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INFLUENCE OF TREATED WASTEWATER IRRIGATION ON WHITE-CORN PLANT

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Abstract

Water shortage and environmental hazards of wastewater have increased the need of wastewater reuse to be used for agricultural irrigation. Experimental approach was used in order to examine the influence of applying treated wastewater as a source of irrigation on physical properties and chemical composition of white-corn, this experiment was performed on a land with an estimated area about 100 m^2 behind the main wastewater treatment plant. The land was divided into three equal cells with different water irrigation types, fresh water, Treated wastewater, and finally alternating irrigation equally with both fresh water and treated wastewater. Physical and chemical tests for white-corn plant were conducted and then analyzed statistically. As a result of analysis, alternating irrigation with water and treated wastewater do not recorded significant difference in term of the physical properties comparing with water irrigation; nevertheless, the wastewater irrigation showed lower physical properties with significant differences. On the other hand, high level of the Total Kjehldal Nitrogen (TKN), Total Phosphorus (TP) and Potassium (K) concentrations found in plant's leaves in case of alternating irrigation. They were evidenced during chemical analyses as the following, 14%, 20% and 33%, respectively.

***Key words**: treated wastewater, white-corn, alternating irrigation.*

INTRODUCTION

Gaza Strip lies on the southwestern part of the Palestinian coastal plain. It is very crowded place with an area of 378 km^2 (Mogheir et al., 2005), and it's expected to reside a population of over two million Palestinians by 2020 (Metcalf and Eddy, 2000). The annual average rainfall varies from 400 mm at the north to about 200 mm at south of the Strip (Palestinian Water Authority, 2007). The entire population depends totally upon groundwater as a source of potable water not only for domestic use, but also for agricultural and industrial activities which put more stress on the existing scarce resources (Shomar et al., 2004). The agriculture abstraction alone consumes around two thirds of groundwater which pumped through more than 4000 wells located overall Gaza Strip. The gap between water demand and water supply is currently 55-60 million cubic meters (MCM) per year (Nassar et al., 2009), and is expected to increase with time as a result of rapid population growth in this small area.

The main objective of this study is to estimate the effects of using treated wastewater as a source of irrigation in term of both physical properties and chemical composition of white-corn, by using pilot project.

MATERIALS AND METHODS

A land of 100 m^2 was used in order to carry out the experiment; it was divided into nine district cells grouped later in three equal sets according to the irrigation water type, the nine cells were distributed as a Latin square. First group was irrigated with Fresh Water (FW), second with Treated Wastewater (TW), and last one with both FW and TW in an alternating way (AW). Surface drip irrigation system was used for irrigation in the experiment.

For both FW and TW, three time-difference grab samples were obtained from the end of a dripper line to have one representative composite sample of each water type. Each grab sample was 500 ml in volume. The following parameters considered to be analysed were, Biological Oxygen Demand (*BOD)*, Chemical Oxygen Demand *(COD)*, Total Suspended Solid *(TSS)*, Electrical Conductivity *(EC)*, Potential Hydrogen *(pH)*, Sodium

Adsorption Ratio *(SAR)* and finally with a biological test which was Fecal Coliform *(FC)*.
Plant Height, Plant Thickness and Number of Leaves measurements were conducted for the half of the plants once per week for a period of two and a half months. The measurements were started in the third week after planting and stopped when the fruits started to appear. These parameters were used as an indicator of plants health and the capability of the plant to produce and hold the fruits.

Figure 1. Surface drip irrigation system

Figure 2. Plant height measurement

RESULTS AND DISCUSSIONS

A. Water and Wastewater analyses

The following table (Table 1) shows the concentration of BOD, COD, TSS, EC, pH and SAR of the effluent of Gaza wastewater treatment plant (GWWTP) and the world health organization (WHO) standards for treated wastewater reuse in irrigation.
The table clearly illustrates that the TW used in the experiment meets the WHO standards regarding the reuse issues except the Fecal Coliform concentrations and the salinity.

Table 1. Wastewater parameters (BOD, COD, TSS, EC, PH and SAR and F.C.)

Parameter	FW	TW	WHO standards*
BOD (mg/l)	<10	<10	< 100
BOD (mg/l)	<10	<10	< 150
TSS (mg/l)	0.5	17.4	< 100
EC (µS/cm)	2500	3010	< 2500
pH	7.17	7.64	6.5-9.5
SAR	4.5	8	< 9
F.C	0	1x105	< 2x102

* World Health Organization (WHO), 2006.

B. Physical parameters

1. Plant Height.

Figure 3 shows the average heights of white-corn plants through 7-weeks period of measurements from the beginning of the experiment to the eight week.

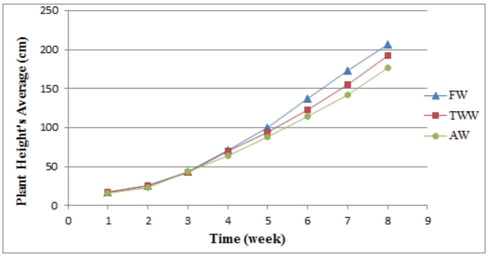

Figure 3. The average heights of white-corn plant of each irrigation type with time

After three weeks of measurements (six weeks after planting), a visible difference among the three groups were observed. FW irrigation recorded the highest height followed by TW irrigation. Alternating water irrigation (AW) recorded the least heights.

2. Plant Thickness.

Figure 4 shows the average thicknesses of white-corn plants through 7-weeks period of measurements for each group.
The figure shows that both FW and TW irrigation were approximately the same in terms of plant thickness from the beginning to the end, whereas after three weeks of measurements (six weeks after planting); AW irrigation started to show different records away from the others. FW and group TW recorded the highest thickness, and AW recorded the lowest.

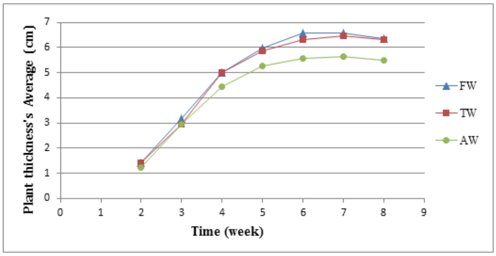

Figure 4. The average plant thicknesses with time of each group

3. Number of Leaves.
Figure 5 shows the average number of leaves of the white-corn plants in each group.

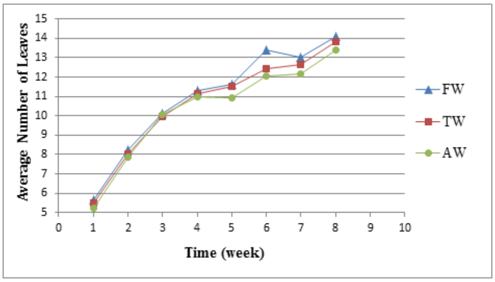

Figure 5. The average number of leaves of each group's plants

In other words, the use of the treated wastewater in irrigation would pose no change on the number of leaves of the plants. This is very important since the leaves in the plant are the places in which the photosynthesis process occurs.

4. Number of Fruits.
Figure 6 shows the number of fruits of each group.

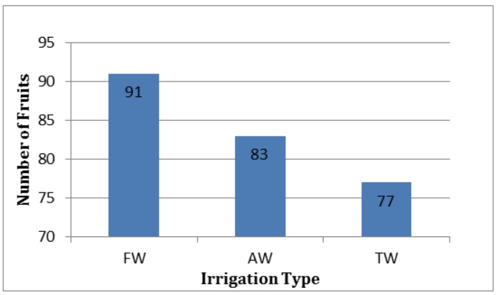

Figure 6. Number of Fruits in each irrigation type

As shown above that the highest number of fruits were recorded for the FW irrigated group, while the lowest number was recorded for the TW irrigated group.
It is clear from Figure 6 that the yield of the white-corn that was irrigated with treated wastewater is lesser than those with tap water.

C. Chemical Analyses Results

Figure 7 presents the results of the chemical analyses for each component.
As demonstrated in Figure 7 each of TKN, TP and K concentrations in white-corn plant's tissue of the AW irrigation, increased by 14%, 20% and 33% respectively as compared to the FW irrigation. Also, it appeared that the AW set was the closest to the FW, which mean that the fresh water can be replaced by the treated wastewater in irrigation in alternating way which is capable of providing the plant with the needed nutrients.

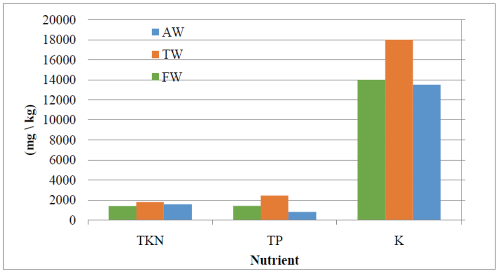

Figure 7. Concentrations of TKN, TP and K in each irrigation type sample

CONCLUSIONS

The results of the statistical and chemical analyses regarding the irrigation with treated wastewater were positive in term of plant's productivity, therefore the treated wastewater can be used in agricultural irrigation with emphasis on the WHO guidelines and regulations regarding the reuse of treated wastewater in agriculture. Since the treated wastewater from GWWTP was in compliance with the WHO standards regarding the reuse of treated wastewater in irrigation, huge amounts of the wasted treated wastewater can serve as a source of water to fulfill the needs of the agriculture sector in Gaza Strip.

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