Effect of Reclaimed Water Irrigation on Soil Physico-Chemical, Yield Attributes, and Chemical Composition of Wheat (*Triticum austivum L.*), Cowpea (*Vigna unguiculata L.*), and Maize (*Zea mays L.*) Plants in Arid Regions

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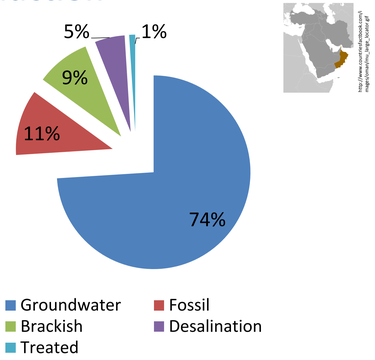
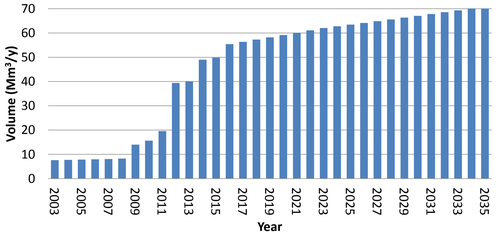
Introduction



Sources of water to cover the deficit in annual water requirements (378 Mm³/year)

"There is a need to maximize the use of treated wastewater in the country"

Recommendation of the Oman's Symposium on Sustainable Development of Agricultural Sector and its Labor market (2009)



Estimates of annual treated wastewater production (source: Oman Wastewater Service Company)

Objectives

- To monitor the impact of reclaimed water on some soil physical and chemical properties in arid regions
- To monitor the chemical composition and yield components of major crops irrigated with reclaimed water

Methodology

A field experiment was conducted for 12 months (2010-2011) in Oman to study the effects of treated wastewater (reclaimed water). Plots with sandy loam texture soil were irrigated with three different water types: groundwater (GW), desalinized water (DW), and reclaimed water (RW). The design was RCBD with six replications. The three different water types were used as the treatments. Wheat (*Triticum austivum* L.) was used in the first period followed by cowpea (*Vigna unguiculata* L.) and then maize (*Zea mays* L.). Soil samples were collected prior to planting and after harvesting each crop at 4 depths. All data were subjected to analysis of variance (ANOVA) and the LSD at $p<0.05$ was performed to compare means.

Results

Soil Parameters

The analysis of variance for soil salinity showed significant differences ($p<0.05$) among the treatments and timing, while there were no significant difference with respect to depth

Soil Salinity (dS/m)

Treatment	Soil after wheat	Soil after cowpea	Soil after maize	Mean
Groundwater	2.06	0.86	0.44	1.12^{b}
Desalinized water	2.14	1.10	1.15	1.47^{a}
Reclaimed water	1.17	1.06	0.69	0.97^{b}
Mean	1.79^{A}	1.01^{B}	0.76^{B}	

Regarding the soil pH, there were significant differences ($p<0.05$) among the treatments, soil depth, and timing

Soil pH

Treatment	Soil after wheat	Soil after cowpea	Soil after maize	Mean
Grounwater	7.89	8.23	8.20	8.11^{b}
Desalinized water	7.89	8.20	8.18	8.09^{b}
Reclaimed water	8.06	8.26	8.26	8.19^{a}
Mean	7.95^{B}	8.23^{A}	8.21^{A}	

As for the soil hydraulic conductivity (cm/s), there were no significant differences among the different types of water as to their influence on the hydraulic conductivity, however, the soil hydraulic conductivity significantly differed with depth.

Soil Hydraulic Conductivity (cm/s)

Treatment	Soil depth					Soil H. C. Before planting
	30 cm	45 cm	60 cm	90 cm	Mean	
Groundwater	0.016	0.017	0.044	0.083	0.041^{a}	0.033
Desalinized water	0.038	0.018	0.031	0.087	0.043^{a}	0.031
Reclaimed water	0.032	0.024	0.031	0.093	0.045^{a}	0.019
Mean	0.028^{a}	0.021^{a}	0.035^{b}	0.088^{c}	Average = 0.027	

Plant Parameters

The results revealed significant differences among the water type treatments with respect to most growth and yield parameters and water use efficiency (WUE) (kg grain/ ha) of wheat. The wheat grain yield was superior in RW (4.53 t/ha) in comparison to DW and GW. The cowpea plant showed significant differences in respect to all traits under study except the dry forage yield (t/ha). For maize, the plants irrigated with RW gave the highest fresh (35.87 t/ha) and dry (12.46 t/ha) yield as well as WUE (1.19 kg dry/ m^3).

Wheat

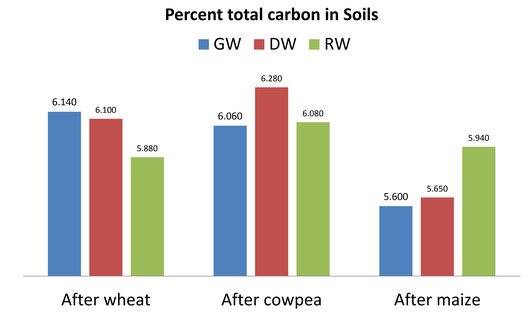
Treatment	Plant height (cm)	No. of tillers/ 50cm	Chloro-phyll	Leaf area (cm2)	Leaf length (cm)	Grain yield (t/ha)	Straw yield (t/ha)	Biological yield (t/ha)	Harvest index (%)	WUE (kg grain / m^3)
Groundwater	65.07^{b}	55.00	46.25^{b}	9.80^{b}	13.92^{b}	3.81^{b}	6.41	10.22	0.37	0.84^{ab}
Desalinized water	63.60^{b}	63.83	44.85^{b}	9.60^{b}	14.87^{ab}	3.49^{b}	6.55	10.03	0.35	0.75^{b}
Reclaimed water	71.28^{a}	53.50	49.92^{a}	12.85^{a}	16.13^{a}	4.53^{a}	6.67	11.20	0.41	0.98^{a}

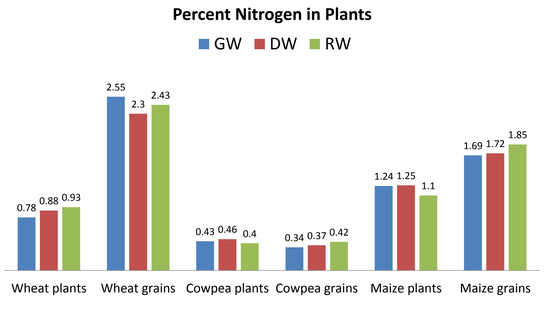
Cowpea

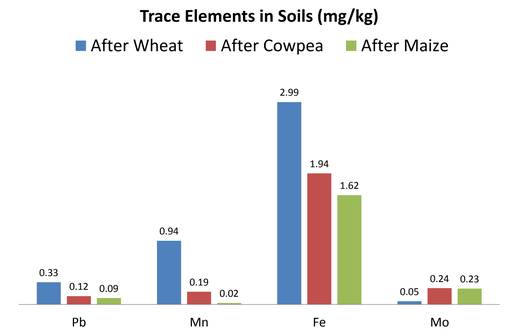
Treatment	Chloro-phyll	No of pods per plant	Fresh fodder yield (t/ha)	Fresh pod yield (t/ha)	Total fresh yield (t/ha)	Dry pod yield (t/ha)	Total dry yield (t/ha)	Harvest index (%)	WUE (kg Dry/ m3)	WUE (kg Fresh / m3)
Groundwater	56.87^{b}	7^{b}	12.18^{b}	1.75^{ab}	13.65^{b}	0.41^{b}	3.49^{ab}	11.47^{b}	0.23^{ab}	0.89^{b}
Desalinized water	56.03^{b}	6^{b}	11.01^{b}	0.94^{b}	13.07^{b}	0.23^{b}	3.05^{b}	7.58^{b}	0.19^{b}	0.84^{b}
Reclaimed water	61.18^{a}	11^{a}	14.46^{a}	2.49^{a}	15.74^{a}	0.65^{a}	4.01^{a}	15.57^{a}	0.26^{a}	1.02^{a}

Maize

Treatment	Plant height (cm)	Chloro-phyll	Leaf length (cm)	Plant fresh yield (t/ha)	Cob fresh yield (t/ha)	Total fresh yield (t/ha)	Plant dry yield (t/ha)	Cob dry yield (t/ha)	Total dry yield (t/ha)	WUE (kg dry/ m3)
Groundwater	109.50^{b}	36.82^{b}	51.17^{b}	9.73^{b}	8.53^{b}	18.27^{b}	2.76^{b}	3.27^{b}	6.02^{b}	0.57^{b}
Desalinized water	108.50^{b}	35.95^{b}	51.67^{b}	11.07^{b}	10.20^{b}	21.27^{b}	2.77^{b}	3.30^{b}	6.07^{b}	0.58^{b}
Reclaimed water	128.67^{a}	40.53^{a}	58.67^{a}	19.07^{a}	16.80^{a}	35.87^{a}	5.79^{a}	6.67^{a}	12.46^{a}	1.19^{a}







Conclusions

- use of reclaimed water irrigation significantly increased the yield of wheat, cowpea and maize
- use of reclaimed water irrigation did not have significant effect the chemical composition of wheat, cowpea, and maize
- Trace elements in soils decreased regardless of the type of water used
- Soil salinity levels decreased with time for all types of water with reclaimed water having the lowest levels on average