Influences of Potassium Foliar Fertilization and Irrigation by Diluted Seawater on Growth and Some Chemical Constituents of Cotton

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Abstract: ***A pot experiment was conducted in the greenhouse of the NRC, Dokki, Giza, Egypt aimed to evaluate the influences of K foliar fertilization [one or two sprayings in the rate of 200 ppm potassium chloride more than the distilled water (as a control)] and irrigation by (DSW) diluted seawater (with EC 3.91 and 7.82 dS/m more than the fresh water 0.30 dS/m as a control) on growth and some chemical constituents of cotton plants. Contentious decreases were detected in plant height, area of green leaves, number of bolls, stem, bolls and top fresh weight (FW) and dry weights (DW) exerted by the increasing in salt concentration in the DSW. However, the response of number, FW and DW of green leaves to both salt levels was approximately equal. Significant effects were shown in area of green leaves, FW and DW of bolls and top FW and DW/plant. The increments in bolls and stem numbers, FW and DW of bolls, top FW and DW increased by one spraying of K fertilizer and depressions were induced as a result of application K fertilizer twice. The differences in plant height, number of leaves and stem and leaves FW as well as DW were not significance. In plants irrigated by fresh water (0.38dS/m) area of green leaves increased by 8.46 and 46.25 %, FW increased by 25.55 % and decreased by 22.54 % and bolls DW by 22.54 and 49.62% when plants receive one or two sprayings of potassium chloride, respectively. Effect of salinity and potassium spraying on some chemical constituents (Chlorophyll and some macronutrients) were also evaluated. Nitrogen, phosphorus and potassium concentrations in cotton leaves increased as the salt concentration increased in irrigation water. Foliar application increased the concentration as well as content of N, P and K in leaves.***

Keywords: Cotton (*Gossypium barbadence* L), Salinity, Diluted seawater, Potassium chloride, Growth, Chemical constituents.

1. Introduction

Cotton (*Gossypium barbadence L*) is one of the most economically important crop in Egypt, supplied the national and international demands with the highest cotton lint quality. In the last decade, the cultivated area in Egypt decreased to be less than half million feddan (fed.=4200 m^2) in summer season of 2007. Therefore, increasing productivity under the limited cultivated area is very important. No doubt that cotton production as for other crops could be easily maximized through appropriate fertilization, short season high yielding varieties. Early recorded results on cotton fertilization under local conditions indicated that nitrogen is the 1st nutrient element for its production. On the other hand, the response of P and K invaluable and generally not so marked with N. Nevertheless, several workers recommended that the application of these elements to establish nutritional balance among different nutrient elements. Oosterhuis et al. (1995) noticed that the use of foliar fertilization with potassium has a widespread practice in the USA to overcome K deficiencies and increase yield. Williams and Kafkafi (1995) and Ankorion (1995) demonstrated that foliar K fertilizer enhancing the growth and yield of different crops especially when applied at the period of fruiting which great quantity of nutrients depleted which the soil application did not cover this requirement. In addition, Etuorneoaud (1998) reported that cotton cultivated in wide range of soils especially clay and heavy clay soils as in Nile Valley and Delta, this type of soils required well drainage to avoid saturation and oxygen stress which affected considerably the nutrient absorption and addition fertilizers in one dose or in split application was needed in bad drainage and saline conditions. Several investigations were reported the adverse effect of salt stress on growth and yield of cotton plants: Triantafilis et al. (1998); Meloni et al. (2001) and Read et al. (2006). Differences in K^+ and Na^+ uptake and compartnmentation are related to salinity tolerance but the value of ion uptake as a traetment for discriminating salt-tolerant genotypes is controversial (Leidi et al., 1998). Cotton is rated as a salt tolerant with a threshold salinity level of 7.7 millimohos ECe/cm of 17.0 millimohos resulting in a 50 % reduction in yield in tested genotypes (Mass, 1986). Chen-Deming et al. (1996) concluded that salt tolerant of cotton was associated with the high accumulation of Na^+ at all salinity levels used.

Application of potassium improves the growth, fruiting and yield of cotton plants. Many studies were conducted to spraying K fertilizer in order to ameliorate the adverse effect of abiotic stresses which were conducted by Badr et al. (2005) and Thalooth et al. (2006). This study aimed to investigate the effect of potassium chloride spraying and irrigation by diluted seawater on growth and some chemical constituents of cotton plants.

2. Materials and Methods

A pot experiment was conducted in the greenhouse of the National Research Centre, to evaluate the influences of K foliar fertilization and irrigation by diluted seawater on growth and some chemical constituents of cotton plants. The treatments were as follows:

Salinity: Irrigation by diluted seawater with 3.91 and 7.82 dS/m more than that irrigated by fresh water as a control. Some chemical properties of used seawater were shown in Table (1).

K fertilizer: Potassium chloride as once or twice was sprayed (45 and 60 days). Soil sample was taken from Kerdasa region, Giza Governorate. Some physical and chemical characteristics of the investigated soil were given in Table (2). Every pot contained 30 Kg. of air dried soil.

Seeds of cotton (*Gossypium barbadence L.*) cv Giza 85 were sown and seedlings were thinned twice at 15 and 30 days to left two plants/pot. Calcium super phosphate (15.5 % P_2O_5) and potassium sulfate (48.5 % K_2O) in the rate of 3.0 and 1.50 g/pot were added before sowing. Ammonium sulfate (20.5 % N) in the rate of 6.86 g/pot was added in two equal portions, the first at 21 days from sowing and the second two weeks latter. Irrigation with diluted seawater in different concentrations was started 30 days after sowing.

Table 1: Some chemical properties of used seawater

Characteristics	*Values*
pH	8.4
EC (dSm^{-1})	50
Total salinity (g/L)	36
Cations (g/L):	
Calcium	0.42
Magnesium	1.31
Potassium	0.42
Sodium	11.02
Anions (g/L):	
Bicarbonate	0.12
Chloride	19.88
Sulphate	2.74

Table 2: Some physical and chemical characteristics of the investigated soil

Characteristics	*Values*
Chemical properties	
pH (1 : 2.5 soil : water ratio)	7.15
EC (Soil paste extraction) dSm^{-1}	1.30
Soluble cations (me/100g):	
Calcium	2.38
Magnesium	1.27
Potassium	0.23
Sodium	1.82
Soluble anions (me/100g):	
Carbonate	-
Bicarbonate	0.91
Chloride	1.90
Sulphate	1.89
Physical properties (%):	
Organic matter	1.30
Calcium carbonate	2.53
Sand	21.5
Silt	30.2
Clay	48.3
Textural class	Clayey

Cholorophylls and carotenoids were in leaves determined according to the method described by Von Wetistien (1957). Plant samples from every treatment were collected, cleaned, dried in an electric oven at 70 °C. The dry matter was ground in a stainless steel mill. Chemical analysis was carried out according to the methods which described by Cottenie et al. (1982). The experimental design was split plot in 8 replicates. All collected data were subjected to the proper statistical analysis as described by Snedecor and Cochran (1990).

3. Results and Discussion

3.1 Growth

a) Effect of salinity

Data in Table (1) Showed that contentious decreases were detected in plant height, area of green leaves, number of bolls, stem, bolls and top fresh and dry weights exerted by the increasing in salt concentration in the diluted sea water. Meanwhile, the response of number, fresh and dry weight of green leaves to both salt levels was approximately equal. Several investigations showed the adverse effect of salinity on growth and yield of cotton plants (Triantafilis et al., 1998; Leidi et al., 1998; and Hussein, 2004). The results obtained by Goldhirish et al. (1990) suggested that inhibition of plant growth, by salt stress was accompanied by inhibition of cell wall proteins synthesis. Therefore, changes in the physicochemical properties of cell wall accompanying the osmotic adjustment should be sought in other post translational modifications of extension(s), either glycosylation or inter-and/or intermolecular cross-linking in the cell wall. Meloni et al. (2001) mentioned that both leaf water potential (psiw) and osmotic potential (psis) decreased in response to NaCl levels. Muhling and Lauchli (2002) reported that salinity may reduce plant growth via Na^+-toxicity symptoms in mature leaves after long-term exposure. It has been suggested by other authors that Na^+ accumulates in the leaf apoplast and leads to dehydration of leaves, wilting, and finally to death of these leaves. A significant increase in Na^+ concentration was found in the leaf apoplast under salinity (75 mM NaCl), but no further significant increase was determined when NaCl supply was increased from 75 to 150 mM. Also, Salt stress may be affected cotton plant through its effect in its anatomical structure. The exodermises, which never developed in control roots, may play a role in protecting the root from water loss and/or leakage of solutes important for osmotic adjustment. Negative relationship was shown between salt stress degree and plant growth characters i.e. plant height, leaves area and dry weight of root, stem and leaves of moringa leaves, which decreased as the salt concentration increased in the diluted seawater (Hussein and Abou-Baker, 2014).

Table 1: Effect of salinity on growth of cotton plants

Salinity dS/m	Plant height (cm)	No of leaves	Leaves area (cm^2)	No of bolls	Fresh weight g/plant				Dry weight g/plant			
					Stem	Leaves	Bolls	Total	Stem	Leaves	Bolls	Top
0.39	93.3	11.90	523	3.20	28.2	36.2	35.6	100.0	14.6	11.5	15.6	41.7
3.91	87.7	15.77	476	3.54	27.6	33.0	31.8	92.4	12.9	12.7	14.6	40.2
7.80	81.0	15.57	335	2.70	20.9	34.3	17.4	72.6	11.5	11.5	5.1	26.4
LSD at 5 %	N.S	N.S	95.2	N.S	N.S	N.S	17.3	16.5	N.S	N.S	6.95	9.13

b) Effect of potassium foliar application

Significant effects were shown in area of green leaves, fresh and dry weight of bolls and top dry and fresh weight/plant by K fertilizer application. The increments in number, fresh and dry weight of bolls, top fresh and dry weights increased by one spraying of K fertilizer and depressions were induced as a result of application K fertilizer twice. The differences in plant height, number of leaves and stem and leaves fresh as well as dry weight are not great enough to reach the level of significance (Table 2).

Table 2: Effect of K foliar fertilizer application on growth of cotton plants

Potassium spraying	Plant height (cm)	No of leaves	Leaves area (cm^2)	No of bolls	Fresh weight g/plant				Dry weight g/plant			
					Stem	Leaves	Bolls	Total	Stem	Leaves	Bolls	Top
Without	84.3	14.0	396	3.23	23.1	34.1	27.5	84.7	11.6	11.7	9.2	32.5
Once	90.3	16.7	513	3.33	27.5	27.5	37.1	92.1	18.8	13.8	17.2	44.8
Twice	87.2	16.9	428	2.90	26.0	26.0	20.3	73.3	11.9	10.4	8.9	31.2
LSD at 5%	N.S	N.S	83.9	0.11	N.S	N.S	14.1	18.7	N.S	N.S	7.99	7.67

Willams and Kafkafi (1995) used different K sources foliar spraying and found that all the foliar K treatments increased boll weight above the untreated control except for K_2CO_3 at standard pH, which was the same. The KNO_3, K_2SO_4 and KOH treatments increased the number of open bolls /ha. Plant height was decreased slightly in K_2CO_3. The number of mean stem nodes was not affected by foliar K. All K sources included KCl increased lint yield. It is known that the combination with soil K- application with foliar spray of K showed that potassium treatment increased the growth traits and the highest increments were obtained by the combination and attributed this finding that K soil content not fairly enough to face the requirements of plants and foliar application may offer opportunity of correcting the deficiencies more quickly and efficiently, especially when soil application may not be effective. Youssef (1999) supported this finding since the K moves by diffusion and sodium by mass flow mechanism in the rhizosphere area.

Potassium is essential in the growth and development of the cotton plant. Potassium is essential for many of the enzyme systems in the plant, plays a role in reducing the incidence and severity of the wilt disease, increases water efficiency, affects the speed of almost all plant biological systems (Marchener, 1995), and affects fiber properties such as micronair, length, and strength. In addition, uptake of potassium is increase during early boll set with some 70 percent of total uptake occurring after first bloom (Marchener, 1995).

c) Salinity X Potassium foliar application

The interaction effect of salinity and K foliar application on growth parameters were illustrated in Table (3). In plants irrigated by fresh water (0.38dS/m) area of green leaves increased by 8.46 and 46.25 %, fresh weight increased by 25.55 % and decreased by 22.54 % and bolls dry weight by 22.54 and 49.62 % when plants received one or two sprayings from potassium chloride, respectively. Table (3) shows that area of green leaves responded approximately similar to both K treatments either irrigated by water with 3.91 dS/m or 7.82 dS/m. Spraying cotton plant after 45 days was the superior in fresh weight of bolls under that irrigated by the two salty water treatments. Also, dry weight of bolls in plants received water with 3.91 dS/m EC responded as boll fresh weight, meanwhile, under the highest salt level used this criterion improved by one spray as well as two sprays of K. The values reached to be two folds of that of the control plants.

Salinity limiting plant growth in different ways as suggested by many investigators: through water status (Meloni et al., 2001) nutrients uptake (Shannan et al., 1994) , ion toxicity effects (Quintero et al. 2007), protein metabolism (Ashraf, et al. 2002), photosynthesis (Bednarz et al., 1998), hormonal disorder and antioxidant enzymes and activity (Hussein et al., 2002 and Garrat et al., 2002). One from the superior character in salt tolerant genotypes, the higher K uptake and translocation to the new tissues and the lower Na uptake and its translocation to the old leaves (Reboucas et al., 1989). In many glycophytes, the maintenance of higher Na^+/Ka^+ ratio in the shoots by excluding Na^+ and accumulating K^+ is associated with salt tolerance (Gorham, 1992 and Leidi et al.,1998). Mechanism that lead to selective K^+ transfer from roots to shoots are a main factor for avoiding Na^+ accumulation in leaves (Jeschke, 1984). In addition, K play important roles in the physiological processes in leaves tissues such as osmotic adjustment, stomatal closure in new cells buildings and carbohydrates assimilation. Therefore, supplementation by a considerable quantity of K in leaves tissues through foliar application especially at the time of higher needs of this nutrient i.e. the fruiting period one from the vital and affective way gives advantage over avoidance the negative effects of increased Na ions. On the other hand, with higher Na^+ and CL^- levels, tolerant varieties maintained a higher K^+ concentration compared to that of salt sensitive varieties

(Chhipa and Lal, 1995 and Badr and Shafei, 2002). Read et al. (2006) stated that early stages of fiber development were indirectly affected by plant N and K status.Yield and fiber quality of upland cotton influenced by nitrogen and potassium nutrition. Leidi et al. (1998) observed reduction of salinity Na^+ uptake was decreased by high Ca^{2+} level and K only affected photosynthesis. Salinity Na^+ concentration at high Ca^{2+} was observed only reduced translocation and stomatal closure. Meloni et al. (2001) mentioned that potassium level remained stable in the leaves and decreased in the roots with increasing salinity. They also added that salinity decreased Ca^{2+} and Mg^{2+} concentrations in leaves but did not affect the root levels of these nutrients. The K: Na selectivity ratio was higher in the saline-treated plants than in the control plants and this may be through the affect on the osmotic adjustment.

Table 3: Effect of salinity and K foliar fertilizer application on growth of cotton plants

Salinity dS/m	Potassium spraying	Plant height (cm)	No of leaves	Leaves area (cm^2)	No of bolls	Fresh weight g/plant				Dry weight g/plant			
						Stem	Leaves	Bolls	Total	Stem	Leaves	Bolls	Top
0.30	Without	88.7	15.0	390	3.3	26.2	35.3	36.4	97.9	13.55	11.35	14.89	39.79
	Once	101.7	17.7	696	3.3	35.4	43.4	45.7	124.5	18.51	14.36	19.28	52.05
	Twice	89.0	18.0	492	3.0	23.0	29.9	24.7	77.6	1169	9.42	12.54	33.65
3.91	Without	88.0	15.3	477	3.7	24.1	36.9	36.6	97.6	12.18	11.44	8.90	32.52
	Once	90.2	17.0	497	4.0	26.2	34.0	40.7	100.9	13.06	16.00	26.74	55.80
	Twice	85.0	15.0	453	3.0	32.4	28.2	18.2	78.8	13.66	10.58	8.14	3239
7.82	Without	76.3	14.0	320	2.7	19.0	30.0	9.4	58.4	12.17	12.17	3.88	25.08
	Once	79.0	15.0	346	2.7	21.0	39.0	24.9	84.9	11.22	11.22	5.47	26.64
	Twice	87.7	17.7	339	2.7	22.6	34.0	17.9	74.5	11.05	11.50	6.00	27.39
LSD at 5%		N.S	N.S	145	N.S	N.S	N.S	26.8	N.S	N.S	N.S	13.25	N.S

Photosynthetic pigments

a)- Effect of salinity

Chlorophyll a concentration raised slightly in plants irrigated by 3.91 dS/m salt level, however, chlorophyll b and carotenoids concentration increased as the salt level increased but chlorophyll a + chlorophyll b gave approximately equal increments. The ratio between chlorophyll a+ chlorophyll b : carotenoids showed similar response of chlorophyll a while chlorophyll a: chlorophyll b ratio reversely to the increase of salts in water of irrigation (Table 4 and Fig. 1). These results are in agreement with those obtained by Khalil (2006). These results were confirmed by Bekheta (2000) who found that salinity decreased chlorophyll in two wheat cultivars. Manceau et al. (2004) showed the decrease of chlorophyll in four cereal plants. Hussein et al. (2007) pointed out that irrigation by diluted sea water with EC 3.91 and 7.82 dS/m reduced the concentration of Chlorophyll a, Chlorophyll b and carotenoids in leaves of barley plants. On the other hand, Badr (2005) revealed that irrigation faba bean by water contains 2500 ppm stimulating the concentration of chlorophyll a and chlorophyll b and the total of chlorophyll a and chlorophyll b and carotenoids. Nevertheless, Ayala an O'Leary (1995) stated that when photosynthesis was expressed relative to the amount of chlorophyll in salicornia, no significant differences were found among salinity levels. Munns and Termaat (1986) and Khalil (2006) attributed this matter to the destruction in of chlorophyll under saline condition. Chlorophyll b concentration in corn leaves was decreased by salt stress (Hussein et al., 2012).

Table 4: Effect of salt stress on photosynthetic pigments concentration in cotton leaves

Salinity dS/m	Chl. a	Chl. b	Carot.	Chl. a +Chl. b
0.38	7.75	2.83	1.58	10.58
3.91	9/02	4.62	1.76	13.61
7.82	7.35	5.75	2.48	13.10
LSDat5%	N.S	2.37	N.S	5.00

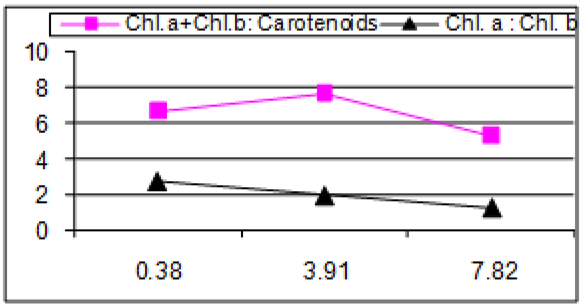

Figure 1: Effect of salt stress on photosynthetic pigments concentration in cotton leaves.

b) Effect of potassium foliar application

Data concerning the effect of potassium chloride effects on photosynthetic pigments were presented in Table (5) and fig. (2). One application of potassium induced depression in concentration of chlorophyll a and total chlorophyll a: carotenoids and chlorophyll a: chlorophyll b ratios. However, the reverse was true for chlorophyll b and carotenoids. Spraying potassium chloride twice led to increase in chlorophyll b and the ratio of total chlorophyll: total carotenoids and reversely affected the carotenoids concentration. This treatment decreases the chlorophyll a and the chlorophyll a: chlorophyll b ratio but the decrement less than that caused by one application. Meanwhile, the total chlorophyll did not affected by this treatment. HeZhong et al. (2004) emphasized that single leaf photosynthesis (Pn) reduction results mainly from decreased stomatal conductance, low chlorophyll content, poor chloroplast ultra structure, restricted saccharide translocation, and decreased synthesis of RuBP carboxylase under K deficient conditions. Zhao et al. (2001) noticed that decreased leaf P and N of K-deficient cotton was mainly associated with dramatically low chlorophyll content, poor chloroplast ultrastructure, and restricted saccharide translocation, rather than limited stomata conductance in K-deficient leaves. On the other side, Chapagain and Wiesma (2004) found that Chlorophyll content was higher in plants sprayed by foliar potassium fertilizers.

Table 5: Effect of potassium spray on photosynthetic pigments concentration in cotton leaves

Potassium spraying	Chl. a	Chl. b	Carot.	Chl. a +Chl. b
Without	8.90	3.54	1.83	12.44
Once	7.03	5.46	2.50	12.49
Twice	8.19	4.21	1.50	12.40
LSD $_{5\%}$	1.12	N.S	N.S	N.S

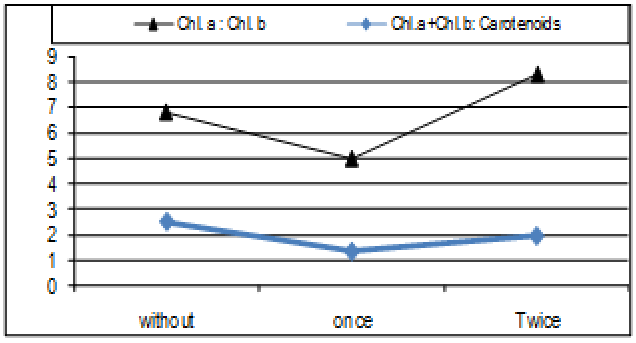

Figure 2: Effect of potassium spray on photosynthetic pigments concentration ratios in cotton leaves

c) Salinity X Potassium foliar application

The interactive effect of salinity and potassium foliar fertilization on chlorophyll and carotenoids were illustrated in Table (6) and Fig. (3). Data showed that in spite of the increment in carotenoids concentration by application potassium one time but sharply depressed when plants irrigated either by 3.91 or 7.82 dS/m salt level. Positive effect was detected in the concentration of this pigment by spray potassium fertilizer but the effect by two sprays was more than one only compare to that in the control plants. Data also clearly indicated that when plants irrigated regularly by tap water, the total chlorophyll increased by potassium treatment and the effect was more by twice application. In plants irrigated by water with 3.91dS/m this parameter lowered markedly by one spray and slightly two sprays. Under 7.82 dS/m salinity level total chlorophyll seemed to be without effect in plants received two potassium sprays increased while it increased by one spray. Kaya et al. (2001) concluded that supplementary P and K can reduce the adverse effects of high salinity on plant growth and physiological development. Kaya et al. (2007) demonstrated that chlorophyll content was decreased by salinity and supplementary NO_3 and proline treatments significantly ameliorated the adverse effect of salinity on growth, yield and physiological parameters.

Table 6: Effect of potassium spraying and salt stress on photosynthetic pigments in cotton leaves

Salinity dS/m	*Potassium spraying*	*Chl. a*	*Chl. b*	*Carot.*	*Chl.a+Chl.b*
0.38	Without	7.97	1.87	1.10	9.84
	Once	7.09	3.13	1.73	10.22
	Twice	8.18	3.50	1.92	11.68
3.91	Without	11.28	4.68	1.54	15.86
	Once	7.12	4.78	2.60	11.90
	Twice	8.66	4.40	1.15	13.06
7.82	Without	7.44	4.06	2.85	11.50
	Once	6.89	8.46	3.17	15.35
	Twice	7.72	4.72	1.43	12.44
L.S.D at 5%		N.S	N.S	3.04	N.S

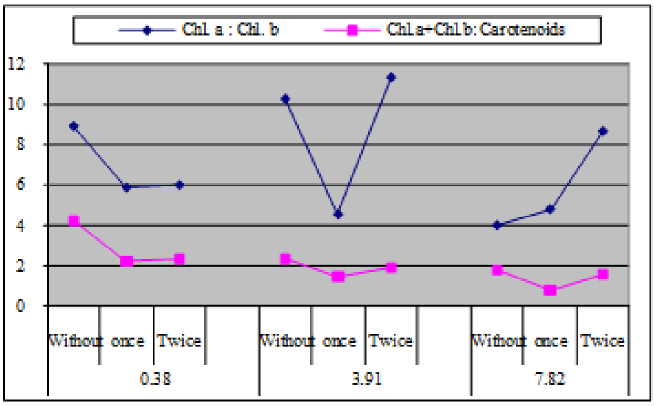

Figure 3: Effect of potassium spraying and salt stress on photosynthetic pigments ratios in cotton leaves

Macronutrients

a)Effect of salinity

Data in Table (7) and Fig. (4) indicated that nitrogen, phosphorus and potassium concentrations in cotton leaves increased as the salt concentration increased in irrigation water. Data in the same table showed that N content increased by the 1st level of salinity and tended to decreased by the highest salinity level used. Phosphorus content increased gradually with increasing salinity level. Nevertheless, K content (mg/plant) decline by both salinity treatment but the decrement by the 1st level of salt was little more than that caused by the 2nd level of salts in water of irrigation. Gouia et al. (1994) demonstrated that Na and Cl concentration increased in NaCl treated plants. The concentration of K, Ca and N were reduced in shoots and increased in roots. Heikal (2004) revealed that Na and Ca contents in all tested plants (Sunflower, wheat and radish) were decreased progressively with salinity while P was not affected. Potassium addition was positively correlated with nutrient content (N, P and K) of bean plants under salt stress conditions and the superiority for potassium silicate; this may be due to the role of potassium in water regulation, intake and increase water use efficiency (Abou- Baker et al., 2011), in addition to the role of potassium in mitigating the toxic effect of Na (Abou-Baker et al., 2012). In this concern Hussein et al. (2012) reported that uptakes of different elements (N, P and K of cotton leaves) were significantly affected with salt stress. This may be due to that effect of salinity was more clearly on dry weight so that, data of uptake take the same trend of dry weight.

Table7 : Effect of salinity on macronutrients content in cotton leaves

Salinity dS/m	Content (mg/pot)		
	N	P	K
0.38	40.07	7.72	28.72
3.91	44.44	13.68	25.97
7.82	41.89	7.36	26.09
LSD at 5%	N.S	3.79	N.S

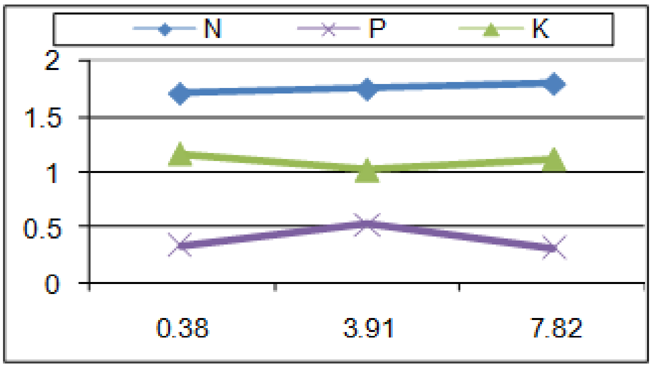

Figure 4: Effect of salinity on macronutrients concentration in cotton leaves.

b) Effect of potassium foliar application

Data presented in Table (8) and Fig. (5) showed that potassium chloride as foliar application increased the concentration as well as content of N, P and K in leaves; meanwhile, the increment with one application was more than two sprays**.** Hussein et al. (2006) found that N and K concentrations in shoots of barley plants were increased as a result of K application. Foliar application of K may offer the opportunity of correcting these differences more quickly and efficiently especially late in the season when soil application of K may not be effective. Also, to face the great needs of nutrients especially at the period of fruiting (Marchener, 1995 and Oosterhuis et al., 1995). On barley, Ouda et al. (2005) observed that application of K increased N, P and K percentages in grains. Chapagain and Wiesma (2004) found that chlorophyll, potassium, phosphate, magnesium and iron contents in the leaves were significantly higher in plants sprayed with potassium as Mono-potassium phosphate than that of non sprayed plants.

Table 8: Effect of potassium spraying on content of macronutrients in cotton leaves

Potassium spraying	Content (mg/pot)		
	N	P	K
Without	39.49	7.08	23.78
Once	49.87	12.66	31.94
Twice	37.79	9.63	22.22
LSD at 5%	N.S.	2.16	5.4

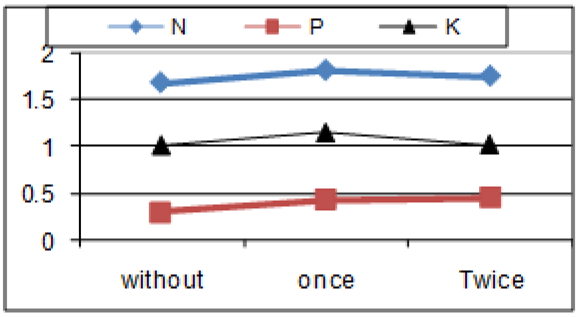

Figure 5: Effect of potassium spraying on concentration of macronutrients in cotton leaves.

c)Salinity X Potassium foliar application

The interactive effect of salinity and potassium chloride foliar spraying on the macronutrients concentration were recorded in Table (9**)** and Fig. (6). On the concentration of N, under irrigation by fresh water or with that contains the 1st level of salts, potassium one or two sprays seemed to be affected similarly; however, irrigation by diluted seawater with 7.82 dS/m, one spray of potassium only increased N concentration in leaves. The response of P concentration to K spraying under the 3rd level of salt or irrigated by fresh water regularly was approximately similar, while both K sprayings gave the same value by the 1st level of salt water. Data in Table (9) also cleared that application of one spray of K pronouncedly affected N and P concentrations under the high level of salt. Under fresh water irrigation K concentration increased by both number of sprays but the increase by one spray more than that with two sprays. Under the 1st level of salt in water of irrigation, sprays K showed the opposite effect on K concentration. Concerning the interactive effect on content of the above mentioned three macronutrients, the higher values N and K was by one spray of potassium chloride. This was true under the three salinity treatments. Meanwhile, K content showed similar response under the 1st level of salt or regular irrigation by fresh water, however, it decreased by one spray and increased by the two sprays compare to that of leaves without K application.

Table 9: Effect of potassium spraying and salinity on macronutrients content in cotton leaves.

Salinity dS/m	Potassium spraying	Content (mg/pot)		
		N	P	K
0.38	Without	37.0	4.54	14.98
	Once	49.69	9.19	50.83
	Twice	33.53	9.42	20.35
3.91	Without	39.12	9.15	28.14
	Once	56.96	19.20	32.0
	Twice	37.24	12.70	17.77
7.82	Without	42.34	7.54	28.23
	Once	42.86	7.85	22.44
	Twice	40.48	6.67	27.6
L.S.D at 5 %		N.S	N.S	N.S

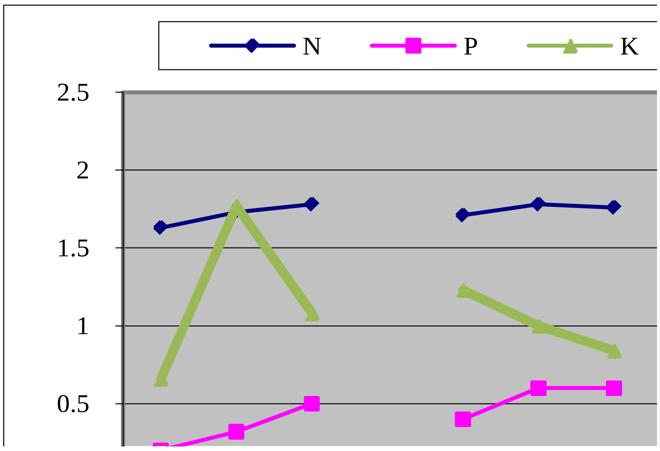

Figure 6: Effect of potassium spraying and salinity on macronutrients concentration in cotton leaves

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