.10	166.04	14.49	15.36
Phosphoric Acid	Without B	165.70	166.00	15.00	15.30
	Boric acid	166.80	167.20	15.26	15.66
	B-Nano	169.66	170.76	16.00	17.10
	B-Edta	168.13	169.40	15.10	16.30
Mean		167.57	168.34	15.34	16.09
Phosphorein	Without B	160.90	161.00	12.86	12.96
	Boric acid	161.33	161.53	12.96	13.16
	B-Nano	164.06	164.96	13.76	14.66
	B-Edta	162.33	163.33	13.13	14.13
Mean		162.15	162.70	13.18	13.73
Boron sources Mean	Without B	163.39	163.79	13.90	14.30
	Boric acid	163.97	164.46	14.16	14.66
	B-Nano	166.85	168.05	14.76	15.89
	B-Edta	164.84	166.24	14.21	15.51
LSD at 0.05 for	A	0.90	0.37	0.19	0.35
	B	0.55	0.52	0.17	0.22
	A X B	N.S	N.S	N.S	N.S

2- Effect of boron treatments:

Foliar application with the different boron sources had significant effect on final plant height and No. of sympodia/plant in both seasons (Table 5), in favor of foliar spray with B-Nano 5 g/liter water at the flowering initiation then after 15 days, while the lowest values of plant height at harvest and no. of sympodia/plant were produced from control (without application with B). Such increase in cotton plant growth, plant height and no. of sympodia/plant due to foliar spray with B-Nano treatment may attribute to its role in enhancing biological activities such as photosynthesis, enzyme activities, uptake of nutrients and translocation rate of photosynthetic products. In this concern, B has been reported to be essential for the biosynthesis and structure of cell walls in the rapidly growing tissues, which leads to a cascade of secondary effects on plant growth. It also increases endogenous level of IAA via antagonizing its oxidative degradation by IAA-oxidase enzyme, Blevins and Lukaszewski (1998) and Niaz *et al.*, (2002). Similar results were obtained by El-Shazly *et al.,* (2005); Kassem *et al.,* (2009); Halepyati et al., (2012) and El-Gabiery, (2014).

3- Effect of the interaction:

The interaction between phosphorus sources fertilizer treatments and foliar application with boron sources treatments fertilization gave insignificant effect on final plant height and no. of sympodia/plant in both seasons (Table 5).

Yield and yield components:

1- Effect of phosphorus sources:

Phosphorus treatments had significant effects on No. of open bolls/plant, boll weight, seed cotton yield/plant, lint percentage and seed index in both seasons, in favor of soil application of 22.5 kg P_2O_5/fed., as superphosphate during land preparation (control) and the least values resulted from seed inoculation with phosphorein 400g/30kg seeds. The significant increase in seed cotton yield/plant due to the former treatment is mainly due to the heavier bolls and the higher No. of open bolls/plant. In this concern, Wahdan *et al*., (2000), Muhammed *et al.,* (2001), Singh, (2003), Kefyalew *et al*., (2007), Sawan *et al*., (2008) and Saleem *et al*., (2010) found that phosphorus fertilizer significantly increased No. and weight of open bolls/plant and seed cotton yield/plant as compared with the other treatments

Soil application of 22.5 kg P2O5/fed., as superphosphate during land preparation (control) significantly increased seed cotton yield/fed. By about 16.84 and 21.83% compared to seed inoculation with phosphorein 400g/30kg seeds in 2015 and 2016 seasons, respectively.

The observed increment of seed cotton yield may be a result of (1) the increase in number of open bolls as well as boll weight and higher seed cotton yield/plant, (2) the important role of phosphorus in the physiological processes in cotton plants and its positive effect on photosynthetic pigments in leaves (Table 4), which reflects on the increase of total carbohydrates and sugars concentrations in leaves (Table 3) due to the significant increase of nitrogen, phosphorus and potassium concentrations in leaves (Table 3), which led to the significant increase in plant growth and (3)the positive effect on water relations in leaves (Table 2). Also, this treatment significantly decreased leaves proline content which indicates favorable conditions.

The highest value of lint percentage (41.22 and 40.16%) and seed index (10.57 and 10.23 g) were obtained from soil application of 22.5 kg P_2O_5/fed., as superphosphate during land preparation (control), while the lowest values of lint percentage (40.53 and 39.44%) and seed index (9.97 and 9.63 g) were obtained from seed inoculation with phosphorein 400g/30kg seeds/fed. in 2015 and 2016 seasons, respectively. In this concern, Reiter and Kreig, (2000), Singh, (2003), Sawan *et al.*, (2008) and Saleem *et al.,* (2010) found that the seed index and lint percentage was insignificance affected by the foliar application of phosphorus treatments. While Omran *et al.*, (1999) reported that lint percentage and seed index were increased significantly by phosphorus spraying.

2- Effect of boron treatments:

Foliar application with boron sources fertilization had a significant effect on No. and weight of open bolls/plant, and seed cotton yield/plant in both seasons, in favor of foliar spray with B-Nano 5 g/L water at the flowering initiation then after 15 days. The significant increase in seed cotton yield/plant due to the foliar application treatment of B-Nano treatments is mainly due to the heavier bolls and the higher No. of open bolls/plant. The highest values of lint percentage (41.72 and 40.44%) and seed index (10.85 and 10.10 g) were obtained from foliar application of treatment of B-Nano, while the lowest values of lint percentage (40.00 and 39.01%) and seed index (9.71 and 9.67 g) were obtained from without foliar application with B in 2015 and 2016 seasons, respectively.

Foliar spray with B-Nano 5 g/L water at the flowering initiation then after 15 dayssignificantly increased seed cotton yield/fed. by 12.19 and 20.32% compared to without B application in 2015 and 2016 seasons, respectively. The increase in seed cotton yield/fed is mainly due to the higher No. of open bolls/plant, heavier bolls, seed index and higher seed cotton yield/plant. Also, such improvements in yield and its components due to foliar spray with B-Nano could be a result of their effects on fundamental metabolic activities which may be positively reflected on growth and seed cotton, leading to increasing boll production and retention, boll weight, seed index and seed cotton yield/pant and /feddan. In addition, the positive effect in increasing leaves water relations and contents of N, P and K in leaves as shown in Tables 2 and 3 reflects on significant increase in leaves photosynthetic pigments (chlorophyll a, b, total chlorophyll and carotenoids) as shown in Table 4 leading to significant increase in production of assimilates by the leaves. Also, this treatment significantly decreased leaves proline content which indicates favorable conditions.

These results are in general agreement with those of, El-Shazly *et al*., (2005), Kassem *et al*., (2009), Halepyati *et al*., (2012) and Attia *et a*l., (2016).

3- Effect of the interaction:

The results in Table 6 show that the interaction between phosphorus sources fertilizer treatments and foliar application boron sources treatments fertilization gave significant effect on no. of open bolls/plant, seed cotton yield/plant and /feddan in both seasons and boll weight, lint percentage and seed index in 2015 season only.

Table 6. Cotton yield and yield components as affected by the different phosphorus and boron fertilizers sources and their interaction during 2015 and 2016 seasons.

Characters		No. of open bolls/plant		Boll weight (g)		Seed cotton yield/plant (g)		Seed cotton yield (Kentar/fed.)		Lint percentage (%)		Seed index (g)	
Seasons Treatments		2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
Phosphorus sources (A)	Boron sources(B)												
Superphosphate	Without B	16.40	16.70	2.64	2.71	43.30	45.26	10.67	10.18	40.55	39.80	9.87	10.09
	Boric acid	16.30	17.70	2.63	2.71	42.87	47.97	11.19	10.80	40.95	39.71	10.67	10.19
	B-Nano	18.40	19.23	2.70	2.84	49.68	54.61	12.04	12.32	42.03	40.67	11.15	10.38
	B-Edta	17.66	19.00	2.65	2.81	46.80	53.39	11.62	12.04	41.33	40.48	10.62	10.26
Mean		17.19	18.15	2.66	2.77	45.73	50.28	11.38	11.33	41.22	40.16	10.57	10.23
Phosphate Rock + Phosphorein	Without B	15.53	16.90	2.58	2.64	40.07	44.62	10.67	10.03	40.01	39.08	10.00	9.63
	Boric acid	16.00	16.90	2.60	2.66	41.60	44.95	10.67	10.12	40.65	39.36	10.28	9.96
	B-Nano	16.73	19.70	2.66	2.79	44.50	54.96	12.26	12.37	41.82	40.36	10.85	10.22
	B-Edta	16.16	19.06	2.63	2.77	42.50	52.80	11.73	11.91	40.84	39.81	10.49	10.10
Mean		16.10	18.14	2.62	2.71	42.18	49.16	11.33	11.11	40.83	39.65	10.40	9.98
Phosphoric Acid	Without B	16.00	15.80	2.55	2.58	40.80	40.76	9.93	9.19	39.97	38.55	9.62	9.55
	Boric acid	16.93	16.36	2.58	2.62	43.68	42.86	10.35	9.66	40.28	39.25	10.09	9.69
	B-Nano	17.73	17.83	2.61	2.72	46.28	48.50	10.99	10.94	41.39	40.56	10.75	9.94
	B-Edta	17.40	17.36	2.59	2.71	45.07	47.05	10.56	10.61	40.58	39.84	10.47	9.83
Mean		17.01	16.84	2.58	2.66	43.89	44.79	10.46	10.10	40.56	39.55	10.23	9.75
Phosphorein	Without B	15.10	15.20	2.50	2.51	37.75	38.15	9.40	8.59	39.48	38.62	9.37	9.39
	Boric acid	15.20	15.40	2.53	2.55	38.46	39.27	9.51	8.85	40.19	39.25	9.70	9.57
	B-Nano	16.06	16.96	2.57	2.64	41.27	44.77	10.35	10.10	41.63	40.16	10.67	9.89
	B-Edta	15.60	16.60	2.48	2.58	38.69	42.83	9.72	9.66	40.82	39.72	10.14	9.69
Mean		15.49	16.04	2.52	2.57	39.03	41.22	9.74	9.30	40.53	39.44	9.97	9.63
Boron sources Mean	Without B	15.75	16.15	2.57	2.61	40.48	42.15	10.17	9.50	40.00	39.01	9.71	9.67
	Boric acid	16.10	16.59	2.58	2.63	41.54	43.63	10.43	9.86	40.52	39.39	10.18	9.85
	B-Nano	17.23	18.43	2.64	2.75	45.49	50.68	11.41	11.43	41.72	40.44	10.85	10.10
	B-Edta	16.70	18.00	2.59	2.72	43.25	48.96	10.91	11.05	40.89	39.96	10.43	9.97
LSD at 0.05 for	A	0.29	0.41	0.02	0.03	0.76	1.17	0.18	0.31	0.18	0.32	0.07	0.07
	B	0.20	0.25	0.02	0.02	0.58	0.70	0.19	0.16	0.20	0.24	0.08	0.06
	A X B	0.40	0.49	0.04	N.S	1.16	1.40	0.37	0.32	0.41	N.S	0.16	N.S

The highest values of no. of open bolls/plant (18.40 and 19.70 bolls) and seed cotton yield/plant (49.68 and 54.61 g/plant) in 2015 and 2016 seasons, respectively. Boll weight (3.03 g), lint percentage (42.03%) and seed index (11.15 g) in 2015 season were produced from soil application of 22.5 kg P_2O_5/fed., as superphosphate during land preparation (control) in combination with foliar spray with B-Nano 5 g/L water at the flowering initiation then after 15 days, while the lowest values of these traits in consideration were produced from seed inoculation with phosphorein 400g/30kg seeds/fed without B application. The highest values of seed cotton yield/feddan (12.26 and 12.04; 12.37 and 12.32 Kentar/fed.) were produced from phosphate rock + phosphorein in combination foliar spray with B-Nano 5 g/L water at the flowering initiation then after 15 days and from soil application of 22.5 kg P_2O_5/fed., as superphosphate during land preparation (control) in combination with foliar spray with B-Nano 5 g/L water at the flowering initiation then after 15 days in the first and second seasons, respectively. while the lowest values of were produced from seed inoculation with phosphorein 400g/30kg seeds/fed without B application. This may be attributed to the retardant effect of phosphorus and boron on vegetative growth of cotton plant. Also, the positive effect of phosphorus and boron fertilizer on seed cotton yield is mainly due to the following points:

1. Increased in growth under phosphorus and boron fertilizer extend to tissues such as lateral buds and fruiting branches. Increase initiation of squares, diced flowering, increased boll set, early senescence, and increased boll maturity of set bolls are apparent if phosphorus and boron persists (Brown and Ware, 1958).
2. Effects of phosphorus and boron fertilizer are ultimately expressed in no. bolls set. for bolls retained by the plant, adequate phosphorus and boron is generally available to mature the seed and lint.
3. The positive effect of this interaction treatment on leaves water relations, N, P, K, photosynthesis pigments, total sugars and total carbohydrates contents in leaves. Also, this treatment significantly decreased leaves proline content which indicates favorable conditions.

F-Fiber quality traits:

Phosphorus and boron fertilizers sources and their interaction had no measurable effect on fiber properties under study in both seasons (Table 7). These results are similar to those obtained by Sawan *et al.*, (2008) and Muhammed *et al.*, (2001).

Table 7. Influence of the different phosphorus and boron fertilizers sources and their interaction on cotton fiber traits during 2015 and 2016 seasons.

Characters		Fiber length parameters: Upper half mean length (UHML)		Fiber length parameters: Uniformity index (UI %)		Micronaire reading		Fiber strength (Presley units)	
Seasons Treatments		2015	2016	2015	2016	2015	2016	2015	2016
Phosphorus sources (A)	Boron sources (B)								
Superphosphate	Without B	34.10	33.86	86.36	86.16	4.40	4.30	10.76	10.70
	Boric acid	34.33	34.33	86.73	86.30	4.33	4.23	10.60	10.40
	B-Nano	33.96	34.10	86.13	86.16	4.50	4.36	10.80	10.86
	B-Edta	33.86	34.33	86.16	86.63	4.56	4.43	10.60	10.40
Mean		34.06	34.15	86.35	86.31	4.45	4.33	10.69	10.59
Phosphate Rock + Phosphorein	Without B	33.96	34.13	85.83	86.26	4.36	4.46	10.63	10.63
	Boric acid	34.66	34.36	86.56	86.73	4.46	4.40	10.36	10.46
	B-Nano	34.13	33.90	86.36	86.03	4.26	4.50	10.50	10.46
	B-Edta	34.13	34.13	86.33	86.66	4.63	4.40	10.70	10.36
Mean		34.22	34.13	86.27	86.42	4.43	4.44	10.55	10.48
Phosphoric Acid	Without B	34.10	34.06	86.50	86.16	4.36	4.50	10.60	10.53
	Boric acid	33.96	34.06	86.46	86.33	4.43	4.40	10.33	10..76
	B-Nano	33.86	34.30	85.96	86.13	4.50	4.50	10.86	10.33
	B-Edta	33.93	33.66	86.36	85.93	4.23	4.40	10.83	11.10
Mean		33.96	34.02	86.32	86.14	4.38	4.45	10.65	10.68
Phosphorein	Without B	33.83	33.96	86.23	86.03	4.30	4.36	10.86	10.70
	Boric acid	34.46	34.50	86.93	86.66	4.33	4.43	10.50	10.66
	B-Nano	34.00	34.23	86.06	86.66	4.50	4.16	10.33	10.66
	B-Edta	34.36	34.43	86.73	86.66	4.40	4.86	10.83	10.90
Mean		34.16	34.28	86.49	86.50	4.38	4.45	10.63	10.73
Boron sources Mean	Without B	34.00	34.00	86.23	86.15	4.35	4.40	10.71	10.64
	Boric acid	34.35	34.31	86.67	86.50	4.39	4.36	10.45	10.57
	B-Nano	34.19	34.13	86.13	86.25	4.44	4.38	10.62	10.58
	B-Edta	34.07	34.14	86.40	86.47	4.45	4.52	10.74	10.69
LSD at 0.05 for	A	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S
	B	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S
	A X B	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S

CONCLUSION

It could be concluded soil application with 22.5 kg P_2O_5/fed as calcium superphosphate and foliar spraying with boron-Nano 5 g/liter water twice at the initiation of flowering then after 15 days for producing better leaves chemical composition and water relations, growth traits and high yield and quality of cotton (Giza 86 variety) under the conditions of El-Gemmeiza location.

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تأثير مصادر مختلفة من الفوسفور والبورون علي التركيب الكيماوي والعلاقات المائية بالأوراق ونمو وانتاجية القطن المصري.

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أجريت تجربتان حقليتان بمحطة البحوث الزراعية بالجيزة بمحافظة الغربية خلال موسمى النمو 2015و 2016 وذلك لدراسة تأثير التسميد ببعض المصادر المختلفة من الفورسفور والبورون علي صنف القطن المصري جيزة 86، وأثر ذلك علي العلاقات المائية داخل النبات، التركيب الكمياوي للأوراق، صبغات التمثيل الضوئي، النمو، المحصول ومكوناته وبعض صفات الجودة للتيلة. زُرعت التجارب في تصميم القطع المنشقة مرة واحدة في أربعة مكررات حيث وضعت معاملات ومصادر التسميد الفوسفاتى (أ- أضافة أرضية بسوبر فوسفات 22.5 كجم بو$_2$أ$_5$/فدان (المقارنة)، ب- أضافة أرضية لصخر الفوسفات بمعدل + أضافة المخصب الحيوي الفوسفورين، ج- رش حامض الفورسفوريك بمعدل 2 مل/لتر ماء، د- أضافة المخصب الحيوي الفوسفورين بمعدل 400 جم/30 كجم تقاوي) فى القطع الرئيسية بينما وضعت معاملات الرش بالبورون (1- المقارنة بدون رش بورون، 2- رش حامض بوريك 2 جم/لتر ماء ، 3- رش مركب البورون النانو بمعدل 5 جم/لتر ماء، 4- رش بورون مخلبي بمعدل 2 جم/لتر ماء) فى القطع المنشقة. وتتلخص أهم النتائج المتحصل عليها فيما يلى:1- أعطت معاملات التسميد الفوسفاتى تأثيرات معنوية علي كل من أرتفاع النبات عند الجني، عدد الافرع الثمرية/نبات، عدد اللوز المتفتح/نبات، وزن اللوزة، محصول القطن الزهر/النبات وايضاً محصول القطن الزهر بالقنطار/الفدان، تصافي الحليج ومعامل البذرة وكل صبغات البناء الضوئي والسكريات الكلية والكربوهيدرات ومحتوي الاوراق من البرولين وعناصر الازوت والبوتاسيوم والفوسفور في موسمي الدراسة 2015 و2016 وذلك لصالح معاملة الأضافة الأرضية من سوبر فوسفات 22.5 كجم بو$_2$أ$_5$/فدان ، وفي نفس الوقت لم يكن لمعاملات التسميد الفوسفاتى اي تأثير معنوي على متوسط طول التيلة، معامل الانتظام، النعومة ومتانة التيلة في كلا الموسمين تحت الدراسة.2- أعطت معاملات الرش الورقى بالبورون تأثيرات معنوية علي كل من صفات النمو، وكذلك المحصول ومكوناته، صبغات البناء الضوئي والمكونات الكيميائية للورقة في كلا من موسمي الدراسة 2015 و2016 حيث تفوقت المعاملة الرش بالبورون النانو بمعدل 5 جم/لتر ماء مرتين (عند بداية التزهير وبعد التزهير بأسبوعين)، وعموماً لم يكن هناك أي تأثيرات معنوية لتلك المعاملات علي متوسط طول التيلة، معامل الانتظام، النعومة ومتانة التيلة في كلا الموسمين تحت الدراسة.3- أعطي التفاعل بين معاملات مصادر التسميد الفوسفاتى ومعاملات الرش الورقى بالبورون تأثيرات معنوية علي كل من طول النبات عند الجني وعدد الافرع الثمرية/نبات في كلا من موسمي الدراسة 2015 و2016، وجميع صفات التيلة في كلا الموسمين تحت الدراسة. ومتوسط وزن اللوزة، تصافي الحليج ومعامل البذرة في موسم 2016 فقط، ولكنه كان له تأثيراً معنوياً علي عدد اللوز المتفتح/نبات، محصول القطن الزهر/نبات وكذلك محصول القطن الزهر بالقنطار/فدان وكل صبغات البناء الضوئي والمكونات الكيميائية للورقة في كلا من موسمي الدراسة 2015 و2016، حيث تفوقت معاملة أضافة أرضية من سوبر فوسفات 22.5 كجم بو$_2$أ$_5$/فدان (المقارنة) بالاضافة الي الرش بالبورون النانو بمعدل 5 جم/لتر ماء مرتين (عند بداية التزهير وبعد التزهير بأسبوعين).علي باقي المعاملات تحت الدراسة في كلا الموسمين.التوصية:يمكن التوصية بالاضافة الارضية من سوبر فوسفات 22.5 كجم بو$_2$أ$_5$/فدان بالاضافة الي الرش بالبورون النانو بمعدل 5 جم/لتر ماء مرتين (عند بداية التزهير ثم بعد أسبوعين) وذلك لزيادة الإنتاجية والجودة لصنف جيزة 86 المنزرع تحت ظروف أراضي وسط الدلتا بالجميزة.