

EFFECT OF PIX AND POTASSIUM CITRATE ON GROWTH, PRODUCTIVITY FIBER QUALITY AND YARN ON EGYPTIAN COTTON

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ABSTRACT

Two field experiments were conducted at the Agriculture Experimental and Research Station, Faculty of Agriculture, Moshtohor, Benha University, during 2012 and 2013 seasons to study the effect of spraying Mepiquate chloride (Pix) at 100, 200 and 250 mg/l, potassium citrate (K₂) at 500 and 1000 mg/l and the combination of pix at 200 mg/l + potassium citrate at 500 mg/l as foliar spray at 50,70 and 90 days after sowing, on different growth and plant yield characteristics including fiber properties, minerals, carbohydrates and crude protein contents in the two cotton cultivars Giza 86 and Giza 88. The results showed that the different applied treatments increased growth characteristics, *i.e.*, leaf and branch number, total leaf area/plant, dry weight/plant and total chlorophyll (SPDS) in Giza 86 and Giza 88 cotton cultivars at 120 days after sowing during 2012 and 2013 seasons. Maximum increase was with pix at 200 mg/l + potassium citrate at 500 mg/l in both seasons. Meanwhile plant height decreased with different applied treatments in the two assigned seasons. Also, Yield and yield components *i.e.*, bolls number and weight, seed cotton yield/plant and seed index significantly increased with different treatments and gave the highest value with pix at 200 mg/l + potassium citrate at 500 mg/l in the two cultivars in both seasons. In addition, span length SL2.5%, SL 50%, UR %, ML, UHM, UI%, SL66.7%, Rd%, elongation and Strength. Fiber tests were increased with different treatments. On the other hand, different treatments decreased SFC %, C.V%, b, MIC, C.V%, Thin Places, Thick Paces and Neps in Giza 86 during 2012 and 2013 seasons. But, in Giza 88 the different treatments increased SL 50%, UR%,UHM, SL 66.7%, elongation, Mic. and Neps during 2012 and 2013 seasons. Different applied treatments decreased SL2,5% , ML, UL %, C.V. % Rd, STR, C.V % , Thin Places and Thick Places during 2012 and 2013 seasons. Furthermore, some minerals and bio constituents were increased with different applied treatments.

Key words: *Egyptian cotton, Giza 86, Giza88, pix, potassium citrate, growth, yield, fiber properties, Yarn properties.*

1.INTRODUCTION

Egyptian cotton (*Gossypium barbadense* L.) is the most important commercial fiber crop in Egypt. Cotton plays a key role in the economic activity. It is the oldest among the commercial crops and is termed as white gold. Plant growth parameters are used to improve lint yield, fiber quality and yarn properties. Obviously, the best means to achieve these aims is through the use of desirable genotypes in the form of well-adapted high-yielding varieties. Plant growth regulators“PGR” When produced endogenously by plants, they are referred to plant hormones. when used as either naturally or synthetic compounds that are applied directly to a target plant to alter its physiological processes or its

structure to improve quality. Increasing yield, or facilitate harvesting control, prevent undesirable late vegetative growth of plants, and enhancing fruiting could be achieved. Like promoters, inhibitors play a key role in control mechanism of plant growth by interacting with metabolic processes such as nucleic acid and protein synthesis. Of these substances is Pix (N,N-dimethyl piperidinium chloride), commonly referred to as Mepex, Topit, and Mepiquate Chloride which consists of 4.2 % N, N-dimethyl piperidinium chloride, a quaternary ammonia compound (Mohammad *et al.*, 2007, Ahmed 2010 ; Najma *et al.*, 2000 and Niakan *et al.*, 2012).

Pix, is the first plant growth regulator that has significant effect on cotton growth and yield. Plant growth regulators such as pix decrease cotton vegetative growth by inhibiting gibberellic acid synthesis, a common plant hormone, which in turn, decreases cell elongation. Also, it suppresses vegetative growth in cotton, mainly by reducing the main stem and fruiting branch interned lengths (Ahmed 2010).

On the other hand, the importance of K₂ fertilization in Egyptian agriculture has become more apparent since the establishment of the High Dam, which resulted in the deposition of the suspended Nile silt upstream from the formed lake. This Nile silt was a source of K-bearing minerals that enriched the soils during the seasonal floods. Potassium affects respiration, photosynthesis, chlorophyll development, water content of leaves, carbon dioxide (CO₂) assimilation, and carbon movement (Sangakkara *et al.*, 2000 and Ahmed, 2002). Also potassium, has an important role in the translocation of photosynthesis from sources (leaves) to sinks (bolls), (Cakmak *et al.*, 1994). Potassium deficiencies can limit the accumulation of crop biomass. This has been attributed to a reduction in the partitioning of assimilates to the formation of leaf area and a decrease in the efficient use of intercepted radiation for the production of above-ground biomass. In this respect, Colomb *et al.* (1995) and Pettigrew (1999) stated that part of the overall effect of K₂ deficiency was reducing the amount of photosynthetic available for reproductive sinks, which produced changes in lint yield, fiber quality and yarn properties.

Therefore, this study aimed to determine the effect of different applied pix and potassium on growth and the balance between vegetative and reproductive growths to attain efficient cotton production, maximizing yield and high quality fiber properties for the Egyptian cotton cultivars Giza 86 and Giza 88.

2.MATERIAL AND METHODS

These experiments were conducted at the Agriculture Experimental and Research station, Faculty of Agriculture, Moshtohor, Benha University Egypt. Experiments were carried out during 2012 and 2013 seasons to study the effect of foliar spray with Mepiquate chloride (Pix) at 100, 200 and 250 mg/l and potassium citrate (K₂) at 500 mg/l and 1000 mg/l as well as its assigned combination on growth, yield

components and fiber properties for the Egyptian cotton Giza 86 and Giza 88 cultivars.

The design of the experiment was randomized complete block design arrangement with four replicates. Plot area was 10.5 m² (5 ridges, 3.5 m long and 60 cm a part). Distance between hills was 25 cm leaving two plants hill⁻¹ at thinning time (after five weeks from sowing). Cotton seeds were sown according to the usual dry method on 19th and 18th April in 2012 and 2013 seasons, respectively. Foliar sprays of different treatments were applied at 50, 70 and 90 days after sowing *i.e* Mepiquate chloride (Pix) at 100, 200 and 250 mg/l; potassium citrate (K₂) at 500 and 1000 mg/l and the combination of pix at 200 mg/l + potassium citrate at 500 mg/l as well as distilled water for the control. The other required culture practices for growing cotton plants (fertilizers, irrigation pest and diseases control) were followed as recommended.

The experiments were laid out in a clay soil; its physical and chemical properties are shown in Table (1). Each experiment included 5 treatments for each cultivar.

2.1. Recording of the Data

The plants were taken at random from each experimental plot at 120 days after sowing to determine some growth attributes, *i.e.*, plant height, no. of leaves, leaf area were measured by the disc method according to Johnson (1967), total dry weight and total chlorophyll content by chlorophyll meter (SPDS) Model SPAD 402.

2.2. Yield components, fiber properties and yarn properties

At harvest (*i.e.*, at 180 days after sowing) ten guarded plants from each experimental unit were chosen randomly taken the central row and the following traits were estimated; no. of sympodial branches/ plant, no. of open bolls/ plant, boll weight (g), seed index(g), and seed cotton yield plant⁻¹ (g).

2.2.1. Fiber properties The following fiber properties were measured using high volume Instrument (HVI). High volume fiber test system according to (A.S.T.M: D 46050 - 1998).

2.2.1.1. Fiber length parameters Fiber length at upper half means (U.H.M) mm. - uniformity index (U.I).

2.2.1.2. Fiber bundle tensile Fiber strength in gram / tex. - Fiber elongation %: the percentage of elongation, which occurs before a fiber bundle breaks.

Table (1):Physical and chemical properties of the experimental soil at the Farm, Faculty of Agriculture, Moshtohor during 2012 and 2013 seasons.

| Properties | Seasons | |
|---|---------|--------|
| | 2012 | 2013 |
| Particle size distribution (mechanical analysis) | | |
| Course sand % | 7.21 | 6.54 |
| Find sand % | 25.92 | 26.62 |
| Silt % | 12.86 | 13.62 |
| Clay % | 51.98 | 53.22 |
| Texture grade | Clay | Clay |
| Chemical analysis | | |
| E.C. | 2.15 | 2.18 |
| pH (1 :2.5) | 8.10 | 8.08 |
| CaCO ₃ % | 3.45 | 3.02 |
| O.M % | 2.13 | 2.20 |
| N % (total) | 0.165 | 0.165 |
| N(ppm) (available) | 51.05 | 52.63 |
| P % (total) | 0.116 | 0.118 |
| P(ppm) (available) | 19.4 | 20.81 |
| K % (total) | 0.65 | 0.63 |
| K(ppm) (available) | 937.75 | 996.35 |
| Soluble cations and anions (ppm) | | |
| Ca ⁺⁺ | 185.6 | 192.6 |
| Mg ⁺⁺ | 40.06 | 41.83 |
| K ⁺ | 42.64 | 41.81 |
| Na ⁺ | 191.42 | 191.25 |
| Cl ⁻ | 222.83 | 252.26 |
| Co ₃ ⁻ | 0.00 | 0.00 |
| H Co ₃ ⁻ | 344.28 | 365.37 |
| So ₄ ⁻ | 491.96 | 461.12 |

2.2.1.3. Fineness characters Fiber fineness (Micronaire reading). Fiber fineness was expressed as micronaire instrument reading, measured by (HVI).

2.2.1.4. Color attributes values Reflectance (Rd %) and Yellowness (+b)

2.2.1.5. KEISOKKI kcf-v/l/s version 1.29.3. The following fiber properties were measured using Keisokki (2013) kcf-v/l/s version 1.29.3. Instrument High volume fiber Length test system.

2.2.1.6 Fiber length parameters Coefficient of variation c.v % for length - Spain length at 66.7% - Spain length at 50 SL % -

Uniformity Ratio UR % - Short Fiber content (S.F.C. %).

2.2.2. Yarn properties

The R.S.S second part was spun fiber into (R.S.S) Ring spinning system 60^s carded count yarns at 3.6 (T.M.) for tests of yarn properties. Skein strength was measured according to ASTM: D-1578-67, (1998). Neps, thick places, thin places per/100 meter and yarn evenness (C.V %) was measured by Uster tester 3 according to ASTM: D-1425-60, (1998). All fiber tests were performed at the laboratories of the cotton Research Institute, Agricultural Research Center. Fiber tests were conducted at a relative humidity of 65 ± 2% and a temperature of 21 ± 2°C to determine.

2.4. Chemical analysis

Samples of cotton leaves at 100 days after sowing were taken to determine at 4 upper sympodial, total nitrogen as described by Horneck and Miller (1998), phosphorus by Sandell (1950), potassium by Horneck and Hanson (1998). While Ca, Mg, Fe, Zn and Cues described by A.O.A.C. (1990). The Crude protein was calculated according to the followings equation: Crude protein= total nitrogen x 6.25 (A.O.A.C., 1990). Total carbohydrates, were determined according to Dubois *et al.*, (1956).

2.5. Statistical analysis

All data were statistically analyzed and the means were compared using the least significant difference Test (LSD) at 5% level according to Snedecor and Cochran (1989).

3.RESULTS AND DISCUSSIONS

3.1. Growth characteristics

Data in Table (2) indicate that, leaf number, number of branches, total leaf area/plant, dry weight/plant and total chlorophyll SPDS at 120 days after sowing were significantly affected with different applied treatments, *i.e.*, Mepiquate chloride (Pix) at 100, 200 and 250 mg/l, potassium citrate (K₂) at 500&1000 mg / l and combination of pix at 200 mg/l+ potassium citrate at 500 mg / l also, as shown in Table (2) the highest values of increase were obtained with pix at 200 mg/l + potassium citrate at 500 mg/l in Giza 86 and Giza 88 C vs., during 2012 and 2013 seasons. On the other hand, plant height decreased by using pix treatments in the different levels (100, 200 and 250 mg/l) during 2012 and 2013 seasons. Meanwhile, potassium citrate at 500 & 1000 mg/ l, significantly

Table (2): Effect of pix and potassium citrate on growth attributes in some Egyptian cotton, cultivars during 2012 and 2013 seasons.

| Characteristics | Vegetative growth | | | | | | | | | | | |
|------------------------------|-------------------|--------|---------------|-------|--------------------|-------|---------------------------------|---------|--------------|-------|-------------------|--------|
| | Plant height | | Leaves number | | Number of branches | | Total leaf area cm ² | | Dry weight g | | Total chlorophyll | |
| cultivars | G 86 | G 88 | G 86 | G 88 | G 86 | G 88 | G 86 | G 88 | G 86 | G 88 | G 86 | G 88 |
| Treatments | | | | | | | | | | | | |
| Season 2012 | | | | | | | | | | | | |
| Control | 165.00 | 156.42 | 55.33 | 42.66 | 23.00 | 22.33 | 2321.2 | 2140.5 | 80.12 | 55.18 | 65.25 | 78.52 |
| Pix 100 mg/l | 130.14 | 151.22 | 65.00 | 46.33 | 25.00 | 24.66 | 2382.2 | 2312.3 | 82.34 | 62.56 | 90.56 | 91.62 |
| Pix 200 mg/l | 125.26 | 149.26 | 67.66 | 48.33 | 26.66 | 25.00 | 2415.1 | 2352.2 | 86.23 | 69.30 | 108.56 | 112.23 |
| Pix 250 mg/l | 128.32 | 148.72 | 69.33 | 50.66 | 29.00 | 27.33 | 2480.2 | 2448.6 | 87.43 | 73.12 | 115.12 | 117.81 |
| k ₂ 500mg/l | 165.16 | 159.22 | 72.66 | 53.00 | 28.66 | 29.66 | 2623.3 | 2518.1 | 90.73 | 78.25 | 112.46 | 120.15 |
| k ₂ 1000mg/l | 166.12 | 160.1 | 73.33 | 54.66 | 29.00 | 30.33 | 264.50 | 2521.2 | 91.15 | 78.82 | 113.40 | 121.15 |
| Pix 200 + k ₂ 500 | 162.11 | 155.20 | 75.33 | 55.66 | 29.00 | 32.66 | 2685.12 | 2572.14 | 91.15 | 81.25 | 120.16 | 123.52 |
| LSD 5 % | 1.65 | 1.52 | 1.85 | 1.80 | 1.23 | 1.35 | 10.25 | 10.23 | 2.26 | 2.45 | 2.42 | 2.92 |
| Season 2013 | | | | | | | | | | | | |
| Control | 160.15 | 156.42 | 60.66 | 42.66 | 23.33 | 22.33 | 2372.1 | 2140.5 | 81.18 | 55.18 | 62.22 | 75.33 |
| Pix 100 mg/l | 132.13 | 151.22 | 63.33 | 46.33 | 25.66 | 24.66 | 2386.3 | 2312.3 | 83.46 | 62.56 | 85.14 | 90.52 |
| Pix 200 mg/l | 127.39 | 149.26 | 68.33 | 48.33 | 27.33 | 25.00 | 2425.6 | 2352.2 | 89.22 | 69.30 | 101.2 | 110.16 |
| Pix 250 mg/l | 129.42 | 148.72 | 70.00 | 50.66 | 29.66 | 27.33 | 2493.3 | 2448.6 | 82.12 | 73.12 | 110.15 | 115.75 |
| k ₂ 500mg/l | 167.19 | 159.22 | 73.00 | 53.00 | 29.00 | 29.66 | 2626.4 | 2518.1 | 91.81 | 78.25 | 107.30 | 118.22 |
| k ₂ 1000mg/l | 167.20 | 160.1 | 73.66 | 54.66 | 29.66 | 30.33 | 2641.3 | 2521.2 | 92.70 | 78.82 | 110.20 | 120.46 |
| Pix 200 + k ₂ 500 | 159.25 | 155.20 | 76.66 | 55.66 | 30.33 | 32.66 | 2692.74 | 2572.14 | 93.02 | 81.25 | 115.23 | 120.12 |
| LSD 5 % | 1.71 | 1.52 | 1.92 | 1.80 | 1.32 | 1.35 | 12.18 | 10.23 | 2.56 | 2.45 | 2.15 | 2.71 |

increased plant height in Giza 86 and Giza 88 during 2013 season only.

In this respect, the obtained increase of these traits may be attributed to the expected role of pix and potassium treatments in the balance of vegetative growth and increased the numbers of leaves and branches and accumulation of different plant growth substances in different organs of the plants and effects of pix on photosynthesis, carbohydrate status, membrane integrity and nutrient uptake which have been documented and the results used to explain the mode of action (Guo *et al.*,1994). Pix is a compound that could promote, inhibit, or even modify some physiological processes and/or its ability to affect morphological traits. This compound has been developed and tested on cotton plants (Zhao and Oosterhuis, 2000 and Sawan *et al.*, 2006).

Here, also it could be concluded that, despite that obvious and significant reduction in plant height in different pix treatments; branches and leaf number as well as the total leaf area in the same treatments significantly increased.

This result could be attributed to the fact that any growth inhibitor such as pix, paclobutrazol ...etc, in other meaning the gibberellins inhibitors strictly cause more cytokines creation (Opik and Rolfe, 2005). Thereby, more branches

carrying a plenty of small leaves is attained. So, the largest leaf area accompanied with high chlorophyll content (Table 3) could be synthesizing more assimilates leading to role dry weight increases (Table 2). Therefore, under these circumstances more bolls and great yield could be expected (Table 3) with good quality of fiber properties (Tables 4, 5& 6) Oosterhuis (1994).

3.2 Yield components

Data in Table (3) show that all applied treatments gave a significant increase in the number of fruiting branches, number of open bolls/plant, boll weight, seed cotton yield/plant and seed index that was true with the two cv. during 2012 and 2013 seasons . Also, it could be noticed that the highest values of all these parameters existed with the treatment of Mepiquate chloride (Pix) at 200 mg/l+ potassium citrate at 500 mg / l in Giza 86 and Giza 88 cultivars during 2012 and 2013 seasons. These results agree with those previously reported by Oosterhuis (1994), Mekki (1999), Biles and Cothren (2001) and Ram *et al.* (2001).

Here, it could be noticed that increases in the number of fruiting branches/plant, were accompanied with significant increase in each of bolls/plant, boll weight, seed cotton yield and seed index (Wu *et al.*,1985),in this respect

Table (3): Effect of pix and potassium citrate on yield components in some Egyptian cotton, cultivars during 2012 and 2013 seasons.

| Characteristics | yield components | | | | | | | | | |
|------------------------------|---------------------------------|-------|------------------------|-------|-----------------|------|-----------------------------|-------|----------------|-------|
| | No. of fruiting branches/ plant | | No. of open Boll/plant | | Boll weight (g) | | Seed Cotton yield/plant (g) | | seed index (g) | |
| cultivars | G 86 | G 88 | G 86 | G 88 | G 86 | G 88 | G 86 | G 88 | G 86 | G 88 |
| Season 2012 | | | | | | | | | | |
| Control | 17.33 | 20.00 | 24.00 | 22.33 | 2.10 | 2.10 | 20.20 | 20.15 | 8.17 | 8.52 |
| Pix 100 mg/l | 20.66 | 23.66 | 28.66 | 24.66 | 2.43 | 2.62 | 22.23 | 25.13 | 10.52 | 9.85 |
| Pix 200 mg/l | 21.33 | 26.33 | 29.33 | 26.00 | 2.79 | 2.82 | 25.18 | 26.52 | 10.89 | 10.21 |
| Pix 250 mg/l | 24.00 | 28.00 | 32.00 | 27.33 | 2.93 | 2.95 | 33.54 | 28.18 | 10.25 | 11.25 |
| k ₂ 500mg/l | 26.66 | 30.33 | 33.33 | 29.66 | 2.98 | 3.05 | 41.46 | 32.15 | 11.18 | 11.78 |
| k ₂ 1000mg/l | 27.33 | 30.66 | 34.00 | 31.00 | 3.00 | 3.15 | 42.45 | 32.21 | 12.14 | 11.85 |
| Pix 200 + k ₂ 500 | 27.33 | 31.33 | 35.33 | 30.66 | 3.10 | 3.25 | 45.12 | 33.18 | 12.20 | 12.80 |
| LSD 5 % | 1.12 | 1.52 | 1.20 | 1.33 | 0.05 | 0.10 | 1.85 | 0.72 | 0.08 | 0.52 |
| Season 2013 | | | | | | | | | | |
| Control | 19.66 | 22.33 | 25.33 | 24.00 | 2.15 | 2.42 | 21.25 | 22.25 | 8.26 | 8.62 |
| Pix 100 mg/l | 22.33 | 25.00 | 30.00 | 26.33 | 2.52 | 2.72 | 24.89 | 27.35 | 10.68 | 9.92 |
| Pix 200 mg/l | 23.66 | 27.66 | 32.66 | 27.66 | 2.84 | 2.91 | 28.59 | 29.24 | 10.93 | 10.56 |
| Pix 250 mg/l | 25.33 | 29.66 | 35.33 | 28.66 | 2.97 | 3.01 | 35.73 | 32.91 | 10.42 | 11.68 |
| k ₂ 500mg/l | 27.00 | 31.00 | 38.66 | 30.33 | 3.01 | 3.12 | 48.14 | 34.72 | 11.85 | 11.91 |
| k ₂ 1000mg/l | 28.00 | 31.33 | 39.00 | 32.33 | 3.05 | 3.20 | 49.25 | 35.14 | 12.32 | 11.95 |
| Pix 200 + k ₂ 500 | 29.66 | 32.66 | 39.66 | 31.66 | 3.15 | 3.52 | 52.26 | 37.85 | 13.12 | 12.85 |
| LSD 5 % | 1.18 | 2.05 | 1.32 | 1.41 | 0.12 | 0.15 | 1.99 | 1.02 | 0.15 | 0.62 |

attributed the increases of different parameters in photosynthetic activity of leaves to potassium and pix application. Kler *et al.*, (1989) stated that, increased photosynthesis increases flowering and boll retention. Also, Khan (1996) stated that plant growth regulators could be used for maintaining internal hormonal balance and an efficient sink source relationship that enhances crop productivity. Yield increases could be attributed to the effect of potassium on new growth and nutrient uptake (Fan *et al.*, 1999), which caused favorable effects on the number of opened bolls per plant and boll weight, leading to higher cotton yield. Zeng (1996) indicated that K fertilizer reduced boll shedding. Potassium deficiencies can also limit the accumulation of crop biomass (Colomb *et al.*, 1995). Potassium also has an important role in the translocation of photosynthesis from sources to sinks Cakmak *et al.*,(1994) and Li *et al.* (1999) reported that cellulose synthesis and dry matter accumulation increased by K application, which indicates that K deficiency during the reproductive period changes the structure of fruit-bearing organs and decreases yield and its quality.

The present results could support the foundation of Khan (1996) and Fan *et al.*(1999) for maintaining the internal hormonal balance and providing an efficient sink-source

relationship since, increasing the number of fruiting branches and bolls as well as boll weight are established effect of improving cytokines creation and that could be in the present of sufficient amount of potassium could be a direct and true reason for that significant increases in different yield characteristics (Table 3). This physiological role of cytokines and potassium has been established by many researchers (Ahmed 2002, Opik and Rolfe, 2005 and A.S.T.M., 1998).

3.3 Fiber and yarn properties

Data in Tables (4,5,6&7) indicated that different applied treatments i.e. pix at 100, 200 and 250 mg/l, potassium citrate at 500& 1000 mg/l and combination of Mepiquate chloride (Pix) at 200 mg/l+ potassium citrate at 500 mg/l increased SL2.5%, SL 50%, UR %, ML, UHM, UI%, SL66.7%, Rd%, Elong, and STR. The highest value of these traits existed with combination of pix at 200 mg/l + potassium citrate at 500 mg/l in Giza 86 during 2012 and 2013 seasons. On the other hand, different treatments decreased SFC %, C.V%, b, MIC, C.V%, thin places, thick places and neps in Giza 86 during 2012 and 2013 seasons. But, in Giza 88 different applied treatments increased SL 50%, UR%, UHM, SL 66.7%, Elong%, Mic and neps during 2012 and 2013 seasons. The maximum effective of these traits by using

Table (4): Effect of pix and potassium citrate (K₂) on fiber properties in some Egyptian cotton cultivars during 2012 and 2013 seasons.

| Characteristics | Fiber properties | | | | | | | | | |
|------------------------------|------------------|-------|--------|-------|-------|-------|-------|-------|------|------|
| | SL2.5% | | SL 50% | | ML mm | | UR% | | SFC% | |
| cultivars | G 86 | G 88 | G 86 | G 88 | G 86 | G 88 | G 86 | G 88 | G 86 | G 88 |
| Treatments | | | | | | | | | | |
| Season 2012 | | | | | | | | | | |
| Control | 34.4 | 36.85 | 16.45 | 17.48 | 29.83 | 31.98 | 47.83 | 47.43 | 4.93 | 4.25 |
| Pix 100 mg/l | 36.05 | 36.50 | 17.55 | 17.50 | 31.88 | 31.93 | 48.65 | 47.93 | 3.75 | 4.03 |
| Pix 200 mg/l | 36.35 | 36.50 | 17.65 | 17.60 | 32.23 | 30.08 | 48.58 | 46.68 | 4.03 | 4.07 |
| Pix 250 mg/l | 35.52 | 36.67 | 17.40 | 18.15 | 32.88 | 31.75 | 49.00 | 47.43 | 3.98 | 4.00 |
| k ₂ 500mg/l | 36.52 | 36.78 | 17.85 | 18.53 | 33.52 | 31.82 | 50.42 | 47.80 | 4.05 | 4.08 |
| k ₂ 1000mg/l | 36.72 | 36.82 | 17.92 | 18.62 | 33.75 | 31.83 | 51.15 | 47.90 | 4.06 | 4.10 |
| Pix 200 + k ₂ 500 | 36.72 | 36.95 | 17.92 | 18.79 | 33.83 | 31.89 | 51.03 | 47.97 | 4.80 | 4.15 |
| LSD 5 % | 0.15 | 0.12 | 0.23 | 0.05 | 0.35 | 0.28 | 0.42 | 0.25 | 0.24 | 0.02 |
| Season 2013 | | | | | | | | | | |
| Control | 33.4 | 33.4 | 16.55 | 17.58 | 29.52 | 30.95 | 47.93 | 47.53 | 4.53 | 4.15 |
| Pix 100 mg/l | 35.05 | 35.05 | 17.65 | 17.60 | 30.88 | 31.00 | 48.85 | 48.23 | 3.45 | 4.00 |
| Pix 200 mg/l | 35.35 | 35.35 | 17.75 | 17.70 | 31.25 | 30.00 | 48.98 | 47.68 | 4.00 | 4.02 |
| Pix 250 mg/l | 34.52 | 35.52 | 17.50 | 18.25 | 31.95 | 31.02 | 49.20 | 47.83 | 3.88 | 4.01 |
| k ₂ 500mg/l | 35.52 | 36.52 | 17.95 | 18.63 | 32.62 | 31.42 | 50.52 | 47.95 | 4.12 | 4.05 |
| k ₂ 1000mg/l | 37.62 | 36.45 | 18.02 | 18.71 | 34.72 | 31.51 | 52.21 | 47.98 | 4.15 | 4.12 |
| Pix 200 + k ₂ 500 | 37.55 | 36.98 | 17.99 | 18.94 | 33.91 | 31.96 | 51.52 | 48.02 | 4.05 | 4.26 |
| LSD 5 % | 0.15 | 0.15 | 0.25 | 0.08 | 0.30 | 0.21 | 0.44 | 0.30 | 0.24 | 0.05 |

Table (5): Effect of pix and potassium citrate (K₂) on fiber properties in some Egyptian cotton cultivars during 2012 and 2013 seasons.

| Characteristics | Fiber properties | | | | | | | | | |
|------------------------------|------------------|-------|-------|-------|---------|-------|-------|-------|-------|-------|
| | UHM m.m. | | UI% | | SL66.7% | | c.v% | | +b | |
| cultivars | G 86 | G 88 | G 86 | G 88 | G 86 | G 88 | G 86 | G 88 | G 86 | G 88 |
| Treatments | | | | | | | | | | |
| Season 2012 | | | | | | | | | | |
| Control | 34.68 | 36.70 | 86.20 | 87.13 | 12.23 | 12.90 | 26.08 | 26.33 | 11.40 | 10.43 |
| Pix 100 mg/l | 36.93 | 37.05 | 86.35 | 86.18 | 12.95 | 12.93 | 24.68 | 25.40 | 10.20 | 11.28 |
| Pix 200 mg/l | 37.30 | 37.48 | 86.40 | 84.83 | 12.98 | 12.33 | 25.08 | 27.55 | 10.00 | 10.53 |
| Pix 250 mg/l | 48.38 | 36.73 | 87.93 | 86.43 | 12.80 | 12.83 | 24.53 | 25.63 | 10.18 | 11.20 |
| k ₂ 500mg/l | 50.32 | 36.82 | 88.54 | 85.35 | 12.99 | 12.96 | 25.41 | 25.50 | 10.30 | 11.52 |
| k ₂ 1000mg/l | 51.42 | 36.84 | 88.58 | 85.45 | 13.00 | 12.97 | 25.52 | 25.65 | 10.40 | 11.61 |
| Pix 200 + k ₂ 500 | 50.86 | 36.91 | 88.92 | 86.14 | 13.12 | 13.02 | 26.46 | 25.82 | 10.52 | 11.85 |
| LSD 5 % | 0.62 | 0.41 | 0.05 | 0.11 | 0.07 | 0.08 | 0.12 | 0.05 | 0.06 | 0.08 |
| Season 2013 | | | | | | | | | | |
| Control | 33.50 | 36.02 | 85.10 | 85.13 | 12.05 | 12.75 | 26.00 | 26.23 | 11.00 | 10.32 |
| Pix 100 mg/l | 36.10 | 36.82 | 85.35 | 85.18 | 12.2 | 12.82 | 24.52 | 25.20 | 10.10 | 11.02 |
| Pix 200 mg/l | 37.00 | 36.44 | 85.43 | 84.63 | 12.72 | 12.10 | 25.10 | 26.51 | 10.01 | 10.35 |
| Pix 250 mg/l | 48.00 | 36.31 | 86.83 | 86.73 | 12.67 | 12.73 | 24.22 | 25.61 | 10.03 | 11.02 |
| k ₂ 500mg/l | 49.20 | 36.84 | 87.64 | 85.95 | 12.85 | 12.75 | 24.25 | 25.72 | 10.15 | 11.48 |
| k ₂ 1000mg/l | 49.25 | 36.91 | 87.71 | 85.98 | 12.91 | 12.82 | 24.60 | 25.78 | 10.23 | 11.51 |
| Pix 200 + k ₂ 500 | 50.93 | 36.99 | 88.98 | 86.53 | 13.02 | 12.85 | 26.58 | 25.75 | 10.65 | 11.92 |
| LSD 5 % | 0.56 | 0.42 | 0.08 | 0.12 | 0.10 | 0.12 | 0.15 | 0.08 | 0.05 | 0.09 |

Table (6): Effect of pix and potassium citrate (K₂) on fiber properties in some Egyptian cotton cultivars during 2012 and 2013 seasons.

| Characteristics | Fiber properties | | | | | | | |
|------------------------------|------------------|-------|-------------|------|---------------|-------|------|------|
| | Rd% | | Elongation% | | Str. Gram/tex | | Mic. | |
| cultivars | G 86 | G 88 | G 86 | G 88 | G 86 | G 88 | G 86 | G 88 |
| Treatments | | | | | | | | |
| Season 2012 | | | | | | | | |
| Control | 68.03 | 65.00 | 7.63 | 7.43 | 45.10 | 49.38 | 4.65 | 4.00 |
| Pix 100 mg/l | 68.03 | 65.73 | 7.78 | 7.53 | 43.20 | 48.13 | 4.23 | 4.08 |
| Pix 200 mg/l | 71.43 | 65.13 | 7.70 | 7.63 | 43.10 | 45.10 | 4.03 | 4.05 |
| Pix 250 mg/l | 67.60 | 62.78 | 7.38 | 7.58 | 46.18 | 43.33 | 4.28 | 4.00 |
| k ₂ 500mg/l | 68.85 | 63.52 | 7.81 | 7.73 | 47.15 | 48.50 | 4.45 | 4.23 |
| k ₂ 1000mg/l | 69.90 | 64.23 | 7.91 | 7.72 | 47.17 | 48.52 | 4.48 | 4.25 |
| Pix 200 + k ₂ 500 | 69.15 | 63.72 | 7.92 | 7.81 | 47.22 | 48.60 | 4.42 | 4.32 |
| LSD 5 % | 0.15 | 0.06 | 0.05 | 0.09 | 0.05 | 0.12 | 0.08 | 0.12 |
| Season 2013 | | | | | | | | |
| Control | 67.82 | 65.10 | 7.55 | 7.41 | 44.00 | 48.40 | 4.52 | 3.95 |
| Pix 100 mg/l | 68.00 | 67.56 | 7.76 | 7.26 | 43.10 | 48.50 | 4.15 | 4.05 |
| Pix 200 mg/l | 71.23 | 68.10 | 7.62 | 7.45 | 42.18 | 45.20 | 4.00 | 4.00 |
| Pix 250 mg/l | 67.72 | 62.52 | 7.48 | 7.50 | 45.60 | 43.42 | 4.02 | 4.02 |
| k ₂ 500mg/l | 69.20 | 63.42 | 7.82 | 7.65 | 46.25 | 48.32 | 4.25 | 4.18 |
| k ₂ 1000mg/l | 69.52 | 64.52 | 7.92 | 7.79 | 46.32 | 48.33 | 4.27 | 4.20 |
| Pix 200 + k ₂ 500 | 69.82 | 63.82 | 7.95 | 7.75 | 46.35 | 48.71 | 4.32 | 4.25 |
| LSD 5 % | 0.20 | 0.09 | 0.08 | 0.12 | 0.08 | 0.13 | 0.10 | 0.13 |

Table (7): Effect of pix and potassium citrate (K₂) on yarn properties in some Egyptian cotton cultivars during 2012 and 2013 seasons.

| Characteristics | Yarn properties | | | | | | | | | |
|------------------------------|-----------------|-------|-------|-------|-------------|------|--------------|-------|-------|-------|
| | Skein strength | | C.V.% | | Thin Places | | Thick Places | | Neps | |
| cultivars | G 86 | G 88 | G 86 | G 88 | G 86 | G 88 | G 86 | G 88 | G 86 | G 88 |
| Treatments | | | | | | | | | | |
| Seasons 2012 | | | | | | | | | | |
| Control | 2630 | 2850 | 16.96 | 16.54 | 9.00 | 4.00 | 20.00 | 15.00 | 11.00 | 6.00 |
| Pix 100 mg/l | 2660 | 2870 | 16.80 | 16.50 | 7.00 | 3.00 | 17.00 | 13.00 | 9.00 | 5.00 |
| Pix 200 mg/l | 2690 | 2890 | 16.75 | 16.41 | 6.75 | 3.00 | 16.00 | 12.00 | 8.00 | 9.00 |
| Pix 250 mg/l | 2715 | 2920 | 16.62 | 16.35 | 4.00 | 2.50 | 17.00 | 10.00 | 6.75 | 8.00 |
| k ₂ 500mg/l | 2660 | 2885 | 16.92 | 16.45 | 7.75 | 3.72 | 18.00 | 14.00 | 9.85 | 10.00 |
| k ₂ 1000mg/l | 2645 | 2870 | 16.93 | 16.47 | 7.78 | 3.75 | 18.00 | 14.00 | 9.90 | 10.00 |
| Pix 200 + k ₂ 500 | 2650 | 2865 | 16.95 | 16.46 | 7.82 | 3.82 | 19.00 | 14.00 | 9.95 | 11.00 |
| LSD 5 % | 23.45 | 15.12 | 0.15 | 0.10 | 0.10 | 0.11 | 0.25 | 0.18 | 0.16 | 0.15 |
| Seasons 2013 | | | | | | | | | | |
| Control | 2640 | 2855 | 16.96 | 16.20 | 9.00 | 4.02 | 20.00 | 15.05 | 11.00 | 5.00 |
| Pix 100 mg/l | 2670 | 2885 | 16.80 | 16.15 | 7.00 | 3.02 | 7.00 | 13.04 | 9.00 | 4.00 |
| Pix 200 mg/l | 2690 | 2860 | 16.75 | 16.32 | 6.75 | 3.05 | 16.00 | 12.06 | 8.00 | 8.00 |
| Pix 250 mg/l | 2750 | 2895 | 16.62 | 16.25 | 4.00 | 2.58 | 17.00 | 10.18 | 6.75 | 7.00 |
| k ₂ 500mg/l | 2630 | 2880 | 16.92 | 16.35 | 7.75 | 3.65 | 18.00 | 14.29 | 9.85 | 9.00 |
| k ₂ 1000mg/l | 2620 | 2870 | 16.93 | 16.40 | 7.78 | 3.73 | 18.00 | 14.30 | 9.90 | 9.00 |
| Pix 200 + k ₂ 500 | 2600 | 2860 | 16.95 | 16.48 | 7.82 | 3.80 | 19.00 | 14.32 | 9.95 | 10.00 |
| LSD 5 % | 21.68 | 16.83 | 0.15 | 0.09 | 0.10 | 0.13 | 0.25 | 0.19 | 0.16 | 0.16 |

potassium citrate at 500 mg/l during 2012 and 2013 seasons. On the other hand, different applied treatments decreased SL_{2,5}, ML, UL %, C.V. % Rd, STR, C.V %, Thin Places and Thick Places during 2012 and 2013 seasons

(Oosterhuis, 1994, Oosterhuis *et al.*, 1990 and Elayan, *et al.* 2008).

In this respect, pix and potassium citrate increased the physiological processes in plant growth such as photosynthesis partitioning and

accumulated and allocation from source to sink and which is believed to be related to the improved partitioning and accumulation of dry matter into fiber properties (Zhao and Oosterhuis, 2000).

It was reported that leaf carbohydrates represent the primary metabolic carbohydrate pools for cotton thus understanding their dynamics during cotton growth and boll development is important for fiber properties increases. It was stated that plant growth regulators (pix) can influence carbohydrate translocation out of the cotton leaf (source) to boll (sink) thereby increased yield and fiber properties. The slight effects of pix and potassium on fiber properties in this study, and the inconsistent effects in other searches, indicate that these treatments should be expected to have inconsistent and small effects that are not likely to be of economic importance.

3.4.Nutrients content

Data in Tables (8 and 9) show that Mepiquate chloride (Pix) at 100, 200, 250 mg/l ,potassium citrate at 500&1000 mg/l and combination of pix at 200 mg/l +potassium citrate at 500 mg/l increased N, P, K, Mg, Ca, Fe and Cu concentration in leaves of cotton plant cultivars Giza 86 and Giza 88 at 100 days after sowing during 2012 and 2013 seasons. The maximum

effective of different minerals contents by using combination of pix at 200mg/l+ potassium citrate at 500 mg / l in Giza 86 and Giza 88 cotton cultivars during 2012 and 2013 seasons.

3.5. Carbohydrates and crude protein content

Data in Table (9) show that total carbohydrates and crude protein content significantly increased by using different applied treatments at 120 days after sowing in Giza 86 and Giza 88 during 2012 and 2013 seasons. In this context, the highest value of these traits was existed with combination of Mepiquate chloride (Pix) at 200mg/l +potassium citrate at 500 mg / l in Giza 86 and Giza 88 during 2012 and 2013 seasons.

Here, the obtained increase of minerals concentration, carbohydrates and crude protein contents may be attributed to the role of pix and potassium up on biochemical pathways of photosynthesis rates, stomata conductance in treated plants. Also, Pettigrew (1999) stated that, the elevated transpiration was positively correlated with leaf N and carbohydrate concentrations. Similar findings such as leaves, appear to be part of the overall. Palomo *et al.*,(1999), found that when potassium was applied, it increased different minerals uptake. Since, leaf carbohydrates represent the primary metabolic carbohydrate pools for cotton plants,

Table (8): Effect of pix and potassium citrate (K₂) on some macro element contents some Egyptian cotton cultivars during 2012 and 2013 seasons.

| Characteristics | Some macro element contents | | | | | | | | | |
|------------------------------|-----------------------------|------|------|------|------|------|------|------|------|------|
| | N % | | P % | | K % | | Mg % | | Ca % | |
| cultivars | G 86 | G 88 | G 86 | G 88 | G 86 | G 88 | G 86 | G 88 | G 86 | G 88 |
| Treatments | | | | | | | | | | |
| Season 2012 | | | | | | | | | | |
| Control | 1.55 | 1.44 | 0.50 | 0.62 | 1.35 | 1.45 | 0.20 | 0.22 | 0.42 | 0.35 |
| Pix 100 mg/l | 1.92 | 1.52 | 0.66 | 0.73 | 1.75 | 1.65 | 0.59 | 0.67 | 0.52 | 0.45 |
| Pix 200 mg/l | 1.99 | 1.95 | 0.74 | 0.78 | 1.95 | 1.75 | 0.65 | 0.72 | 0.65 | 0.59 |
| Pix 250 mg/l | 2.15 | 2.29 | 0.83 | 0.85 | 2.23 | 2.13 | 0.72 | 0.75 | 0.72 | 0.72 |
| k ₂ 500mg/l | 2.30 | 2.71 | 0.91 | 0.89 | 3.00 | 2.51 | 0.78 | 0.76 | 0.79 | 0.76 |
| k ₂ 1000mg/l | 2.35 | 2.73 | 0.92 | 0.90 | 3.01 | 2.53 | 0.79 | 0.78 | 0.80 | 0.77 |
| Pix 200 + k ₂ 500 | 2.45 | 2.81 | 0.93 | 0.91 | 3.05 | 2.82 | 0.81 | 0.82 | 0.82 | 0.80 |
| LSD 5 % | 0.15 | 0.15 | 0.22 | 0.05 | 0.42 | 0.18 | 0.12 | 0.10 | 0.05 | 0.05 |
| Season 2013 | | | | | | | | | | |
| Control | 1.62 | 1.53 | 0.52 | 0.67 | 1.42 | 1.52 | 0.32 | 0.31 | 0.47 | 0.37 |
| Pix 100 mg/l | 2.05 | 2.15 | 0.69 | 0.73 | 1.94 | 1.74 | 0.65 | 0.71 | 0.57 | 0.47 |
| Pix 200 mg/l | 2.33 | 2.43 | 0.78 | 0.81 | 2.01 | 1.89 | 0.68 | 0.76 | 0.72 | 0.63 |
| Pix 250 mg/l | 2.29 | 2.59 | 0.87 | 0.87 | 2.35 | 2.25 | 0.79 | 0.77 | 0.78 | 0.75 |
| k ₂ 500mg/l | 2.52 | 2.82 | 0.90 | 0.92 | 3.02 | 2.71 | 0.82 | 0.83 | 0.85 | 0.85 |
| k ₂ 1000mg/l | 2.56 | 2.79 | 0.92 | 0.93 | 3.03 | 2.73 | 0.84 | 0.85 | 0.86 | 0.86 |
| Pix 200 + k ₂ 500 | 2.72 | 3.01 | 0.99 | 0.95 | 3.12 | 2.85 | 0.86 | 0.86 | 0.91 | 0.91 |
| LSD 5 % | 0.41 | 0.21 | 0.23 | 0.09 | 0.55 | 0.23 | 0.15 | 0.13 | 0.13 | 0.13 |

Table (9): Effect of pix and potassium citrate (K₂) on mine elements, total carbohydrates and crude protein contents some Egyptian cotton cultivars during 2012 and 2013 seasons.

| Characteristics | some mine elements, total carbohydrates and crude protein contents | | | | | | | |
|------------------------------|--|------|---------|--------|-----------------|-------|-----------------|-------|
| | Fe mg/l | | Cu mg/l | | Total Carboh. % | | Crude protein % | |
| cultivars | G 86 | G 88 | G 86 | G 88 | G 86 | G 88 | G 86 | G 88 |
| Season 2012 | | | | | | | | |
| Control | 202 | 198 | 78.14 | 68.14 | 20.15 | 22.12 | 9.69 | 9.00 |
| Pix 100 mg/l | 220 | 210 | 85.12 | 75.22 | 26.28 | 24.15 | 12.00 | 9.50 |
| Pix 200 mg/l | 225 | 220 | 92.18 | 82.28 | 27.29 | 25.42 | 12.44 | 12.19 |
| Pix 250 mg/l | 218 | 235 | 98.14 | 98.34 | 30.15 | 26.18 | 13.44 | 14.31 |
| k ₂ 500mg/l | 224 | 240 | 105.18 | 102.48 | 36.17 | 28.22 | 14.38 | 16.94 |
| k ₂ 1000mg/l | 230 | 241 | 107.12 | 105.30 | 37.21 | 29.26 | 14.68 | 17.06 |
| Pix 200 + k ₂ 500 | 242 | 256 | 110.25 | 105.54 | 42.25 | 30.29 | 15.31 | 17.56 |
| LSD 5 % | 1.20 | 1.20 | 2.15 | 2.15 | 1.10 | 1.10 | 1.33 | 1.33 |
| Season 2013 | | | | | | | | |
| Control | 208 | 200 | 82.14 | 72.64 | 25.14 | 23.2 | 10.13 | 9.56 |
| Pix 100 mg/l | 225 | 222 | 92.18 | 82.58 | 28.19 | 25.33 | 12.81 | 13.44 |
| Pix 200 mg/l | 235 | 240 | 100.27 | 90.47 | 29.18 | 26.72 | 14.56 | 15.19 |
| Pix 250 mg/l | 231 | 242 | 105.40 | 102.30 | 32.12 | 28.25 | 14.31 | 16.19 |
| k ₂ 500mg/l | 228 | 255 | 108.97 | 108.97 | 40.15 | 30.15 | 15.75 | 18.25 |
| k ₂ 1000mg/l | 233 | 226 | 110.15 | 110.90 | 41.25 | 30.25 | 16.00 | 17.43 |
| Pix 200 + k ₂ 500 | 251 | 272 | 116.52 | 112.14 | 45.33 | 31.35 | 17.00 | 18.81 |
| LSD 5 % | 1.14 | 1.14 | 2.25 | 2.25 | 1.56 | 1.56 | 1.56 | 1.56 |

an understanding of their dynamics during cotton growth and boll development could be reported.

Conclusions

The maximum growth, yield and yield components, fiber properties, minerals and total carbohydrates & crude protein contents were achieved by using foliar application of combination of pix at 200 mg/l⁺ potassium citrate at 500 mg/l through plant growth in the two Egyptian cotton cultivars Giza 86 and Giza 88. Therefore, the present study strongly suggest the use of such two treatments to improve each of cotton growth and the final yield with good quality as well.

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تأثير البكس وسترات البوتاسيوم على النمو والإنتاجية وجودة صفات التيلة والغزل في القطن المصري

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ملخص

أجريت تجربتان حقليتان بمحطة التجارب والبحوث الزراعيه بكلية الزراعة بمشتهر- جامعه بنها, خلال موسمی الزراعة 2012، 2013 لدراسة تأثير الرش بمنظم النمو البكس بتركيزات 100، 200، 250 مللجم/ لتر وكذلك سترات البوتاسيوم بتركيز 500، 1000 مللجم/ لتر ومخلوط من البكس بتركيز 200 مللجم/ لتر + سترات البوتاسيوم بتركيز 500 مللجم/لتر، والرش عند عمر 50، 70، 90 يوم من الزراعة ودراسة تأثير ذلك على نمو وإنتاجية النبات وصفات المحصول المختلفه ومحتوى الأوراق من العناصر المعدنية والكربوهيدرات ونسبة البروتين بالإضافة إلى صفات التيلة والغزل لصنفى القطن المصرى جيزة 86 وجيزة 88.

وأظهرت النتائج زيادة صفات النمو الخضري (عدد الأوراق، عدد الأفرع، مساحة الأوراق، وزن الأوراق الجافه ومحتوى الأوراق من الكلورفيل الكلى، عدد الأفرع، عدد اللوز المتفتح/ النبات عند 120 من الزراعة) وأعلى زياده كانت بإستخدام البكس بتركيز 200 مللجم/ لتر + سترات البوتاسيوم بتركيز 500 مللجم/ لتر لصنفى القطن المصرى جيزة 86 وجيزة 88 فى كلا الموسمين).

أدت كل المعاملات إلى إنخفاض طول النبات مقارنة بالنباتات غير المعامله وأيضا زياده فى صفات المحصول ومكوناته وكان أعلى تأثير مع إستخدام مخلوط البكس بتركيز 200 مللجم/ لتر + سترات البوتاسيوم بتركيز 500 مللجم/ لتر عند عمر 120 يوم من الزراعة فى كلا الصنفين جيزة 86 وجيزة 88 خلال موسمی الزراعة.

أدت المعاملات المختلفه الى تحسين صفات جودة المحصول (طول التيلة عند 2.5%، 50%، الإنتظاميه، متوسط الطول، معامل الإنتظام، الطول عند 66.7%، الإستطاله، متانة التيلة، إنخفاض محتوى الشعيرات القصيره، معامل الإختلاف، الميكرونيير، الأماكن السميكة والرفيعه والعقد - للخيظ المغزول) فى الصنف جيزة 86 خلال موسمی الزراعة، وفى الصنف جيزة 88 أدت إلى تحسين فى (الطول عند 50%، الإنتظاميه، الطول عند 66.7%، الإستطاله، العقد للخيظ المغزول) وأنخفض طول التيلة عند 2.5%، متوسط الطول، معامل الإختلاف، المتانه، الأماكن السميكة والرفيعه للخيظ المغزول) خلال موسمی الزراعة.

أدت المعاملات أيضا إلى زيادة محتوى الأوراق من العناصر المعدنية (النيتروجين، الفوسفور، البوتاسيوم، الكالسيوم، الماغنسيوم، الحديد، النحاس)، المكونات الحيويه (الكربوهيدرات الكليه والبروتين الخام عند عمر 120 يوم من الزراعة) خلال موسمی الزراعة فى الصنفين جيزة 86 وجيزة 88.

المجلة العلمية لكلية الزراعة - جامعة القاهرة - المجلد (65) العدد الرابع (أكتوبر 2014): 420-430 .