

# Water Use Efficiency, Flower Yield and Quality of "*Lilium aziatische*" Irrigated with Different Water Types

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## ABSTRACT

The effect of three water types with different salinity levels; the effluent from Al-Baq'a treatment plant 'EF' (2.02 dS m<sup>-1</sup>) and extra treated wastewater after ultra-filtration membrane 'UF' (1.91 dS m<sup>-1</sup>) and mixed water (50% after reverse osmosis-membrane 'RO' with 50% of UF (1.15 dS m<sup>-1</sup>) on flower production and quality and water use efficiency of three *Lilium aziatische* cv. "Elite, Prato and Pollyanna" planted in soil under the plastic house conditions was investigated during the year 2005. Water type had a significant effect on lily flower yield and quality produced. In general, lily cultivars produced the highest flower yields (kg m<sup>-2</sup>) when irrigated with the UF water type compared to the EF and Mix water treatments. The significantly highest flower yield was recorded in Elite followed by Prato cultivar irrigated with the UF water type, whilst it was the lowest with Mix water treatment. This increase in flower yield weight is a reflection of longer and thicker stalks and more buds per stalk produced by Elite and Prato irrigated with UF compared to the other water types. Data strongly suggests that the lower the percentage of buds dropped per stalk the higher the number of flower buds remained on stalk in relation to water type used for irrigation. The highest calculated water use efficiency was shown by Elite cultivar when irrigated with UF water type, while the least was recorded for Pollyanna and Prato irrigated with the mix water treatment, respectively. The results emphasize that there is an opportunity for re-treated reclaimed wastewater to be used for agriculture irrigation as a new water source helping to improving our fragile national water balance. However, more field-oriented research is imperative for such low water quality reuse for cut flower productions as they can be planted in sustainable and profitable bases.

**Key Words:** Lily; Effluent; Ultra-filtration; Reverse osmosis

## INTRODUCTION

The rapidly expanding population of the Middle East region has generated an ever-increasing volume of reclaimed water, which has raised question as to how this low quality water should be managed and possibly recycled for the benefit of society. In agriculture, the challenge is represented by the extreme difficulty to sustain high consumption levels currently required by growers, particularly due to the limited water resources and a succession of droughty winters over the past several years.

Reclaimed water is applied mainly to field crops (Middle East Water Shortage, 2000), irrigate citrus trees in Florida (Parson *et al.*, 1997), highway landscapes in Egypt (Heliopolis, 2001) and cut flowers (Safi *et al.*, 2005 a & b). One of the main potential risks of reclaimed water reuse in agriculture is the heavy metals impact (Water Corporation, 2000; Amin, 2001; Kretchmer *et al.*, 2002). However, benefits can be gained from this water such as conserving of fresh water sources, reduction of the use of synthetic fertilizer and improvement of soil properties, soil fertility and higher yields (Kretchmer *et al.*, 2002).

Since membranes of extra reclaimed water treatments such as Ultra Filtration and Reverse Osmosis reduce the adverse chemical impact on soil and plant (Tamimi, 2004)

through their effects in improving the ultimate quality of water expanding the opportunity of reuse of such low water quality in more safe way. Cut flower (non-edible) crops offer a better agricultural option and give new dimensions on reclaimed water use since they can be used on profitable and sustainable bases. Among these, cut flower lily is one of the most important horticultural crop in the world. Lilies have been reported to be low salt tolerant less than 2 dS m<sup>-1</sup> (Kotuby *et al.*, 2000; Yiasoumi *et al.*, 2003). The objective of this study was to evaluate the performance of three Lili (*Lilium aziatische*) cultivars irrigated with three types of reclaimed (the effluent EF) and/or extra treated water after ultra-filtration (UF) and reverse osmosis (RO) membranes planted in soil under the plastic house conditions.

## MATERIALS AND METHODS

This experiment was carried out for one season 2005 by the cooperation between the National Center for Agricultural Researches and Technology Transfer "NCARTT" and the USAID.

Bulbs of 14 - 16 cm circumference grade of *Lilium aziatische* cvs. "Elite, Prato and Pollyanna" purchased from the Netherlands by a flower bourse Agent in Jordan. The

bulbs were planted in soil under a plastic house of 360 m<sup>2</sup> area at Al-Baq'a site north of Amman at the end of July 2005. Experimental plots (raised beds) of 1 x 2 m area and 64 m<sup>2</sup> plants planting density was used 128 bulbs per experimental plot.

All bulb plants were watered uniformly with three water types: W1: the Effluent of Al-Baq'a WW treatment plant EF (2.02 dS m<sup>-1</sup>); W2: after Ultra-Filtration membrane UF (1.91 dS m<sup>-1</sup>); W3: mixed water (50% after Reverse Osmosis membrane RO with 50% of UF, 1.15 dS m<sup>-1</sup>) by drip irrigation network, passed through sand, screen and disc filters.

One irrigation level (frequency) treatment was applied every day at level of 100% of the Class A evaporation pan readings. Water types and lily plants were distributed in a split plot with randomized complete block design (RCBD) with four replications. All the plants were irrigated and sprayed with a fungicide as a protective measure immediately after planting; Insect and fungal disease control program was followed during the experiment time in cooperation with specialists of NCARTT. All plants received 1.6 kg mono ammonium phosphate during the first week after emergence, after that fertilizing program performed by adding 40 gm NPK + TE plot<sup>-1</sup> week<sup>-1</sup> for the EF and UF irrigated plants and 80 gm NPK + TE plot<sup>-1</sup> week<sup>-1</sup> for the plants irrigated with the Mix water type. Flower stalk harvesting at the end of experiment took place in the suitable stage of flower development at the soil surface according to Wilkins (1980).

Assessing plant performance proceeded on the parameters of harvested flower stalks weight (kg m<sup>-2</sup>), average flower stalk length and diameter, average number of flower buds per stalk and percentage buds drop of a stalk.

All the results were tabulated and statistically analyzed, mean comparisons were performed according to the least significant difference (LSD) at 5% level of significance.

## RESULTS AND DISCUSSION

Water type had a significant effect on lily flower yield and quality produced (Fig. 1 and Table I). In general, the three lily cultivars produced the highest flower yields kg m<sup>-2</sup> when irrigated with the UF water type compared to the EF and Mix water treatments (Fig. 1). The significantly highest flower yield was recorded for the Elite followed by Prato cultivar (6.06, 4.62 kg m<sup>-2</sup>) and irrigated with the UF water type respectively. While the lowest flower yields were recorded for the three cultivars (3.16, 2.67, and 2.48 kg m<sup>-2</sup>) irrigated with the Mix water treatment respectively. Our results agreed with Tamimi (2004) that the UF membrane can improve water quality and its positive effects on crop response. On the contrary, Safi *et al.* (2005a & b) found that EF was superior in regard to higher flower yields of rose and carnation emphasizing that different crop type might exert

**Table I. Flower quality parameters and water use efficiency of three lily cultivars irrigated with three types of water planted in soil, season 2005**

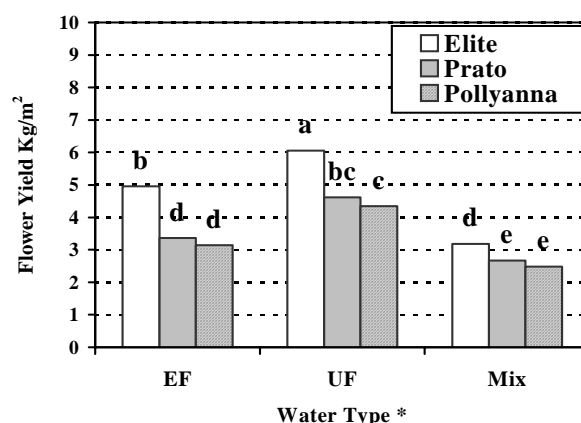
W.T. <sup>(1)</sup>	Cultivar	Flower stalk length (cm)	Flower stalk diameter (cm)	No. buds stalk <sup>-1</sup>	Water use efficiency
EF	Elite	106.0 b <sup>(2)</sup>	0.85 bc	5.7 c	1.11
	Prato	104.9 b	0.84 bc	6.8 b	0.76
	Pollyana	99.3 c	0.85 bc	6.6 b	0.70
UF	Elite	110.1 a	1.04 a	7.8 a	1.36
	Prato	107.7 ab	0.99 a	7.6 a	1.04
	Pollyana	105.1 b	0.96 a	6.7 b	0.97
Mix	Elite	94.5 d	0.79 bc	3.5 e	0.71
	Prato	94.7 d	0.77 c	4.1 d	0.60
	Pollyana	91.7 d	0.78 bc	4.0 d	0.55
LSD		3.82	0.081	0.53	

(1): Water types: EF = effluent from treatment plant; UF = after Ultra Filtration membrane; Mix = (50 % after Reverse Osmosis membrane 'RO' with 50 % of UF).

(2): Mean separation for each factor within columns by LSD test, 5% level.

**Fig. 1. Flower Yield response of three lily cultivars irrigated with three water types planted in soil, season 2005**

(\*): Water types: EF = effluent from treatment plant; UF = after Ultra Filtration membrane; Mix = (50 % after Reverse Osmosis membrane 'RO' with 50 % of UF)

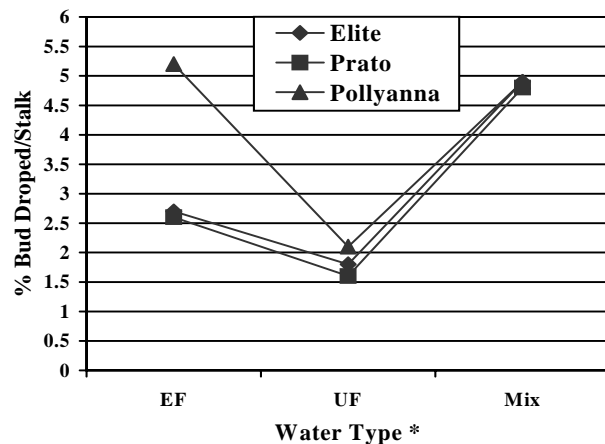


different response to water type used in irrigation. In this study, we can notice that this increase in flower yield weight is a reflection of longer and thicker stalks and more buds per stalk produced by Elite and Prato irrigated with UF compared to the other water types (Table I).

The lowest flower quality parameters were recorded for the three cultivars when irrigated with the Mix water treatment. However lily plants irrigated with EF water type showed an intermediate flower quality parameters compared to the UF or Mix water treatments (Table I). Whereas, Elite and Prato cultivars showed lower percentage of dropped flower buds when irrigated with EF water type compared to Pollyanna cultivar (Fig. 2). The three lily cultivars showed the same trend of lowest percentage of bud dropped when irrigated with the UF water treatment. These results are strongly coincided with

**Fig. 2. Percentage bud dropped per stalk of three lily cultivars irrigated with three water types planted in soil, season 2005**

(\*): Water types: EF = effluent from treatment plant; UF = after Ultra Filtration membrane; Mix = (50 % after Reverse Osmosis membrane 'RO' with 50 % of UF)



lily's classification of Kotuby *et al.* (2000) and Yiasoumi *et al.* (2003) who reported that lily plants were low salt tolerant ( $< 2.0 \text{ dS m}^{-1}$ ). However, in our study water salinity levels were almost within to this range except for the EF water type which exceeded.

The highest percentage was recorded for the three cultivars irrigated with the Mix water treatment. These results are strongly reflected on the number of flower buds produced per stalk (Table I), indicating that the lower the percentage of buds dropped per stalk the higher the number of flower buds remained on stalk in relation to water type used for irrigation. Although, the mixed-water irrigated plants received higher fertilizing levels, it seems not enough to give flower yield and quality as those irrigated with other water treatments EF or UF. The highest calculated water use efficiency was given by Elite cultivar when irrigated with the UF water type. This is in concurrence with the results of Tamimi (2004) who noted that the water after Ultra-filtration "UF" membrane is superior as being more available for plants. while the least was recorded for Pollyanna and Prato irrigated with the mix water treatment respectively.

## CONCLUSIONS

The three lily cultivars produced the highest flower yields  $\text{kg m}^{-2}$  when irrigated with the UF water type compared to the EF and Mix water treatments. Significantly the highest flower yield was recorded for the Elite followed by Prato cultivar irrigated with the UF water type. While the lowest flower yields were recorded for the three cultivars irrigated with the Mix water treatment. The results emphasize that there is an opportunity for re-treated reclaimed wastewater to be used in future for agriculture irrigation as a new water source helping to improving our fragile national water balance.

## REFERENCES

- Middle East Water Shortage, 2000. <http://weather.nmsu.edu/hydrology/wastewater/wastewater.htm>
- Parsons, L., A. Wheaton and J. Jackson, 1997. *Reclaiming Waste Water for Irrigation in Florida*. <http://www.agweb.okstate.edu/agbase/agbex99-19.htm>
- Heliopolis, 2001. *Egypt Goes Green*. <http://www.heliopolisegypt.com/012001/earth.htm>
- Water Corporation, 2003. *Treated Wastewater Re-use*. Bulletin No. 2. [www.watercorporation.com.au](http://www.watercorporation.com.au)
- Amin, J.S., 2001. [Ngo-list] *Waste as Resource*. <http://lists.isb.sdnpg.org/pipermail/ngo-list/2001-december/001526.html>
- Kretschmer, N., L. Ribbe and H. Gaese, 2002. *Wastewater Reuse for Agriculture*. [http://www.tt.fh-koeln.de/publications/ittpub301202\\_4.pdf](http://www.tt.fh-koeln.de/publications/ittpub301202_4.pdf)
- Tamimi, A., 2004. *Agricultural Demand Management*. Membrane Filtration Process (Desalination). The University of Arizona
- Kotuby-Amacher, J., R. Koeing and B. Kitchen, 2000. *Salinity and Plant Tolerance*. Utah State University Extension. <http://www.extension.usu.edu/publica/agpubs/agso03.pdf>
- Safi, M.I., A. Fardous, M. Muddaber, S. El-Zuraiqi, L. Al-Hadidi and I. Bashabsheh, 2005. Effect of treated saline water on flower yield and quality of roses *Rosa hybrida* and Carnation *Dianthus caryophyllus*. *Sci. Asia*, 31: 335–9
- Safi, M.I., A. Fardous, M. Muddaber, S. El-Zuraiqi, L. Al-Hadidi and I. Bashabsheh, 2005. Evaluation of yield responses of carnation and rose cut flowers to salinity. *Mu'tah Lil Buhuth Wa-Dirasat*, 20: 89–104
- Yiasoumi, B., L. Evans and L. Rogers, 2003. *Salinity Tolerance, Ornamentals in Media*. <http://www.ricecrc.org/reader/ac2-salinity-table07.htm>
- Wilkins, H.F., 1980. Easter Lilies. In: Larson, R.A. (ed.), *Introduction to Floriculture*. Academic Press. Harcourt Brace Jovanovich

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