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EFFECTS OF IRRIGATION WITH TREATED WASTEWATER ON THE PHYSICAL PROPERTIES AND CHEMICAL COMPOSITION OF WHITE CORN

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Abstract: In order to investigate the effects of applying treated waste water as a source of irrigation on both physical properties and chemical composition of white corn, this study was conducted at a land in the neighborhood of Gaza Waste Water Treatment Plant (GWWTP). The land was divided into three groups of cells; each group was irrigated with one water type. The Irrigation types were: (1) Irrigation with Tap water (TW) *The control*, (2) Irrigation with Treated Waste Water (TWW) and (3) Alternating Irrigation with both TW and TWW. The results indicated that the second set, as compared to the control, had not recorded significant difference in the physical properties, whereas the third set had recorded lower physical properties and had seen significant difference. On the other hand, the chemical analyses demonstrated high increase in concentration of each of TKN, TP and K in plant's leaves of the second set.

Keywords: Municipal Waste Water, Reuse, Corn, Drip Irrigation, Agriculture, Gaza.

الأثار الناجمة عن الري باستخدام المياه العادمة المعالجة على كل من الخصائص الفيزيائية والتركيب الكيميائي لنبات الذرة البيضاء

ملخص: تم اجراء هذه الدراسة في أرض مجاورة لمحطة غزة لمعالجة المياه العادمة بهدف دراسة التأثيرات الناجمة عن استخدام المياه العادمة المعالجة في الري على الخصائص الفيزيائية والتركيب الكيميائي لنبات الذرة البيضاء . تم تقسيم الارض المختارة إلى تسع خلايا منفصلة متساوية المساحة، تم تجميعها في ثلاث مجموعات كل مجموعة تضم ثلاث خلايا موزعة حسب المربع اللاتيني . تم ري كل مجموعة بنوع واحد من المياه . الانواع المستخدمة هي : (1) الري بمياه الخزان الجوفي والتي كانت المحدد في التجربة، (2) الري بمياه عادمة معالجة، (3) الري بكلا النوعين السابقين بطريقة تبادلية. أظهرت نتائج التجربة ومن خلال التحاليل الاحصائية أن المجموعة الثانية لم تسجل فارقاً كبيراً فيما يتعلق بالخصائص الفيزيائية مقارنة مع المحدد على عكس ما اظهرته المجموعة الثالثة . وعلى صعيد الخصائص الكيميائية اظهرت المجموعة الثانية تفوقا كبيرا، حيث اظهرت التحاليل زيادة في تركيز كل من TKN , TP , K بـ نسبة 14%، 200%، 33% على الترتيب، في حين اظهرت المجموعة الثالثة تقارباً مع المحدد.

Introduction:

The Gaza Strip is 40 kilometers *km* long and on average 9 km wide located between the Negev desert and the Mediterranean Sea with an area of 365 km^2, [8]. On this narrow band of semi-arid land will reside a population of over two million Palestinians by 2020, [6]. The average rainfall depth over the strip is estimated about 364.7 millimeter *mm* with local amount 133.1 Million Cubic Meters *MCM* received through 46 rainy days, [12]. The annual average rainfall varies from 400 mm at the North to about 200 mm at South of the Strip. 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, [13]. The total abstraction of groundwater in all Gaza governorates exceeds 155 MCM $year^{-1}$, [6], the agriculture alone consumes around two thirds of groundwater pumped through more than 4000 wells located overall Gaza Strip, [9], with the remainder used for both industrial and domestic water supplies. The gap between water demand and water supply is currently 55-60 MCM $year^{-1}$, [9], and is expected to increase with time as a result of rapid population growth in this small area. As a result, a lot of environmental problems have started to arise at all places and levels, and are expected to be more acute in the near future if the current utilization patterns continue, [13]. Therefore there is an essential need to start looking at the different options and mechanisms that will help overcome these escalating environmental problems. On the other hand the lack of waste water management has a direct impact on problems related to public health, marine and coastal pollution, deterioration of the nature and biodiversity, as well as landscape and aesthetic distortion in the Gaza Strip, [13]. The United Nations county team in the occupied Palestinian Territory estimated that about 44 MCM of waste water is currently generated annually, out of them 33 MCM has to be released into the nearby Mediterranean sea creating pollution, public hazards, and problems for the fishing industry, [14].

For a number of countries where current fresh water reserves are or will be at critical limit, recycled water is the only significant low-cost alternative resource for agricultural, industrial and urban non potable purposes, [3]. The study conducted by Pescode, 1992; has shown that the best way for usage of treated waste water is in the agriculture, [3]. The agricultural irrigation is the largest current use of reclaimed water, and offers significant future opportunities for water reuse, [7]. This is obvious since the agricultural sector consumes more than half of the total water consumed, [1]. Treated waste water is a potential alternative resource in agriculture since it is considered a reliable and permanent source, a source for nutrients that can satisfy the need of agriculture products for water and manure during critical periods, [1]. In addition, the amount of waste water salts in some cases is lower than that of the underground water used in agriculture, [3]. Therefore, the use of waste water with lower amount of salts and sufficient nutrients leads to higher yield in many plants. Since the use of waste water is an uncommon source of water, its application in agriculture requires especial management to take satisfactory advantage, and prevent its environmental and sanitary dangers in soil, plant, surface water and underground water,[3].

Reuse of treated waste water is considered a priority in the Gaza Strip due to a number of factors including the depletion of groundwater resources and the fact that reuse would increase the availability of freshwater resources for domestic and industrial use, [9], and could be one of the main options to develop the water resources in the Gaza Strip as it represents an additional renewable and reliable water source, [1].

Twelve elements (Silver *Ag*, Aluminum *Al*, Arsenic *As*, Cadmium *Cd*, Cobalt *Co*, Chromium *Cr*, copper *Cu*, Iron *Fe*, Manganese *Mn*, Nickel *Ni*, Lead *Pb* and Zinc *Zn*) were analyzed in 120 composite samples of influent and effluent of Beit Lahia wastewater treatment plant *Beit Lahia WWTP* and Gaza Waste Water Treatment Plant *GWWTP*, [13]. The study concluded that domestic wastewater influent contains considerable amount of heavy metals and the partially functional treatment plants; Beit Lahia WWTP and GWWTP are able to remove 40-70 % of most metals during the treatment process. The research also indicated that in 31 sample of industrial waste water effluents, the heavy metals were within the ranges of international standards. In Addition, the Study highlighted the fact that all industries of Gaza are light; although they have no treatment facilities, their effluent are being discharged to municipal sewerage system and the existing treatment plants are capable of absorbing the industrial effluents with no significant impact on treatment bioprocesses.

Regarding the socio-economic aspects of the reuse, a questionnaires to farmers in three areas in Gaza Strip were conducted and two sites irrigated with treated effluent were monitored. The results indicated an economical improvement for farmers switching from groundwater to treated waste water effluent irrigation, [9].

The main objective of this research is to assess the effects of using treated waste water as a source of irrigation on both physical properties and chemical composition of White Corn, using pilot project on the ground.

Materials and Methods:

In cooperation with the Ministry of Agriculture *MOA*, and the Municipality of Gaza (Waste Water Sector), this agricultural field experiment was carried out in a local farm in Al-Zaiton Neighborhood from April to July, 2012 (Planting date: April 1st, 2012). The objective of this set of experiments is to examine the effects of irrigation with treated waste water on the physical properties and chemical composition of white corn. No fertilizers were used in the experiment.

A land of 100 m^2 was used in order to carry out the experiment in the field. The land was divided into nine district cells, grouped later in three equal sets according to irrigation water type. Group 1 was irrigated with Tap Water (TW), group 2 was irrigated with Treated Waste Water (TWW), and group 3 was irrigated with both TW and TWW in an alternating way. Figure 1 shows the location of cells representing each group which being distributed as a Latin Square. Each cell of the nine is 240 x 240 cm and 70 cm apart from the nearby cells.

Surface drip irrigation system was used for irrigation in the experiment. The irrigation dripper lines are placed 45 cm apart. The emitters are at 25 cm apart and work at a flow of 4 $L.h^{-1}$ and a pressure of 1 to 1.5 bars (Figure 2).

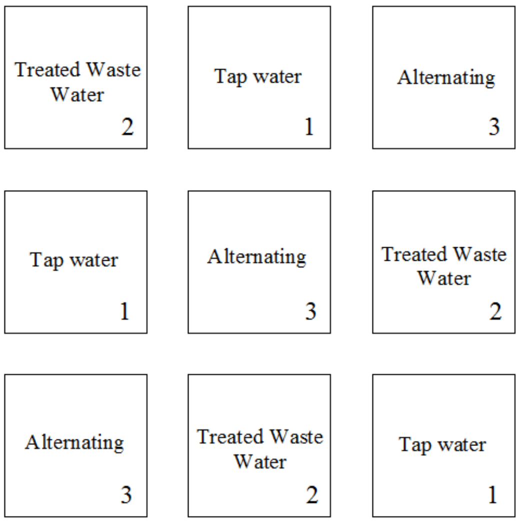


Figure (1): General Layout of the experiment's cells and sets.

Each emitter of the dripper line was surrounded with four corn plants at the first stage of the experiment (Figure 2). Later in the second stage when the plants were 5 cm high above the ground, the weakest two of the four plants were removed, so the final number of corm plants around each emitter is two (Figure 2).

The proper amount of water requirement for irrigation was determined using CROPWAT model, [4]. The model requires four main data to be provided in order to calculate the water requirement. The data is climate data, rainfall data in form of mm/month, soil type data and finally White Corn coefficient K_c. Table 1 shows the irrigation water requirements per 10 days (Decade) from April to July. (The irrigation schedule was thrice a week, day after day).

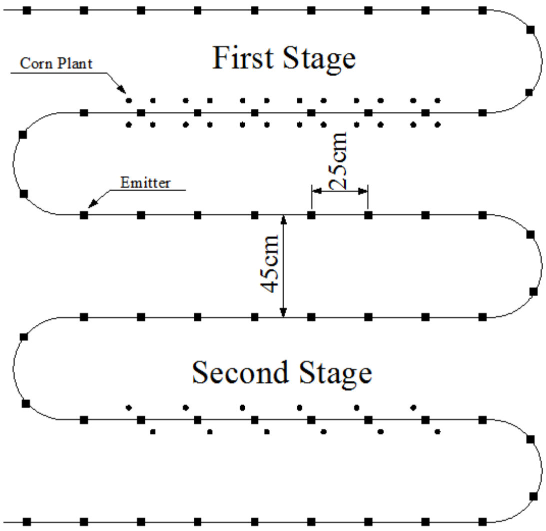


Figure (2): Typical layout of irrigation network for each cell of the nine.

Table (1): Water requirements of irrigation for each set / decade.

Month	Decade	mm / Decade	Phase
April	**1**	13	Initial stage
April	**2**	19	Initial stage
April	**3**	30	Crop development
May	**1**	51	Crop development
May	**2**	74	Crop development
May	**3**	94	Mid-season
June	**1**	87	Mid-season
June	**2**	89	Mid-season
June	**3**	92	Late-season
July	**1**	81	Late-season
July	**2**	60	Late-season
July	**3**	35	Late-season

From each cell, four location-difference grab samples (500 g) were collected from the surface of the soil to a depth of 30 cm. The grab samples of the same cell were mixed together to form a representative composite sample of the cell. United States Department of Agriculture *USDA* Textural Triangle was used in soil classification analysis, [15]. The analysis was conducted in the laboratories of the Islamic University of Gaza.

For both TW and TWW, 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 composite samples were used to identify the chemical composition of TW and TWW and more importantly to check whether the TWW meeting the applicable standards of reusing it in agriculture or not. The following parameter considered to be analyzed were, Biological Oxygen Demand *BOD*, Chemical Oxygen Demand *COD*, Total suspended Solid *TSS*, Electrical Conductivity *E.C*, Potential Hydrogen *pH*, Sodium Adsorption Ratio *SAR* and Fecal Coliform *FC*. The analyses were conducted in Bir Zeit University Testing Laboratories.

Later, the results of TWW sample were compared with the standards of World Health Organization *WHO* regarding reuse of TWW in irrigation.

Due to irrigating with different water types with different nutrient concentrations, it is expected that differences will exist upon plant growth among the three groups. Four physical parameters, plant height, plant thickness, number of leaves and number of fruits while three chemical components, Total Kjehldahl Nitrogen *TKN*, Total Phosphorus *TP*, and Potassium *K*. These measurements were carried out in the three groups in order to find out the effects of irrigation with treated waste water on the plant and whether this source of water capable of satisfying the nutrition needs for the plant or not.

Plant Height, Plant Thickness and Number of Leaves measurements were conducted for 50% 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. Later the records collected in the same day of each parameter of all plants in the same group are averaged. These parameters were used as an indicator of capability of the plant to produce and hold the fruits and how much healthy the plant is.

Plant height was measured from the soil surface to the highest point of the arch of the uppermost leaf that is more than 50% emerged. According to reference [10] it is wrong to measure to the highest point of the plant, which is often the tip of the next emerging leaf above (Figure 3).

Figure (3): Plant height measurement

The thickness of corn stalk was determined by measuring the perimeter of corn stalk using a fabric measuring tape.

The number of leaves in a corn plant was counted through counting the number of leaves, starting from the lowest one (with a rounded tip) up to the last leaf that is more than 50% emerged. The 50% emerged is a little subjective and is usually taken to be the leaf that has emerged enough so that its tip is starting to point down, below the horizontal, [10]. The reference stated not to count leaves younger (inside) than this one, even though you can see them in the whorl (Figure 4).

Figure (4): Number of leaves measurements.

The number of fruits in a corn plant were counted through counting the number of fruits once per week. The counting process was started in the middle stages of the Mid-Season phase and continued for one month for each group. The fruits should be big enough and noticeable to be counted (Figure 5). This parameter was used as an indicator of productivity of the plant.

The One Way Analysis of Variance *ANOVA* test was used in order to find out whether the differences observed in plant height, plant thickness and number of leaves were significant and caused by the usage of different irrigation water. Moreover the ANOVA test was used to determine the time at which these differences became clear and meaningful.

TUKEY test [11] was used to identify the group/s of significant difference and to categories the three types of water according to their level of influence on the examined physical parameter.

Figure (5): Corn fruit (from the experiment).

Three random samples were collected from each set and mixed together to have one composite representative sample of each group in order to conduct the chemical analyses. These samples were collected from the leaves of the plants immediately before harvesting, [16]. The concentration of three chemical components, TKN, TP and K were analyzed to figure out what chemical changes may occur on the plant's chemical composition and whether the treated waste water could provide the plant with the needed nutrients.

Results and discussion:

A. Soil Texture:

Based on to the relative amount of sand, silt and clay contained in the soil samples, and using the USDA Textural Triangle, the texture of the soil of all cells of our experiment were defined.

Table (2) clearly shows that the soil texture in all cells are the same, which is *Sand* (Permanent Wilting Point Θ_{WP} = 0.07 and the Field Capacity Θ_{fc} = 0.15). This is mean that the sand comprise more than 85% of the soil in all cells, and the remaining portion are silt and clay combined.

Table (2): Soil Texture of the cells.

Cell	Soil classification
Cell # 1	Sand
Cell # 2	Sand
Cell # 3	Sand
Cell # 4	Sand
Cell # 5	Sand
Cell # 6	Sand
Cell # 7	Sand
Cell # 8	Sand
Cell # 9	Sand

The results show that the soil in all cells is the same, which mean that any observed changes among the three groups can't be linked to the soil. So the soil factor has been neutralized.

B. Water and Waste Water analyses:

Table 3 shows the concentration of tap water and waste water parameters, BOD, COD, TSS, EC, PH and SAR of the effluent of GWWTP and the WHO standards for treated waste water reuse in irrigation.

Table (3): Waste Water Parameters (BOD, COD, TSS, EC, PH and SAR).

Parameter	TW	TWW	WHO standards, [17]	Does TWW meet the Standers?
BOD mg/l	<10	<10	< 100	Yes
COD mg/l	<10	<10	< 150	Yes
TSS mg/l	0.5	17.4	< 100	Yes
EC µS/cm	2500	3010	< 2500	**No**
pH	7.17	7.64	6.5-9.5	Yes
SAR	4.5	8	< 9	Yes
F.C MPN/100ml	0	1x105	< 2x102	**No**

The table clearly illustrates that the TWW used in the experiment meets the WHO standards regarding the reuse issues except the Fecal Coliform concentrations and the salinity.

The Fecal Coliform problem can be resolved by adding advanced treatment units to the GWWTP, (for instance disinfection units), or/and by following and concentrating on the safety guidelines and precautions when using the TWW in irrigation as stated and published either by WHO or Environmental Quality Authority *EQA*.

Regarding the salinity increase, it could be overcome by selecting the appropriate crops that are more salt-tolerant. It will be prudent to mention that the high salinity concentration in the treated waste water is deeply connected with the high salinity of groundwater in Gaza Strip.

C. Physical parameters: Plant Height, Plant Thickness, Number of Leaves, and Number of Fruits:

Table (4) shows the statistical results of the final week of measurements.

Table (4): Plant Height, Thickness, and Number of Leaves in the Final Week of measurements.

Parameter		TW	TWW	AW
Plant Height	**Mean (cm)**	207.18	191.96	176.38
	N	49	52	52
	STD	47.696	43.175	55.125
Plant Thickness	**Mean (cm)**	8.54	8.52	7.61
	N	49	52	52
	STD	1.82	1.65	1.84
Number of Leaves	**Mean**	14.08	13.85	13.40
	N	49	52	52
	STD	1.694	1.304	1.943

Plant Height:

Figure (6) shows the average heights of corn plants over an 8-week period of measurements from the beginning of the experiment to the tenth week.

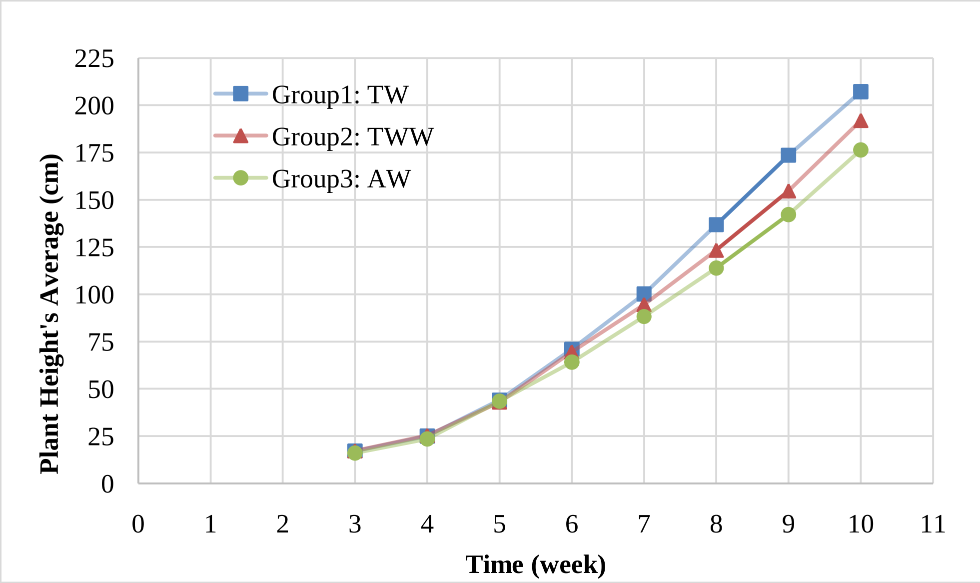


Figure (6): The average Heights of Corn plant of each group with time.

After three weeks of measurements (six weeks after planting), a visible difference among the three groups were observed. Group 1, *the control group* recorded the highest height followed by group 2. Group 3 recorded the least heights. These data was manipulated using ANOVA test. Table (5) summaries the results and outcomes of this analysis.

Table (5): Results of the One Way ANOVA Test for the Plant Heights.

Week No.	Sum of Squares	df	Mean Square	F	Sig.
4	11.577	2	5.789	0.223	0.800
5	59.616	2	29.808	0.264	0.768
6	1014.077	2	507.038	2.089	0.127
7	3149.441	2	1574.720	2.856	0.061
8	12549.938	2	6274.969	6.443	**0.002***
9	24065.246	2	12032.623	7.675	**0.001***
10	22732.518	2	11366.259	5.272	**0.006***

*Significant at the 0.05 significance level

Statistically if the significant value (Sig.) is less than 0.05, the difference observed among the three groups in terms of plant height could be surly connected to the only variable parameter in the experiment which is the water type.

By following the last column in table (5). It can be observed that the sig. value is less than 0.05 starting from the eighth week and forward. Therefore, the difference became significant and meaningful eight weeks after planting. Since the same growth conditions were used for each group except for the irrigation water, the observed difference in plant height can certainly be connect to the use of different water types.
Since the ANOVA test does not indicates which group/s caused the difference, the TUKEY test was used to identify the group/s of significant difference. Table (6) shows the classification of our groups as obtained using Tukey test based on their level of influence on the plant height.

Table (6): Classification Results of TUKEY test for the Plant Heights.

Water Type	N	Subset	
		1	2
Group 1: TW	52	91.0292	
Group 2: TWW	52	82.4398	82.4398
Group 3: AW	49		76.7253

The table obviously shows that both group 1 and group 2 were classified in one subset because of the negligible difference between them. It is clearly seen that the meaningful and considerable difference is located between group 1 and group 3 in favor of group 1.
Even when the differences were significant according to ANOVA test in term of plant height between group 1 and 2 several times, TUKEY test classifies both of group 1 and 2 in one category and dealt with them as one subset. Practically, this is mean that the use of treated waste water in irrigation would not negatively affect the height of plant.

Plant Thickness:

Figure (7) shows the average thicknesses of corn plants over an 8-week period of measurements of each group from the beginning of the experiment to the tenth week.
The figure shows that both group 1 and group 2 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); group 3 started to show different records away from the other groups. Group 1 and group 2 recorded the highest thickness, and group 3 recorded the lowest.
By using the *ANOVA* test in processing the numbers in figure 7. It is clear that the differences observed in plant thickness parameter among the groups were significant, and therefore these differences are linked to the usage of

different irrigation water types which is the only variable parameter in the experiment. Table (7) summaries the results and outcomes of this analysis.

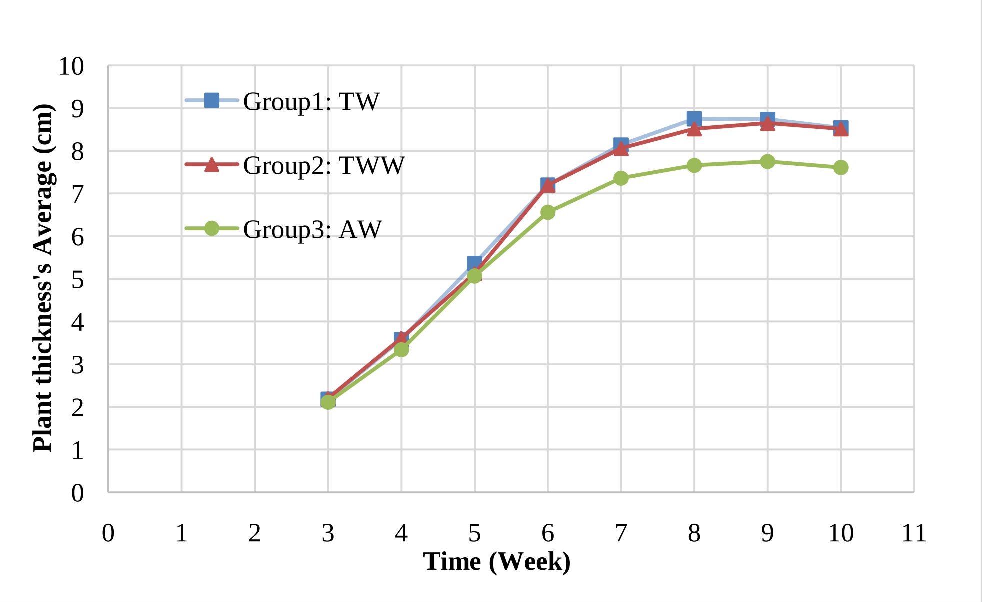


Figure (7): The average plant thicknesses with time of each group.

Table (7): Results of ANOVA test for the Plant Thickness

Week No.	Sum of Squares	df	Mean Square	F	Sig.
4	1.225	2	0.612	1.285	0.279
5	1.919	2	0.959	0.768	0.465
6	12.028	2	6.014	2.414	0.093
7	15.348	2	7.674	2.328	0.101
8	29.344	2	14.672	5.432	**0.005***
9	25.684	2	12.842	5.128	**0.007***
10	23.933	2	11.967	4.771	**0.010***

*Significant at the 0.05 significance level

As shown in the last column of table (7), the sig. value is less than 0.05 starting from the eighth week and forward. Therefore, the difference became significant and meaningful eight weeks after planting. Therefore, it can concluded that the differences in plant thicknesses is due to usage of different water types.

Moreover TUKEY test was used in order to place the three types of water under two categories according to their level of influence on the plant thickness. Table (8) shows the classification of our groups (in terms of the plant thickness) as obtained using Tukey test. The table obviously shows that group 1 and group 2 have negligible differences and therefore were placed in one subset by the test. Group 3 recorded the lowest thickness values. The table also shows that the meaningful and considerable difference is located between group 1 and group 3 in favor of group 1.

Table (8): Classification Results of Tukey test for the Plant Heights.

Water Type	N	Subset	
		1	2
Group 1: TW	52	4.9948	
Group 2: TWW	52	4.8563	4.8563
Group 3: AW	49		4.3338

Despite of results of ANOVA test regarding the plant thickness, which indicate that the differences were significant in the advanced weeks of planting, TUKEY test classifies both group 1 and 2 in one category. Practically, this is mean that the use of treated waste water in irrigation would not negatively affect the thickness of plant.

Number of Leaves:

Figure (8) shows the average number of leaves of the corn plants in each group.

The *Analysis of Covariance* was used in order to check whether the differences observed in number of leaves of corn plants were significant or not. The test resulted in a sig. value of 0.422 which is much higher than the critical value of 0.05. Therefore, the use of different water types did not cause any significant difference in the number of leaves among the three plant groups.

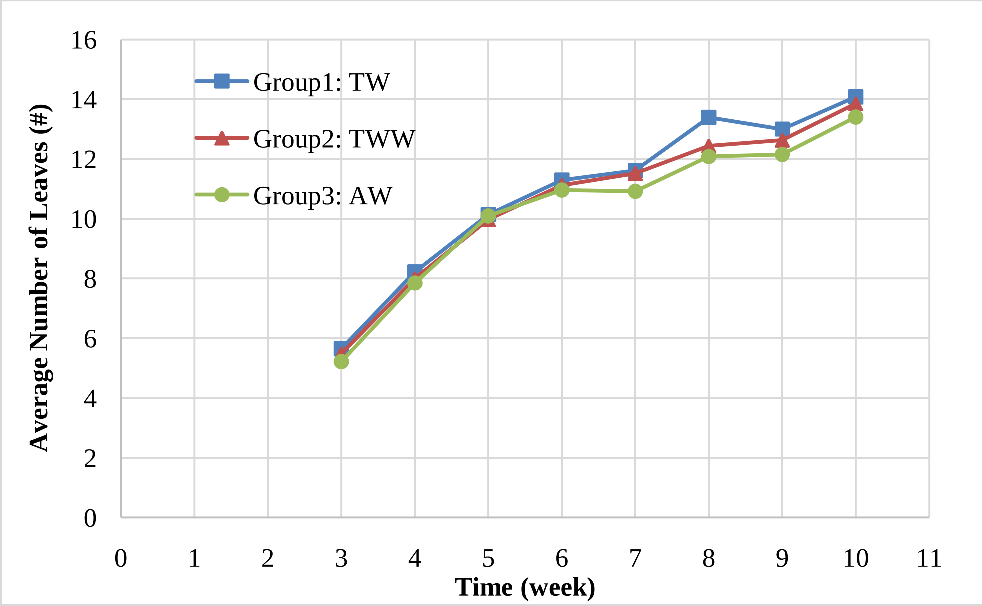


Figure (8): The average number of leaves of each group's plants.

In other words, the use of the treated waste water 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. The photosynthesis process is responsible for food production.

Number of Fruits:

Figure (9) shows the number of fruits of each group.

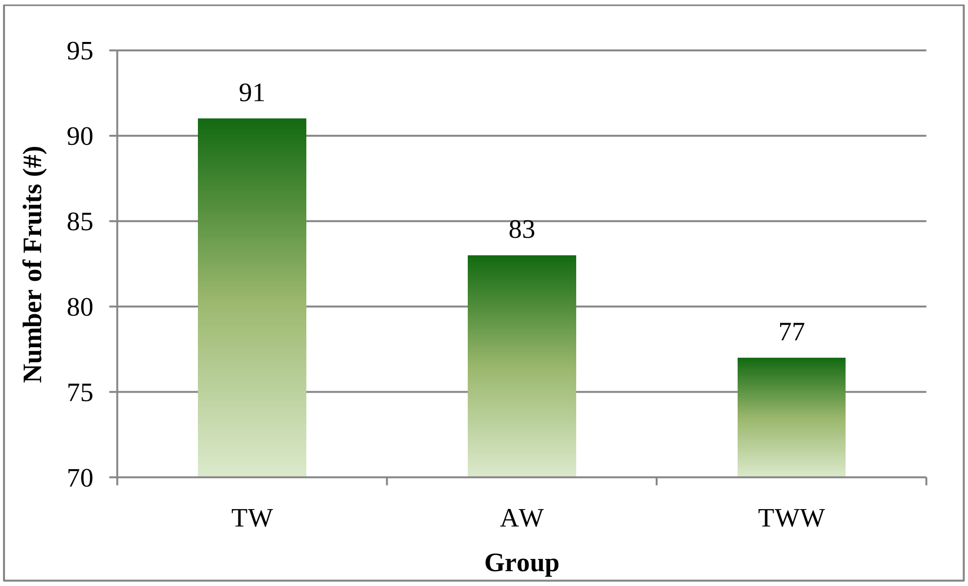


Figure (9): Number of Fruits in each group.

As shown above that the highest number of fruits was recorded for the TW irrigated group (Group 1), while the lowest number was recorded for the TWW irrigated group (Group 2).

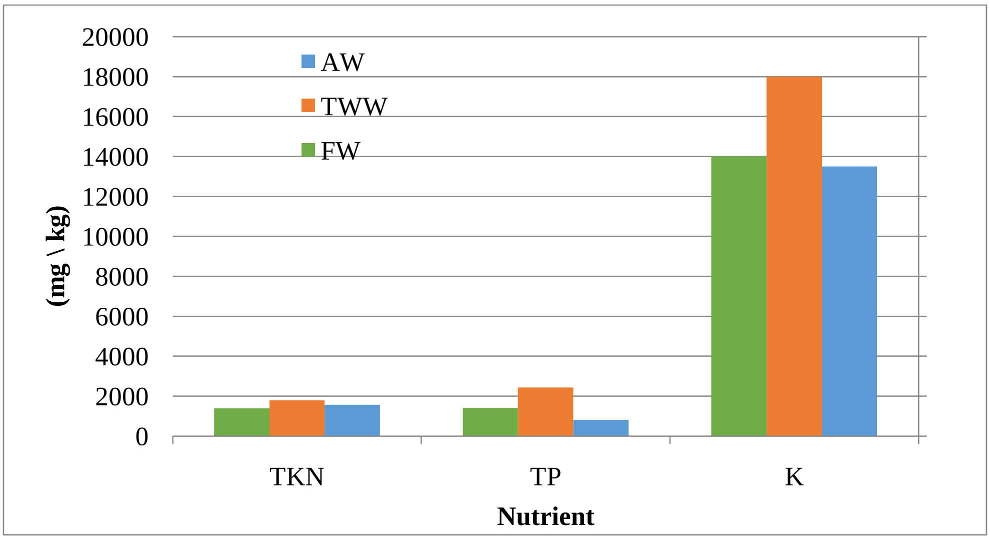
It is clear from figure 9 that the yield of the corn that was irrigated with treated waste water is lesser than the corn that was irrigated with tap water.

The average number of fruits for the plants irrigated with TW and TWW is 1.75 and 1.48 respectively for each plant. This results is in agreement with the results conducted at Birzeit University [2] which achieved an average number of fruits 1.7 and 1.5 for corn plants irrigated with TW and TWW respectively.

D. Results of Chemical Analyses:

Figure (10) presents the results of the chemical analyses for each component.

As demonstrated in Figure (10) each of TKN, TP and K concentrations in corn plant's tissue of the second set, increased by 14%, 200% and 33% respectively as compared to the control, which mean that the tap water can be replaced by the treated waste water in irrigation which is capable of providing the plant with the needed nutrients. It appeared that the AW set was the closest to the control (TW).



Figure(10): Concentrations of TKN, TP and K in each group's sample.

It is clear from figure (10) that concentrations of TKN, TP and K in percentage are 0.18%, 0.24% and 1.8%, respectively. These results are in agreement with the results obtained by Faculty of agriculture, Ataturk University, [5], in which they achieved concentration of K as 1.8% for Cauliflower and 1.7% for Cabbage.

Conclusion:

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

The high plant's uptake of nutrient existed in the treated waste water helps in purifying and therefore minimizing the danger on the groundwater.

Recommendation:

1. Ministry of Agriculture, Environmental Quality Authority, Municipalities, and all the related stakeholders have to consider this wasted source in their water resources management and planning and utilize it in a large scale.
2. The stakeholders should urge and encourage the farmers to use this source of water in their fields by arranging concentrated workshops, seminars and awareness campaigns about reusing of treated waste water

and moreover facilitate and support any attempt to use the treated waste water in irrigation.

3. Provide the farmers with guidelines that show and inform them with the needed information about treated waste water reuse; for example, treated waste water standards for reuse, types of crops, safety issues, appropriate irrigation method and schedule.
4. Conduct other similar studies to examine the effects of irrigation with treated waste water on the soil texture, chemical content, heavy metals concentrations on plant tissues and biomass weight.
5. Studies should be done on examining the health effects on both humans and animals of eating such plants.
6. Put more concentration on enhancing the level of waste water treatment.

References:

[1] Abu-Shaban, A., Doppler, W. and Wolff, H. P., *Determination of Farmers acceptance of Treated Waste water in Irrigation Agriculture in the Northern Gaza Strip*. Conference on International Agricultural Research for Development- University of Bonn, P: 74 (2006).

[2] Amer, A., *Reuse of reclaimed wastewater to irrigate corns designated for animal feedings.* Master thesis research, Birzeit University. Palestine, P: 80, (2012).

[3] Asgari, K., Najafi, P., Soleymani, A. and Larabi, R., *Effects of Treated Municipal Waste water on Growth Parameters of Corn in Different Irrigation Conditions*. Journal of Biological Science, Vol. 7, No. 8, P: 1430 (2007).

[4] http://www.fao.org/nr/water/infores_databases_cropwat.html. (October, 13 2013)

[5] Kiziloglu, F.M., Turan, M., Sahin, U., Kuslu, Y. and Dursun, A., *Effects of untreated and treated wastewater irrigation on some chemical properties of cauliflower (Brassica olerecea L. var. botrytis) and red cabbage (Brassica olerecea L. var. rubra) grown on calcareous soil in Turkey*, Agricultural Water Management, Vol. 95, No. 6, P: 716 -724 (2008).

[6] Metcalf & Eddy, Inc., *Integrated Aquifer Management Plan*. Coastal Aquifer Management Program (CAMP study), Vol. 1, P: 1-1

[7] Metcalf & Eddy, *Waste water Engineering Treatment and Reuse*. Republic of China, P 1351, (2003).

[8] Mogheir, Y., Abu Hjair, T., Zomlot, Z., Ahmed, A. and Fatta, D., *Treated Waste water Reuse in Palestine*. International Conference "Water, Values and Rights" (2005).

[9] Nassar, A., Najar, H. and Aldadah, J., *Socio-Economic Aspects of Waste water Reuse in the Gaza Strip*. Journal of Environmental Science and Technology, Vol. 2, No. 4, P: 170 (2009).

[10] Nordby D., Hager A. and Nafziger E., *Staging Corn Plants and Implications Associated with Herbicide Application*. The bulletin, No. 7, article 9 (2006).

[11] Ntoumanis N., *A Step-by-step Guide to SPSS for Sport and Exercise Studies*. Britain, P: 89, (2001).

[12] Palestinian Water Authority, *Rainfall Data in Gaza Strip*. Palestine, P: 4 (2007).

[13] Shomar, B., Muller, G. and Yahya, A., *Potential Use of Treated Waste water and Sludge in the Agricultural Sector of the Gaza Strip*. Clean Technologies and Environmental Policy, Vol. 6, No. 2, P: 128 (2004).

[14] United Nations (UN), *Gaza in 2020 A liveable place?*. Palestine, P:12, (2012).

[15] Ward, R., *Ward Guide*. Ward Laboratories, USA, P:104-105, (2010).

[16] Ward, R., *Ward Guide*. Ward Laboratories, USA, P:128-129, (2010).

[17] World Health Organization (WHO), *Standards and Guidelines for Municipal Waterworks, Waste water and Storm Drainage Systems.* Canada, P:3-4, (2006).