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Response of Allium Crops to Nitrogen Fertilization Rates and Different Irrigation Water Sources

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TWO field experiments with onion and garlic were carried out on clay loam soil under different water sources (i.e. fresh, drainage and mixed) in interaction with four rates of N (30%; 45 and 60 kg N fed^{-1}, 60%; 90 and 120 kg N fed^{-1}, 90%; 135 and 180 kg N fed^{-1} and 120%; 180 and 240 kg N fed^{-1} of the recommended rate for onion and garlic, respectively) to assess its effects on growth attributes and yield as well as following up the changes of some soil chemical properties after the growing seasons. The side effect of using low water quality on soil properties and water relations was also traced. Drainage and mixed water significantly increased the EC, pH and sodium adsorption ratio (SAR) of the soil under both crops comparing to the fresh water. This was more vigorous under 120% nitrogen rate. In soil irrigated with fresh water, EC were decreased by ~ 26.5% under the initial level on base of over all mean of nitrogen treatments. The low quality waters reflected decrements in EC values by about 10.6% under initial and increments by about 9.7% over the initial for mixed and drainage water, respectively. In meanwhile, the SAR values increased after growing seasons with all water sources, and it affected by water quality where it increased as the low water quality applied, whereas it recorded the highest value with drainage water followed by mixed water. Additionally, the application of 60 and 90% reveal a slight increase in soil chemical properties as the mixed and drainage water were used. Fresh water treatment increased growth and crop yields for both garlic and onion compared to mixed and drainage water treatments. Increasing N rate from 30 up to 120 % of the recommended N rate significantly increased garlic yield by 53.9% and onion yield by 16.3%. The highest WUE for onion (7.44 and 6.79 kg m^{-3}) and for garlic (3.33 and 3.00 kg m^{-3}) resulted from 120 % of the recommended N rate with fresh and mixed water, respectively.

Key words: Soil Chemical properties, Onion, Garlic, WUE, Low water quality

Introduction

Onion and garlic are of the most important vegetable and spice crops grown in Egypt and worldwide (FAOSTAT, 2014). In arid and semi arid regions, onion and garlic production is entirely dependent on irrigation (Halvorson et al., 2008 and Mohammadi et al., 2010) along with balanced application of plant nutrients, where onion and garlic are heavy feeders, extract nutrients from the soil to met the crop requirement which results in depletion of essential nutrients from the soil native reserves (Thangasamy et al., 2018). In Egypt, plans have been made to conserve fresh water using technological development tools. One of these tools is the re-use of drainage water in irrigation, either directly or alternatively with fresh irrigation water under suitable irrigation

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system. Many investigators have studied the influence of irrigation by different water sources on soil properties and irrigation efficiencies (Karajeh et al., 2013). In arid and semi-arid regions, low quality of irrigation water with excess salt produced soil salinity, alkalinity and changes its physical properties (Elwan and Kandil, 1992) as well as the osmotic relationship between plant root and soil moisture, which negatively affect plant growth and yield (Malash et al., 2005 and Nahid et al., 2008), so quality assurance is the major driver for irrigation to provide demand by the major retailers (Knox et al., 2010).

Nitrogen element play a vital role in increasing onion and garlic growth attributes like the number of leaves, leaf length, plant height, bulb size and other quality traits as well as yield. Crop response to N fertilization can be expressed in terms of higher yield and improved crop quality (Gulser, 2005). Garlic has a high N requirement, particularly in the early growth stage; the highest yield was obtained with high N application of 300 kg N ha^{-1} (Sardi and Timer, 2005). Also, Maryam et al. (2012) and Tibebu et al. (2014) indicated an increase of length and number of leaves and fresh bulb yield of garlic and onion with increasing N rate from 60 up to 180 kg ha^{-1}, while El-Hifny (2010) found that bulb fresh weight significantly increased by 17.6 and 21.5% along with increasing N application from 80 up to 120 kg ha^{-1} in the two growing seasons. Fatideh and Asil (2012) evaluate the different water (0.50, 0.80, 1.10 and 1.40 pan evaporation "PE") and nitrogen regimes (50,100 and 150 kg ha^{-1}) for quality onion production and found that irrigation at 1.40 PE and nitrogen at 150 kg ha^{-1} produced high bulbs and dry matter yield.

This work aimed to evaluate the potential of alternative water sources like drainage and mixed waters against the fresh one in conjunction with different nitrogen fertilizer rates on some soil chemical proprieties, water relations, growth and yield of onion and garlic grown under conditions of King Maryout region, Egypt.

Materials And Methods

Experimental site and soil properties

Field experiment was carried out in clay loam soil located at the Experimental Farm of King Maryout, Alexandria Governorate, Egypt (30° 59` 5˝N, 29° 48` 45˝E and 9 m above sea level (asl), during 2016 / 2017 season with an average annual temperature of 24.8 ^{0}C and annual precipitation of 30-150 mm. Physical and chemical analysis of different soil depth of the experimental site are presented in Tables 1 and 2 according to Jackson (1973).

TABLE 1. Soil physical characteristics and irrigation waters chemical properties

Character	Soil Depth (cm)			Character	Composition of irrigation water		
	(0–30)	(30–45)	(45–60)		Fresh	Mixed	Drainage
Sand (%)	42.59	27.74	40.04	pH	8.00	8.11	8.23
Silt (%)	26.39	34.86	29.18	EC (dS m^{-1})	0.72	1.42	2.54
Clay (%)	31.02	37.40	30.78	CO_3^{--}	–	–	–
				HCO_3^-	1.73	1.96	5.54
Field capacity (%)	20.67	31.63	23.71	CL^-	0.75	9.71	14.00
				SO_4^{--} (meq.L^{-1})	4.92	3.33	5.98
				Ca^{+2}	2.97	3.25	5.88
Wilting Point (%)	9.26	15.67	11.83	Mg^{+2}	0.56	2.80	3.20
				Na^+	3.55	8.47	15.84
				K^+	0.32	0.48	0.60
Available water (%)	11.41	15.96	11.88	SAR	2.67	4.87	7.43
				Adj. SAR	5.21	10.96	21.18

TABLE 2. Soil chemical properties

Soil Depth (cm)	Anions (meqL^{-1})				Cations (meqL^{-1})				SAR	EC (dS m^{-1})	pH
	$CaCO_3$ g. 100 g^{-1}	HCO_3^-	CL^-	SO_4^{--}	Ca^{++}	Mg^{++}	Na^+	K^+			
0-30	54.24	4.63	22.29	3.54	6.35	6.59	16.9	0.62	6.64	3.1	8.02
30-45	68.41	4.68	22.8	7.1	7.89	8.9	17.02	0.77	5.87	3.4	8.24
45-60	85.32	4.74	25.02	12.1	13.64	9.65	17.98	0.59	5.27	4.2	8.51
Mean	69.32	4.68	23.37	7.58	9.29	8.38	17.30	0.66	5.92	3.56	8.25

Experimental treatments

Water sources: Three water sources, fresh (Nile water), mixed (50 Nile/50 drainage) and drainage water. Chemical analyses of irrigation water sources are presented in Table (1). Where the total applied water for onion were; 2275, 2415 and 2885 m^3, and for garlic were; 2050, 2210 and 2330 m^3 for fresh, mixed and drainage water treatment, respectively.

Nitrogen fertilization: Four nitrogen rates, 30% (45 and 60 kg N fed^{-1}), 60% (90 and 120 kg N fed^{-1}), 90% (135 and 180 kg N fed^{-1}) and 120% (180 and 240 kg N fed^{-1}) of the recommended N rate (150 and 200 kg N fed^{-1}) for onion and garlic, respectively.

Experimental design, plantation and some agricultural practice

Split plot design with three replicates was used; water sources were arranged in the main plot and nitrogen fertilizer rates in the sub plot. Garlic was planted on October 1st as well as onion was transplanted on November 20th. Two meters were left between each two experimental plots as a guard distance to avoid the overlapping or the interactions and seepage of irrigation water. Urea (46% N) as nitrogen source was applied in application with four rates. The cultivated area for each crop was 150 m^2 (5 * 30 m) included 36 plots with area of 4.1 m^2. All agronomic techniques, agricultural practices and fertilizer rates were applied as recommended. Onion was harvested on April 5th while garlic harvested on May 1st.

Studied traits

Soil chemical properties after harvesting

Soil chemical analyses were determined as the difference between the mean values of the chemical analysis of soil extract 1:1 before cultivation (initial status) and after harvesting (final status).

Soluble cations (Ca^{+2}, Mg^{+2}, Na^+ and K^+) and anions (CO_3^{-2}, HCO_3^- and Cl^-) were determined according to Black (1965). Soil pH, Electrical conductivity (EC) and $CaCO_3$ were determined according to USDA, 2014.

Growth traits

Fifteen plants from each experimental plot were randomly selected in two weeks before harvest to measure the vegetative growth attributes, *i.e.* plant height and leaf number.

Yield

At harvest, all plants of each treatment were harvested and the total yield per feddan was recorded.

Water measurements

Irrigation requirement,

Irrigation water requirement for both onion and garlic was calculated using the weather data at King Maryout Weather Station as follows:

Crop consumptive use was calculated according to Doorenbos and Pruitt (1977):

where:

Et_c = crop consumptive use, mm day^{-1},

Et_0 = reference evapotranspiration, mm day^{-1} and

K = crop coefficient (dimensionless) for onion and garlic crops was used according to FAO (1994).

Reference evapotranspiration (ET_0) was calculated according to ET_0 calculator program.

Applied irrigation water was calculated according to Vermeiren and Jobling (1980).

where:

IR= applied irrigation requirement, m^3 fed^{-1} irrigation,

LR= leaching requirement, % and equal ECi/2ECd

ECi=salinity of irrigation water, dS m^{-1},

ECd= salinity of drainage water, dS m^{-1},

Ea= application efficiency, % and

I= irrigation intervals, days

Amount of irrigation water was calculated based on the crop evapotranspiration (Etc mm/day) using FAO CLIMWAT 2.0 P.M. method (CROPWAT program, Smith, 1992).

Rectangular weir was used for measuring the amount of water applied to each treatment using the equation given by Masoud (1967).

where:

Q = Discharge, m^3 min^{-1}

C = an empirical coefficient that must be determined from discharge measurements

L = Length of the crest, m

H = Head above the weir crest, m

Water Use Efficiency (WUE)

The water use efficiency was calculated according to Jensen (1983) as follows:

Economic evaluation

1- Costs; including the costs of network, irrigation, labors, transplant of seed, fertilizers and pesticides.

2- Gross Return; including the prices in Egyptian Pound (LE) which paid for the harvested of onion and garlic yield (ton fed^{-1}).

3- Net Return = Gross return – Costs.

The average prices of were taken from the local market prices. Economic evaluation was done using the methods described by CIMMYT (1988).

Statistical analysis

The obtained data were subjected to statistical analysis of variance of split plot design according to the procedures outlined by Snedecor and Cochran (1980). Comparison among treatment means was done using L.S.D at 5% level of significance according to Steel and Torrie (1980). All statistical analysis was performed by using analysis of variance technique of (Mstat-C, 1989) computer software package.

TABLE 3. **Average soil chemical properties after Onion irrigated with varied water sources**

Water Source		Fresh				Mixed				Drainage			
N Rate %		30	60	90	120	30	60	90	120	30	60	90	120
Anions ($meq.L^{-1}$)	CO_3^{--}	–	–	–	–	–	–	–	–	–	–	–	–
	HCO_3^-	3.22	3.25	3.28	3.87	4.56	4.89	4.97	5.53	4.59	5.38	4.78	4.79
	CL^-	17.00	17.58	18.44	18.98	20.41	21.06	24.56	26.3	26.45	33.22	24.12	24.10
	SO_4^-	3.74	3.99	4.12	4.88	11.96	15.93	7.94	9.90	8.66	9.40	6.64	5.89
Cations ($meq.L^{-1}$)	Ca^{++}	4.98	5.21	5.64	6.67	8.12	8.75	6.98	6.99	8.13	10.88	6.69	6.33
	Mg^{++}	4.47	4.62	4.77	5.24	9.31	11.45	7.90	9.59	10.37	10.99	7.50	6.12
	Na^+	14.12	14.54	14.91	15.21	18.89	21.02	21.90	24.53	20.70	25.54	20.79	21.78
	K^+	0.39	0.45	0.52	0.61	0.61	0.66	0.69	0.62	0.50	0.59	0.56	0.55
EC ($dS.m^{-1}$)		2.40	2.48	2.58	2.77	3.69	4.19	3.75	4.17	3.97	4.80	3.55	3.48
SAR		6.50	6.56	6.54	6.23	6.40	6.61	8.03	8.52	6.81	7.72	7.81	8.73
pH		8.28	8.32	8.44	8.47	8.64	8.55	8.70	8.97	8.63	8.72	8.81	8.91

Results and Discussion

Soil chemical properties

Data presented in Tables 3 and 4 depict the results of chemical properties of soil samples after onion and garlic crops irrigated with fresh, mixed and drainage water.

The soil profile irrigated with fresh water reflected decreases in average values of electric conductivity (EC) after growing season by ~ 33 % from the initial level over all the nitrogen treatments. In spite of, the fresh water treatment achieved the highest salt leaching. Similar findings were found by Abo Soliman et al. (2001) whom they confirmed that the long term applying of fresh water leached about 47% of the soil salts while the continuous use of low quality water leached lower amounts of salts than those recorded with fresh water.

Substantially, the soil profile irrigated with mixed and drainage water revealed relative increase in soil EC accounted for 17.69 and 34.83% with mixed and drainage water, respectively, with increase of nitrogen rate, as the mixed and drainage water, accumulated salts as a result of salt loads. These finding were in agreement with Ould Ahmed et al., (2010); Choudhary et al. (2004), and Arora et al. (2012) whom they found that the existence of anions and cations in irrigation water can lead to increases in the EC. Regarding ~~to~~ the nitrogen application, the lowest values of EC were observed with 30% of nitrogen rate and the highest values were with 120% over all water sources.

Values of SAR after growing season were increased with all water sources. Use of drainage water increased the values of SAR by 50.1%, 52.7% and 72.5% from the initial soil SAR, followed by mixed water by 19.0%, 78.4% and 58.8%, then by fresh water ~~by~~ which accounted for 16.0%, 17.6% and 17.1% irrespective of to the rate of nitrogen. The lowest value was recorded with fresh water (6.23 %) under the application of 120%. This could be a result of increasing the availability of Ca^{++} due to the high amount of applied urea, where the highest value (8.73 %) was observed with drainage water under the same rate of N application.

Soil pH values were fluctuated among the all treatments, it increases of by 0.21, 0.65 and 0.71 as affected by fresh, drainage and mixed water, respectively, under the highest application of urea (N). The maximum value of soil pH (8.97) was recorded under mixed water in combination with 120% of the N recommended rate followed by (8.91) under drainage water ~~also~~ under the same N rate. Our findings were in agreement ~~d~~ with Minhas and Bajwa (2001) and Jalali and Ranjbar (2009) whom they reported that the existence of cations and anions such as Na^+, HCO_3^- and Cl^- (15.84, 5.54 and 14.00 meL^{-1}) in irrigation water can lead to increases in the soil pH.

The same tendency, with somewhat different, of EC behavior were observed in soil profile after the garlic growing season compared to onion (Table 4). The EC values in soil profile

TABLE 4. Average soil chemical properties after Garlic irrigated with varied water source

W Source		Fresh				Mixed				Drainage			
N Rate %		30	60	90	120	30	60	90	120	30	60	90	120
Anions ($meq.L^{-1}$)	CO_3^{--}	–	–	–	–	–	–	–	–	–	–	–	–
	HCO_3^-	3.26	3.29	3.22	3.99	4.53	4.96	5.97	6.21	7.21	7.37	7.06	6.98
	CL^-	18.87	18.97	18.18	18.78	20.91	20.65	21.02	22.21	23.21	25.10	26.1	26.80
	SO_4^-	3.70	4.21	4.01	3.78	5.83	5.35	5.55	5.9	10.99	11.03	12.45	10.00
Cations ($meq.L^{-1}$)	Ca^{++}	5.42	5.3	6.82	6.84	8.74	7.03	7.45	7.99	10.2	9.6	9.87	7.5
	Mg^{++}	4.71	5.79	4.12	5.22	6.78	7.12	8.01	8.87	9.52	10.3	11.9	8.73
	Na^+	15.23	14.86	14.05	14.09	15.14	16.13	16.4	16.76	20.98	22.91	23.14	26.9
	K^+	0.47	0.52	0.42	0.40	0.61	0.68	0.68	0.70	0.71	0.69	0.70	0.65
EC ($dS.m^{-1}$)		2.58	2.65	2.54	2.66	3.13	3.10	3.25	3.43	4.14	4.35	4.56	4.38
SAR		6.77	6.31	6.01	5.74	5.43	6.06	5.90	5.77	6.68	7.26	7.01	9.44
pH		8.12	8.22	8.28	8.37	8.45	8.56	8.72	8.80	8.55	8.69	8.77	8.86

after garlic growing season were higher than that observed in soil after onion growing season. The maximum values of EC in soil profile recorded 2.66, 3.43 and 4.38 dS m^{-1} for fresh, mixed and drainage water, respectively, where it increased with increasing N rates, this might be due to the lower amount of applied water and the higher amount of N application in garlic (Sardi and Timer, 2005) comparing to those applied with onion. Also, the amount of salt accumulated in soil profiles irrigated with mixed and drainage water was higher after garlic growing season than those accumulated in soil profile after onion growing season which irrigated with the same water due to the low evidence of leaching. Schoups, et al. (2005) and Geerts, et al. (2008) concluded that one effect of reducing irrigation water use is the larger danger of increased salinity of soil as result of reduced leaching.

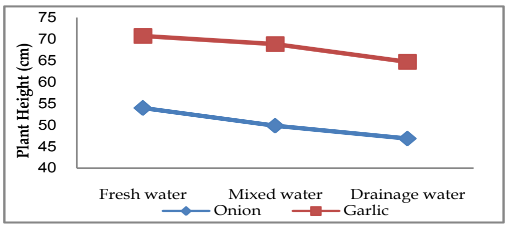
It is worth noticed that the values of SAR in soil profiles after garlic growing season were lower than those observed after onion growing season with somewhat exception (9.44%) under the N application of 120% from the recommended rate. In this respect, using the mixed water along with different rates of N recorded the lowest values of SAR, this might have been attributable to the loaded amount of salts within the mixed water caused the high amount of available Ca^{++} and remove part of Na^{+}.

Regarding the soil pH, the values were fluctuated among all the treatments, but still lower than those detected after onion growing season. It was true with some exception (8.72) under the soil irrigated with mixed water which received 90% N of the recommended rate.

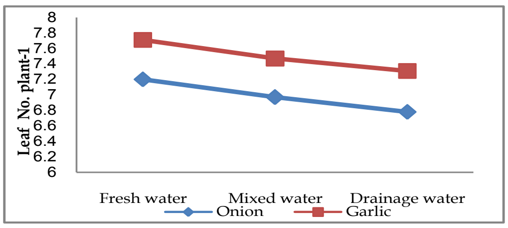
Growth and total yield of garlic and onion crops

Water sources significantly affect plant height, leaf number and total yield of both garlic and onion crops, except garlic plant height (Fig. 1). As reported by Perezortola and Knox (2014) that onion is one of the most saline sensitive crops with yields to decreased when EC_e values rise above 1.2 dS m^{-1} that's consist with the present results where fresh water resulted in the highest values of plant height and leaf number which consequently affect the total yield of onion and garlic crops, followed by mixed water. On the other hand, the lowest values resulted with drainage water treatment. It's worth noting that the depression in yields was 3.7 and 3.5% for garlic and onion, respectively as affected by irrigation with mixed water. Use of drainage water decreased garlic and onion yields by about 18.4% and 29.2%, respectively.

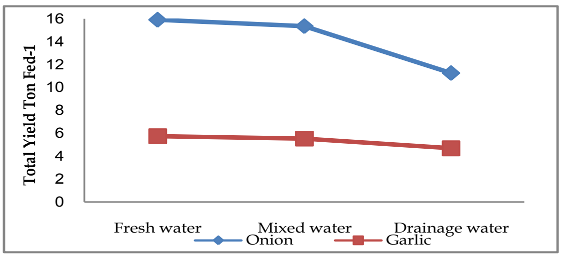
Data in Fig. 2 indicated significant differences among nitrogen rates ~~in~~ when plant height, leaf number and garlic and onion yields were concerned. Similar findings were reported by Ncayiyana et al. (2017) whom found that increase of N fertilization rate had a positive effect on plant height and leaf development of onion plants.



Means in the same column followed by the same letter are not significantly different at $p \leq 0.05$, L.S.D. $_{at\ 5\%}$ for onion 3.44 and for garlic N.S.

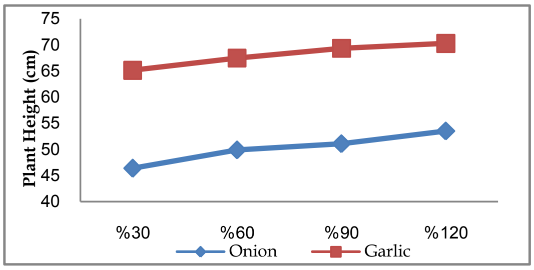


Means in the same column followed by the same letter are not significantly different at $p \leq 0.05$, L.S.D. $_{at\ 5\%}$ for onion 0.31 and for garlic 0.38.

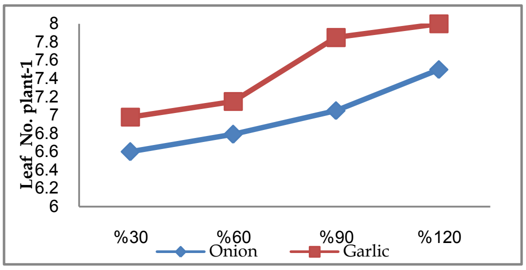


Means in the same column followed by the same letter are not significantly different at $p \leq 0.05$, L.S.D. $_{at\ 5\%}$ for onion 0.58 and for garlic 0.85.

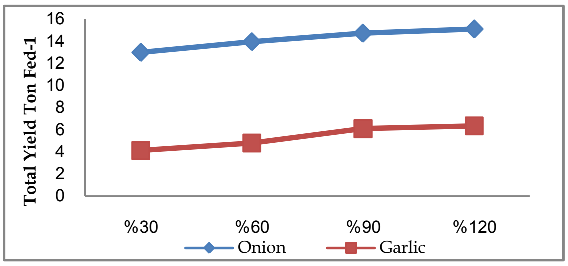
Fig. 1. Growth attributes and yield of onion and garlic as affected by varied water sources



Means in the same column followed by the same letter are not significantly different at $p \leq 0.05$, L.S.D. $_{at\ 5\%}$ for onion 4.79 and for garlic 3.72.



Means in the same column followed by the same letter are not significantly different at $p \leq 0.05$, L.S.D. $_{at\ 5\%}$ for onion 0.59 and for garlic 0.57.



Means in the same column followed by the same letter are not significantly different at $p \leq 0.05$, L.S.D. $_{at\ 5\%}$ for onion 0.84 and for garlic 0.68.

Fig. 2. Growth attributes and yield of onion and garlic as affected by nitrogen rates

Increasing N rate from 30 up to 120 % of the recommended N rate increased plant height by 7.9 and 15.4% and leaf number by 14.6 and 13.6% for garlic and onion crops, respectively, thus increase in plant growth reflected an increase in garlic yield by 53.9% and onion yield by 16.3%, which clear the increase in potential nutrient of garlic compared to onion as reported by Cantwell et al. (2001). These results are consist with findings of Mozumder et al. (2007) and Nasreen et al. (2007) who reported that increase N fertilizer rate from 0 to 150 kg ha^{-1} significantly increased onion plant height and leaf growth rate by 8% and 11.5%, respectively.

Growth traits in terms of plant height and leaf number as well as total yield traits of both garlic and onion significantly affected by water sources interacted with nitrogen fertilizer rates (Tables 5 and 6). Fresh water combined with 120 % of the recommended N rate recorded the highest plant height (73.14 and 58.50 cm), leaf number per plant (8.12 and 7.78) and the highest total yield (6.82 and 16.93 ton fed^{-1}) for garlic and onion crop, respectively.

Water use efficiency (WUE)

Water use efficiency was significantly affected by water sources, nitrogen rate and their interaction for both onion and garlic crops (Table 7). On grand mean basis, irrigation with fresh water increased WUE by 10.1 and11.9 compared to mixed water, and by 60.6 and 39.1 comparing with drainage water source for onion and garlic, respectively.

The slight decrease in WUE of mixed water comparable to fresh water gave us the chance to recommend it for irrigation taking some precautions into account. The reduction in WUE along with mixed and drainage water treatments might have been a result of increasing the amount of applied water in comparison with fresh water treatment which related to water quality in addition to the reduction in yields. In this regard, Bagali et al. (2012) reported that WUE by intervals irrigation surpassed the flood irrigation treatment, where the amount of applied water under intervals was lower than that applied in flood irrigation.

120 % of the recommended N rate recorded the highest WUE (6.28 and 2.91 kg m^{-3}) for onion and garlic, respectively, followed by 90, 60 and 30 % of the recommended N rate for both onion and garlic (Table 7), which reflected the increase in plant growth by increasing the applied nitrogen consequently enhanced the crop yield.

In conclusion, WUE for onion and garlic was significantly affected by water sources and N rate interaction. The highest WUE for onion (7.44 and 6.79 kg m^{-3}) and for garlic (3.33 and 3.00 kg m^{-3}) resulted from 120 % of the recommended N rate combined with fresh and mixed water, respectively.

TABLE 5. Growth attributes and yield of garlic as affected by the interaction of varied water sources with nitrogen rates

Water source	N Rate %	Plant height (cm)	Leaf No plant^{-1}	Total yield (ton fed^{-1})
Fresh water	30	67.80	7.19	4.32
	60	69.87	7.31	5.19
	90	71.99	8.12	6.71
	120	73.14	8.21	6.82
Mixed water	30	65.53	6.94	4.12
	60	67.88	7.12	5.07
	90	70.49	7.84	6.40
	120	71.45	7.98	6.62
Drainage water	30	62.15	6.81	3.92
	60	64.72	7.01	4.15
	90	65.61	7.60	5.16
	120	66.31	7.82	5.58
L.S.D. $_{at\ 5\%}$		6.45	0.97	1.18

Means in the same column followed by the same letter are not significantly different at $p \leq 0.05$.

TABLE 6. Growth attributes and yield of onion as affected by the interaction of varied water sources with nitrogen rates.

Water source	N Rate %	Plant height (cm)	Leaf No plant^{-1}	Total yield (ton fed^{-1})
Fresh water	30	47.47	6.86	14.64
	60	55.53	6.97	15.45
	90	54.33	7.20	16.64
	120	58.50	7.78	16.93
Mixed water	30	46.87	6.56	14.12
	60	48.27	6.75	15.15
	90	51.22	7.05	15.81
	120	53.15	7.51	16.39
Drainage water	30	44.84	6.39	10.19
	60	45.99	6.63	11.26
	90	47.81	6.91	11.72
	120	48.97	7.20	11.95
L.S.D. $_{at\ 5\%}$		8.29	1.02	1.45

Means in the same column followed by the same letter are not significantly different at $p \leq 0.05$

Economic analysis

The results data illustrated in Table 8 showed the economic analysis under different water sources as well as different rate of fertilizers. It could be noticed that irrigating both garlic and onion crops with fresh water resulted in the highest values in gross and net return per feddan followed by mixed water treatment without big differences (only 1621 and 1259 LE in net return of garlic and onion, respectively), while the treatment of drainage water recorded the lowest value, reflecting the effect of chemical compassion of irrigation water on crop yield.

TABLE 7.Water use efficiency (WUE) (kg m-3) for onion and garlic crop as affected by varied water sources, nitrogen rate and their interaction.

Water source	Fresh water				Mixed water				Drainage water				Grand mean of N rate			
N rate %	30	60	90	120	30	60	90	120	30	60	90	120	30	60	90	120
WUE onion	6.43	6.79	7.32	7.44	5.85	6.27	6.55	6.79	3.94	4.35	4.54	4.62	5.41	5.81	6.13	6.28
Mean	7.00 a				6.36 ab				4.36 c				d	c	ab	a
WUE garlic	2.11	2.53	3.27	3.33	1.86	2.29	2.90	3.00	1.68	1.78	2.21	2.39	1.88	2.20	2.79	2.91
Mean	2.81 a				2.51 ab				2.02 c				d	c	ab	a

Means in the same column followed by the same letter are not significantly different at $p \leq 0.05$, LS.D.at 5% for water sources: 1.81 and 0.45; for N rate: 0.28 and 0.30 and for interaction: 2.00 and 0.82 for onion and garlic, respectively.

TABLE 8. Costs, gross and net return (LE/fed) under different treatments

Treatment		Garlic			Onion		
		Costs	Gross Return	Net Return	Costs	Gross Return	Net Return
Fresh water	30	11850	32400	20550	13570	33672	20102
	60	12380	38925	26545	13840	35535	21695
	90	12650	50325	37675	14110	38272	24162
	120	12920	51150	38230	14380	38939	24559
Mean		12450	43200	30750	13975	36605	22630
Mixed water	30	12110	30900	18790	13570	32476	18906
	60	12380	38025	25645	13840	34845	21005
	90	12650	48000	35350	14110	36363	22253
	120	12920	49650	36730	14380	37697	23317
Mean		12515	41644	29129	13975	35345	21370
Drainage water	30	12110	29400	17290	13570	23437	9867
	60	12380	31125	18745	13840	25898	12058
	90	12650	38700	26050	14110	26956	12846
	120	12920	41850	28930	14380	27485	13105
Mean		12515	35269	22754	13975	25944	11969
Grand Mean	30	12023	30900	18877	13570	29862	16292
	60	12380	36025	23645	13840	32093	18253
	90	12650	45675	33025	14110	33864	19754
	120	12920	47550	34630	14380	34707	20327

Prices in LE; Onion = 2300 per ton, Garlic = 7500 per ton, labors + farm rent = 9100, N fertilizer = 270 per 50 kg, K2O, P2O5 and micro fertilizers = 2450, irrigation = 900, Pesticide = 850.

Although the high application of nitrogen fertilizers resulted in increasing the input costs, 90 and 120 % of the recommended nitrogen rate surpassed the other nitrogen treatments in gross and net return.

It can be concluded from the economic point of view of the water quality and nitrogen rate interaction results that irrigation with mixed water along with 90% nitrogen rate could be recommended for garlic and onion production under King Maryout condition.

Conclusion

It could be concluded that the application of 60 and 90% (90 and 120; 135 and 180 kg N fed^{-1}) of recommended nitrogen rate are considered as the best solutions in case of using the low water quality as a source of irrigation under Allium crops without measurable yield reduction, and to conserve the soil from being salt-affected soil. Further, irrigate garlic with low water quality negatively affect the soil chemical properties.

The use of mixed water in irrigation decreased total yield by 3.7 and 3.5% for garlic and onion crops, respectively comparing with fresh water, whereas irrigation with drainage water decreased garlic yield by 18.4% and decreased onion yield by 29.2%. Increasing N application significantly increased growth and yield traits. Fresh water + 120 % of the recommended N rate recorded the highest growth and yield values for both garlic and onion crops, whereas fresh or mixed water treatment with 120 % of the recommended N rate recorded the highest WUE without significant differences.

Taking into account the economical costs of manufactured chemical-N fertilizer and water scarcity, there was no significant differences between 90 and 120 % of the recommended N rate in total yield for both onion and garlic. So, we recommend the use of 90% in spite of slight reduction in yield.

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استجابة محاصيل جنس Allium لمعدلات التسميد النيتروجيني ومصادر مياه الري المختلفة

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أجريت تجربتان حقليتين لنباتي البصل والثوم في تربة طينيه طميية تحت ثلاث مصادرمختلفة من المياة (مياه نيلية، مياه مخلوطة، مياه صرف) بإستخدام اربع مستويات من التسميد النيتروجيني (٣٠٪; ٤٥ و ٦٠ كجم ن للفدان، ٦٠٪; ٩٠ و ١٢٠ كجم ن للفدان، ٩٠٪; ١٣٥ و ١٨٠ كجم ن للفدان و ١٢٠٪; ١٨٠ و ٢٤٠ كجم ن للفدان من المعدلات الموصى بها لكلا من البصل والثوم، علي التوالي)، لدراسة التغيرات التي حدث في الخصائص الكيميائية للتربة بعد موسمي النمو، ولتقييم الأثار الجانية لإستخدام تلك المياه ذات الجودة المنخفضة علي المحصول وصفات الجودة وكذلك العلاقات المائية.

أوضحت النتائج المتحصل عليها أن إستخدام المياه المخلوطه ومياه الصرف أثرت معنويا علي ملوحة (EC)، ودرجة الحموضه (pH) وكذلك نسبة الصديوم المتبادل (SAR) في التربة تحت كلا المحصولين مقارنة بإستخدام المياه النيلية، وكان هذا واضحا عند إستخدام أعى مستوى من التسميد النيتروجيني (١٨٠ و ٢٤٠ وحدة نيتروجين للفدان للبصل والثوم، علي التوالي). بينما ادى إستخدام المياه النيلية إلي إنخفاض قيم ملوحة التربة (EC) إلي ما ياقرب من (٢٦,٥ ٪) مقارنة بقيم الملوحة التي تم قياسها في التربة قبل بداية التجربة تحت جميع معاملات السماد النيتروجيني المضاف، في المقابل فقد زادت قيم ملوحة التربة بنسب قدرت ب ١٠,٦ و ٩,٧ ٪ عند إستخدام المياه المخلوطة ومياه الصرف، علي التوالي. في حين زادت نسبة الصوديوم المدمص في التربة بعد حصاد المحصولين مع جميع أنواع المياه المستخدمه، حيث تأثرت القيم بمستوى جودة المياه، فقد زادت بقلة جودة المياه المستخدمه، وسجلت أعلي قيمة لنسبة الصوديوم المتبادل عند إستخدام مياه الصرف تلاها في ذلك عند إستخدام المياه المخلوطه. بالإضافة إلي ذلك، وجد أن إستخدام ٦٠ و ٩٠ ٪ من كمية السماد النيتروجيني الموصى به عكس زيادة طفيفة في خصائص التربة الكيميائية عند الري بإستخدام المياه المخلوطة ومياه الصرف.

هذا وقد أوضحت النتائج أيضا، أن كلا من محصول الثوم والبصل قد زاد عند إستخدام المياه النيلية مقارنة بإستخدام المياه المخلوطه ومياه الصرف. كذلك زيادة مستوى التسميد النيتوجيني من ٣٠ إلي ١٢٠ ٪ من المكميات الموصي بها قد زاد معنويا كلا من محصول الثوم بمقدار ٥٣,٩ ومحصول البصل بمقدار ١٦,٣٪. هذا بالإضافة إلي أنه قد سجلت أعلى قيمة لكفاءة إستخدام المياه في البصل (٧,٤٤ و ٦,٧٩ كجم م$^{-٣}$) وفي الثوم (٣,٣٣ و ٣,٠٠ كجم م$^{-٣}$) عند إستخدام ١٢٠ ٪ من الكيمات الموصى بها للسماد النيتروجيني مع كلا من المياه المخلوطة ومياه الصرف، علي التوالي.