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Influence of Potassium Fertilization and Spraying of Zinc and Manganese on Cotton Growth and Productivity

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ABSTRACT

Two field experiments were carried out on clay soil in El-Gemmeiza Agricultural Research Station, Agricultural Research Center, El-Gharbiya Governorate, Egypt during 2013 and 2014 seasons to study the effect of five potassium treatments and four foliar applications with Zinc and Manganese on growth, earliness, yield, yield components and fiber quality of Egyptian cotton cultivar Giza 86 (*Gossypium barbadense, L.*). The experimental design was a split-plot with four replications. The main plots involved the five potassium treatments namely; A- Soil application of 24 kg K_2O/fed. as potassium sulfate at thinning, B- Foliar application of 5 kg potassium sulfate/fed., C- Foliar application of 2.5 g potassium citrate/L., D- Foliar application of 500 cm^3 potassium humate/fed. and E- Foliar application of 2.5 cm^3 potassium silicate/L. and the sub plots involved the four foliar applications of Zn and Mn namely; 1- Control (without foliar application), 2-Foliar application of Zn-EDTA, 3- Foliar application of Mn-EDTA, and 4- Foliar application of Zn-EDTA + Mn-EDTA. The timing of foliar applications was at the start of flowering and 15 days later. The most important results obtained could be summarized as follows: 1-The potassium treatments gave significant effect on plant height at harvest, no. of internodes and sympodial/plant, no. of open bolls/plant, boll weight, seed index and seed cotton yield/plant as well as /fed. in both seasons and lint percentage in the second season only, in favor of foliar application of 2.5 cm^3 potassium silicate/liter water. Also, potassium treatments gave significant effect on internode length in both seasons, in favor of foliar application of 2.5 cm^3 potassium silicate/liter water. On the other hand, the potassium treatments gave insignificant effect on first sympodium node, days to first flower, upper half mean length, uniformity index, micronaire reading and fiber strength in both seasons.2- Foliar application with Zn and Mn treatments gave significant effect on plant height at harvest, no. of internodes/plant, internode length, no. of sympodia/plant, no. of open bolls/plant, boll weight, seed index and seed cotton yield/plant as well as /fed. in both seasons and on lint percentage in the second season only, where the superiority was found in favor of applying Zn and Mn in mixture at one level for each (2 g/L water) twice at the start of flowering and 15 days later. However, insignificant effect was obtained due to these treatments on first sympodium node, days to first flower, upper half mean length, uniformity index, micronaire reading and fiber strength in both seasons.3-The interaction between potassium treatments and foliar application of Zn and Mn treatments gave a significant effect on plant height at harvest, no. of internodes/plant, internode length, no. of sympodia/plant, boll weight and seed index in both seasons and no. open bolls/plant, seed cotton yield/plant as well as /fed. in the second season only, where the highest values of these traits were obtained from foliar application of 2.5 cm^3 potassium silicate/liter water and foliar application with Zn and Mn in mixture contains 2 g/L water from each element twice (at the start of flowering and 15 days later). This interaction gave insignificant effect on first sympodium node, days to first flower, lint percentage, upper half mean length, uniformity index, micronaire reading and fiber strength in both seasons.

keywords: Cotton, Potassium (Sulfate, Citrate, Humate and Silicate), Micronutrient, Manganese, Zinc, Growth, Earliness, Yield.

INTRODUCTION

Cotton is not only the king of fibers and crucial crop used for fiber production all around the world (Killi and Aloğlu, 2000) but also it is a vital source of foreign exchange earnings. In Egypt, two major decisions should be taken to restore the situation of the Egyptian cotton. The first is the improvement of the growing conditions of the crop or simply improving the crop management. The second is the reduction of production cost, especially cost of mineral fertilizers. Soil fertility and crop management are the two most important factors of modern agricultural activity.

Some soil conditions in Egypt are perceived as being likely to induce micronutrients deficiencies such as high pH, low organic matter and high calcium carbonate, (Hamissa and Abdel-Salam, 1999). Although, required by plants in small amounts, micronutrients play many complex roles in plant growth, plant nutrition, development and production. For example, zinc and manganese function in many plant enzyme systems as bridges to connect the enzyme with the substrate upon which it is meant to act. Micronutrients are involved in regulating plant physiology and in enhancing plant stress tolerance, El-Fouly (2006). Also, micronutrients have positive environmental impacts through increasing the use efficiency of macronutrients, Malakouti (2006).

Potassium is an essential macro-element required in large amounts for normal plant growth and development. Potassium is an important nutrient that has favorable effects on the metabolism of nucleic acids, proteins, vitamins and growth substances. Furthermore, Potassium plays important roles in the translocation of photsynthates, sugars and activation of many enzymes required from sources to sinks Morteza *et al.*, (2005). However, Pettigrew (1999) indicated that the elevated carbohydrate concentrations remaining in source tissue, such as leaves, appear to be part of the overall effect of potassium deficiency in reducing the amount of photosynthetic available for reproductive sinks and thereby producing changes in the yield and quality of cotton. Many studies have shown increased yield and productivity in response to potassium fertilization as reported by Sharma and Sundar (2007), Abou-Zaid *et al.*, (2009), Emara (2012), Emara and

Hamoda (2012), Sawan (2013 and 2014), Gomaa *et al*., (2014), Abdel-Aal Amal *et al*., (2014 and 2015) and Emara (2014 and 2015).

Silicon, (Si) the mineral substrate is the most abundant elements in the soils for most of worlds plants (Sommer *et al*., 2006). Silicon does not form a constituent of any cellular components but primarily deposited on the walls of epidermis and vascular tissues conferring strength, rigidity and resistance to pests and diseases (Epstein and Bloom, 2005). Silicon nutrition alleviate many abiotic stresses including physical stress like lodging, drought, high temperatures, freezing and chemical stress like salt, metal toxicity, nutrient imbalance, ultraviolet radiation and many others (Epstein, 1994). Korndo¨rfer *et al*., (2004) and Mattson and Leatherwood (2010) concluded that improvement in plant growth results from a higher mechanical stability of stems and leaves caused by silicon addition and thus better light interception and higher photosynthetic capacity. Several workers documented favourable responses of cotton growth, yield, productivity and fiber quality to application with potassium silicate fertilization Almeida *et al*., (2005), Madeiros *et al*., (2005 a & b), Ferreira *et al*., (2005) and Emara (2014).

Zinc is one of the eight essential trace elements or micronutrients for the normal healthy growth and reproduction of crop plants because of its function such as its activity in biological membrane stability, a cofactor of over 300 enzymes and proteins involved in cell division, nucleic acid metabolism and protein synthesis, and about 50% of the soils cultivated for cereal production have low levels of available zinc Rengel, (2007). Zinc deficiency occurs in cotton grown in highly weathered acid soils of high pH soils, particularly where topsoil has been removed in preparing fields for irrigation and thereby exposing the Zn-deficient subsoil. Thus, tolerance to environmental stresses has a high requirement for Zn and Zn-deficient plants are sensitive to stress conditions, Cakmak (2000). Cotton is reported to be particularly sensitive to Zn deficiency compared to some other crops such as wheat, oat, or pea Alloway, (2008). Moreover, its deficiency has been reported to cause reduction in dry matter production of many crop plants (El-Fouly, 2006). Several workers documented favorable responses of cotton growth, productivity and fiber quality to foliar application with zinc Suresh and Kumar (2005), Sawan *et al*., (2006 and 2007), Kassem *et al*., (2009), Lale and Emine (2011), Sema *et al*., (2012) and Emara *et al*., (2015).

Biochemical roles of Mn in cotton plants, under mild Mn deficiency, photosynthetic oxygen evolution decreases with a corresponding decrease in assimilates, high energy phosphates, and reducing equivalents Burnell (1986). Rate of cell elongation is more affected by Mn deficiency than rate of cell division (Campbell and Nable, 1988). Inadequate or imbalanced levels of IAA could cause many of the symptoms of Mn deficiency or toxicity (Morgan *et al*., 1976), including inhibition of growth, shortened internodes, leaf abscission is increased, and cessation of lateral root formation (Taylor *et al*., 1968). Joham and Amin (1967) reported delayed flowering in Mn deficient cotton. Lint yields of cotton were decreased under Mn-deficient conditions, although lint quality was virtually unaffected (Anderson and Boswell, 1968). Anter *et al*. (1976) reported that fiber length was shorter in plants not supplied with foliar applications of Mn. Lower yields under Mn deficient conditions most likely result from lower carbohydrate supply, but poor lignification and indehiscence in anthers has also resulted in male sterility (Campbell and Nable, 1988). Several workers documented favorable responses of cotton growth, productivity and fiber quality to foliar application with manganese Eleyan (2008), Dordas (2009), Abdallah Amany and Mohamed (2013) and Eleyan *et al*., (2014).

Manganese (Mn) and zinc (Zn) were two essentia l micronutrients that are routinely measured in soil testin g and can sometimes be deficient in cotton. Both Mn and Zn are less available for plant uptake at higher soil pH (Bednarz *et al*., 1999). Mefhar *et al*., (2009) compared with the untreated control, application of foliar potassium, zinc and micronutrients insignificantly affected lint turnout, seed cotton yield, and fiber quality parameters. Halepyati *et al*., (2012) found that foliar spraying of water-soluble Zn, Fe, Mn and B recorded the highest seed cotton yield/plant, boll weight and seed cotton yield. Wazir and Shahbaz (2013) reported that foliar application of a spray containing Zn, B, Mn, Cu and Fe on cotton crop grown on calcareous soils increase in the no. of bolls/plant and ultimately of seed cotton yield. Foliar application of micronutrients during flower and boll development stages have been shown to be effective in efficient utilization of nutrients by cotton and thereby reduce boll shedding and increase the yield (Radhika *el al*., 2013).

Our objectives were to determine the influence of different potassium sources fertilizers and foliar application of manganese and zinc on growth, earliness, yield, yield components and fiber quality of Egyptian cotton Giza 86 cultivar in El-Gemmeiza Agricultural Research Station, El-Gharbiya Governorate, Egypt.

MATERIALS AND METHODS

Two field experiments were carried out on a clay soil in El-Gemmeiza Agricultural Research Station, El-Gharbiya Governorate, Egypt, during the two growing seasons of 2013 and 2014 to study the effect of different potassium sources fertilizers and foliar application of zinc and manganese on growth, earliness, yield, yield components and fiber quality of Egyptian cotton cultivar Giza 86 (*Gossypium barbadense,* L.). The experimental design was a split-plot with four replications.

The main plots involved the five potassium treatments namely;

A- Soil application of 24 kg K_2O/fed. as potassium sulphate (48% K_2O) after thinning.

B- Foliar application of 5 kg potassium sulphate (48% K_2O)/fed.

C- Foliar application of 2.5 g potassium citrate (30% K_3O_7)/L.
D- Foliar application of 500 cm^3 potassium humate (8% K_2O and 20% Humic acid)/fed.
E- Foliar application of 2.5 cm^3 potassium silicate (10% K_2O and 25% SiO_2)/L.

The sub plots involved the four treatments of foliar spraying with Zn-EDTA (13%) and Mn-EDTA (13%), which were:

1) Control (without foliar spraying).
2) Foliar spraying of Zn (2 g/L water).
3) Foliar spraying of Mn (2 g/L water).
4) Foliar spraying of Zn (2 g/L water) + Mn (2 g/L water).

The addition of foliar spraying of the treatments under study was done twice at the beginning of flowering and 15 days later.

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

Table 1. Soil properties of the experimental sites at El-Gemmeiza in 2013 and 2014 seasons.

Mechanical analysis

Season	Clay (%)	Silt (%)	Sand (%)	Organic matter (%)	Texture class
2013	51.32	32.20	17.13	2.00	Clayay
2014	59.30	26.11	14.59	1.59	Clayay

Chemical analysis

Season	pH	EC (mmhos/cm)	HCO_3^- (%)	Available element (ppm)							
				N	P	K	Fe	B	Zn	Cu	Mn
2013	7.60	0.68	0.63	30.20	17.07	312.2	10.6	0.65	1.00	3.06	1.10
2014	8.10	0.02	0.87	28.10	11.08	354.8	11.8	0.42	1.30	3.50	1.32

The experimental plot area of each plot was 21 m^2 (including sex ridges each of 0.70 m wide x 5 m long). The distance between hills was 25 cm with two plants/hill after thinning. Seeds of Egyptian long staple cotton cultivar Giza 86 (*Gossypium barbadense,* L.) were planted on 3 and 8 April after Egyptian clover (*Trifolium alexandrinum,* L.) in 2013 and 2014 seasons, respectively. The first irrigation was applied after 21 day from planting irrigation, while the other irrigations were given at 15-day interval. Before the second irrigation, the plants were thinned to two plants/hill. Hand hoeing was carried out three times during the season before the first, second and third irrigations, respectively.

Phosphorus in the form of superphosphate (15.5% P_20_5) was applied during land preparation at the rate of 22.5 kg P_20_5/fed. Nitrogen fertilizer in the form of ammonium nitrate (33.5% N) was applied at the rate of 45 Kg N/fed. in two equal doses (27.5 + 27.5 Kg N/fed.) after thinning and at the next irrigation. Potassium was added to soil in the form of potassium sulphate (48% K_2O) at the rate of 24 kg K_2O/fed. in one dose after thinning, while foliar application of the other potassiumtreatments was done twice at the beginning of flowering and 15 days later.

The other standard agricultural practices were followed throughout the growing seasons.

In both seasons, five representative hills (10 plants/sub-main plot) were taken at random to study the following traits: Ggrowth characters; plant height at harvest (cm), no. of internodes/plant, internode length (cm), no. of sympodia/plant. Earliness measurements; first sympodial node, days from sowing to the first flower. Yield and its components; no. of open bolls/plant, boll weight (g), seed cotton yield/plant (g), lint percentage and seed index (g). The yield of seed cotton in kentars/fed. was estimated from the four inner ridges, (One kentar = 157.5 kg.). Fiber parameters; Fiber upper half mean length (UHML), uniformity index (UI %), were determined on digital fibrograph instrument 630 according to A.S.T.M. (2012) D1447-07. Micronaire reading was determined on micronaire instrument 675 according to A.S.T.M. (2012) D1448-97. Fiber strength was determined on Pressley instrument at zero gauge clamp spacing using a simple inclined plane breaker and simple specimen preparation and clamp loading techniques according to A.S.T.M. (2012) D1445-67. All fiber tests for the samples were made at the cotton laboratories under controlled atmospheric conditions according to A.S.T.M.(2004) D1776-04.

The obtained data were subjected to statistical analysis according to the procedures outlined by Snedecor and Cochran (1980) using M Stat-C microcomputer program for a split plot, L.S.D. values at 5% level of significance ($P \leq 0.05$) were used to compare between treatments means.

RESULTS AND DISCUSSION

The results of growth traits, earliness parameters, yield and yield components as affected by potassium treatments, micronutrient fertilization and their interaction and methods of application on cotton Giza 86 during 2013 and 2014 seasons are shown in Tables (2) to (6).

A- Growth traits:

1- Effect of potassium sources:

The results in Table (2) show that potassium sources treatments had a significant effect on plant height at harvest, no. of nodes/plant, internode length and no. of sympodia/plant in 2013 and 2014 seasons. The tallest plants (167.53 and 164.04 cm) and shortest internode (6.93 and 7.50 cm) were produced from foliar application of 2.5 cm^3 potassium silicate/liter water, while the shortest plants (153.78 and 152.16 cm) were produced from soil application of 24 Kg potassium sulfate/fed. in 2013 and 2014 seasons, respectively.

The tallest internode (7.24 and 8.09 cm) were produced from foliar application of 2.5 g potassium citrate/fed. in 2013 and 2014 season, respectively. The highest values of no. of sympodia/plant (17.30 and 15.49) and no. of internodes/plant (24.18 and 21.87) were obtained from foliar application of 2.5 cm^3 potassium silicate/liter water, while the lowest values of no. of sympodia/plant (14.80 and 12.96) were obtained from soil application of 24 Kg potassium sulfate/fed. in 2013 and 2014 season, respectively.

Table 2. Cotton growth attributes as affected by the potassium source, zinc and manganese fertilizer and their interaction during 2013 and 2014 seasons.

Characters / Treatments: Potassium sources (A)	Seasons / Micronutrient fertilizer (B)	Plant height at harvest (cm) 2013	Plant height at harvest (cm) 2014	No. of internodes/plant 2013	No. of internodes/plant 2014	Mean internode length (cm) 2013	Mean internode length (cm) 2014	No. of sympodia/Plant 2013	No. of sympodia/Plant 2014
	Without foliar	145.75	142.83	20.40	18.23	7.14	7.83	13.55	11.66
Soil 24 Kg	Foliar Mn	151.87	151.16	20.87	18.24	7.28	8.29	13.97	12.00
K-Sulfate	Foliar Zn	154.25	154.83	21.85	20.01	7.06	7.74	15.02	13.73
	Foliar Mn + Zn	163.25	159.83	23.65	20.89	6.90	7.65	16.65	14.46
Mean		153.78	152.16	21.69	19.34	7.09	7.87	14.80	12.96
	Without foliar	152.75	151.66	21.75	19.50	7.02	7.78	15.10	12.90
Foliar 5 Kg	Foliar Mn	153.75	153.16	21.97	19.93	7.00	7.68	15.07	13.60
K-Sulfate	Foliar Zn	158.25	154.50	23.45	19.99	6.75	7.73	16.70	13.76
	Foliar Mn + Zn	171.25	168.33	23.87	20.44	7.17	8.24	17.02	13.96
Mean		159.00	156.91	22.76	19.96	6.99	7.86	15.97	13.55
	Without foliar	149.50	145.33	20.70	18.46	7.22	7.87	13.95	12.06
Foliar 2.5 g K-	Foliar Mn	154.50	153.00	21.67	18.96	7.13	8.07	14.82	12.66
Citrate	Foliar Zn	160.50	157.16	22.22	18.91	7.22	8.31	15.32	12.63
	Foliar Mn + Zn	166.62	164.66	22.57	20.28	7.18	8.12	15.77	14.03
Mean		157.78	155.04	21.79	19.16	7.24	8.09	14.96	12.85
	Without foliar	155.62	154.83	22.05	19.38	7.06	7.99	15.17	13.03
Foliar 500cm^3 K-	Foliar Mn	164.12	160.83	22.23	19.64	7.08	8.19	15.55	13.36
Humat	Foliar Zn	168.50	166.50	24.62	20.93	6.84	7.96	17.82	14.70
	Foliar Mn + Zn	173.75	168.83	24.73	21.23	7.00	7.95	17.10	15.00
Mean		165.50	162.75	23.43	20.29	7.06	8.02	16.66	14.02
	Without foliar	157.62	155.16	23.35	21.28	6.75	7.29	16.50	14.63
Foliar 2.5cm^3	Foliar Mn	166.50	164.16	24.17	21.78	6.89	7.54	17.42	15.43
K-Silicate	Foliar Zn	170.00	165.66	24.45	22.21	6.95	7.46	17.52	15.93
	Foliar Mn + Zn	176.00	171.16	24.83	22.21	7.38	7.71	17.75	15.96
Mean		167.53	164.04	24.18	21.87	6.93	7.50	17.30	15.49
	Without foliar	152.25	149.96	21.65	19.38	7.03	7.74	14.85	12.86
Micronutrient	Foliar Mn	158.15	156.46	22.19	19.71	7.10	7.83	15.37	13.41
Mean	Foliar Zn	162.30	159.73	23.31	20.41	7.11	7.92	16.47	14.15
	Foliar Mn + Zn	170.17	166.56	23.93	21.01	7.13	7.95	17.06	14.68
	A	0.89	0.86	0.53	0.42	0.08	0.11	0.41	0.36
LSD at 0.05 for	B	0.66	0.66	0.42	0.51	0.12	0.19	0.31	0.27
	A X B	1.47	1.48	0.86	0.96	0.26	0.33	0.68	0.61

Such increase in plant height and mean length of internode due to potassium fertilizer may attributed to stimulation of cell division and internode elongation, and potassium is needed in photosynthesis and the synthesis of protein. Plants lacking K will have slow and stunted growth. Similar results were obtained by Sharma and Sundar (2007), Abou-Zaid *et al*., (2009), Emara (2012), Emara and Hamoda (2012), Abou-Zaid *et al*., (2013), Abdel-Aal Amal *et al*., (2014), Emara (2014), Gomaa *et al*., (2014) and Emara (2015).

The positive effect of potassium silicate on growth traits is mainly attributed to the promotive effect of potassium in addition to the effect of silicon which deposited on the walls of epidermis and vascular tissues conferring strength, rigidity and resistance to pests and diseases (Epstein and Bloom, 2005). Silicon nutrition alleviate many abiotic stresses including physical stress like lodging, drought, high temperatures, freezing and chemical stress like salt, metal toxicity, nutrient imbalance, ultraviolet radiation and many others (Epstein, 1994). Korndo¨rfer *et al*., (2004) and Mattson and Leatherwood (2010) concluded that improvement in plant growth results from a higher mechanical stability of stems and leaves caused by silicon addition and thus better light interception and higher photosynthetic capacity.

2- Effect of Zn and Mn treatments:

The results in Table (2) show that foliar application with micronutrients treatments had significant effect on all growth traits in 2013 and 2014 seasons. The highest values of plant height at harvest (170.17 and 166.56 cm) and no. of internodes/plant (23.93 and 21.01), internode length (7.13 and 7.95 cm) and no. of sympodia/plant (17.06 and 14.68) were produced from foliar feeding with Mn and zinc mixture which contains two elements (Zn-EDTA and Mn-EDTA) at the start of flowering and 15 days later stages, while the lowest values of plant height at harvest (152.25 and 149.96 cm) and no. of internodes/plant (21.65 and 19.38) internode length (7.03 and 7.74 cm) and no. of sympodia/plant (14.85 and 12.86) were produced from without foliar application with Zn or Mn treatment in 2013 and 2014 seasons, respectively.

Such increase in cotton plant growth, plant height and internode length due to foliar application with Zn + Mn mixture treatment may attributed to stimulation of cell division and internode elongation, where Zinc is required in the synthesis of tryptophan, which, in turn, is necessary for the production of indole acetic acid in plants. Zn and Mn is needed in photosynthesis, the synthesis of protein and dry matter production. Plants lacking Zn and Mn will have slow and stunted growth

(Blevins and Lukaszewski, 1998 and Uchida, 2000). Similar results were obtained by El-Marsi (2005), Sawan *et al.*, (2006 and 2007), Eleyan (2008), Kassem *et al.*, (2009), Sema *et al.*, (2012), Radhika *el al.*, (2013) and Eleyan *et al.*, (2014).

3- Effect of the interaction:

The results in Table (2) show that the interaction between potassium sources fertilizer and foliar application of Zn + Mn gave significant effect on all growth traits in 2013 and 2014 seasons. The highest values of plant height at harvest (176.00 and 171.16 cm) and no. of nodes/plant (24.83 and 22.21) and no. of sympodia/plant (17.75 and 15.96) were produced from foliar application of 2.5 cm^3 potassium silicate/Liter water twice in combined with foliar application with Zn-EDTA and Mn-EDTA in mixtures which contain two elements at one level for each 2 g/L water at the start and peak of flowering stages, while the lowest values of plant height at harvest (145.75 and 142.83 cm) and no. of nodes/plant (20.40 and 18.23) and no. of sympodia/plant (13.55 and 11.66) were produced from soil application of 24 Kg potassium sulfate/fed. + Without foliar application with Zn or Mn, in 2013 and 2014 seasons, respectively. The improvement in plant growth results from a higher mechanical stability of stems and leaves caused by silicon addition and thus better light interception and higher photosynthetic capacity. The response of growth parameters to potassium silicate may be due to it is a source of highly soluble potassium and has the additional benefit of supplying silicate Adatia and Besford (1986).

B- Earliness parameters:

The results in Table (3) indicate that potassium sources, foliar application of Zn and Mn treatments and their interaction did not exhibit significant effect on earliness properties under study i.e.; first sympodial node and days to the first flower in 2013 and 2014 seasons.

Table 3. Earliness parameters as affected by the potassium source, zinc and manganese fertilizer and interaction during 2013 and 2014 seasons.

Characters / Treatments: Potassium sources (A)	Seasons: Micronutrient fertilizer (B)	First sympodial position 2013	First sympodial position 014	Days to the first flower 2013	Days to the first flower 2014
Soil 24 Kg K-Sulfate	Without foliar	7.85	7.58	81.90	80.63
	Foliar Mn	7.90	7.23	81.90	80.18
	Foliar Zn	7.83	7.28	81.85	80.18
	Foliar Mn + Zn	8.00	7.43	82.08	80.45
Mean		٧.٨٩	٧.٣٨	٨١.٩٣	٨٠.٣٦
Foliar 5 Kg K-Sulfate	Without foliar	7.65	7.60	81.68	80.63
	Foliar Mn	7.90	7.33	81.88	80.30
	Foliar Zn	7.75	7.23	81.75	80.13
	Foliar Mn + Zn	7.85	7.48	81.83	80.40
Mean		٧.٧٩	٧.٤١	٨١.٧٨	٨٠.٣٦
Foliar 2.5 g K-Citrate	Without foliar	7.75	7.40	81.85	80.45
	Foliar Mn	7.85	7.30	81.88	80.25
	Foliar Zn	7.90	7.28	81.93	80.20
	Foliar Mn + Zn	7.80	7.25	81.83	80.23
Mean		٧.٨٣	٧.٣١	81.87	٨٠.٢٨
Foliar 500 cm^3 K-Humat	Without foliar	7.88	7.35	81.95	80.38
	Foliar Mn	7.68	7.28	81.65	80.25
	Foliar Zn	7.80	7.23	81.83	80.10
	Foliar Mn + Zn	7.73	7.23	81.75	80.10
Mean		٧.٧٧	٧.٢٧	81.79	٨٠.٢١
Foliar 2.5 cm^3 K-Silicate	Without foliar	7.85	7.65	81.85	80.78
	Foliar Mn	7.75	7.35	81.73	80.40
	Foliar Zn	7.93	7.28	81.95	80.25
	Foliar Mn + Zn	7.98	7.25	82.00	80.18
Mean		٧.٨٨	٧.٣٨	81.88	٨٠.٤٠
Micronutrient Mean	Without foliar	7.80	7.52	81.85	80.57
	Foliar Mn	7.82	7.30	81.81	80.28
	Foliar Zn	7.84	7.26	81.86	80.17
	Foliar Mn + Zn	7.87	7.33	81.90	80.27
LSD at 0.05 for	A	N.S	N.S	N.S	N.S
	B	N.S	N.S	N.S	N.S
	A X B	N.S	N.S	N.S	N.S

These results are in partial agreement with those obtained by Abou-Zaid *et al.*, (2009), Emara and Hamoda (2012), Abou-Zaid *et al.*, (2013), Gomaa *et al.*, (2014), Emara (2015) and Emara *et al.*, (2015) where they found that the earliness was insignificant affected by the tested treatments.

C- Yield and yield components:

1- Effect of potassium sources:

The results in Table (4) show that potassium sources fertilizer had significant effects on no. of open bolls/plant, boll weight, seed cotton yield/plant, seed index and seed cotton yield/fed. in 2013 and 2014 seasons, lint percentage in 2014 season only.

The no. of open bolls/plant (16.17 and 16.24 bolls/plant) which produced from soil application of 24 Kg ptassium sulfate/fed. was significantly increased to (19.33 and 16.87 bolls/plant) due to foliar application of 2.5 cm^3 potassium silicate/liter water in 2013 and 2014 seasons, respectively. Thus, the highest value of boll weight (2.96 and 3.31 g) was obtained from foliar application of 2.5 cm^3 potassium silicate/liter, while the lowest value (2.82 and 2.81 g) was obtained from soil application of 24 Kg potassium sulfate/fed. in 2013 and 2014 seasons, respectively.

These results may be due to potassium silicate compounds which have various biochemical effects either at cell wall membrane level in the cytoplasm including in plants enhanced protein synthesis and plant hormone- like activity which might have results increasing boll weight. Also, enhancement effect of these treatments on yield components is mainly due to its effect on increasing plant growth as mentioned before where yielded height plant and more fruiting branches/plant resulted in more flowers and bolls. Also, added the favorable potassium silicate fertilization enhanced formation of carbohydrates, proteins, photosynthesis translocation regulation, enzyme action, Chlorophyll oxidative, photo-phosphorylation of solution Mengel and Kirkby (1987). Similar results were obtained by Emara and Hamoda (2012), Abou-Zaid *et al.*, (2013) and Emara (2014 and 2015) where they found that the application of potassium significantly increased boll weight as compared with the other treatments.

The seed cotton yields/plant of the soil application of 24 Kg potassium sulfate/fed. (45.86 and 45.63 g/plant) were significantly increased to (57.35 and 55.84 g/plant) due to foliar application of 2.5 cm^3 potassium silicate/liter in 2013 and 2014 seasons, respectively. The significant increase in seed cotton yield/plant due to the two former treatments is mainly due to the heavier bolls and the higher no. of open bolls/plant. These results are in line with those obtained by Emara and Hamoda (2012), Abou-Zaid *et al.*, (2013) and Emara (2014 and 2015) where they found that the application of potassium significantly increased seed cotton yield/plant as compared with the other treatments.

Foliar application of 2.5 cm^3 potassium silicate/liter significantly increased seed cotton yield/fed. by 21.48 and 13.61% compared to soil application of 24 Kg potassium sulfate/fed., in 2013 and 2014 seasons, respectively.

Table 4. Cotton yield and yield components as affected by the potassium source, zinc and manganese fertilizer and interaction during 2013 and 2014 seasons.

Characters		No. of bolls/plant		Boll weight (g)		Seed cotton yield/plant (g)		Seed cotton yield (Kentar/fed.)		Lint percentage (%)		Seed index (g)	
	Seasons												
Treatments Potassium sources (A)	Micronutrient fertilizer (B)	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
	Without foliar	14.02	15.80	2.76	2.45	38.74	38.71	9.80	11.46	40.55	39.57	10.15	10.01
Soil 24 Kg	Foliar Mn	15.55	16.15	2.80	2.73	43.53	44.09	11.63	12.51	40.32	39.87	10.42	10.04
K-Sulfate	Foliar Zn	16.65	16.44	2.82	2.92	47.08	48.00	12.80	13.31	40.12	40.10	10.67	10.22
	Foliar Mn + Zn	18.47	16.50	2.92	3.15	54.08	51.98	13.24	14.15	40.40	40.76	11.17	10.57
Mean		16.17	16.24	2.82	2.81	45.86	45.63	11.87	12.86	40.35	40.07	10.60	10.21
	Without foliar	15.77	16.20	2.80	2.86	44.17	46.33	11.77	13.41	40.40	40.10	10.45	10.11
Foliar 5 Kg	Foliar Mn	16.95	16.43	2.83	2.97	48.09	48.80	12.85	13.73	40.27	40.52	10.75	10.33
K-Sulfate	Foliar Zn	18.25	16.48	2.90	3.07	52.92	50.59	13.00	13.67	40.57	40.55	10.90	10.51
	Foliar Mn + Zn	19.62	16.52	2.99	3.41	58.73	56.33	14.45	15.21	41.22	41.50	11.95	10.80
Mean		17.65	16.42	2.88	3.07	50.98	50.41	13.02	14.00	40.61	40.67	11.01	10.44
	Without foliar	13.95	16.16	2.78	2.70	38.88	43.63	10.70	12.09	40.85	39.76	10.22	10.04
Foliar 2.5 g K-	Foliar Mn	16.55	16.42	2.84	2.92	47.04	47.95	12.47	13.52	40.25	40.16	10.57	10.12
Citrate	Foliar Zn	18.65	16.53	2.92	3.11	54.55	51.41	12.71	13.83	40.52	40.60	11.02	10.71
	Foliar Mn + Zn	18.85	16.97	2.94	3.26	55.46	55.32	13.92	14.26	40.22	40.95	11.37	10.56
Mean		17.00	16.50	2.87	3.00	48.98	49.50	12.45	13.42	40.46	40.37	10.80	10.36
	Without foliar	17.90	16.21	2.83	3.10	50.79	50.25	12.80	13.73	40.72	40.34	10.77	10.37
Foliar 500cm^3 K-	Foliar Mn	18.67	16.45	2.93	3.19	54.81	52.48	14.08	14.26	40.10	40.74	11.30	10.61
Humat	Foliar Zn	19.27	16.94	2.95	3.29	56.86	55.73	14.95	14.52	40.72	41.27	11.57	10.68
	Foliar Mn + Zn	19.70	17.32	3.01	3.43	59.30	59.41	15.78	15.16	40.12	41.55	12.05	11.09
Mean		18.88	16.75	2.93	3.25	55.44	54.44	14.40	14.42	40.41	40.98	11.42	10.69
	Without foliar	17.87	16.72	2.88	3.06	51.57	51.16	12.85	13.67	40.70	40.46	10.77	10.41
Foliar 2.5 cm^3 K-	Foliar Mn	19.10	16.71	2.94	3.26	56.24	54.47	13.97	14.47	40.75	41.09	11.37	10.56
Silicate	Foliar Zn	19.37	16.92	2.99	3.32	57.93	56.17	14.81	14.78	40.85	41.40	11.80	10.72
	Foliar Mn + Zn	20.97	17.15	3.03	3.63	63.65	62.25	16.07	15.53	40.20	41.61	12.15	11.27
Mean		19.33	16.87	2.96	3.31	57.35	55.84	14.42	14.61	40.62	41.14	11.52	10.74
	Without foliar	15.90	16.21	2.81	2.83	44.83	45.87	11.59	12.87	40.64	40.05	10.47	10.19
Micronutrient	Foliar Mn	17.36	16.43	2.87	3.01	49.94	49.45	13.00	13.70	40.34	40.48	10.88	10.33
Mean	Foliar Zn	18.44	16.66	2.91	3.14	53.87	52.31	13.65	14.02	40.56	40.78	11.19	10.57
	Foliar Mn + Zn	19.52	16.89	2.98	3.37	58.24	56.92	14.70	14.86	40.43	41.27	11.74	10.86
	A	0.29	0.11	0.03	0.07	0.78	0.69	0.29	0.29	N.S	0.11	0.09	0.14
LSD at 0.05 for	B	0.23	0.21	0.02	0.06	0.77	0.72	0.26	0.33	N.S	0.16	0.11	0.07
	A X B	0.52	N.S	0.04	0.12	1.72	1.13	0.59	N.S	N.S	N.S	0.25	0.16

The increase in seed cotton yield/fed due to the higher no. of open bolls/plant, heavier bolls and higher seed cotton yield/plant, and the positive effect of potassium silicate on seed cotton yield due to foliar feeding with potassium silicate at the rate of 2.5g/L. twice as compared with the other sources could be explained in view of the following points:

1- Foliar feeding to cotton plants on soils high in pH (Table 1) seems to be proper rate at which the response of cotton yield to foliar feeding with potassium may occur.

2- Earlier-maturing higher yielding, faster-fruiting cotton varieties creating a greater demand than the plant system is capable of supplying.

3- This point explains the positive response of the cotton Giza 86 which characterized by its earlier-maturing and higher yielding to foliar feeding with the different sources of potassium especially potassium silicate.

Similar results were obtained by Sharma and Sundar (2007), Abou-Zaid *et al*., (2009), Emara (2012), Emara and Hamoda (2012), Abou-Zaid *et al*., (2013), Abdel-Aal Amal *et al*., (2014), Emara (2014 and 2015) and Gomaa *et al*., (2014).

The highest value of lint percentage (41.14%) was obtained from foliar application of 2.5 cm^3 potassium silicate/liter, while the lowest value (40.07%) was obtained from soil application of 24 Kg potassium sulfate/fed., in 2014 season. In this concern, Emara and Hamoda (2012) and Abou-Zaid *et al*., (2013) found that the lint percentage was insignificance affected by the tested treatments.

2- Effect of Zn and Mn treatments:

The results in Table (4) show that foliar application of Zn + Mn had a significant effect on no. of open bolls/plant, boll weight, seed cotton yield/plant, /feddan and seed index in 2013 and 2014 seasons, respectively, and lint percentage in 2014 season only.

The no. of open bolls/plant (15.90 and 16.21 bolls/plant), boll weight (2.81 and 2.83 g), seed cotton yields/plant (44.83 and 45.87 g/plant) of the without foliar application treatment was significantly increased to (19.52 and 16.89 bolls/plant), boll weight (2.98 and 3.37g) and seed cotton yields/plant (58.24 and 56.92 g) due to foliar application treatment of Zn + Mn in 2013 and 2014 seasons. The significant increase in seed cotton yield/plant due to the foliar application treatment of Zn + Mn treatments is mainly due to the heavier bolls and the higher no. of open bolls/plant. The highest values of seed index (11.74 and 10.86 g) were obtained from foliar application of treatment of Zn + Mn, while the lowest values (10.74 and 10.19 g) were obtained from without foliar application treatment in 2013 and 2014 seasons, respectively.

Foliar application of treatment of Zn + Mn significantly increased seed cotton yield/fed. by 26.8.0 and 15.5% compared to without foliar application treatment in 2013 and 2014 seasons, respectively. The increase in seed cotton yield/fed due to the higher no. of open bolls/plant, heavier bolls, seed index and higher seed cotton yield/plant. Similar results were obtained by Anter *et al*. (1976), Anderson and Boswell, (1968), Kassem *et al*., (2009), Mefhar *et al*., (2009), Halepyati *et al*., (2012) and Wazir and Shahbaz (2013).

3- Effect of the interaction:

The results in Table (4) show that the interaction between potassium sources fertilizer and foliar application of Zn + Mn gave significant effect on boll weight, seed cotton yield/plant and seed index in both seasons, and on no. of open bolls/plant and seed cotton yield/feddan in 2013 season only, but lint percentage was insignificantly affected in both seasons.

The highest values of no. of open bolls/plant (20.97 and 17.15 bolls/plant), boll weight (3.03 and 3.63 g), seed cotton yield/plant (63.65 and 62.25 g/plant) and seed index (12.15 and 11.27 g) were produced from foliar application of 2.5 cm^3 potassium silicate/liter water + foliar application of Zn + Mn, while the lowest values of no. of open bolls/plant (14.02 and 15.80 bolls/plant), boll weight (2.76 and 2.45 g), seed cotton yield/plant (38.74 and 38.71 g/plant) and seed index (10.15 and 10.01 g) were produced from soil application of 24 Kg potassium sulfate/fed. + Without foliar application of Zn + Mn, in 2013 and 2014 seasons, respectively. But the highest value of seed cotton yield/feddan (16.07 Kentar/fed.) was produced from foliar application of 2.5 cm^3 potassium silicate/liter water + foliar application of Zn + Mn, while the lowest value of (9.80 Kentar/fed.) was produced from soil application of 24 Kg potassium sulfate/fed. + Without foliar application of Zn + Mn, in 2013 season. This may be due to these treatments, had a primitive effect on vegetative growth led to delay the beginning of flowering. It is obvious to notice that, in general, potassium silicate treatments produced highest earliness percentages comparing with potassium sulphate ones. This may be attributed to the retardant effect of silicate salt on vegetative growth of cotton plant, consequently not delaying the flowering stage. Similar results were obtained by Anderson and Boswell (1968), Anter *et al*. (1976) and Mefhar *et al*., (2009).

The positive effect of the interaction on these traits may be attributed to:

- The simulative effect due to the role of potassium on enzymes promotion activity and enhancing the translocation of assimilates and protein.
- Because K is needed in photosynthesis and the synthesis of protein, plants lacking K will have slow and stunted growth. Potassium reduces boll shedding (Zeng, 1996).
- Potassium and manganese nutrition had pronounced effect on carbohydrates partitioning by affecting either phloem export of photosynthesis (sucrose) or growth rate of sink and/or sources organ (Cakmak *et al*., 1994).
- The role of macro and micro nutrients under study, which are known to promote photosynthesis and plant development which reflected on enhancing the quality and seed development and consequently the productivity of unit area. Nutrients (in the form of mixture) enriched the cotton plant with appreciable amount of Zn and Mn.

D- Fiber quality traits:

The results in Table (5) indicate that potassium sources, foliar application of Zn and Mn and their interaction did not exhibit significant effect on fiber properties under study i.e., fiber length parameters (fiber upper half mean length and uniformity index), micronaire reading and fiber strength in 2013 and 2014 seasons.

Table 5. Cotton fiber parameter as affected by the potassium source, zinc and manganese fertilizer and interaction during 2013 and 2014 seasons.

Characters		Fiber length parameters: Upper half mean length (UHML)		Fiber length parameters: Uniformity index (UI %)		Micronaire reading		Fiber strength (Presley units)	
Treatments Potassium sources (A)	Seasons / Micronutrient fertilizer (B)	2013	2014	2013	2014	2013	2014	2013	2014
	Without foliar	34.56	35.33	85.43	85.06	4.56	4.46	9.97	9.76
Soil 24 Kg K-Sulfate	Foliar Mn	34.19	34.96	83.93	85.33	4.60	4.66	10.20	10.00
	Foliar Zn	34.13	34.96	83.96	85.00	4.50	4.53	10.50	9.86
	Foliar Mn + Zn	34.80	35.83	87.03	86.03	4.80	4.70	10.33	10.03
Mean		34.42	35.27	85.09	85.35	4.61	4.59	10.25	9.91
	Without foliar	35.00	35.93	85.30	85.53	4.63	4.40	10.23	9.93
Foliar 5 Kg K-Sulfate	Foliar Mn	34.90	34.13	86.80	84.13	4.70	4.50	10.33	10.06
	Foliar Zn	34.80	34.00	84.40	84.73	4.86	4.43	10.20	9.90
	Foliar Mn + Zn	34.20	34.76	85.20	85.73	4.76	4.70	10.33	9.93
Mean		34.72	34.70	85.42	85.03	4.74	4.50	10.27	9.95
	Without foliar	34.83	34.96	85.13	85.76	4.80	4.60	10.00	9.80
Foliar 2.5 g K-Citrate	Foliar Mn	34.16	34.56	85.90	82.83	4.60	4.60	10.20	9.86
	Foliar Zn	34.13	35.63	84.03	83.16	4.76	4.50	10.06	9.80
	Foliar Mn + Zn	35.16	35.70	85.40	86.13	4.80	4.53	9.80	9.90
Mean		34.57	35.21	85.11	84.47	4.74	4.55	10.01	9.84
	Without foliar	35.26	34.43	87.30	85.16	4.50	4.70	10.06	10.10
Foliar 500 cm^3 K-Humat	Foliar Mn	34.36	34.70	84.65	84.60	4.46	4.43	10.16	10.00
	Foliar Zn	34.36	34.43	85.13	84.90	4.56	4.26	10.30	10.00
	Foliar Mn + Zn	34.86	35.00	84.90	85.00	4.86	4.80	10.20	10.03
Mean		34.71	34.64	85.49	84.91	4.60	4.55	10.18	10.03
	Without foliar	34.60	34.86	86.06	85.36	4.50	4.56	10.13	10.13
Foliar 2.5 cm^3 K-Silicate	Foliar Mn	35.56	34.56	85.06	84.43	4.50	4.53	9.93	10.10
	Foliar Zn	34.80	35.23	85.16	86.20	4.76	4.60	10.10	10.06
	Foliar Mn + Zn	35.03	34.53	85.06	86.46	4.70	4.53	9.86	9.70
Mean		35.00	34.80	85.34	85.61	4.61	4.55	10.00	10.00
	Without foliar	34.85	35.10	85.84	85.38	4.60	4.54	10.08	9.94
Micronutrient Mean	Foliar Mn	34.63	34.58	85.27	84.26	4.57	4.54	10.16	10.00
	Foliar Zn	34.44	34.85	84.54	84.80	4.69	4.46	10.23	9.92
	Foliar Mn + Zn	34.81	35.16	85.52	85.87	4.78	4.65	10.10	9.92
	A	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S
LSD at 0.05 for	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

These results are in partial agreement with those obtained by Abou-Zaid *et al.*, (2009), Emara and Hamoda (2012), Abou-Zaid *et al.*, (2013), Gomaa *et al.*, (2014) Emara (2014 and 2015) and Emara *et al.*, (2015) where they found that the fiber quality were insignificant affected by the tested treatments.

CONCLUSION

The results obtained in this study could lead us to a package of recommendations, which seemed to be useful for increasing the cotton yield production. It could be concluded the foliar application of 2.5 cm^3 potassium silicate/Liter water twice in combined with foliar application with Zn-EDTA and Mn-EDTA in mixture which contains two elements at one level for each 2 g/L water at the start and twice of flowering and 15 days later for producing better growth and high productivity of cotton (Giza 86 variety), under the conditions of El-Gemmeiza location.

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تأثير التسميد البوتاسي والرش بالمنجنيز والزنك علي نمو وإنتاجية القطن

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أجريت تجربتان حقليتان بمحطة البحوث الزراعية بالجميزة بمحافظة الغربية خلال موسمى النمو 2013، 2014 وذلك لدراسة أستجابة صنف القطن المصري جيزة ٨٦ للتسميد ببعض مصادر البوتاسيوم المختلفة وطرق إضافتها مع الرش بالزنك والمنجنيز أو بدون، وأثر ذلك علي النمو، التبكير، المحصول ومكوناته. زُرعت التجارب في تصميم القطع المنشقة مرة واحدة في أربعة مكررات حيث وضعت مصادر وطرق إضافة البوتاسيوم (أ- سلفات بوتاسيوم ٢٤ كجم/فدان أرضي عند الخف، ب- رش سلفات بوتاسيوم بمعدل ٥ كجم/فدان، ج- رش سترات بوتاسيوم بمعدل ٢.٥ جم/لتر ماء، د- رش هيومات بوتاسيوم بمعدل ٥٠٠ سم٣/فدان، هـ- رش سيليكات بوتاسيوم بمعدل ٢.٥ سم٣/لتر ماء) فى القطع الرئيسية ووضعت معاملات الرش بالزنك والمنجنيز (١- المقارنة بدون رش عناصر، ٢- رش زنك، ٣- رش منجنيز، ٤ -رش زنك + منجنيز) في القطع المنشقة، وكانت مواعيد الرش مرتين (عند بداية التزهير + بعد التزهير بأسبوعين). وتتلخص أهم النتائج المتحصل عليها فيما يلى: ١) أعطت معاملات التسميد البوتاسي تأثيرات معنوية علي كل من أرتفاع النبات عند الجني، عدد السلاميات/النبات، متوسط طول السلامية، عدد الافرع الثمرية/نبات، وعدد اللوز المتفتح/نبات، وزن اللوزة، معامل البذرة ومحصول القطن الزهر/النبات وايضاً محصول القطن الزهر بالقنطار/الفدان في موسمي الدراسة وتصافي الحليج في الموسم الثاني فقط. وذلك لصالح معاملة الرش بسيليكات البوتاسيوم بمعدل ٢.٥ سم٣/لتر ماء مرتين (عند بداية التزهير + بعد التزهير بأسبوعين)، وفي نفس الوقت لم يكن لمعاملات البوتاسيوم اي تأير معنوي على موقع أول عقدة ثمرية، عدد الايام حتي ظهور أول زهرة، متوسط طول التيلة، معامل الانتظام، النعومة ومتانة التيلة في كلا الموسمين. ٢) أعطت معاملات الرش بالزنك والمنجنيز تأثيرات معنوية علي كل من طول النبات عند الجني، عدد العقد/نبات، متوسط طول السلامية، عدد الافرع الثمرية/نبات، عدد اللوز المتفتح/نبات، متوسط وزن اللوزة، محصول القطن الزهر/نبات وكذلك محصول القطن الزهر بالقنطار/فدان في كلا الموسمين وعلي تصافي الحليج في الموسم الثاني فقط وذلك التفوق راجع للمعاملة الرش بمخلوط الزنك والمنجنيز بمعدل ٢ جم/لتر ماء من كل عنصر مرتين (عند بداية التزهير وبعد التزهير بأسبوعين)، وعموماً لم يكن هناك أي تأثيرات معنوية لتلك المعاملات علي موقع أول عقدة ثمرية، عدد الايام حتي ظهور أول زهرة، متوسط طول التيلة، معامل الانتظام، النعومة ومتانة التيلة في كلا الموسمين. ٣) أعطي التفاعل بين معاملات البوتاسيوم ومعاملات الرش بالزنك والمنجنيز تأثيرات معنوية علي كل من طول النبات عند الجني، عدد العقد/نبات، متوسط طول السلامية، عدد الافرع الثمرية/نبات، متوسط وزن اللوزة ومعامل البذرة في كلا الموسمين، وعدد اللوز المتفتح/نبات، محصول القطن الزهر/نبات وكذلك محصول القطن الزهر بالقنطار/فدان في الموسم الثاني فقط، حيث تحصلت أعلي القيم لتلك الصفات من المعاملة وذلك التفوق راجع للمعاملة الرش بسيليكات البوتاسيوم بمعدل ٢.٥ سم٣/لتر ماء بالاضافة الي الرش بمخلوط الزنك والمنجنيز بمعدل ٢ جم/لتر ماء من كل عنصر مرتين (عند بداية التزهير وبعد التزهير بأسبوعين). ولم يكن للتفاعل أي تأثير معنوي على موقع أول عقدة ثمرية، عدد الايام حتى ظهور أول زهرة، وتصافي الحليج، متوسط طول التيلة، معامل الانتظام، النعومة ومتانة التيلة في كلا الموسمين. التوصية: من النتائج المتحصل عليها والموضحة في هذه الدراسة فأنه يمكن التوصية بالرش بسيليكات البوتاسيوم بمعدل ٢.٥ سم٣/لتر ماء مرتين (عند بداية التزهير وبعد التزهير بأسبوعين) بالاضافة الي الرش بمخلوط الزنك والمنجنيز بمعدل ٢ جم/لتر ماء من كل عنصر وذلك لزيادة إنتاجية محصول القطن صنف جيزة ٨٦ المنزرع تحت ظروف أراضي وسط الدلتا.