Impact of Irrigation with Drainage Water on the Productivity of Forage Maize Grown on Calcareous Soil

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ABSTRACT

A greenhouse experiment was conducted to mitigate the deterious effect of drainage water on growth and nutrient uptake of forage maize grown on Borg ElArab calcareous soil. The soil has high $CaCo_3$ content and irrigated with well water (22.5 %) and drainage water (27.5 %). This practice increased calcium carbonate content in soils and increased electric conductivity values to 3.65 dS/m and 9.30 dS/m in soils irrigated with well water and drainage water, respectively. The obtained results indicated that the saline water have a significant effect on maize fodder, silage quality and maize plant, seed weight, plant height, root / shoot ratio.

The forage maize and maize silages yield were significantly reduced at different irrigation water treatments. The forage yield, silages index and forage index (%) also significantly reduced. The mean **forage index** was found to be 0. **36** and was not affected by **well water salinity level. In addition, the results showed that, the maize silages with lower content of crude fiber are considered as important energy source for feeding. The content of acetic acid was lower in silages at different salinity levels and the values were 25.34, 21.33, 11.27 and 11.27 S_0, S_1, S_2 and S_3. Direct cause for reduction of maize silages quality was the higher content of acetic acid.**

Keyword: saline water, forage maize, maize silages, calcareous soil

INTRODUCTION

Salinity is the major environmental stress and is a substantial constraint to crop production. Soil salinity is one of the major factors limiting plant growth and productivity (Bohnert and Jensen, 1996; Munnus, 2002; Abdelrazek S. A. E. 2014**).** Excessive accumulation of salt ions, mainly Na and Cl ions in the leaves is the major contributory factor (Hajibagheri *et al.,* 1989).

High sodium concentration in particular which deposit in the soil can alter the basic texture of the soil resulting in decreased soil porosity and consequently reduced soil aeration and water conductance (Mahajan and Tuteja, 2005). The saline growth medium causes many adverse effects on plant growth, which are due to a low osmotic potential of the soil solution (osmotic stress), specific ion effect (salt stress), nutritional imbalances or a combination of these factors (Hassanein, 2000; Ashraf, 2004).

The decrease in plant length, leaf area and number of leaves due to the increase in concentration of sodium chloride was recorded (Rui et al., 2009: Memon et al., 2010).

Many studies have shown that the fresh and dry weights of the shoot system are affected, either negatively or positively, by changes in salinity levels (Memon *et al*., 2010 and Hashem *et al*., 2013). Also, other studies confirmed the inhibitory effect of salinity on biochemical processes, such as photosynthetic process.

Forage maize is one of the most important crops in Egypt agriculture, where the irrigation is required throughout the year, mainly in semi-arid areas. The waters used for irrigation in these areas, especially well waters, are frequently saline and/or alkaline, with high concentration of Cl^- and, to a lesser extent, Na^+ (Katerji *et al*., 2001; Yazar *et al*., 2003).

The objective of this study was: to mitigate the deterious effect of saline drainage water as saline water on growth and nutrient uptake of forage maize grown on calcareous soil.

MATERIALS AND METHODS

I- Experimental Layout

The experiment was conducted in a greenhouse of in Soil Salinity and alkalinity Laboratory, Alexandria.

Experimental design was a randomized complete block design with four treatments and three replications. The treatments were well water as control treatment (S_0), one third drainage water mixed with two third well water (S_1) two, third drainage water mixed with

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Received July 25, 2016, Accepted August 25, 2016

one, third well water (S_2) and only drainage water (S_3). The plants were sown in plastic pots.

The pots were 35 (d) × 80 (L) cm dimensions and were placed in open space and filled with Borg El Arab soil.

The Borg El Arab soil was irrigated with drainage water since years ago. The control treatments soil represents adjacent farms irrigated with well water and had the same physical and chemical properties of Borg El Arab soil.

Soil samples of both regions were taken from depth of 0-40 cm and salinity were assayed. Seed of forage maize were sown (Single hybrid Shandaweel-1).

The fertilizer requirements of forage maize were added in the form of superphosphate (OSP) (15 %) and up to (10-15 kg/ha) (8-12 units/ ha) of the nitrogen (N) in the form of Urea NH_2-CO-NH_2 (46 %) required and (K) in the form of potassium sulfate K_2SO_4 (50-52%) K_2O.

In each pot when fourth leaf was appeared, the plants were thinned to three plants. Irrigation water was supplied from the upstream channel and transferred to the site of study by tank. In control treatments the pots were irrigated by well water.

The pots were irrigated every week at early period of plant growth after that the plants were irrigated three times a week.

After 14 weeks, from each treatment three plants were sampled.

The roots were removed from soil and then roots were cleaned by hand.

Samples were washed several times by tap water and then were washed with distilled water at room temperature and then were completely dried in the oven at 70° C/48 hrs. The dried plant samples were dry as had in muffle furnace at 500 °C, and then the ash was dissolved in nitric acid (Jones, 2001)

Concentrations of elements were analyzed by Atomic Absorption model PYE Unicam SP9

II- WATER SAMPLES

Well and drainage water samples were taken and stored in clean glass bottles (WPCE, 1998) for the analysis of the major contents of water. The water samples were analyzed according to the following methods:

pH was measured using Beckman's pH meter (Jackson, 1958). Electrical conductivity was measured (EC dS/m) using conductometer (Jackson, 1958).

Soluble cation and anion were according to (Page *et al.,* 1982).

SAR (Sodium Adsobtion Ratio) was calculated as:

$$SAR = \frac{[Na^+]}{\sqrt{\frac{[Ca^{2+} + Mg^{2+}]}{2}}}$$

Where Na^+, Ca^{++} and Mg^{++} refer to their concentrations in meq/l (Donahue *et al.,* 1990)

III - SOIL SAMPLING

The soil samples were analyzed according to the following methods:

Soil bulk density was determined using core sampler, as described by (Richards, 1954)

Soil hydraulic conductivity (K cm/ hr) was determined using the constant head test for disturbed coarse textured soils as described by (Baruah and Barthakur, 1997)

Mechanical analysis was determined using the pipette method, as cited by (FAO, 1970)

Electrical conductivity (EC dS/m) of the saturated soil extracts using a conductometer (Jackson, 1958).

Soil reaction (pH) of the saturated soil paste was determined using Beckman's pH meter (Jackson, 1958).

Total carbonate content was estimated volumetrically by Collin's calcimeter (Williams, 1948).

The soil physical and chemical analyses are presented in Tables (3, 4)

IV- Quality of Silage

The parameter quality of maize silages was determined in Central Laboratory for Food and Feed - Ministry of Agriculture as follows.

Content of dry matter (DM) we determined by drying of sample to constant weight by temperature 103±2 ^oC (predrying by t 60 ^oC) (Ferreira, 2002). Content of nitrogen free extract (NFE) and organic matter (OM) were calculate (NFE = dry matter-crude protein-crude fiber-fat-ash, OM = dry matter-ash) (Mertens, D.R. 2005). Crude protein was measured using the micro-Kjeldahl method, crude fat extraction by light petroleum (Ferreira, and Mertens 2005).

Ash was determined by combustion in a muffle furnace at 550 ^oC. Starch was determined by polarimetric method (Ferreira, and Mertens 2005). Crude fiber was determined gravimetrically as the residue remaining after extraction in acid and alkali (Ferreira, 2002).

Lignin content was determined gravimetrically according to (Dhiman et al., 2005) fiber content was determined gravimetrically as the residue remaining after extraction (Dhiman *et al.,* 2005).

Neutral detergent fiber: gravimetrically as the residue remaining after extraction in neutral detergent solution (Dhiman *et al.,* 2005)

Energy (NEL, NEG) and protein values (PDI) were calculated by regression Equations. Silage extracts were prepared from 200 g of sample and 2000 ml of distilled water, after 20 hours staining, contents of fermentation acids (formic, lactic, acetic, butyric, propionic) were extracted using the ionic electrophoresis method. Active acidity was determined by electrometric method. Fermentation products were calculated by count of fermentable acids without alcohols (Ferreira, and Mertens 2005).

Forage index %

The metabolisable energy (ME) concentration trait is quantified as the megajoules of metabolisable energy per kilogram of dry matter (MJME/kg DM) (Ludemann *et al.,* 2015)

Forage index % = ME/ dry matter

Statistical analysis

The experiment utilized a completely randomized design. Mean values were calculated from measurements of five replicates and standard deviations of the means were calculated. All data were subjected to Duncan's multiple range tests to discriminate significance (defined as $p < 0.05$). All data were analyzed statistically by one-way analysis of variance using the SPSS program (version 18.0) (Duncan, 1955).

RESULTS AND DISCUSSIONS

The properties of water samples were presented in Tables (1&2)

Table (1) shows the EC of Well and drainage water (1.56 dS/m and 4.92 dS/m), respectively.

The electrical conductivity of the irrigation water (EC) affected most variables related to the growth of maize plants Table (1).

In addition, there was a significant difference among treatments in Zn content in leaves and soil. In addition, the results showed significant difference among treatments in P and K concentrations in leaves (Fig 1) because of high level of these elements in drainage water (Table 2). Also there was significant difference among treatment in Fe accumulation in soil and water (Tables 2& 4).

Table (3) Shows that EC values were 3.65 dS/m and 9.30 dS/m in soils irrigated with well and drainage water respectively. This management practice causes secondary salinization in soils. These results coincided with the result of (El-Gabaly 1971)

Table 1. Chemical analysis and quality classes of irrigation water used in this study

Irrigation water	pH	EC dS/m	Soluble cations (meq / L)				Soluble anions (meq / L)				Quality classes
			Na	K	Ca	Mg	HCO_3	Cl	SO_4	SAR	
Well water	8.52	1.56	8.30	0.38	1.90	1.96	5.10	4.82	2.62	4.89	C3 - S2
Drainage water	8.81	4.92	19.40	0.15	6.10	6.82	2.50	15.90	14.08	6.29	C4 - S2
Permitted level for irrigation FAO guidelines 1976	6.5-8.4	< 3	< 70	===	==	==	< 90	< 140	==	< 9.0	

C_3: high salinity and C_4: very high salinity, S_2: medium alkalinity

Table 2. Some trace element of water used in this study

Irrigation water	N	P	K	Mn	Fe	Cu	Zn
	%	mg.kg^{-1}					
Well water	**ND**	**ND**	**ND**	**ND**	**ND**	**Trace**	**Nd**
Drainage water	0.1	0.1	0.02	108.4	142.9	0.05	1.7
Permitted level for irrigation	5	Nd	Nd	0.2	5	0.2	2

ND: not detected

Table 3. Some chemical characteristics of the soil used in this study after irrigation

Irrigation water	pH	EC dS/m	Soluble cations meq / L				Soluble anions meq / L			SAR
			Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO_3^{-}	Cl^{-}	SO_4^{--}	
Control (Well water)	8.68	3.65	2.75	1.51	13.78	0.58	2.12	12.41	4.08	9.37
Drainage water	8.68	9.30	14.88	10.00	85.40	3.62	3.30	84.66	25.94	21.08

Table 4. Fertility characteristic of soil used in this study before irrigation

Irrigation water	N	P	K	Mn	Fe	Cu	Zn	$CaCO_3$	Texture
		%			mg.kg^{-1}			(%)	
Control (Well water)	0.04	5.7	399	785.2	209.2	27.9	77	22.5	SCL
Drainage water	0.19	9.6	282	796.5	269.3	34.5	69.8	27.5	SCL

SCL: Silt Clay Loam

Table 5. Effect of different waters on metal concentrations in soil after irrigation (mg.kg^{-1})

Treatments	Cu	Mn	Fe	Zn
		mg.kg^{-1}		
S_0	47.14	528.67	24.650	51.232
S_1	56.72	874.12	6623.96	128.00
S_2	41.57	768.52	1952.00	65.13
S_3	50.74	943.41	5199.61	118.99
Maize standard		-----		

S_0: Control (well water) S_1: Drainage water and well water (1:2) S_2: Drainage water and well water (2:1) S_3: Drainage water

Table 6. Effect of different Drainage water in maize plant (mg.kg^{-1})

Treatments	N	P	K	Cu	Mn	Fe	Zn
S_0	1.26a	0.28a	3.576a	12.68a	47.58a	443.8a	29.59b
S_1	1.82a	0.25a	2.973a	14.69a	44.58a	351.07a	36.48ab
S_2	1.46a	0.14a	2.186a	11.64a	41.50a	312.32a	31.85a
S_3	0.28a	0.15a	1.863a	4.64a	38.68a	265.18a	24.87b

Within each column followed by the same letter are not significantly differences ($p < 0.05$)

S_0: Control (well water) **S_1:** Drainage water and well water (1:2) S_2**:** Drainage water and well water (2:1) **S_3:** Drainage water

Table (4) illustrated that $CaCo_3$ content are higher in soils irrigated with well water (22.5 %) and drainage water (27.5 %). This practice may increase calcium carbonate content in soils and increase area of calcareous soils (Balba, 1981).

Trace element concentrations were significantly increased in leaves of maize plants irrigated with well and/ or drainage waters. This was due to high concentration of trace elements in irrigation water sources (Table 6 and Fig 1). These results coincided with the results of Gaui, *et al.,* (1997)

The first effect of salts is reducing the ability of plants to absorb water (osmotic effect), which leads to slower growth; second, salts may enter the transpiration stream and injure leaf cells, further reducing growth (Munns, 2005 and Mohamed Fattah and Abdelrazek, 2014).

The high concentration of Na^+ and Cl^- in soil solution is generally the main cause of the saline stress (Hasegawa *et al*., 2000) and the consequent slower growth is an adaptive feature for plant survival because it allows plants to rely on multiple resources to combat stress.

Using the 1.56 dS m^{-1} treatment as reference, the seed weight and plant height was higher than the 100 cm per plant (well water) found by (Hasegawa *et al.,* 2002) and are in agreement with (FAO, 1973) who found seed weight and plant height values varying from 112 to 181cm per plant for different hybrids (Table 7). In contrast for 4.92 dS m^{-1} (drainage water), plant height recorded 127.38 cm.

But 154 cm, which was lower than 188 cm, was recorded by Katerji *et al*., (2001).

There were expected differences of root to shoot ratio because the root to shoot ratio depends on several variables like soil fertility, meteorological conditions, plant density and genetic characteristics of cultivars and hybrids (FAO 1973).

The salinity of irrigation water delayed the growth of plants, with reduction of the root to shoot ratio (Table 7)

Irrigation with saline water did not supply nutritional elements and thus not improved plant growth characteristics. Studying the effects of water salinity on maize, showed that, there was significant difference among treatments in plant dry weight, root weight, stem weight, plant height, seed weight and root to shoot ratio at 0.01 probability level (Table 7). Comparison of means related saline water that application significantly decreased plant height, seed weight, root weight, stem weight and total plant weight (Fig 2). Decrease of root volume as results of saline water application can be due to direct effects of organic substances in wastewater (Fig 2).

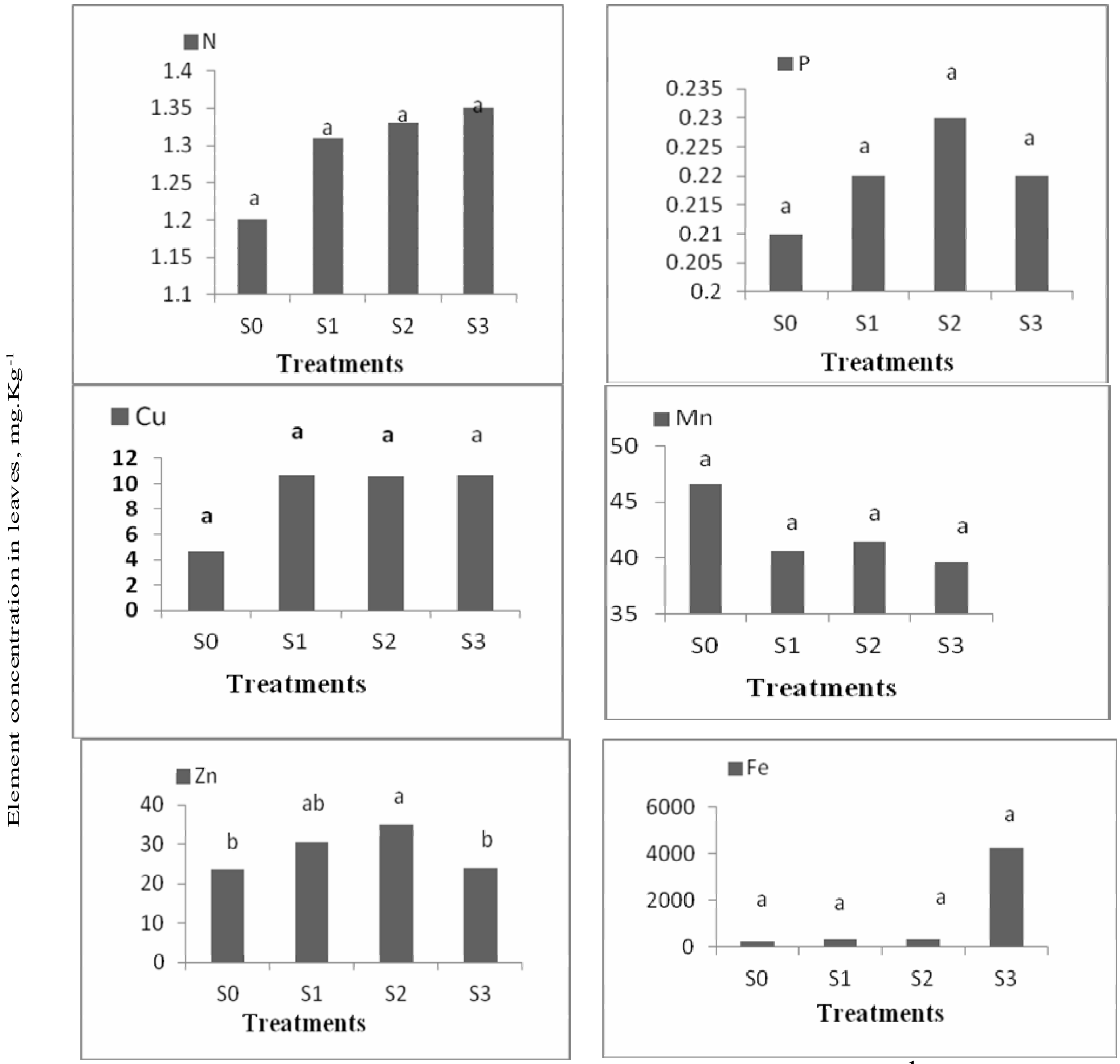

Fig 1. Effect of different drainage water on elements N (%), P, K ($mg.kg^{-1}$) and salinity in maize plant

Table 7. Effect of Drainage water on morphological traits of maize

Treatments	Seed weight (g)	Plant height (cm)	Root / shoot ratio
S_0	18.59a	225.54a	0.350a
S_1	17.90a	189.97a	0.189a
S_2	17.87a	182.06a	0.185a
S_3	6.98b	127.38b	0.145b

Within each column followed by the same letter are not significantly differences ($p < 0.05$)

S0: Control (well water) S_1: Drainage water and well water (1:2) S_2: Drainage water and well water (2:1) S_3: Drainage water

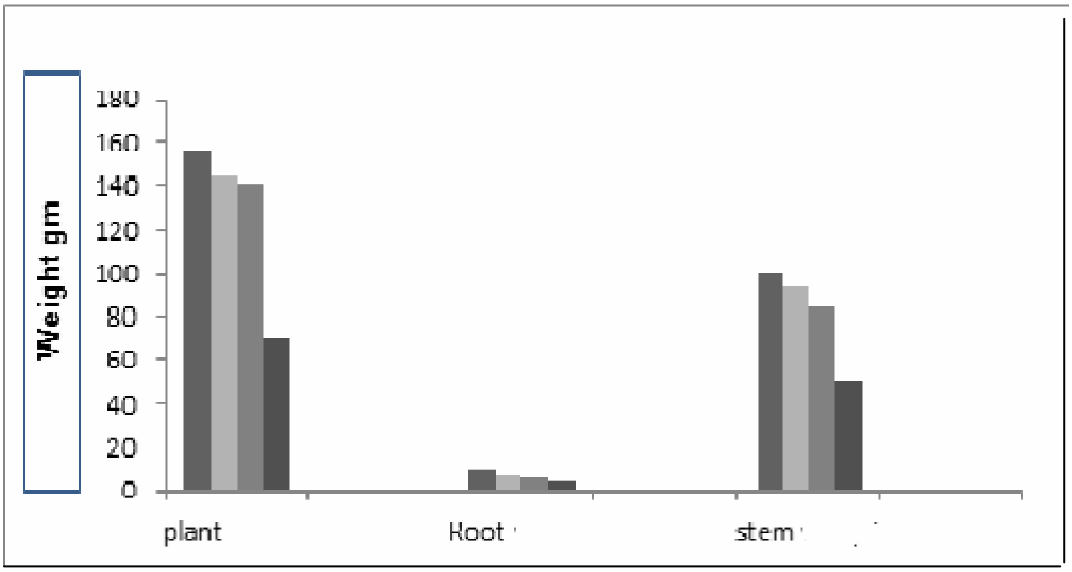

Fig. 2. Effect of different irrigation waters on dry weight of maize plant tissues

The large amount of salts introduced to soil after irrigation with drainage water reduced the yield and sometime makes impossible for crop production. Once the soils are saline the recommended method for reclamation is leaching the soils and providing the drainage facilities and controlling these factors responsible for secondary salinization of soil. This is widely used practice in many parts of the world. But the success of leaching depends upon the quality of leaching water, amount and kind of salts and their distribution in the soil profile and water movement properties of soils. Mahdy *et al.,* (2012) suggested that antioxidants can improve growth and nutrients content of corn plants grown under moderate to high salinity and/or water deficit stresses.

On the other side Fathi and Goafer, (2015) revealed, to seed priming technique in saline media to increase germination and early growth of corn seeds.

The cultivated area of forage maize (Nile and summer season) 222.531fed (93.461 Ha)

The nutritional value of 4 kg maize silage equal one kg feed so, must if you use 50% of silage in the feed provided by the combination may help in reducing the cost in the range of 20-25%.

In Table (7) illustrated the forage maize and maize silages yield (Ton Fed^{-1}) at different irrigation water treatments.

The EC reduced forage yield, silages index and forage index % (Table 8). The mean forage index % was found to be 0. 36 and was not affected by well water salinity level. This is in accordance with (Yazar *et al.,* 2003)

For maximization maize ,silage production, early planting and adequate populations, soil fertility, row spacing, hybrids, crop rotations, soil management and dry matter measurements at harvest are necessary (Tenison 2007, 2009)

Salinity negatively affects the root distribution and thus affects the plant's ability to use the elements

Accumulation of macro and micro elements in plant tissues after irrigation with well and / or drainage water revealed that irrigation water treatment significantly affected concentration of element in soil and plant (Table 5 & 6)

Table 8. Effect of Drainage water on maize plant productivity

Treatments	forage maize yield (TonFed^{-1})	maize silages yield (TonFed^{-1})	forage index %	silages index %
S_0	12	18	36	67.3
S_1	9	15	28	52.4
S_2	6.5	11	20	27.3
S_3	5	9.5	15	28
L.S.D	1.6	3.3	---	----

S_0: Control (well water) S_1: Drainage water and well water (1:2) S_2: Drainage water and well water (2:1) S_3: Drainage water

Table 9. Bio concentration factor of some elements and salinity from soil to maize plant under salinization

Treatments	Cu	Mn	Fe	Zn
S_0	0.269	0.09	0.18	0.577
S_1	0.259	0.051	0.053	0.285
S_2	0.28	0.054	0.16	0.489
S_3	0.19	0.041	0.051	0.209
Maize standard		-----		

S_0: Control (well water) S_1: Drainage water and well water (1:2) S_2: Drainage water and well water (2:1) S_3: Drainage water
Bio concentration factor = microelement value in plant/ microelement value in soil

The accumulation of trace elements, bio concentration factor (BCF) of some elements from soil to maize plant under salinization are presented in Table (9) BCF of Cu were 0.269, 0.28, 0.259 and 0.19, For Mn 0.09, 0.054, 0.051 and 0.041, For Fe 0.18, 0.16, 0.053 and 0.051 and For Zn 70.577, 0.489, 0.285 and 0.209 at S0, S2 and S1 and finally S3 treatments, respectively Table (9).

Bio-concentration factor in Table (9) was calculated from Table (5) and Table 6 had illustrated effect of different drainage water in maize plant and soil.

The quality of maize silages

Salinity is abiotic factor that limiting plant growth, productivity and quality of maize silages.

Dry matter (DM) content of maize silage depends greatly on the maturity of the maize at time of harvest often reflecting the proportion and development of kernels in the silage (Kolver *et al.,* 2001). Maize silage provides important source of energy in the form of starch and fibre fractions for dairy cattle sheep nutrition (USDA, 2013). In the present study the average dry matter content (157.87g.kg^{-1}) was recorded at So (Table 10).

Also, the highest was observed at so starch (341.90) content of acid detergent fiber and neutral detergent fiber were observed at So. The value of net energy of maize silage were very similar (5.36, 4.21, 3.22. and 5.37) at S0, S_1, S_2, and S3 respectively

In comparison with silages produced maize plants irrigation with different water from these treatments, lower content of ash in silages was observed at S_2 (12.6) Thus, it should be taken to consideration that these types of water can be used to produce safety silages material has high quality and productivity Table 10 these result reached by(Bosworth, 2006) It is reported that all maize silages with lower content of crude fiber are considered as important energy source crop for feeding (Jung et al 1998). The silage hybrid, dry matter content, addition of additives technological silage making and method of unloading silage affects the quality of maize silage (summers, 2001)

Content of acetic acid was lower in silages at different salinity levels and the values were 25.34, 21.33, 17.21 and 11.27 S_0, S_1, S_2, and S_3 respectively (Table 12). Direct cause for reduction of maize silages quality was higher content of acetic acid (Biro, 2002).

Table 10. Nutritive value of maize silages in (g.kg^{-1}) of dry matter

Treatments	S_0	S_1	S_2	S_3	S.D
			parameters		
			x		
dry matter	157.87	140.00	112.86	94.30	3.30
crude protein	85.65	65.98	35.86	0.94	0.84
crude fat	36.17	37.52	20.8	19.80	0.40
crude fiber	199.57	27.78	16.98	177.52	0.75
acid detergent fiber	247.97	234.9	112.9	239.16	45.60
neutral detergent fiber	422.61	123L8	119.8	410.34	38.71
ash	29.75*	16.86	12.6	25.38*	1.93
nitrogen free extract	669.80*	99.4	87.8	569.90*	3.95
starch	341.90	143.8	131.9	234.61	28.66
organic matter	890.15*	782.78	699.98	870.15*	1.47

S_0: Control (well water) S_1: Drainage water and well water (1:2) S_2: Drainage water and well water (2:1) S_3: Drainage water
X: mean, S.D.: standard deviation, *the values with identical superscripts in row are significantly different at $P<0.05$

Table 11. Energy and protein value of maize silages NEL, NEG in $MJ.kg^{-1}$ of dry matter and PDIN, PDIE in $g.kg^{-1}$ of dry matter

Treatments / parameters	S_0	S1	S_2	S_3	S.D
			x		
NEL	5.36*	4.21	3.22	5.37*	0.03
NEG	5.28	4.32	3.24	5.25	0.03
PDIN	34.37	29.43	27.65	21.14	2.43
PDIE	46.39	29.34	28.54	46.85	2.16

NEL: net energy of lactation, NEG: net energy of gain, PDIN: protein digestible in intestine when degradable N is limiting microbial protein synthesis in the rumen, PDIE: protein digestible in intestine when rumen fermentable energy (organic matter) is limiting microbial protein synthesis in the rumen, X: mean, S.D.: standard deviation, *the values with identical superscripts in column are significantly different at P<0.05

MJ: Millijoules/ kilogram

Table 12. Fermentation products in maize silages in ($g.kg^{-1}$) of dry matter

	Treatments				
	S_0	S_1	S_2	S_3	S.D
parameters					
			$\bar{x}$		
formic acid	0.82	0.79	0.72	0.75	0.92
lactic acid	43.18	13.26	12.13	34.19	15.70
acetic acid	25.34	21.33	17.21	11.27	9.02
propionic acid	2.16	0.82	0.71	2.02	1.24
butyric acid	0.00	0.00	0.00	0.00	-
Fermentation products	78.11*	23.47*	14.67*	63.57*	19.18
pH	2.79	1.88	0.98	2.97	0.15

x: mean, S.D.: standard deviation

*the values with identical superscripts in column are significantly different at P<0.05

CONCLUSION

From the previous data, it could be concluded that the electrical conductivity of the irrigation water (EC) affected most variables related to the growth of maize plants and types of water can be used to produce safety silages material with high quality and productivity.

These also help in reducing saline water use without treatment in maize fodder irrigation and production at the national level. Therefore, it is recommended that to study water irrigation quality and calcareous soil before forage maize planting. Acetic acid was lower in silages at different salinity levels and the values were 25.34, 21.33, 11.27 and 11.27 S_0, S_1, S_2 and S_3. Direct cause for reduction of maize silages quality was higher content of acetic acid.

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الملخص العربي

اثر الرى بمياه الصرف الزراعي على إنتاجية نبات ذرة العلف كسيلاج والمزروع في تربة جيرية

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تهدف هذه الدراسة إلى تخفيف الأثر الضار للمياه ذات الملوحة المرتفعة وذلك على النمو وامتصاص المواد الغذائية عن طريق الذرة الرفيعة المستخدمة كعلف وكسيلاج والمزروعة في ارض جيرية.

يعتبر ارتفاع تركيز الصوديوم والكلوريد في محلول التربة ويعتبر السبب الرئيسي للإجهاد الملحي، ويترتب على ذلك بطء النمو، وظهور التكييف لمقاومة الإجهاد الملحي، وتعتمد النباتات على طرق متعددة من اجل مقاومة الإجهاد.

استخدم في هذه الدراسة ذرة علف صنف شندويل-١ والذي يزرع عادة في منطقة برج العرب واهم خصائص التربة بها ارتفاع نسبة كربونات الكالسيوم وقد وجد أن الأراضي المروية بمياه الآبار (كونترول) تحتوى ٢٢,٥% أما نسبة كربونات الكالسيوم في الأراضي المروية بمياه الصرف تحتوى ٢٧,٥% وكانت قيم التوصيل الكهربائي لهذه الاراضى ٣,٦٣ dS/m، ٩,٣٠ dS/m وملوحة مياه الرى ابار ١,٥٦ dS/m، ٤,٩٢ dS/m على التوالى.

واظهرت النتائج ارتفاع قيم عنصرى الفوسفور والبوتاسيوم فى اوراق النباتات ووجود فروق معنوية بين المعاملات وخاصة فى العناصر الغذائية الصغرى وذلك عند مستوى معنوية اقل من ٠,٠١ ويرجع ذلك الى وجودها بمستويات عالية فى التربة ومياه الرى.

وتاثير الاملاح هذا يحد من قدرة النباتات على امتصاص الماء وبطء النمو ويؤثر على النتح وخلايا الاوراق.

كما يؤدى إرتفاع الملوحة وتراكم العناصر الى خفض الإنتاجية فى محصول الذرة ومؤشر السيلاج ومؤشر العلف كما يؤثر ارتفاع الملوحة على معامل انتقال العناصر وكانت ترتيبها فى المعاملات كالتالي $S_0>S_1>S_2>S_3$.

وفى النهاية تنخفض كمية حمض الخليك كمؤشر هام لجودة السيلاج تحت تاثير الملوحة مقدرا بالجرام لكل كيلو جرام مادة جافة كالاتى ٢٥,٣٤، ٢١,٣٣، ١٧,٢١ واخيرا ١١,٢٧ وذلك في المعاملات $S_0>S_1>S_2>S_3$ على التوالي والسبب المباشر لسوء جودة السيلاج على وجه الخصوص انخفاض كمية حمض الخليك وتأثير جودة مياه الري، حيث أوضحت الدراسة أن استعمال الماء المالح في الري يؤدى إلى تراكم مجموع الأملاح الذائبة في التربة.

الكلمات الدليلية: مياه الصرف الزراعي، مياه الارتوازي علف الماشية، السيلاج، أراضى الجيرية.