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Evaluation of using potassium and putressine (1, 4 diaminobutane dihydrochloride) to alleviatethe negative effects on sorghum plants (Sorghum bicolor L) irrigated with different irrigation water.

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Abstract

A field experiment was conducted in the north western part of Kom Osheem district, Tamiya Town, El-Fayoum Governorate, Egypt to study the possibility of using potassium foliar spray of (K_2SO_4) at rate of 1000 L/ ha^{-1} twice after one month from sowing and at one month later and putressine (1,4 Diaminobutane dihydrochloride) foliar spray of 10 u M solution, The putressine was spraied in two equal doses, one dose after one month from the sorghum sowing and the second dose one month later at rate of 1000 L/ ha^{-1}., to mitigate the negative effect of irrigation with mixed water and drainage water on sorghum plants. Irrigation with the Nile fresh water was used for comparison. Soil pH, EC, soluble cations both soluble sulphate and chloride and SAR significantly increased due to using mixed or drainage water. Higher values of plant height, dry weight/plant, weight of grains/panicle, 1000-grain weight and both grain and stalk yields, as will as N, P, K, Ca and K/Na ratio in sorghum leaves and grains were recorded for the plants irrigated with the Nile fresh water or supplied with potassium and/or putressine. Plants irrigated with drainage water without potassium or putressine recorded the lowest values, except for the 1000-grain weight which was not affected by putressine. Effect of putressine was more pronounced under mixed or drainage water. The treatment of using mixed water + potassium + putressine resulted in sorghum yield almost equal to that irrigated with the Nile fresh water. Foliar spraying with potassium and putressine might mitigate the adverse effect of using saline water for irrigation.

Key words: Sorghum, water quality, potassium, putressine, growth parameters, yield and its components and nutrient status.

Introduction

Sources of suitable water are not enough for irrigation on purposes specially in arid and semi-dry regions. Therefore, low quality water such as drainage water are used to meet the increasing crop water requirements. Chandra *et al.* (1997) reported that drainage water can be used to supplement irrigation water. However, the quality of this water determines types of the crops to be irrigated. This means that low quality water requires selection of appropriate salt tolerance crops.

Reuse of drainage water appears to be one of the most promising, practical and economical means of increasing the Egyptian water budget. Already 10% of the water used for irrigation in the Nile-Delta is drainage water and it is planned to double this amount in future. However, reuse of drainage water has its limitations and drawbacks. Available information shows that the River Nile, its branches, canals and the drains are suffering from an increase in pollution by wastewater. The drainage system particularly is receiving the heaviest pollution loads. The major sources of water pollution are agricultural chemicals (salts, nutrients and pesticides), municipal and rural domestic sewage and industrial wastewater (DRI-WL/DELFT HYDRAULICS-TAUW B.V. 2000). The used agricultural drainage water used for irrigation was estimated by 4.5 billion m^3 annually in the Delta area. Accordingly, the water policy is aiming now at increase the quantities of reused agricultural drainage water in order to reach 8.4 billion m^3 annually in the year 2017 (El-Eshmawiy *et al*,. 2006).

Sorghum (*Sorghum bicolor*.) is an increasingly important crop in many regions of the world. Sorghum is one of the most important cereal crops in Egypt, it ranks third among summer cereal crops after rice and maize in acreage and total production. This crop, on the other hand, is considered the first summer crop in El-Fayoum Governorate. Sorghum tolerates many growth limiting factors, including heat, drought, salinity and poor soils (El-Kady, 2006). Nasir *et al.* (1990) reported that tolerance of sorghum to salinity is moderate. Increased tolerance of sorghum to salts has been related to its ability to overcome reduced uptake of K^+ and Ca^{2+}/or accumulation in the leaves of toxic ions, in the leaves (especially Na^+ and Cl^-) (Lacerda *et al*., 2003). Grain sorghum is grown mainly for bread industry in Upper Egypt and El-Fayoum Governorate and recently to great extent for many other purposes, such as using livestock and poultry feeding. Tall stalks after harvesting are used as hedges for winter crops, also leaves and stalks of double purpose cultivars and hybrids are used as green forage and several industrial purposes.

Potassium is required by all plants and animals. Plants require potassium for photosynthesis, osmotic regulation and the activation of enzyme systems. Potassium deficiency in cereal crops results in reduced growth, delayed maturity, lodging caused by weak straw, and low bushel weight (AGRl-FACTS, 2000). Potassium is an essential nutrient for grain filling and its deficiency can increase the level of screenings and can reduce the tolerance of plants to environmental stresses, such as drought, frost and water logging as well as pests and diseases (Bowden, 2007).

Putressine (1,4Diaminobutane dihydrochloride) has a curing effect on plant seedlings suffering salinity since it increases plant tolerance against salinity stress (Abd El-Magid *et al*. 2007). The universal occurrence of putressine in plants suggests that it fulfills important functions in relation to senescence, light and stress and by its biosynthesis increase period to growth (Smith, 1985). The aim of this study is to evaluate the implications of using potassium and putressine to reduce the negative effect of irrigation with saline water on the productivity of sorghum plant grown in Kom Osheem distract, El-Fayoum.

Materials and Methods

Outline of the study

A field experiment was conducted at the North Western part of Kom Osheem district near Tamiya Town, El-Fayoum Governorate, Egypt, to study the advising effect of application potassium and putressine on sorghum plants irrigated with low quality irrigation waters. Soil properties after harvesting, growth parameters of sorghum and yield and its components of sorghum as well as N, P , K, Na and Ca concentration beside of the K/ Na ratio in grains and leaves of sorghum will be considered in this study.

Experimental site description

The experimental site of this study comprised 3 areas (about 691.2 m^2 each). One area was irrigated from Bahr Wahbi canal water (Nile water treatment), the second area was irrigated from El-Batts drain (drainage water treatment), while the third was irrigated from El-Batts station (mixed water treatment). The three areas represent soils irrigated previously with fresh water near Baher Wahbi canal.

A split plot design with four replications was used in this study. Water quality treatments were arranged in the main plots (in one area), treatments (control, potassium, putressine and potassium plus putressine) were plotted in the sub plots. Each experimental plot (sub plot) was 43.2 m^2(6 × 7.2 m) and consisted of 12 ridges, 6 meter along and 60 cm apart and 20 cm between hills. Each plot was separated from the other by 100 cm alley. The plots were irrigated by flooding. Before sowing, surface soil samples (0 - 30) for each area were collected for physical and chemical properties according to Klute (1986) and Page *et al.* (1982), respectively and listed in Table (1).

Table 1. Physical and chemical properties of the studied soil before planting of sorghum.

Soil property	Soil irrigated with the Nile water	Soil irrigated with the mixed water	Soil irrigated with the drainage water
*pH	7.98	8.00	8.04
**EC (dS m^{-1})	1.79	1.81	1.84
Soluble cations mmol L^{-1}:			
Ca^{2+}	5.11	5.32	5.40
Mg^{2+}	3.30	3.39	3.41
Na^+	5.90	5.93	5.94
K^+	3.51	3.34	3.61
Soluble anions mmol L^{-1}:			
CO_3^{2-}	0.00	0.00	0.00
HCO^{3-}	3.15	3.14	3.17
$SO4^{2-}$	7.03	7.19	7.23
Cl^-	7.64	7.65	8.19
SAR	2.87	2.85	2.84
Particle size distribution (%):	39.05		
Clay	37.95		
Silt	23.00		
Sand	Clay loam		
Texture grade***			

*pH was measured in a soil-water suspension (1:2.5).
*** According to the USDA triange
** EC = Electrical conductivity was measured in a soil-water extract (1:5).

Experimental treatments

Water sources

1 - Nile water from Bahr Wahbi (first area).
2 - Mixed water from El-Batts Station, (Bahr Wahbi canal water and El-Batts drain water) (1:1) (second area).
3 - Drainage water from El-Batts drain water (third area).

Foliar treatments

1- Control
2- Foliar spraying of (K_2SO_4) at a rate of 1000 L ha^{-1} twice after one month from sowing and at one month later.
3 - Foliar spraying of putressine.
Putressine (1,4 Diaminobutane dihydrochloride) was sprayed on the sorghum plants at concentration of 10 uM putressine solution1000 Lha^{-1}. Two equal doses, the first dose after a month from the sorghum sowing and the second one was one month later.
4- Foliar spraying of K_2SO_4 + putressine.
Calcium superphosphate (6.6% P) at a rate 24 $kgha^{-1}$was added during soil preparation. Grains of sorghum, cultivar Giza were hand drilled at a rate of 11.9 $kgha^{-1}$in hills spaced 20 cm apart along the row at the second week of June. Thinning was done 2 weeks, after sowing. Nitrogen fertilizer was (46% N) at the standard recommended rate of 175 kg urea/feddan) added in two equal doses after 20 and 40 days after sowing. All cultural practices except for potassium fertilization were followed as recommended for grain sorghum cultivation in district. Harvesting took place on 30th of September.

Gorwth characters:

After 65 days of sowing, sample of ten plants was taken randomly from each plot to measure the following parameters:

1 - Plant height.
2 - Dry weight/ plant.

Yield components:

Ten guarded of sorghum plants were taken randomly from each plot at harvest to measure the following characters:

1 - Number of grains / pancile.
2 - Weight of 1000 grains.

Grain and stalks yields:

Plants of each plot were harvested, air dried and weighed to determine the following characters:

1 - Grain yield.
2 - Stalks yield.

Laboratory analyses

Soil analysis

After harvesting, representative soil samples were collected from each area (main plot) to determine, soil pH, electrical conductivity (EC), and soluble cations and anions. SAR and Ca^{2+}/ Mg^{2+} ratio were calculated.

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Water analysis

A representative water sample from each of the three water sources used for irrigation in this study were taken to determine pH, EC and soluble cations and anions. SAR and Ca^{2+}/ Mg^{2+} ratio were calculated and the obtained results are listed in Table 2 (accodiring to Ayers and Westcot, 1994).

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Plant analysis

Grains stalks in each plot were sampled to determine N, P, K, Na and Ca content accodiring to Chapman and Pratt (1961).

Table 2. Chemical composition of the water sources used for sorghum irrigation.

Irrigation water chemical criteria	Nile water	Mixed water	Drainage water
pH	7.40	7.60	7.70
EC (dS m^{-1})	0.85	1.50	2.11
Soluble cations (mmolc L^{-1})			
Calcium	2.31	4.29	6.37
Magnesium	1.55	2.97	4.29
Sodium	4.06	6.27	8.56
Potassium	0.57	0.74	0.82
Soluble anions(mmolc L^{-1}):			
Carbonate	0.00	0.00	0.00
Bicarbonate	2.84	3.54	4.96
Sulphate	2.54	4.39	6.98
Chloride	3.11	6.34	8.10
SAR	2.92	3.30	3.72
Ca / Mg-Ratio (%)	1.49	1.44	1.48

Results

Effect of water quality on some soil properties:

Table 3 shows the effect of water quality on some chemical properties, pH, EC, soluble salts and SAR values. The results show that ions (except for K and HCO_3) were lowest in soil irrigated with Nile water and highest in soil irrigated with drainage water. As for soluble K ions they were highest in soil irrigated with mixed water and lowest in soil irrigated with drainage water. HCO_3 ions were highest in soil irrigated with drainage water and lost in soil irrigated with mixed water. The relative increase in these parameters compared with the initial values before sowing were 0.75, 5.52, 3.38, 10.61, 3.03, 11.07, 11.67, 30.70 and 5.67 for the soil irrigated with the mixed water. The corresponding values for these parameters, except for K^+ for the soil watered with drainage water were 0.11, 19.56, 14.81, 25.51,14.64,3.32,14.96,30.15 and 0.85%respectively.

Table 3. Effect of irrigation water quality on some chemical properties of the soil surface (0.0-30 cm) after harvesting.

Soil property	Soil irrigated with the Nile water	Soil irrigated with the mixed water	Soil irrigated with the drainage water
*pH	7.99	8.06	8.13
**EC (dS m^{-1})	1.81	1.91	2.20
Soluble cations (mmolc L^{-1}):			
Ca^{2+}	5.23	3.50	3.20
Mg^{2+}	3.31	3.75	4.28
Na^+	6.01	8.11	9.81
K^+	3.48	3.71	4.73
Soluble anions (mmolc L^{-1}):			
CO_3^{2-}	0.00	0.00	0.00
HCO_3^-	3.11	3.54	3.61
SO_4^{2-}	7.09	7.45	7.45
Cl^-	7.83	10.01	10.96
SAR	2.91	4.27	5.08

*pH was measured in a soil-water suspension (1:2.5).

**EC = Electrical conductivity was measured soil paste extract.

- **Effect of water quality as well as potassium and putressine foliar spray on growth and yields of sorghum.**

The data in Tables 4, 5 and 6 show that Nile fresh water resulted in the tallest sorghum plants, the highest dry weight/ plant, 1000 – grain weight and grain weight / stalks panicle as well as the grain and sorghum yields . Using the mixed water resulted in relatively lower values for the parameters, while drainage water produced the lowest ones. The decrease caused due to using the mixed and drainage water as compared with using the Nile water reached to 6.56 and 15.85, 7.54 and 16.8, 4.94 and 12.45, 12 and 18, 6.65 and 16.8 and 5.4 and 20.1% for plant height, dry weight/ plant, grain weight/ panicle, 1000 grain weight, grain yield and stalks yield, respectively.

Spraying sorghum plants with potassium sulphate significantly increased plant height, dry weight /plant, grain weight/ panicle, 1000 – grain weight, grain and stalks yields. The relative increase over Control were12.8, 13.0, 34.23, 5.7, 26.7 and 29.15%, for the above mentioned characters, respectively.

With respect to putressine, the data show that. Foliar spraying of putressine enhanced plant height, dry weight/ plant, grain weight/ panicle, 1000 – grain, grain yield and stalks yields by 8.7, 7.9,7.5, 11.6 and 15.08%, respectively as compared with no putressine for the above mentioned characters,

Grain yield was not affected by putressine spray under the Nile water treatment. The treatment of mixed water + potassium + putressine produced yields of sorghum and its components, (except for 1000 – grain weight) similar to those obtained under the treatment of Nile water + potassium + putressine. Spraying of potassium with putressine could alleviate the negative effect of drainage water on sorghum productivity.

Table 4. Effect of water quality as well as potassium and putressine foliar spray with 10uM on plant height **and** dry weight/ plant.

Water quality	Plant height (cm)					Dry weight/ plant (g)				
	Control	K_2SO_4	Putressine	K+ Putressine	Mean	Control	K_2SO_4	Putressine	K+ Putressine	Mean
Nile water	99.6	104.7	99.8	104.8	102.2	35.92	37.52	35.94	37.58	36.74
Mixed water	85.3	99.1	93.6	104.1	95.5	30.78	35.39	32.18	37.56	33.97
Drainage water	72.5	86.6	86.5	98.2	86.0	25.34	31.05	31.15	34.70	30.56
Mean	85.8	96.8	93.3	102.4	94.6	30.68	34.67	33.09	36.59	33.75

L.S.D. at 5%	A	B	C	AB	AC	BC	ABC	A	B	C	AB	AC	BC	ABC
	2.15	2.03	٧٦.١	NS	3.16	NS	3.89	1.13	1.25	0.86	NS	1.57	NS	1.82

Table 5. Effect of water quality as well as potassium and putressine foliar spray with 10uM on grain weight/ panicle and 1000 - grain weight.

Water quality	Grain weight/ panicle					1000 - grain weight				
	Control	K_2SO_4	Putressine	K+ Putressine	Mean	Control	K_2SO_4	Putressine	K+ Putressine	Mean
Nile water	45.82	61.35	45.91	61.53	53.65	31.36	33.07	31.38	33.11	32.23
Mixed water	41.27	55.53	45.57	61.63	51.00	27.75	28.96	27.80	28.90	28.35
Drainage water	37.38	50.19	42.33	57.97	46.97	25.46	27.36	25.50	27.37	26.42
Mean	41.49	55.69	44.60	60.38	50.54	28.19	29.09	28.32	29.97	29.00

L.S.D. at 5%	A	B	C	AB	AC	BC	ABC	A	B	C	AB	AC	BC	ABC
	0.63	0.81	0.33	NS	1.13	NS	1.73	0.35	0.47	NS	NS	NS	NS	NS

Table 6. Effect of water quality as well as potassium and putressine foliar spray with 10uM on grain and stalks yields (Mg h^{-1}).

Water quality	Grain yield (Mg h^{-1})					Stalks yield (Mg h^{-1})				
	Control	K_2SO_4	Putressine	K+ Putressine	Mean	Control	K_2SO_4	Putressine	K+ Putressine	Mean
Nile water	17.01	19.35	17.11	19.37	18.21	7.15	8.36	7.14	8.37	7.76
Mixed water	14.33	18.19	16.08	19.38	17.00	5.93	7.68	7.36	8.39	7.34
Drainage water	11.47	16.69	14.57	17.85	15.15	4.61	6.83	5.86	7.48	6.20
Mean	14.27	18.07	15.92	18.86	16.79	5.90	7.62	6.79	8.08	7.10

L.S.D. at 5%	A	B	C	AB	AC	BC	ABC	A	B	C	AB	AC	BC	ABC
	0.26	0.33	0.17	NS	0.76	NS	0.81	0.10	0.45	0.27	NS	0.66	NS	0.73

- **Effect of water quality as well as potassium and putressine foliar spray on nutrients concentration in sorghum leaves and grains.**

Tables 7 and 8 show that percentages of N, P, K, Ca and K/ Na ratio in sorghum stalks and grains were significantly higher in plants irrigated with the Nile water than those irrigated with the mixed water, the least concentrations of these nutrients were achieved due to irrigation with the drainage water. Onthe other hand sodium concentration in stalks and grains allowed on the adverse trend to that of the nutritive elements.

Foliar application of potassium in the from of K_2SO_4 increased N, P, K, Ca and K/ Na ratio in both stalks and grains of sorghum, however Ca concentration in stalks under irrigated the plants with mixed and drainage water significantly decreased due to potassium sprayed. On the other hand potassium fertilization significantly decreased sodium concentration in both sorghum stalks and grains.

N, P, K, Ca and K/ Na ratio in sorghum stalks and grains except K/ Na in plants irrigated with mixed and drainage water were not affected by putressine treatment whereas, putressine application significantly decreased the sodium and calcium concentrations in stalks except in plants irrigated with Nile water and Na in grains of plants irrigated with mixed and drainage water, however calcium concentration in grains except in plants irrigated with Nile water significantly increased due to application of putressine.

In general, the results confirm the beneficial effect of sprayed potassium with putressine in decreasing the adverse effect of saline water through decreasing Na and at the same time, increasing Ca concentration specially in grains.

Table7. Effect of water quality as well as potassium and putressine foliar sprayed on nutritional status in sorghum stalks.

Water quality	Foliar treatments	N %	P %	K %	Na %	Ca %	K / Na
The Nile water	Control	2.10	1.04	2.28	0.63	1.11	3.62
	K_2SO_4	2.25	1.33	2.48	0.54	1.22	4.59
	Putressine	2.11	1.06	2.27	0.63	1.12	3.60
	K+ Putressine	2.23	1.35	2.49	0.55	1.23	4.53
	Mean	2.17	1.20	2.38	0.59	1.17	[4.08]
The mixed water	Control	1.96	0.82	1.93	0.96	1.01	2.01
	K_2SO_4	2.05	1.17	2.30	0.71	0.93	3.24
	Putressine	1.95	0.83	1.93	0.75	0.97	2.57
	K+ Putressine	2.06	1.18	2.29	0.64	0.85	3.58
	Mean	2.01	1.00	2.11	0.77	0.94	[2.85]
The drainage water	Control	0.82	0.59	1.27	1.29	0.92	0.98
	K_2SO_4	1.11	0.97	2.01	0.91	0.80	2.21
	Putressine	0.84	0.57	1.28	1.01	0.85	1.27
	K+ Putressine	1.12	0.96	2.00	0.74	0.71	2.70
	Mean	0.97	0.77	1.64	0.98	0.82	[1.79]
L.S.D. at 5%	A	0.08	0.10	0.08	0.03	0.04	0.76
	B	0.12	0.17	0.15	0.04	0.05	0.55
	C	NS	NS	NS	0.3	0.03	NS
	AB	NS	0.31	0.75	0.11	0.06	NS
	AC	NS	NS	NS	0.13	0.06	NS
	BC	NS	NS	NS	NS	NS	NS
	ABC	NS	NS	NS	0.15	0.07	NS

Table 8. Effect of water quality as well as potassium and putressine foliar sprayed on nutritional status in sorghum grains.

Water quality	Foliar treatments	N %	P %	K %	Na %	Ca %	K / Na
The Nile water	**Control**	1.49	0.45	1.89	0.36	0.69	5.25
	K_2SO_4	1.65	0.61	2.18	0.32	0.87	6.81
	Putressine	1.50	0.46	1.90	0.36	0.69	5.28
	K+ Putressine	1.65	0.62	2.18	0.33	0.88	6.61
	Mean	1.57	0.54	2.04	0.34	0.78	[5.99]
The mixed water	**Control**	1.27	0.28	1.45	0.63	0.60	2.30
	K_2SO_4	1.31	0.39	1.92	0.46	0.72	4.17
	Putressine	1.28	0.28	1.46	0.57	0.65	2.56
	K+ Putressine	1.32	0.40	1.93	0.40	0.79	4.83
	Mean	1.30	0.34	1.69	0.52	0.69	[3.47]
The drainage water	**Control**	0.88	0.18	1.12	0.88	0.42	1.27
	K_2SO_4	1.27	0.28	1.70	0.61	0.52	2.79
	Putressine	0..88	0.19	1.14	0.78	0.51	1.46
	K+ Putressine	1.28	0.28	1.71	0.52	0.60	3.29
	Mean	1.07	0.23	1.41	0.70	0.51	[2.20]
L.S.D. at 5%	**A**	0.85	0.03	0.10	0.02	0.03	0.83
	B	0.71	0.04	0.13	0.02	0.03	0.77
	C	NS	**NS**	NS	0.01	0.02	NS
	AB	NS	**0.10**	0.31	0.05	NS	NS
	AC	NS	**NS**	NS	0.03	0.04	NS
	BC	NS	**NS**	NS	NS	NS	NS
	ABC	NS	NS	NS	0.07	0.04	NS

Discussion

The soil properties were affected by water quality. Nile water showed lowest pH, and soil salinity, Mixed and the drainage water negatively affected soil properties after harvest. The increases in soil salinity due to irrigation with the mixed or drainage water reflects the higher EC values of these water sources. Similar results were reported by Dubey and Mondal (1994), Mostafa *et al.,* (2004) and Mashali *et al*., (2009) who reported that increasing salinity level of irrigation water increased all cations and anions in soil, except for HCO^{-3}. The increases occurred in SAR is due to the high sodium values existed in these waters. These results are similar to those obtained by Mostafa *et al.,* (2004).

Using the mixed or drainage water significantly reduced in plant height, dry weight/ plant, grain weight/ panicle, 1000 – grain weight, grain and stalks yield as compared with using the fresh water. The decrease in sorghum yield with increasing salt stress, reflects a reduction of turger and that plants suffered from restricted water availability to cells (Munns *et al.,* 2000 and Munns ,2002). The decrease in dry weight/ plant reflects the increase of metabolic energy cost and reduced carbon gain, which are associated with salt adaptation (Richardson and Mc Cree, 1985 and Netondo *et al*., 2004). It also reflects salt impact on tissues (Greenway and Munns, 1980), decrease in photosynthetic rates per unit of leaf area (McCree, 1986), and attained of maximum salt concentration tolerated by the fully expanded leaves (Munns and Termaat, 1986). These results agree also with those obtained by El-Mowelhi *et al,.* (1995), Bkhit (2010) and Hussein *et al.,* (2010). Foliar application of potassium had a favourable effect on all studied sorghum parameters. Quintero *et al.,* (1990) reported that K fertilization is associated with increasing growth because of the positive effect of this nutrient on osmotic adjustment, stomata regulation, photosyn synthesis and protein synthesis. Maser *et al*., (2002) reported that potassium is essential for many plant processes such as enzyme activation, protein synthesis, photosynthesis, osmoregulation during cell expansion.

With regard to putressine, the results indicated that foliar spraying of 10 uM putressine twice on sorghum leaves had a positive effect on plant height, dry weight/ plant, weight of grains/ panicle and straw yields. The improvement of sorghum growth due to putressine may be due to the role of putressine in enhancing cell divition activity. El-Bassiouny and Bekheta (2004) showed that exogenous application of putressine on salt-stressed wheat plants considerably increased shoot growth (number of tillers, number of leaves, leaf area and dry weight/ plant). Davis and Olson (1994) stated that putressine may be involved in the cell division stage of plant development, and not cell enlargement, in turn increased plant dry weight not its elongation.

The positive effect of potassium with putressine on enhancing plant growth under salt stress my be due to K being is readily absorbed by the plant roots and this is retained mainly in the cell sap, playing a part in regulating osmotic pressure and maintaining the turgidity of the plant (Simpson, 1986), Putressine increases proline accumulation in plant as well as endogenous phytohormones (IAA, GA3 cytokinins) and ABA content (Hussein *et al*., 2008). Also, Todorov *et al*., (1998) reported that foliar application of putressine induced a potent effect on reducing the stomatal aperture and increased the stomata number on both leaf surface, in turn alleviated to some extent the plant damage by salt stress.

Salinity stress had a negative effect on N, P, K, Ca and K/ Na ratio in sorghum stalks and grains which could be attributed to inefficient utilization of the absorbed nutrients and \ or poor response to fertilizes application under saline condition (Shi and Cheng, 2005). Netondo *et al.*(2004) mentioned that high Na^+ concentration strongly inhibited uptake and concentration of K^+ and Ca^{2+} and to a lesser extent of Mg^{2+} by roots. High Na^+ levels in the external medium greatly reduced the physicochemical activity of dissolved calcium and may thus displace Ca^{2+} from the plasma membrane of root cell, (Cramer and Lauchli, 1986). Ali *et al.,* (2005) stated that the typical mechanism of salinity tolerance is the Na^+ exclusion or uptake reduction and increased absorption of K^+ maintain a good K^+/ Na^+ balance in the shoot. The K^+/ Na^+ ratio in the shoot is a valid criterion in measuring salinity tolerance in wheat. If K^+/ Na^+ is narrow then the variety is tolerant and if K^+/ Na^+ is wide then it is called sensitive. These results are in line with those obtained by Ahmed *et al.*(2000), Lacerda *et al.*(2005) and Hussein *et al.*(2010). On the other hand using mixed or drainage water increased sodium concentration in both stalks and grains of sorghum. This reflects the high sodium content in such water. Thes results agree with those obtained by Shi and Cheng (2005).

Foliar application of K increased concentrations of N in stalks as well as grains. The enhancement of nitrogen concentration in both sorghum stalks and grains as reported by (Jones *et al*,.1991) may be due to strong relationship between these two nutrients for plants, where K improves the uptake and/ or utilization of ammonium nitrogen source. The enhancing effect of potassium on P, K and Ca status in plant tissues is mainly could be ascribed to K involved in the essential processes of photosynthesis and respiration as well as the movement of carbohydrates, in turn improved roots growth and nutrient uptake (Simpson, 1986). On the contrary, Na content in stalks and grains of sorghum decreased due to potassium application. In this concern Jones *et al.,* (1991) mentioned that sodium concentration in several tropical and temperate plants is reduced as K additions increased. Sodium can substitute for potassium, but the extent of this substitution is dependent on plant species and the amount of potassium present. The antagonistic relationship between K and Na has been observed by Hallmark and Barber (1981). As for putressine, the results show that putressine did not effect N, P, K, Ca and K/ Na ratio in sorghum stalks and grains. Putressine application significantly decreased sodium concentration in both stalks and grains of sorghum plants irrigated with mixed and drainage water while increased calcium concentration in grains. The decrase of sodium concentration in plant tissues may be considered the mechanism by which putressine alleviates the negative effect of irrigation with saline water. Concerning the interaction effects, the results revealed that P, K and Ca contents in sorghum tissues significantly responded to the interaction between water quality and potassium (A×B), water quality and putressine and all the studied factors. The increases in these nutrients due to potassium and / or putressine were greater in the plants subjected to salinity stress as compared with the plants under no salinity stress. Similar results were obtained by Kaya *et al.*(2001) and Hussein *et al.*(2010). The adverse effect was observed for sodium concentration, where the decreases in sodium concentration due to potassium and/ or putressine was more pronounced under saline water than fresh one.

Conclusion

It is recommend to spraying sorghum plants with 2% potassium sulphate, and 10 uM putressine solution, twice on sorghum plants irrigated with mixed or drainge water to obtained sorghum production equal to the plants irrigated with fresh water.

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"تقيم استخدام البوتاسيوم والبتروسين (١ و ٤ داى امينوبنتا داى هيدروكلوريد) فى تخفيف التاثيرات السلبية على محصول السورجم المروي بمياه رى مختلفة النوعية"

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في تجربه حقليه تم تنفيذها في منطقه كوم أوشيم قرب مدينة طاميه بمحافظه الفيوم وذلك بغرض تقييم فائدة الرش الورقى للبوتاسيوم (رش بمعدل ٢ % كبريتات بوتاسيوم مرتان) وكذلك رش البتروسين (رش محلول البتروسين بتركيز ١٠ ميكرومولار/ فدان مرتان) لتقليل الأضرار الناتجة عن رى محصول السورجم (صنف جيزه ١٥) بمصادر مياه مختلفة الملوحة (مياه عذبة من بحر وهبى ، مياه خلط بين مياه بحروهبى ومصرف البطس بنسبه ١:١، مياه صرف مصدرها مصرف البطس) وتم تصميم التجربة فى قطاعات منشقة قطاعات كاملة العشوائية في أربعة مكررات وحيث تم دراسة هذه المعاملات والتداخل بينهما على خواص التربة بعد الحصاد وعلى أنتاجية محصول السورجم ومحتوى الاوراق والحبوب من العناصر.

ويمكن تلخيص أهم نتائج هذه الدراسة كما يلي :–

- لم تحدث تغيرات فى حموضة أو ملوحة التربة نتيجة استخدام المياه العذبة، ولم يؤثر الرى بالمياه العذبة على تركيز الكاتيونات والانيونات الذائبه فى التربة ، بينما أدى استخدام مياه الخلط ومياه الصرف إلى زيادة تلك الكاتيونات والانيونات ماعدا الكربونات والبيكربونات التى لم تتأثر. ولم تتأثر نسبة امتصاص الصوديوم بالرى بالمياه العذبة بينما أدى استخدام كلا من مياه الخلط ومياه الصرف إلى زيادة معنوية فى نسبة ادمصاص الصوديوم.
- أدى استخدام المياه العذبة إلى اعلي قيم لكل من طول النبات ووزن النبات الجاف ووزن حبوب القنديل ووزن الألف حبة ومحصول الحبوب والقش وتركيز عناصر النتروجين والفوسفور والبوتاسيوم والكالسيوم ونسبة الكالسيوم إلى الصوديوم فى أوراق وحبوب السورجم يليه استخدام مياه الخلط ، بينما أدى استخدام مياه الصرف إلى اقل القيم ، فى حين ان تركيز الصوديوم فى الحبوب والأوراق قد أخذ اتجاه عكس.
- أدى رش نباتات السورجم بالبوتاسيوم إلى أعلي القيم لطول النبات ووزن النبات الجاف ووزن حبوب القنديل ووزن الألف حبة ومحصول الحبوب والقش وتركيز عناصر النتروجين والفوسفور والبوتاسيوم ونسبة البوتاسيوم الى الصوديوم فى الحبوب والقش وكذلك تركيز الكالسيوم فى الحبوب مقارنة بالمعاملة بدون البوتاسيوم. ومن ناحية أخرى أدى إضافة البوتاسيوم الى نقصان معنوى لتركيز الصوديوم فى الحبوب والقش وتركيز الكالسيوم سيقان السورجم المروى بمياه خلط او صرف مقارنة بالكنترول.
- ادى الرش بالبتروسين الى الحصول على أعلي قيم لطول النبات ووزن النبات الجاف ووزن حبوب القنديل ومحصول الحبوب والقش وتركيز عنصر الكالسيوم ونسبة البوتاسيوم إلى الصوديوم فى الحبوب والقش لمعاملة الرش بالبتروسين، بينما أدى الرش بالبتروسين الى نقصان فى تركيز الصوديوم فى الحبوب والقش وتركيز الكالسيوم فى أوراق الذرة الرفيعة مقارنة بالكنترول.
- بصفة عامة أظهرت نتائج التفاعل بين المعاملات بأن تأثير البتروسين على صفات النمو ومكونات المحصول كانت أكثر وضوحا فى حالة الرى بمياه مخلوطة أو مياه الصرف، فى حين لم توثر إضافة البتروسين على اى من صفات النباتات التى رويت بمياه النيل، وكذلك فإن معاملة الرى بمياه مخلوطة + الرش بالبوتاسيوم + الرش بالبتروسين أدت الى صفات نمو ومحصول السورجم مساو تقريبا لتلك التى رويت بمياه النيل.

ومن نتائج هذه الدراسة يمكن التوصية برش نباتات السورجم بكبريتات البوتاسيوم ٢ % مرتين مع الرش بمادة البتروسين بتركيز ١٠ ميكرومولار/ فدان مرتين فى حالة استخدام اى من مياه الخلط او الصرف للحصول على انتاج من السورجم قريب من تلك التى رويت بمياه جيده من نهر النيل.