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Effect of Arginine, Prohexadione-Ca, Some Macro and Mirco-Nutrients on Growth, Yield and Fiber Quality of Cotton Plants

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Abstract: Two field experiments were carried out in the experimental farm, Faculty of Agriculture, Menofia University during two successive seasons (2007 & 2008) to study the effect of bioregulators, amino acid arginine and new growth retardant "prohexadione-Ca" and / or some macro or micro nutrient elements (P,K, B or Zn) on vegetative growth, flowering, fruiting, yield and fiber quality of cotton plants. Application of arginine or prohexadione-ca and /or macro or micro nutrient elements significantly increased growth characters (number of symbodials/plant, boll setting/plant), as well as, the studied yield parameters e.g. number of bolls /plant, boll weight/plant, seed index and seed cotton yield (kentar/ feddan).All the used treatments significantly increased fiber properties of the produced cotton (lint %, fiber fineness and Pressley), oil and protein percentages of the produced seeds. The most effective interaction treatment was that of prohexadione-Ca at 30 mg/l combined with the potassium treatment.

Key words: Bioregulators . Arginine . Prohexadione-Ca . Macro and micro nutrients . Seed cotton yield .Lint % - Pressley . fineness .oil and protein %

INTRODUCTION

In recent years, growth regulating substances played an important role in controlling seed germination, vegetative growth, flowering and yield of several crop plants. Besides growth regulators, the nutrient elements, especially micro-nutrients when applied as foliar spray exert pronounced influence on plant growth and yield, which in some respects resembles those of growth regulators. Cotton is an important crop that is widely grown and is used to producing both natural textile fiber and cotton seed oil. Commercial cotton is grown in more than 80 countries, including Egypt, Australia, China, Africa, India, Pakistan, USA and Uzbekistan. China is the largest user and producer of raw cotton, while USA is the second largest producer, with the cotton industry contributing about $5 billion per year to the US economy. Cotton fibers can be used for producing innumerable commodities, ranging from textile fabrics and computer screens to automobile brakes. More than 150 countries are involved in import and export of cotton.

Cotton seed oil contains a balance of various fatty acids and is mainly used for various food manufacturing purposes. Most of the polyunsaturated fatty acids is linoleic acid, produce some of the best-fried food flavors. Cottonseed oil is the standard against which other oils are compared for pleasing aroma, flavor and performance [1].

Cotton has an indeterminate growth habit and can grow very tall under conditions of unrestrained growth. Growth substances, such as Prohexadione-Ca, generally applied to cotton to slow internode elongation, especially for well-fertilized irrigated cotton. Otherwise, vigorous cotton varieties with plenty of water and nutrients can develop very tall, heavy vegetative growth. This type of rank growth promotes boll rot and fruit abscission and makes a cotton crop difficult to harvest. In addition, Kuzentsov *et al.* [2] suggested that amino acids and amids (mainly arginine, proline and asparagine) were severely accumulated in the cell sap of cotton plants grown under water deficit to increase the resistance system under stress conditions. Plant growth regulators are an important tool of short season cotton system to increase the productivity, fiber quality and earliness. Application of bioregulators induces changes in germination, flowering, assimilation partitioning, growth modification, fruit retention, defoliation, boll opening and yield enhancement [3]. Growth retardants have been

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directed primarily at yield enhancement through greater fruit retention and earlier maturity. Anti-gibberellin is currently recognized as standard for reducing plant height and increasing earliness [4-6]. Nutrient elements have critical functions in metabolism of the plants. Macro and micronutrients are essential for normal growth and development processes of plants because through their work as mediators or activators of many enzyme systems, for example, the carboxylase of *Proteus vulgaris*, catalyze oxidative decarboxylation of pyruvic acid to acetic acid. Micronutrients disorder is known to be a widespread and serious problem in soils. Zinc is needed for plants in some of their enzyme systems [7, 8]. The deficiency or biological availability of nutrients adversely affects the growth and development of plants, for example effects of nutrient elements on fruiting efficiency has been received by Joham [9].

Further adverse conditions of water stress due to high temperature even with good irrigation system cotton may need additional supply of micronutrients to realize the yield potential [8]. Cotton needs for nitrogen is the greatest during boll filling, but carry-over into harvest is detrimental. Phosphorus is needed all season long, but the ability of roots to extract phosphorus is reduced in cool spring soils, justifying "at planting" fertilizer applications for increased availability. The heaviest demand for potassium and boron occurs during boll filling. Phosphorus, potassium, calcium and magnesium stay where they are placed until that soil zone is disturbed, but nitrogen, boron and sulfur are lose from the root zone prior to plant uptake.

MATERIALS AND METHODS

Two field experiments were carried out during two growth seasons 2007 and 2008 at the experimental farm, Faculty of Agriculture, Menofia University to study the effect of bioregulators amino acid "arginine" or new growth retardant "Prohexadione–Ca" and/or some macronutrients e.g. Phosphorus, potassium or some micronutrients e.g. Zinc and boron on vegetative growth parameters, flowering, fruiting, habits, yield, yield components, seed oil and protein contents, as will as fiber characters of Egyptian cotton (*Gossypium barbadanse* L.).

Substances Used: It is necessary to mentioned here that all the used concentrations of bioregulators or mineral nutrients were chosen according to the results obtained from the preliminary experiments and / or according to the previous recommended references [10, 11].

The Bioregulator Treatments Consisted of :

- Amino acid "arginine" at the rate of 2.50 mM and /or Prohexadione-Ca at the concentration equal 30 ppm in addition to the control plants.
- Macronutrients treatments consisted of two elements: phosphorus (P) solution was prepared as orthophosphoric acid ":H_3PO_4" at the rate of 1 ml/litter. Potassium solution (as potassium citrate) at the concentration equal 1g./l. in addition to the control plants.
- Micronutrients treatments consisted of two micro-elements: Zinc (Zn) was prepared as Zinc chelate 14% at the rate of 1 g / l. (140 ppm), Boron as boric acid 17.2 % at the concentration equal 172 ppm. The plants were sprayed twice after 80 and 110 days from planting (at full blooming stage).

A spilt-spilt design with three replications was used. The bioregulators were randomly assigned to the main plot; the sub-plots were randomly assigned to macro and micro nutrients. Plot area was 14 m^2 (5 rows each one as 0.7m wide x 4 m long). The seeds of cotton (*Gossypium barbadence* cv. Giza 86) were hand planting in hills apart of 25 cm at 15th and 17th of March in 2007 and 2008 seasons respectively. The plants were thinned leaving 2 plants/hill after 40 days from sowing. The density of plants was about 48.000 plant / feddan.

Number of plants= 24000 hills x 2 plants = 48000 plant / Feddan

The soil of the experiments was medium to heavy clay containing 1.5% organic matter, available N 40.20 ppm, available phosphorus 15.40 ppm available potassium 240 ppm and soil pH was 7.90. It is necessary to mentioned here the preceding crop was Egyptian clover in both seasons. Phosphorus fertilizer in the form of calcium superphosphate (15.5 % P_2O_5) was added during soil preparation at the rate of 22.5 kg of P_2O_5 / fed. Nitrogen fertilizer (as 33.5% N) was applied at the rate of 60 kg / fed at two equal doses; the first dose was applied after 40 days from sowing, while the second dose was applied 14 days later. In addition, potassium fertilizer as potassium sulphate (48 % K_2O) was added at the rate of 24 kg / fed in one dose after 40 days from planting. Culture practice was carried out as followed in Shibin El-Kom region, while the pest control was applied according to the pest control program. The first ginning was accompanied after 150 days from sowing (about 65% opening bolls), while the second ginning was carried out 25 days later.

Studied Traits: Plant height (cm), number of fruiting branches (symbodials)/plant, number of bolls/plant, boll setting %, boll shedding %, boll weight (g), seed cotton yield / plant (g), seed cotton yield (kentar / fed.), seed index, seed oil and protein %.Fiber strength (Pressley index) was estimated using Stelometer tester. The fineness was tested using the Micronair instrument to determine fineness as micronair units in addition to lint % was also estimated. All fiber properties were carried out at Fiber Technology Institute, Agric. Res. Centre, Giza, Egypt according to Anonymous [12] which specified by American Society for Testing and Materials (ASTM).

Chemical Analysis

Seed Oil Percentage: Determination of seed oil percentage of cotton seeds was carried out according to the methods described by A.O.A.C. [13].

Seed Protein Percentage: Total nitrogen of the produced seeds of cotton plants was extracted and determined by Micro-Kjeldahl method as described by A.O.A.C. [14]. The value of total crude protein was calculated by multiplying total values of total – N by factor 6.25.

Statistical Analysis: The data obtained were subjected to statistical analysis of variance according to Snedecor and Cochran [15] the treatment means were compared using LSD at 5 % level of probability.

RESULTS AND DISCUSSION

Effect on Plant Growth: Data presented in Table 1 indicated that plant height was significantly increased by arginine and reduced by Prohexadione-Ca treatments in the two successive seasons. Macronutrient treatments, (K, P) slightly increased plant height of the treated plants during the two seasons. Also the tested micronutrients (Boron and Zinc) enhanced the plant growth represented as plant height. As for the effect of bioregulators, macro and micronutrients application on the number of sympodials /plant, data presented in Table 1 revealed that all of these factors significantly increased the number of sympodials branches/plant during the two successive growth seasons. Prohexadione-Ca was more effective in increasing number of sympodials than amino acid "arginine". Application of macro (K and P) and micro (B, Z) nutrients appeared to have similar effect in increasing number of sympodials/plant during the two studied seasons.

Interaction effect of bioregulators and macro or micro nutrients on plant growth showed that amino acid arginine or growth retardant Prohexadione-Ca had the highest effect on plant growth (such as plant height and number of sympodials/plant) in combination with macro (K, P) or micro (B, Z) nutrients in cotton plants during the two successive growth seasons. The positive effect of arginine on plant growth was previously reported by Vervaeke *et al.* [10], El-Bassiouny and Bekheta [16] and Iqbal and Ashraf [17] all on wheat plants. The improvement in vegetative growth of cotton plants in response to arginine could be attributed to the high levels of endogenous hormones IAA, GA_3 and cytokinins in treated plants which appear to form a sink mobilizing the different nutrients which are involved in building new tissues in treated plants [18, 19].

Most of growth retardants inhibit the formation of gibberellin biosynthesis (GAs) and can, be used to reduce undesired shoot elongation. So, Prohexadione-Ca inhibits the conversion of geranylgeranyl-pyrophosphate to ent-kaurene. The following steps leading to ent-kaurenoic acid are catalyzed by monooxygenases which are cytochrome P_{450}-dependent. Under certain conditions, side effects on related enzymatic reactions can be observed [1, 11]. This may affect-positively or negatively-the usefulness of a given compound in a distinct indication. In addition to morphoregulation an improved resistance against different types of climatic stress can often be observed. Acylcyclo-hexadiones, which are currently introduced into the market, appear to offer advanced solutions for some indications.

The positive effects of growth retardant and macro or micronutrients on plant growth had been reported by Bekheta and Ramadan [5], El-Fouly *et al.*[20], Sawan *et al.*[21] and Armengaud *et al.*[22] on cotton plant and Fan *et al.* [6] on sunflower plant.

Effect on Boll Setting and Shedding: Data presented in Table 2 indicated that boll setting percentage of cotton plants was significantly increased under the effect of arginine or Prohexadione-Ca during the two successive growing seasons. It could be also observed from the present results that addition of macro elements (K or P) or micro nutrients (B or Z) significantly enhanced boll setting of cotton plants during the two studied seasons. These results were supported by Khandagave *et al.* [23] who reported that application of zinc sulphate significantly increased dry matter, harvested bolls and seed cotton yield per plant. Sawan *et al.* [24] indicated

Table 1: Effect of spraying cotton plants with arginine, Prohexadione-Ca and macro or micronutrients on some growth characters

		2007		2008	
Treatments	Minerals	Plant height (cm)	Number of symbodial /plant	Plant height (cm)	Number of symbodial /plant
Control	Control	144	14	143	14.85
	K	145.81	15.7	146	15
	P	146.5	15.8	145.1	16
Arginine 200 ppm	Control	151.9	15.1	150.25	14.85
	K	155.6	18.25	156.25	19.42
	P	154	20.1	152.9	19.8
Phd-Ca 30 ppm	Control	128.9	17.33	129.2	17
	K	130.7	21	130	21.9
	P	132.33	22.5	133.19	21.8
LSD at 5 %		1.66	0.54	1.44	0.35
Control	Control	135	13	140	12.12
	B	144.1	14.5	146.3	14.8
	Zn	146	14	148.5	14.9
Arginine 200 ppm	Control	150.5	16.07	148	17
	B	153	18.62	151	20.3
	Zn	153.9	20.46	153.5	21
Phd-Ca 30 ppm	Control	128	18	127.2	19
	B	130.7	22.3	129	22
	Zn	132	23	131	22.5
LSD at 5 %		1.4	0.4	1.5	0.64

Table 2: Effect of spraying cotton plants with arginine, Prohexadione-Ca and macro or micronutrients on boll shedding and boll setting percentage

		2007		2008	
Treatments	Minerals	Boll shedding %	Boll setting %	Boll shedding %	Boll setting %
Control	Control	42	53	43.5	54.3
	K	40.5	56.7	48.28	58
	P	38.83	58.17	40	59.5
Arginine 200 ppm	Control	40	50.37	39.08	53
	K	38	62	37.66	62.5
	P	36.18	64	35	63.6
Phd-Ca 30 ppm	Control	36.8	55.1	37	57
	K	35	65	35.39	64.16
	P	43.01	60.9	35.2	62.85
LSD at 5 %		2.28	3.08	2.6	1.15
Control	Control	44.16	54.84	42.8	56.12
	B	41.4	56.11	40	54.3
	Zn	42	57.71	40.5	60
Arginine 200 ppm	Control	42.9	50.1	41.1	53.2
	B	38.5	62	36.11	65.11
	Zn	37	64.25	36.1	62.1
Phd-Ca 30 ppm	Control	41.9	57	40	58.2
	B	35.5	56	36	63.19
	Zn	37	63	35.5	65.11
LSD at 5 %		2.5	1.9	2	1.75

that application of phosphorus, calcium and Zn increased open bolls/plant, boll weight and seed index of cotton plants. In addition, Khan *et al.* [25] found that the combination of Mg, Zn and B increased seed cotton yield by 18 % which mainly due to increase in the number of bolls per plant. The interaction between bioregulators and macro or micro nutrients treatments showed the most positive effect on boll setting of cotton as indicated in the same Table.

Concerning boll shedding, data presented in Table 2 showed that arginine and Prohexadione-Ca significantly decreased boll shedding of cotton plant during the two successive growing seasons. Phosphorus treatments also decreased shedding percentage while potassium application had no significant effect on ball shedding during the two studied seasons. The interaction effect of bioregulators and macro or micro-nutrients showed the highest reduction in boll shedding of cotton plants during the two successive growth seasons. Similar results were obtained by Abro *et al.* [8] who used different concentrations of bioregulators and micronutrient elements on cotton plants. The effect of Prohexadione-Ca in enhancing boll setting and decreasing shedding could be attributed to its physiological role in

Table 3: Effect of spraying cotton plants with arginine, Prohexadione-Ca and macro or micronutrients on the yield and its components

		2007					2008				
Treatments	Minerals	No. of bolls/ plant	Boll weight (g)	Seed cotton yield	Seed index	Seed cotton yield (K/fed)*	No. of bolls/ plant	Boll weight (g)	Seed cotton yield (g/plant)	Seed index	Seed cotton yield (K/fed)
	Control	16.4	2.0	34.1	8.7	7.0	16.0	2.1	33.0	8.5	6.5
Control	K	17.7	2.4	40.0	9.5	8.8	15.6	2.6	39.15	9.3	7.8
	P	17.0	2.17	39.02	9.9	8.0	16.2	2.42	38.5	10.0	7.7
Arginine 200 ppm	Control	17.2	2.2	35.23	9.0	7.5	18.0	2.5	34.13	9.1	8.0
	K	20.5	2.51	42.0	11.0	9.85	20.0	2.85	43.11	9.8	9.7
	P	19.0	2.7	41.0	10.2	9.66	19.5	2.9	41.04	10.0	9.45
Phd-Ca 30 ppm	Control	19.2	2.5	35.6	9.8	8.7	18.5	2.4	38.0	10.0	8.1
	K	23.5	3.12	44.0	10.53	10.5	24.0	3.0	44.5	10.0	10.0
	P	21.0	3.0	43.06	10.15	9.55	21.5	2.9	42.41	10.3	9.0
LSD at 5%		0.55	0.08	0.09	0.14	0.17	0.41	0.07	1.1	0.17	0.51
	Control	16.2	1.8	34.0	8.2	7.0	16.8	1.9	35.0	8.35	6.69
Control	B	17.0	2.2	40.0	9.53	7.8	18.5	2.0	40.5	9.22	7.0
	Zn	17.1	2.0	41.0	9.35	7.6	17.7	2.3	44.0	9.0	6.88
Arginine 200 ppm	Control	17.8	2.3	35.0	10.0	8.0	17.8	2.2	43.2	9.8	8.9
	B	19.5	2.83	42.1	10.5	9.67	19.5	2.6	43.5	10.2	9.75
	Zn	21.9	2.7	42.0	10.25	9.6	21.9	2.6	42.6	10.1	9.5
Phd-Ca 30 ppm	Control	17.4	2.5	36.0	10.0	9.0	18.0	2.3	36.5	10.12	9.1
	B	20.5	2.9	43.2	10.4	9.7	20.0	3.0	42.7	10.6	9.9
	Zn	22.0	2.8	42.0	10.2	9.8	22.5	2.9	44.0	10.3	9.73
LSD at 5%		0.39	0.09	0.3	0.16	0.18	0.51	0.09	1.0	0.14	0.15

*(K/fed.) = Kentar /fed, one Kentar = 157.5 kg seed cotton, one feddan= 4200 m^2

Table 4: Effect of spraying cotton plants with arginine, Prohexadione-Ca and macro or micronutrients on lint %, fineness and Pressley index of cotton fibers

		2007			2008		
Treatments	Mineral ions	Lint %	Fineness	Pressley index	Lint %	Fineness	Pressley index
Control	Control	34.3	3.5	8.11	33.17	3.62	8
	K	37	4	9	36.29	4.13	8.25
	P	36.03	4.17	9.3	37.02	3.97	8.45
Arginine 200 ppm	Control	38	3.85	9.36	37.11	4	9.13
	K	40.8	4.53	10.17	39.9	4.62	10.02
	P	38.1	4.25	10	37.19	4.5	9.9
Phd-Ca 30 ppm	Control	37.6	3.88	9.65	36.92	4	9
	K	39.68	4.41	10.19	40	4.59	10.3
	P	38.8	4.3	10.4	38.7	4.71	10.12
LSD at 5%		0.31	0.06	0.4	0.2	0.08	0.19
Control	Control	35	4	8.13	34.5	3.8	7.96
	B	36	4.6	9.33	37	4.1	9.27
	Zn	36.3	4.33	9.21	36.08	4.29	9.1
Arginine 200 ppm	Control	36.8	4.01	9.3	36.5	4.07	9.11
	B	38.6	4.94	10.1	37.97	4.64	10.2
	Zn	37.67	5	10	38.87	4.9	9.8
Phd-Ca 30 ppm	Control	37.8	3.9	9	37	4.01	9.78
	B	38.9	4.58	10.17	38.94	4.65	10.23
	Zn	38.25	4.8	10.09	38	4.5	10
LSD at 5%		0.31	0.07	0.35	0.21	0.06	0.15

inhibiting gibberellin biosynthesis and transiently alters the spectrum of flavonoids and their phenolic precursors [6].

Effect on Yield and its Components: Data recorded in Table 3 revealed that amino acid arginine or Prohexadione-Ca significantly increased the seed cotton yield/plant in the two successive growing seasons. This increment in yield might be attributed to the increase in the number of bolls/plant and/or increased boll weight which increased markedly by using amino acid arginine or prohexadioe-Ca. These results are similar to that obtained by Nobreqa *et al*. [26] who reported that application of growth retardant Pix (mepiquate chloride) had enhancing effect on fruiting of cotton plants which increased yield.

Concerning the effect of macro or micro nutrients on the seed cotton yield (g /plant), The obtained results showed that seed cotton yield (g/plant) was significantly increased as a results of application of macro (potassium and phosphorus) or micro (boron and zinc) treatments. Number of bolls/plant and average boll weight were also increased significantly by macro or micro nutrients application. The combined treatments of arginine or Prohexadione-Ca and macro or micro nutrients showed the highest positive effect on cotton seed yield (g /plant), number and weight of bolls /plant with superiority of Prohexadione-Ca + potassium treatments. These results agreed with those obtained by Wright *et al.*, [27]and Abro [8] who reported that application of growth regulators and/ or macro or micronutrient at different concentrations

Table 5: Effect of spraying cotton plants with arginine, Prohexadione-Ca and macro or micronutrients on oil and protein % of seeds

		2007		2008	
Treatments	Minerals	Seed oil %	Seed protein %	Seed oil %	Seed protein %
Control	Control	18	18.2	17.6	18.21
	K	18.6	19	18.9	18.5
	P	18.2	19.74	18.5	19.15
Arginine 200 ppm	Control	19	19.1	18.676	19.33
	K	19.9	20	19.6	19.67
	P	19	19.67	19.2	20
Phd-Ca 30 ppm	Control	20.91	20	19.8	20
	K	21.81	22.8	21	21.8
	P	21.5	21.39	20.67	21.39
LSD at 5%		0.3	0.21	0.25	0.29
Control	Control	18.5	17.6	17.6	17.2
	B	19	20.15	20.15	19.8
	Zn	19.48	19.72	19.72	19.5
Arginine 200 ppm	Control	18.39	18.6	18	18.6
	B	19.63	20.15	19.05	20.15
	Zn	20.01	20.26	19.99	20.26
Phd-Ca 30 ppm	Control	19.6	18.57	19	18.57
	B	21.07	21.9	20.92	21.89
	Zn	21.11	21.45	21.6	21.5
LSD at 5%		0.17	0.25	0.16	0.29

increased the yield of cotton plants and yield components. The effect of growth retardant Prohexadione-Ca could be attributed to its role in increasing number of branches, flowering and fruit setting as indicated by Sorensen *et al.* [28].

Data presented in Table 3 also showed that seed index and yield (Kentar/ fed) were increased as a result of application of arginine or Prohexadione-Ca as well as macro or micro nutrient treatments. The interaction effect of bioregulators and macro or micro nutrients showed mostly the highest increase in seed cotton yield (Kentar/ fed) and seed index of cotton plants under investigation. These results are supported with those obtained by Bourland *et al.* [29].

It could be concluded from the above mentioned data that the reduction of vegetative growth resulted from applications of growth retardant "Prohexadione-Ca" shifts nutrient resources to developing bolls and a greater proportion of boll production is shifted to lower nodal positions than in untreated cotton. This shift can lead to earlier cessation of flowering, which is often beneficial in short-season environments. The gradual shift from vegetative to reproductive organs is reflected by the progression of flowering towards the apex of the plant, from bottom to top.

Effect on Fiber Properties: Data in Table 4 illustrated that lint percentage of cotton fibers was significantly increased by arginine or Prohexadione-Ca as well as macro or micro nutrients application during the two successive growing seasons. The combined treatments of arginine or Prohexadione-Ca and macro or micro nutrients produced higher values of lint percentage compared with the individual treatments. The most effective treatment in this respect was that of 200 ppm of arginine combined with potassium application which recorded the highest lint percentage (40.8 %).

Concerning the effect of fiber fineness (micronair reading) and Pressley index, the present results indicated that arginine and Prohexadione-ca as will as macro (K, P) or micro (B, Z) nutrients slightly affected the fiber fineness or the values of Pressley index in the two successive growing seasons compared to the corresponding control. On the other hand, the interaction effect between arginine or Prohexadione-Ca and macro or micro nutrient treatments was much higher than the individual treatments of bioregulators or nutrient elements. The most effective treatments in this respect was that of arginine (200 ppm) combined with zinc application which recorded 5.0 micronair The highest value of Pressley index (10.40) was obtained with application of Prohexadione-Ca combined with potassium treatment at the first season. These results are in agreement with those obtained Bekheta and Ramadan [5] found that application of bioregulators uniconazole and coumarin at different rates improved fiber quality of cotton plants.

Effect on Oil and Protein Content: Cotton seeds contain approximately 18 – 20% oil. Cotton seed oil is one of the healthiest vegetable oils and is known for its neutral, slightly nutty flavor.

Cotton seed oil is described as being "naturally hydrogenated" because of the levels of oleic, palmitic and stearic acids, which it contains. These make it stable frying oil without the need for additional processing or the formation of trans. fatty acids. Data presented in Table 5 indicated that arginine and Prohexadione-Ca treatments slightly increased oil and protein percentages in the seeds of cotton plants during the two successive growing seasons. Addition of macro or micro nutrients to the above mentioned bioregulators resulted in the highest values of oil and protein contents in the seeds. The most effective interaction treatments was that of Prohexadione-Ca (30 mg/l) combined with potassium treatment. These results are in agreement with those obtained by Fan *et al.* [6] who indicated that using prohexadione-ca improved seed quality of sun flower (*Helianthus annuus*). Recently, Fax *et al.* [1] indicated that application of mepiquat chloride on cotton plants strengthened the security regarding the cotton seed as the material of cooking oil.

It could be concluded from the above mentioned results that application of bioregulators arginine or prohexadione-ca under the influence of some macro (K or P) or micronutrient (B or Zn) elements improved the growth and productivity of cotton plants in addition to increasing the percentage of oil and protein of the produced seeds.

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