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# Feasibility of Reusing the Agricultural Drainage Water for Irrigation of Taimour Mango Transplants

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## ABSTRACT

Nowadays, reusing drainage water in Egypt represents a major potential water resource for expanding more cultivated area. This study was conducted during 2011 and 2012 seasons to test the possibility of reusing the agricultural drainage water for irrigating of Taimour mango transplants. In addition, to examine the effect of this water on some vegetative growth and root characters, total carbohydrate percentage in the leaves, plant pigments and uptake of N, P, K, Na ad Cl by plants. Transplants were irrigated with both drainage water and Nile water alone and also with different proportions from each (75:25, 50:50 and 25:75). The obtained data reveal that irrigation with drainage water alone or mixed with Nile water at a ratio of 25% badly affected all the investigated parameters of transplants. A positive relation between the proportion of drainage water and the uptake of Na and Cl. Irrigation using drainage water mixed with river Nile at a ratio of 50-75 was apparently no depressive effect on all of the considered aspects of the transplants. From the economical standpoint, drainage water may be mixed in equal parts (50: 50%) with river Nile for irrigate Taimour mango transplants growing on sandy soil. For more safety, irrigation with Nile water may be applied for leaching soil and preventing salt accumulate every four mixed water irrigation.

**Key words:** Taimour mango, agricultural drainage water, irrigation, transplants

## INTRODUCTION

Water resources in Egypt are Nile river (55.5 billion $m^3$ $year^{-1}$), drainage water (27.0 billion $m^3$ $year^{-1}$ that reach from irrigated lands, domestic and industrial sources), groundwater (5.3 billion $m^3$ $year^{-1}$), rainfall, sewage water and industrial effluent (FAO, 2012).

Increasing water efficacy reuse is an important and natural methods for managing drainage water. As water resources are increasingly becoming scarce, agricultural drainage water reuse has become an important source of irrigation water in Egypt. The reuse of drainage water increased from 2.6 billion cubic meters in 2002 to about 10 billion $m^3$ $year^{-1}$ in 2012 (FAO, 2012).

Salinity in water and in soil retards growth and causes nutrients imbalance in various crop fruits. It is responsible for inhibiting the biosynthesis of plant pigments and organic foods. The different responses of fruit crops to salinity was reviewed by Aly (1979), Sourial *et al.* (1979), Lauchli and Epstein (1984), Dahshan (1986), Bhambota *et al.* (1990), Issa (1991), Abd El-Karim-Nemat (1991), Ahmed and Darwish (1992), Schmutz and Ludders (1993, 1994, 1998, 1998a, b), Haggag *et at.* (1994), Aly (1995), Ahmed and Ahmed (1998), Jury *et al.* (2003), Qian and Mecham (2005), Kassam *et at.* (2006), Dubey *et al.* (2007), Ahmad and Al Rawashdeh (2012) and Abid *et al.* (2013).

The present study aimed to clarify the effect of using drainage water alone or in different proportions with River Nile on growth and nutritional status of young Taimour mango trees.

## MATERIALS AND METHODS

This study was carried out in a private nursery located at El-Kosyia district Assuit Governorate during 2011 and 2012 seasons. For achieving this study 150 uniform in vigour and grafted Taimour mango transplants (30 months age) were selected. They were planted in March in clay pots (34 cm diameter) and filled with 10 kg sandy soil (one transplant/pot).

This experiment involved the following five treatments from drainage water and/or Nile water alone and at various proportions:

- Irrigation with 100% agricultural drainage water
- Irrigation with 75% agricultural drainage water+25% Nile water
- Irrigation with 50% agricultural drainage water+50% Nile water
- Irrigation with 25% agricultural drainage water+75% Nile water
- Irrigation with 100% Nile water

In both seasons, a fixed amount of water from the five irrigation treatments i.e., 2 L $pot^{-1}$ was added 6, 4 and 7 days intervals in Spring (March, April, May), Summer (June and July) and Autumn (Sept.) months, respectively. One irrigation with Nile water was applied every four irrigations from agricultural drainage water treatments for preventing salt accumulations. The methods of Ayers and Branson (1977) and Wilde *et al.* (1985) were used for the determination of water quality parameters. The values are the average of seven samples taken during each season. Averages of the two seasons of electrical conductivity of the water before the forty two irrigations are shown in Table 1.

The experimental was laid out in a complete randomized design with five irrigation treatments and three replications each with ten transplants. Plants were maintained under uniform program of N, P, K and micronutrients fertilization besides diseases and insects control.

The effects of different treatments on the following measurements were recorded.

**Growth characters:** At the termination of experiment in both seasons (last week of Sept.) all Taimour mango transplants were excavated and washed with tap water twice then the following growth parameters were recorded:

- Stem height (cm)
- Stem thickness (cm)
- No of leaves/plant
- Leaf area ($cm^2$) (according to Ahmed and Morsy, 1999)
- Root distribution ($cm^2$)
- Main root length (cm)
- Fresh and dry weights of whole plant (g)

**Plant pigments:** Chlorophylls a and b were determined in the fresh leaves (Carlson, 1981). Total carbohydrates percentage in the dry leaves was determined according to Anthron method (AOAC, 1995).

Table 1: Averages of the two seasons of electrical conductivity of the water before the forty two irrigations

| Treatments (proportions of drainage water: Nile water) | March, April and May | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| 100% drainage water+0% Nile water | 2.26 | 2.28 | 3.31 | 2.31 | 2.33 | 2.35 | 2.36 | 2.40 | 2.41 | 2.42 | 2.43 | 2.44 | 2.46 | 2.50 | 2.51 |
| 75% drainage water+25% Nile water | 1.71 | 1.73 | 1.75 | 1.76 | 1.78 | 1.80 | 1.81 | 1.82 | 1.84 | 1.86 | 1.90 | 1.90 | 1.91 | 1.92 | 1.92 |
| 50% drainage water+50% Nile water | 0.69 | 0.71 | 0.72 | 0.72 | 0.73 | 0.73 | 0.73 | 0.75 | 0.76 | 0.76 | 0.76 | 0.77 | 0.77 | 0.78 | 0.80 |
| 25% drainage water+75% Nile water | 0.66 | 0.68 | 0.70 | 0.70 | 0.70 | 0.71 | 0.71 | 0.72 | 0.72 | 0.73 | 0.73 | 0.75 | 0.76 | 0.78 | 0.80 |
| 0% drainage water+100% Nile water | 0.33 | 0.33 | 0.33 | 0.34 | 0.35 | 0.35 | 0.36 | 0.37 | 0.37 | 0.37 | 0.37 | 0.37 | 0.38 | 0.39 | 0.40 |
| | June, July and August | | | | | | | | | | | | | | |
| | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
| 100% drainage water+0% Nile water | 2.55 | 2.60 | 2.66 | 2.67 | 2.69 | 2.71 | 2.72 | 2.79 | 2.81 | 2.84 | 2.85 | 2.88 | 2.89 | 2.90 | 2.91 |
| 75% drainage water+25% Nile water | 1.93 | 1.94 | 1.95 | 1.97 | 1.98 | 1.99 | 2.00 | 2.01 | 2.02 | 2.02 | 2.03 | 2.05 | 2.05 | 2.06 | 2.06 |
| 50% drainage water+50% Nile water | 0.81 | 0.82 | 0.82 | 0.82 | 0.82 | 0.83 | 0.83 | 0.84 | 0.85 | 0.86 | 0.87 | 0.88 | 0.88 | 0.89 | 0.88 |
| 25% drainage water+75% Nile water | 0.82 | 0.85 | 0.85 | 0.86 | 0.87 | 0.89 | 0.90 | 0.90 | 0.91 | 0.92 | 0.93 | 0.94 | 0.95 | 0.95 | 0.93 |
| 0% drainage water+100% Nile water | 0.41 | 0.41 | 0.41 | 0.41 | 0.41 | 0.41 | 0.42 | 0.42 | 0.42 | 0.42 | 0.42 | 0.40 | 0.40 | 0.39 | 0.39 |
| | June, July and August | | | | | September | | | | | | | | | |
| | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | | | |
| 100% drainage water+0% Nile water | 2.92 | 2.93 | 2.95 | 2.95 | 2.90 | 2.88 | 2.80 | 2.71 | 2.66 | 2.60 | 2.55 | 2.50 | | | |
| 75% drainage water+25% Nile water | 2.07 | 2.09 | 2.10 | 2.11 | 2.00 | 1.98 | 1.94 | 1.90 | 1.88 | 1.85 | 1.80 | 1.77 | | | |
| 50% drainage water+50% Nile water | 0.87 | 0.84 | 0.80 | 0.80 | 0.77 | 0.76 | 0.74 | 0.73 | 0.72 | 0.70 | 0.67 | 0.66 | | | |
| 25% drainage water+75% Nile water | 0.92 | 0.91 | 0.90 | 0.89 | 0.88 | 0.87 | 0.86 | 0.84 | 0.80 | 0.75 | 0.74 | 0.71 | | | |
| 0% drainage water+100% Nile water | 0.38 | 0.38 | 0.38 | 0.38 | 0.38 | 0.38 | 0.38 | 0.38 | 0.36 | 0.36 | 0.36 | 0.36 | | | |

**Uptake of N, P, K, Na and Cl:** Uptake of N, P, K, Na and Cl by each transplants was recorded by multiplying dry weight of each transplant by percentage of each element according to Chapman and Pratt (1975) and Wilde *et al.* (1985) and multiplying the product by 1000 (mg element/transplant).

**Statistical analyze:** All the obtained data were tabulated and statistically analyzed according to Mead *et al.* (1993) using new LSD parameter at 5% for made comparisons among different irrigation treatments.

## RESULTS AND DISCUSSION

**Electrical conductivity, pH and T.S.S of agricultural drainage water and Nile water:** Overall, the agricultural drainage water is having a water quality that is less than that of the Nile water, as the electrical conductivity and total soluble salts were about 3.09 fold those of the River Nile water. In addition, pH was higher in agricultural drainage water (7.9 and 7.6) than in River Nile (7.5 and 7.2) in both seasons. This is indicated that a salinity problem would occur when irrigation was done by using agricultural drainage water alone or mixed with Nile water at 75:25%, respectively (Table 1).

**Effect of water quality treatments on vegetative growth characters:** It is clear from the data in Table 2 that significant and great reduction on the investigated growth characters were observed when Taimour mango transplants were irrigated with drainage water alone or when irrigated with water containing 75% agricultural drainage water+25% Nile water. The inhibition on such growth characters was associated with increasing the percentage of agriculture drainage water applied with Nile water. Mixing agricultural drainage water with Nile water at 25-50% failed to show significant reduction on these growth characters compared with using Nile water alone. The maximum values for stem height (100 and 111 cm), stem thickness (1.55 and 1.63 cm) and number of leaves/plant (36 and 35 leaves) were recorded on transplants irrigated with Nile water alone during both seasons, respectively. Insignificant reduction on such growth traits was obtained with using agricultural drainage water at percentages ranged from 25-50+75-50% Nile water compared to irrigation with 100% Nile water. Generally the foregoing trends noticed in 2011 season were the same as those noticed in 2012 seasons.

These results are in agreement with those obtained by Aly (1979), Lauchli and Epstein (1984), Dahshan (1986) and Haggag *et al.* (1994).

**Effect of water quality treatments on some root characters:** It is clear from the obtained data in Table (2) that root distribution and main root length of Taimour mango transplants were negatively affected by using water containing more than 50% drainage water plus 50% Nile water. Irrigation with drainage water at 75-100+25-0.0% Nile water significantly was accompanied with decreasing root distribution and main root length of Taimour mango transplants compared to using Nile water alone or using a mixture of drainage water+Nile water at 25-50:75-50%, respectively. The reduction on such root characters was associated with increasing percentages of drainage water from 25-l00% out of the total water irrigation. Using the drainage water alone for irrigating of transplants reduced root distribution area (110.00 and 109.50 $cm^2$) compared with irrigation with the Nile water alone (150.50 and 152.00 $cm^2$) in the first and second seasons, respectively. No harmful effects were detected for the application of 25-50% drainage water with 75-50% River Nile water in comparison to Nile watering on either root distribution or main root length. Irrigation with drainage water alone or when mixing with Nile water at 25% resulted in highly depressive effect on such two root parameters. These results were true in both seasons.

Similar trend was reported by Sourial *et al.* (1979), Bhambota *et al.* (1990), Issa (1991) and Ahmed and Darwish (1992).

**Effect of water quality treatments on total carbohydrates percentage and plant pigments:** It is clear from the obtained data in Table 3 that total carbohydrates and plant pigments significantly varied among different irrigation management treatments. The reduction

Table 2: Effect of irrigation with agricultural drainage water and or Nile water at various proportious on some vegetative and root characters of Taimour mango transplants during 2011 and 2012 seasous

| Treatments (proportions of drainage water: Nile water) | Characters: Stem height (cm) 2011 | Stem height (cm) 2012 | Stem thickness (cm) 2011 | Stem thickness (cm) 2012 | No. of leaves/plant 2011 | No. of leaves/plant 2012 | Leaf area ($cm^2$) 2011 | Leaf area ($cm^2$) 2012 |
|---|---|---|---|---|---|---|---|---|
| 100% Drainage water+0% Nile water | 80.2 | 81.0 | 1.10 | 1.04 | 20 | 19 | 61.0 | 60.0 |
| 75% Drainage water+25% Nile water | 90.0 | 94.0 | 1.30 | 1.22 | 27 | 26 | 70.0 | 66.3 |
| 50% Drainage water+50% Nile water | 97.5 | 108.3 | 1.52 | 1.58 | 34 | 32 | 81.5 | 82.0 |
| 25% Drainage water+75% Nile water | 98.0 | 109.5 | 1.54 | 1.60 | 35 | 33 | 82.0 | 83.0 |
| 0% Drainage water+100% Nile water | 100.0 | 111.0 | 1.55 | 1.63 | 36 | 35 | 83.0 | 84.0 |
| New L.S.D at 5% | 2.9 | 3.3 | 0.05 | 0.06 | 4 | 5 | 2.5 | 3.0 |

| | Characters: Fresh weight of plant (g) | | Dry weight of plant (g) | | Root distribution ($cm^2$) | | Main root length (cm) | |
|---|---|---|---|---|---|---|---|---|
| 100% Drainage water+0% Nile water | 211 | 209.2 | 40.1 | 38.3 | 110.0 | 109.5 | 18.1 | 17.3 |
| 75% Drainage water+25% Nile water | 250 | 241.0 | 52.5 | 55.0 | 120.0 | 122.3 | 22.0 | 21.3 |
| 50% Drainage water+50% Nile water | 315 | 326.0 | 78.0 | 82.5 | 148.3 | 150.0 | 29.0 | 27.8 |
| 25% Drainage water+75% Nile water | 317 | 327.0 | 79.0 | 83.0 | 149.0 | 151.0 | 29.5 | 28.0 |
| 0% Drainage water+100% Nile water | 320 | 330.0 | 80.0 | 84.0 | 150.5 | 152.0 | 30.3 | 28.2 |
| New L.S.D at 5% | 6 | 7.0 | 2.5 | 3.0 | 4.1 | 3.9 | 1.2 | 1.5 |

Table 3: Effect of irrigation with agricultural drainage water and Nile water at various proportions on total carbohydrates%, plant pigments (mg/1 g F.W) and uptake of N, P, K, Na and Cl (mg $plant^{-1}$) of Taimour mango transplants during 2011 and 2012 seasons

| Treatments (proportions of drainage water: Nile water) | Characters: Total carbohydrates (%) 2011 | Total carbohydrates (%) 2012 | Chlorophyll a (mg 1 $g^{-1}$) 2011 | Chlorophyll a (mg 1 $g^{-1}$) 2012 | Chlorophyll b (mg 1 $g^{-1}$) 2011 | Chlorophyll b (mg 1 $g^{-1}$) 2012 | Uptake of N (mg $plant^{-1}$) 2011 | Uptake of N (mg $plant^{-1}$) 2012 |
|---|---|---|---|---|---|---|---|---|
| 100% Drainage water+0% Nile water | 10.0 | 9.9 | 0.88 | 0.86 | 0.60 | 0.52 | 1.22 | 1.18 |
| 75% Drainage water+25% Nile water | 12.0 | 12.5 | 1.01 | 1.00 | 0.70 | 0.68 | 1.41 | 1.33 |
| 50% Drainage water+50% Nile water | 15.8 | 15.5 | 1.89 | 1.95 | 0.98 | 0.98 | 1.63 | 1.67 |
| 25% Drainage water+75% Nile water | 16.0 | 15.8 | 1.91 | 1.96 | 1.00 | 1.00 | 1.65 | 1.68 |
| 0% Drainage water+100% Nile water | 16.2 | 16.0 | 1.92 | 1.98 | 1.01 | 1.04 | 1.66 | 1.69 |
| New LSD at 5% | 1.2 | 1.5 | 0.04 | 0.05 | 0.04 | 0.04 | 0.05 | 0.05 |

| | Characters: Uptake of P (mg $plant^{-1}$) | | Uptake of K (mg $plant^{-1}$) | | Uptake of Na (mg $plant^{-1}$) | | Uptake of Cl (mg $plant^{-1}$) | |
|---|---|---|---|---|---|---|---|---|
| 100% Drainage water+0% Nile water | 0.11 | 0.10 | 0.44 | 0.45 | 0.46 | 0.46 | 0.59 | 0.60 |
| 75% Drainage water+25% Nile water | 0.16 | 0.14 | 0.62 | 0.66 | 0.41 | 0.40 | 0.50 | 0.48 |
| 50% Drainage water+50% Nile water | 0.22 | 0.23 | 0.82 | 0.87 | 0.36 | 0.35 | 0.38 | 0.36 |
| 25% Drainage water+75% Nile water | 0.23 | 0.24 | 0.83 | 0.88 | 0.35 | 0.34 | 0.36 | 0.35 |
| 0% Drainage water+100% Nile water | 0.24 | 0.25 | 0.85 | 0.90 | 0.34 | 0.34 | 0.35 | 0.34 |
| New LSD at 5% | 0.03 | 0.04 | 0.06 | 0.05 | 0.03 | 0.03 | 0.04 | 0.05 |

on such parameters was associated with increasing percentages of agricultural drainage water applied with Nile water. Values were slightly reduced with using drainage water at percentages ranged from 25-50% with 75-50% Nile water compared to using Nile water alone. Irrigation with drainage water at 75-l00% out of the amount of total irrigation water significantly was followed by minimizing such traits. Using the drainage water alone reduced total carbohydrates (10.00 and 9.90%) in relative to using the Nile water alone (16.20 and 16.00%) in both seasons, respectively. The maximum values were recorded on the leaves from transplants irrigated only with Nile water. These results are in concordance with those obtained by Aly (1979), Abd El-Karim-Nemat (1991), Ahmed and Darwish (1992) and Haggag *et al.* (1994).

**Effect of water quality treatments on uptake of N, P, K, Na and Cl:** It is clear from the data in Table 3 that uptake of N, P, K, Na and Cl by each transplant were greatly varied among the five water quality treatments. Taimour mango transplants irrigated with Nile water alone contained the higher uptake of N, P and K and the lowest uptake of Na and Cl.

The transplants irrigated with agricultural drainage water had the minimum uptake of N, P and K and the maximum uptake of both Na and Cl. Irrigation with either drainage water alone or with the diluted drainage waters at different proportions caused a reduction on uptake of N, P and K and a promotion on uptake of Cl and Na compared to irrigation with Nile water. Irrigation with water containing 75-100% drainage water significantly decreased uptake of N, P and K and increased uptake of Na and Cl compared to irrigation with Nile water and other diluted drainage waters. Similar results were announced in the two seasons. These results are in coincidence with those obtained by Aly (1979), Sourial *et al.* (1979), Lauchli and Epstein (1984), Dahshan (1986), Bhambota *et al.* (1990), Schmutz and Ludders (1993) and Haggag *et al.* (1994).

The previous negative effects of water salinity on growth and nutritional status of young Taimour mango transplants might be attributed to the impaired effects of salinity on cell division, plant pigments, uptake of nutrients, water absorption and plant metabolism (Nijjar, 1985).

## CONCLUSION

A general look for the obtained data reveal that agricultural drainage water alone or mixed with Nile water at 75% seriously affected the plant. Doubtless, the considerations of water salinity are the principal factors in deciding the suitability of such water for irrigation of mango which is considered as low tolerant plant (Singh, 1960). Therefore, it may be concluded that no harmful effects on plant were obtained with using drainage water mixed with Nile water at ratio of l:1 in comparison to using Nile water alone. Na and Cl contents of plants subjected to such mixed water were very closer to those obtained with Nile water. Accordingly, and from an economical point of view, agricultural drainage water with qualities similar to those of the present work may be combined in equal proportions with Nile water for irrigation Taimour mango transplants on sandy soil. To minimize salts accumulation, one complete Nile irrigation may be applied every four mixed water irrigations for leaching the excess of salts in the soil.

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